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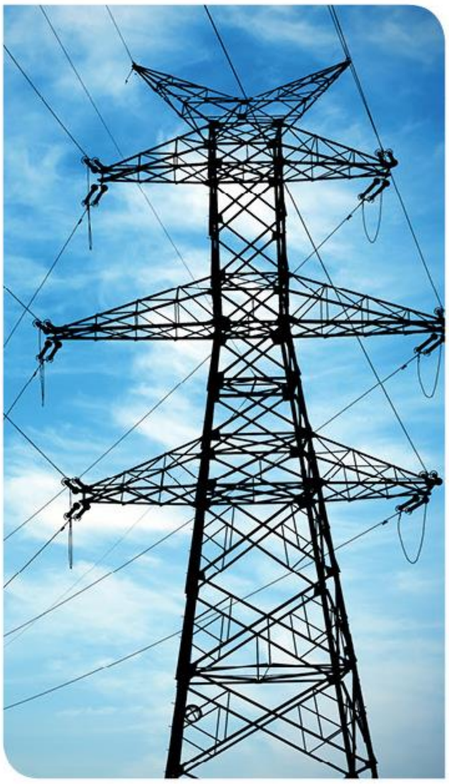

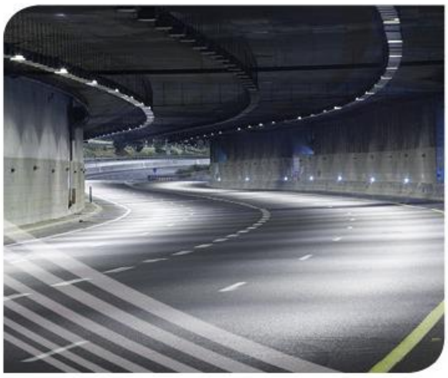

RAILWAY LINE BELGRADE–NIŠ, SECTION III
Paraćin to Trupale (Niš)
Environmental and Social Impact Assessment,
1. INTRODUCTION, 2. PROJECT DESCRIPTION AND 3. LEGAL FRAMEWORK

EU PPF
PROJECT PREPARATION FACILITY

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LIST OF ABBREVIATIONS AND ACRONYMS

AT	aluminothermic
AVIS	Integrated system for visual and audio passenger information
BMP	Biodiversity Management Plan
CTC	Centralised Traffic Control
EIA	Environmental Impact Assessment
EIB	European Investment Bank
EPC	Engineering Procurement and Construction
E&S	Environmental and Social
ESAP	Environmental and Social Action Plan
ESIA	Environmental and Social Impact Assessment
ESMP	Environmental and Social Management Plan
ETCS	European Train Control System
EU	European Union
EU-D	European Union Delegation
FOC	Fibre Optic Cable
GHG	greenhouse gas
ILO	International Labour Organisation
km/h	kilometres per hour
m	meter
MoCTI	Ministry of Construction, Transport and Infrastructure of the Republic of Serbia
NATM	New Austrian Tunnelling Method
NTS	Non-Technical Summary
OCS	Overhead Catenary System
PR	Performance Requirement
PS	Sectioning plants
RAP	Resettlement Action Plan
RAT	Railway automatic telephone

RoS	Republic of Serbia
RPF	Resettlement Policy Framework
SEP	Stakeholder Engagement Plan
SRI	Serbian Railway Infrastructure
SS	signalling and safety
TEN-T	Trans European Transport Network
TK	telecommunications
TS	transformer stations
TSIs	Technical Specifications for Interoperability
UIC	International Union of Railways
WTC	wildlife-train collisions

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1. INTRODUCTION

This Environmental and Social Impact Assessment (ESIA) Report has been prepared by Project Preparation Facility 9 (PPF9), which is a consortium of Suez, Egis, KPMG and Epem, led by Suez.

1.1. Overview of the Belgrade - Niš Railway Corridor Rehabilitation Project

The overall Belgrade - Niš Railway Corridor Rehabilitation Project (hereinafter the Corridor Project) foresees the modernization and upgrade of the existing, primarily double-track 230km railway between Belgrade Centre (Resnik) and Niš, via Rasputnica G, Rakovica, Mladenovac and Lapovo. This is a part of the Belgrade Centre–State border (Tabanovce) railway. The Corridor Project aims to achieve a design speed of up to 200 km/h and enhance the quality and efficiency of passenger and freight rail services.

The railway from Belgrade-Niš represents one of the most important transport corridors in the Republic of Serbia. It is a part of the South-East Europe Transport Observatory (SEETO) Corridor X (a pan-European rail corridor running through Serbia), as well as the Core Trans-European Transport Network (TEN-T) rail network in the Western Balkans.

The Corridor Project is under the direct management of the Ministry of Construction, Transport and Infrastructure of the Republic of Serbia (MoCTI), whilst operational management will be the responsibility of the Joint Stock Company for the Management of Public Railway Infrastructure (Serbian Railway Infrastructure (SRI)). The European Union Delegation (EU-D) has provided technical assistance, in the form of consultancy support during the development of the Corridor Project, and will also provide financing.

The Project is being considered for financing by two international financial institutions (IFIs), the European Bank for Reconstruction and Development (EBRD) and the European Investment Bank (EIB) (together the Lenders). The Project therefore must demonstrate compliance with the Lenders' environmental and social (E&S) Policies, which are summarised in Chapter 3.

The Corridor Project has been divided into three Sections for the purposes of further project development, as shown in Figure 1-1:

- **Section 1**: Belgrade (Resnik) to Velika Plana,
- **Section 2**: Velika Plana to Paraćin,
- **Section 3:** Paraćin to Trupale (Niš), excluding the section from Stalać to Đunis, which is not part of this Project and is in a more advanced stage of project preparation. It should be noted that the end location of the Project is Trupale, however for planning purposes this also referred to as Niš, because it is part of the Belgrade- Niš Corridor Project.

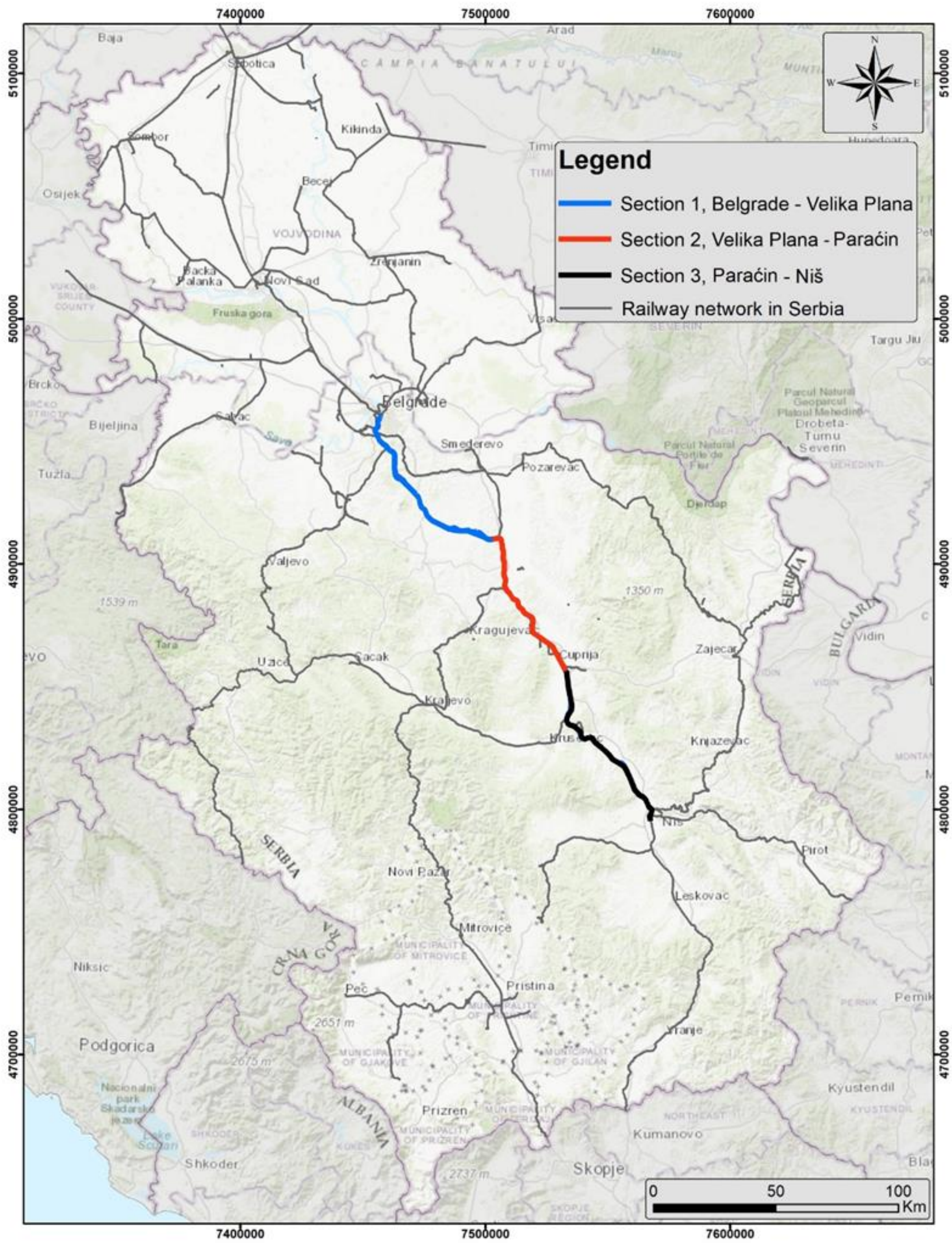

Figure 1-1. Sections of railway line Belgrade–Niš

In July 2022, a number of E&S documents were prepared for the Corridor Project based on the available Conceptual Design and were publicly disclosed on the SRI website. The purpose of these documents was to inter alia provide a high-level E&S assessment of the Corridor Project, determine the general measures to be implemented to mitigate and manage adverse E&S impacts, and determine the scope of further detailed surveys needed to facilitate the completion of an ESIA for each of the three Sections listed above.

In parallel, the Project is being progressed to the stage of 'Preliminary Design' for each of the three Sections. Upon completion of the Preliminary Design, procurement for detailed design and construction services will be undertaken for each Section of the Corridor Project, and an Engineering Procurement and Construction (EPC) Contractor will be engaged to carry out these works.

A Spatial Plan for the Belgrade-Niš Railway Infrastructure Corridor, covering Sections 2 and 3 of the railway has also been prepared by PPF9, with relevant inputs from the Preliminary Design (as described in more detail in Section 3.3).

1.2. Aim of the Corridor Project

The Corridor Project will contribute to the development of rail infrastructure in Serbia, which will in turn advance Serbia's economic development, contribute to its local and regional connectivity and integration, and enhance the competitiveness of rail transport, especially for international freight traffic, encouraging a modal shift from road to rail (as a low carbon intensity sector) with associated environmental benefits. Additionally, rail safety, the capacity of freight services, and the comfort and capacity of passenger rail travel will be improved.

Through the Trans European Transport Network (TEN-T) Policy, the EU aims to build a coherent, efficient, multimodal and high-quality EU-wide transport infrastructure network. As such, the TEN-T Policy is a key instrument for the development and implementation of a Europe wide network of railway lines, roads, inland waterways, maritime shipping routes, ports, airports and railroad terminals. The ultimate objective of the TEN-T is to strengthen the EU's economic, social and territorial cohesion and create seamless transport systems across borders, without gaps, bottlenecks or missing links. The Corridor Project will form a part of, and thus aid the development of, the TEN-T.

The Corridor Project is therefore required to not only meet the socioeconomic, demographic and infrastructure demands forecasted for Serbia, but commitments to trans-national infrastructure policies.The high-level goals of the Corridor Project are:

- To increase the competitiveness of the railway in relation to other modes of transport.
- To decrease the volume of road traffic by providing a safe, efficient and suitable alternative and achieving associated environmental benefits;
- To achieve a higher level of safety, capacity and comfort for the transport of passengers and goods.

Specific Corridor Project objectives are as follows:

- Contribute towards the achievement of:
  - Increasing rail speeds to up to 200 km/h, whilst enhancing the quality of passenger and freight rail services.

  - Enhancement of the sustainability and safety of the national transport system;
  - Improved efficiency of the existing rail transport system;
  - Facilitation of a shift to sustainable, accessible and inclusive modes of public transport at the national level.
- Remove the railway capacity limitations and encourage a modal shift from the current heavy reliance on road transport to railway transportation by:
  - Improving the level of service to passengers/customers by reducing travel times and increasing train frequency;
  - Increasing capacity and the level of service for freight customers; and
  - Reducing the passenger and freight traffic loads on highways, thereby reducing the risk of accidents on said highways.

1.3. Purpose of the ESIA

This report presents the Environmental and Social Impact Assessment (ESIA) for **Section 3 (Paraćin to Trupale (Niš)) of the Corridor Project** (hereinafter 'the Project').

It complements the Corridor Project E&S Assessment by providing further systematic, in-depth identification and assessment of potentially significant environmental and social impacts that could result from the construction and operation of the Project. It also defines specific mitigation measures that will be necessary to avoid, minimise or offset any negative impacts of the Project (in addition to any general measures already outlined in the Project Corridor E&S Assessment).

The environmental and social baseline information presented in this Report has been obtained through desktop research into publicly available information, site visits, surveys and discussions held with relevant stakeholders (as detailed in the Stakeholder Engagement Plan).

The assessments have been informed by the technical (engineering) and design (Preliminary Design) information that is available at the time of writing (but which are under development and may, therefore, change). If there are significant changes to the Project Design, the ESIA will be revised accordingly, as further described in the ESMP Management of Change Procedure. For the purpose of this ESIA, the 'Project' refers to the following:

- Paraćin – Trupale (excluding section Stalać - Đunis), Section 3 of the Belgrade Centar–Niš railway line, totalling 58.1 km in length. The entire Section can be divided in 2 sub-sections Paraćin – Stalać and Đunis – Trupale both double track, electrified railway line.
- The modification and/or reconstruction of existing infrastructure at existing stations.
- The construction of new ancillary structures, inclusive of bridges, viaducts, overpasses and underpasses.
- The construction of power supply systems, inclusive of overhead lines and substations.
- The electrification, signalling, telecoms and control systems for the railway.

1.4. Structure of the ESIA

This ESIA Report is structured as follows:

- Non-Technical Summary (also available as a stand-alone document).
- Chapter 1: Introduction (introduction to the Project).
- Chapter 2: Project Description (description of the Project, construction approach and programme).
- Chapter 3: Legal framework (overview of relevant national and international E&S regulations and legislation, and Lenders' standards).
- Chapter 4: Analysis of the alternatives (an assessment of possible alternatives to the Project).
- Chapter 5: Approach to ESIA (definition of the methodology for the environmental and social assessment).
- Topic Specific Chapters (including a description of the baseline, detailed impact assessments, proposed mitigation measures and an outline of predicted residual impacts (following the implementation of the mitigation measures) covering the following:
    - Chapter 6: Air quality
    - Chapter 7: Soil quality
    - Chapter 8: Geology
    - Chapter 9: Surface water
    - Chapter 10: Groundwater
    - Chapter 11: Climate change
    - Chapter 12: Noise and vibration
    - Chapter 13: Landscape and visual
    - Chapter 14: Biodiversity
    - Chapter 15: Cultural heritage
    - Chapter 16: Materials and waste
    - Chapter 17: Major accidents
    - Chapter 18: Occupational health and safety
    - Chapter 19: Social Impacts
- Chapter 20: Cumulative effects.
- Environmental and Social Management Plan (ESMP) (sets out the necessary measures that must be implemented during both the construction and operation phases of the Project to manage E&S performance and avoid or minimise adverse E&S impacts).
- Appendices
    - Maps
    - Baseline survey reports
    - Biodiversity Management Plan (BMP) – standalone document
    - Biodiversity Appropriate Assessment

- Resettlement Policy Framework (RPF) – standalone document
- Stakeholder Engagement Plan (SEP) – standalone document

1.5. Limitations of the ESIA

The assessment is based on the project design information available at the time of writing.

The requirements for and locations of construction facilities, such as materials laydown areas, construction compounds, workers accommodation camps, access roads, and spoil disposal areas, have not yet been determined. The assessment is therefore limited to evaluating potential significant impacts related to the known Project alignment and components.

Further limitations and assumptions associated with each technical assessment are included in the relevant Chapters of this Report.

1.6. Disclosure of the ESIA and supplementary documentation

This ESIA, along with the Non-Technical Summary (NTS) of the ESIA, Environmental and Social Action Plan (ESAP), Environmental and Social Management Plan (ESMP), Stakeholder Engagement Plan (SEP), and Resettlement Policy Framework (RPF) (together the disclosure package), will be publicly disclosed for a minimum of 120 days in line with the Lenders' requirements. The disclosure process is outlined in detail in the SEP. The ESIA will remain publicly accessible throughout the duration of the Project.

2. PROJECT DESCRIPTION

2.1. Overview of Belgrade–Niš railway corridor

The Belgrade-Niš railway was built in 1884 as a single-track railway, and from 1934 to 1993, a second track was added in increments to increase capacity. The total length of the Belgrade-Niš railway is around 244 km, of which 137,691 km is currently double track. The entire railway is electrified.

After years of poor maintenance and a lack of investment, the current condition of railway infrastructure is unsatisfactory and not in accordance with EU standards. Operational speeds are significantly limited, and electrical equipment is outdated. Furthermore, the high number of level crossings, often without adequate safety equipment, represents a safety risk to both rail and road traffic.

The overall objective of the Belgrade-Niš Railway Corridor Rehabilitation Project (hereinafter the Corridor Project) is to contribute to the modernisation of all railway infrastructure in Serbia, to not only enhance capacity, but align with the safety and quality of service of the pan-European SEETO Corridor X, of which it forms a part. This Project should ensure the provision of a modern, high-speed, high-performance, double-track railway line for both passenger and freight rail traffic. This should enhance the competitiveness of rail transport, especially for international freight traffic, allowing for a significant modal shift from road to rail (as a low carbon intensity sector), with associated environmental benefits.

Summaries of the existing Corridor Project characteristics are presented below:

Speed: Restricted-speed running has been introduced on multiple sections of the Belgrade-Niš railway. The highest permissible speed of trains on the existing line is 160 km/h, between Gilje and Paraćin. Between Jagodina and Paraćin speeds of up to 120 km/h are possible over a distance of 17.4 km. However, the highest permissible speed on the remainder of the railway line from Belgrade Centre, to Mladenovac, to Niš is 100 km/h, although on some sections it is only possible to achieve speeds of between 50 to 80 km/h. At the entrance to the Niš station, the permissible speed of trains is 30 km/h. The current maximum possible speed of passenger trains is less than 50 km/h.

Electrification: Despite the Corridor Project railway line being completely electrified, the existing electrical and telecommunications equipment are technologically obsolete.

Tracks: From Belgrade (Resnik) to Velika Plana, there are two separate single-track railway lines (as shown on Figure 2-1), which are intended to be used in one direction only i.e. either towards Niš via Mladenovac, or towards Niš via Mala Krsna. However, in reality trains are using these single-track lines in both directions. From Velika Plana to Niš, (with the exception of the section between Stalać-Đunis) the railway is double-track.

The section from Gilje to Paraćin was modernised in 2016 by constructing a new double-track railway, to enable speeds of up to 160 km/h. This included the construction of a new double-track bridge over the Velika Morava River.

The section from Stalać to Đunis is currently a single-track railway. A Preliminary Design for the construction of a new double-track section to accommodate speeds of up to 160 km/h has been completed and a contractor has been selected for the detailed design and construction of the first part of this section (i.e. construction of tunnel No. 4). A contractor will be selected in the near future for the remainder of this section.

Structures: There are a total of 9 tunnels, 130 bridges and bridge structures, 449 culverts and other smaller-sized structures, as well as 126 level crossings within the Corridor Project.

Stations: There are 31 stations, 27 stops/halts (smaller stations for local rail traffic only), 4 passing points, 5 junctions and 1 service point along the Corridor Project railway. Twenty five of the stations are ‘mixed’, serving both passengers and freight, whereas the other six are exclusively for passenger services (namely, Belgrade Centre, Rakovica, Klenje, Ripanj tunel, Kovačevac and Mala Plana). Belgrade Centre Station is the central passenger station of the railway network in the Republic of Serbia (RoS).

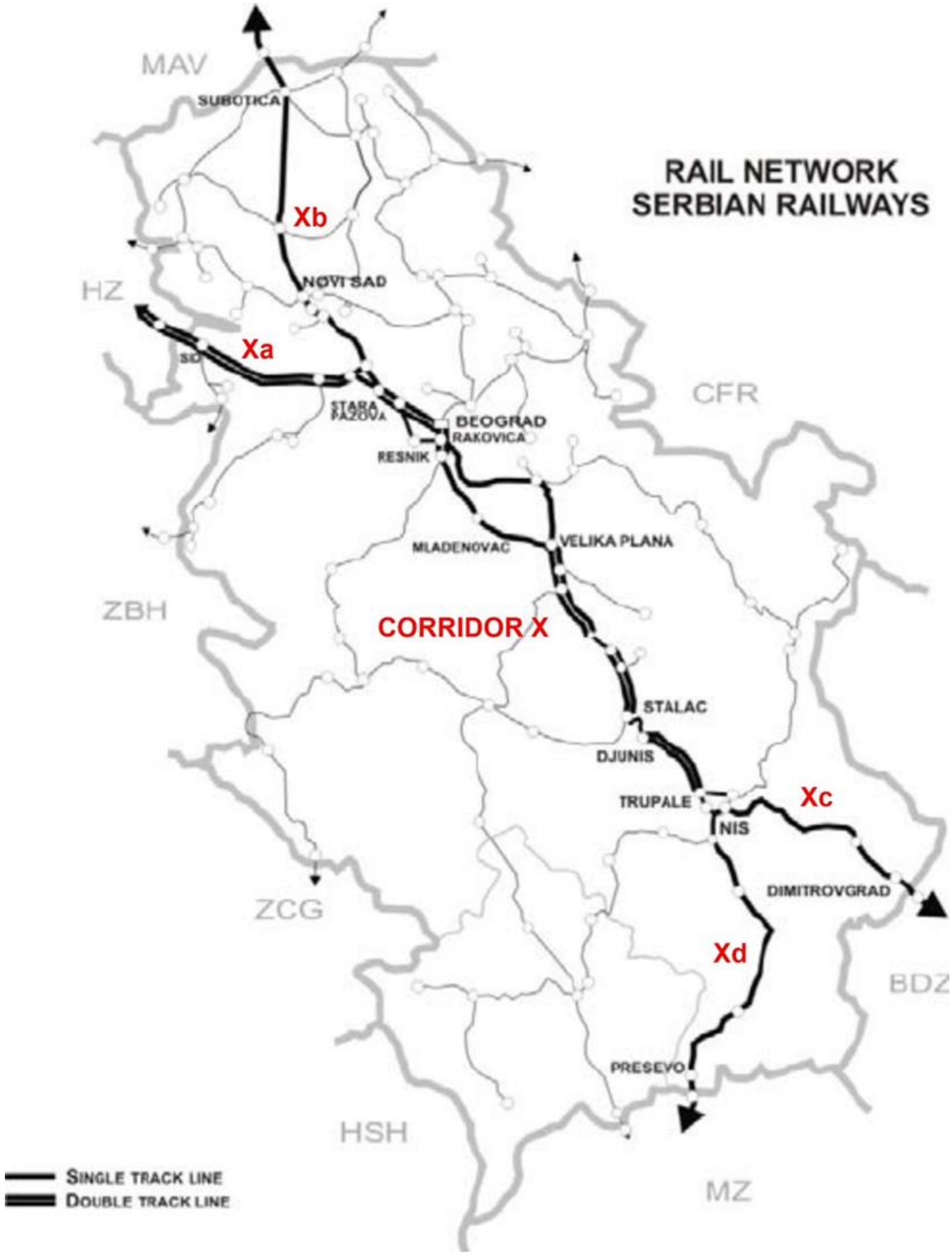

Figure 2-1. Schematic representation of the railway Belgrade (Resnik)–Niš (Trupale) with connecting railway lines

The Corridor Project has been divided into three Sections for the purposes of further project development, as shown in Figure 1-1 and outlined in Section 1.1:

This report presents the Environmental and Social Impact Assessment (ESIA) for **Section 3 of the Corridor Project, Paraćin to Trupale (Niš),** (hereinafter 'the Project').

2.2. Project (Section 3: Paraćin– Trupale (Niš) Overview

Spatially, the Project is being considered as 2 sub-sections on either side of the Stalać to Đunis stretch of the railway (which is already under construction), namely: 1) Paraćin–Stalać and 2) Đunis–Trupale (Niš), which are outlined below and described in more detail in Section 2.3.3.

1) Paraćin–Stalać

The Paraćin–Stalać sub-section runs from km 153+380 to km 174+170.79, with a total length of 20.4 km.

The characteristics of this sub-section are as follows:

- The existing railway route passes through or near to the following 8 settlements: Paraćin, Striža, Ratare, Sikirica, Drenovac, Pojate, Ćićevac and Stalać.
- Double track electrified railway line.
- Design speed 120 km/h.
- Actual speed achieved 50–100 km/h.
- Stations: Paraćin and Ćićevac.
- Stops: Sikirica–Ratare, Drenovac, and Lučina.

2) Đunis–Trupale (Niš)

The Đunis–Trupale sub-section runs from km 191+937.96 to km 229+642, with a total length of 37.7 km.

The characteristics of this section are as follows:

- The existing railway route passes through or near to the following 19 settlements: Đunis, Vitkovac, Donji Ljubeš, Gornji Ljubeš, Korman, Trnjane, Donji Adrovac, Prćilovica, Žitkovac, Moravac, Nozrina, Lužane, Tešica, Grejač, Veliki Drenovac, Supovac, Mezgraja, Vrtište and Trupale.
- Double track electrified railway line
- Designed speed 160 km/h
- Actual speed achieved 100 km/h
- Stations: Korman, Adrovac, Aleksinac, Grejač and Trupale.
- Stops: Trnjane, Nozrina, Lužane, Tešica, Supovački most, Mezgraja and Vrtište.

2.2.1. Project Components

The Project incorporates the following components:

- Railway Line
  - Superstructure: rails, sleepers, fastening components, protective layer and ballast bedding;
  - Substructure: sub-ballast or formation and the subgrade or natural layer;
- Signalling
- Telecommunications
- Electrification
- Tunnels
- Bridges
- Viaducts
- Underpasses
- Overpasses
- Stations
- Culverts
- Drainage Channels
- Retaining Walls
- Fencing
- Service Roads
- Environmental Components (see Section 2.3.16)

These components are described in detail in the remainder of this Chapter.

2.2.2. Technical Requirements

In accordance with the required technical and operational characteristics of the railway, the proposed Project must achieve the following:

- arrangement of the track bed and superstructure elements to accommodate speeds of up to 200 km/h;
- making the railway ready for an axle load of 225 kN and a permissible load per length meter of 80 kN/m' (category D4);
- provision of the UIC GC (International Union of Railways) load profile on railway and station tracks in conditions of an electrified railway with a 25kV/50Hz system for speeds of up to 200 km/h, in order to enable intermodal transport of goods on Corridor X;
- provision of a useful track length in stations of 650 m or 750 m to enable overtaking of the longest trains at distances of up to 30 km;

- equipping all official places (i.e. any facility such as a station, stop, or manned building) open for the reception and dispatch of passengers with platforms and facilities for accessing them;
- installation of modern signalling and safety (SS) and telecommunication (TK) plants and devices on the railway and in official places;
- installation of SS systems APB (automatic track block) for double-track traffic;
- equipping buildings with appropriate, fire alarm systems and alarm systems and fire-fighting apparatus and systems;
- installation of an SOS telephone for the needs of passengers and official staff;
- reconstruction of existing bridges and culverts and construction of new bridges and culverts to meet the UIC GC (International Union of Railways) load profile;
- reconstruction and modernization of the traction power supply system on the open track and in official places;
- installation of safety fencing to prevent unauthorised/uncontrolled access;
- deleveling of road crossings at intersections with state and local roads, whilst maintaining the distance between two consecutive de-levelled road crossings according to current regulations;
- modernisation of the power supply and electrification system;
- the number of tracks and functionality of official places must be based on train traffic management requirements and the expected volume of passenger and freight traffic.

2.3. Preliminary design

The preliminary design for the Project is aligned with all Technical Specifications for Interoperability (TSIs) as defined in Directive 2016/797 on the interoperability of the rail system within the EU. Interoperability will enable trains, passengers and train crew from one EU country to operate safely and reliably in all other EU countries, by ensuring the compatibility of rail systems and relevant safety requirements. Despite Serbia not yet being a member of the EU, national legislation stipulates that TSIs must apply to newly built, upgraded or renewed railway lines covered by the TEN-T network for Southeast Europe.

The preliminary design has also been developed in accordance with applicable Eurocodes and National Annex (an addition to the Eurocodes that defines national parameters).

2.3.1. Design standards

The following documents and legislation form the basis for the Preliminary Design:

- Applicable location conditions (acquired after the adoption of the Spatial Plan)
- Law on Railways (Official Gazette of RS No. 41/18 and 62/23)
- Law on Safety in Railway Traffic, Sl. RS Gazette No. 41/18)
- Law on Interoperability of the Railway System (Official Gazette of the RS No. 62/23)
- Law on Roads (Official Gazette of RS No. 41/18 and 95/23)

- Commission Regulation (EU) No. 1299/2014, No. 1300/2014, No. 1301/2014, No. 1303/2014 of November 18, 2014, on technical specifications for interoperability related to the "infrastructure" subsystem of the railway system in the European Union
- Commission Regulation (EU) No. 1300/2014 of November 18, 2014, on technical specifications for interoperability related to the accessibility of the railway system of the Union for persons with disabilities and persons with reduced mobility.
- Commission Regulation (EU) No. 1301/2014 of November 18, 2014, on technical specifications for the interoperability of the "energy" subsystem of the railway system in the Union
- Commission Implementing Regulation (EU) 2023/1695 of 10 August 2023, on the technical specification for interoperability relating to the control-command and signalling subsystems of the rail system in the European Union.
- Commission Regulation (EU) No. 1303/2014 of November 18, 2014, on the technical specification for interoperability relating to "safety in railway tunnels" of the European Union railway system
- Law on Planning and Construction (Official Gazette of RS No. (72/2009, 81/2009, 64/2010, 24/2011, 121/2012, 42/2013, 14/2016, 76/2018, 95/2018, 52/2020, 122/2020 with all amendments)
- Law on Safety and Health at Work (Official Gazette of RS No. Official Gazette of RS No. 35/2023)
- Law on Environmental Impact Assessment (Official Gazette of RS No. 94/2024)
- Law on Environmental Protection ("Official Gazette of RS" no. 135/2004 and 36/2009 36/2009 - other law 72/2009 - other law 43/2011 - decision of the US, 14/2016, 76/2018, 95/2018 - other laws and 95/2018 - other laws)
- Rulebook on the content, method and procedure of preparation and the method of control of technical documentation according to the class and purpose of the object (Official Gazette of RS No. 96/2023)
- Rulebook on the maintenance of the superstructure and substructure of railways ("Official Gazette of RS" no. 39/2023)
- Rulebook on technical conditions of infrastructure subsystems (Official Gazette of RS No. 39/2023)
- Rulebook on technical conditions for signalling and safety devices (Official Gazette of RS No. 118/21)
- Rulebook on technical conditions and maintenance of the railway telecommunications network (Official Gazette of RS No. 68/21)
- Rulebook for building constructions Rulebook on technical conditions of infrastructure subsystems (Official Gazette of RS No. 89/2019, 52/2020 and 122/2020)
- Regulation on safety and security at work on temporary and mobile construction sites (Official Gazette of RS No. 15/2009, 95/2010 and 98/2018)
- Regulation on location conditions (Official Gazette of RS No. 87/2023)
- Spatial plan of the special purpose area of the infrastructural corridor of the Belgrade - Niš railway line (Official Gazette of the RS No. 91/2024 from October 2024)
- General regulation plans and detailed regulation plans for the subject area.
- Decision of the Board of Directors of "Serbian Railway Infrastructure" JSC which brings a catalog of symbols for electronic signs installed in the area of "Serbian Railway Infrastructure" JSC number 4-2020-2344-520 from November 17, 2020.
- Decision of the Board of Directors of "Serbian Railway Infrastructure" JSC which adopts the Specification of user/functional requirements for ETCS level 2 on the railway network in the Republic of Serbia, together with Annex A: Operative scenarios for ETCS, level 2 and Annex B: Catalogue of symbols and functions of ETCS at the RBC workstation, number 4/2021- 2630-571 from April 13, 2021.

- Decision of the Board of Directors of "Serbian Railway Infrastructure" JSC which approves the electrotechnical affairs sector to proceed with changes to the regulations and instructions for the transition from copper railway cables in all systems to optical cables in the "Railway Infrastructure of Serbia" JSC number 4/2023-4746-870 dated June 23, 2023.
- Rulebook on the technical conditions that must be met by the energy subsystem (Official Gazette of RS No. 6/20)
- Valid laws, regulations, SRPS standards, internal standards of EMS AD, internal standards of ODS, technical instructions of EMS A, technical recommendations of ZEP/EMS/ODS, data and conditions from competent institutions

2.3.2. Permanent Right of Way

The Railway Law of the RoS[1] defines the railway zone (railway right of way), which encompasses land within up to an 8 m corridor from the most external railway track. However, in inhabited areas, the width of the railway zone can be reduced to 6m. No structures other than railway structures, and/or any other assets (such as trees, crops, etc.) are allowed within the railway zone.

The Spatial Plan (see Section 3.3 of this Report) defines the boundaries of the public purpose land for the Project railway zone, which includes areas needed for the construction of new project components and reconstruction/refurbishment of existing components. As such, this encompasses the land on which new railway tracks and other structures (bridges, viaducts, etc.) will be located, as well as land needed for railway stations, service roads, underpasses and overpasses, all infrastructure facilities and networks, and land needed for the regulation of water flows (rivers, streams, etc.).

The defined boundaries of the public purpose land within the Spatial Plan comprise:

a) public land already occupied by the existing railway, and

b) new areas of public and privately owned land, where the railway corridor diverges from its existing route and where new facilities (overpasses, access roads, etc.) will be built. Privately owned land will be acquired through expropriation, and Expropriation Elaborates will be developed on the basis of the public purpose land defined by the Spatial Plan, with further adjustments, as needed.

The information from the Expropriation Elaborate for Section 3, which includes a list of all affected land plots, their total size, the area to be acquired, registered structures, the names of the owners/users, their share in ownership, etc. will be used for developing a detailed Resettlement Action Plan for Section 3, as further described in the Resettlement Policy Framework (RPF) (provided as Appendix 1 to this ESIA Report), which includes details of the

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[1] *Official Gazette of the RS 41/2018*

approach to Project land acquisition and restrictions on land use and associated impacts in different phases of the Project.

During the construction phase, additional land may also need to be acquired temporarily, for construction camps, material laydown areas, storage of topsoil and excavated materials, etc. The land required for these facilities will be identified and accessed by the Engineering Procurement and Construction (EPC) in accordance with the provisions of the ESMP and as defined in the RPF.

If it is determined through the ESIA process that certain significant negative impacts on people residing along the railway cannot be fully mitigated, additional land may need to be acquired to avoid these impacts. Public interest, as the basis for carrying out expropriation, can occur up until the requisite 'use permit' is issued following construction and the railway is put into operation, after which further land acquisition is not possible. If required, these areas will be identified and acquired by SRI in accordance with the provisions of the ESMP, and as defined in the RPF.

In addition to the railway zone (general railway right of way), the Railway Law defines additional zones in which certain land use restrictions apply (Figure 2-2) which are:

- Infrastructure zone with a width of 25m from the external track – existing structures are allowed to remain, while new structures may be constructed only with the fulfilment of two conditions:
    - That the construction of such structures is foreseen by the urban plan of the relevant unit of local self-government (municipality)
    - That all conditions and approvals provided by SRI are fulfilled (a request for approval has to be submitted by the person intending to construct)
- Fire safety zone (forest land) with a width of 18m from the external track – the owners of the land are obliged to regularly remove trees, plants and leaves
- Fire safety zone (agricultural land) with a width of 13m from the external track – the owners of the land are obliged to remove mature crops in a timely manner and, if needed, undertake other fire protection measures.

As the Project railway corridor largely follows the existing corridor, in the majority of locations these zones have been established and in force for a long time. However, in locations where the Project alignment deviates from the existing route, the zones (and use restriction impacts) will be newly established when the railway becomes operational.

A typical cross section of double track railway line in cut is shown in Figure 2-3 and a typical cross section of double track railway line on an embankment is shown in Figure 2-4.

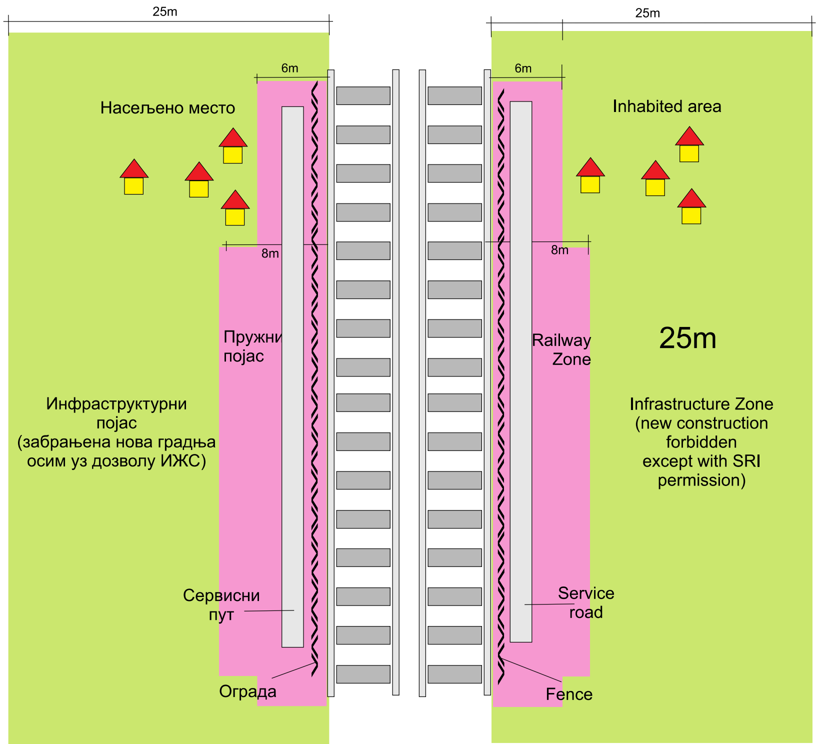


Figure 2-2. Right of way and Restriction Zones

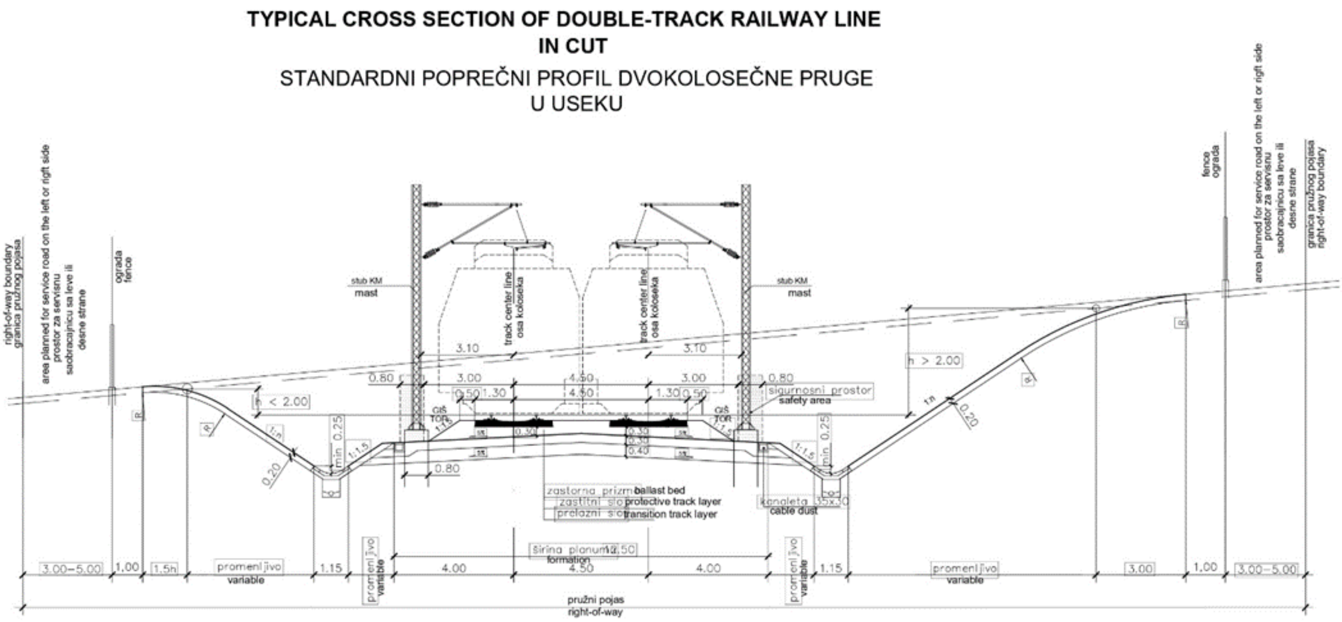


Figure 2-3. Typical cross section in cut

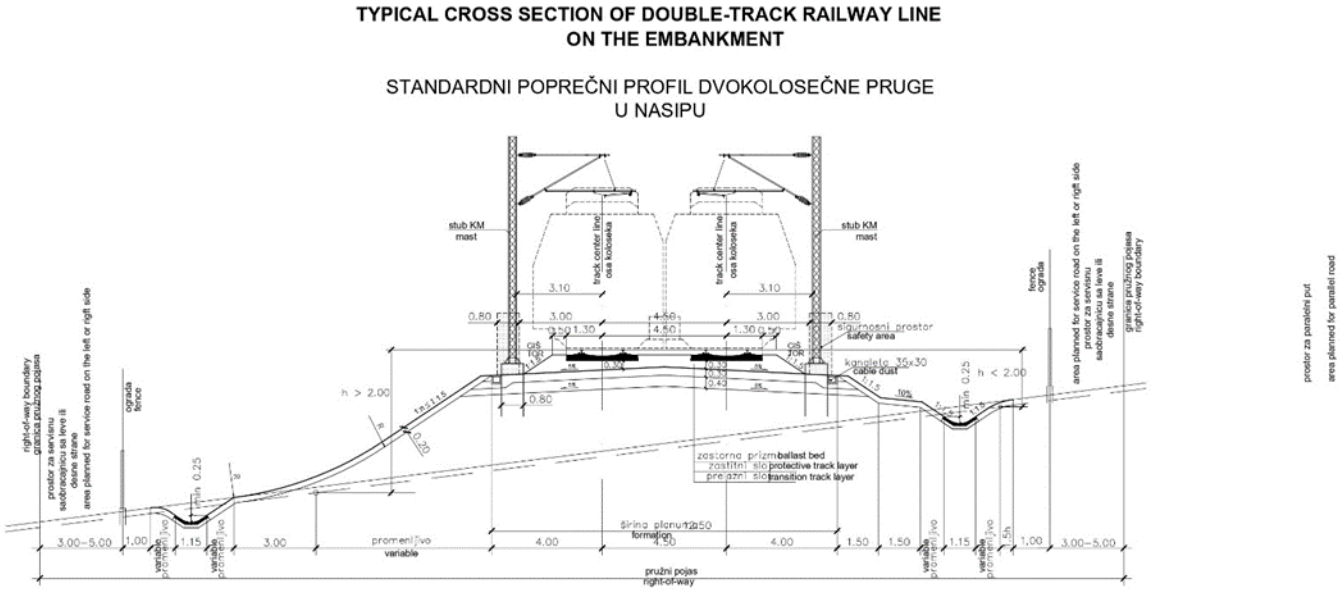


Figure 2-4. Typical cross section on the embankment

2.3.3. Project Route Alignment

The overall Paraćin–Niš (Project) route is described in further detail as two sub-sections: Paraćin–Stalać, shown in **Error! Reference source not found.** below, and Đunis–Trupale, shown in Figure 2-6 below.

Paraćin–Stalać Sub-Section

The Paraćin–Stalać sub-section of the Project route runs from km 153+380 to km 174+170.79, with a total length of 20.8 km. The sub-section begins immediately before the entrance turnout of Paraćin Station and ends in front of Stalać Station. The route on this subsection does not deviate significantly from the existing railway alignment. On parts of the route where the existing alignment allows for high-speed trains, no changes will be required to the curvature of the railway. Where the existing alignment does not allow for the proposed design speed of up to 200 km/h, minor deviations may be necessary to increase the length of curves in the track.

The two existing stations (Paraćin and Ćićevac) will be retained but reconstructed and modernized in accordance with the needs of passenger and freight traffic on the double-track line and the local needs of the settlements in which they are located. Additionally, the existing Sikirica–Ratare stop is kept, but upgraded to be a station to accommodate the expected additional rail traffic resulting from the Project. Two existing stops, Drenovac and Lučine, will be decommissioned due to the expected low number of passengers using them.

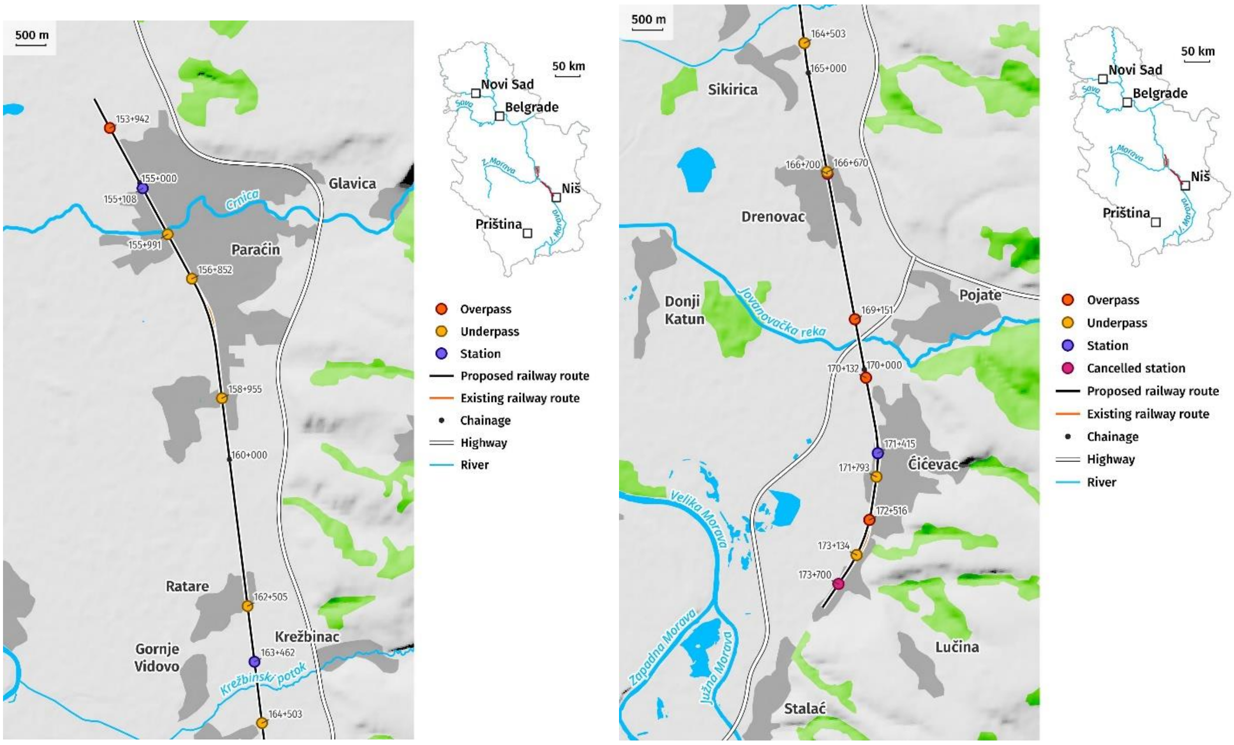


Figure 2-5. Overview of Paraćin–Stalać railway subsection

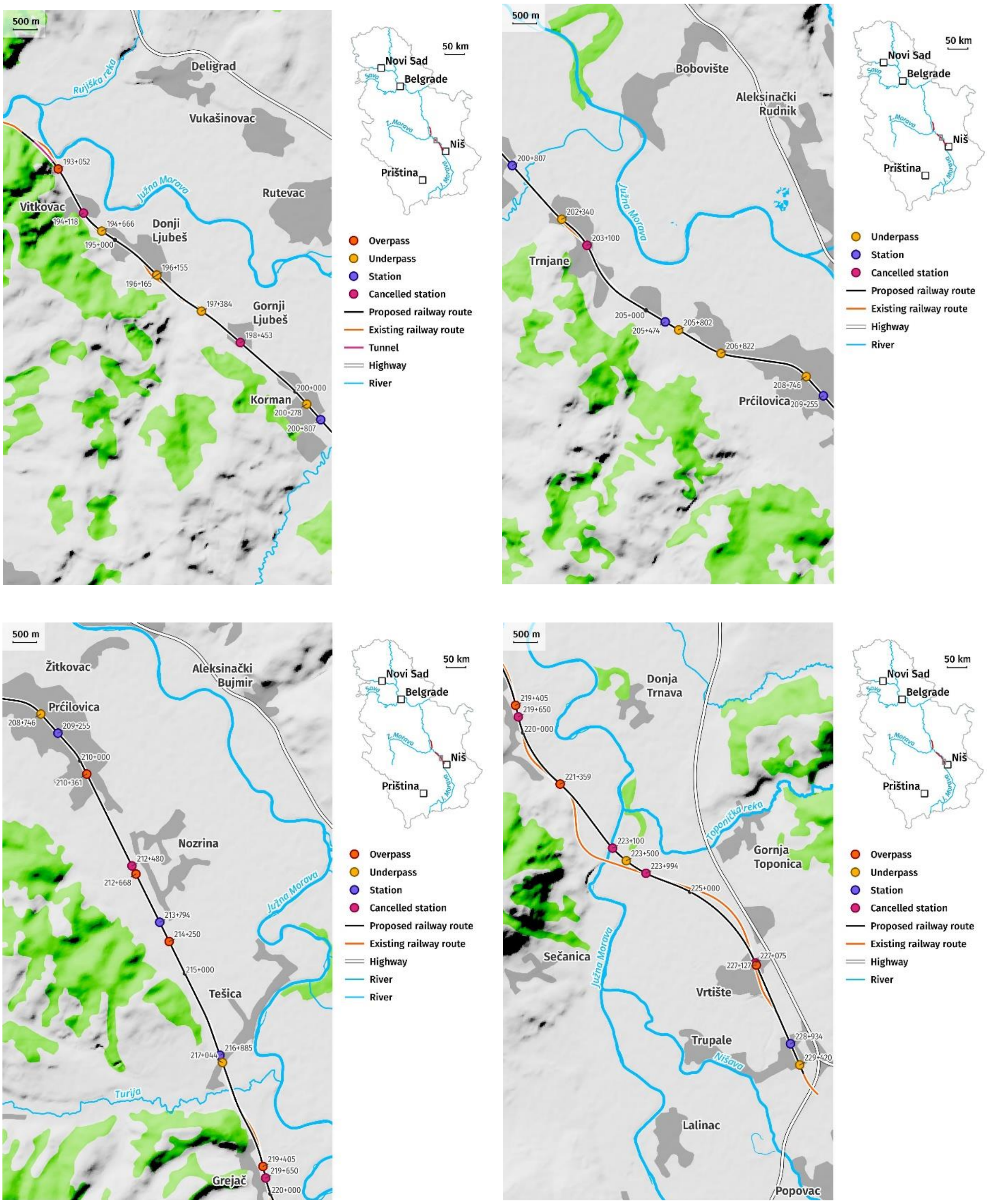


Figure 2-6. Overview of Đunis–Trupale railway subsection

Đunis–Trupale Sub-Section

On the majority of the Đunis–Trupale sub-section of the Project route, the radius of the curves does not meet the requirements for a design speed of 200 km/h. The alignment has therefore been revised in places to allow for increasing the radius of curves and milder turning angles.

The start of this sub-section connects to the Stalać–Đunis section (not part of this Project). At this location, the tracks are at a 4.0 m distance apart and this distance has been maintained on the initial part of the Đunis–Trupale sub-section up to the Đunis tunnel that is located within this sub-section. Please see Section 2.3.11 of this ESIA Report for details. After the tunnel, the track distance increases to 4.5 m, which is the standard for open sections of track for speeds of up to 200 km/h. This means that speeds within the tunnel are limited to 160 km/h.

In the Adrovac station zone, the route is designed for a speed of up to 160km/h. It is not possible to increase the design speed further at the location because increasing the curvature of the existing railway corridor would require the expropriation of additional land and properties.

In the Aleksinac station zone, the route is designed for a speed of up to 120 km/h. In order to increase the design speed, the required realignment of the railway would necessitate the relocation of the station. However, the cost of this is considered to be justified considering the benefits that would result from an increase in speed in that zone.

The existing Korman, Adrovac, Aleksinac, Lužane, and Trupale stations will be retained but reconstructed and modernized in accordance with the needs of passenger and freight traffic on the double-track line and the local needs of the settlements in which they are located. The existing Tešica stop will be fully modernized and reconstructed to became a station. The existing stops, Vitkovac, Donji Ljubeš, Gornji Ljubeš, Trnjane, Norzina, Supovački most, Mezgraja and Vrtište, will be decommissioned due to the expected low number of passengers using them or due to the vicinity of the bigger stations. The existing Grejač station will also be decommissioned and replaced by the new Tešica station.

Table 2-1. Stations and open sections along the alignment

No.	Station or section	Chainage (km)	Town/Village	Proximity to Route
PARAĆIN – STALAĆ Sub-Section				
1	Paraćin station	153+777–155+880	Paraćin	ON
2	Open section Paraćin–Sikirica	155+880–163+264	Paraćin	ON
3	Sikirica–Ratare station	163+264–163+803	Ratare	ON

4	Open section Sikirica–Ćićevac	163+803–170+632	Sikirica, Drenovac, Pojate	ON
5	Ćićevac station	170+632–172+186	Ćićevac	ON
6	Open section Ćićevac–Stalać	172+186–174+170	Ćićevac,Stalać	ON
ĐUNIS – TRUPALE Sub-Section				
7	Open section Đunis–Korman	191+937–200+206.33	Đunis, Vitkovac, Donji Ljubeš, Srezovac, Gornji Ljubeš, Korman	Partially Routed Away from Settlement
8	Korman station	200+206.33–201+521.70	Korman	ON
9	Open section Korman–Adrovac	201+521.70–204+648.57	Korman, Trnjane, Adrovac	Partially Routed Away from Settlement
10	Adrovac station	204+648.57–206+083.01	Adrovac	ON
11	Open section Adrovac–Aleksinac	135+917.09–139+850.00	Adrovac – Aleksinac (Žitkovac)	ON
12	Aleksinac station	208+760.73–210+333.58	Aleksinac (Žitkovac)	ON
13	Open section Aleksinac–Lužane	210+333.58–213+541.12	Aleksinac (Žitkovac), Norzina, Lužine	ON
14	Lužane station	213+541.12–214+063.43	Lužine	ON
15	Open section Lužane–Tešica	214+063.43–216+354.22	Lužane - Tešica	Partially Routed Away from Settlement
16	Tešica station	216+354.22–217+715.46	Tešica	ON

17	Open section Tešica–Trupale	217+715.46–227+766.26	Tešica, Grejač, Veliki Drenovac, Supovac, Mezgraja, Trupale	Partially Routed Away from Settlement
18	Trupale station	227+766.26–229+734.68	Trupale	ON

2.3.4. Railway superstructure

The railway superstructure includes the rails, sleepers, fastening components, protective layer and ballast bedding. The existing track superstructure (rails, sleepers with rail attachment, equipment and ballast) will be dismantled and a new railway superstructure procured and installed.

The superelevation of the track in curves is designed in accordance with the design speed, with a subsequent check according to the obtained speed diagram (i.e. the technical specification diagram used by the design team).

For protection against the harmful effects of train derailment, the design envisages guard rails (type 60E1) with elastic rail fastenings, which are to be placed on bridge structures and at 10.4m in front of and behind the bridge.

Concrete sleepers with even top surfaces are envisaged, onto which running rails, and guard rails shall be mounted via double steel base plates.

For the switches in the stations, standard switches will be used.

The type of rail used is dependent on the purpose of the track, as follows:

- Rail type:
  - 60E1 - open track, main passing tracks and overtaking tracks in stations,
  - 49E1 - other station tracks, industrial and connection tracks of lower rank,

At the points of transition from one type of rail to another, transition rails of 10 m length are provided.

All tracks will be placed on concrete sleepers with an elastic system of rail attachment in accordance with SRPS EN 13481:2017. All sleepers will be placed within in category I ballast with a minimum thickness of 30 cm. The gradient of the ballast is 1:1.5.

The nominal distance between 2 rail tracks in straight lines and curves is 1435 mm, with permitted deviations in accordance with the SRPS EN13231-1 standard. The length of concrete sleepers is as follows:

- 2.60 m for open track, main passing and overtaking tracks in stations,
- 2.40 m for other station tracks, industrial and connecting tracks of lower rank,

The width of the ballast at the front of the concrete sleepers is as follows:

- 0.50 m open track, main passing and overtaking tracks in stations and other station tracks,
- 0.20 m of industrial track,

The project proposed rail track section lengths of 120 m as optimal. An aluminothermic (AT) procedure is provided for the welding of 120m track sections and before welding the sections must be brought to the designed axis and height position as per relevant regulatory requirements.

At the end of each 120m section, devices are provided installed to prevent the longitudinal movement of the rails. Devices against the lateral movement of tracks on all curves will also be installed.

All tracks on the bridge structures are designed with a closed track in the ballast, i.e. the ballast is placed in a reinforced concrete “tub”.

2.3.5. Railway substructure

Lower embankments will have a slope of 1:1.5, while larger embankments will have a slope of 1:2. Where embankments are over 3m in height, the slope is reduced to 1:2.25. Embankments will be constructed from existing materials (from which the existing embankments are comprised) and installed in layers of up to 30 cm, with mechanical compaction to the required degree.

All requirements for compaction, load capacity and quality of the installed material are prescribed by the current regulations and must be fully complied with.

The removal of a 20cm layer of topsoil is planned prior to construction of railway substructure.

2.3.6. Bridges and Viaducts

All bridges within the Project route will be newly constructed following demolition of the existing bridges, i.e. no existing bridges will be refurbished. The bridges within each sub-section are detailed below

Due to the requirement for traffic to be able to continue to use one track during the entire construction phase, all new bridges will be built in two phases. In the first phase, the existing bridge structure on one track will be removed to facilitate building one half of the new bridge. In the second phase, the equivalent works will be carried out on the second track.

Paraćin–Stalać Sub-Section Bridges

Bridge over the Crnica river at km 155+908.80

A new bridge over the Crnica River in Paraćin is designed at km 155+908.80. There is an existing bridge in the same location that will be demolished.

Figure 2-7. Existing Bridge over the Crnica river

Table 2-2. Existing and newly designed state of bridge at km 155+908.80

Existing state	Newly designed state
The existing double-track railway bridges the Crnica River with two independent bridge structures. The bridges are a simple beam system with steel truss structures with a span of 31.60 m.	There are 2 tracks across the bridge. The reinforced concrete semi-integral bridge of a continuous frame system, with a span of 11.25 + 13.50 + 11.25 m is designed. The total length of the bridge (span structure with end pillars and wings) is 44.50 m, and the width is 13.55 m

Bridge over the Planski stream at km 163+861.90

At km 163 + 861.90, a new bridge over the Planski stream has been designed to replace the existing bridge.

Figure 2-8. Existing Bridge over the Planski stream

Table 2-3. Existing and newly designed state of bridge at km 163+861.90

Existing state	Newly designed state
The existing double-track railway bridges the Planski potok with two independent bridge structures. On the left is the old track and on the right is the new one. The bridges are simple beam systems with reinforced concrete slab structures with a span of 5.0 m.	There are 2 tracks across the bridge. Reinforced concrete integral bridge with a span of 11 m has been designed. The total length of the bridge (span structure with end pillars and wings) is 21.00 m, and the width is 13.55 m.

Bridge over the Jovanovačka river at km 169+425.70

At km 169+425.70, a new bridge over the Jovanovačka River is designed to replace the existing bridge in the same location.

Figure 2-9. Existing Bridge over the Jovanovačka river

Table 2-4. Existing and newly designed state of bridge at km 169+425.70

Existing state	Newly designed state
The existing double-track railway bridges the Jovanovačka River with two independent bridge structures. On the left is the old track and on the right is the new one. The bridges are a simple beam system with steel truss structures with a span of 21.25 m.	There are 2 tracks across the bridge. A reinforced concrete prestressed bridge with a frame system with a span of 9.85 + 13 * 10.40 + 9.85 m, founded on piles, was designed. The total length of the bridge (span structure with columns and wings) is 162.10 m, and the width is 14.50 m.

Bridge over the Kočanski stream at km 172+051.85

A new bridge over the Kočanski stream is designed at km 172 + 051.85 to replace an existing bridge in the same location.

Figure 2-10. Existing Bridge over the Kočanski stream

Table 2-5. Existing and newly designed state of bridge at km 172+051.85

Existing state	Newly designed state
The existing double-track railway bridges the Kočanski stream with two independent bridge structures. On the left is the new track and on the right is the old one. The bridges are a simple beam system with steel girders with a span of 6.55 m.	There are 2 tracks across the bridge. A reinforced concrete integral bridge with a frame system with a span of 11.00 m, founded on piles, has been designed. The total length of the bridge (span structure with columns and wings) is 16.0 m, and the width is 13.55 m.

Bridge over the Akalavica stream at km 173+709.21

A new bridge over the Akalavica stream is designed at km 173+709.21 to replace the existing bridge at the same location.

Figure 2-11. Existing Bridge over the Akalavica stream

Table 2-6. Existing and newly designed state of bridge at km 173+709.21

Existing state	Newly designed state

The existing double-track railway bridges the Akalavica stream with two independent bridge structures. On the left is the new track and on the right is the old one. The bridges are a 4.5 m beam system with a reinforced concrete slab structure on the left and steel girders on the right bridge.	There are 2 tracks across the bridge. A reinforced concrete integral bridge with a frame system with a span of 11.00 m, founded on piles, has been designed. The total length of the bridge (span structure with columns and wings) is 18.8 m, and the width is 13.30 m.

Đunis–Trupale Sub-Section Bridges

Bridge over the Simin stream at km 193+426.23

At km 193+426.23, a new bridge over Simin stream has been designed to replace the existing bridge. However, the newly designed railway route has been moved to the left by 2.20 m.

Figure 2-12. Existing Bridge over the Simin stream

Table 2-7. Existing and newly designed state of bridge at km 193+426.23

Existing state	Newly designed state
The existing double-track railway bridges Simin potok with a bridge reinforced concrete slab structure of a simple beam system with a clean opening of ~ 8.00 m.	There are 2 tracks across the bridge. A reinforced concrete integral bridge with a frame system with a span of 12.00 m was designed, founded on piles. The total length of the bridge (span structure with columns and wings) is 18.30 m, and the width is 13.30 m.

Bridge over the Srezovačka river at km 196+848.21

A new bridge over the Srezovačka River is designed at km 196+848.21. The newly designed railway route has been moved to the left by ~ 30 m compared to the existing one. This will enable the construction of the new bridge without the need to first demolish the existing structure, allowing for uninterrupted traffic flow throughout construction.

Figure 2-13. Existing Bridge over the Srezovačka river

Table 2-8. Existing and newly designed state of bridge at km 196+848.21

Existing state	Newly designed state
The existing double-track railway bridges the Srezovac River with a reinforced concrete bridge structure.	There are 2 tracks across the bridge. A reinforced concrete integral bridge with a frame system with a span of 12.00 m was designed, founded on piles. The total length of the bridge (span structure with columns and wings) is 30.80 m, and the width is 13.30 m.

Bridge over the Radevačka river at km 201+255.67

A new bridge over the Radevacka River is designed at km 201+255.67 to replace the existing bridge. However, the newly designed railway route has been moved to the right by 0.80 m.

Figure 2-14. Existing Bridge over the Radevačka river

Table 2-9. Existing and newly designed state of bridge at km 201+255.67

Existing state	Newly designed state
The existing double-track railway bridges the Radevačka River with two bridge structures. The right structure is a newer reinforced concrete bridge with a load-bearing slab span structure of a straight beam system with a clean opening of ~ 11 m. The left structure is an old massive arched bridge built of brick.	There are 5 tracks across the bridge. A reinforced concrete integral bridge with a frame system with a span of 17.00 m, founded on piles, has been designed. The total length of the bridge (span structure with columns and wings) is 27.60 m, and the width is 27.80 m.

Bridge over the Suvi stream at km 205+958.44

At km 205+958.44, a new bridge over the Suvi stream is designed. The hydrotechnical conditions of this location require that the existing stream must be moved ~22m to the south. The stream is ephemeral and only flows during periods of heavy rainfall or during snow melt. The railway alignment at this location has also moved to the right by ~ 3.2 m.

Table 2-10. Existing and newly designed state of bridge at km 205+958.44

Existing state	Newly designed state
The existing double-track railway bridges the Suvi stream with a bridge structure. The right bridge is a concrete vault, and the left vault is built with brick openings ~ 6 m..	3 tracks cross the bridge. A reinforced concrete integral bridge with a frame system with a span of 11.50 m was designed, founded on piles. The total length of the bridge (span structure with columns and wings) is 27.54 m, and the width is 19.95 m.

Bridge over the Turija river at km 217+642.36

A new bridge over the Turija River is designed at km 217+642.36 to replace the existing bridge. However, the newly designed railway route has been moved to the left by ~ 17m.

Figure 2-15. Existing Bridge over the Turija river

Table 2-11. Existing and newly designed state of bridge at km 217+642.36

Existing state	Newly designed state
The existing double-track railway bridges the Turia River with two independent bridge structures made of reinforced concrete prestressed prefabricated girders with a span of ~ 25 m.	There are 4 tracks crossing the bridge. A reinforced concrete prestressed bridge of the straight beam system with a span of 25.00 m has been designed, with bank pillars founded on piles. The total length of the bridge (span structure with columns and wings) is 38.75 m, and the width is 24.70 m.

Bridge over the Dašnička river at km 219+097.12

A new bridge over the Dašnička River is designed at km 219+097.12. The newly designed railway route has been relocated to the right by ~ 19 m. This will enable the construction of the new bridge without demolishing the existing structure, and an uninterrupted flow of traffic on one track.

Figure 2-16. Existing Bridge over the Dašnička river

Table 2-12. Existing and newly designed state of bridge at km 219+097.12

Existing state	Newly designed state

The existing double-track railway bridges the Dašnička River with a reinforced concrete bridge structure.	3 tracks cross the bridge. A reinforced concrete integral bridge with a frame system with a span of 17.00 m, founded on piles, has been designed. The total length of the bridge (span structure with columns and wings) is 34.60 m, and the width is 18.05 m.

Viaduct at km 220+544.70

A new viaduct has been designed at km 220+544.70. The Project route has been realigned in this location in relation to the existing route. It is therefore possible to construct the viaduct without hindrance to the existing railway and flow of traffic.

Table 2-13. Newly designed state of viaduct at km 220+544.70

Newly designed state
2 tracks cross the viaduct. A reinforced concrete prestressed bridge of a system of 12 straight beams in a row, each with a span of 25.00 m, with central and end pillars founded on piles, was designed. The total length of the bridge (span structure with columns and wings) is 5.70 + 25.60 + 10*26.60 + 25.60 + 5.70 = 328.60 m, and the width is 13.30 m.

Bridge over the Južna Morava River at km 223+054.78

A new bridge over the river Južna Morava is designed at km 223+054.78. The Project route has been realigned in this location in relation to the existing route. It is therefore possible to construct the new bridge without hindrance to the existing railway and flow of traffic.

Table 2-14. Newly designed state of bridge at km 223+054.78

Newly designed state
There are 2 tracks across the bridge. The railway route crosses with the Južna Morava at an angle of ~ 58°, as a result of which a sloping bridge with axes of pillars in the direction of the watercourse is designed. The bridge chamfer (the angle between the normal on the axis of the bridge and the axis of the piers) is ~32°. A semi-integral reinforced concrete prestressed bridge with a continuous frame with three spans has been designed. The span structure is wedged into the middle columns, and freely supported over the beds on the shore. The total length of the bridge (span structure with columns and wings) is 6.36 + 33.00 + 34.00 + 33.00 + 6.32 = 112.68 m, and the width is 13.30 m.

Viaduct at km 223+205.49

A new viaduct has been designed at km 223+205.49. The Project route has been realigned in this location in relation to the existing route. It is therefore possible to construct the viaduct without hindrance to the existing railway and flow of traffic.

Table 2-15. Newly designed state of viaduct at km 223+205.49

Newly designed state
2 tracks cross the viaduct. A reinforced concrete prestressed bridge of a system of 5 straight beams in a row, each with a span of 25.00 m, with central and end pillars founded on piles, was designed. The total length of the bridge (span structure with columns and wings) is 5.70 + 25.60 + 3*26.60 + 25.60 + 5.70 = 142.60 m, and the width is 13.30 m.

2.3.7. Level Crossings, Underpasses and Overpasses

Level Crossings

In addition to increased rail speeds, the goal of the Project is to create a modern, double-track railway with a high level of safety. In order to facilitate increased levels of safety (because many of the existing crossing are uncontrolled without barriers, signalling or signage), it is planned that all 48 of the existing road level crossings will be abolished and replaced with 30 new deleveled crossings (i.e. not level with the railway including overpasses and underpasses) which may not be in the same location as the abolished crossings.

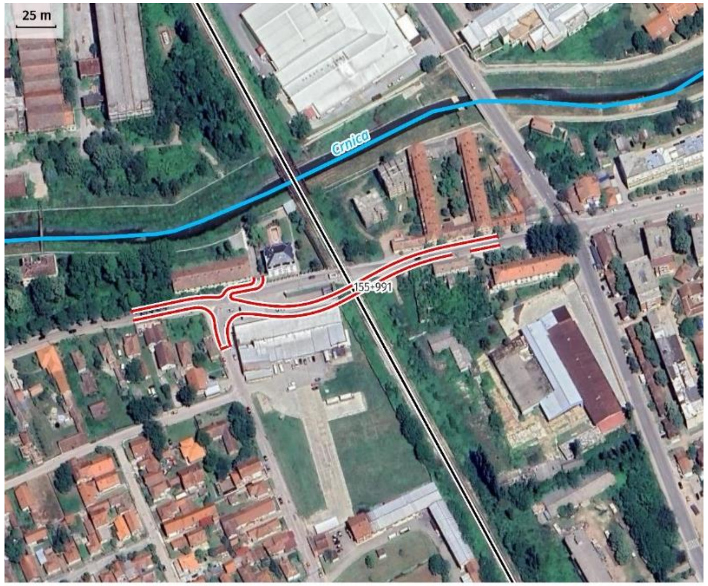
Error! Reference source not found. below gives the locations of new deleveled crossings and abolished level crossings.

The locations for the construction of deleveled road infrastructure along the railway were determined based on detailed traffic analysis. Depending on the category of the road and the characteristics of the location (including the existence of residential buildings in the immediate vicinity of the intersection, the geomorphological characteristics and topography of the location) rational technical solutions were determined in terms of the horizontal and vertical geometry of the road, considering all spatial limitations.

The PPF9 design team had meetings with representatives of all affected municipalities to present the proposed closures of deleveled crossings and seek feedback from stakeholders. The proposals were also discussed during public consultations on the Spatial Plan. More details are presented in Stakeholder Engagement Plan and Chapter 19 of this ESIA Report.

Table 2-16. Locations of deleveled crossings

	Object	Purpose
	PARAĆIN – STALAĆ Sub-Section	
	Overpass at km 153+941.53 In the wider zone of the Paraćin station, the existing intersection of the railway and road infrastructure is located in the form of a level crossing in Šumadijska Street. The design of a deleveled intersection in this place (overpass or underpass) would cause the demolition of many buildings as well as the unsafe connection of secondary routes. In view of the above, and considering the traffic analysis and spatial plan, the Designer decided to abolish this road crossing and design of an overpass at 1500m north, as well as an underpass at the next location 450m south, in Majora Gavrilovića Street. The overpass at this location will be part of the bypass road, which is envisaged by the Spatial Plan of the Municipality of Paraćin and is in accordance with the request of the local self-government to have a deleveled intersection with the railway at this location. The location in question is a link between the state road IIA Category No. 158 and Šumadija. Street. This connects the village of Žabari, where the industrial zone is located, with the central part of the city. The length of the road is 1800m, it is designed for the calculated speed Vr = 60km/h, it consists of two lanes of 3m and two edge lanes of 0.25m, i.e. the total width of the road is 6.50m. A pedestrian path is planned on the left side of the roadway.	 Part of bypass road

	Local road Level crossing at km 155+532	Existing crossing location removal- an underpass is being built for pedestrians and cyclists 155+495 and traffic is redirected to the planned overpass at km 153+941.53 Distance: 1.591m
	Underpass at km 155+991.45 The local road in question is a connection between the eastern and western parts of the city of Paraćin, south of the Crnica River. When developing the project documentation at a specific location, the Designer considered different variants of the de-levelling of the existing road route. The current situation is characterized by a level crossing in the form of a road crossing. In the immediate zone of the road crossing there is a building – villa Teokarević, while on the opposite side there is a gas station. Initially, the designer analyzed the variant with an overpass. Given the height position of the railway, a solution with a significant elevation of the level would require the demolition of the mentioned villa and would make it impossible to establish a traffic connection with Sinđelićeva Street. The above reasons led the Designer to choose a solution with an underpass. Spatial analyses have determined that it is not possible to define the geometry of denivelation in the plan and profile that would meet the minimum program conditions, without jeopardizing the existing gas station facility, primarily in terms of access to it. The main problem is the spatial position of the gas station, which is located directly next to the railway and along the road in question. Deleveling the road directly around the perimeter of the internal traffic surfaces of the gas station completely prevents access to it. For these reasons, the technical solution adopted implies the demolition of the gas station.	

	With regard to the traffic requirements to enable the passage of heavy goods vehicles with the newly designed underpass, and the above-mentioned space limitations, the Designer has defined a technical solution in the form of a underpass. The axle of the road is positioned in such a way that it intersects with the railway at right angles, which is the most rational solution from the aspect of the constructive solution of the underpass. The designed technical solution enables vehicular access to the facility under protection, as well as the realization of a traffic connection with Sinđelićeva Street through a surface intersection. The traffic connection in question is a city road, where the boundary elements are dimensioned for the calculated speed of Vr = 40km/h. The length of the newly designed road is 244.23m, it consists of 2 lanes with a width of 2.75m and an edge lane of 0.25m. In order to achieve the continuity of pedestrian and bicycle flows on both sides of the railway, a pedestrian path is designed on the right side of the roadway, while a bicycle path is planned on the left, which is deleveled in relation to the main roadway.	

	Underpass at km 156+851.81 In the current state, this crossing is not defined and arranged as a level crossing, but the local population uses it at their own risk. At this intersection, the designer decided to design an underpass, taking into account the height position of the railway and the proximity of Vidovdanska Street to which it fits. Also, by analysing the space constraints and the surrounding content, the design of the overpass would not be possible. This traffic connection allows a connection to the State Road IIA Order No. 158 and Striška Street. The designed road is defined within the dimensions that are already defined by the existing planning document of the Municipality of Paraćin. The spatial plan also envisages the construction of a roundabout with Sinđelićeva Street. During the design, it was considered that the newly designed road in the future represents a branch that can be introduced into the roundabout (the roundabout is not part of this project documentation). In terms of deleveling, the underpass is designed to enable the passage of heavy-duty vehicles, so due to the large cut and length of the wing walls of the building itself, it is necessary to demolish several buildings in the immediate vicinity. On the left side of the roadway, a pedestrian path is designed in order to achieve the continuity of pedestrian flows. The length of the newly designed road is 458.97m, it consists of 2 lanes 2.75m wide, 2 edge lanes 0.25m wide, and a pedestrian path is designed on the left side of the roadway in order to achieve continuity of pedestrian flows.	 Striška Street
	Underpass at km 158+955.08 The existing intersection of the railway and road infrastructure is in Kralja Petra I Street in the form of a level crossing. This street connects the state road IIA Category No. 158 with the settlement of Striža and thus provides a connection with the city. With geometric analyses of the route and level of the railway	

	line and the street deleveling in question, the Designer concluded that it is only possible to achieve the continuity of traffic flows at this location, and that this does not result in the demolition of many residential buildings, with an underpass. The design geometry enables the passage of heavy goods vehicles, and a pedestrian path is designed on the left side of the carriageway to achieve the continuity of pedestrian flows. To the south of the deleveled intersection in its current state is a football field. Between the railway and the football field, there is an agricultural road that allows agricultural vehicles to access the fields. As the level of the newly designed railway was raised, the railway slope endangered both the football field and the road. In this regard, a new parallel macadam road was designed along the railway slope in the length of 710 m, thus providing access to agricultural land. The length of the newly designed road is 171.33m, it consists of 2 driving lanes 3m wide and 2 edge lanes 0.25m wide and the passage of heavy goods vehicles is enabled, and a pedestrian path is designed on the left side of the roadway to achieve continuity of pedestrian flows.	 Kralja Petra I Street
	Local road Level crossing at km 162+128	The level crossing is cancelled, it is redirected to the planned underpass at km 162+505 Distance: 377

	Underpass at km 162+505.32 The existing intersection of the railway and road infrastructure is in Vožda Karađorđa Street in the form of a level crossing. This street connects the state road IIA Category No. 158 with the village of Ratare. Also, it is an important connection with the settlements on the west side of the railway and the city of Paraćin and the city of Ćićevac. For this reason, it is necessary to make a deleveled cross at this location, in this case in the form of an underpass. The current situation is characterized by a level crossing in the form of a road crossing. Residential buildings are in the immediate zone of the road crossing, but they are at a sufficient distance from the railway and will not be endangered by the construction of the underpass. The length of the newly designed road is 221.80 m, it consists of 2 lanes 2.75 m wide, two edge lanes of 0.25 m wide and the passage of heavy goods vehicles is enabled. On the right side of the roadway, a pedestrian path is designed in order to achieve continuity of pedestrian streams.	 Vožda Karađorđa Street
	Local road Level crossing at km 163+810	The level crossing is cancelled, it is redirected to the planned underpass at km 162+505 and to underpass at km 164+502 Distance: 1305m or 692m

Underpass at km 164+502.60

The next level crossing located on this stretch is Ravnogorska Street, which is located between Vožda Karađorđa Street (underpass No. 5) and Branka Krsmanovića Street (underpass No. 6). Traffic analysis determined that the mentioned road crossing is located at a short distance (1000 m) from these two newly designed underpasses and that the construction of a deleveling station at that location would be economically unjustified. During the construction of the underpass no. 5 and no. 6 level crossing over Ravnogorska Street will be used as a temporary deviation through which traffic will move through, after which the crossing will be abolished. Also, between these two deleveled crossings there is a railway station Sikirica-Ratare and through them the local population will be provided with a connection with the settlements on the west side of the railway.

Based on the above, the deleveled intersection will be located at the site of the existing intersection of the railway and Branka Krsmanovića Street in the settlement of Sikirica. This street connects the state road IIA Category No. 158 with the village of Sikirica.

An analysis of the current state of the intersection in question revealed only one object nearby. Bearing in mind the height position of the railway, the Designer decided to design an underpass under the railway. In this way, it is only possible to secure the connection to the object. The design of the overpass would be an irrational solution, because the intervention zone would be much longer and access to the building would be prevented, which would require its demolition.

The design geometry allows the passage of heavy goods vehicles, and a pedestrian path has been designed on the right side of the roadway in order to achieve the continuity of pedestrian flows.

The length of the newly designed road is 228.55 m, it consists of 2 lanes 2.75 m wide, two edge lanes of 0.25 m wide and the passage of heavy goods vehicles is enabled. On the right side of the roadway, a pedestrian path is designed in order to achieve the continuity of pedestrian flows.

Branka Krsmanovića Street

	Underpass at km 166+669.98 The existing condition is characterized by residential construction on both sides of the railway. The aim of the project documentation is to envisage the de-leveled crossing of the railway and the road and thus ensure greater safety of all participants in both road and rail traffic. Accordingly, any solution requires the demolition of a certain number of buildings in the vicinity of the railway. Considering the level of the railway, as well as the position of the built edge contents in the intersection zone, the Designer opted for the design of the underpass under the railway. Spatial analyses have determined that it is not possible to define the geometry of the delevelling in the plan and profile that would meet the minimum program conditions, without endangering the existing facilities along the left side of the road, in terms of access to it. Bearing in mind the location and importance of this road route, the newly designed underpass is designed to enable the passage of heavy goods vehicles. To achieve a more favourable angle of intersection from the point of view of the constructive solution of the underpass, the axis of the road is positioned in such a way that it intersects with the railway at a right angle. The length of the newly designed road is 256.41m, it consists of 2 lanes of 2.75m wide, two edge lanes of 0.25m wide, and pedestrian paths are designed on both sides of the roadway in order to achieve continuity of pedestrian flows. The construction of the underpass, due to the great deleveling, made it impossible to connect Stefana Prvovenčanog Street to Beogradska Street, as it is in its current state. With a detailed analysis of the wider area, as well as on the basis of traffic analysis, the designer came to the conclusion that it is possible to direct vehicles coming from Stefana Prvovenčanog Street to Dr Milana Milovanovića Street. As the railway slope threatens the existing condition of Stefana Prvovenčanog Street, the reconstruction of the street in the length of 529.95 m with an asphalt cover is planned. By translating the relocation of	 Beogradska Street

	the main road (Beogradska Street) in relation to the existing state, it is possible to design an additional access road. The function of this road is to provide access to residential buildings on the right side of the main road, and access will be allowed only to residents. The entrance to the yard is solved by car ramps. The road will have a blind ending, in order to prevent the movement of other vehicles coming from Stefan Prvovenčani Street. The geometry of the connection to the main road is designed with boundary elements, while the width of the roadway is 3.5m. There are also 0.5m stabilized shoulders on both sides that vehicles can use in the event of a passing.	
	Local road Level crossing at 168+180	The level crossing is cancelled, it is redirected to the planned overpass at km 169+150 Distance: 970m
	Overpass at km 169+150.51 The intersection in question represents a significant and only connection with arable agricultural land west of the railway line with the settlement of Pojate. In the current state, this crossing is not defined and regulated as a level crossing. Users who cultivate agricultural land use this link at their own risk for access to it. Considering the height position of the railway, as well as the topography of the terrain in the intersection zone, the Designer opted for the design of the overpass, i.e. for the crossing of the road above the railway. The road is designed at right angles to the railway, which is the most favourable solution from the point of view of the construction of the overpass. Also, there are no objects at the location in question that can be endangered, and this has additionally affected the solution of the deleveled intersection in the form of an overpass. As only agricultural vehicles are expected to pass through at this intersection, no pedestrian paths are planned. The length of the newly designed road is 580.95 m. It consists of 2 lanes 3 m wide, 2 curb lanes 0.25 m wide, 1.25 m wide shoulders and asphalt cover. In horizontal curves where radii R <200 m were applied,	 Agricultural road

	extensions were designed on the inside of the curve and thus enabled unhindered passing of vehicles. How to only agricultural vehicles are expected to pass through this intersection, no pedestrian paths are provided. At the stationary 0 + 550.00m of the road, a connection of the macadam road in the length of 242.56m is planned, which is connected to the newly designed parallel macadam road along the railway, in the length of 537.62m. Gravel roads are designed in a width of 4 m with double-sided shoulders of 0.5 m. In the wider area of the intersection, macadam roads have been designed in order to provide access to arable land and comfortable movement of agricultural vehicles.	
	Overpass at km 170+132.23 At the request of the local self-government, in order to provide access to agricultural land, it is necessary to provide a deleveled intersection at this location. Bearing in mind that there were no space limitations, the Designer chose to design the overpass, with elements of situational and levelling geometry that correspond to the calculated speed of Vr = 50km/h. Also, the geometry of the road corresponds to the geometry from the spatial plan. The length of the newly designed road is 452.19 m. It consists of 2 lanes 3 m wide, 2 curb lanes 0.25 m wide, 1.25 m wide shoulders and asphalt cover. On the left side of the roadway, a pedestrian path is designed.	 Zmaj Jovina Street
	National road Level crossing at 171+793	The level crossing is cancelled, and the underpass for traffic only will be built at the same location Distance: 0m

	Underpass at km 171+793.08 During the drafting of the technical documentation, the representatives of the local self-government insisted on the construction of an underpass on Železnička Street. At all meetings and through letters, the designer explained that the design of the underpass at this location is not in accordance with positive design practice. Among other things, the existing state road IIA Order No. 190 is diverted to Radnička Street, 720m south of the site in question, with a profile and capacity that allows uninterrupted heavy goods traffic. On the basis of the Instruction of the Ministry of Construction, Transport and Infrastructure, for railways and intermodal transport", on 171+793.08 of the track, a single-track underpass has been designed in Železnička Street, with the aim of solving the problem of movement of local population, as stated in the Instruction. Given the space limitations, at the location of the existing road crossing in Železnička Street, an underpass with a reduced free profile (height 3.00 m) has been defined, only for passenger cars. Given the space limitations, it is a profile with only one lane. This solution involves an alternating omission vehicles, i.e. regulating traffic with the use of traffic lights. In general, the one-way road in question has been moved to the right side in the direction of the growth of the station of Železnička Street, so that only the buildings on the right side are demolished, while the buildings on the left side of Železnička Street would be preserved. The width of the single-lane carriageway is 3.50 m. Considering the high level of groundwater, an underpass with a "bathtub" type facility is designed. Above the retaining structure, which is connected to the underpass building, a service road is defined for the needs of residential building users on the left side (3.50m wide). Also, in the underpass building, a sidewalk with a width of 2.00 m is envisaged.	 Železnička Street

	The proposed solution requires the installation of traffic lights on both approaches to the underpass, i.e. the regulation of the intersection of Adama Rajića and Železnička Streets and the intersection of Svetog Sava and Železnička Streets by applying traffic lights. Given that the design of the underpass in this zone implies the interruption of the road connection with the railway station, a new transverse connection has been designed, which provides access to the Ćićevac railway station.	
	Overpass at km 172+515.95 In the wider zone of Ćićevac station, the existing intersection of railway and road infrastructure is in the form of a level crossing in Železnička Street (IIA Category state road No. 190). An analysis of the current situation showed dense population on both sides of the railway. At the site of the existing level crossing (km 171+793.08), the project documentation envisages an underpass for the passage of passenger vehicles. For the design of the underpass with a larger free profile would cause the demolition of a large number of buildings, the project defines a new location of the deleveled intersection 720m south, across Radnička Street (km 172+515.95). Such a solution implies a deviation of the state road IIA Category No. 190 which connects to the state road IIA Order No. 215. Bearing in mind that this is a state road design, it was necessary to provide a higher level of service. In connection with this, an overpass was designed, where the geometry of the road corresponds to the geometry from the spatial plan. The length of the newly designed road is 1150.00m. It consists of 2 lanes 3m wide, 2 edge lanes 0.25m wide, 1.25m wide shoulders and asphalt cover. On the right side of the roadway, a pedestrian path is designed in order to achieve the continuity of pedestrian flows. In horizontal curves where radii R<200 m were applied, extensions were designed on the inside of the curve and thus enabled unhindered passing of vehicles. The road is designed to allow the movement of heavy-duty vehicles. At km 1+004.67, a bridge structure is planned over the Kočanski stream.	 Radnička Street

Underpass at km 173+134.14

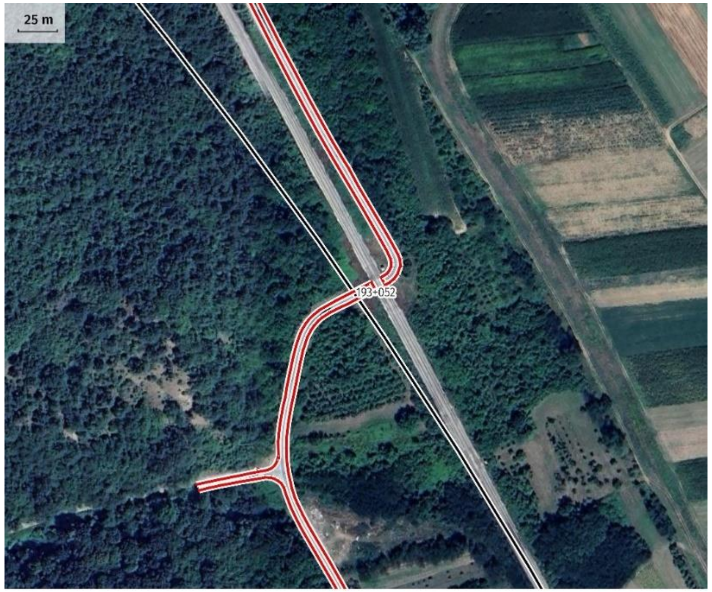
The last existing intersection of the railway and road infrastructure in the form of a level crossing is located in Moravska Street. The design of a de-levelled intersection at this place (overpass or underpass) would cause the demolition of many buildings. Also, it would not be possible to connect Mirka Tomić Street, and the parallel road located south of the Akalavica stream. The proximity of the mentioned stream further complicates the design of a deleveled intersection at this location, due to the adverse impact of groundwater and problems with flooding.

In view of the above, the Designer decided to abolish this road crossing and design an underpass at the next location 500m north, in the continuation of Mirka Tomić Street.

By analyzing the existing condition of the intersection in question, a commercial facility was noticed nearby. During the design, care was taken to ensure that the road does not enter the private plot on which it is located and that it is not endangered. The designer analysed the crossing of the railway in the form of an overpass, as well as the different geometry of the road. Bearing in mind the height position of the railway, the Designer concluded that such a solution is unfeasible. This is because the level of the line is set high, and the geometry of the road in the longitudinal sense would deviate from the limit values prescribed by the design regulations. Based on the above, the Designer decided to design the underpass under the railway. The road in question is connected to the state road IIA Category No. 215, then passes under the railway and continues to Mirka Tomića Street. As the newly designed railway escarpment endangered the existing Mirko Tomić Street, a new traffic connection parallel to the railway was designed. The geometry of the road has been adapted to the street as it was in its existing state, and in this way access to the houses located along the street is enabled. This solution enters private plots, but it is the only way to establish a connection with the settlement, taking into account all the space limitations at this location.

Mirka Tomića Street

	The length of the newly designed road is 686.16 m. The width of the pavement is from the junction to the state road and along its entire length through the underpass 6m wide (two lanes 2.75m wide and two edge lanes 0.25m wide), as well as the pedestrian path on the right side of the roadway. After the second horizontal curve, at the entrance to Mirka Tomić Street, the carriageway is narrowed to 4.5m (two lanes 2.25m wide) and 1m wide shoulders are designed. In the current state, the width of the street is 3m, and this extension provides greater comfort compared to the current driving conditions at the location in question.	
	Local road Level crossing at km 173+655	Existing crossing location removal- an underpass is being built for pedestrians and cyclists at km 173+678 and traffic is diverted to the planned underpass at km 173+134 Distance: 521m

ĐUNIS – TRUPALE Sub-Section		
	Overpass at km 193+051.67 The road in question is an important traffic link between the inhabited town of Vitkovac and other settlements on the left bank of the South Morava River with the state road IIa Category No. 215 and E-75 highway. In the current state at this location, intersection with the railway line is located at the level of a road crossing. The solution is deleveled crossing in the form of an overpass. The width of the existing pavement is about 5 m. The elements are designed for a calculated speed of 50 km/h. The length of the newly designed road is about 480.00 m, and the total width of the roadway is 6.50 m.	 JNA Street – Vitkovac
	Local road Level crossing at km 194+105	The level crossing is cancelled, diverted to the planned underpass at km 194+665 Distance: 560m
	Underpass at km 194+665.63	

	As in the previous case, it is the same road that was laid on the route parallel to the railway, and thus connects the settlements on the left bank of the South Morava with the national road no. 215. At this location, a deleveling is designed in the form of an underpass that connects the peripheral part of Donji Ljubeš with J.N.A. Street and further with the national road infrastructure. A cross-traffic connection was established in a location where the demolition of residential buildings was avoided. This traffic connection connects to Sava Kovačevića Street in the form of a three-way surface intersection. In order to achieve the intersection of the road and the railway, it was necessary to deviate J.N.A. Street in the length of 612.86m. The width of the existing pavement is about 5.00m. The length of the newly designed road with an underpass is about 377.38 m, and the total width of the pavement is 6.00 m.	 Traffic connection between JNA and Save Kovačevića Street - Vitkovac
	Local road Level crossing at km 194+975	The level crossing is cancelled, diverted to the planned underpass at km 194+665 Distance: 310m

	Underpass at km 196+164.67 The existing road crossing is positioned at km 195 + 556 of the railway and is a connection on the left and right side of the railway that passes through the settlement of Donji Ljubeš. Given the spatial limitations and dense population in the zone of the road crossing, the Designer decided to design a deleveled intersection in the form of an underpass about 380 m back. This traffic connection connects Jordana Pavlovića Street – Pavla Street and 1st May Street. The connection to 1st May Street is envisaged in the form of a three-way surface intersection. This location is also advantageous because there is a direct connection to the school and the demolition of existing buildings is avoided. The length of the newly designed road is about 320.00 m, and the total width of the roadway is 6.00 m. On the right side of the roadway, a pedestrian path is designed in order to achieve the continuity of pedestrian flows. The minimum boundary elements are designed for a calculated speed of 40 km/h.	 Jordana Pavlovića-Pavla Street – Donji Ljubeš
	Local road Level crossing at km 196+550	The level crossing is cancelled, diverted to the planned underpass at km 196+164 Distance: 386m
	Underpass at km 197+383.93 The deleveled intersection in question connects residential buildings and agricultural land on the right side of the railway line with the settlement of Srezovac and the road infrastructure on the left side of the railroad tracks. Due to the newly designed railway route, the existing Trnjane – Vitkovac road is intersected from the km 196+700.00 to km 197+150.00 of the railway, while at km 197+383.93 it intersects with the underpass.	

	For this reason, the deviation of the road in the length of 1091.20m has been designed. The adopted width of the road is 6.00m, which corresponds to the existing width of the road. In the zone of the intersection of the deviation of the road and the underpass at km 197+383.93 of the railway, the position of the level of the road, which crosses the underpass and is located at similar elevations of the railway, was considered. The length of the newly designed road on which the underpass is designed is about 375.00 m, and the total width of the roadway is 6.00 m. On the right side of the roadway, a pedestrian path is designed in order to achieve the continuity of pedestrian flows.	 25 May Street - Srezovac
	Local road Level crossing at km 198+450	The level crossing is cancelled, diverted to the planned underpass at km 197+383 Distance: 1067m

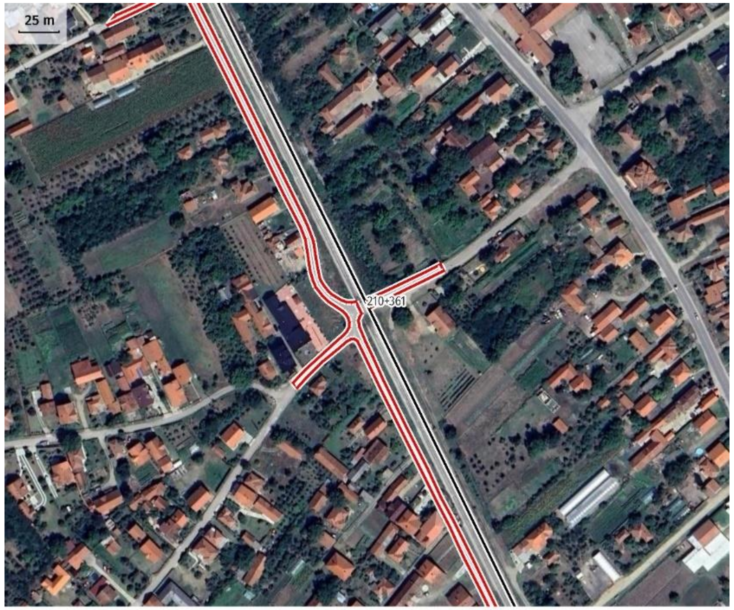
	Underpass at km 200+277.95 The position of the railway line divides the inhabited town of Korman into two parts. The deleveled intersection in question in the form of an underpass connects the left and right sides of this inhabited place. In the zone of the deleveled intersection, there is an access road that provides a connection with the newly designed Korman station. The width of the existing pavement is about 3.50m. The length of the newly designed road is about 310.00 m, and the total width of the roadway is 6.00 m. On the left side of the roadway, a pedestrian path is designed in order to achieve the continuity of pedestrian flows.	 Kneza Lazara Street – Milana Marinkovića - Korman
	Local road Level crossing at km 200+360	The level crossing is cancelled, diverted to the planned underpass at km 200+277 Distance: 83m
	Local road Level crossing at km 201+390	The level crossing is cancelled, diverted to the planned underpass at km 200+277 and underpass at km 202+340 Distance: 1050m or 950m

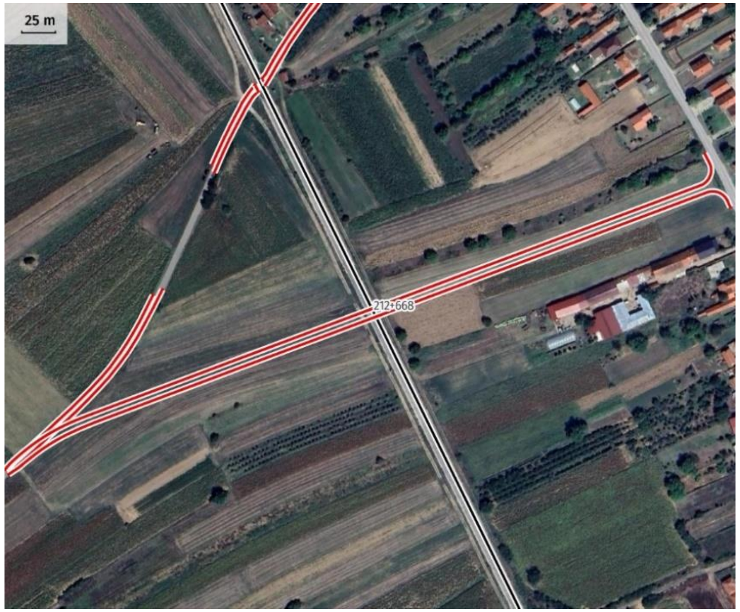
	Underpass at km 202+340.17 At the site in question, a deleveled intersection of road and railroad in the form of underpass. Given that this traffic connection is an important link between the settlement of Trnjane and other settlements east of the railway, the Designer decided to design a new underpass at the same location. Bearing in mind that the axis of the newly designed railway has been moved by about 22m towards Stojana Živkovića – Stoleta Street, it is necessary to correct the axle and level of the existing road, therefore it is necessary to demolish the existing underpass. The new solution provides a free profile for the passage of heavy-duty vehicles. The width of the existing pavement is about 5.00m. The length of the newly designed road is 225.19m, and the total width of the roadway is 6.00m. On the right side of the roadway, a pedestrian path is designed in order to achieve the continuity of pedestrian flows.	 Omladinska Street - Trnjane
	Local road level crossing at km 203+158	The level crossing is cancelled, it is redirected to the planned underpass at km 202+340 and underpass at km 205+802 Distance: 818m or 2644m

	Underpass at km 205+802.46 In the immediate vicinity of the Adrovac station, a deleveled intersection of the road and the railway in the form of an underpass has been identified. This road is the only connection between the settlements of Donji and Gornji Adrovac. For this reason, the Designer decided to keep this location and design a deleveled intersection in the same place. The new solution provides a free profile for the passage of heavy-duty vehicles. The width of the existing pavement is about 5.00 m. The minimum boundary elements are designed for a calculated speed of 50 km/h, and the total width of the carriageway is 6.00 m.	 Local road – Donji Adrovac
	Underpass at km 206+821.81 The next existing intersection of the road into the railways is also located in the village of Donji Adrovac, in view of the underpass. Given that the village is located on the north side of the railroad, and agricultural land from the south, this intersection is also in its current state intended for access to agricultural land and for the passage of agricultural vehicles. Also, the traffic analysis determined that the local population gravitates towards the north side of the settlement, i.e. towards Milentija Popovića Street. In this regard, the Designer decided to keep this location and design an underpass for the needs of the passage of agricultural mechanization. The width of the existing pavement is 3.00m. The length of the	 Deligradska Street – Donji Adrovac

	newly designed road is 105.03 m. A free profile of 4.00m is provided, while the pavement width of 5.00m is adopted.	
	Local road Level crossing at km 207+885	The level crossing is cancelled, it is redirected to the planned underpass at km 206+821 and to underpass at km 208+746 Distance: 1064m or 860m
	Local road Level crossing at km 208+715	The level crossing is cancelled, it is redirected to the planned underpass at km 208+746 Distance: 30m
	Underpass at km 208+746.36 The position of the railway line divides the inhabited town of Žitkovac into two parts. The intersection in question in the form of an underpass connects the left and right sides of this inhabited place. At this location, in the existing state, the intersection with the railway was realized in the form of a level crossing. What characterizes this location is the dense population in the zone of the road crossing, so it was not possible to define a deleveled intersection that does not involve the demolition of buildings. The designer also considered the design of a deleveled intersection 350 m back from the existing crossing. Bearing in mind the very unfavourable configuration of the terrain and the newly designed position of the railway, it is not possible to define the design geometry in this zone that meets the minimum technical requirements for the design of the overpass. The designer also analysed the potential application of a technical solution with an underpass. The spatial position of the existing road infrastructure and residential buildings has a negative impact on the implementation of the constructive solution of the underpass, because it is necessary to achieve de-	 Milentija Popovića Street - Prćilovica

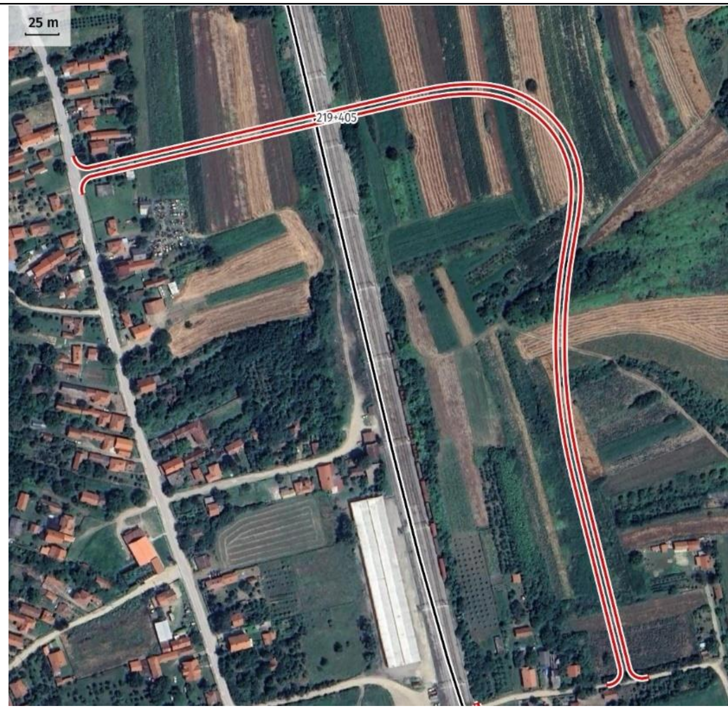
	levelling with Ratka Jovića and Jelke Radulović Streets. This means that a very long underpass would have to be designed, which would result in the demolition of more residential buildings. As it is a densely populated place, pedestrian and bicycle paths are planned. The width of the underpass is 14.00 m, and the length would be almost 80 m, and having in mind the demolition, the intersection at this place is economically unprofitable. On the basis of the above explanations, as well as the traffic analysis that shows a significant volume of traffic at this level crossing, the Designer decided to design a deleveled intersection at the site of the existing level crossing. The length of the newly designed road is 238.34 m, and the total width of the pavement is 6.00m. In order to achieve continuity of pedestrian and bicycle flows on both sides of the railway, a pedestrian path is designed on the left side of the roadway, while a bicycle path is planned on the right, which is deleveled in relation to the main roadway.	

	Overpass at km 210+360.94 The newly designed railway route in this zone is located in the existing railway corridor, and in the immediate vicinity of the intersection in question there is an existing level crossing in the settlement of Moravac. During spatial analyses in a zone of about 500 m, it was determined that there is no zone in which it is possible to define a deleveled intersection without resulting in the demolition of residential buildings. Defining the deleveled crossing much further away from the existing location in a functional sense would be ineffective because the denivelation would be too far from the previous one. Also, it was found that in the more remote uninhabited parts there is no developed transport infrastructure that could accommodate the assumed traffic load. For this reason, the de-levelling of the road in question in the form of an overpass is planned. This traffic link allows the gravity of the local population on both sides of the newly designed railway. The road in question connects the local road with IIA Category state road No. 217. The connection to the state road is provided by a surface three-way intersection. The width of the existing pavement is about 5.00m. The minimum boundary elements are designed for a calculated speed of 50 km/h. The length of the newly designed road is about 380.00 m, and the total width of the roadway is 6.50m. On the left side of the carriageway, a pedestrian path is designed to achieve continuity of pedestrian flows.	 Traffic connection of settlement Moravac with national road IIA no.217
	Local road Level crossing at km 212+480	The level crossing is cancelled, it is redirected to the planned overpass at km 212+668 Distance: 188m
	Overpass at km 212+668.35	

	The newly designed railway route in this zone is located in the existing railway corridor, and at the location in question it intersects the existing level crossing in the settlement of Stublina. For this reason, the delevelling of the road in question in the form of an overpass is planned. This traffic connection allows the connection of the settlements of Stublina and Nozrina. The road in question connects Patriarch Pavla Street with the IIA Category state road No. 217. The connection to the national road is provided by a surface three-way intersection. The width of the existing pavement is about 4.00m. The minimum boundary elements are designed for a calculated speed of 50 km/h. The length of the newly designed road is about 580.00 m, and the total width of the roadway is 6.50 m. On the left side of the roadway, a pedestrian path is designed to achieve the continuity of pedestrian flows.	 Traffic connection of settlement Stublina with national road IIA no.217
	Local road Level crossing at km 213+756	The level crossing is cancelled, it is redirected to the planned overpass at km 212+668 and overpass at km 214+249 Distance: 1088m or 493m
	Overpass at km 214+249.68	

	As the overpass at km 212+668.35 and Underpass at km 217+044.45 are located at more than 4 km from each other, at the request of the representatives of the local self-government, a deleveled intersection in the form of an overpass was designed at this location. Bearing in mind that in the wider zone of the location in question there are arable agricultural areas, the construction of this deleveling facility provides access to them from the settlements of Lužane and Tešica. The road in question connects the local road with IIA Category national road No. 217. The connection to the national road is provided by a surface three-way intersection. In order to increase the level of service, a local road in the length of 554.14 m was reconstructed, which was 2.50 m wide from the gravel road. The width of the newly designed road SAO12-1 is 4.50 m and a flexible pavement structure with an asphalt cover is planned. In the wider zone of the intersection in question, there is also the Lužane station. The length of the newly designed road with the overpass is about 470.00m, and the total width of the pavement is 6.50m	 Agricultural road - Lužane
	Agricultural road Level crossing at km 215+710	The level crossing is cancelled, it is redirected to the planned overpass at km 214+249 or to underpass at km 217+044 Distance: 1461m or 1334m

	Underpass at km 217+044.45 The denivelation in question is a part of the IIA national road, No. 217, between the interchanges Vukanja and Aleksinac, in the inhabited village of Tesica, municipality of Aleksinac. The width of the existing pavement is 5.5-6.0m. The reconstruction of the railway envisages the expansion of track capacities at the Tesica railway station, in the zone of intersection with the state road in question. At this location, in the existing state, the intersection with the railway was realized in the form of a level crossing. What characterizes this location is the dense population in the zone of the road crossing, so it was not possible to define a deleveled intersection that does not involve the demolition of buildings. Considering the edge construction, as well as the levelling position of the railway line, it is designed underpass under the railroad tracks. Considering the space limitations, the boundary elements of the vertical geometry of the road were designed for the calculated speed of Vr = 50 km/h, while more comfortable elements were applied in the site plan. Given the residential buildings in the immediate zone of the road and the railway line, it was not possible to define the vertical geometry of the road without the consequence of demolishing the buildings in the closer zone of the intersection itself. On the right side of the roadway, a pedestrian path is designed to achieve the continuity of pedestrian flows. The extensions in the curves are defined in such a way as to allow the passage of 2 heavy goods vehicles. The length of the newly designed road is about 332.95.00m, and the total width of the pavement is 6.50m.	 Vojvode Stepe Street - National Road IIA no.217 - Tešica
	Local road Level crossing at km 218+270	The level crossing is cancelled, it is redirected to the planned underpass at km 217+044 and to overpass at km 19+404 Distance: 1226m or1134m

	Overpass at km 219+404.75 In the settlement of Grejač there is a level crossing at km 219+863.33 of the newly designed railway. As there is also a glass recycling factory at the location of the road crossing, the construction of a deleveled intersection at that place would make it impossible to access it. According to the agreement with the representatives of the local self-government, the deleveled intersection is designed at 460.00 m back. The deleveled intersection in question connects the inhabited village of Grejač with arable land along the coast of the South Morava. The design solution involves a deleveled intersection in the form of an overpass. The minimum boundary elements are dimensioned for a computational rate of 50 km/h. The length of the newly designed road is 807.35m, and the total width of the pavement is 6.50m.	 Local road - Grejač
	Local road Level crossing at km 219+863	The level crossing is cancelled, it is redirected to the planned overpass at km 219+404 Distance: 459m

	Overpass at km 221+359.49 At the location in question, there is a deleveled intersection in the form of an underpass for the passage of agricultural machinery to the arable land on the left side of the railway in the direction of the growth of the station. With the newly designed geometry of the railway route, there is a displacement in relation to the existing railway, and for this reason, it is necessary to demolish the existing underpass and build a new one at this location. The length of the newly designed road is 84.66 m, and the total width of the roadway is 6.00 m.	 Agricultural road – Veliki Drenovac
	Underpass at km 223+500.00 In the cadastral municipalities of Supovac and Mezgraja, the route of the newly designed railway line significantly deviates from the existing railway. The newly designed geometry of the railway intersects Peke Dapčevića Street along the South Morava River. As this road represents an important connection between the mentioned cadastral municipalities, the deleveling of the intersection in question in the form of an underpass is designed at that place. The width of the existing pavement is about 5.00m. The minimum boundary elements are dimensioned for the calculated speed of 40 km/h. The length of the newly designed road is about 559.18m, and the total width of the pavement is 6.00m.	 Peke Dapčevića Street - Mezgraja

	Local road Level crossing at km 224+205	Existing crossing location removal - an underpass is being built for pedestrians and cyclists at km 224+180 and traffic is redirected to the planned underpass at km 223+500 Distance: 700m
	Overpass at km 227+126.66 At this location, in the existing state, the intersection with the railway was realized in the form of a level crossing. What characterizes this location is the dense population in the zone of the road crossing, which results in the demolition of buildings to define a deleveled intersection. In the wider zone of the road crossing, the Designer considered several locations for the design of the deleveled crossing. Bearing in mind the extremely unfavourable configuration of the terrain along the route and the fact that the newly designed railway is in a cut, it was not possible to design a deleveled intersection at any other location than at the site of the existing road crossing. The denivelation itself connects the settlement of Vrtište with residential buildings and arable land on the other side of the railway. In the continuation of Beogradska Street, there is an overpass over the E-75 highway, which connects the settlement of Žitkovac with the IIa Category national road No. 158 and still with the city of Niš. The length of the newly designed road is about 411.52m, and the total width of the roadway is 6.50m. To achieve the continuity of pedestrian and bicycle flows on both sides of the railway, a pedestrian path is designed on the left side of the roadway, while a bicycle path is planned on the right.	 Beogradska Street - Vrtište
	Local road Level crossing at km 227+850	The level crossing is cancelled, it is redirected to the planned overpass at km 227+126 Distance: 724m

Underpass at km 229+419.58

The denivelation in question connects the settlement of Trupale with residential buildings and arable land on the other side of the railway. In the continuation of Železnička Street, there is an underpass under the E-75 highway, which connects the settlement of Trupale with the IIa Category national road No. 158 and further with the city of Niš. The design solution involves a deleveled intersection in the form of an underpass.

The length of the newly designed road is 789.06m, and the total width of the roadway is 6.00m. To achieve continuity of pedestrian flows on both sides of the railway, on the left. A pedestrian path is designed in the area of the underpass.

Železnička Street - Trupale

Underpasses

The construction of three underpasses to allow the passage of pedestrian and bicycle traffic is planned, namely in:

- Paraćin in Šumadijska street at km 155+495;
- Ćićevac in Moravska Street at km 173+678 and
- Mezgraja in Maršala Tita Street at km 224+180.

All domestic and international regulations and standards for safety have been applied. Special attention has also been given to technical standards ensuring unrestricted and safe movement, as well as access for persons with disabilities, children, persons with children and babies, elderly persons. As such, the underpasses will be equipped with both elevators (designed to accommodate a cyclist with his bicycle, as well as a disabled person in a wheelchair) and stairs. The height of the underpasses will be 2.6 m, and the width, 4 m.

The underpasses are designed with several specific features:

- Video Surveillance: Complete coverage of underpass and their entrances with video surveillance systems to enhance security.
- Enhanced Lighting: Increased lighting levels at underpass entrances, to ensure safety and visibility.

These design elements are intended to prioritize safety, accessibility, and comfort for all users and employees of the stations, aligning with modern standards and regulations for public infrastructure.

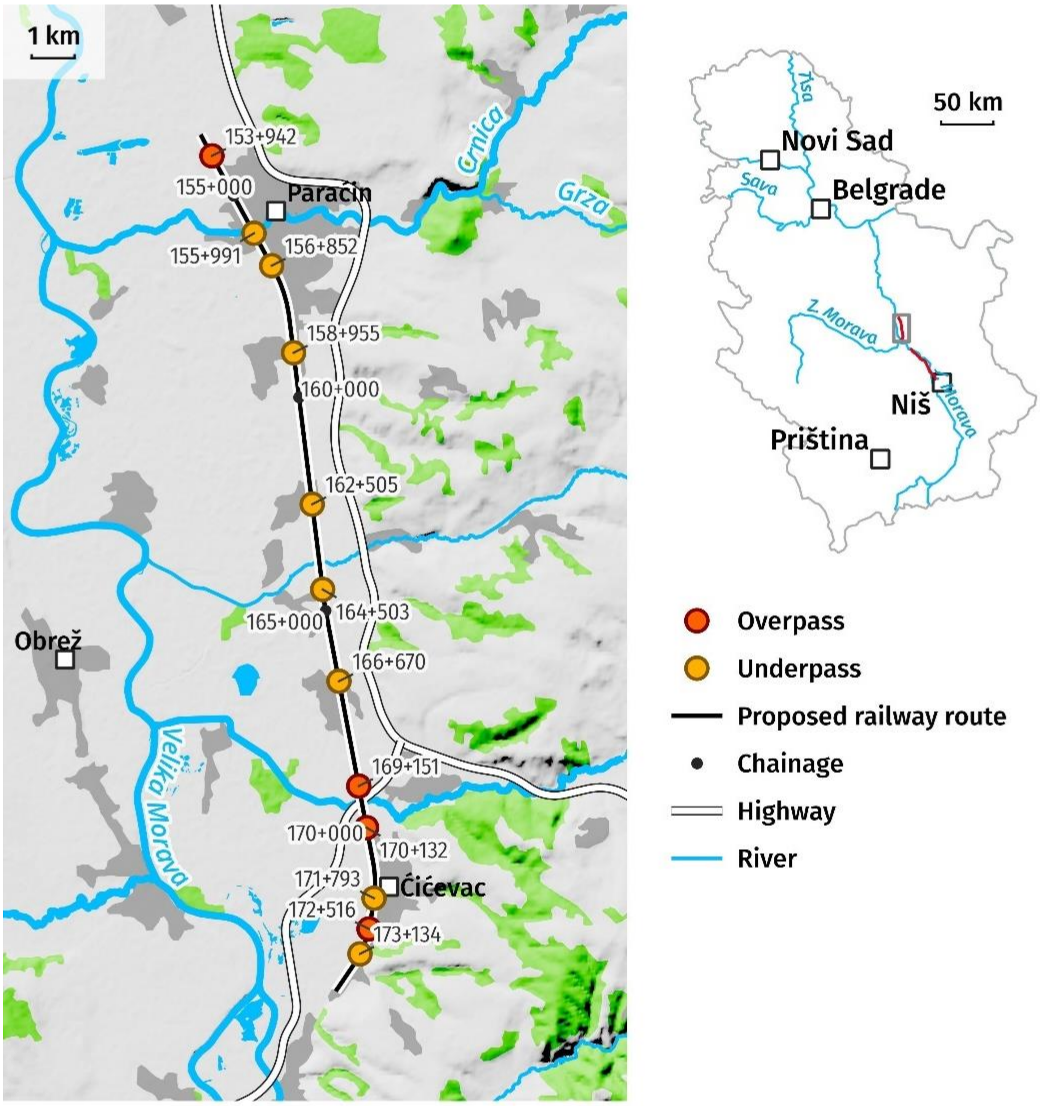


Figure 2-17. Locations of overpasses and underpasses on Paraćin – Stalać sub-section

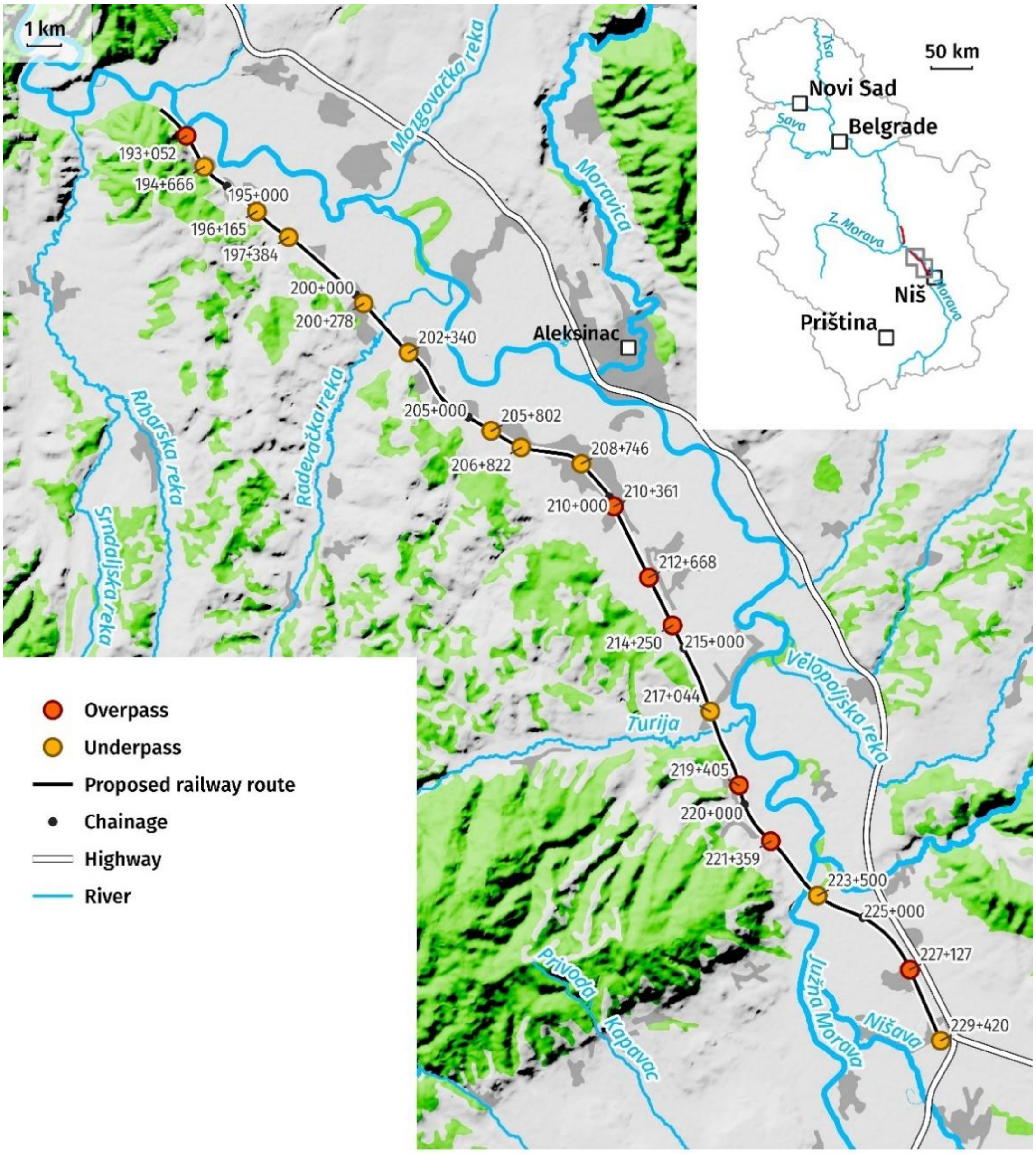


Figure 2-18. Locations of overpasses and underpasses on Đunis – Trupale sub-section

2.3.8. Culverts

There are 35 existing culverts within the Project area. A number of them will be adapted as part of the Project to jointly function as wildlife crossings. For more information refer to Chapter 2.3.16 of this ESIA Report.

2.3.9. Drainage channels (Hydrotechnical infrastructure in the function of the railway)

Hydrotechnical infrastructure deals with surface water drainage and the protection of the railway from stormwater and surface water run-off in stations and along the railway. Surface water drainage channels will be constructed in the cuts and also at the foot of embankments. Channels will be constructed one or both sides of the railway, depending on the level of the railway and the configuration of the surrounding terrain. Within stations, drainage systems will be installed beneath the tracks incorporating oil/water separators, which will discharge externally of the stations. Surface water drainage channels and station drainage systems will discharge to receiving surface watercourses, existing municipal storm sewers (if available), drainage channels or absorption (infiltration fields) or wells in places where there are no natural watercourses. Absorption (infiltration fields) and wells will allow surface water run-off and drainage to filter naturally into the ground. Atmospheric water from the railway is typically unpolluted and can therefore be discharged into the ground.

In order for the absorption (infiltration) fields to function effectively, the filtration coefficient of the soil must be high enough. Additionally, the maximum estimated groundwater level should be sufficiently below the level of the bottom of the absorption field, so that it does not slow down (or prevent) infiltration.

The planned absorption (infiltration) fields will have a trapezoidal cross-section, with a slope of 1:1.5 and a bottom elevation about 1.0m below the elevation of the outflow from the channel (or drainage). The slopes will be covered with a plastic geo-grid, which will be vegetated with grass to prevent soil erosion. At the bottom of the field, a layer of gravel will be laid 30 cm thick, through which the water will filter into the natural soil beneath.

Hydrotechnical infrastructure will also be constructed to facilitate drainage of the following Project components:

- Underpasses and overpasses.
- Bridges.
- Roads being reconstructed, relocated or designed for access to stations and other railway facilities.
- Tunnels

2.3.10. Stations and Stops

As outlined above in Section 2.3.3, not all of the existing Project stations and stops will be retained, some existing stations are to be reconstructed and modernised and some existing stops are to be reconfigured as stations. Table 2-17 summarises the planned Project outcomes for existing stations and stops.

Table 2-17. Overview of existing stations and stops and their planned status

No.	Name	Chainage (km)	Existing type of official place and planned status	Justification
PARAĆIN – STALAĆ Sub-Section				
1	Paraćin station	155+108	Station - remains	Important station featured passenger flows. Main center of the municipality of the same name. The city is populated with over 22000 people.
2	Sikirica–Ratari station	163+462	Stop – New station	There was a good passenger flow, so Srbijavoz as state passenger railway transport operator expressed strong interest in keeping this official place in function. It is expected to improve passenger flow, because additional passengers will be taken over from Drenovac.
3	Drenovac	166+700	Stop – it is decommissioned	This official place will be closed as it is located near Sikirica/Ratari (2.5 km away) and passengers will be redirected there.
4	Ćićevac station	171+415	Station - remains	Station Ćićevac has passenger flow. City of Ćićevac is the center of the municipality Ćićevac and all nearby settlements gravitate to this station. Also, this station will take over passengers from halt Lučina (2.5 km away)
5	Lučina	173+700	Stop – it is decommissioned	This official place will be closed as it is located near Ćićevac (2.5 km away) and passengers will be redirected there.
ĐUNIS – TRUPALE Sub-Section				
6	Vitkovac stop	194+118	Stop - it is decommissioned	Small settlement near Đunis (about 5 km), and in last several years there was no passengers. Passengers could reach Đunis station by good road connection.
7	Donji Ljubeš stop	196+155	Stop - it is decommissioned	Donji Ljubeš is small settlement, practically leaned to Vitkovac with good road connection with Đunis.

8	Gornji Ljubeš stop	198+453	Stop - it is decommissioned	Small settlement with no passengers during the last several years. As it is located within just 2 km away from Korman, passengers will be directed to there.
9	Korman station	200+807	Station- remains	This station has small passenger flow, but it is expected to pick up the part of passenger flow from neighboring settlements (Donji Ljubeš, Gornji Ljubeš and Trnjani). The location of this station is suitable for overtaking station for trains.
10	Trnjane stop	203+100	Stop – it is decommissioned	As it is located just 2 km away from Korman, passengers will be directed to there.
11	Adrovac station	205+474	Station - remains	This station has an important role in freight railway transport, although there was a small freight flow. Also, there is a strong request of the state railway freight operator "Srbija Kargo" in keeping this station in operate. Moreover, it is possible to take over some passengers from Trnjane which is about 4.5 km away.
12	Aleksinac station	209+255	Station - remains	This is very important station as there was strong passenger flow, small freight flow, and significant role in local passenger transport to Niš. Also, it is expected that this station will take over the passenger flow from halt Nozrina that it will be closed.
13	Nozrina stop	212+480	Stop – it is decommissioned	This halt has good passenger flow, but due to it is located near to the station Aleksinac (3 km) and neighboring Lužane (about 1.6 km), and for the reason to rationalization the number of stations, Nozrina is selected to be closed. Passenger flow will be redirected to Aleksinac and Lužane.
14	Lužane station	213+794	Station - remains	This station features moderate passenger flow. Its location is suitable for remaining as a station because there is a proposal to close halt Nozrina. This station will take over passengers from Nozrina.

15	Tešica stop	216+885	Stop – New station	This Stop will be converted in station as it is expected to take over the role of the nowadays station Grejač in terms of passenger and freight transport. Also, Tešica has own passenger flow, and it will take over the part of passenger flow from Supovački Most.
16	Grejač station	219+650	Station – it is decommissioned	The station has passenger flow, and small freight flow, but there is an objective problem to keep this station on the new high-speed line because of the geometry of the railway line. So, there was proposal to make one station much closer to settlement Tešica that will replace two old official places (old halt Tešica and station Grejač). New station Tešica will be only 2.6 km away from old station Grejač.
17	Supovački most stop	223+100	Stop – it is decommissioned	This stop has very small passenger flow that will be redirect to the stations Tešica (7.5 km away).
18	Mezgraja stop	223+994	Stop – it is decommissioned	This halt was with very small passenger flow, as well as there is objective problem with geometry of the railway line and to build capacities for the operating. It was rational to redirect passenger to Trupale or Tešica.
19	Vrtište stop	227+075	Stop – it is decommissioned	This halt is with very small passenger flow (few passengers per day), and located near to Trupale (5 km away).
20	Trupale station	228+934	Station - remains	This station is very important as it is a part of Niš railway node. Moreover, it is expected to take over passengers from Mezgraja, and Vrtište.

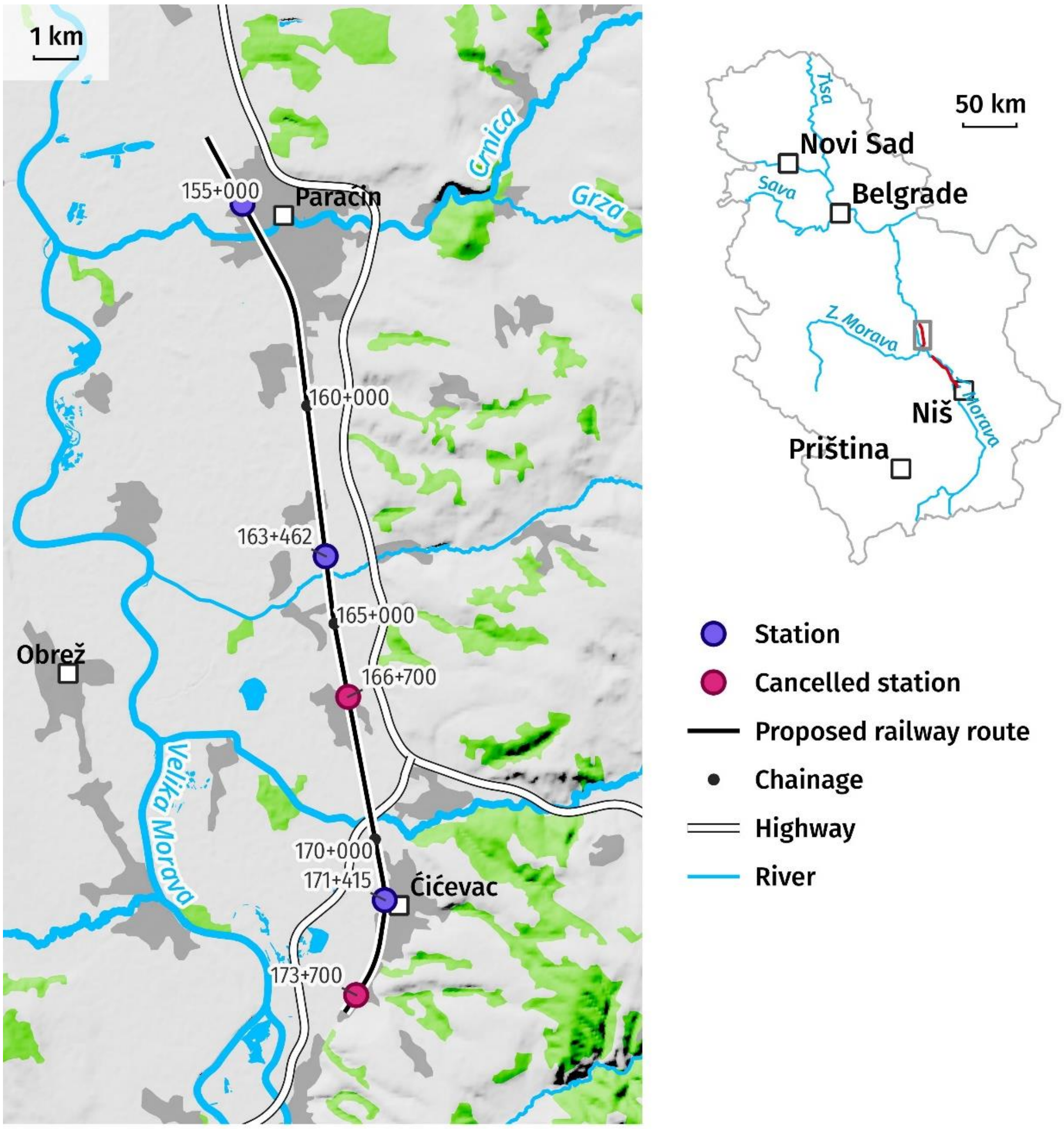


Figure 2-19. Overview of existing and proposed stations and stops on Paraćin – Stalać sub-section

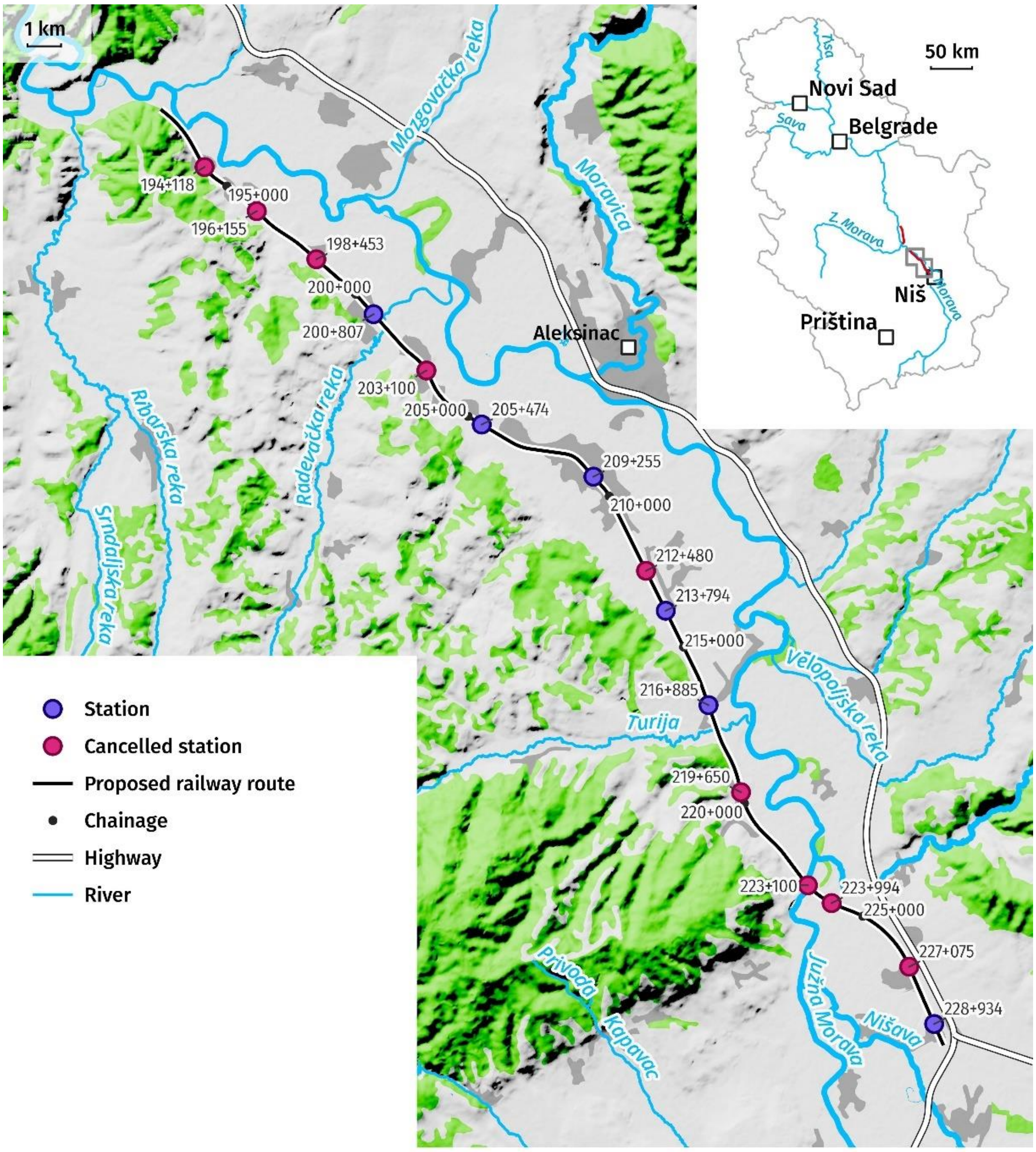


Figure 2-20. Overview of existing and proposed stations and stops on Đunis – trupale sub-section

Energy Efficiency

As part of the reconstruction of existing station facilities, the complete replacement of the roof (with the addition of thermal insulation), replacement of internal and external joinery, and the construction of a new facade with thermal insulation is planned. This will improve the energy efficiency of the facilities and increase their energy class by at least one level.

Special attention has been paid to minimizing the operating costs of new station facilities. Therefore, the design includes the use of sandwich walls, high-quality external and internal joinery, and flat roofs with additional thermal insulation. This will achieve building energy efficiency in accordance with domestic regulations and standards.

Gender, safety and accessibility in all station facilities

As part of the reconstruction of existing station facilities and the construction of new ones, all domestic and international regulations and standards for safety in the use of public infrastructure have been applied. Special attention has also been given to technical standards ensuring unrestricted and safe movement, as well as access for persons with disabilities, children, persons with children and babies, and elderly persons. As such, the stations are designed with several specific features intended to prioritize safety, accessibility, and comfort for all users and employees of the stations, as follows:

- Video Surveillance: Complete coverage of stations and their entrances with video surveillance systems to enhance security.
- Enhanced Lighting: Increased lighting levels at station entrances, pedestrian underpasses and platforms, to ensure safety and visibility.
- Facilities for Small Children: Special rooms equipped for baby changing and attending to small children, catering to the needs of families using the stations.
- Facilities for Women Employees: Dedicated rooms or areas specifically designed for the comfort and privacy of women employed at the stations.

Information Equipment

On the approach to station buildings, underpasses and platforms, equipment for informing and guiding the movement of passengers (hereinafter referred to as "info equipment") will be installed according to the content it indicates, and in accordance with international regulations in railway traffic (International Union of railways - UIC). The newly planned info equipment will be unified for all places where the reception and departure of passengers is anticipated.

The basis for determining the content of the info equipment are the standard SRPS ISO 3864-1, published IRS 10181, UIC 413 and UIC 140, and Regulation of the EU Commission no. 1300/2014.

Tactile surfaces are also planned for the blind and partially sighted. This includes that the tiles on the handrails of the stairs contain Braille and symbols that direct passengers to the platform, the underpass and the station building.

For people with impaired hearing, pictograms will be used to indicate where inductive loops are located (for example at ticket sales points).

Paraćin Station

- Existing state

Paraćin station is an intermediate station on the Belgrade–Niš railway, and a branch station for the single-track main line railway 104: Rasputnica Ćuprija–Ćuprija–Paraćin and the single-track industrial railway line 404: Paraćin–Stari

Popovac It should be noted that the industrial railway Paraćin–Stari Popovac is currently closed to traffic, and the resumption of freight traffic on this railway will primarily depend on the future development plans of the industrial entities directly connected to it, namely Moravac Cement Plant and the Serbian Glass Factory.

The station has the facilities to enable the reception and dispatch of passengers and freight.

Paraćin station currently has 6 main tracks, 2 manipulative tracks (tracks to facilitate the movement of freight trains separately from passenger trains), and 1 industrial track (for freight only). The station has 2 passenger platforms and facilities for goods operations (warehouses and loading and unloading ramps).

The current condition of Paraćin station is characterized by:

- the lack of a track to facilitate trains overtaking in the direction of Niš;
- a lack of shunting locomotive that would enable the manoeuvring of trains without disrupting rail traffic on the tracks of the open railway;
- an industrial track that is not in operation;
- low passenger platforms (non-compliant with the provisions of the Commission's (EU) Regulations on technical specifications for interoperability related to the subsystem "infrastructure" and to the accessibility of the railway system to persons with disabilities and persons with reduced mobility);
- the facilities for commodity operations are not in good condition.

Newly designed state

The Paraćin station will remain an intermediate station on the double-track main railway Belgrade–Niš, and a branch station for the single-track main railway Rasputnica Ćuprija–Ćuprija–Paraćin, and the single-track industrial railway Paraćin–Stari Popovac.

Additionally, the tracks serving the Electrotechnical Service are retained but relocated to the opposite side of the station due to spatial constraints.

The primary requirements of the station are:

- Regulating train traffic on the connecting lines, including overtaking long freight trains in combined transport.
- Receiving and dispatching local and regional passenger trains,
- Receiving and dispatching freight trains with wagons designated for local operations,
- Shunting operations to separate freight wagons.

In order to meet these requirements, the refurbished station will be designed with 7 main and 3 auxiliary tracks (which will provide a temporary stopping place for trains if all other tracks are busy), and 2 service tracks (to access service areas), as follows:

- Track 1: Auxiliary track for temporary storage.

- Track 2: Arrival-departure track for freight trains on the Paraćin–Stari Popovac line.
- Tracks 3 and 6: Overtaking tracks, also used as arrival-departure tracks for passenger trains.
- Tracks 4 and 5: Main through tracks.
- Tracks 7 and 8: Arrival-departure tracks for freight trains carrying wagons for local operations, which would also serve for temporary wagon storage, locomotive operations, and similar purposes. Track 7 can also be used for passenger traffic.
- Track 9: Industrial track with a loading/unloading ramp 250 m in length.

The station is designed with two platforms, each 220 m in length. The first platform is the main station platform located adjacent to the station building, while the second is an island platform located between tracks 6 and 7. The platforms are connected via an underpass and are equipped in compliance with the relevant technical specifications for interoperability (INF TSI and PRM TSI).

Sikirica-Ratari station

- Existing state

The Sikirica-Ratari stop has two platforms adjacent to each of the open railway tracks with a length of 50 m, a width of 1.6 m and a height of 0.35 m.

- Newly designed state

Sikirica–Ratare station will be a newly designed and constructed station on the double-track main railway Belgrade–Niš, located at the site of the existing Sikirica–Ratare stop. The primary purpose of the station is to facilitate the boarding and alighting of passengers using local trains.

To achieve its required purpose, the station is designed with 4 main tracks and 2 protection tracks as follows:

- Tracks 2 and 3: Main through tracks
- Tracks 1 and 4: Arrival-departure tracks for local passenger trains. The station includes two side platforms, each 110 m in length, with reserved space for future extensions to 160 m or 220 m. The platforms are connected via an underpass and are equipped in compliance with the relevant technical specifications for interoperability (INF TSI and PRM TSI).

Ćićevac station

- Existing state

Ćićevac station is an intermediate station on the Belgrade–Niš railway line with facilities to enable the reception and dispatch of passengers and freight. The station is unmanned and covered by the remote traffic management system (remote control). Ćićevac station has 4 main tracks, 1 manipulative track and 1 industrial track. The station has 2 passenger platforms and facilities for goods operations (warehouse and loading and unloading ramp).

The current state of the Ćićevac station is characterized by:

- the lack of a track to facilitate trains overtaking,
- the lack of shunting locomotive that would enable manoeuvring of trains to be carried out without disrupting traffic on the tracks of the open railway,
- low passenger platforms (non-compliant with the provisions of the Commission Regulation (EU) on technical specifications for interoperability related to the "infrastructure" subsystem and the accessibility of the railway system to persons with disabilities and persons with reduced mobility),
- the facilities for goods operations and the station building are not in good condition and need to be reconstructed.

- Newly designed state

Ćićevac station will remain an intermediate station on the double-track main railway Belgrade–Niš.

The requirements of the station are:

- Regulating train traffic,
- Receiving and dispatching local passenger trains,
- Receiving and dispatching freight trains with wagons for the industrial track,
- Shunting operations within the station to service the industrial track.

In order to meet these requirements, the station will be designed with 5 main tracks, 2 escape tracks, and 3 protection tracks:

- Tracks 2 and 3: Main through tracks.
- Tracks 1 and 4: Overtaking tracks, also used as arrival-departure tracks for local passenger trains.
- Track 5: Arrival-departure track for freight trains carrying wagons for the industrial track. The usable length of the track, including turnout overlap, is 659 m.

The station is designed with two platforms, each 220 m in length. The first platform is the main station platform located next to the station building, while the second is an island platform situated between tracks 4 and 5. The platforms are connected via an underpass and are equipped in compliance with the relevant technical specifications for interoperability (INF TSI and PRM TSI).

Korman station

- Existing state

Korman station is an intermediate station on the Belgrade–Niš railway line, with facilities to enable the reception and dispatch of passengers and freight. The station is unmanned and covered by the remote traffic management system (remote control). Korman station has 4 main tracks, 1 manipulative track and 1 short track for the accommodation of machinery. The station has 2 passenger platforms and facilities for goods operations (warehouse and loading and unloading ramps).

The current state of Korman station is characterized by:

- limited length of tracks intended for overtaking freight trains. The station meets the condition for freight trains to overtake with a length of 600 m (only for the 5th track), but not the condition for trains of combined and intermodal transport to overtake (i.e. a length of 750 m).
- low passenger platforms (non-compliant with the provisions of the Commission Regulation (EU) on technical specifications for interoperability related to the "infrastructure" subsystem and the accessibility of the railway system to persons with disabilities and persons with reduced mobility),
- the facilities for goods operations and station building are not in good condition and need to be reconstructed.

- Newly designed state

Korman remains an intermediate station on the main railway line Belgrade–Niš.

The main requirements of the station are related to traffic management and local passenger services.

Planned track capacities:

- two main through tracks on the Belgrade–Niš line (Tracks 2 and 3),
- two overtaking tracks (Tracks 1 and 4, with a usable length of 659 m),
- two tracks extending from the overtaking tracks for the formation of crossing routes.

The Korman station is designed with side platforms adjacent to the overtaking tracks, each 220 m in length.

Adrovac station

- Existing state

Adrovac station is an intermediate station on the Belgrade–Niš railway line, with facilities to enable the reception and dispatch of passengers and freight. The station is unmanned and covered by the remote traffic management system (remote control). Adrovac station has 5 main tracks and is also served by one industrial track. The station has 2 passenger platforms and facilities for goods operations (warehouse and loading and unloading ramps).

The current condition of Adrovac station is characterized by:

- limited length of tracks intended for overtaking freight trains. The station meets the condition of being able to overtake freight trains with a track length of 600 m, but not the condition of a useful track length of 750 m for the needs of overtaking trains of combined and intermodal transport on the 4th track;
- low passenger platforms (non-compliant with the provisions of the Commission Regulation (EU) on technical specifications for interoperability related to the "infrastructure" subsystem and the accessibility of the railway system to persons with disabilities and persons with reduced mobility),
- facilities for goods operations and the station building are in poor condition and are not in operation.

- Newly designed state

Adrovac station remains an intermediate station on the double-track Belgrade–Niš railway line. The main requirements of the station are related to train traffic management and servicing the industrial track.

Planned track capacities:

- two main through tracks (Tracks 2 and 3),
- two overtaking tracks (Track 1 with a usable length of 772 m and Track 4 with a usable length of 750 m),
- two arrival-departure tracks for freight trains, which can also be used for temporary storage and sorting of wagons for local operations (Track 5 with a usable length of 659 m and Track 6 with a usable length of 486 m),
- a track extending from Track 4 (on the Niš side) for servicing the industrial track and performing shunting operations,
- a pull-out track extending from Track 5 (on the Belgrade side) providing access to the industrial track,
- two tracks extending from the overtaking tracks for the formation of crossing routes.

Aleksinac station

Existing state

Station Aleksinac is an intermediate station on the Belgrade–Niš railway line, with facilities to enable the reception and dispatch of passengers and domestic and international freight. Both Korman and Adrovac Stations are under the supervision of Aleksinac station. Aleksinac station has 5 main tracks and 3 manipulative tracks. The station has 2 passenger platforms and facilities for goods operations (warehouse, loading and unloading ramps and a crane with manipulative surface).

The current condition of the Aleksinac station is characterized by:

- limited length of tracks intended for overtaking freight trains. The station does not meet the condition of being able to overtake freight trains with a track length of 600 m
- low passenger platforms (non-compliant with the provisions of Commission Regulations (EU) on technical specifications for interoperability relating to the "infrastructure" subsystem and to accessibility of the railway system for persons with disabilities and persons with reduced mobility),
- the facilities for goods operations and the station building are not in good condition and need to be reconstructed.

Newly designed state

Aleksinac station will remain an intermediate station on the Belgrade–Niš railway line, for both domestic and international passenger and freight traffic.

Planned track capacities:

- two main through tracks (Tracks 3 and 4),
- two arrival-departure tracks for passenger trains, also serving as overtaking tracks (Tracks 2 and 5),
- an arrival-departure track for local passenger trains that begin or end their journey at the station. This track is single-ended and allows the turnaround of local passenger trains in the direction of Niš,
- two arrival-departure tracks for freight trains, which can be used for temporary storage and sorting of wagons for local operations,
- a siding track for the storage of maintenance machinery (Track 2a),

- a siding track for storing passenger train sets awaiting operations (Track 2b),
- a loading-unloading track (Track 8),
- a pull-out track on the entry side from Belgrade, directly connected to the freight group of arrival-departure tracks and the loading-unloading tracks,
- four tracks for the formation of crossing routes and lateral protection of train movement paths. Two are extensions of the overtaking tracks, one is an extension of Track 1, and another is an extension of Track 2b,
- track connections on both entry sides of the station, enabling access to all station tracks from both mainline tracks for train movements in both directions.

Aleksinac station is planned with two island platforms, each 400 m in length, and one side platform, 150 m in length. The island platforms are located between Tracks 2 and 3, and Tracks 4 and 5, while the side platform is adjacent to Track 1.

Lužane station

- Existing state

The Lužane stop has two side platforms 85 and 77 m long, 1.6 m wide and 0.35 m high.

- Newly designed state

The primary role of the new Lužane station will be the boarding and alighting of passengers using local trains.

Planned track capacities:

- two main through tracks on the Belgrade–Niš line (Tracks 2 and 3),
- two overtaking tracks (Tracks 1 and 4, with a usable length of 266 m),
- two tracks extending from the overtaking tracks for the formation of crossing routes.

The Lužane station is designed with side platforms adjacent to the overtaking tracks, each 220 m in length

Tešica station

- Existing state

The Tešica stop has two side platforms next to the open railway tracks with a length of 102 m, a width of 1.6 m and a height of 0.35 m.

- Newly designed state

The new Tešica station will be an intermediate station on the double-track Belgrade–Niš railway line. The main requirements of the newly designed station are train traffic management, passenger boarding and alighting for local services, and handling freight. The station is planned to take over and consolidate the roles of the existing Grejač station and the Tešica stop.

Planned track capacities:

- two main through tracks on the Belgrade–Niš line (Tracks 2 and 3),

- two overtaking tracks (Tracks 1 and 4), where trains stop for passenger boarding and alighting,
- one handling track (Track 5) used for loading and unloading freight shipments,
- two tracks extending from the overtaking tracks for the formation of crossing routes. The track extending from Track 4 on the Niš side will also functions as a track for servicing the handling track,
- a short track extending from Track 4 on the Belgrade side, enabling a change of locomotive direction when moving between Tracks 4 and 5 without interfering with movements on the main through track.

The Tešica station is designed with two platforms, each 220 m in length. The first platform is the primary station platform located adjacent to the station building, while the second is an island platform situated between Tracks 5 and 6.

Trupale station

Existing state

Trupale station is an intermediate station on the Belgrade–Niš railway line and a branch station for the main line number 125: Trupale–Niš shunting station - Međurovo. It is also a transition station from a double-track to a single-track railway, and a border TK station (not included in the remote-control system). Trupale station has facilities to enable the reception and dispatch of passengers and road shipments. Trupale station has 6 main tracks and 1 manipulative track. The station has 2 passenger platforms and facilities for goods operations (loading and unloading ramp).

The current condition of the Trupale station is characterized by:

- limited length of tracks intended for overtaking freight trains. The station meets the condition of being able to overtake freight trains with a track length of 600 m, but not the condition of a useful track length of 750 m for the needs of overtaking trains of combined and intermodal transport;
- low passenger platforms (non-compliant with the provisions of the Commission Regulation (EU) on technical specifications for interoperability related to the "infrastructure" subsystem and the accessibility of the railway system to persons with disabilities and persons with reduced mobility),
- the facilities for goods operations and the station building are not in good condition and need to be reconstructed.

Newly designed state

Trupale station retains its role as a border station at the Niš railway junction, where the tracks for the Crveni Krst and Niš marshalling stations diverge. The main requirements of the station are related to train traffic management, passenger boarding and alighting for local services, and handling wagonload shipments on the handling track.

Planned track capacities:

- two main through tracks (Tracks 3 and 4),
- two overtaking tracks, which represent the direct continuation of the track to/from the direction of the Crveni Krst station (Track 2 with a usable length of 842 m and Track 5 with a usable length of 770 m),

- three receiving and dispatching tracks (Track 1 with a usable length of 633 m, and Tracks 6 and 7 with a usable length of 690 m),
- a handling track with a long (military) ramp of 400 m in length) used for loading and unloading goods. The usable length of the track is 633 m,
- two tracks extending from Tracks 1 and 2 for the formation of crossing routes. The track extending from Track 1 will be used as a track for servicing the handling track,
- track connections on both entrance sides of the station, allowing connections of all station tracks with the tracks of the connecting railway line for both directions of train movement and simultaneous train operations.

Trupale station is designed with two island platforms, each 400 m in length (located between Tracks 1 and 2, and between Tracks 5 and 6).

2.3.11. Tunnel

The Đunis tunnel will be newly constructed and will be 580 m in length. The tracks will be 4.0m distance apart, and the axis will be curved with a radius of 3002 m, to enable a design speed of up to 160 km/h. The entrance portal is at km 192+274, and the exit portal is at km 192+854.

The tunnel is designed to facilitate the application of modern tunnel construction technology (the concept of the New Austrian Tunnelling Method - NATM.)

2.3.12. Signalling Infrastructure

- Existing state

The electro-relay signaling system of the double-track, Belgrade–Niš railway was completed around 45 years ago, with certain sections subsequently being reconstructed. The ageing system increasingly suffers from failures and maintenance costs are increasing. Furthermore, it is becoming increasingly difficult to source replacement components. As such, the signalling technology needs to be replaced. The replacement of signalling components must be conducted in accordance with strict procedures, including the preparation and verification of a safety analysis.

All Project stations are covered by the Westinghouse Flexicode Centralised Traffic Control (CTC) system, controlled from the TK Centre in Belgrade Ranžirna station.

- Newly designed state

The Project will be equipped with conventional electronic signal safety devices, with visual signals and devices to control the speed of trains, and a centralized automatic railway block, so that trains equipped with an autostop device will be automatically stopped in an emergency when travelling at speeds of up to 160 km/h .

Also, the Project should meet the interoperability requirements for trains equipped with ETCS L2 locomotive train control devices and enable train traffic to achieve speeds of up to 200 km/h on both tracks.

The intended signal-safety equipment must meet requirements for reliability and the possibility of expansion. It must also satisfy the principles of failure safety and comply with the relevant technical standards of the European Union, as well as national standards.

The technical solution envisages equipping all stations with electronic signalling and interlocking devices (CBI) for double-track railways, with centralized setting of switch points (by means of an electric switch point machine) and automatic routing of trains through the station area. The signalling and interlocking devices will include all the necessary equipment (interfaces) to enable connection to the transmission system that connects to the CTC (TK Centres in Belgrade Ranžirna station and Niž Putnicka station), the European Train Control System (ETCS), and the Centralised Signalling Monitoring System (CSM).

The main source of power for signalling and interlocking devices is the public distribution network. The overhead railway electrical contact network 25 kV, 50 Hz is a backup power source, and accumulator batteries positioned at intervals along the railway line are an auxiliary power source. The power supply device for each station will be designed to provide complete power supply for all signalling and interlocking devices for at least 3 hours, as well as a power supply for the red lights on the main signals for an additional 8 hours.

Specific signalling system design features are as follows:

- New signal lights will be installed equipped with LED bulbs.
- Switching points and derailers in all stations will be equipped with an electric switch point machine adapted for concrete sleepers.
- Control of occupation of stations and interstation sections will be carried out by using an axle counter device (which detects whether a section of track is occupied or clear).
- Cables with polyethylene insulation, i.e. optical cables, will be used to connect external security elements.
- Existing rooms for the accommodation of signalling and interlocking equipment in the stations will be adapted according to the valid technical conditions and standards for the proposed electronic equipment.
- Devices for the electric heating of switch points will be installed in all stations, using power supply from the catenary line (SCADA system with a central dispatch terminal, station terminals and control cabinets per station).

It is also planned to install new signalling and interlocking devices in the CTC Centre in Belgrade Ranžirna, that is planned to be the Unified Dispatch Centre for the entire Serbian railway network.

2.3.13. Telecommunication Infrastructure

- Existing state

The existing railway telecommunication infrastructure includes old copper cables connecting local networks with dispatching and railway telephone devices, switching facilities and transmission systems, radio-dispatch systems, the business-information system (computer network with server structure), and security systems.

The existing systems rely on analogue technology and are outdated. It is therefore necessary to replace them with updated systems that will meet the requirements of a modern railway.

- Newly designed state

The planned telecommunication systems will ensure the reliable and smooth running of railway traffic, and operation of a modern passenger information system.

The planned telecommunication systems include:

- cable infrastructure
- dispatch and railway telephone devices
- radio dispatch system
- GSM-R wireless communications system
- transport system
- station telecommunication systems
- security systems.

Cable infrastructure

The planned cable infrastructure envisages laying fibre optic cable (FOC) along the entire length on both sides of the reconstructed railway. Cables will be single mode with 96 and 48 optical fibres. Flexible FOC will also be introduced in each fully operational station.

A separate FOC with a capacity of 48 fibres is foreseen for connecting the telecommunication, signal and power systems in official places and at points along the Project route where FOC have not been introduced.

A new local cable network is also planned in all stations, which will connect to all local railway facilities and telecommunications.

Dispatch and railway telephone devices

All existing station dispatcher railway telephone devices and telephones at station entrance and exit signals will be dismantled, as well as all telephones on the open railway (e.g. telephones at level crossings).

New integrated digital station dispatch telephone devices (central devices with telecommunication desk and anti-vandal telephones on input and output signals) are foreseen in all stations. Telephones will be installed in anti-vandal housings on the open track, with selective transmitters for spatial signals and telephones.

Radio dispatch system

The radio dispatch system will continue to function as it currently does but will be adjusted to respond to the new railway route, track situation and traffic management centres. The existing analogue radio stations will be replaced by devices incorporating modern technology, whilst ensuring interoperability with existing systems.

GSM-R Wireless Communication System

A GSM-R system is envisioned as an information transfer platform for ETCS L2 (primary) and a platform for voice communication and other services between railway staff. The system must be interoperable with the European rail traffic management system.

Transmission systems

The planned transmission system will include the following:

- SDH system for transmission of critical services of telecommunication and signalling devices, for the ETCS L2 system and remote control of stable electric traction plants, with traffic protection, which ensures a very fast response, better than 50 ms, in case of failure of a network element or interruption of an optical cable.
- DWDM system for transmission of non-critical services based on IP solutions.
- The IP network organized through the MPLS structure ensures the coverage of control centres with IP networks based on Ethernet technology at speeds of 10Gbps. The MPLS network must be connected to the existing Intranet network.
- Synchronization networks (with primary and secondary sources of synchronization);
- Management and monitoring system (NMS) of transport systems, that is, of all network elements of this system, which must be geo-redundant.

Station telecommunication systems

All railway stations will be equipped with the following telecommunication systems:

- Telephone and computer installation performed according to the principle of structural cabling within the common communication network.
- Railway automatic telephone (RAT) network intended as a centralized VoIP telephony system for railway staff communication on the entire railway section.
- The clock system is planned on the basis of IP technology and equipment, which includes central equipment (master clock and GPS receiver) and secondary IP clocks in all official places.
- Integrated system for visual and audio passenger information (AVIS) designed on IP technology and equipment. The system includes central and peripheral equipment that is installed in all official places and includes speakers and equipment for announcing and informing passengers, information boards, etc.

- A video surveillance system designed on IP technology and equipment that provides recording, monitoring and review of recorded material, placed at locations inside and outside the facilities and aims to monitor the movement of passengers and protect critical locations.

Safety systems

All railway stations are equipped with the following safety systems:

- Access control system
- Burglary protection system
- Fire detection system
- SOS system.

2.3.14. Electrification

- Existing state

The contact network of the Belgrade–Niš railway is electrified with a single-phase 25kV, 50Hz system.

Following an inspection of the state of existing transformer stations (TS) devices and equipment, it was determined that TS have been in operation for over 50 years, the equipment is outdated and the transformers have worn out.

- Newly designed state

The existing contact network will be removed and a new network installed at the following facilities:

Paraćin – Stalać Sub - Section

- Paraćin station
- open railway line Paraćin–Sikirica
- Sikirica station
- open railway Sikirica – Ćićevac
- Ćićevac station
- open railway Ćićevac – Stalać

Đunis – Trupale Sub - Section

- open railway line Đunis – Korman
- Korman station
- open railway line Korman – Adrovac
- Adrovac station
- open railway line Adrovac – Aleksinac
- Aleksinac station

- open railway line Aleksinac - Lužane
- Lužane station
- open railway line Lužane - Tešica
- Tešica station
- open railway line Tešica - Trupale
- Trupale station

The electrification of both tracks on sections of open railway is planned, as well as all tracks within stations, in accordance with technological requirements.

All existing equipment will be dismantled and replaced with more modern equipment in the existing sectioning plants (PS) namely, Paraćin, Aleksinac, Trupale and sectionalizing plants to provide neutral zones (PSN) Sikirica and Tešica.

2.3.15. Fencing

Given the category of the railway line and the design speed of up to 200 km/h, the design envisages that the railway line will be fenced with the type of fence used for highways. The purpose of the fence is to protect against and deter unauthorized/uncontrolled access to railway facilities and equipment by people and animals (thus reducing the risk of an accident or collisions and vandalism). A 1.80 m high fence will be installed on both sides of the railway line, at a distance of 1.0m from the toe of the embankment. A 5m wide zone will be reserved outside of the fence for service roads. The fencing will consist of:

- 3mm diameter galvanised steel wire,
- A 50 mm square mesh structure,
- Circular galvanised steel fence posts (installed in concrete foundations).

2.3.16. Environmental design

The design includes the following provisions to mitigate environmental impacts:

Wildlife crossings

In order to reduce the potential for wildlife-train collisions (WTC), where fences are planned, these will be designed specifically to prevent wildlife access at identified locations (e.g. will be higher). Additionally, existing culverts beneath the railway will be adapted for reptile migration. Locations of all wildlife crossing are provided in the Biodiversity Chapter 14.

Noise barriers

Noise mitigation measures are planned for all residential and other sensitive areas that will be exposed to nuisance noise levels, i.e. those exceeding the limits established by Serbian legislation and/or Project standards. The design of noise barriers shall comply with provisions of the National and European legislation, as well as corresponding standards: SRPS EN 16272-1, SRPS EN 16272-2, SRPS EN 16272-3-1, SRPS EN 16272-3-2, SRPS EN 16727-1, SRPS EN 16727-2-1, SRPS EN 16727-2-2, SRPS EN 16727-3, SRPS EN 16951-1 and SRPS EN 16951-2. The acoustic panels that will be used as noise barriers shall have a sound absorption capacity of at least 12 dB (class A4 in accordance with SRPS EN 16272-1) and soundproofing of at least 25 dB (class B3 in accordance with SRPS EN 16272-2). Further details are provided in the Noise and Vibration Chapter 12.

Rubber pads

Vibration mitigation measures are planned for all residential and other sensitive areas that will be exposed to vibration levels exceeding the limits established by the Project. As a primary solution, technical measures will be applied on the track, including the use of rubber pads beneath the rail fastening system and sleepers, as well as under ballast mats to minimize vibration from trains. Further details are provided in the Noise and Vibration Chapter 12.

Environmental design of Stations

It is intended that all Stations will be designed to minimize resource requirements (energy and water) as far as practicable. The designs for stations are ongoing at the time of this assessment but measures may, for example, include the use of LED light bulbs, installation of thermal insulation in roofs and double glazed windows, low flow and infrared taps.

2.4. Associated facilities

Associated facilities are defined by:

- EBRD´s Environmental and Social Policy, as “facilities or activities which are not financed by EBRD as part of the project, but which are significant in determining the success of the project or in producing agreed project outcomes. These are new facilities or activities without which the project would not be viable, and would not be constructed, expanded, carried out or planned.”
- EIB E&S Standard 1 as, Ancillary/Associated Facilities/infrastructure are “(i) assets and facilities directly owned or managed by the promoter that relate to the project activities to be financed, (ii) supporting activities, assets and facilities owned or under the control of parties contracted for the operation of the promoters business or for the completion of the project (such as contractors); (iii) associated facilities or businesses that are not funded by the EIB as part of the project and may be separate legal entities yet whose viability and existence depend exclusively on the project or whose goods and services are essential for the successful operation of the project.”

Should any new high voltage lines have been needed they would have been Associated Facilities. However, there are no such new lines required for the Project and as such, there are no Associated Facilities for this Project.

2.5. Construction Approach

The overall project timeline, as anticipated at the time of this assessment, is outlined in Table 2-18.

Table 2-18. Project timeline

Project Stage	Timeline
Preliminary Design	July 2022 to Octobar 2025
Tender Process for Construction Contractor	November 2025 to August 2026
Detailed design	August 2026–June 2027
Construction phase	June 2027–June 2030
Readiness Testing	June 2030–November 2030
Operational phase	From November 2030

2.5.1. Overview of the construction phase

Construction works will be undertaken by the main Project Construction Contractor, is planned to be in accordance with the timeline indicated in Table 2-18. The appointed Construction Contractor will define the exact construction programme and methodology. However, for the purposes of this ESIA, assumptions have been made regarding the likely construction programme and activities that will be performed; based on similar railway construction projects (including in the Republic of Serbia). This includes the assumption that many construction activities will be performed concurrently at multiple locations along the Project alignment.

The assumed likely key construction activities are summarised below. Works have been classified according to both type and methodology, as stated below:

- Preliminary works
- Permanent works, and
- Finishing works

Preliminary works

Preliminary (or enabling) works will be undertaken to prepare the Project area for the construction of permanent infrastructure, and include the following activities:

Table 2-19. Preliminary works

Preliminary works

Clearing the ground and cutting bushes and trees
Setting out the alignment
Establishing temporary construction sites and material storage areas
Establishing workers accommodation camps if necessary
Building haul roads
Haulage and stockpiling of substructure and permanent way material
Dismantling and removing existing low platforms
Removing and scarifying pavement on level crossings
Demolishing and removing the existing structures of solid material

Permanent works

Permanent works can be divided into the following six sub-groups: earthworks, drainage works, works on structures, works on permanent way structure, electrical works and hydraulic engineering works. The activities that come under each sub-group are listed in Table 2-20.

Table 2-20. Permanent works

Earthworks
Stripping and storage of topsoil, and removal and storge of sub-soil
Removal of the existing ballast
Bulk excavations
Stepped excavation in the existing embankments
Embankment construction and control of tamping work
Levelling and rolling of subgrade
Construction of 40 cm thick transition layer together with levelling and rolling
Excavation together with construction of platform walls
Placement of material for platform covering
Preparation of the bed for placement of Behaton paving blocks
Placement of 30 cm thick protective cover with levelling and rolling
Reinstatement of slopes with topsoil
Drainage works

Trenching for laying of drain pipes, inspection manholes and discharge pipes
Laying of drain pipes of various diameter
Placement of geotextile
Construction of Ø1000 inspection manholes
Placement of filter layer
Placement of discharge pipes of various diameter together with backfilling
Construction of lined concrete ditches
Construction of concrete channels
Works on structures
Works on subway construction
Works on culvert construction
Tunnel construction (see below)
Works on bridge construction (see below)
Works on construction of underpasses and overpasses
Works on construction of noise suppression walls
Works on construction of new buildings
Works on reconstruction and rehabilitation of the existing buildings
Works on canopy construction
Works on station plateau development
Works on construction of access roads
Works on permanent way structure
Dismantling the existing track
Dismantling the existing switches
Assembly and laying of track
Assembly and installation of switches
Ballast placement
Mechanical aligning and dynamic stabilization of track to level and grade
Mechanical aligning of switches to level and grade
Installation of anti-creep devices
Welding of rails into long sections
Hydraulic engineering works

Partial displacement and protection of the existing water supply and sewerage installations in the area affected by works
Works on drainage of subways and underpasses
Placement of indoor and outdoor hydraulic installations within the station complex
Drainage of access (service) roads
Water course regulation

Table 2-21. Electrical installations

Electrical installations	
WORKS ON SIGNALLING/INTERLOCKING AND TELECOMMUNICATION	Displacement and protection of telecommunication cables and devices
	Defining cable routes, trenching and laying signalling/interlocking and telecommunication cables
	Trenching, laying of local signalling/interlocking and telecommunication cables in stations
	Placement and connecting indoor and outdoor signalling/interlocking and telecommunication equipment
	Testing and starting operation of signalling/interlocking and telecommunication devices and cables
WORKS ON OCS AND TRANSFORMER STATIONS	Dismantling the existing Overhead Catenary System (OCS) fittings
	Excavation and foundation construction for OCS masts
	Erection of masts and mounting of OCS fittings
	Installation of catenary system, OCS fittings grounding of OCS masts
	Catenary system adjustment
WORKS ON POWER SUPPLY AND ETF INSTALLATIONS	Introduction of a new remote-control system in newly-constructed sectioning posts and sectioning posts with neutral section
	Reconstruction of existing and construction of new electric traction fixed installations

Tunnel Construction

In accordance with the prevailing geotechnical conditions, a tunnel structure with a base vault (applicable to the part of the tunnel that is built in a rock complex of category IV and V according to the RMR classification) is proposed for the entire length of the tunnel (excepting the entrance and exit points). This is illustrated in Figure 2-21.

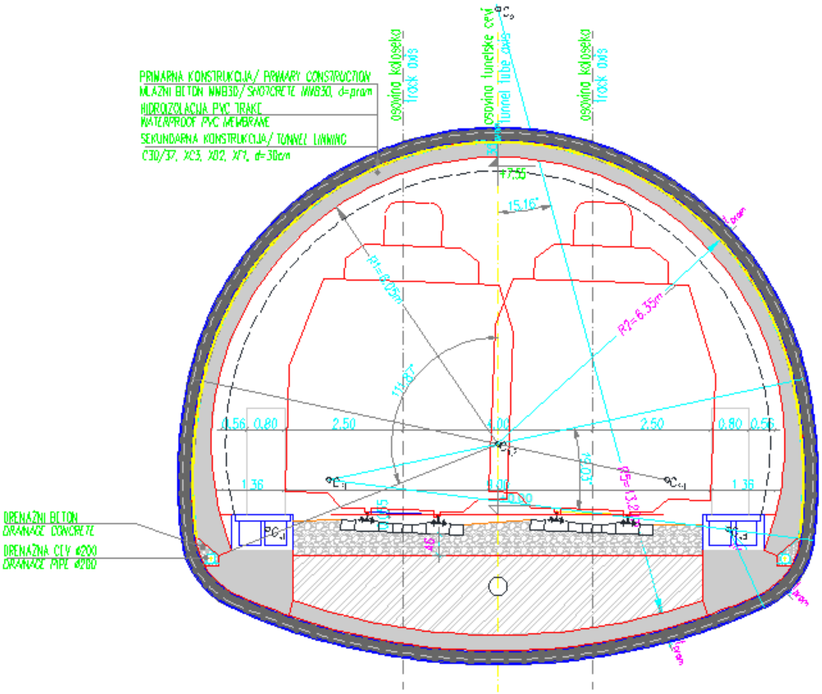


Figure 2-21. Tunnel structure with base vault

At the entrance and exit points of the tunnel, the construction approach will be cut and cover. Here, the tunnel structure will comprise a reinforced concrete vault, with a minimum thickness of 60 cm on a concrete slab, made of concrete quality C30/37.

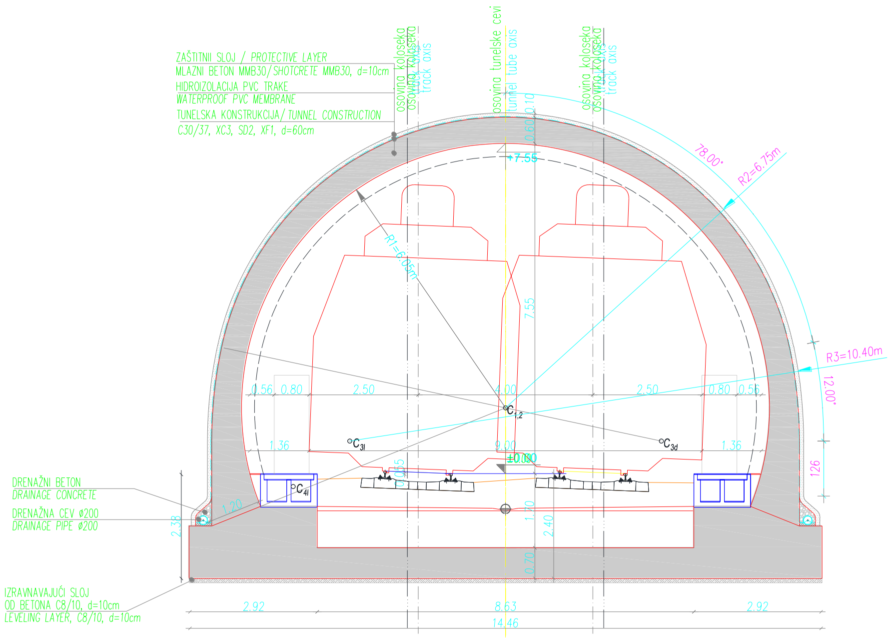


Figure 2-22. Tunnel structure for cut and cover sections

Bridge Construction

For structures where the newly designed railway alignment coincides with the existing one, a phased construction method will be adopted, including excavation support and the protection of the existing embankment using steel sheet piles. The existing structures will be demolished while maintaining uninterrupted traffic on a single track. This will be achieved by demolishing one half of the existing structure first, while traffic continues on the undisturbed half, and constructing one half of the new structure. Subsequently, the second half of the existing structure will be demolished, and the remaining half of the new structure built, with traffic redirected to the newly completed portion. Once traffic has been established along the newly designed tracks, the remaining construction will be carried out.

Monolithic structures will be constructed through in-situ concrete pouring. For structures where the main girders consist of pre-stressed prefabricated beams, these beams will be delivered to the site and then integrated by casting the deck slab and transverse girders in place.

The abutments are reinforced concrete walls supported on piles via pile caps. If the piers are located in water, excavation is protected using steel sheet piles. The foundations are constructed on bored piles.

Finishing works

Finishing works shall be performed upon completion of the permanent works and shall include the activities listed in Table 2-22.

Table 2-22. Finishing works

Finishing works on the railway line
Stress relief and final welding
Stress relief of switches and final welding
Placing lineside markers (km signs, hectometre signs, curve, and continuous rail length markers)
Placing gradient posts
Placing fouling points in switches
Reinstatement of all temporary works areas (camps, construction areas etc) to near original condition
Landscaping and tree planting
Technical acceptance of the specified alignment segment
Putting into operation the segment of the alignment (track)

Construction Plant and Vehicles

Table 2-23 shows two potential combinations of construction plant and vehicles required for the execution of earthworks including on the sub-structure (the most extensive works during the construction phase).

Table 2-23. Choice of plant/vehicles for earthworks (2 combinations)

Activities / Machinery		Bulk and stepped excavations	Loading of material	Haulage of material	Unloading of material	Spreading of material	Fine levelling	Wetting	Rolling and tamping
1	Bulldozer								
	Loader								
	Truck								
	Light bulldozer								
	Grader								
	Tank truck								
	Sheepsfoot vibro roller								
	Vibro plate								
2	Dredger								
	Truck								
	Light bulldozer								

	Grader								
	Tank truck								
	Sheepsfoot vibro roller								
	Vibro plate								

Table 2-24 shows the machinery assumed to be required for works on road construction, in accordance with the type of the pavement structure.

Table 2-24. Machinery for road construction

Activities Machinery		Mixing	Loading	Haulage and unloading	Spreading	Tamping
A	Loader					
	Truck					
	Grader					
	Sheepsfoot vibro roller					
	Sheepsfoot rollers					
B	Concrete plant					
	Truck – agitator truck					
	Grader					
	Sheepsfoot vibro roller					
C	Asphalt plant					
	Truck					
	Finisher					
	Tandem roller					
	Rubber wheeled roller					
	Smooth wheel roller					

A	Graded gravel
B	Cemented gravel
C	Asphalt pavement layers

Table 2-25 shows the machinery assumed to be needed for works on the permanent way structure, related to the dismantling and lying of track.

The following sequence of activities will be followed when executing the works on the removal of the existing track and switches. First, rails will be cut into sections 25.20 m long with a machine specialized for works on substructure and permanent way and then loaded onto the flat wagons together with sleepers by means of crane and hauled to the area planned for dismantling and stacked for further handling. The existing ballast bed shall be then removed with standard construction machinery: loaders and trucks. The track will be dismantled in situ and hauled in sections (rails, sleepers, and track fastenings) to the area planned for stacking of permanent way members as specified by SRI. Excavations and the accompanying earthworks that will require the machinery specified in Table 2-23 shall commence upon removal of both the track grating and ballast.

Works on the placement of permanent way structure shall be executed by machinery specialized for the laying of track and switches. A ballast plough will be used for ballast placement and tamping machines used for aligning track to line and grade.

Table 2-25. Machinery for permanent way laying

Activities / Machinery	Removal of the existing track and switches	Removal of the existing ballast	Laying of track and switches	Ballast placement	Mechanical aligning
Locomotive					
Flat wagons					
FAD wagons					
Vehicle-mounted crane or gantry crane					
Loader					
Tipper truck					

Machinery specialized for permanent way					

Construction Materials and Waste

The Contractor will be responsible for sourcing construction materials and the management of all wastes generated during the construction phase in accordance with the provisions of the ESMP. Construction materials including sand, gravel and rock are likely to be sourced from existing or new quarries, since such materials need to meet prescribed quality standards. Material arising from excavations or deconstruction of existing embankments will be re-used subject to testing if it meets such standards.

Concrete and asphalt will either be sourced from existing plants and delivered by truck to the construction site, or Project specific concrete batching and/or asphalt plants will be established by the Construction Contractor. Excess spoil material which cannot be re-used in the construction of the Project may be able to be re-used in other projects or will be disposed of in designated spoil disposal areas.

More information is provided in Chapter 16 Waste and Materials.

Construction Workforce

At the time of this assessment, no detailed information is available on the required or planned workforce. This will be determined by the appointed Construction Contractor.

Construction will be completed in phases, and not all workers will be employed all the time. The frequency at which workers will be employed and the duration of their engagement will depend on the contractors' organisation of work. Based on similar projects in Serbia, it is possible that the workforce may reach 3,000 at its peak. The workforce could include foreign workers, especially having in mind the deficit of workers in the construction sector in Serbia and the numerous ongoing infrastructure projects in other parts of the country. It is expected that approximately 15% of the workforce will need to be professional workers (such as engineers), 35% skilled workers (such as welders), 25% semi-skilled workers (such as construction drivers) and 25% unskilled workers (such as labourers).

Construction Compounds and Construction Workers Accommodation

Construction compounds for site offices, and the storage of materials and equipment will be required. These areas will likely include parking, materials storage and warehouse areas, fuel storage, waste segregation ad temporary storage facilities, healthcare facilities, and catering / canteen facilities. Based on the scale of the Project and the potential number of workers, it is likely that these areas may also include accommodation facilities for the workforce (which will additionally include dormitories, laundry and recreation facilities).

The Construction Contractor will be responsible selecting the location of these facilities, with consideration of potential environmental and social impacts, as outlined in the ESMP. If these facilities are located outside of the permanent way (i.e. land acquired for the Project) the Contractor will also be responsible for making temporary agreements with landowners and users as described in the RPF.

Arranging the provision of utilities (water and electricity), wastewater and waste management, as well as telecommunications to construction compounds, camps and the construction area will also be the responsibility of the Construction Contractor. It is assumed that back-up generators will be made available in the event of an electricity outage. It is assumed that non-potable water (e.g. for flushing toilets) will either be pumped from groundwater sources or sourced from the local municipal supply network. If necessary, pumped groundwater will need be filtered to remove particles, and if it is to be used for any other purposes besides flushing toilets, it will likely require further treatment (such as ultraviolet treatment or chemical additions). Drinking water for the construction workforce is expected to be delivered in bottles to the construction compounds. Sanitary wastewater will need to be treated on-site through a bespoke treatment plant or transported by truck to the nearest compliant municipal waste treatment facilities for treatment and disposal.

All accommodation must meet the requirements of the IFC and EBRD guidance note: Workers' accommodation: processes and standards (2009). The Contractor may decide to use local, private accommodation, which must first be subject to screening and risk assessment to ensure facilities meet these standards and do not pose significant social impacts to local communities. The Contractor will be required to develop a Workforce Accommodation Management Plan to manage and mitigate potential impacts of accommodation as described further in Chapter 19 Social.

Access Routes

The Contractor will define existing and any new access routes required for Project vehicles and equipment to access construction sites, compounds and worker accommodation. It is expected that the existing main national road network and Motorway E75/A1 will predominantly be used to access smaller existing roads in the proximity of the Project (Figure 2-23 and Figure 2-24).

Construction plant and equipment will be able to travel along the permanent way once preliminary works have been completed. New temporary access routes may be needed where existing access is limited, including in areas where the new alignment deviates from the existing alignment. Any land required for such roads will need to be acquired in accordance with the provisions of the RPF. The Contractor will be responsible for assessing the suitability of existing routes to carry project vehicles and equipment, carrying out upgrades to any existing roads and repairing any damage to existing roads as a result of the Project. In addition, the selection of all routes must consider the presence of sensitive receptors (e.g. schools; residential areas) appropriate mitigation measures must be implemented as described further in Chapter 19 Social and the ESMP.

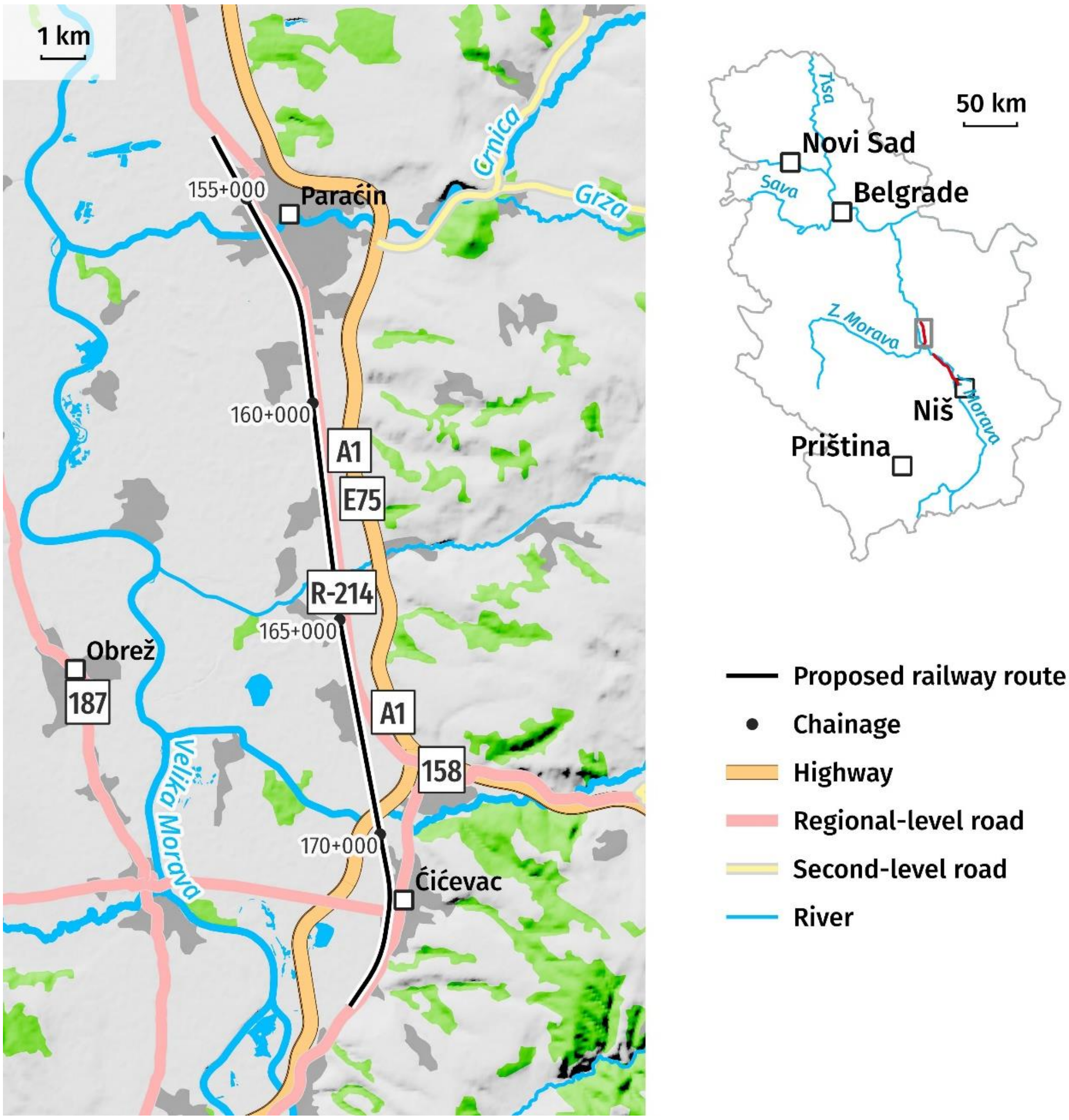


Figure 2-23. Overview of the existing road network relative to Paraćin – Stalać sub-section

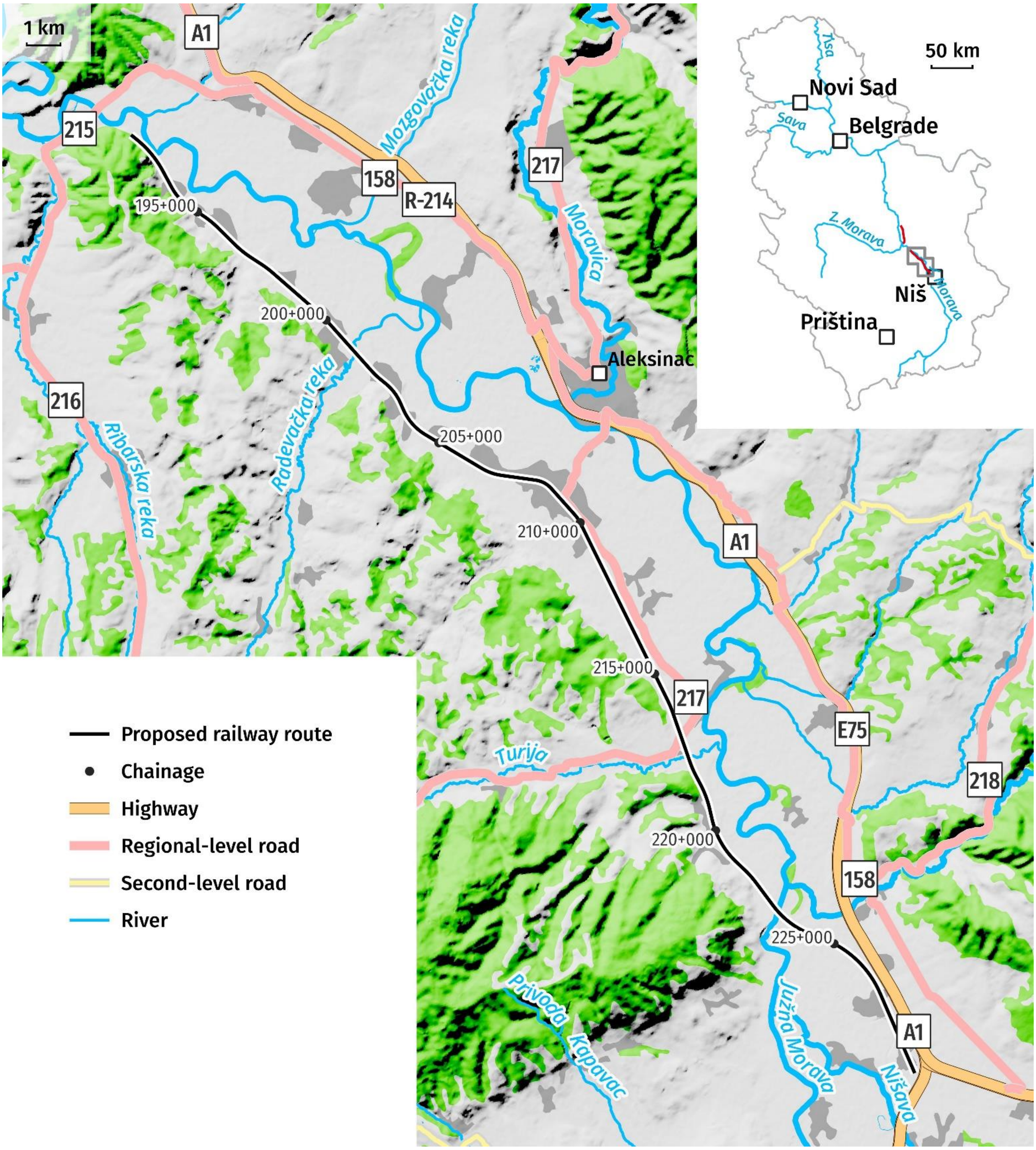


Figure 2-24. Overview of the existing road network relative to Đunis – Trupale (Niš) sub-section

Security

The Contractor will be responsible for the security of all Project worksites, plant and equipment, construction compounds and worker accommodation. This is expected to comprise a combination of fencing, access controls and security personnel, potentially provided by a private security sub-contractor.

Decommissioning of the existing railway

In sections where the new railway alignment deviates from the existing route, the railway structure will be decommissioned and the superstructure of the railway line (rails, sleepers, ballast, fastenings) and substructure will be removed. Such areas may then be utilised for biodiversity restoration as described in the Biodiversity Chapter 14. In exceptional cases, the substructure of the railway line can be retained if there is a need by the local government for it to be used for the construction of a road.

2.6. Commissioning and Testing

Upon completion of the construction works commissioning and testing of the Project will commence. This will include:

- Progressive verification and validation through inspection and testing, that all rail systems and structures operate correctly and meet the Project requirements including all specifications and standards;
- Verification that all safety requirements are met including specific tests to show that safety features operate correctly;
- Specific tests of fault conditions to show that redundancy features and emergency and protective features work as intended and that single fault conditions do not have catastrophic consequences;
- Integration testing to show that the railway performs safely and meets operational requirements through: (i) undertaking test runs, whereby the speed is gradually increased to reach the maximum speed for the trains; and (ii) undertaking test runs, whereby the number of trains operating on the line is gradually increased to reach the maximum number of trains.

The exact details of the commissioning and testing activities will be developed by the Construction Contractor and managed in accordance with the ESMP.

All of the commissioning and testing should be clearly documented as to:

- Details of the test procedure, equipment, and methodology;
- A clear description of the pass/fail criteria;
- Recording of actual results to ensure there is a clear audit trail showing the successful completion of commissioning and testing.

2.7. Operation and Maintenance

SRI will be responsible for the operation and maintenance of the railway infrastructure. This will involve routine, planned maintenance and system testing, as well as ad-hoc maintenance and repairs. Maintenance activities will include, among other things, the replacement of ballast, sleepers, rails, fastenings, switches, and component parts of the overhead line system, etc.

It is likely that the maintenance regime would be inclusive of, but not limited to:

- Replacement of the ballast yearly where needed, or regular complete replacement on 20-year basis;
- Replacement of component parts of the Overhead Line System on a 15 -year basis depending on usage;
- Replacement of component parts of the catenaries (part of the Overhead Line System), for example the contact wires, on a regular basis (40 years). There will be different wear rates for each electromechanical component part; and
- Replacement of the components of the signalling and telecommunication systems on a 15 -year basis, with the supporting radio frequency cabling being replaced on a 25-year basis and the antenna towers on a 30-year basis.

The design life of structures such as the rail track, platforms, footbridges, and all ancillary structures is approximately 20 years.

Maintenance activities would be planned to enable them to be conducted safely, and in a manner that minimises disruption to the operation of the railway where practicable. The maintenance of trains will be carried out at Technical Passenger Station (TPS) Zemun. This station is currently being reconstructed and modernized to satisfy the requirements for the maintenance of modern trains, including depot areas.

2.7.1. Forecast Train Movements

The total number of passenger and freight trains has been derived from the timetable developed under this assignment for the year 2060. Detailed information on the number of trains per time period (day, evening, night) is presented in the tables below.

The maximum projected number of trains per day in 2060 is expected to reach 174 on the Paraćin– Trupale section.

However, the total forecasted traffic cannot be fully represented by focusing solely on this subsection. Each subsection within Section 3 (Paraćin–Trupale) has specific operational characteristics and projected train volumes. Therefore, the forecasted number of train movements has been disaggregated and is presented for each subsection in the table below

Table 2-26. Forecast number of trains on the Paraćin–Stalać sub-section

Paraćin – Sikirica/Ratare sub-section					
Train category	Train type	Day	Evening	Night	Total number of trains
		6.00-18.00	18.00-22.00	22.00-06.00	
Passenger	Local	21	10	7	38
	Regio	16	7	5	28
	High-speed	21	8	5	34
	EuroCity	8	-	-	8
	EuroNight	-	-	4	4
Freight	-	23	8	31	62
Total		89	33	52	174
Sikirica/Ratare - Ćićevac sub-section					
Train category	Train type	Day	Evening	Night	Total number of trains
		6.00-18.00	18.00-22.00	22.00-06.00	
Passenger	Local	21	10	7	38
	Regio	16	8	4	28
	High-speed	21	8	5	34
	EuroCity	8	-	-	8
	EuroNight	-	-	4	4
Freight	-	23	8	31	62
Total		89	34	51	174
Ćićevac - Stalać sub-section					
Train category	Train type	Day	Evening	Night	Total number of trains
		6.00-18.00	18.00-22.00	22.00-06.00	
Passenger	Local	21	10	7	38
	Regio	17	7	4	28
	High-speed	21	8	5	34
	EuroCity	8	-	-	8

	EuroNight	-	-	4	4
Freight	-	23	8	31	62
Total		90	33	51	174
Đunis - Aleksinac sub-section					
Train category	Train type	Day	Evening	Night	Total number of trains
		6.00-18.00	18.00-22.00	22.00-06.00	
Passenger	Local	10	6	2	18
	Regio	8	4	2	14
	High-speed	21	8	5	34
	EuroCity	8	-	-	8
	EuroNight	-	-	4	4
Freight	-	23	10	33	66
Total		70	28	46	144
Aleksinac - Trupale sub-section					
Train category	Train type	Day	Evening	Night	Total number of trains
		6.00-18.00	18.00-22.00	22.00-06.00	
Passenger	Local	24	8	2	34
	Regio	8	4	2	14
	High-speed	21	8	5	34
	EuroCity	8	-	-	8
	EuroNight	-	-	4	4
Freight	-	23	10	33	66
Total		84	30	46	160

3. LEGAL FRAMEWORK

The environmental and social legislation and regulations applicable to the Project are numerous and diverse. Therefore, only the most relevant are presented in this Section. A full and detailed list will be developed as part of the Environmental and Social Management System (ESMS) for Project construction and operation.

3.1. National Environmental and Social Regulatory Framework

The legislative and institutional framework for environment and society i.e. social considerations in Serbia, is founded on the Constitution of Serbia, which stipulates the right to a healthy environment and the duty of all, in line with the law, to protect and enhance the environment. Health and environment are also supported by many governmental strategies, international agreements and the Millennium Development Goals. Environmental legislation in Serbia has over 100 laws and regulations. Currently, the majority of these are harmonized with EU directives and other legislation.

The Constitution of the Republic of Serbia (RoS) was approved in the constitutional referendum held on the October 28-29, 2006, and was officially proclaimed by the National Assembly of Serbia on November 8, 2006. Constitution of RoS proclaims the rule of law and social justice, principles of civil democracy, human and minority rights and freedoms, and commitment to European principles and values. Article 58 generally acknowledges guarantees of peaceful tenure of a person's own property and other property rights acquired by law. It states that rights of property may be revoked or restricted only in the public interest established by law and with compensation which cannot be less than market value. It is important to note that the Constitution of RoS prohibits the payment of compensation less than the "market value", but allows the payment over the established market value, which is an important provision for bridging gaps between Serbian laws and EIB resettlement policies, as will be presented later in this document. The provisions of the Constitution also do not differ property (buildings etc.) constructed without a building permit, a practice that became common during last 30 years in RoS. The Constitution further proclaims that all human rights (including the right of property) and minority rights guaranteed by the Constitution shall be implemented directly.

According to Article 74 of the Constitution:

- Everyone shall have the right to live in healthy environment and the right to timely and full information about the state of environment.
- Everyone, especially the Republic of Serbia and autonomous provinces, shall be accountable for the protection of environment.
- Everyone shall be obliged to preserve and improve the environment.

The following table presents the key national laws and regulations applicable to the reduction of potential environmental and social impacts that may result from the construction and operational activities of the Project.

A more detailed presentation of legislation related to information disclosure and consultation, land acquisition and labour and working conditions is provided in separate sections further in the text.

Table 3-1. Main national legislation regarding environmental and social parameters

Laws and regulations	Official gazette Republic of Serbia	Relevance
Law on Environmental Protection	98/2023	The Law on Environmental Protection is the framework national environmental law in Serbia. It currently serves as the main legislation concerning environmental protection and is harmonized with the Council Directive 2003/105/EC, which amends Council Directive 96/82/EC on the control of major-accident hazards involving dangerous substances (Seveso II Directive). The main objectives of the Law on Environmental Protection are: • Conservation and improvement of the environment. • Control and mitigation of pollution to protect the environment. The key focus areas of the Law on Environmental Protection include: • Declaration of ecologically critical areas and the restriction of operations and processes that can or cannot be carried out or initiated in these areas. • Environmental Approval: A process to ensure compliance with environmental standards before initiating certain activities. • Promulgation of standards for the quality of air, water, noise, and soil for various areas and purposes. • Establishment of standard limits for discharging and emitting waste into the environment. • Formulation and declaration of environmental guidelines aimed at preserving and improving environmental quality. .
Law on Environmental Impact Assessment	94/2024	. This Law regulates the Environmental Impact Assessment (EIA) process, the content of the EIA, the participation of Interested Authorities and organizations, as well as public participation. It also covers international notification for projects that may have significant impacts on the environment of other countries, and addresses other key issues related to the EIA process.

Law on Strategic Environmental Assessment	135/04 and 88/10	The Law on Strategic Environmental Impact Assessment regulates the conditions, manner and procedure for assessing the environmental impact assessment of certain plans and programs, on the environment.
Law on Air Protection	36/09, 10/13 and 26/21	The Law on Air Protection regulates the management of air quality and determines the measures, manner of organization and control of the implementation of protection and improvement of air quality as a natural value of general interest that enjoys special protection.
Law on Nature Conservation	36/09, 88/10, 91/10, 14/16, 95/18 and 71/21	This law creates the following objectives: 1) protection, preservation and improvement of biological (genetic, spices and ecosystem), geological and landscape diversity, 2) harmonization of human activities, economic and social development plans, programs, bases and projects with sustainable use of renewable and non-renewable natural resources and long-term preservation of natural ecosystems and natural balance, 3) sustainable use and / or management of natural resources and goods, ensuring their function while preserving natural values and balance of natural ecosystems, 4) timely prevention of human activities and activities that may lead to permanent impoverishment of biological, geological and landscape diversity, as well as disturbances with negative consequences in nature, 5) determining and monitoring the state of nature, 6) improvement of the condition of disturbed parts of nature and landscapes. The Law on Nature Conservation adopted EU Habitats Directive and the Birds Directive. The Decree on Ecological Network ("Official Gazette of RS", No. 102/10) identifies ecological network areas in Serbia and sets the management, financing, monitoring and protection requirements. Serbian Legal Framework on Habitats and Species: Regulation on the criteria for separation of habitat types, habitat types, sensitive, vulnerable, rare, and for the protection of priority habitat types and protection measures for their preservation (Official Gazette of No. 35 /10),

		Regulation on cross-border trade and trade in protected species (Official Gazette No. 6/14), Regulation on special technical and technological solutions that enable undisturbed and safe communication of wild animals (Official Gazette of No. 72/10), Regulation on control of use and trade of wild flora and fauna (Official Gazette of No. 69/11) Regulation on the proclamation and protection of strictly protected and protected wild species of plants, animals and fungi (Official Gazette of No. 98/16)
Law on Waste Management	36/09, 88/10, 14/16 and 95/18	The Law on Waste Management is harmonized with all relevant EU directives. The Law regulate: types and classification of waste; waste management planning; waste management entities; responsibilities and obligations in waste management; organization of waste management; managing special waste streams; conditions and procedure for permit issuance; transboundary movement of waste; reporting on waste and database; financing of waste management; supervision, and other issues relevant for waste management. The Law on Waste Management has transposed the European Waste Framework Directive (2008/98/EC as last amended by 851/2018/EC), the European Directive on Landfills (1999/31/EC, as amended) through transposition in the Serbian Law on Waste Management and/or Regulation on waste landfilling in combination with the Regulation on Categories, Testing and Classification of Waste, the European Directive on Packaging and Packaging Waste (1994/62/EC, as amended transposition in the Serbian Law on Packaging and Packaging Waste. The European Directive on Waste Electric and Electronical Equipment (WEEE) (2012/19/EU, as amended) has experienced transposition though the Serbian Law on Packaging and Packaging Waste in combination with the Rulebook on the List of Electric and Electronic Products, Measures of Prohibition and Restriction of Use of Electric and Electronic Equipment Containing Hazardous Substances, Methods and Procedures of Managing Waste from Electric and Electronic Products. In April 2016, IZS the Board of Directors of IZS adopted a Hazardous waste Manual governing management, disposal, and deposit and selling of materials characterized as hazardous. The Manual is aligned with the National Strategy on Waste Management, the

		Law on waste Management and the applicable secondary laws. The Manual in particular treats management of PCB containing waste, absorbents, filter material and oil, wooden sleepers, asbestos containing waste. Serbia has ratified the: Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and pesticides in International Trade (Official Gazette of RS, International Agreements, No. 38/09) the Stockholm Convention on Persistent Organic Pollutants (Official Gazette of RS–International Agreements, No. 42/09) the Basel Convention on Trans boundary Movement of Hazardous Wastes and their Disposal Official Journal of FRY, International Treaties, No. 2/99, the Aarhus Convention ("Official Gazette of RS-International Treaties", No. 38/09), the Protocol on Pollutant Release and Transfer Register to the Aarhus Convention" ("Official Gazette of RS - International Treaties", No. 8/1)
Law on Chemicals	36/09, 88/10, 92/11, 93/12 and 25/15	The Law on Chemicals regulates the integrated management of chemicals, their classification, packaging and labelling, register of chemicals and trade of chemicals. It transposed EU legislation in the field of chemicals related to POPs Regulation 1907/2006/EC on registration, evaluation and authorization on chemicals (REACH) – partially harmonized, Regulation 757/2010 amending Regulation 850/2004, Directive 2004/42/EC on limitation of emissions of volatile organic compounds (VOC) from the use of organic solvents in certain paints, varnishes and vehicle refinishing products, Regulation 689/2008/EC export and import of dangerous chemicals on banned and severely restricted chemicals as well as Directive 67/548/EEC on classification, labelling and packaging of substances, Directive 1999/45/EC on classification, labelling and packaging of preparations Regulation 1272/2008/EC on classification, labelling and packaging of substances and mixtures in accordance with GHS and Regulation 440/2008/EC on test methods pursuant to REACH.
Law on Water	30/10, 93/12, 101/16, 95/18 and 95/18 – other law	The Law on Water which incorporates the EU Water Framework Directive, covers water regimes, water management areas, responsibilities for water management (including sub-law water management legislation), water management activities, limitation of owners' and beneficiaries' rights, water cooperatives, financing of water management activities, and administrative inspection to

<table>
<tr><td></td><td></td><td>enforce the Law. The legislation provides for various water management sub-laws on water resource conditions, water resource compliance and water resource permits.</td></tr>
<tr><td>Law on Environmental Noise Protection</td><td>96/21</td><td>The Law on Protection against Environmental Noise, transposes EU Directive 2002/49/EC relating to the assessment and management of environmental noise. The Law has the following main goals: establishment, maintenance and improvement of the system of noise protection on Serbian territory; and determination and realization of measures and standards in the field of noise protection aimed to avoid, prevent or reduce the harmful effects of noise on human health and the environment. The permitted noise levels are defined by the Decree on environmental noise indicators, limITSvalues, assessment methods of the noise indicators, the nuisance and the harmful effects (Off. Gazette of RS No. 75/10). This Decree stipulates the noise levels, which must not be exceeded. Annex 2 of the Decree states that the defined noise limits are applied to the all-encompassing noise generated by all noise sources at the site. Noise levels in open spaces (noise limits as defined in Serbian legislation)
<table>
<tr><th rowspan="2">Zone</th><th rowspan="2">Purpose of the area</th><th colspan="2">Noise Level [dB(A)]</th></tr>
<tr><th>Daytime and evening</th><th>Night-time</th></tr>
<tr><td>1</td><td>Recreation areas, health institution areas, cultural and historical sites, large parks</td><td>50</td><td>40</td></tr>
<tr><td>2</td><td>Tourist areas, schools, camps</td><td>50</td><td>45</td></tr>
<tr><td>3</td><td>Residential areas</td><td>55</td><td>45</td></tr>
<tr><td>4</td><td>Commercial and residential areas, children playgrounds</td><td>60</td><td>50</td></tr>
<tr><td>5</td><td>City centre, workshop area, commercial area, administrative area with apartments, zones along highway, regional roads and city streets</td><td>65</td><td>55</td></tr>
<tr><td>6</td><td>Industrial areas, warehouse, and service areas, transport terminals with no residential buildings</td><td colspan="2">Noise level at the boundary of this zone shall not exceed the limit value defined for the zone it borders</td></tr>
</table>
</td></tr>
<tr><td>Law on safe transport of hazardous goods</td><td>104/16, 83/18, 95/18 and 10/19</td><td>Law on transport of hazardous materials regulates conditions for performing domestic and international transport of dangerous goods in road, rail and inland waterway transport on the territory of the Republic of Serbia. Furthermore, it sets requirements in relation to packaging, mobile pressure equipment (e.g. tanks), means of transport intended for transport of dangerous goods, conditions for body designation which examine and control packaging, mobile pressure equipment, and vehicles for transport of dangerous goods. This Law also defines competencies of state bodies and organizations in transport of dangerous goods,</td></tr>
</table>

		conditions and obligations to fulfil the participants in the transport of dangerous goods, supervision, as well as other issues related to the transport of dangerous goods.
Law on mining and geological explorations	101/15, 95/18 and 40/21	The Law on mining and geological explorations regulate measures and activities of the mineral policy and the manner of implementation thereof, conditions and manner of execution of geological explorations of mineral and other geological resources, researching of geological environment, as well as geological explorations for the purpose of spatial and urban planning, designing, construction of buildings and remediation of site, manner of classification of resources and reserves of mineral raw materials and ground waters, exploitations of reserves of mineral raw materials and geothermal resources, construction, use and maintenance of mining facilities, plants, machines and equipment, execution of mining works, mining waste management, remediation and recultivation of abandoned mining facilities, as well as inspection over the implementation of the present Law. The Geological Institute of Serbia is established by the same Law as an individual organization with the capacity of a legal entity that carries out the basic geological explorations and other geological explorations as well as the works of applied geological explorations of importance for the Republic of Serbia, in accordance with this Law.
Law on Railway	41/18 and 62/23	This law regulates the management of railway infrastructure, the performance of railway transport activities, and the licensing of railway undertakings. Access to railway infrastructure, service facilities and services, principles and procedures for determining and calculating prices of access to public railway infrastructure and prices of services related to railway transport, public railway infrastructure capacity allocation, industrial railways and industrial tracks, competencies of the Railway Directorate, passenger rights and public passenger transport services by rail of general economic interest.
Planning and construction law	72/2009, 81/2009 (Corrigendum), 64/2010 (CC), 24/2011, 121/2012, 42/2013 (CC), 50/2013	The planning and construction law it governs the following issues: the conditions and modalities of spatial planning and development, the development of general and detailed regulation plans, the development and use of construction land and the construction of facilities, predominant use of land when the land has multiple uses, public use of land and other issues of significance in the development of space, landscaping and use of construction land and the construction of facilities. It prescribe procedure for: issuance of site conditions; issuance of building permit; notice of works; issuance of occupancy permit; attainment of

	(CC), 98/2013 (CC), 132/2014, 145/2014, 83/2018, 31/2019, 37/2019 (CC), 9/2020, 52/2020, 122/2020, 62/2023	conditions for design, i.e. connection of a facility to the infrastructure network; obtaining legal instruments and other documents issued by the holders of public authorities required for the construction of facilities, i.e. for the issuance of site location conditions, building permit and occupancy permit within their competence, as well as for the provision of conditions for connection to the infrastructure network and for the registration of title to the built facility and for designating a house number (unified procedure).
Law on Occupational Safety and Health organized	35/2023	The Law on Occupational Safety and Health governs the occupational safety and health system in Serbia. By harmonizing this law with the ratified International Labor Organization conventions and the EU Framework Directive 89/391/EEC, as well as special directives derived from the Framework Directive, Serbia has accepted all guidelines originating from them, adjusted to national conditions. Apart from this Law, the regulatory framework of the occupational safety and health system is integrated by several sub-acts. The Rulebook on preventive measures for occupational health and safety and the prevention and containment of contagious diseases epidemics (Official Gazette of RS No. 94/2020) governs the preventive measures employers must introduce at workplaces and applies to all persons at workplaces when an epidemic is declared. Further provisions are elaborated in numerous by-laws, regulating specific implementation procedures. A total of 8 legal acts and 55 rulebooks related to the area of occupational health and safety ensure the implementation of the Law, and provide targeted OH&S procedures for various activities, including: • Work on temporary and movable construction sites • Deep drilling and exploitation of raw minerals • Exposure to asbestos • Working in environments at risk from explosive atmospheres • Mitigation measures for hazardous electrical risks • Work in quarries, clay, sand, and pebble extraction sites • Rail traffic • Exposure to noise and vibration emissions • Preventive measures during manual cargo handling

		The most recent update to the law, Official Gazette No. 35/2023, expanded the scope of the Law, introducing provisions for self-employed individuals and remote workers, strengthening employer responsibilities, and introducing additional guidelines for specific high-risk activities. For full compliance, all work environments must adhere to the standards set forth in these regulations to ensure the safety and health of all employees, including remote and home-based workers.
Law on Cultural property	71/94, 52/11 – other law, 92/11 – other law, 6/20 and 35/21- other law	The Law on Cultural property regulates the system of the protection and use of cultural property and define conditions for the implementation of activities relating to the protection of cultural property. Depending on its physical, artistic, cultural and historical features, cultural property in Serbia include: cultural monuments, spatial cultural-historical units, archaeological sites and landmarks – immovable cultural property; works of art and history, archival material, film material and old and rare books – movable cultural property. Depending on its importance, cultural property in Serbia is also classified into: cultural property, cultural property of great importance and cultural property of exceptional importance. This Law define chance find procedure. According to Article 28 of subject law, a person who digs out of earth or takes from water property under prior protection outside of organized research shall immediately, within 24 hours at the latest, inform thereof a competent cultural property protection institution and the ministry responsible for interior affairs.
Law on Climate Change	26/2021	This law regulates the system for the limitation of greenhouse gas emissions (hereinafter: GHG) and for adaptation to changed climatic conditions, monitoring and reporting on the strategy of low-carbon development and its improvement, the program of adaptation to changed climatic conditions, adoption of the strategy of low-carbon development and the program of adaptation to changed climate conditions, issuing permits for GHG emissions to the plant operator, issuing approval to the aircraft operator's

		monitoring plan, monitoring, reporting, verification and accreditation of verifiers, administrative fees, supervision and other issues of importance for the limitation of GHG emissions and adaptation to changed climatic conditions. The provisions of the law are applied to the procedure for issuing, revoking, amending and supplementing a GHG emission permit, the procedure for granting approval and approval for changes to the GHG emission monitoring plan, the procedure for granting approval for reports on improvements in the GHG emission methodology, and the procedure for keeping records and registers prescribed by this law. regulates the general administrative procedure, unless otherwise prescribed by this law.
Law on Soil Protection	112/2015	This law regulates soil protection, systematic monitoring of soil condition and quality, remediation measures, remediation, recultivation, inspection supervision and other matters of importance for the protection and preservation of soil as a natural resource of national interest.
Law on Non-Ionizing Radiation Protection	36/2009	This law regulates the conditions and measures for the protection of human health and the protection of the environment from the harmful effects of non-ionizing radiation in the use of sources of non-ionizing radiation. Protection from professional exposure to sources of non-ionizing radiation is not the subject of this law.
The Law on foundations of property law relations	.6/80, 36/90, 29/96 and 115/2005	The Law on foundations of property law relations ("Official Gazette of the SFRY", No. 6/80, 36/90,"Official Gazette of the FRY", No. 29/96 and "Official Gazette of the RS", No.115/2005) stipulates fundamental provisions of property relations, including ownership rights substance, subjects of ownership rights, co-ownership and joint ownership rights, acquiring the right of ownership, right on yields emanating from owned thing, possession rights, ownership acquired by adverse possession, ownership relations deriving in situations when structures were built on someone else's land, protection of ownership rights, protection of possession, cessation of ownership right

The Law on Expropriation	No. 53/95, 16/2000, 43/2001, 65/2003, 72/2009, 18/2010, 55/2013, 106/2015, 113/2017, and 95/2018.	The main law regulating the acquisition of land and assets in the public interest in Serbia is the Expropriation Law[2]. It focuses on properties and assets which may be expropriated and restrictions which may be placed on property rights, in the public interest, which is established in accordance with the law. Public interest is established either through a separate law or by a decision of the Government of Serbia. Following establishment of public interest, an expropriation proposal is submitted by the Beneficiary of Expropriation (in the case of this Project, SRI) to the property administration in the relevant municipality (property administration) together with a set of accompanying documents, including proof that funds needed for compensation are available. Owners of affected properties are individually invited to a hearing by the property administration and notified about the submission of the expropriation proposal. If the documentation is in order, a decision on expropriation (first degree) is passed by the municipal property administration. The affected owners can submit an administrative appeal to the Ministry of Finance, which decides in the second degree, after which the decision becomes final. If there is no further (judicial) appeal, the expropriation decision also becomes legally binding. However, the affected owner can choose to submit a judicial appeal to the relevant administrative court, after whose ruling the decision on expropriation becomes legally binding. When the decision on expropriation becomes legally binding, another hearing must be held by the municipal property administration to discuss and determine the amount of compensation for each affected owner. In case an agreement on the level of compensation (including the timing of payment and the need to vacate the affected property) is not reached within two months of the decision on expropriation becoming legally binding, the case is referred to the courts to decide. The Beneficiary of Expropriation proceeds with the payment of compensation or provision of replacement properties, after the signing of a compensation agreement or the decision on compensation becoming legally binding.

2 Official Gazette of the RS 53/95, 16/01 – Federal Constitutional Court decision, 20/09, 55/13 – Constitutional Court decision and 106/16)

		Solutions for addressing physical and economic displacement can be sought through cooperation with various government and non-government service providers, such as municipal Centers for Social Work which can provide assistance to vulnerable people, under relevant social welfare laws or the National Employment Service (NES) of the RS, which can provide affected people with assistance for employment and training, with the aim of livelihood restoration.
Law on Social Protection	24/2011	The Social Protection Law of Serbia contains provisions regulating the organization, financing, and delivery of social services to citizens. The Republic of Serbia, autonomous province, and local self-government unit ensure the performing of activities in the field of social protection within its rights and obligations determined by the Constitution and law by establishing institutions or entrusting the performance of these activities to other legal and natural persons. Primarily, the law defines the rights to social protection, such as financial assistance, in-kind aid, and various support services for vulnerable population categories. It also stipulates the obligations of the state and local governments to enforce these rights, including standards and criteria for providing social services. The Law outlines mechanisms for monitoring and quality control of services to ensure their efficiency and compliance with regulations. Additionally, the Law emphasizes the importance of user involvement in the planning and delivery of social services and promotes the principle of individualization and the adaptation of services to the specific needs of users. This law is implemented by Centers for Social Work.
The Law on Health Care	25/2019	Ensures access to healthcare services and provides health protection for all citizens, with a special focus on vulnerable groups.
The Law on Social Housing,	72/2009	Regulates the right to social housing for vulnerable groups, including the elderly, people with disabilities, and single parents, to ensure adequate accommodation. This law aims to provide decent housing conditions for the most vulnerable citizens, improve their living standards, and contribute to social inclusion. In addition to the Law on Social Housing, other regulations also address housing and social protection: • Law on Housing and Building Maintenance: This law regulates housing and building maintenance, and was published in the Official Gazette of the Republic of Serbia, No. 104/2016, with amendments in No. 9/2020.

		• Law on Social Protection: This law defines the social protection system, aiming to provide assistance and empowerment for independent and productive living among individuals and families, and was published in the Official Gazette of the Republic of Serbia, No. 24/2011. These laws collectively contribute to the legal framework supporting social housing and the protection of vulnerable populations in Serbia.
The Law on Professional Rehabilitation and Employment of Persons with Disabilities	36/2009	Prescribes measures for professional rehabilitation, employment, and working conditions for people with disabilities, aiming to facilitate their inclusion in the labor market.

3.1.1. Information disclosure and public consultation

The right to information, i.e. that everyone shall have the right to be informed accurately, fully and timely about issues of public importance, is guaranteed to all citizens under Serbian legislation. These provisions are included in the Constitution of the Republic of Serbia[3], as well as in the Law on Free Access to Information of Public Importance[4].

The Law on Planning and Construction of the Republic of Serbia regulates the development and adoption of spatial and urban plans in Serbia, which are all subject to a public disclosure and consultation process. This is described in more detail in the Regulation on the Content, the Method and the Procedure for Developing Planning Documents[5].

Serbian laws and bylaws in the area of environmental protection, including the main Environmental Protection Law, require the public to be informed about and involved in all matters concerning the environment. Public disclosure and consultation procedures are organised in connection to the development of project environmental impact assessments (EIAs) as per the Rules for Disclosure of Information, Presentations and Public Consultations Regarding EIAs[6].

The main required steps in the disclosure and consultation process for the above-mentioned plans and projects are:

- Informing the public through the media about details of disclosure of the draft plan/document (i.e. where the electronic version and hard copy are available for review, the dates and time when the hard copy can be reviewed, the dates when the developer of the draft is available to answer questions) and inviting citizens/organisations to submit comments and/or attend a public meeting/session during the disclosure period. Citizens can request that their comments are responded to in writing.;
- Organizing a public meeting/session to ask further questions and present/elaborate the submitted comments (usually in the municipal building or other appropriate local venue) during the disclosure period;
- Processing comments received from all stakeholders and revising the draft plan/document to reflect them, as well as preparing a report to justify why certain comments were not adopted; in case of significant changes of the plan / document, the revised draft may once again be publicly disclosed for another round of comments;
- Submission of the revised draft plan/document and report to relevant authorities which judge whether the comments have been meaningfully considered and addressed;
- Adopting the final plan / document by the relevant authorities and disclosing it.

[3] *Official Gazette of the RS No. 98/2006*

[4] *Official Gazette of the RS No. 120/2004, 54/2007, 104/2009, 36/2010*

[5] *Official Gazette of the RS No. 32/2019*

[6] *Official Gazette of the RS No. 69/2005*

3.1.2. Land acquisition

The main law regulation acquisition of land and assets in the public interest in Serbia is the Expropriation Law of the Republic of Serbia[7]. The Expropriation Law focuses on properties and assets which may be expropriated and restrictions which may be placed on property rights, in the public interest, which is established in accordance with the law.

Public interest is established either through a separate law or by a decision of the Government of Serbia. Following establishment of public interest, an expropriation proposal is submitted by the Beneficiary of Expropriation (in the case of this Project, SRI) to the property administration in the relevant municipality (property administration) together with a set of accompanying documents, including proof that funds needed for compensation are available.

Owners of affected properties are individually invited to a hearing by the property administration and notified about the submission of the expropriation proposal. If the documentation is in order, a decision on expropriation (first degree) is passed by the municipal property administration. The affected owners can submit an administrative appeal to the Ministry of Finance, which decides in the second degree, after which the decision becomes final. If there is no further (judicial) appeal, the expropriation decision also becomes legally binding. However, the affected owner can choose to submit a judicial appeal to the relevant administrative court, after which the ruling decision on expropriation becomes legally binding.

When the decision on expropriation becomes legally binding, another hearing must be held by the municipal property administration to discuss and determine the amount of compensation for each affected owner. In case an agreement on the level of compensation is not reached within two months of the decision on expropriation becoming legally binding, the case is referred to the courts to decide. The Beneficiary of Expropriation proceeds with the payment of compensation or provision of replacement properties, after the signing of a compensation agreement or the decision on compensation becoming legally binding.

Some of the relevant key characteristics of the Expropriation Law are that it:

- Focuses on providing compensation for any affected properties and assets, rather than on addressing further impacts of land acquisition / restrictions on land use, i.e. physical and economic displacement. The law indirectly covers physical and economic displacement, but only for affected people who have formal legal rights or rights / claims that are recognisable under national law.
- Encourages amicable agreements on expropriation and compensation, however always after proclamation of public interest, rendering land acquisition 'involuntary'.

[7] *Official Gazette of the RS 53/95, 16/01 – Federal Constitutional Court decision, 20/09, 55/13 – Constitutional Court decision and 106/16)*

- Requires the provision of compensation which is determined in accordance with the prevailing market price of the affected property/asset.
- Foresees the possibility of providing increased cash compensation for persons whose sources of livelihoods are adversely affected. Vulnerability, in that regard, is determined by taking into account the number of household members, the number of household members capable of earning a living or who are employed, the health status of household members, the monthly income of the household.
- The Law defines a cutoff date for determining the value of affected properties, and it is the date of notification of the owner that an expropriation proposal has been submitted, meaning that all investments into properties made after this date will not be considered for compensation in the valuation process (unless needed for regular maintenance and use). In practice, certified appraisers create an inventory of affected assets during their site visit and provide a valuation of all of these affected assets, effectively causing the cutoff date to be the date of the site visit of certified appraisers.
- Enables owners whose assets and land are partially acquired, to request expropriation of all the remaining land and assets (orphan land), if the partial expropriation would negatively affect their economic situation or make the remaining part of the property useless or difficult to use. This request can be made even after the completion of expropriation and up to two years following completion of construction works.
- Enables compensation for land and residential and business structures to be provided in kind (replacement properties), at the request of the affected person.
- Allows for the Beneficiary of Expropriation to acquire the right of accessing the land/property, under certain circumstances (if the responsible authority determines it is necessary due to the urgency of constructing a certain structure or executing construction works, if the decision on expropriation is final and if an offer specifying the form and amount of compensation was previously sent to the affected owner).
- Provides administrative and judicial remedies for disputing expropriation and the amount of compensation provided for affected assets.

Solutions for addressing physical and economic displacement can be sought through cooperation with various government and non-government service providers, such as municipal Centres for Social Welfare which can provide assistance to vulnerable people, under relevant social welfare laws or the National Employment Service (NES) of the RS, which can provide affected people with assistance for employment and training, with the aim of livelihood restoration.

In 2020 a special law was passed to regulate the implementation of linear projects of national importance in the Republic of Serbia and a part of this law focuses on land acquisition. The name of this law is the Law on Special Procedures for the Implementation of Construction and Reconstruction Projects of Linear Infrastructure of Particular Importance for the Republic of Serbia[8] (Law on Linear Infrastructure). Although the aforementioned law ceased to be valid with the adoption of the Law on the Termination of the Law on Special Procedures for the Implementation of Construction and Reconstruction Projects of Linear Infrastructure of Particular Importance for the Republic of Serbia[9], which entered into force in August 2023, all projects whose implementation started in accordance with the provisions

[8] *Official Gazette of the RS 09/2020*

[9] *Official Gazette of the RS 62/2023*

of the aforementioned law, are to be concluded in accordance with it. This also applies to the Project of Reconstruction and Modernization of the Belgrade–Niš Railway.

In the field of land acquisition, the law aims to accelerate the expropriation process and to enable more efficient implementation, as it shortens the deadlines from the Expropriation Law, both for affected people and involved institutions.

The most relevant features of this law, for this Project, are:

- Public interest for expropriation lasts until the use permit for the newly built infrastructure is issued (it does not have to be renewed); if during construction additional land is affected (land not originally included in the expropriation zone), a process of concluding a settlement (amicable agreement) with the owner of land is initiated, without having to initiate expropriation.
- The law stipulates that when construction land, on which an unregistered structure has been built (and for which the legalization process has not been completed), is being expropriated, the affected owner of the structure (the person who owns the land), has a right to be compensated for the construction value of that structure.
- If the residence of a registered owner of a property cannot be identified (and he/she has no legal representation) or if the registered owner is deceased and the inheritance proceedings have not been completed, the expropriation authority has a right to set a temporary representative. An appeal against the expropriation decision may be submitted, however this does not prevent issuing of a construction permit and application for starting construction works. It should be noted that the temporary representative does not have a right to conclude a compensation agreement on behalf of the owner (or his/her heirs); their right to claim compensation can never expire and they can do so even years after expropriation has taken place.
- The market value of affected land is determined by the Tax Administration based on the most recent registered sale purchase transactions for similar land in the vicinity of the affected land. The law allows the Tax Administration to align compensation rates with other rates provided for similar land affected by linear projects in nearby municipalities. Structures and other assets located on land are compensated as determined by the Expropriation Law.

3.1.3. Labour and working conditions

Serbia was a member state of the International Labour Organisation (ILO) between 1919 and 1992 and restarted its membership in 2000. The country has ratified 77 ILO International Labour Standards (Conventions) of which 62 are in force, including the eight fundamental Conventions.

Labour and human resource management in Serbia is primarily addressed through the Labour Law of the Republic of Serbia[10]. Compliance with labour laws is monitored by the Labour Inspectorate of the Ministry of Labour, Employment, Veteran and Social Affairs of the Republic of Serbia.

Some of the key provisions of the Labour Law are:

[10] *Official Gazette of the RS No. 24/2005, 61/2005, 54/2009, 32/2013, 75/2014, 13/2017, 113/2017 and 95/2018*

- Labour and working conditions are regulated in line with international conventions, by the Labour Law, which states that the rights, obligations and responsibilities of workers are governed by collective agreements and labour regulations (employment contracts). Labour regulations and employment contracts must be aligned with the law, and they can only provide more rights and improved working conditions compared to those stipulated by the law. Employers are obliged to present workers with their rights, obligations and responsibilities in writing and contracts must be signed by both parties.
- Workers have the right to adequate wages (including paid overtime, expenses), health and safety at work, health protection, protection of personal integrity, dignity and other benefits in case of illness, reduction of the ability to work or old age, financial aid during temporary unemployment and other forms of protection. The law sets out in detail employee rights in relation to hours of work, wages, overtime, compensation and benefits.
- Employees have the right to form and join Labour Unions and freely express their views in relation to labour and working condition issues.
- Discrimination is explicitly prohibited by law, both in relation to employees and those looking for employment and the person who feels discriminated against can turn to the court. Special protection of vulnerable groups, to give them equal opportunities, is allowed. Harassment in any form is also strictly prohibited by law. Women employees have the right to special protection during pregnancy and childbirth. Employees have the right to special protection for childcare. Employees below the age of 18 and those who have disabilities have the right to special protection. Employers are not allowed to request data from employees on their marital status or family planning. Employees are entitled to equal pay for the same work or work of equal value with an employer. These provisions are further defined and strengthened in the Law on Gender Equality.
- The law allows for establishing a mechanism for amicable resolution of disputes between employees and the employer. Employees (or their authorised representatives) can turn to the courts for any breach of their labour and working conditions.
- Employment of minors (over 15) is allowed by law, under certain conditions – approval of parents, guardians and if the work does not jeopardise the minor's health and safety, moral or education. The law sets out in detail workers' rights in relation to working hours, leave, daily work break, termination of employment, etc.
- The law applies to foreign citizens working on the territory of the Republic of Serbia.

Other applicable laws include:

- Law on Amicable Resolution of Labour Disputes [11];
- Law on Strikes [12];
- Law on Mobbing [13];
- Anti-Discrimination Law;
- Pension and Disability Insurance Law [14];

[11] *Official Gazette of the RS No. 125/2004, 104/2009, 50/2018*

[12] *Official Gazette of the FRY No. 29/1996, RS No. 101/2005, 103/2012*

[13] *Official Gazette of the RS No. 22/2009, 52/2021*

[14] *Official Gazette of the RS No. 34/2003, 64/2004, 84/2004, 85/2005, 101/2005, 63/2006, 05/2009, 107/2009, 101/2010, 93/2012, 62/2013, 108/2013, 75/2014, 142/2014, 73/2018, 46/2019, 86/2019*

- Law on Gender Equality [15].

3.2. National EIA procedure

The Environmental Impact Assessment (EIA) procedure in the Republic of Serbia is governed by the Law on Environmental Impact Assessment, which is harmonized with European EIA Directive (85/337/EEC, 97/11/EC, 2003/35/EC and COM 2009/378 as codified by the Directive 2011/92/EU and as amended by the Directive 2014/52/EU).

The Law on Environmental Impact Assessment (EIA) ("Official Gazette of the RS ", No. 23/2024) regulates the EIA process, EIA content, Interested Authorities and organizations participation and public participation, international notification for projects that can have important impacts on other environment and inception and other important issues for EIA.

The requirement for environmental impact assessment includes projects in the field of: industry, mining, energy, transport, tourism, forestry, agriculture, water management, waste management, utilities and projects planned in a protected natural asset or special purpose area; defined by the Decree on making the list of projects which require environmental impact assessment and list of projects which may require environmental impact assessment ("Official Gazette of the RS", No. 114/08).

The process of environmental impact assessment of the modernization project of the existing railway is initiated by the owner of the project, which in this case is "Serbian Railway Infrastructure" AD, with the competent authority for environmental protection. If the request is submitted by another person on behalf of the project - it must have the appropriate authorization issued to the project holder with the number of the request, the date of issue and the signature of the authorized person of the project owner. Facilities whose construction permit is issued by the republic authority; the impact assessment procedure is carried out by the Ministry of Environmental Protection.

Facilities whose construction permit is issued by the Autonomous Region, the impact assessment procedure is carried out by the Provincial Secretariat for Spatial Planning, Construction and Environmental Protection. For projects for which a building permit is issued by the local self-government, the impact assessment procedure is carried out by the local self-government in charge of environmental issues. The Ministry of Environmental Protection is responsible for all projects that may have a trans boundary impact.

The process of environmental impact assessment for railway infrastructure projects consists of the following phases:

- Phase I - Deciding on the need for impact assessment,

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[15] *Official Gazette of the RS No. 52/2021*

- Phase II - Determining the scope and content of the impact assessment.

The process of impact assessment commences with the submission of Request as follows:

- Request for deciding on the need to assess the impact of the project on the environment for reconstruction projects and/or construction of railway lines including associated buildings and equipment i.e. projects that are on the list of projects that may be required to have Environmental impact assessment - List II Regulation (Infrastructure Projects)
- Request for determining the scope and content of the environmental impact assessment for the following projects: main railway lines, including associated facilities (bridges, stations), i.e. for projects that are on the list of projects for which the impact assessment is mandatory - List I Regulations as well as projects that are on the List II for which the competent authority has decided to require assessment of the impact on the environment.

The scope and content of the Request for deciding on the need to assess the impact of the project on the environment and the Request for determining the scope and content of the project impact assessment on the environment are defined by the Law on Impact Assessment and the Ordinance on the content of and the content of the study on environmental impact assessment ("Official Gazette of RS", No. 23/2024).

The request for determining the necessity of the assessment shall be accompanied by the following documents:

- A copy of the current planning document (location information), that is - verified planning design or act on planning requirements for construction of project concerned (location requirements);
- conceptual design or preliminary design, or the excerpt from the preliminary design;
- graphical representation of micro- and macro-location;
- requirements and approvals of other competent authorities and organizations obtained in accordance with the law;
- Proof of payment for the administrative fee;
- other evidence at the request of the competent authority.

In addition to the requirements for determining the scope and content of the EIA assessment shall be accompanied by the following documents:

- A copy of the current planning document (location information), and verified planning design or act on planning conditions for construction of the concerned project (location conditions);
- Preliminary design or the excerpt from the preliminary design;
- graphical representation of micro- and macro-location;
- requirements and approvals of other competent authorities and organizations obtained in accordance with the law;
- Proof of payment for the administrative fee;
- other evidence at the request of the competent authority.

The Rulebook on the content of the Environmental Impact Assessment Study defines the content of the study, including a qualitative and quantitative presentation of possible changes in the environment during the project, regular work, in case of an accident and assessment of whether the changes are temporary or permanent. The decision on defining the scope and content of the study made by the competent authority in charge of environmental issues specifies in detail the content of the study on environmental impact assessment.

The Law explicitly stipulates that the implementation of the project cannot be undertaken without the implementation of the environmental impact assessment procedure and obtained consent to the Environmental Impact Assessment Study, or decision that there is no need for the EIA Study.

- Phase III - Procedure for granting approval for the Environmental Impact Assessment Study

Since the Environmental Impact Assessment Study is an integral part of the technical documentation required to obtain a building permit, it is usually made at a very early design stage at the level of the preliminary or main design, i.e. project for a building permit. More specifically:

- At the request of the project holder, the competent authority shall issue a decision on granting approval to the EIA Study or on rejecting the request for granting approval to the EIA Study, based on the conducted procedure and the report of the Technical Commission.
- The competent authority establishes a technical evaluation committee for the Environmental Impact Assessment Study. The Technical Commission evaluates the EIA study in accordance with the Law on Environmental Impact Assessment and the Rules of Procedure of the Technical Commission for the Evaluation of the Environmental Impact Assessment Study.
- Public participation is ensured at all stages of the environmental impact assessment process: the decision-making process on the need for impact assessment, the procedure for determining the scope and content of the EIA Study and the procedure for giving approval to the Environmental Impact Assessment Study. The competent authority is obliged to inform the interested authorities and organizations and the public about the submitted request, provide insight in submitting the request and documentation that is attached to the request and provide public insight, organize the presentation and conduct a public discussion on the Environmental Impact Assessment Study.

The following Figure presents the EIA Procedure in Serbia through flowchart and the stakeholder engagement required by the law in each phase of the EIA managed by the Ministry of Environmental Protection.

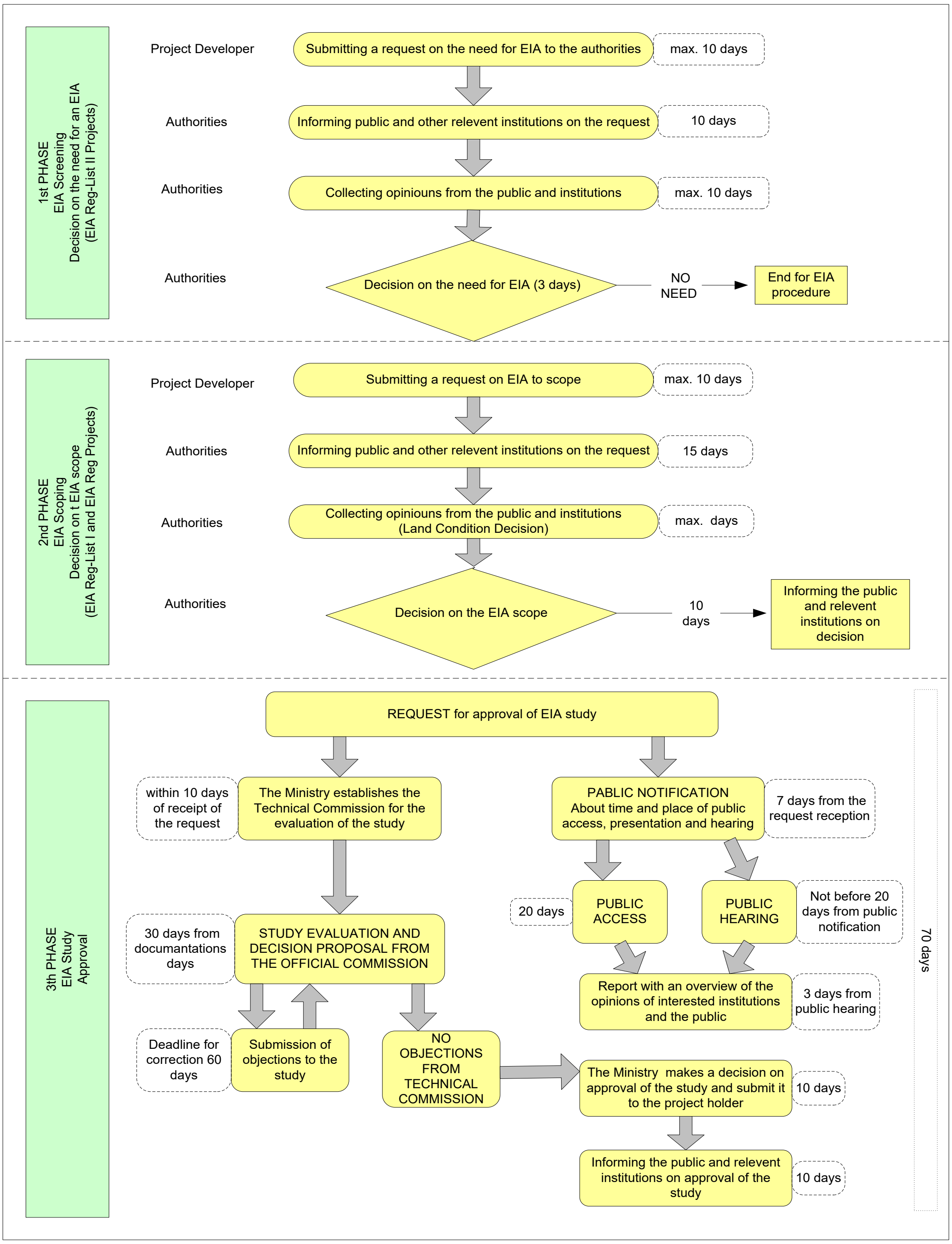

Figure 3-1. The EIA procedure in Serbia

The Ministry of Environmental Protection is responsible for the environmental impact assessment procedure and approves the EIA, in accordance with the Law on Environmental Impact Assessment.

The Decree on Determining the List of Projects for which an Impact Assessment is mandatory and the list of projects for which an Environmental Impact Assessment may be Required ("Official Gazette of the RS", No. 114/08) determines the List I Projects (for which an Environmental Impact Assessment is mandatory) and List II Projects (for which an environmental impact assessment may be required). According to its characteristics, the project in question is classified in List I, under item 7. Construction of: 1). Main railway lines including ancillary facilities (bridges, tunnels and stations).

The Law on Environmental Impact Assessment ("Official Gazette of RS", No. 135/04 and 36/09) regulates the environmental impact assessment procedure, the content of the environmental impact assessment study, the participation of interested bodies and organizations and the public, cross-border notification for projects that may have significant environmental impacts, supervision and other environmental impact assessments.

An overview of the relevant laws governing the permitting process is provided in the table below.

Table 3-2. Relevant law to permitting process

Law	OfG.	Relevance for this ESIA
Law on Planning and Construction	Official Gazette of RS No. 72/2009, 81/2009 (Corrigendum), 64/2010 (CC), 24/2011, 121/2012, 42/2013 (CC), 50/2013 (CC), 98/2013 (CC), 132/2014, 145/2014, 83/2018, 31/2019, 37/2019 (CC), 9/2020, 52/2020, 122/2020, 62/2023	Art. 27-33, 53a-57 and 99- Defines Location Condition Issuance Art. 133-140 - Defines the Issuance of Building Permit Art. 148 - Defines Construction Works Application Submission Art. 154-159- Defines The Issuance Of Use Permit
Law on Environmental Impact Assessment	23/2024	Article 5 - The obligation to obtain an approval for the impact assessment Art. 16-28 - Decision-making process for approving the impact assessment

The following permits will be required for the EIA phase: Location conditions for the preliminary design and the decision to approve the impact assessment. EIA approval is required to issue a building permit.

Related to this project, the official condition of the Ministry of Environmental Protection as key EIA stakeholder is that one overall EIA procedure for entire railway corridor between Belgrade–Niš will be conducted. Procedure will start when Preliminary Design for all three sections are finalized and location conditions for all three sections issued.

3.3. Spatial Plan

The development of Corridor X railway is recognised as one of the strategic priorities in both the previous Spatial Plan of the Republic of Serbia (RoS) (2010-2020) and the latest draft Spatial Plan (2021-2035), which has not been adopted yet.

The Spatial Plan of the Special Purpose Area of the Infrastructure Corridor of the Belgrade-Niš Railway Line (section Velika Plana-Nis, which covers Sections 2 and 3 of the Corridor Project) was developed in 2020 for speeds up to 160 km/h. The Government of RoS adopted the Spatial Plan in September 2020 according to decision 117/2020. Given that the maximum speed on the Belgrade-Niš section has been increased to 200 km/h, the Spatial Plan has been updated for Sections 2 and 3 of the Corridor Project “Changes and Additions of the Spatial Plan of the Special Purpose Area of the Infrastructure Corridor of the Belgrade - Niš Railway (March 2024)”. The plan was publicly disclosed in April 2024 and responses to comments received were issued in June 2024 on the MCTI website. More details on this process are described in the SEP. On 20 November 2024 the Spatial Plan was adopted by the National Assembly of RoS and published in the Official Gazette, decision 91/2024 dated 21.11.2024, and outlines the route alignment adopted by RoS for Sections 2 and 3 of the Corridor Project.

A Strategic Environmental Assessment (SEA) was carried out for the 2020 Spatial Plan and approved on 18.09.2020. According to decision 49/22 published in the Official Gazette of the RoS on 21.04.2022, it was determined by the authorities (Spatial Planning Agency) that a revision to the SEA for the changes to the Spatial plan was not required.

3.4. Overview of the main relevant international regulatory framework

3.4.1. The EU EIA Directive

The Environmental Impact Assessment (EIA) was introduced for the first time in Europe in 1985 by the EIA Directive (85/337/EEC) and represents a key instrument for European Union environmental policy. The EIA Directive of 1985 has been amended three times:

- Directive 97/11/EC brought the EIA Directive in line with the UN ECE Espoo Convention on EIAs in a Trans boundary Context. The 1997 Directive widened the scope of the EIA Directive by increasing the types of projects covered and the number of projects requiring mandatory environmental impact assessment (Annex I). It also provided for new screening arrangements, including new screening criteria (included in Annex III) for Annex II projects, and established minimum information requirements (85/337/EEC);
- Directive 2003/35/EC sought to align EIA Directive provisions with the Aarhus Convention on public participation in decision-making and access to justice in environmental matters (85/337/EEC,96/61/EC);
- Directive 2009/31/EC amended Annexes I and II of the EIA Directive, by adding projects related to the transport, capture and storage of carbon dioxide (CO_2) (85/337/EEC, 2000/60/EC, 2001/80/EC, 2004/35/EC, 2006/12/EC, 2008/1/EC, 1013/2006).

Unless indicated otherwise, all references to the EU legal acts should be construed as references to these legal acts as amended.

On January 28th, 2012, Directive 2011/92/EU on the effects of public and private projects on the environment was published in the Official Journal. Directive 2011/92/EU codifies Council Directive 85/337/EEC on the assessment of the effects of certain public and private projects on the environment (EIA Directive) and its associated amendments. Directive 2011/92/EU fully preserves the content of the acts being codified and does no more than bring them together with only such formal amendments as are required by the codification exercise itself.

The scope of this Directive is to ensure that plans, programmes and projects likely to have significant effects on the environment undergo an Environmental Assessment prior to their approval or authorization. While Annex I contain a list of projects for which the EIA is mandatory, Annex II defines those categories of projects whose ESIA is optional and at the discretion of the community member states.

According to the Directive 2011/92 EC, the proposed Project falls into Annex I, Category 7 (a) “Construction of lines for long-distance railway traffic and of airports with a basic runway length of 2100 m or more".

The EU Directive on Environmental Impact Assessment (Directive 2011/92 EC as amended by EIA Directive [16] 2014/52/EU) defines the requirements for assessment of potential adverse effects on the environment of some public and private projects that are expected to have significant impact on the environment. The EIA is conducted prior to the issue of the construction permit and approval for project implementation.

The environmental impact may be the impact on human beings or on biological diversity, on the quality of soil, water, air or other natural resources, on the climate and contribution on the climate change, or on the historical and cultural heritage, as well as on the interaction between these elements. Cumulative impacts will be taken into account, while

[16] *Directive 2014/52/EU of the European Parliament and of the Council of 16 April 2014 amending Directive 2011/92/EU on the assessment of the effects of certain public and private projects on the environment*

alternatives description will involve the baseline scenario and the "zero" alternative description. The public and other parties are to be consulted on the EIA as the consultation with the public is a key feature of environmental assessment procedures.

3.4.2. Other Most Relevant EU Directives

Other relevant EU Directives that will be considered in this ESIA are the following:

- Water Framework Directive establishing a framework for Community action in the field of water policy (2000/60/EC).
- Directive on the assessment and management of flood risks (2007/60/EC) - Floods Directive.
- Directive 2008/105/EC on environmental quality standards in the field of water policy(amending and subsequently repealing Council Directives 82/176/EEC, 83/513/EEC, 84/156/EEC, 84/491/EEC, 86/280/EEC and amending Directive 2000/60/EC) establishes, among others: (1) limits on concentrations in surface waters of 33 priority substances and 8 other pollutants (Annex I); (2) the possibility of applying Environmental Quality Standards (EQS) for sediment and biota, instead of those for water; (3) the possibility of designating mixing zones adjacent to discharge points where concentrations of the substances in Annex I might be expected to exceed their EQS; and (4) a requirement for Member States to establish an inventory of emissions, discharges and losses of the substances in Annex I.
- Directive 2006/11/EC on Dangerous Substances lays down rules for protection against, and prevention of, pollution resulting from the discharge of certain substances into the aquatic environment of the Community.
- Groundwater Directive 2006/118/EC established a regime which sets groundwater quality standards and introduces measures to prevent or limit inputs of pollutants into groundwater.
- Directive 2012/18/EU on the control of major-accident hazards involving dangerous substances (amending and subsequently repealing Council Directive 96/82/EC), obliges Member States to ensure that operators have a policy in place to prevent major accidents (96/82/EC).
- Environmental Noise Directive 2002/49/EC defines a common approach intended to avoid, prevent or reduce on a prioritized basis the harmful effects, including annoyance, due to exposure to environmental noise, including, among other, assessment methods for the noise indicators.
- Directive 2000/14/EC on the approximation of laws of the Member States relating to noise applies to equipment for use outdoors listed in Articles 12 and 13 and defined in Annex I of this Directive.
- Directive 2008/50/EC 16 on ambient air quality and cleaner air for Europe.
- Directive 2008/98/EC 18 on waste (Waste Framework Directive).
- Habitats Directive 92/43/EEC aims to contribute towards ensuring biodiversity through the conservation of natural habitats and of wild fauna and flora in the territory of the Member States(97/62/EC,1882/2003,2006/105/EC).
- Birds Directive 2009/147/EC relates to the conservation of all species of naturally occurring birds in the wild state in the territory of the Member States.
- Directive 89/391/EEC – Occupational Health and Safety.
- Regulation (EU) 2018/1999 of the European Parliament and of the Council on the Governance of the Energy Union and Climate Action ('European Climate Law') (663/2009, 715/2009, 94/22/EC, 98/70/EC, 2009/31/EC, 2009/73/EC, 2010/31/EU, 2012/27/EU, 2013/30/EU, 2009/119/EC, 2015/652, 525/2013).
- Directive 2012/34/EU on establishing a single European railway area
- Directive 2016/797 on the interoperability of the rail system within the EU

- Directive 2016/798 on railway safety
- Common Safety Method- Risk Assessment (CSM-RA), 2013 (No. 402/2013) (as amended in 2015 (No. 1136))

3.4.3. Relevant International Multilateral Agreements

Most of the International Conventions with regard to the Environment, Public Participation and Labour issues have been transposed in the Serbian national legislation such as:

- Bern Convention for the Protection of flora, wild fauna and nature environment of Europe, ratified by Serbia (Official Journal of SRJ, No. 11/2001, "Official Gazette of the RS", No. 102/2007a, 102/2007b).
- CITES Convention on International Trade in Endangered Species of Wild Fauna and Flora, ratified by Serbia in 2001.
- Convention of Biological Diversity (CBD) Rio de Janeiro, signed in 1996 and ratified by Serbia (Official Journal of SRJ, No. 11/2001, "Official Gazette of the RS", No. 102/2007a, 102/2007b).
- Convention on Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters (Aarhus, 1998), ratified by the Serbian law in 2009.
- United Nations Convention to Combat Desertification (UNCCD) was ratified in 1999.
- Convention on the Conservation of Migratory Species of Wild Animals (CMS or the Bonn Convention) ratified by Serbia (Official Journal of SRJ, No. 11/2001, "Official Gazette of the RS", No. 102/2007a, 102/2007b).
- ESPOO Convention (Finland) "On Environmental Impact Assessment in a Trans boundary Context.", ratified by Serbian law in 2007.
- United Nations Framework Convention on Climate Change (UNFCCC) ratified by the law no. 2/97.
- Kyoto protocol to the United Nations Framework Convention on climate change 1998 ratified by Serbian government 2007.
- Paris Agreement, United Nations 2015, ratified by the law no. 4/17.
- Protocol on Strategic Environmental Assessment ratified by Serbian government at the end of 2004,
- The European Landscape Convention, Florence, 2000, ratified 2011.
- International Convention on the Elimination of all forms of Racial Discrimination, New York, 7.03.1966.
- Convention on Elimination of all forms of Discriminations Against Women, New York, 03.09.1981, ratified by Republic of Serbia in 2001.
- Council of Europe Convention on Preventing and Combating Violence Against Women and Domestic Violence, Istanbul, 11.05.2011, in force in Republic of Serbia from 01.08.2014.
- National Convention on Economic, Social and Cultural Rights New York, 16.12. 1966, ratified by Republic of Serbia in 1990.
- International Labour Organization Convention No. 155: Occupational Safety and Health, 1981, ratified 1992.
- UNESCO Convention for the Safeguarding of the Intangible Cultural Heritage, 2003, ratified in May 2010.
- EUROPEAN Convention "For the Protection of Archaeological Heritage", ratified in 2009.

The Lenders recognise the responsibility of their clients and their business activities to respect human rights. This responsibility involves respecting human rights, avoiding infringement on the human rights of others, and addressing adverse human rights impacts that their business activities may cause, or to which they may contribute. The term "social" refers to those issues which pertain to project-affected people (PAPs) and their communities and workers and related to socioeconomic status, vulnerability, gender equality, human rights, sexual orientation, cultural heritage, labour and working conditions, health and safety and participation in decision making.

The social standard IFIs Policy is guided by provisions of several fundamental treaties and conventions: The International Bill of Human Rights, International Labour Organization (ILO) Conventions, the European Convention on Human Rights, UNESCO World Heritage Convention etc.

In addition to the above, Serbia has adopted or embedded in its regulations the principles of many international treaties[17] and standards that provide a basis for the EIB Policy Social Impact Assessment regulation.

3.5. EBRD Environmental and Social Policy

The European Bank for Reconstruction and Development (EBRD) is committed to promoting environmentally sound and sustainable development in the full range of its activities. The Environmental and Social Policy (April 2019) is a key document that guides that commitment.

The Policy outlines how the Bank will assess and monitor the environmental and social impacts of its projects, sets the minimum requirements for managing E&S risks and impacts caused by EBRD financed projects, and defines the respective roles and responsibilities of both EBRD and its clients in designing, implementing and operating projects in line with the Policy.

Through the Policy, EBRD has adopted a comprehensive set of specific Performance Requirements (PRs) for key areas of environmental and social sustainability that projects are required to meet. These are outlined in Table 3-3, with an indication of which are applicable to this Project.

Table 3-3. EBRD's Performance Requirements

No	Title	Applicability
PR 1	Assessment and Management of Environmental and Social Risks and Issues	Applicable
PR 2	Labour and working conditions	Applicable

[17] *Convention on the Elimination of all Forms of Discrimination Against Women (CEDAW); World Health Organisation (WHO) standards and guidelines ; International Labor Organization Convention on Construction Safety and Health No. 167; EC Directive 98/59/EC of 20 July 1998 on the approximation of the laws of the Member States relating to collective redundancies and collective dismissals; EEC Directive 89/391/EEC the Safety and Health at Work Directive is a European Union directive that sets out general principles for protection of workers' Occupational safety and health; ECDirective 2008/96/EC On Road Infrastructure Safety Management; EU Directive 2012/18/EUon the control of major-accident hazards.*

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No	Title	Applicability
PR 3	Resource Efficiency and Pollution Prevention and Control	Applicable
PR 4	Health, Safety and Security	Applicable
PR 5	Land Acquisition, Restrictions on Land Use and Involuntary Resettlement	Applicable
PR 6	Biodiversity Conservation and Sustainable Management of Living Natural Resources	Applicable
PR 7	Indigenous Peoples	Not applicable, no social and/or cultural group that is distinct from dominant groups within Serbian society is expected to be affected by the Project.
PR 8	Cultural Heritage	Applicable
PR 9	Financial Intermediaries	Not applicable, this only relates to private equity funds, banks, leasing companies, insurance companies and pension funds.
PR 10	Information Disclosure and Stakeholder Engagement	Applicable

EBRD categorizes proposed projects as A / B / C based on environmental and social criteria to: (i) reflect the level of potential environmental and social impacts and issues associated with the proposed project; and (ii) determine the nature and level of environmental and social investigations, information disclosure and stakeholder engagement required commensurate with the nature, location, sensitivity and scale of the Project and significance of potential E&S impacts.

Projects are categorized by EBRD as “A” when they are expected to result in potentially significant environmental and/or social impacts. This Project has been categorised by the Bank as Category A (as listed in Appendix 2 of the Policy, being, '*Construction of lines for long-distance railway traffic; airports with a basic runway length of 2,100 metres or more; motorways, express roads and new roads of four or more lanes, or realignment and/or widening of existing roads to provide four or more lanes, where such new roads, or realigned and/or widened sections of road would be 10 km or more in a continuous length*', and as such will require a formalised and participatory environmental and social impact assessment (ESIA) process.

3.6. EIB Environmental and Social Policy

The European Investment Bank (EIB) Group Environmental and Social Sustainability Framework is an overarching policy framework that allows the Group to focus on sustainable and inclusive development, committing to a just and fair transition and supporting the transition to economies and communities that are climate and disaster resilient, low carbon, environmentally sound and more resource efficient. It consists of a Group-wide Environmental and Social Policy (February 2022) and a revised set of EIB Environmental and Social Standards, which describe the requirements that all EIB-financed projects must meet:

Standard 1 – Environmental and Social Impacts and Risks

Standard 2 – Stakeholder Engagement

Standard 3 – Resource Efficiency and Pollution Prevention

Standard 4 – Biodiversity and Ecosystems

Standard 5 – Climate Change

Standard 6 – Involuntary Resettlement

Standard 7 – Vulnerable Groups, Indigenous Peoples and Gender

Standard 8 – Labour Rights

Standard 9 – Health, Safety and Security

Standard 10 – Cultural Heritage

Standard 11 – Intermediated Finance

All of the ESSs are applicable to this Project except Standard 11.

3.7. GAP analysis

The international and national processes are aligned regarding the requirements for assessment of environmental impact. However, the international ESIA is a more integrated process and needs to encompass the requirements associated with regulatory mechanisms such as those which are part of the local "planning process" and are outside the formal environmental impact assessment process. The international ESIA also needs to consider and address social issues in a more detailed manner, including particularly the preparation of specific management plans for land acquisition related impacts, grievance management and engagement with stakeholders. The table below summarises the similarities and differences between the ESIA and Serbian EIA process.

Table 3-4. Similarities and differences between the ESIA and Serbia EIA process

Activity	ESIA	EIA	Comments
Screening Study	Yes	Yes	Due to nature and scale of the proposed project and the clear requirement under international standards and national legislation the project is a Category A /List I project and a formal screening study was not produced for this project. The procedure started from the scoping study.
Categorisation	Yes	Yes	Formal categorisation in accordance with banking standards and national legislation indicates that the proposed project is a Category A / List I project and requires a full impact assessment.
Stakeholder Engagement Plan	Yes	Partial	A formal stakeholder engagement plan (SEP) is not required under national legislation. However, stakeholder consultation is a part of the planning procedures and the EIA process. A SEP in line with international standards has been developed and will be implemented for the project (appended to this ESIA)
Scoping Study	Yes	Yes	Due to the requirements of the ToR, an International Scoping Study was created for this project. The local scope study has not yet been submitted to the local regulatory authorities because there is no legislative basis for it yet (Location conditions).
Consideration of alternatives	Yes	Yes	Both the impact assessment process for investment and national regulatory requirements, require the consideration of other feasible approaches, including alternatives' locations,
Environmental Impact Assessment	Yes	Yes	The environmental impact assessment requirements are generally aligned. The standards adopted in the environmental assessment undertaken for the ESIA should be in line with European and other international best practice. The requirements under the national EIA regulatory process need to ensure compliance with national legislation and not the regulatory requirements outside of the country.
Environmental impacts assessment in cases of accidents	Yes	Yes	The Serbian EIA legislation requires quite detailed analysis of environmental impacts in case of accidents which includes specification of hazardous substances used, emergency preparedness and response, remediation measures, etc.

Activity	ESIA	EIA	Comments
Socio-Economic Impact Assessment	Yes	Limited	The impact assessment under international standards requires an integrated approach including full deliberation of the socio-economic effects. A formal socio-economic impact assessment is not required under national legislation. However, the local national legislation does require assessment of effects where impacts are associated with impacts to human health. The ESIA contains a full assessment of socio economic impacts as required under international standards.
Resettlement Action Plan	Yes	No	The preparation and implementation of Resettlement Policy Frameworks (RPFs) and/or Resettlement Action Plans (RAPs), as defined by international standards, is not required under national legislation. An RPF was prepared within the framework of the Project prefeasibility study and Corridor E&S Assessment. An updated RPF has been developed as part of this ESIA disclosure package. Based on the updated RPF, when the necessary data on land acquisition becomes available, Project RAPs will be prepared and implemented.
Climate change vulnerability assessment	Yes	Limited	A formal climate change impact assessment is not required under national legislation. However, local national legislation requires an impact assessment where impacts are linked to impacts on meteorological parameters and climate characteristics. A Climate Risk Assessment has been conducted as part of this ESIA.
Environmental and Social Management Plan (ESMP)	Yes	No	ESMP is not typically included as a requirement according to local legislation. It is required for Category A projects according to EBRD and EIB E&S standards. ESMP describes the roles, the responsibilities, the key commitments and general measures, which should be implemented. The Approved Study is the base document for the preparation of ESMP which has been included as part of this ESIA.
Non-Technical Summary (NTS)	Yes	Yes	NTS is required for investment requirements for use as a disclosure document. It is recognised as good practice to produce an NTS to provide readily accessible summary of the project key features, an assessment of its effects, the proposed mitigation measures
Public Consultation & Disclosure	Yes	Yes	The public consultation process for both investment and national regulatory purposes is required. Given the length of the railway and that this project involves the construction of new railway part, the project is categorised in Category A, requiring the full ESIA disclosure package to be publicly disclosed for a minimum of 120 days. Specific arrangements are

Activity	ESIA	EIA	Comments
Management of Grievances and Objections	Yes	No	A project specific Grievance Mechanism is not a formal requirement under national legislation. However, grievances are reported under the consultation process and are encompassed under other regulatory mechanisms (e.g. the local 'planning' process). A project Grievance Mechanism has been established within the SEP and will be implemented for the project, as required under international standards.

Table 3-5. Analyses of Key Gaps Between Lender Requirements and National Legislation

EBRD PR / EIB Standard	Topic	Relevant provisions of Serbian legislation	Compliance with EBRD / EIB requirements
EBRD PR 2 EIB Standard 8	Human resource policies and working relationships	Labour and working conditions are regulated in line with international conventions, by the Labour Law, which states that the rights, obligations and responsibilities of workers are governed by collective agreements and labour regulations (employment contracts). Labour regulations and employment contracts must be aligned with the law and they can only provide more rights and improved working conditions compared to those stipulated by the law. Employers are obliged to present workers with their rights, obligations and responsibilities in writing and contracts must be signed by both parties.	Legislation, as applicable to the Project, is compliant.
EBRD PR 2 EIB Standard 8	Working conditions and terms of employment	The Labour Law states that workers have the right to adequate wages (including paid overtime, expenses), health and safety at work, health protection, protection of personal integrity, dignity and other benefits in case of illness, reduction of the ability to work or old age, financial aid during temporary unemployment and other forms of protection. The law sets out in detail employee rights in relation to hours of work, wages, overtime, compensation and benefits	Legislation, as applicable to the Project, is compliant.
EBRD PR 2 EIB Standard 8	Workers organizations	The Labour Law states that employees have the right to form and join Labour Unions and freely express their views in relation to labour and working condition issues.	Legislation, as applicable to the Project, is compliant.

EBRD PR / EIB Standard	Topic	Relevant provisions of Serbian legislation	Compliance with EBRD / EIB requirements
EBRD PR 2 EIB Standard 8	Non-discrimination and equal opportunity	Discrimination is explicitly prohibited by the Labour Law, both in relation to employees and those looking for employment and the person who feels discriminated against can turn to the court. Special protection of vulnerable groups, to give them equal opportunities, is allowed. Harassment in any form is also strictly prohibited by law. Women employees have the right to special protection during pregnancy and child birth. Employees have the right to special protection for child care. Employees below the age of 18 and those who have disabilities have the right to special protection. Employers are not allowed to request data from employees on their marital status or family planning. Employees are entitled to equal pay for the same work or work of equal value with an employer. The above provisions are further defined and strengthened in the Law on Gender Equality.	Legislation, as applicable to the Project, is compliant.
EBRD PR 2 EIB Standard 8	Internal grievance mechanism	The Labour Law allows for establishing a mechanism for amicable resolution of disputes between employees and the employer. Employees (or their authorised representatives) can turn to the courts for any breach of their labour and working conditions. No specific applicable national legislation which requires the establishment of an internal grievance mechanism for workers (including to receive anonymous complaints or complaints from contractor/supplier workers), as required by EBRD and EIB.	EBRD and EIB requirements have been addressed in the project ESIA and management plans.
EBRD PR 2 EIB Standard 8	Child and forced labour	The Labour Law states that employment of minors (over 15, under 18) is allowed, under certain conditions – approval of parents, guardians and if the work does not jeopardise the minor's health and safety, moral or education. The law sets out in detail workers' rights in relation to working hours, leave, daily work break, termination of employment, etc.	Legislation, as applicable to the Project, is compliant.

EBRD PR / EIB Standard	Topic	Relevant provisions of Serbian legislation	Compliance with EBRD / EIB requirements
		The law applies to foreign citizens working on the territory of the Republic of Serbia.	
EBRD PR 2 EIB Standard 8	Workers engaged by third parties / supply chain	All employers, including contractors and suppliers are expected to comply with national legislation in the area of labour and working conditions. Monitoring is carried out by the State Labour Inspectorate. No specific applicable national legislation which requires the management or monitoring of contractor / supplier performance in fulfilling the requirements of Serbian labour legislation, as required by EBRD and EIB.	EBRD and EIB requirements have been addressed in the project ESIA and management plans.
EBRD PR 1 EIB Standard 7	Assessment, management and monitoring of impacts and risks on vulnerable individuals and groups (including consideration of gender aspects) and stakeholder engagement.	No specific applicable national legislation which requires consideration of project impacts on vulnerable individuals / groups or gender aspects, as required by EBRD and EIB. However, national legislation provides a framework for identifying and assisting vulnerable individuals and groups, including from a gender perspective, to enable the fulfilment of relevant IFI requirements, for example, through the Law on Social Welfare of the RS, the Law on Housing and Building Maintenance, Law on Gender Equality, Law on Prohibition of Discrimination, etc.	EBRD and EIB requirements have been addressed in the project ESIA and management plans.
EBRD PR 10 EIB Standard 2	Disclosure of information and meaningful consultation. Development and implementation of Stakeholder Engagement Plan.	Disclosure of information and consultation requirements in relation to projects are addressed in the process of developing and adopting spatial and urban planning documents, as well as carrying out environmental impact assessments of proposed projects, as described in Section 3.1.1. of this document. There is no specific applicable national legislation which requires the identification of project stakeholders, engagement planning (Stakeholder Engagement Plan), proactive information disclosure and meaningful consultation, as required by EBRD and EIB.	EBRD and EIB requirements have been addressed in the project ESIA and management plans.

EBRD PR / EIB Standard	Topic	Relevant provisions of Serbian legislation	Compliance with EBRD / EIB requirements
EBRD PR 10 EIB Standard 2	External grievance mechanism	No specific applicable national legislation which requires the development and implementation of an external grievance mechanism, as required by EBRD and EIB.	EBRD and EIB requirements have been addressed in the project ESIA and management plans.

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RAILWAY LINE BELGRADE–NIŠ, SECTION III PARAĆIN-TRUPALE,
Environmental and Social Impact Assessment,
4. ASSESSMENT OF ALTERNATIVES

EU PPF
PROJECT PREPARATION FACILITY

DOCUMENT CONTROL SHEET

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LIST OF ABBREVIATIONS AND ACRONYMS

EBRD	European Bank for Reconstruction and Development
EIB	European Investment Bank
ESIA	Environmental and Social Impact Assessment
EUD	European Union Delegation
ha	hectare
IFI	International Finance Institutions
MCTI	Ministry of Construction, Transport and Infrastructure of the Republic of Serbia
MCA	Multi criteria decision analysis
MoM	Minutes of Meeting
PD	Preliminary Design
PFS	Pre-Feasibility Study
PPF9	Preparation Project Facilities 9
RPF	Resettlement Policy Framework
RS	Republic of Serbia
SEP	Stakeholder Engagement Plan
SRI	Serbian Railway Infrastructure
TA	Technical Assistance

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1. ASSESSMENT AND ANALYSIS OF ALTERNATIVES FOR THE PROJECT IMPLEMENTATION

1.1. Introduction

This chapter outlines the main alternatives that have been considerered and assessed during the development of the current Project design. It includes the No–Project scenario, alternative modes of transport, and localized route realignments. Alternatives to the Project's general alignment were already considered during the pre-feasibility phase. These have been presented in detail in the preliminary feasibility study (PFS) and the Scoping Report associated with the PFS prepared by the PPF9 Team in 2022, and subsequently disclosed as part of the Corridor E&S Assessment (as described in Chapter 1 'Introduction' of this ESIA Report). This Chapter summarises the evaluation of the potential alternatives to the general route alignment (as considered in the Pre-Feasibility Study), as well as the minor realignments incorporated into the final alignment as part of Variant II of the 2022 Pre-Feasibility Study (PFS), which were required to facilitate the design speeds and safety specifications. The environmental and social implications of these realignments are assessed in Section 1.3.4. The most significant alignment intervention included in the Project is Deviation 4 (Đunis Tunnel), which was anticipated during the 2022 Pre-Feasibility Study and formalized during the conceptual and preliminary design stages. Its environmental and social implications are evaluated in this Chapter. It should be noted that the mitigation hierarchy approach has been adopted from the outset to avoid adverse environmental or social impacts wherever possible.

A detailed overview of the historical development of the alignment and Project design, including technical and institutional milestones, is presented in Section 1.3.1.

1.1.1. Requirements for an Assessment of Alternatives

This Chapter has been prepared in accordance with the following requirements:

- The EIA Directive which states: "….a description of the reasonable alternatives studied by the developer, which are relevant to the project and its specific characteristics, and an indication of the main reasons for the option chosen, taking into account the effects of the project on the environment".
- EBRD Performance Requirement (PR) 1 which states that ESIA should include: "….an analysis of reasonable alternatives, in terms of project location, technology, size, scale and design, mitigation options and the "without project" scenario."
- EIB Environmental and Social Standard (ESS) 1 which states the ESIA should include: "The description of the reasonable alternatives (for example, in terms of project design, technology, location, size and scale) which are relevant to the proposed project, and an indication of the main reasons for selecting the chosen option, including a comparison of the environmental and social effects."

1.2. Background

There is currently a heavy reliance on road transport between Belgrade and Niš due to the limited capacity of railway transport, rail speed restrictions, and the low frequency of trains running. The main highway E-75/A1 runs in parallel with the existing railway line between Belgrade and Niš and facilitates most of the passenger and freight transport from the north to the south of Serbia.

Increased rail capacity, reduced journey times, and more frequent trains would enable a modality shift of passengers and freight from the road to rail, with all the associated social, environmental, and safety benefits. The modernisation of the country's rail transport system, in particular, the Belgrade-Niš Railway line, was prioritised as a strategy for the country's sustainable development.

The modernisation of railway infrastructure along Railway Corridor X in Serbia will include the reconstruction of the existing lines and the addition of a second track in those sections where single-track lines were originally built. This task is one of the State priorities for the construction of traffic infrastructure in the territory of the Republic of Serbia. The modernised railway would meet the requirements defined by relevant international agreements (Agreement on Main International Railway Lines (AGC), European Agreement on Important International Combined Transport Lines and Related Installations (AGTC), South-East European Countries Cooperation Process (SEECP)). The reconstructed and modernised railway for mixed passenger and freight traffic would be equipped with a modern ERTMS (European Rail Traffic Management System) and be designed, implemented, and operated in line with the technical specifications of interoperability (according to TSI INF (EU) 1299/2014 Technical specification for interoperability relating to the Infrastructure subsystem, and TSI 1300/2014 TSI relating to accessibility of the Union's rail system for persons with disabilities and persons with reduced mobility). The section of Railway Corridor X in Serbia between Belgrade and Novi Sad has already been constructed, and the Section between Novi Sad–Subotica is currently under construction. The construction of the Belgrade–Novi Sad section has led to significantly reduced travel times, more reliable scheduling, and enhanced passenger comfort. As noted in the Feasibility Study for the Belgrade–Niš railway line, prepared by the PPF9 team, these improvements have contributed to a substantial shift from road to rail transport among passengers.

1.2.1. No-Project Scenario

Under the ’no project’ scenario the current downward trend in the utilisation of the Belgrade–Niš railway is expected to continue, with associated increases in the number of passengers who are switching to road-based motorised means of transport and decreases in the utilisation of the railway by freight operators. Additionally:

- the current condition of the railway infrastructure along the Belgrade-Nis line will continue to be unsatisfactory and is expected to deteriorate further in the absence of much needed investment.
- the commercial speed of passenger trains will remain at about 50 km/h on average or lower considering further degradation of the infrastructure.

- the safety of the railway system will deteriorate over time, with diminished reliability of obsolete electrical equipment and technology.
- the large number of level crossings along the line will continue to pose a danger to road users, and jeopardise the safety of both rail and road traffic
- there will be continuing negative impacts on air quality as a result of emissions from passenger and freight road vehicles, contributing to greenhouse gas (GHG) emissions and climate change.

Beyond these direct impacts, the "no-project" alternative would contradict Serbia's key national and international commitments. The Belgrade–Niš railway is identified as a strategic transport corridor in the Spatial Plan of the Republic of Serbia (2010–2020) ("Official Gazette of RS", No. 88/2010), and is defined as a priority for development in the:

- Transport Master Plan for Serbia (2009),
- Development Plan for Railway, Road, Inland Waterways, Air, and Intermodal Transport 2015–2020,
- Railway Master Plan (2012–2021) and
- National Program for Public Railway Infrastructure 2017–2021.

Internationally, the railway line forms a core component of SEETO Corridor X and is part of the indicative extension of the TEN-T network in the Western Balkans, as defined in Commission Delegated Regulation (EU) 2016/758 and reaffirmed in the Treaty establishing the Transport Community (2017). As such, the project is central to Serbia's alignment with EU transport policy, particularly the goals of:

- Enhancing regional integration and connectivity through the Common Regional Market (CRM),
- Supporting modal shift from road to rail in line with the EU Green Agenda, and
- Meeting technical and safety standards through compliance with AGC, AGTC, and Technical Specifications for Interoperability (TSI).

Failure to implement the project would directly undermine these strategic objectives and disregard Serbia's obligations as a candidate country for EU membership. Accordingly, the "no-project" alternative is not considered viable and has been discounted

For the above listed reasons, the 'No-Project' alternative was discounted.

1.3. Alternative Rail Options

1.3.1. Historical Development of the Proposed Route

The development of the Belgrade–Niš Railway Corridor, including the Project (Section 3), has been a staged and cumulative process involving technical studies, environmental and social assessments, stakeholder engagement, and regulatory approvals.

Over nearly two decades, the Belgrade- Niš Railway Corridor project has been progressively redefined through a series of design iterations and strategic decisions. These aimed to modernize the infrastructure in accordance with TEN-T and EU interoperability standards whilst minimizing negative environmental and social impacts.

The Railway Corridor Project has been divided into three Sections for the purposes of further project development:

- **Section 1**: Belgrade (Resnik) to Velika Plana,
- **Section 2**: Velika Plana to Paraćin,
- **Section 3**: Paraćin to Trupale (Niš) (the Project being assessed in this ESIA Report, and as described in detail in Chapter 2)

Spatially, Section 3 (the Project) is being considered as 2 sub-sections on either side of the Stalać to Đunis stretch of the railway, namely: 1) Paraćin–Stalać and 2) Đunis–Trupale (Niš). The Stalać–Đunis section of the railway serves as a connecting section between the two sub-sections and is being addressed separately, and is in a more advanced stage of preparation, so is not part of this ESIA.

The table below provides a chronological overview of key development milestones for the overall Belgrade–Niš Corridor Railway project, illustrating how the current alignment — including the 11 route deviations and station location optimizations relevant to Section 3 was developed and formally adopted through successive planning and design phases.

Table 1-1. Chronological overview of key development milestones for the overall Belgrade–Niš Corridor Railway project

Year	Stage / Document	Key Development / Decision	Notes
2007	Detailed Design: Gilje–Ćuprija	Detailed design for reconstruction and modernization carried out	Early design activities on the wider Belgrade–Niš corridor
2007	General Design + EIA	Initial upgrade concepts for Belgrade–Niš Railway Corridor	No significant deviations proposed at this stage
2016	Feasibility Study + Preliminary Design + ESIA: Niš Railway Bypass	Developed bypass alternatives and assessed E&S impacts	Influential for downstream connections and broader corridor design
2018	Preliminary Design: Stalać–Đunis	Introduced 160 km/h design speed; national EIA completed	Basis for central segment of Section 3
2018	FS + Preliminary Design: Niš–Brestovac (toward North Macedonia)	Single-line upgrade; design and structures assessed	Informs route alignment principles and interoperability planning
2019	Conceptual Design: Velika Plana–Niš	Initial identification of geometric constraints and deviation needs	Technical framework for downstream alignment options speed up to 160 km/h
2022	Pre-Feasibility Study (PFS) + Preliminary ESIA Scoping	Multi-Criteria Analysis of 3 route variants (I, II, III); Variant II selected	Included stakeholder engagement and environmental/social scoping
2022	Corridor-level E&S Assessment	Completion of Environmental and Social Assessment Report, Environmental and Social Management Plan and	Provided a harmonized high-level baseline, assessment of impacts and generic mitigations for all railway

Year	Stage / Document	Key Development / Decision	Notes
		Environmental and Social Action Plan for entire Belgrade–Niš Railway Corridor	sections and a basis for future section-specific ESIAs.
2023	Conceptual Design (Section 3: Paraćin - Trupale)	11 route deviations developed based on Variant II and terrain analysis. The development of the 11 route deviations is further detailed in Sections 1.3.3 and 1.3.4	Alignment optimization to meet 200 km/h design standards
2024	Public Consultation on Draft Spatial Plan (Section 3: Paraćin - Trupale)	Draft plan publicly disclosed; consultations held with local governments	March–June 2024; presentations held in Paraćin, Aleksinac, and Niš; stakeholder concerns regarding alignment and access were discussed
2024	Spatial Plan of Special Purpose Area (Section 3: Paraćin - Trupale)	Final alignment (Variant II + deviations) adopted by National Assembly	Plan adopted in October 2024; published in Official Gazette No. 91/2024
2025	Location Conditions issued (Section 3: Paraćin - Trupale)	Technical planning permits obtained from relevant authorities	Location conditions issued in May 2025
2025	Preliminary Design (Section 3: Paraćin - Trupale)	Detailed technical design of selected alignment, incorporating all approved deviations	Provides basis for ESIA finalization and tender documentation

1.3.2. Review of Alternatives Analysis within the Pre-Feasibility Study

The Pre-Feasibility Study (PFS) study was carried out by the PPF9 team in 2022. Consequently an E&S Scoping Report, Stakeholder Engagement Plan (SEP), and preliminary Resettlement Policy Framework (RPF) were produced. Within the PFS, a Multi-Criteria Analysis (MCA) was carried out that considered three alternative options/variants for the Belgrade–Niš Railway Corridor, as well as the No- Project scenario. Since the goal of the Project is the modernization of the existing 230km primarily double-track railway between Belgrade–Niš (to increase the speed and enhance the quality and efficiency of passenger and freight rail services), each alternative/variant was based on the rehabilitation of the existing railway infrastructure.

The key characteristics of the three proposed variants under PFS are outlined below:

- Variant I would result in the largest part of the railway being designed for speeds of up to 200 km/h, with an expected increase in investment costs. Under this variant, this speed could be achieved on 84% of the line, i.e. around 192 km out of the total length of 227,032 km.
- Variant II considered the possibility of achieving speeds of up to 200 km/h on the entire line from Belgrade to Niš (except for lines in junctions), with the exception of those parts of the line where it was estimated that an increase in the design speed would require a significant increase in investment. This would mainly be the case due to localised restrictions (railway stations located in urban areas), and most stations remain at their existing locations. Thus, Variant II follows the existing corridor but with increased radii of certain curves to be able to achieve speeds of 200 km/h or 160 km/h, depending on the terrain and estimated increase in costs. The total length of Variant II is 228,160 km. A speed of 200 km/h is achieved on 127 km, being 56% of the total length of the line.

- Variant III was based on the premise of achieving the improvements with the least investment. While aiming to design parts of the route for speeds up to 200 km/h, this variant was limited by cost considerations, resulting in only 37% (85 km) of the alignment allowing for such speeds. The remainder of the route, including all stations at their existing locations, would operate at lower speeds, primarily up to 120 km/h. This variant represented the lowest investment cost among the three options.

Section 3 Alternatives Analysis within the Pre-Feasibility Study

For Section 3 (the Project), the following differences in Project design were assumed under the 3 Variants assessed in the 2022 PFS.

- PFS Section 3 Variant I
  - From Paraćin station to Stalać station, the alignment follows the existing railway corridor, with local adjustments to the alignment in order to increase curve radii and enable speeds of up to 200 km/h. In such zones, the new alignment deviates from the existing one but remains within the same general corridor.
  - Ćićevac station is relocated outside the urban area, due to the limited spatial possibilities within the town and to allow for the design speed of 200 km/h.
  - The alignment between Stalać and Đunis is based on the Preliminary Design prepared for a maximum speed of 160 km/h. For the purpose of this option, only cost estimates were used, while curve radii were increased at the exit from Đunis station to match the alignment with 200 km/h speed parameters.
  - From Đunis onwards, the alignment remains in the existing corridor with local realignments where necessary to accommodate increased curve radii.
  - Korman and Adrovac stations remain at their existing locations, as the spatial conditions allow for achieving the required design speed without the need for relocation.
  - Aleksinac station is relocated outside the urban area, in order to eliminate level crossings and improve access to industrial sidings located in the southern part of the city.
- PFS Section 3 Variant II
  - From Paraćin to Stalać station, the alignment follows the existing railway corridor with minor deviations in order to increase the radii of curves and achieve speeds of up to 200 km/h where technically and economically feasible.
  - Ćićevac station remains at its existing location, unlike Variant I, as the available space allows for achieving the required speed profile of up to 160 km/h through the station area.
  - The alignment between Stalać and Đunis is based on the existing Preliminary Design for speeds up to 160 km/h. For the purpose of Variant II, only minor adjustments are considered at the exit from Đunis station to allow for increased curve radii in selected zones.
  - From Đunis to Trupale station, the line continues along the existing corridor, with local realignments where necessary to allow for a speed increase up to 200 km/h, without relocation of stations.
  - Korman and Adrovac stations are retained at their current locations, as there are no major constraints that would require relocation in order to meet the speed requirements.
  - Aleksinac station is retained at its existing location, unlike Variant I, in order to minimize investment costs and reduce the need for expropriation and construction of new access roads. The possibility of connecting the existing industrial sidings remains under consideration for future phases.
- PFS Section 3 Variant III

- From Paraćin to Stalać station, the railway alignment remains within the existing corridor. Where necessary, local adjustments were introduced to increase the curve radii and enable higher speeds, while minimizing construction costs.
- Ćićevac station is retained at its existing location, similarly to Variant II, with the design speed through the station limited to 160 km/h.
- The Stalać–Đunis section follows the alignment from the existing Preliminary Design, with a design speed of up to 160 km/h. In Variant III, no significant modifications are proposed beyond minor adjustments to increase curve radii at the exit of Đunis station.
- From Đunis to Trupale, the alignment remains within the existing railway corridor, with local improvements of curve geometry to allow for 200 km/h where possible, in line with the general concept of maximizing effect with minimal investment.
- Korman and Adrovac stations remain at their current locations, as their retention does not compromise the ability to achieve the planned speeds on this section.
- Aleksinac station also remains at its current location in this variant, unlike Variant I. This solution minimizes expropriation costs and maintains existing urban and industrial connectivity.

Multi Criteria Analysis

The main objective of the Belgrade-Nis Railway Corridor project is to modernise the existing railway line in compliance with TEN-T standards, making it a reliable and competitive mode of transport and increasing passenger and freight traffic demand. Furthermore, the objective is to be achieved in a cost-effective and sustainable way, in compliance with strategic plans at the national, regional, and local levels. Given the line's category, it should comply with internationally agreed-upon Technical Specifications for Interoperability and with the technical requirements for the core TEN-T.

The goal of the options analysis carried out within PFS in 2022 was to identify the significant differential impacts between the proposed alternatives, and in this regard, the evaluation criteria were defined. The criteria for which no significant difference between the multiple options was observed or assumed were excluded from further analyses. A list of the adopted criteria, and their significance for the evaluation of alternatives (weight) is shown in the table below.

Table 1-2. Main criteria with weighting coefficients

Main criteria	Initial weight for main criteria [%]
Financial	22
Demand	20
Operation	13
Social & Environmental	22
Safety	12
Risks	11

Under the Social & Environmental criteria, the following sub-criteria were considered.

- Biodiversity and protected areas.
- Surface waters.
- Floods.
- Noise and vibration.
- Resettlement.

PFS Scoring

The conclusion of the multicriteria analysis can be summarised as follows:

- Variant I was significantly more expensive, and the construction period was assessed to be longer when compared to the other two Variants. It was decided to exclude it from further analysis, as the benefits regarding other criteria were not sufficient to outweigh the disadvantages of the "Financial" criterion.
- Comparing variants II and III, Variant II was more expensive at almost 135 million euros. The difference in the investment costs made it that Variant III was considered more cost-effective despite less travel time savings. Variant III also provided better results in terms of population resettlement avoidance, and noise and vibration impacts on the population. Variant III was the variant with the shortest construction period. Variant II, however, provided a shorter travel time for inter-city trains, which was considered especially important for the future railway traffic attractiveness.
- Variant II also provided better operational efficiency, which in practice should allow not only a shorter travel time for all trains but also significantly lower traction energy consumption for operators. Moreover, Variant II performed better than Variant III with regard to Safety-related criteria in terms of a lower risk of accidents, both at level crossings and on the road network. Finally, Variant II results in greater reductions in CO2 and pollutant emissions due to the larger shift from road transport.
- Variant II has the possibility of achieving a relatively simple improvement regarding the impact on population resettlement and reducing the impact of noise and vibration on the population, without changes in the values of other criteria, including operational and financial.

Table 1-3. Comparison of Variant II and III, including selected sub-criteria

Sub-criterion	Variant 2	Variant 3
Total costs	✖	✔
Cost-effectiveness	✖	✔
Estimated travel time of inter-city trains	✔	✖
Operational efficiency	✔	✖
Population to be resettled	✖	✔
Estimated of noise and vibrations' impact the population	✖	✔
Reduction in total transport CO_2 emissions due to modal-shift	✔	✖
The Expected number of accidents at level crossings	✔	✖
Reduction of road accidents due to modal shift to a safer mode	✔	✖
Duration of construction period	✖	✔

It was concluded that Variant II is the preferred option, according to the following criteria:

- **Estimated travel time of inter-city trains**
- **Operational efficiency**
- **Reduction in total transport CO_2 emissions due to modal shift**
- **The expected number of accidents at level crossings**
- **Reduction of road accidents due to modal shift to a safer mode.**

Variant II was chosen as the final framework for the railway line modernisation, as its potential benefits and advantages compared with Variant III justified the difference in investment costs.

Under all three Section 3 variants, the alignment generally follows the existing railway corridor in all cases, with local deviations introduced to increase curve radii where necessary. All stations— Ćićevac, Stalać, Đunis, Korman, Adrovac, and Aleksinac — would remain at their existing locations under Variants II and III, whilst under Variant I, Ćićevac and Aleksinac stations are relocated outside urban areas in order to enable higher design speeds. The design speed varies across the variants, with 200 km/h achieved on longer segments in Variant I, while Variants II and III prioritize reduced investment costs and retain more existing infrastructure elements.

Following the adoption of Variant II as the preferred option for the Belgrade- Niš Railway Corridor project, the route alignment and Project design for Section 3 were subsequently developed during the conceptual and preliminary design phases according to the principles listed above for this Variant.

1.3.3. Section 3 Route Deviations from the Existing Alignment

As explained above, the preferred PFS Variant II served as the basis for the development of the Preliminary Design for Section 3 of the Belgrade–Niš Railway Corridor, covering the alignment from Paraćin to Trupale (Niš). This section is further divided into two sub-sections:

- **Paraćin–Stalać**, extending from km 153+380 to km 174+170.79 (total length of 20.4 km),
- **Đunis–Trupale**, extending from km 191+937.96 to km 229+642 (total length of 37.7 km).

Section 3 of the railway is a double-track, electrified line intended for mixed passenger and freight traffic. The design aims to achieve target speeds of up to 200 km/h wherever technically and economically feasible, in accordance with TEN-T standards and relevant EU interoperability regulations.

The existing alignment presents significant limitations in terms of horizontal geometry, particularly curve radii, which restrict train speeds and compromise operational efficiency. As such, several segments of the line required adjustments to improve curvature, reduce turning angles, and align with safety, comfort, and speed design standards.

The overall alignment, including the need for localized deviations, was already defined during the 2022 Pre-Feasibility Study (Variant II). The subsequent conceptual and preliminary design phases did not alter the general route but further developed the detail of the alignment, confirming the need for and refining 11 deviations based on technical, environmental, and social parameters.

These deviations are presented and analysed further in this Chapter.

The design process followed the **mitigation hierarchy approach**, aiming first to avoid adverse environmental and social impacts where possible, and subsequently to minimize and mitigate such impacts through route optimization and design integration. In particular, potential social impacts such as physical displacement or proximity of the railway to residential and sensitive areas were considered when defining the final route alignment. The identification and evaluation of deviations were conducted in close coordination with local self-governments and relevant stakeholders through public consultation and inter-institutional technical meetings. This collaborative approach ensured that the final alignment reflects not only technical feasibility but also considers community needs and spatial planning priorities.

The selected Section 3 route alignment has been integrated into the **Spatial Plan for the Special Purpose Area of the Belgrade–Niš Railway Corridor**, which was adopted by the National Assembly on 24 October 2024 and published in the Official Gazette of the Republic of Serbia No. 91/2024 dated 21 November 2024. The Spatial Plan defines the limits of the public purpose land, including both the existing railway right of way and new land to be acquired for deviations, associated infrastructure, and safety buffer zones. A Resettlement Policy Framework (RPF) has been prepared to govern land acquisition procedures, whilst a detailed Resettlement Action Plan (RAP) will be developed for Section 3 based on cadastral data and field investigations.

The **existing stations along this section** include Paraćin, Ćićevac, Korman, Adrovac, Aleksinac, Lužane, Tešica, and Trupale. Most of these stations will be **retained and modernised** to meet operational and safety standards for high-speed traffic. The **Sikirica–Ratare stop** will be upgraded into a full station, while several other stops (e.g., Drenovac, Lučine, Vitkovac, Donji Ljubeš, Gornji Ljubeš, Trnjane, Nozrina, Grejač, Supovački most, Mezgraja, Vrtište) will be **decommissioned** due to low passenger demand or proximity to larger hubs based on the demand analysis conducted as part of the Feasibility Study prepared by the PPF9 team.

In terms of **design speed**, the Paraćin–Stalać sub-section is intended for up to 200 km/h in selected segments, although current achievable speeds are significantly lower (50–100 km/h). The Đunis–Trupale sub-section has been designed primarily for speeds of **160–200 km/h**, except in areas such as **Adrovac (up to 160 km/h)** and **Aleksinac (up to 120 km/h)** where geometric or urban constraints limited full-speed design implementation.

The subsequent sections of this Chapter will provide a detailed description of the 11 proposed deviations, the requirement for their implementation, and a comparison of routing options under the three alignment variants evaluated during prefeasibility and preliminary design stages.

Table 1-4 below provides an overview of the deviations, including their location, length, and primary justification:

Table 1-4. Overview of the deviations

PARAĆIN - STALAĆ			
No.	**Chainage (km)**	**Approx. Length (m)**	**Description / Requirement for Deviation**
1	157+100 - 158+000	900	Paraćin, curve correction, 20 m shift to the south. Residential properties not affected.
2	171+000 - 171+650	650	Ćićevac, curve correction at the entrance point of the railway station, shift 40 m to the west from existing line. Residential properties not affected
3	172+350 - 173+300	950	Ćićevac, curve correction, shift 50 m to the west from existing line. Residential properties not affected
ĐUNIS – TRUPALE			
No.	**Chainage (km)**	**Approx. Length (m)**	**Description / Requirement for Deviation**
4	192+100.00 – 193+200.00	1,100	New tunnel (580 m) and associated alignment adjustment between Đunis and Trupale to ensure minimum curve radius and maintain design speed. Residential properties not affected
5	194+150.00 – 195+100.00	950	Vitkovac, curve correction, shift 40 m northeast from existing line, 1 residential property affected.
6	195+700.00 – 196+500.00	800	Donji Ljubeš, curve correction, shift 70 m northeast from existing line, 4 residential properties affected
7	196+700.00 – 197+750.00	1,050	Srezivac, correction of two curves: 30 m shift NE in first curve, 50 m shift S in second, 2 residential properties affected.
8	202+150.00 – 203+050.00	900	Trnjane, curve correction, 60 m shift northeast from existing line, 10 residential properties affected
9	218+150.00 – 219+150.00	1,000	Tešica, curve correction, 20 m shift northeast. Residential properties not affected.
10	220+000.00 – 221+300.00	1,300	Grejač, curve correction, 50 m shift south from existing line, residential properties not affected.
11	221+650.00 – 228+200.00	6,550	Grejač / Mezgraja / Vrtište, set of curves corrected, up to 600 m shift from existing line, over 20 residential properties affected.

Although the final alignment of Section 3 was subject to detailed engineering refinement, it largely follows the alignment defined under the PFS Variant II. As such, no fundamentally new routing alternatives were considered during the Preliminary Design phase, and the proposed alignment was treated as a continuation and optimization of the preferred prefeasibility solution.

However, one key deviation — not explicitly defined at the prefeasibility stage — was introduced at the transition between the Stalać–Đunis and Đunis–Trupale Sub-Sections. This deviation involves the construction of a new tunnel and represents the most significant geometric intervention along Section 3. The tunnel was introduced as a technical necessity to ensure the minimum curve radius required for maintaining design speeds of 160–200 km/h. It also plays a critical role in ensuring traffic safety and operational continuity by providing a smooth connection between the two design subsections. Importantly, this deviation remains fully within the spatial corridor established under Variant II of the 2022 Pre-Feasibility Study.

Although the tunnel was not explicitly included in the 2022 Pre-Feasibility Study, the need for a geometric intervention in this area was anticipated, and a tunnel was acknowledged as a potential requirement. The decision to formalise the inclusion of the tunnel was taken during the conceptual and preliminary design stages, after it was confirmed that surface-based alternatives would not achieve the required curve radius or design speeds. Whilst a formal alternatives analysis was not carried out, the tunnel emerged as the only technically viable solution that fulfilled speed and safety requirements while remaining entirely within the Variant II spatial corridor, as defined in the PFS and the adopted Spatial Plan. The environmental and social implications of the tunnel alignment are assessed in Section 1.3.4, under the description of Deviation 4.

In summary, the alignment of Section 3: Paraćin–Trupale reflects a technically and strategically consistent solution, first outlined in the 2022 Pre-Feasibility Study. The conceptual and preliminary design phases focused exclusively on refining this alignment within the boundaries set by the PFS, confirming all 11 route deviations through detailed engineering and impact assessments. At no point does the alignment extend beyond the corridor defined by Variant II, as formally adopted in the 2024 Spatial Plan. This approach ensured full continuity of planning, legal compliance, and adherence to the mitigation hierarchy from the early stages of project development.

1.3.4. Assessment of Environmental and Social Implications of Route Deviations

The assessment of environmental and social implications of the 11 route deviations was carried out by the ESIA team during the ESIA preparation process (2024–2025), based on the final alignment provided under the Preliminary Design. While a high-level identification of deviations was made during the 2022 Pre-Feasibility Study (PFS), the ESIA team undertook a detailed, site-specific evaluation of each deviation. This was conducted in close coordination with the designers, as the design and ESIA processes were running in parallel, allowing for continuous technical input and alignment between environmental and engineering decisions.

For each of the 11 route deviations (shown in Figures Figure 1-1 to Figure 1-11) considered in the analysis of the Section 3 route alignment, the specific impacts on the following key parameters were assessed:

- **Biodiversity**: The potential impact on local ecosystems and habitats in areas affected by the deviations was analyzed.
- **Emerald and Protected Areas**: It was assessed whether the deviations had any impact on existing protected ecological zones or natural resources in the vicinity.
- **Noise and Vibrations**: The impact of increased speeds on the new sections of the route on noise and vibration levels, especially in areas close to residential zones, was evaluated.

- **Land Use**: The impact of each deviation on land use was examined, including changes in agricultural production, infrastructure, and land access.
- **Resettlement**: The extent to which deviations required the relocation of buildings and/or households, as well as the need for land expropriation, was analyzed.

For the purpose of this alternatives analysis, all affected structures identified within the 200-meter buffer zone have been conservatively classified as residential buildings, regardless of their current function (e.g. residential, commercial, or mixed-use). This categorization ensures a precautionary approach in estimating potential displacement and facilitates consistent comparison between alignment options. A more detailed classification of affected assets – including commercial and auxiliary structures – will be provided in the Social Assessment and the forthcoming Resettlement Plan (RAP).

Each assessement considered these parameters through a detailed analysis based on spatial and technical data, aimed at identifying potential negative impacts and taking appropriate measures to mitigate them.

Deviation 1 Paraćin km 157+100 – km 158+000

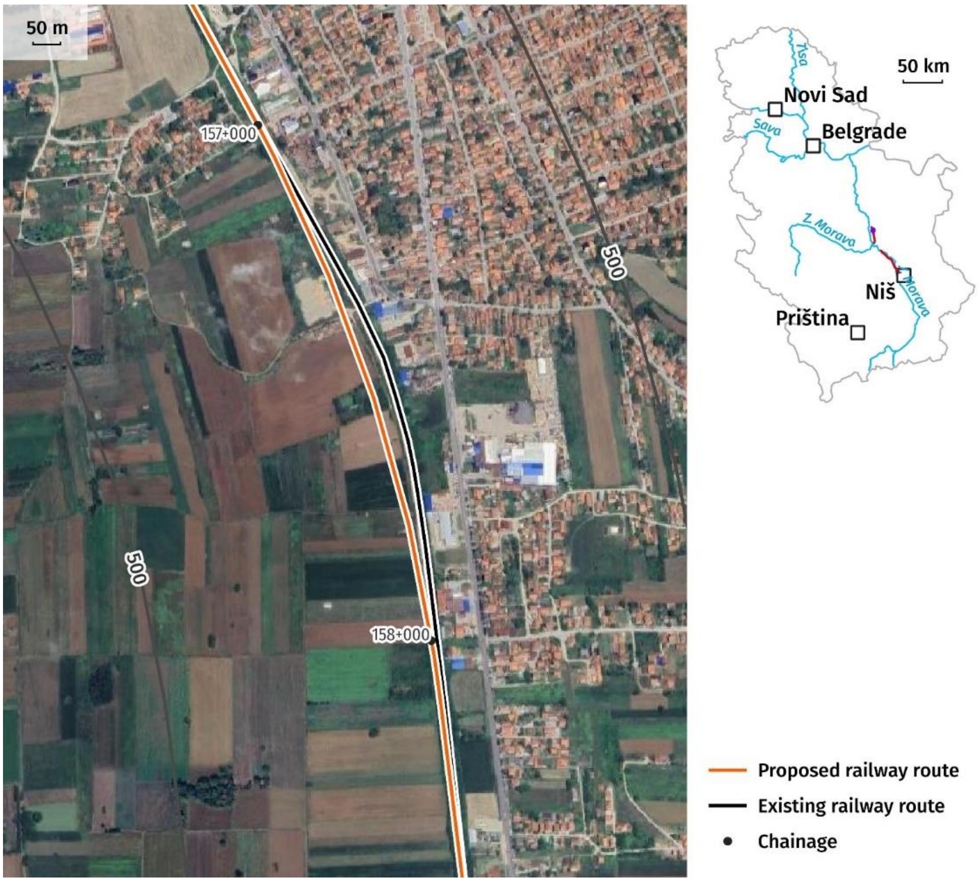

Figure 1-1. Deviation 1 Paraćin km 157+100 – km 158+000

This deviation was introduced to smooth the curvature of the existing railway alignment south of Paraćin, in order to support higher operational speeds and improve track geometry. The new route diverges westward from the existing track by approximately 30–40 meters and re-joins it after approximately 900 meters. The deviation remains within the designated railway corridor and does not introduce major engineering constraints.

The deviation shifts the railway alignment slightly away from the densely populated area east of the existing track. Within a 200-meter buffer from the new alignment, approximately 15–20 residential structures and 2–3 industrial or commercial buildings are located, primarily to the west of the railway. No structures appear to be located within 50 meters of the alignment. As a result, the number of people exposed to operational noise is expected to decrease compared to the baseline. Final exposure levels and mitigation measures will be assessed in the Noise and Vibration chapter of this ESIA.

The deviation crosses habitat type I1.1, which is classified as an anthropogenic habitat. There are no overlaps with Annex I habitats or protected ecological zones. Consequently, no biodiversity-related impacts are expected.

The alignment passes through areas classified as crops, with fields actively cultivated for seasonal or rotational agricultural use. The permanent land take is estimated at approximately 0.8–1.0 hectares, with no significant fragmentation of land parcels. These plots are located within the broader railway corridor and do not affect organized agricultural complexes.

Deviation 2 Ćićevac km 171+000 – km 171+650

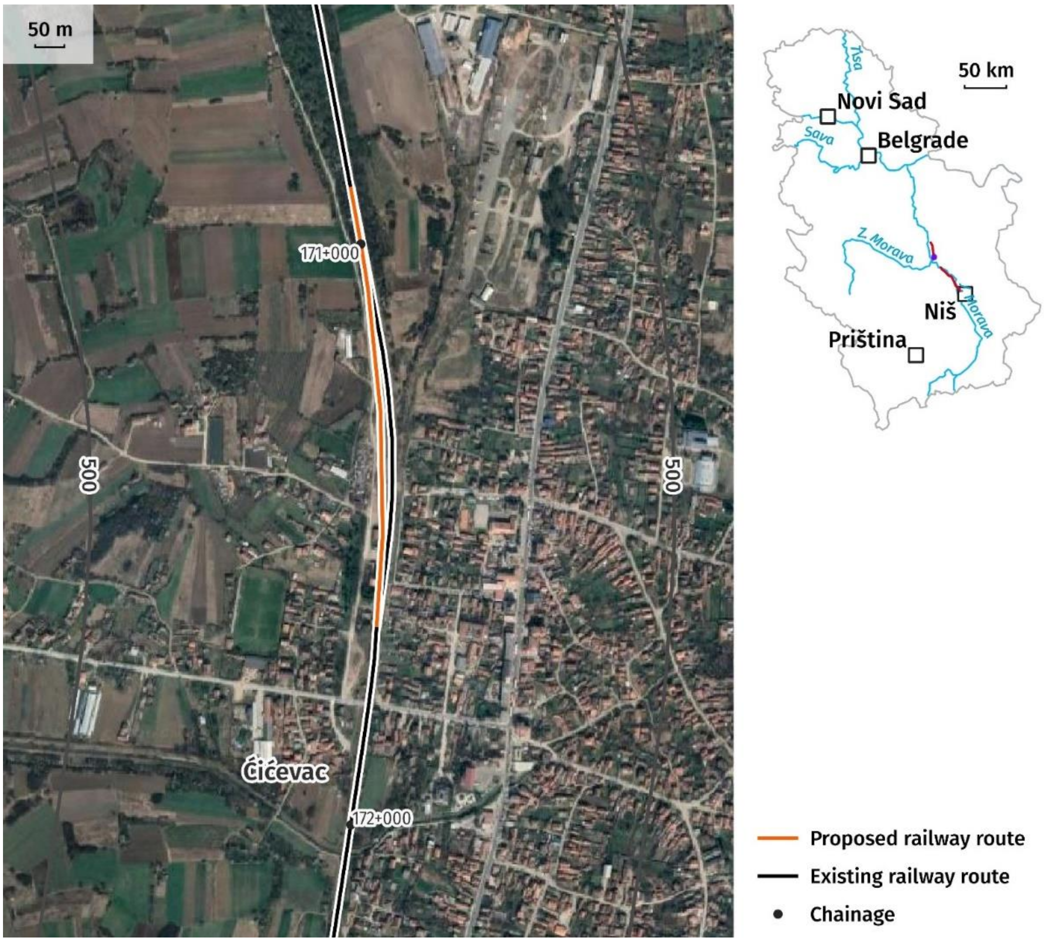

Figure 1-2. Deviation 2 Ćićevac km 171+000 – km 171+650

This deviation was introduced to adjust the alignment near Ćićevac in order to optimize the curve geometry and maintain the required design speed. The new track shifts slightly westward relative to the existing alignment, with a maximum lateral displacement of approximately 20–30 meters over a length of ~650 meters. The deviation remains within the spatially designated railway corridor and does not present major construction or terrain-related challenges.

Within a 200-meter buffer from the new alignment, approximately 25–30 residential structures are present, primarily dispersed on the western side. Additionally, two industrial or commercial facilities and two education or healthcare buildings are located within this buffer zone. While no residential buildings are located within 50 meters of the track, the presence of sensitive receptors such as educational or healthcare facilities within the 200-meter zone requires further consideration. A detailed assessment of potential noise and vibration impacts on these receptors, and corresponding mitigation measures, will be provided in the dedicated chapter of this ESIA.

The alignment crosses habitat type I1.1, classified as an anthropogenic habitat, with no overlap with ecologically sensitive areas or Annex I habitats. As such, no significant biodiversity impacts are anticipated along this deviation.

The deviation crosses agricultural land used for crop cultivation, mainly small-scale fields west of the existing alignment. The estimated permanent land take amounts to approximately 0.6–0.8 hectares. Due to the limited shift and linear nature of the corridor, no significant fragmentation of agricultural plots is expected.

Deviation 3 Ćićevac km 172+350 – km 173+300

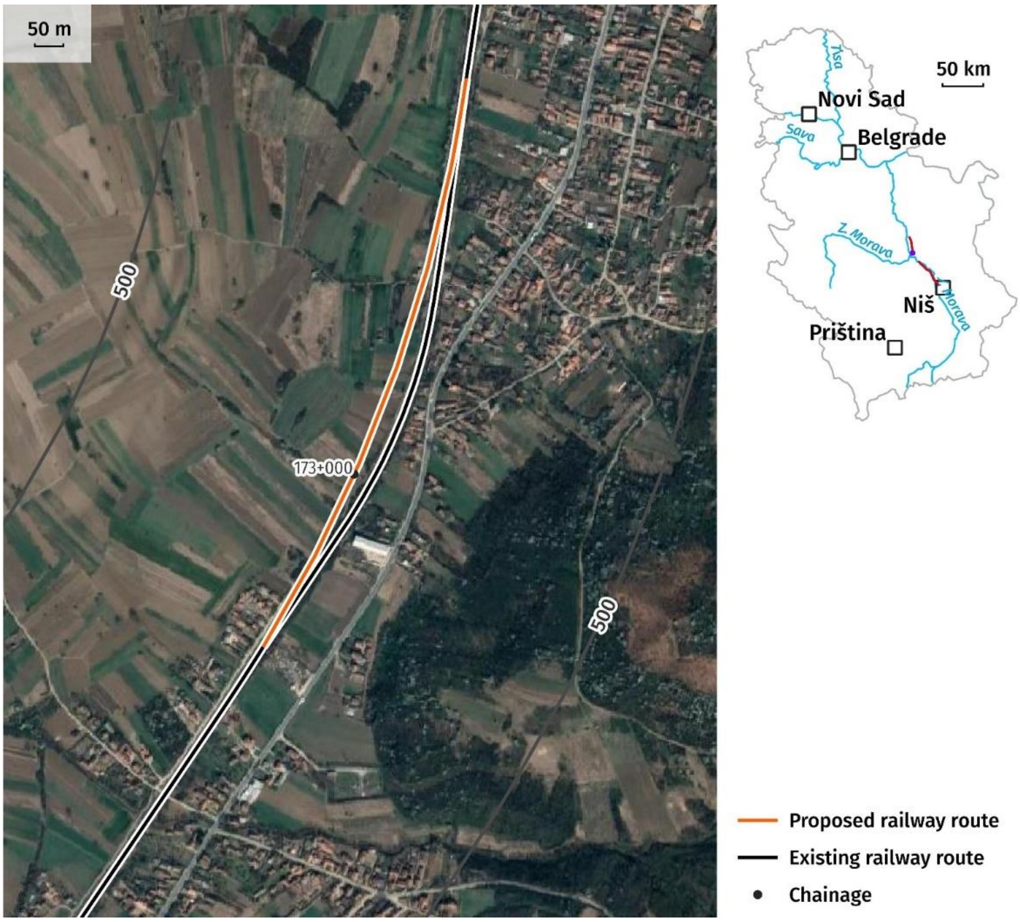

Figure 1-3. Deviation 3 Ćićevac km 172+350 – km 173+300

This deviation was introduced to optimize curve geometry near the southern part of Ćićevac, allowing for increased design speeds while improving track continuity. The realignment shifts the track slightly westward, following a more gradual curve over a length of approximately 950 meters. The deviation remains within the designated railway corridor and does not require major civil engineering interventions.

Within a 200-meter buffer from the new alignment, approximately 20–25 residential buildings are located, primarily dispersed along local access roads on both sides of the corridor. No buildings are situated within 50 meters of the alignment. There are no education or healthcare facilities in this zone, and no industrial facilities were identified.

The deviation results in a slight realignment away from a densely built-up section at the northern end, thereby reducing exposure for approximately 10–12 residential buildings. Toward the southern part of the deviation, the alignment shifts closer to a smaller group of houses, potentially increasing exposure for around 5–7 residential buildings. Overall, the change in exposure is considered limited and localized. Detailed impact assessment and mitigation measures will be presented in the Noise and Vibration chapter of this ESIA.

The deviation passes through habitat type I1.1, categorized as an anthropogenic habitat. There is no presence of protected or ecologically sensitive habitats along the deviation, nor are there any areas classified under Annex I of the EU Habitats Directive. Therefore, no biodiversity-related impacts are anticipated.

The alignment crosses agricultural land predominantly used for seasonal crop production. Based on the spatial overlay with land use data, the permanent land take is estimated at approximately 0.8–1.0 hectares. The deviation does not fragment large continuous land parcels and remains consistent with the existing land use pattern along the railway corridor.

Deviation 4 Đunis Tunnel km192+100.00 – km193+200.00

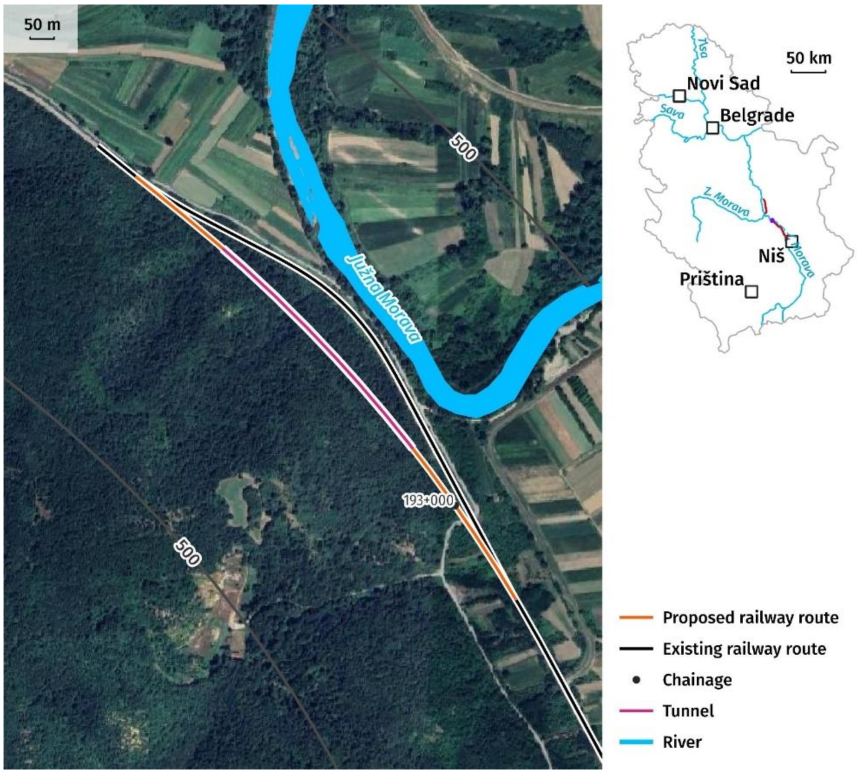

Figure 1-4. Deviation 4 Đunis Tunnel km192+100.00 – km193+200.00

This deviation was introduced to improve alignment geometry near the southern entrance of the planned Đunis Tunnel. The new route enables a better curvature radius and smoother transition into the tunnel, while maintaining the design speed requirements. The shift extends westward from the existing alignment by up to 50 meters over a length of approximately 1.1 km. The deviation includes a tunnel section with a total length of approximately 580 meters, enabling smoother entrance into the Đunis Tunnel, and largely passes through forested and uninhabited terrain.

There are no residential buildings located within 200 meters of the deviation corridor, and no industrial, educational, or healthcare facilities were identified. As such, no noise- or vibration-sensitive receptors are present. Compared to the existing alignment, the deviation moves further away from the nearest populated areas, reducing the potential for noise and vibration exposure. These assumptions will be validated and detailed in the Noise and Vibration chapter of this ESIA.

The alignment crosses a mosaic of natural and semi-natural habitats, including segments of Annex I habitat types G1.76 (thermophilous oak forests) and G1.11 (riparian forests), as well as transitional habitat zones (F9.35, E2.6, I1.1). Although the deviation follows the designated corridor and enters the tunnel early, partial disturbance of forest edge vegetation and crossing near sensitive habitats is anticipated.

The alignment was shifted further westward to move away from the Južna Morava River, thereby reducing the potential for flood-related risks and avoiding direct encroachment into riparian habitat types such as G1.11. This adjustment helps limit ecological fragmentation and minimizes disturbance to sensitive semi-natural ecosystems along the riverbank.

The deviation does not traverse any residential or urbanized zones but crosses through areas classified as crops near the northern tunnel entrance, adjacent to the Južna Morava River. The expected permanent land take for agriculture is approximately 0.5 hectares, concentrated near the approach to the tunnel. Due to the deviation's location and terrain, fragmentation of productive land is minimal.

Deviation 5 Vitkovac km 194+150.00 – km 195+100.00

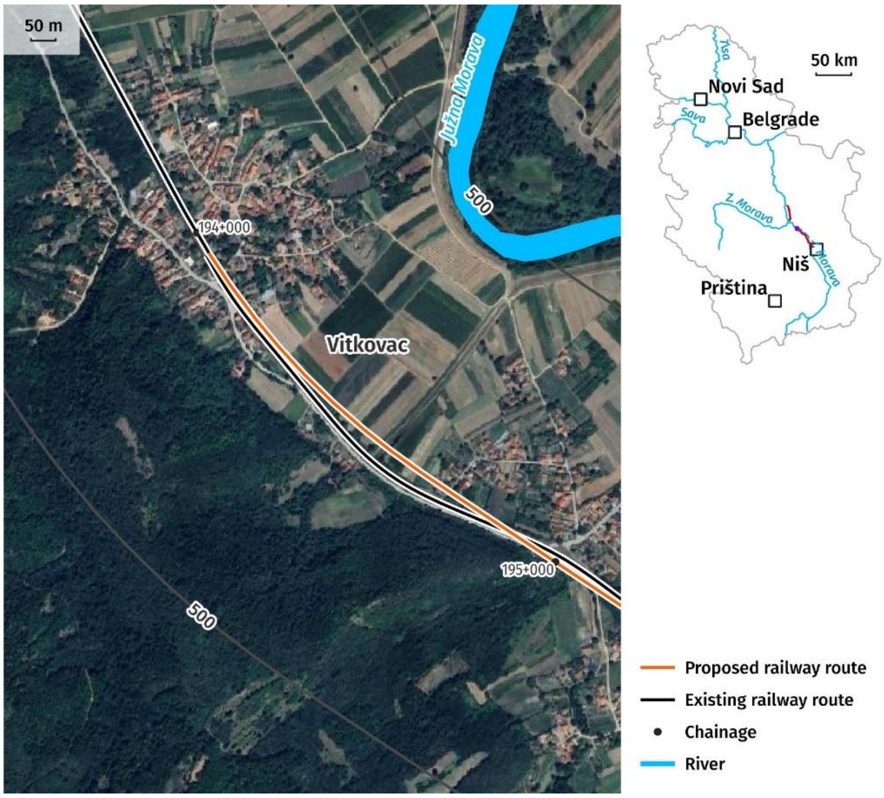

Figure 1-5. Deviation 5 Vitkovac km 194+150.00 – km 195+100.00

This deviation was introduced to optimize track geometry by reducing curve sharpness near the settlement of Vitkovac. The proposed alignment shifts westward from the existing railway by approximately 30–40 meters over a length of 850 meters. The adjustment remains within the existing railway land and does not require significant terrain modification or additional infrastructure.

Within a 200-meter buffer from the new alignment, approximately 30–35 residential buildings are present, forming a continuous built-up zone along the eastern side of the corridor. The deviation results in a slight shift away from the more densely populated eastern edge of Vitkovac, thereby reducing exposure to railway noise and vibration for the majority of these buildings. A smaller number of houses—estimated at around 5 residential buildings—located on the western side of the alignment may experience slightly increased exposure due to the alignment shift. No buildings are located within 50 meters of the new track. Detailed impact assessments and mitigation measures will be presented in the Noise and Vibration chapter of this ESIA.

The alignment passes through habitat type I1.1 (anthropogenic vegetation) and avoids direct interference with surrounding natural forest zones, including habitat type G1.76 (thermophilous oak forests) located to the southwest. Therefore, no significant biodiversity impacts are anticipated.

The deviation affects areas classified as crops, primarily narrow cultivated plots at the forest edge. The estimated permanent land take is less than 1 hectare, and due to the linear nature of the alignment, no fragmentation of agricultural land is expected.

Deviation 6 Donji Ljubeš km 195+700.00 – km 196+500.00

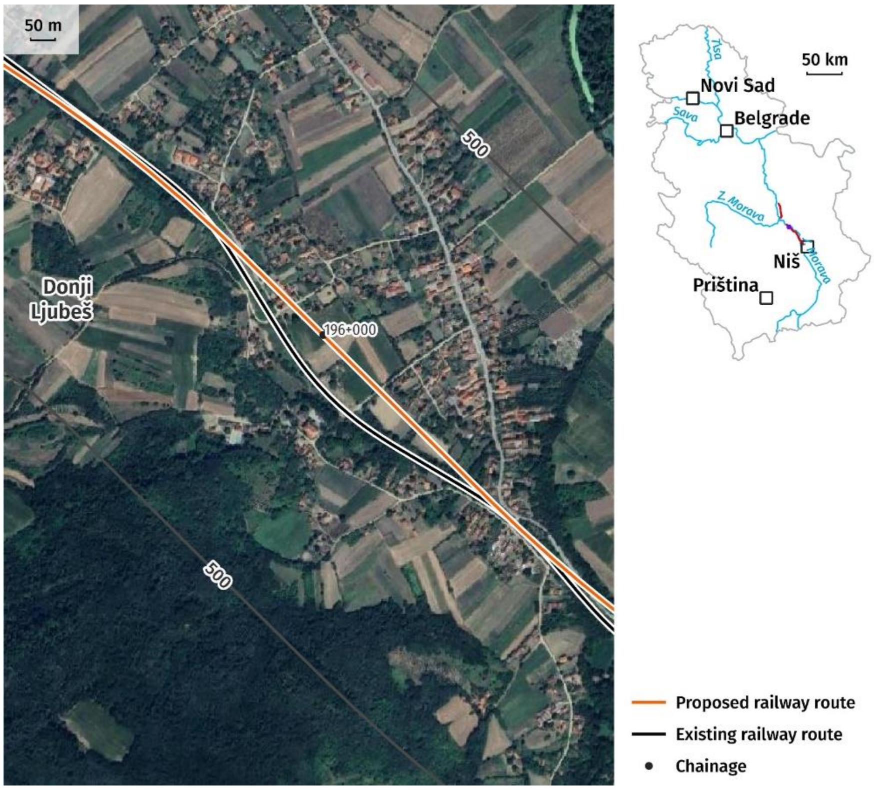

Figure 1-6. Deviation 6 Donji Ljubeš km 195+700.00 – km 196+500.00

This deviation was introduced to correct a curvature near Donji Ljubeš in order to comply with the speed and geometry requirements of the upgraded railway. The alignment shifts slightly northward and westward from the existing route over a length of approximately 800 meters. The deviation remains within the railway corridor and does not involve complex engineering structures.

Within a 200-meter buffer from the new alignment, approximately 35–40 residential buildings are present, forming a densely built-up area both east and west of the corridor. The realignment brings the track slightly closer to residential clusters in the western part of the village, potentially increasing noise exposure for around 10–12 residential buildings. At the same time, the shift moves the railway further away from the more populated area on the eastern side, reducing exposure for approximately 15–20 residential buildings.

At the beginning of the deviation (around km 195+700), one residential building appears to be located within approximately 20 meters of the new alignment and may require partial or full demolition, subject to confirmation during the expropriation and detailed design phase.

In addition to residential buildings, one educational or healthcare facility is located on the western side of the alignment, while one industrial facility is situated to the east. Both are located at an approximate distance of 200 meters from the new alignment. While the industrial facility is not considered a sensitive receptor, the potential impact on the educational/healthcare building will be further assessed in the Noise and Vibration chapter, and mitigation measures proposed as appropriate.

The deviation intersects several habitat types, including I1.1 (anthropogenic) and J4.3, which is a transitional zone. The corridor also intersects G1 (deciduous woodland) and is in proximity to Annex I habitats such as G1.76 and E2.6, although the alignment avoids core forested areas. Minimal vegetation clearance is expected. The deviation remains outside strictly protected habitats, and potential ecological impacts are considered minor and reversible, subject to standard mitigation during construction.

The alignment traverses areas classified as crops, mostly small-scale agricultural parcels around the village. The estimated permanent land take is approximately 0.8–1.0 hectares. There is no fragmentation of consolidated agricultural areas, and affected plots are linear and adjacent to existing infrastructure.

Deviation 7 Srezovac km 196+700.00 – km 197+750.00

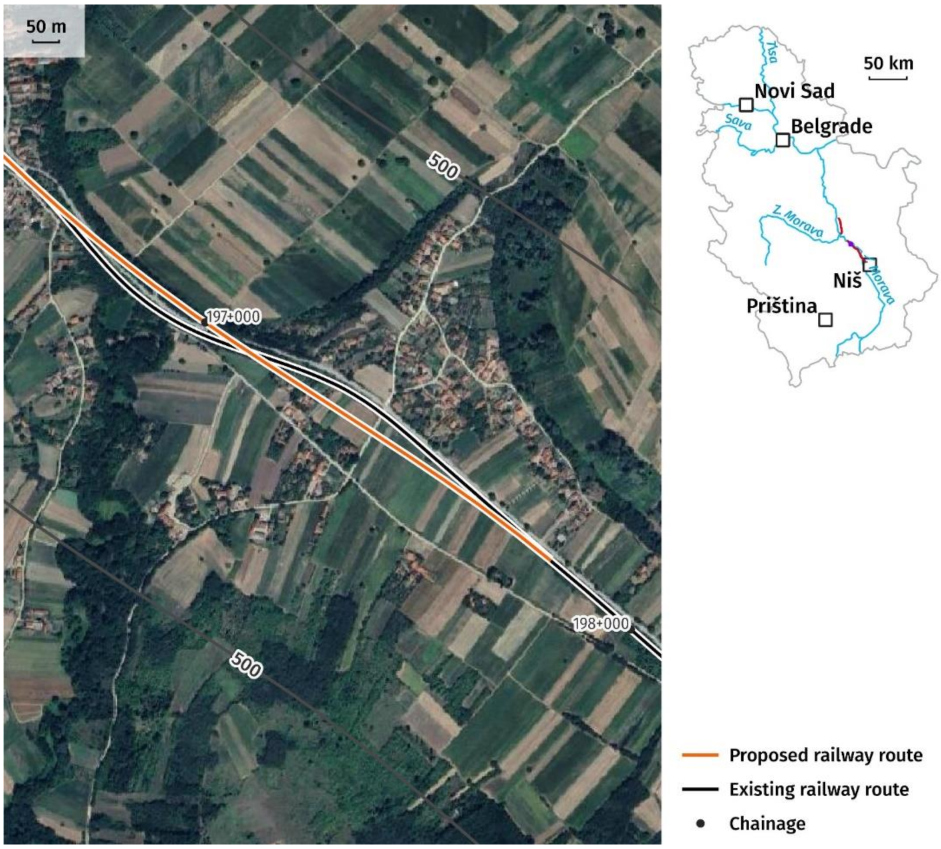

Figure 1-7. Deviation 7 Srezovac km 196+700.00 – km 197+750.00

This deviation aims to correct the curvature near the settlement of Srezovac to ensure compliance with geometric requirements for high-speed operation. The alignment deviates slightly southward from the existing track by approximately 30–50 meters, over a length of around 1.05 km. The adjustment facilitates smoother rail geometry with minimal additional engineering interventions.

Within the 200-meter buffer from the proposed alignment, approximately 50–60 residential buildings are present, primarily concentrated in the central and eastern portions of the deviation corridor. The deviation shifts the railway closer to certain clusters in the southern and southwestern parts of Srezovac, resulting in potentially increased noise exposure for around 20 buildings, while exposure may be reduced for approximately 10–15 buildings on the northern side of the previous alignment. No industrial, educational or healthcare facilities were identified within the zone.

One residential building located near the southern edge of the deviation appears to be within 20 meters of the new alignment and may require partial or full demolition, subject to confirmation during the detailed design and expropriation process.

The full assessment of acoustic impacts and recommended mitigation will be presented in the Noise and Vibration chapter of this ESIA.

The alignment intersects several anthropogenic and semi-natural habitats, primarily I1.1 (arable land with scattered trees) and J4.3 (urban fabric with gardens and orchards). It also passes adjacent to Annex I habitat types G1.76 (thermophilous oak forests) and E2.6 (semi-dry grasslands) in the southern sector. The deviation does not intersect core forested or protected areas, and habitat disturbance is expected to be low, provided construction is confined to the designated corridor.

Agricultural land is dominant throughout the deviation. Based on GIS data, the alignment is expected to permanently affect approximately 1.2–1.5 hectares of crops, mainly narrow parcels along the forest edge and near village boundaries. No fragmentation of large agricultural zones is anticipated.

Devation 8 Trnjane km 202+150.00 – km 203+050.00

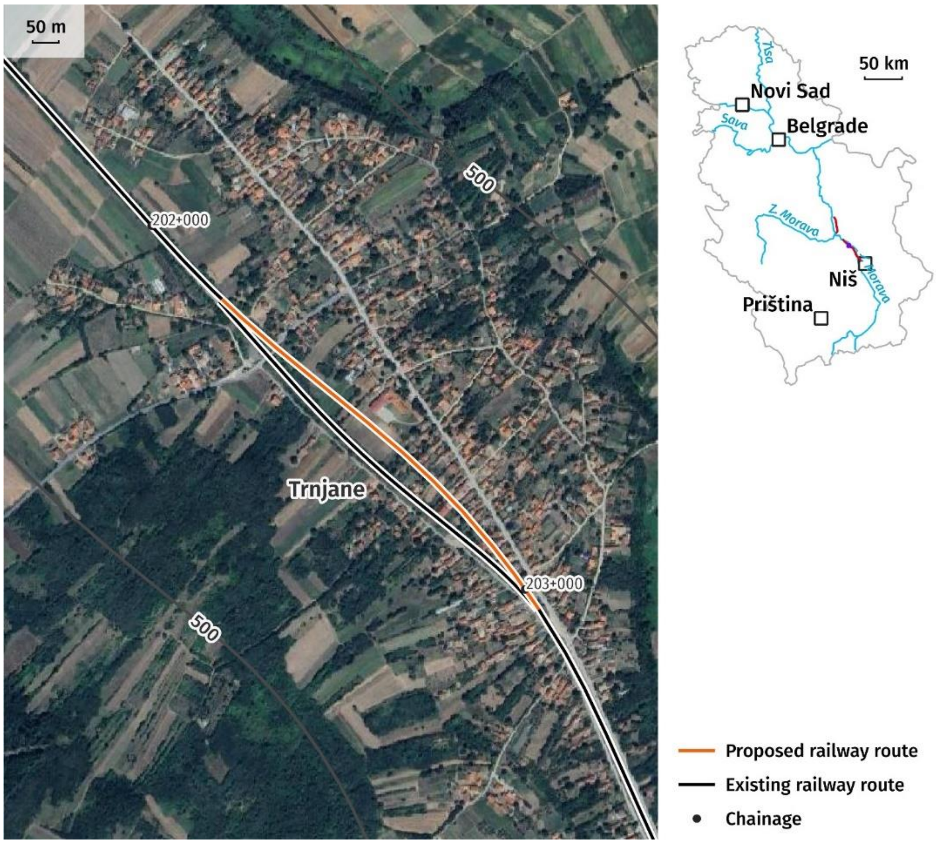

Figure 1-8. Devation 8 Trnjane km 202+150.00 – km 203+050.00

This deviation was introduced to improve the curvature near the Trnjane settlement, in order to meet design speed and safety requirements. The alignment shifts slightly southwestward from the existing railway over a distance of approximately 900 meters, staying within the railway corridor but encroaching further into the residential core of the village.

Several alignment options were assessed during the design phase in order to minimize physical displacement. One alternative involved retaining the existing alignment with reduced curvature and design speeds. However, this was rejected as it would not meet the operational standards for high-speed rail and, crucially, did not comply with the specific requirement of Serbian Railways Infrastructure (SRI) that railway traffic must be maintained during construction. Under such a scenario, the new track would need to be constructed at a safe distance from the existing one, including space for drainage and technical infrastructure, resulting in the demolition of over 30 residential properties located on both sides of the existing line between km 202+500 and 203+000.

A more substantial realignment outside the village was also considered. However, this option would have required a major detour into challenging terrain and made it impossible to reconnect to the locations of planned stations at

Korman and Donji Adrovac. The rationale for rejecting this alternative is further explained in Section 1.4.2 of this Chapter.

Within a 200-meter buffer zone, the final alignment intersects a dense urban area with over 80–90 residential buildings. The deviation brings the track closer to the village center, increasing potential noise and vibration exposure for at least 30–40 residential building, including a primary school located approximately 100 meters from the track. Two industrial facilities are also situated within this buffer.

Due to the proximity of the new alignment to existing structures, it is expected that approximately 10 residential buildings may require full or partial demolition. These will be addressed in the Expropriation Plan and Resettlement Action Plan (RAP), in accordance with national procedures and the Resettlement Policy Framework (RPF) prepared for the Project.

In terms of biodiversity, the deviation traverses mostly I1.1 (arable land and gardens) and J4.3 (urban gardens and mixed-use areas). No protected areas or sensitive Annex I habitats are intersected, and only marginal vegetation clearance is expected. Given the urbanized character of the surroundings, ecological impacts are considered negligible.

The land take will primarily affect crops, covering approximately 0.5–0.7 hectares, mostly linear parcels along the edge of the existing corridor. There is no fragmentation of large-scale agriculture.

Deviation 9 Tešica km 218+150.00 – km 219+150.00

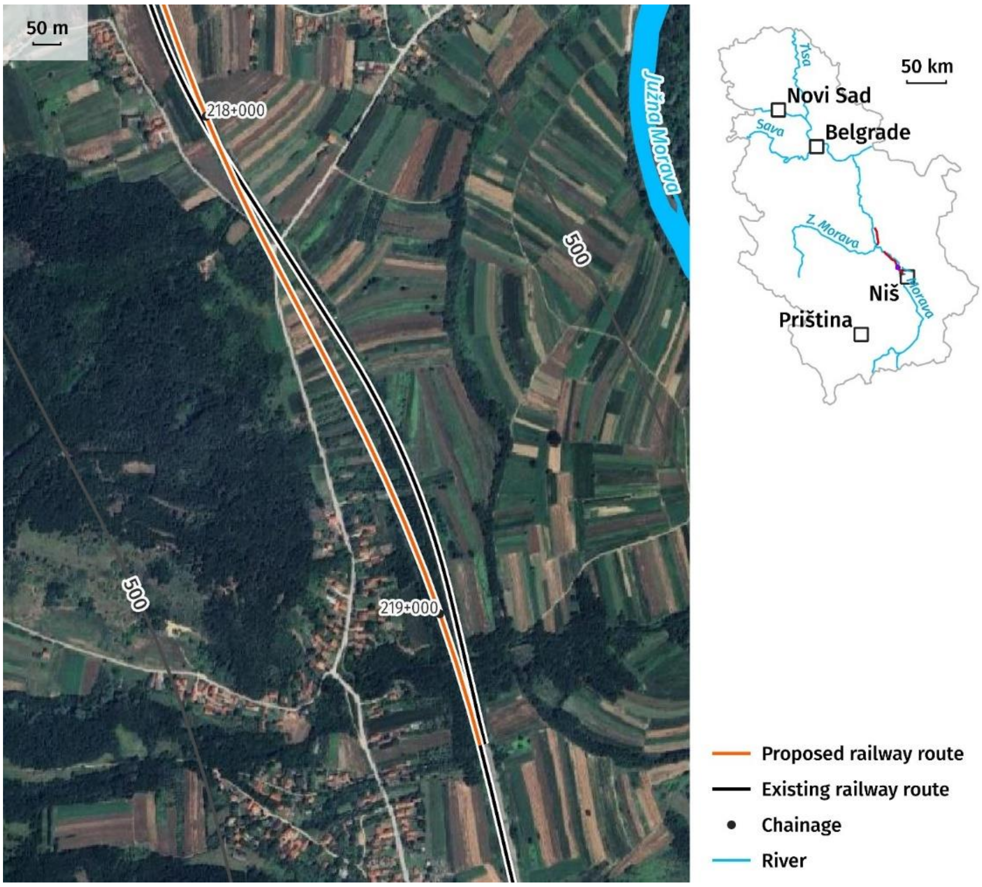

Figure 1-9. Deviation 9 Tešica km 218+150.00 – km 219+150.00

The deviation near the village of Tešica spans approximately 1 km and was introduced to straighten the alignment and reduce the curvature radius. The new alignment remains entirely within the existing railway corridor and does not require displacement of the alignment to adjacent areas.

The deviation crosses predominantly agricultural land (crops), with an estimated land take of approximately 1.5 ha, primarily related to the technical need for shifting the track axis. According to habitat maps, the alignment traverses a mosaic of habitat types including J1.2 (heavily modified areas) and G1.223 (riparian vegetation). These habitats are not classified as sensitive or protected and do not include any critical biodiversity features.

A noise buffer analysis (200 m) indicates that approximately 30–35 residential buildings fall within the zone of potential noise and vibration exposure. These are located to the west and east of the alignment in the outskirts of Tešica and Grejač. There are no schools, kindergartens, healthcare or industrial facilities within the buffer zone. Compared to the existing alignment, the deviation does not significantly change the exposure of receptors to noise; however, the spatial distribution of affected buildings may shift slightly. Detailed assessment of noise and vibration impacts and associated protection measures will be provided in the corresponding ESIA chapter.

The alignment does not require demolition of any structures, and no buildings are located directly along the route that would need to be removed. Land acquisition will affect agricultural plots only.

Deviation 10 Grejač km 220+000.00 – km 221+300.00

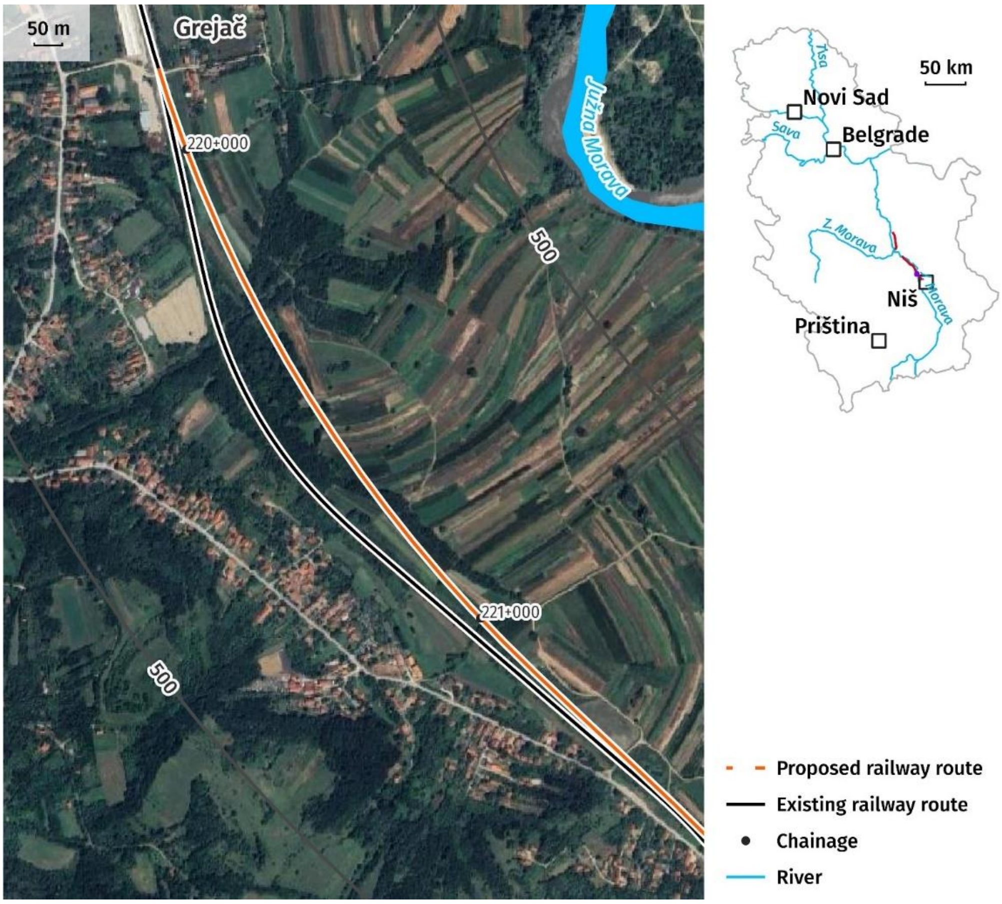

Figure 1-10. Deviation 10 Grejač km 220+000.00 – km 221+300.00

This deviation was introduced to improve track geometry in the area of Grejač by realigning the railway corridor slightly eastward over a length of approximately 1.3 km. The shift allows for a more favorable curve radius while remaining within the designated corridor and minimizing major construction works.

Within a 200-meter buffer zone, approximately 70 residential buildings are located, primarily along the central and southern parts of the alignment. The deviation brings the track slightly closer to several buildings compared to the current alignment, leading to a potential increase in noise exposure for a limited number of households. No industrial or healthcare facilities are located within the buffer. One residential building near km 220+000 appears to be within 20 meters of the new alignment and may require partial or full demolition. Final assessments of noise and vibration impacts and corresponding mitigation measures will be detailed in the relevant chapter of this ESIA.

The alignment crosses areas primarily classified as crops, with an estimated land take of approximately 1.2 hectares of agricultural land. The deviation does not cause fragmentation of large-scale agricultural plots.

From a biodiversity standpoint, the alignment crosses habitat types J1.2 (heavily modified areas) and G5 (meadows and pastures). However, the deviation does intersect the boundaries of the proposed Special Protection Area (pSPA) Dobrič–Nišava.

Avoiding the pSPA entirely was not feasible due to significant spatial and engineering constraints. The proposed alignment is confined between the A1 motorway to the east and hilly terrain to the west. Any shift of the alignment further to the west would increase the extent of intrusion into the pSPA and approach ecologically valuable zones, including the Lalinačka Slatina. A shift to the east would require crossing the motorway and adjacent rivers (Toponica and South Morava), which is not compatible with technical or spatial planning requirements.

The selected route follows the corridor of the existing railway, which already passes through the same marginal area of the pSPA. Therefore, the deviation does not introduce a new intersection but maintains the current spatial footprint, adjusted only to meet the geometric requirements for speed and safety.

A detailed assessment of potential impacts on the Dobrič–Nišava pSPA is provided in ESIA Chapter 14 Biodiversity. The analysis concludes that the affected area lies along the degraded periphery of the pSPA, and that no significant impacts are expected on key habitats or species, particularly birds. Site-specific mitigation measures will be applied during construction to avoid disturbance, including seasonal restrictions and ecological monitoring.

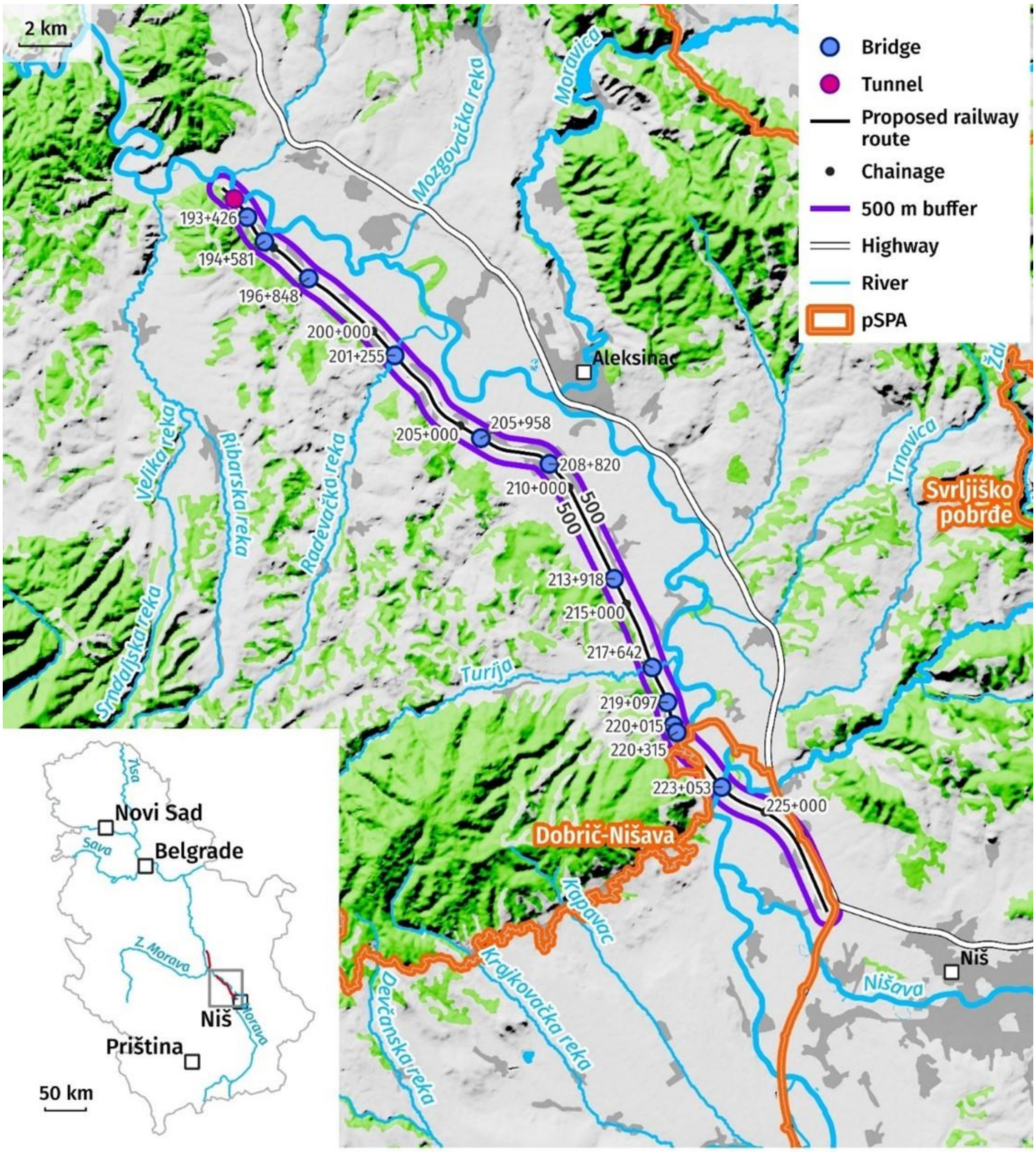

Figure 1-11. Dobrič–Nišava pSPA

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Deviation 11 Grejač / Mezgraja / Vrtište km 221+650.00 – km 228+200.00

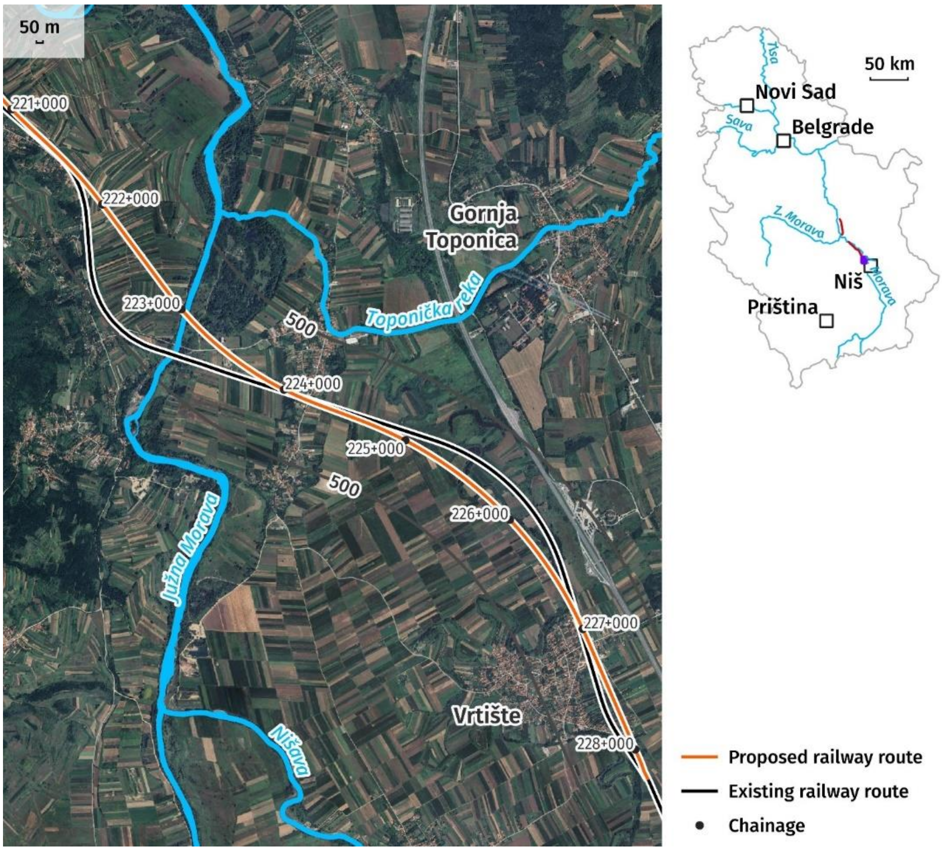


Figure 1-12. Deviation 11 Grejač / Mezgraja / Vrtište km 221+650.00 – km 228+200.00

This deviation was introduced to improve track geometry through the settlements of Grejač, Mezgraja, and Vrtište in order to comply with the speed and alignment requirements of the upgraded railway. The alignment shifts slightly southward from the existing route over a length of approximately 6.5 km. The deviation includes the construction of a new bridge over the Južna Morava River and two viaducts crossing the floodplain and low-lying terrain near Vrtište.

The existing track radius in this area was approximately 1,500 meters, which is below the standard for 200 km/h operations. In order to meet the required service level defined in the Terms of Reference, the curve radius was increased to 3,000 meters, which corresponds to the standard value for the target speed.

Maintaining the existing alignment was not feasible due to geometric limitations, as the tangent emerging from Trupale Station intersects the previous curve in a way that would necessitate the introduction of an “S” curve, which is not allowed by national design standards due to insufficient length and the proximity to the station area.

Further increase of the radius to avoid the oxbow (mrtvaja) of the Južna Morava would have required the demolition of a significantly higher number of residential buildings comparing to 20 following the designed solution..

Moreover, fully shifting the alignment westward to avoid the wetland complex would have required the route to traverse the densely populated areas of Mezgraja, Vrtište, and Trupale. This would have resulted in large-scale displacement and prevented proper integration into the existing Trupale Station area, which is the designated end point of Section 3. Such a variant would not only increase social impacts but also undermine the technical and operational objectives of the Project.

From a biodiversity standpoint, the alignment crosses habitat types I1.1 (anthropogenic), J4.3 (semi-urban gardens and orchards), and passes near forest patches classified as G1.76 (thermophilous oak forests) and E2.6 (semi-dry grasslands), which are considered Annex I habitats. The route also crosses through the potential Special Protection Area (pSPA) Dobrič–Nišava, and passes adjacent to an oxbow of the Južna Morava River—classified as degraded C1.33 habitat with limited biodiversity value.

As confirmed by the pSPA boundaries and spatial data, the entire length of this deviation remains within the pSPA. The existing railway also lies within the boundaries of the pSPA, and it was not technically or spatially feasible to avoid routing through this area. This deviation is a direct continuation of Deviation 10, which also intersects the pSPA, and the same spatial and engineering constraints apply. The A1 motorway forms a hard boundary on the eastern side, while hilly terrain and forest patches limit movement to the west. A shift toward the Lalinačka Slatina protected zone would have introduced higher biodiversity risks and greater fragmentation of sensitive habitats. Figure 1-11 illustrates the spatial intersection between the proposed alignment and the boundaries of the Dobrič–Nišava pSPA.

To mitigate potential impacts, two additional culverts have been integrated into the design at chainages 225+170 and 225+525 to maintain hydrological connectivity and preserve residual wetland function. A detailed assessment of potential impacts on habitats and species is provided in Chapter 14 – Biodiversity, which concludes that the affected area lies along the degraded periphery of the pSPA and that no significant impacts are expected on key species, particularly birds.

Within a 200-meter buffer from the new alignment, approximately 70–75 residential buildings are located, primarily dispersed along the entire stretch, particularly in the areas of Mezgraja and Vrtište. The realignment brings the track closer to residential clusters in several sections, most notably around chainages km 224+000 to km 225+500 and near km 227+000. Compared to the existing situation, noise exposure is expected to increase, especially in Vrtište. Based on available data and visual interpretation, approximately 20 residential buildings in Vrtište and around 5 buildings in Mezgraja are located within the zone of direct impact and may require full demolition.

In addition to residential buildings, one educational or healthcare facility is located in Mezgraja, while several industrial or commercial facilities are situated near the approach to Vrtište. These structures are located within the 200-meter buffer. Noise and vibration effects on all identified receptors will be assessed in detail in the dedicated chapter of this ESIA.

The alignment traverses areas classified as crops, with cultivated land extending between the settlements. The estimated permanent land take is approximately 16 hectares. While the deviation intersects several agricultural parcels, no fragmentation of consolidated agricultural zones is anticipated, and affected plots remain adjacent to existing railway infrastructure.

The alignment traverses areas classified as crops, with cultivated land extending between the settlements. The estimated permanent land take is approximately 16 hectares. While the deviation intersects several agricultural parcels, no fragmentation of consolidated agricultural zones is anticipated, and affected plots remain adjacent to existing railway infrastructure.

Conclusion

A total of 11 route deviations have been introduced along Section 3 (Paraćin–Trupale) to optimize railway geometry, ensure compliance with design speeds of 160–200 km/h, and meet interoperability standards. These deviations were developed based on engineering, environmental, and social criteria, following the mitigation hierarchy: avoiding, minimizing, and mitigating potential impacts.

All 11 deviations were subject to detailed environmental and social screening during the design phase, with the findings presented in this chapter. For each deviation, a site-specific assessment was carried out, including proximity to residential structures, noise and vibration exposure, impacts on agricultural land and habitats, and any potential for displacement or fragmentation. These assessments informed the final routing of each deviation, ensuring that the selected alignments reflect a practical balance between technical requirements and the mitigation of environmental and social impacts, in line with the mitigation hierarchy.

The combined length of all deviations is approximately 16.15 km, while the total analyzed section is 58.1 km, meaning that around 27.8% of the route consists of modified alignment outside the original railway corridor.

Key findings:

- Physical displacement: An estimated 40–45 residential buildings may require full or partial demolition, mostly within Deviation 11 (Vrtište) and Deviation 8 (Trnjane).
- Noise and vibration: The introduction of higher design speeds and realignment leads to both increases and decreases in noise exposure depending on deviation direction and proximity to receptors. Notable increases are expected in Trnjane, Grejač, Vrtište, and Donji Ljubeš, while decreases occur in Paraćin and Đunis Tunnel area. Sensitive receptors such as schools and clinics are present near several deviations and will be addressed with targeted mitigation in the Noise and Vibration chapter of the ESIA.
- Land use: The total estimated land use requirement (permanent take) is approximately 25–30 hectares, mostly agricultural land. Additional space for access roads and supporting infrastructure will be defined during detailed design and addressed in the Resettlement Action Plan (RAP).
- Biodiversity: Most deviations cross anthropogenic or transitional habitats, with limited impact on sensitive areas. However, Deviations 10 and 11 intersect the potential Special Protection Area (pSPA) Dobrič–Nišava, which has been thoroughly assessed in the Biodiversity chapter.

All deviations are fully integrated into the Spatial Plan for the Special Purpose Area of the Belgrade–Niš Railway Corridor, adopted by the National Assembly in October 2024. The chosen alignment represents a technically optimized and environmentally and socially balanced solution, enabling high-speed rail modernization whilst keeping residual impacts within acceptable limits. Land acquisition and resettlement will be implemented in line with the Resettlement Policy Framework (RPF) and further detailed in a Resettlement Action Plan to be developed for Section 3.

Table 1-5 summarizes key environmental and social characteristics of the 11 route deviations identified along the Paraćin–Trupale section of the Belgrade–Niš railway line. Each deviation was assessed for its impact on residential structures, noise and vibration exposure, land use, and biodiversity. While formal alternatives were not developed for each deviation, the alignments presented here were refined during the design process to minimise environmental and social impacts to the extent feasible. The analysis reflects the outcomes of this process and provides the rationale for each deviation's final alignment.

Table 1-5. Key environmental and social characteristics of the 11 route deviations identified along the Paraćin–Trupale section of the Belgrade–Niš railway line

Dev. No.	Location	Residential Buildings Affected	Noise and Vibration Impact	Land Use (ha)	Biodiversity Considerations
1	Paraćin	0	Decreases (alignment shifts away)	0.9	Anthropogenic habitat (I1.1)
2	Ćićevac (171+000–171+650)	0	Slight increase (proximity to school)	0.7	Anthropogenic habitat, near sensitive receptors
3	Ćićevac (172+350–173+300)	0	Mixed (shift reduces exposure north, increases south)	0.9	No protected areas
4	Đunis Tunnel	0	Decreases (tunnel bypasses populated area)	0.5	Annex I habitats nearby, risk minimized
5	Vitkovac	1	Mixed (minor increase west, decrease east)	0.9	Avoids natural forest zones
6	Donji Ljubeš	4	Increases (closer to western part of village)	0.9	Near Annex I, no core habitats
7	Srezovac	2	Mixed (closer to southern buildings)	1.35	Adjacent to G1.76 and E2.6
8	Trnjane	10	Increases (alignment enters denser area)	0.6	Urban zone, negligible ecological impact
9	Tešica	0	Neutral	1.5	Riparian vegetation, not sensitive
10	Grejač	1	Slight increase (proximity to residences)	1.2	Crosses pSPA Dobrič–Nišava
11	Grejač / Mezgraja / Vrtište	20	Increases (notably in Vrtište and Mezgraja)	16.0	pSPA Dobrič–Nišava, Annex I nearby

1.4. Station Siting and Crossing Decisions Based on Stakeholder Engagement

The locations and configuration of stations and level crossings along Section 3 (Paraćin–Trupale) were initially developed through the Conceptual Design process and served as the technical basis for the Spatial Plan for the Special Purpose Area of the Belgrade–Niš Railway Corridor. These conceptual design proposals were used to define the spatial corridor and associated infrastructure elements, which were subsequently adopted in the Spatial Plan following stakeholder consultations and public disclosure in 2024.

Once the Spatial Plan was adopted (October 2024), it provided the statutory framework for finalising the Preliminary Design, which was developed in parallel during 2024–2025. In this context, the Spatial Plan did not determine station and level crossing locations independently; instead, it formalised and confirmed the alignment and infrastructure elements developed through prior technical design stages.

The alternatives analysis presented in this Chapter reflects technical assessments and stakeholder discussions carried out in support of design decisions prior to and during the development of the Spatial Plan. During the public consultation process for the Draft Spatial Plan (March–June 2024), additional feedback was received from local communities and municipalities, particularly regarding the siting of the stations in Aleksinac (Žitkovac) and Trnjane, as well as the proposed closure of the level crossing at Šumadijska Street in Paraćin. These inputs were evaluated jointly by the MCTI, local governments, and the design team and informed the final design refinements.

In parallel, technical requirements related to high-speed rail operations (160–200 km/h), safety, track geometry, and EU interoperability standards necessitated further rationalisation of station positions and replacement of certain level crossings with grade-separated alternatives. The final design thus reflects a compromise between technical, environmental, and social considerations, developed in accordance with the mitigation hierarchy and EBRD/EIB environmental and social standards.

The following subsections present the key cases (Aleksinac, Trnjane, Sikirica, and Paraćin), illustrating how stakeholder concerns and technical criteria were jointly considered in determining the final configuration of stations and access infrastructure.

1.4.1. Location of Aleksinac Station

This section outlines the comprehensive analysis of the location of Aleksinac Station, including technical solutions, environmental, social, and economic considerations. The station plays a significant role in the Belgrade–Niš railway corridor due to its strategic position and the various challenges it poses in terms of railway design and operational requirements.

Introduction to Aleksinac station

Aleksinac Station, situated in the settlement of Žitkovac and defined as a functional node in the Spatial Plan of the Special Purpose Area, represents a strategically important point within the Đunis–Trupale section of the Belgrade–

Niš railway corridor. Functioning as an operational hub for both passenger and freight rail traffic, the station plays a key role in regional mobility and economic connectivity.

In line with the principles of sustainable infrastructure development and the requirements of EBRD Performance Requirement 1 and EIB Environmental and Social Standard 1, a structured alternatives analysis was carried out to evaluate technically and economically feasible solutions for the station's location and layout. The aim of the analysis was to identify an option that would fulfil the operational needs of Serbia Voz and Serbia Railway Infrastructure, Serbia Cargo and other cargo operators, while avoiding or minimizing adverse environmental and social impacts, particularly with respect to land acquisition, physical displacement, and disruption to the surrounding communities.

The assessment process incorporated multiple layers of input, including technical specifications, spatial constraints, institutional consultations, and feedback received from the Municipality of Aleksinac during the disclosure of the Spatial Plan. Several alternative layouts were considered, ranging from full relocation of the station to optimization within the existing railway corridor. Each alternative was evaluated based on technical feasibility, operational efficiency, cost implications, and its potential to minimize environmental footprint and social disturbance.

This analysis illustrates the application of the mitigation hierarchy and demonstrates how environmental and social considerations were embedded in the design process from its earliest phases.

Reviewed Alternatives for Aleksinac station

The following variants were reviewed as part of the station location analysis. Each variant was evaluated based on its technical feasibility, environmental impact, social consequences, and economic costs.

- Variant 1:

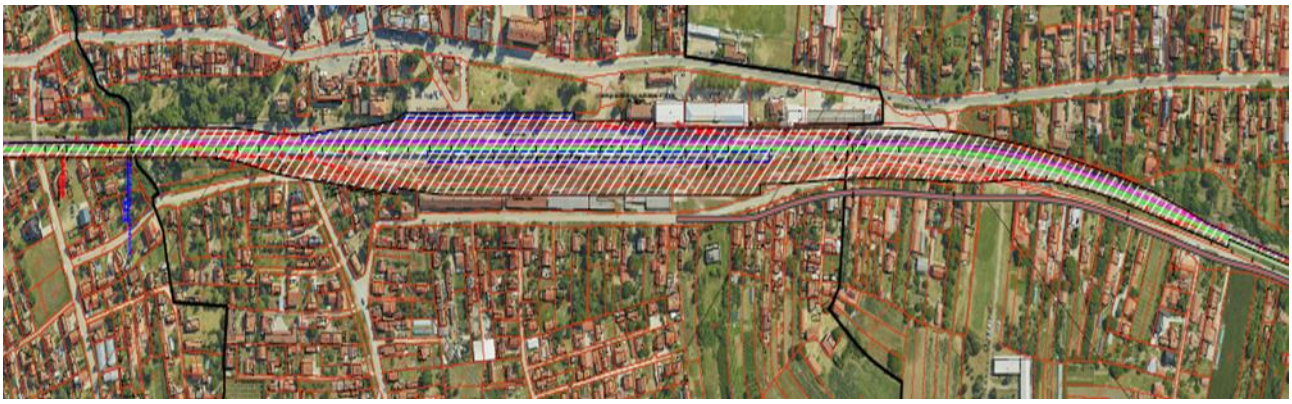


Figure 1-12. Aleksinac Station – Variant 1

- **Technical Description**

  This variant retains the station at its existing location in Žitkovac but reduces the scope of the proposed freight facilities to the minimum required by SRI and Serbia Voz. The solution includes two freight reception tracks, one loading/unloading track with an overhead crane, a shortened extraction track (250 m), and omits the cargo ramp. This redesign reduces the number of affected structures to 5–7, representing an 80% reduction compared to the original design. The revised plan maintains local connectivity, reduces expropriation, and remains within the physical footprint of the existing station. This solution has been selected and will be confirmed in coordination with the Serbian Railways Infrastructure (IŽS).

- **Environmental and Social Considerations**

  The reconfiguration reduces the number of buildings affected by expropriation from approximately 30 to just 5–7. The expropriated area is limited to approximately 1.5–2 hectares, remaining largely within the existing railway footprint. Noise and vibration impacts remain largely within the boundaries of the existing railway corridor, limiting the potential exposure of additional residential areas. However, the increase in train frequency and speed may exacerbate impacts already experienced by properties located near the alignment and increase the number of properties that are impacted. No major ecological disturbance or hydrological redirection is expected. Social impacts are moderate and fully mitigable. The variant is cost-effective (saving approx. €700,000 compared to the original design).

- Variant 2:

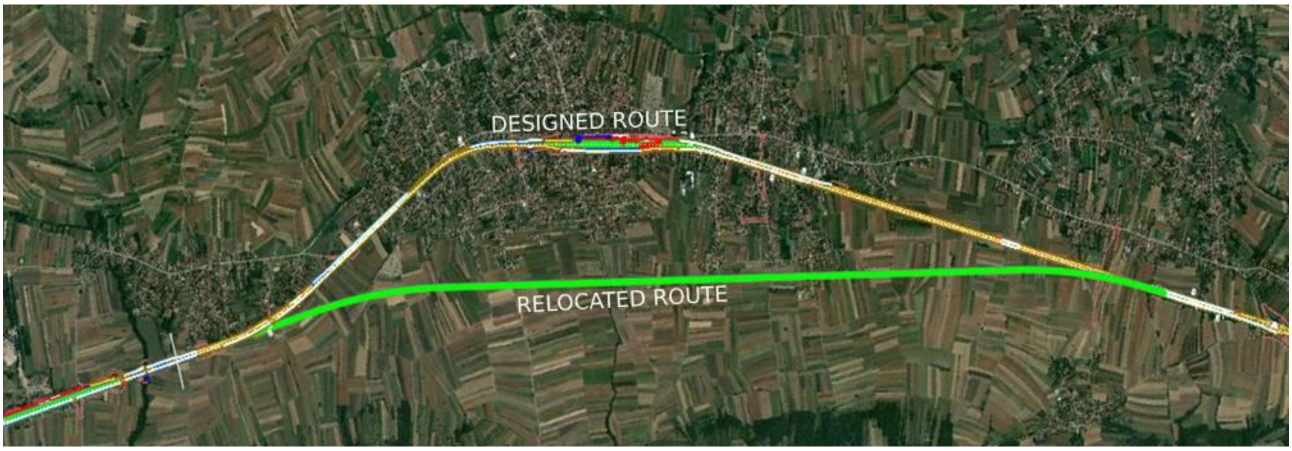


Figure 1-13. Variants 2, 3 and 4 – railway relocation

- **Technical Description**

  This variant proposes relocating the station approximately 1 km outside Žitkovac, requiring the construction of a new 6 km-long alignment segment and full passenger and freight station infrastructure. This would include new tracks, platforms, access roads, and technical facilities on an undeveloped site. This solution was initially suggested by residents during informal consultations to avoid impacts in the densely populated area.

- **Environmental and Social Considerations**

  Although relocation reduces the impact within Žitkovac, it would still require the demolition of 10–12 homes and the expropriation of approximately 6 hectares of land. The new alignment would introduce noise and vibration into previously unaffected zones, particularly in the southern parts of Moravac settlement, where the railway does not currently pass. Variant 2 would shift the railway further south, placing it along the edge of the settlement and increasing exposure for residential areas that are currently unaffected.. The location lacks supporting road infrastructure, leading to increased car dependency and decreased accessibility for local residents. This variant is associated with higher financial costs (+€35 million) and delays (12 months), along with long-term environmental and social impacts, including land conversion and potential permanent changes to local land use and community structure.

- Variant 3:

- **Technical Description**

This option considers maintaining freight operations at the existing station while building a new passenger station on a separate alignment (Figure 1-13). It would require the design of a complex junction between high-speed and conventional lines, which is operationally inefficient and technically non-compliant with safety regulations. This layout introduces redundancy in infrastructure and operational risks due to train crossing.

- **Environmental and Social Considerations**

  Similar to Variant 2, 10–12 residential buildings would be demolished, and approximately 5 hectares of land would be acquired. This variant creates two separate zones of environmental disturbance, increasing cumulative noise and fragmentation effects. It duplicates impacts without significantly reducing the social burden. The added cost is estimated at €25 million, with a 12-month design delay.

- Variant 4:
  - **Technical Description**

    This solution retains the Aleksinac station at its current location but constructs a new high-speed bypass track to the south (Figure 1-13). It requires the complete reconstruction of existing station infrastructure and the realignment of a significant portion of the corridor to separate high-speed from mixed-use operations.

  - **Environmental and Social Considerations**

    The bypass would require the demolition of 10–12 homes and approximately 5.5 hectares of land. Environmental risks include disruption to natural drainage, new exposure to rail noise, and loss of undeveloped land. Socially, it risks splitting local communities between the old and new alignments. The solution adds €30 million in cost and causes a 12-month design delay, without sufficient benefit in impact reduction compared to the selected option.

Table 1-6. Summary Table of Alternatives – Aleksinac Station

Variant	Structures Affected	Land Take (ha)	Biodiversity Impact	Cost Impact	Design Delay	E&S Summary
Variant 1	5–7	1.5–2	None (within existing area)	–€0.7M	1 month	Least displacement, compliant
Variant 2	10–12	~6	New undeveloped area	+€35M	12 months	Fragmentation risk
Variant 3	10–12	~5	New dual impact zone	+€25M	12 months	Technically inefficient
Variant 4	10–12	~5.5	Minor (new bypass zone)	+€30M	12 months	Community split risk

Conclusion and preferred variant

Among the alternatives considered, Variant 1 — optimization of the existing Aleksinac Station layout — was identified as the most technically, economically, and socially balanced solution. It minimizes physical displacement and land acquisition while fulfilling all operational requirements.

Stakeholder Involvement and Consultations

During the planning process, significant attention was paid to stakeholder consultations, particularly with the residents of Žitkovac and the surrounding areas. Public hearings and meetings with local communities, as well as consultations with Serbia Voz and Serbia Cargo, played a crucial role in shaping the final recommendations for the station's location.

The local community expressed concerns about the displacement of homes and businesses, particularly in the context of Variant 2 and Variant 3, which would require large-scale expropriation. Some residents of Žitkovac voiced support for the relocation of the station, believing it would bring economic benefits and reduce the risks associated with living near the current railway line. Others, however, were concerned about the disruption caused by the relocation and the loss of community ties.

From a technical standpoint, the input from Serbia Cargo and Serbia Voz was instrumental in ensuring that the selected location would meet the operational requirements of the modernized railway line. Their feedback highlighted the importance of balancing high-speed rail requirements with local community needs.

Final Decision and Justification

Based on a comprehensive evaluation of technical, operational, environmental, and social parameters, as well as feedback from institutional stakeholders and the Municipality of Aleksinac, Variant 1 – optimization within the existing station footprint in Žitkovac – has been confirmed as the final and preferred solution for the Aleksinac Station.

The initial configuration of Variant 1, as included in the Draft Spatial Plan, featured a larger station footprint with additional sidings and freight infrastructure. This was subsequently revised and optimized through design adjustments aimed at minimizing land take and displacement, while maintaining all core operational functions.

This decision was made following technical adjustments to the station layout which significantly reduced the land take and number of affected properties, while maintaining compliance with the minimum operational requirements of both Serbia Voz and Serbia Cargo. The final layout includes a reduced number of freight sidings, shortened maneuvering tracks, and the removal of certain loading infrastructure elements that were not essential for the station's future role. These modifications result in a decrease in the number of structures subject to demolition from approximately 30 to 5–7, and a reduction of the expropriation footprint to approximately 1.5–2 hectares.

The selected option reflects a balanced approach, meeting high-speed rail operational needs while avoiding the extensive environmental and social impacts associated with full relocation alternatives. Alternative solutions (Variants 2, 3, and 4) were found to be technically, financially, or spatially less favorable, with significantly greater impacts on local communities, higher project costs (ranging from €25 to €35 million), and delays in implementation (up to 12 months). Additionally, the spatial constraints of the surrounding terrain and road infrastructure rendered full relocation impractical.

The final decision was made in coordination with the Serbian Railways Infrastructure (IŽS), and further communication and engagement with the residents of Žitkovac will be organized prior to implementation in line with the Stakeholder Engagement Plan (SEP) and Resettlement Policy Framework (RPF) for the project. Where residual impacts are unavoidable, mitigation measures, including compensation, relocation assistance, and environmental protection measures, will be applied in accordance with EBRD and EIB requirements.

This conclusion aligns with the mitigation hierarchy and demonstrates the integration of environmental and social considerations into early project decision-making.

1.4.2. Trnjane Railway route variants

This section presents the analysis of the location of Trnjane Station, with a focus on the challenges associated with the current alignment and proposals for adjustments to accommodate future railway needs. The analysis evaluates the existing infrastructure, environmental factors, and social implications

Introduction to Trnjane station

Trnjane Station, located along the Belgrade–Niš railway corridor, is a critical point of consideration in the modernization of Section 3 due to its proximity to a sharp S-curve which limits the achievable design speed to 120 km/h under the current track geometry. The station will be closed, and passenger services will be redirected to the nearby stations of Donji Adrovac and Korman. As the project's overall objective is to enable high-speed operations (up to 160 km/h) and reduce travel times between Belgrade and Niš to under two hours, this section posed a significant technical challenge requiring realignment.

In line with the principles of sustainable infrastructure development and the requirements of EBRD and EIB regarding alternatives analysis, multiple alignment solutions in the vicinity of Trnjane were examined. The analysis focused on reconciling high-speed rail performance objectives with the need to minimize environmental and social impacts, particularly the displacement of residential properties and the fragmentation of local communities.

Variant 1, which was presented in the Draft Spatial Plan during the public consultation phase, served as the basis for further evaluation. Feedback received during this process informed the refinement of the station layout and corridor configuration, while maintaining the overall alignment proposed under Variant 1.

Several alternative approaches were assessed, including retention of the existing alignment with speed limitations, localized curve correction, and complete relocation of the railway line from the village. These options were analyzed through a combination of engineering feasibility, spatial constraints, and environmental and social impact perspectives, reflecting the application of the mitigation hierarchy from the early stages of design.

Reviewed Alternatives for Trnjane route

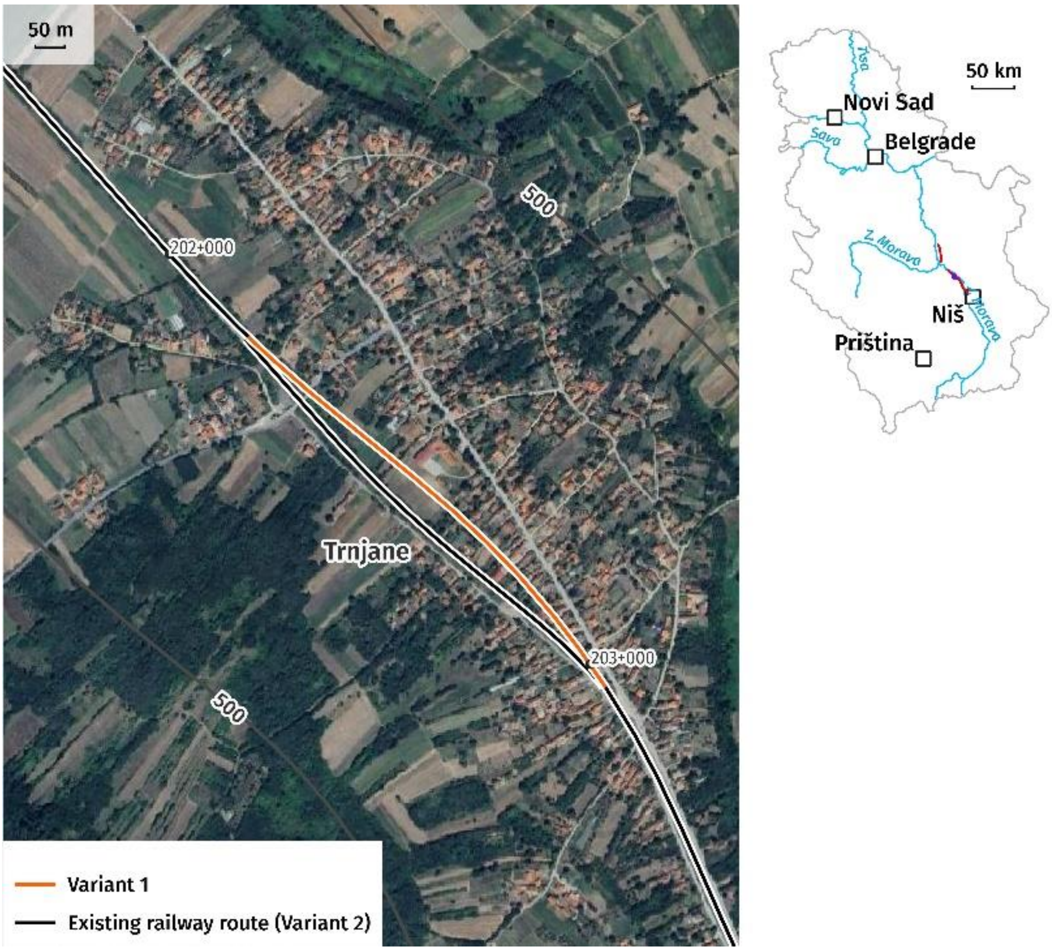


Figure 1-14. Reviewed Variants 1 and 2 for Trnjane route

- Variant 1:
  - **Technical Description**

    This variant corrects the existing S-curve geometry in Trnjane to enable a design speed of 160 km/h. The realignment involves shifting the track approximately 60 meters northeast from the existing alignment, which necessitates the demolition of 20 residential buildings. The solution maintains the railway route through current location of Trnjane Station, ensuring operational continuity and integration with nearby settlements such as Korman and Donji Adrovac. The design allows construction under traffic and adheres to modern geometric and safety standards for high-speed operations.
  - **Environmental and Social Considerations**

    The proposed alignment affects a defined corridor adjacent to the existing railway, with approximately 20 structures subject to demolition. Total estimated land take is approximately 3.5–4.0 hectares, covering both permanent railway footprint and associated construction zones. Impacts are spatially limited and considered manageable within the scope of a site-specific Resettlement Action Plan (RAP). No protected areas or environmentally sensitive zones are affected. Noise and vibration impacts will be addressed through design-level mitigation measures outlined in the dedicated chapter of the ESIA. The solution is consistent with the mitigation hierarchy and meets project performance objectives.

- Variant 2:
  - **Technical Description**

    This option retains the current station location and limits design speed to 120 km/h through minimal curve adjustments. While geometric changes are smaller, construction would still require track separation and minor elevation adjustments, resulting in the demolition of around 10 buildings. Due to suboptimal speed performance and minimal engineering benefit, the solution is considered technically inferior.
  - **Environmental and Social Considerations**

    This variant reduces the number of affected properties to approximately 10 and limits land acquisition to an estimated 2.0–2.5 hectares. However, the residual social impact remains relevant, and the option fails to meet corridor-wide travel time and efficiency targets. From an environmental and operational perspective, this alternative offers minimal advantage and was therefore excluded from further consideration.

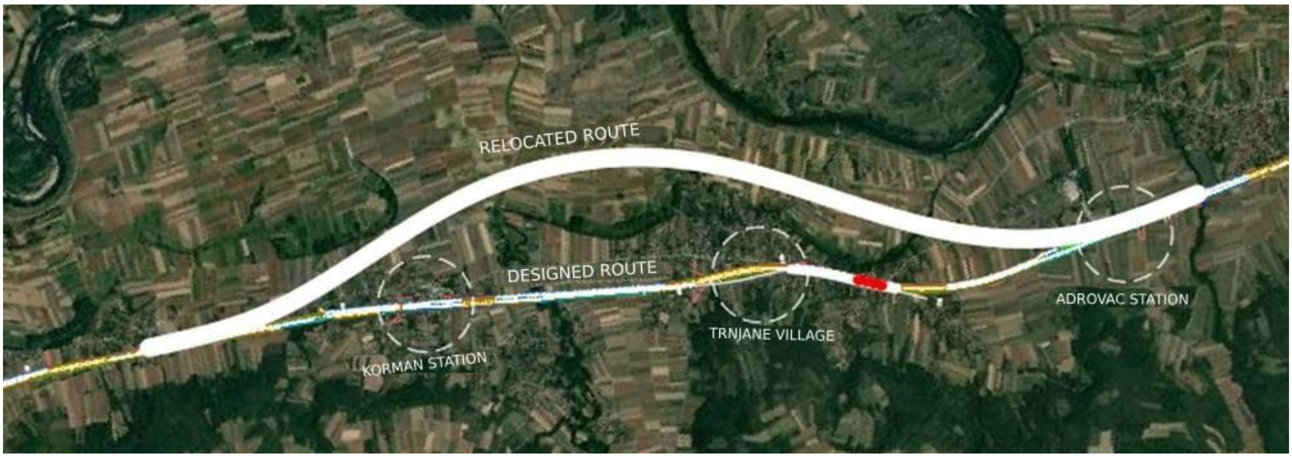


Figure 1-15. Reviewed Alternative 3 for Trnjane relocated route

- Variant 3:
  - **Technical Description**

    This variant proposes shifting the railway alignment entirely outside of Trnjane to avoid any physical displacement in the village. Technical assessments show that a relocation would require at least 1 km of lateral deviation and construction of a new 6 km stretch of track, with complex reintegration into the corridor near planned stations. It would also disconnect Korman and Donji Adrovac from planned rail access.
  - **Environmental and Social Considerations**

    Preliminary assessment indicates that it would likely require the demolition of approximately 30 residential structures — a number higher than the expected impact under Variant 1. In addition, land acquisition needs would increase significantly (estimated at 8–10 hectares) due to the broader corridor and new access road requirements. The surrounding topography is also unfavorable for construction, and the route would result in more extensive environmental impacts, higher costs, and delays in technical preparation. Due to these limitations, the variant was considered non-viable and was not taken forward.

Table 1-7. Summary Table of Alternatives – Trnjane route

Variant	Structures Affected	Land Take (ha)	Biodiversity Impact	Cost Impact	Design Delay	E&S Summary
Variant 1	20	3.5–4.0	None	Baseline	None	Concentrated displacement
Variant 2	10	2.0–2.5	None (existing corridor)	Baseline	None	Still impacts residents, suboptimal
Variant 3	30+	8–10	New terrain, larger footprint	High	>12 months	Widespread disruption

Conclusion and preferred variant

Among the alternatives considered, Variant 1 — curve correction with retention of the route trough existing station location — was identified as the most technically feasible and environmentally and socially balanced option. It meets the design speed requirements of the corridor while minimizing broader impacts on land, population, and spatial planning integration. Other options were either technically unfeasible or resulted in a higher number of displaced structures and significantly greater land take.

Stakeholder Involvement and Consultations

During the development of technical documentation and the public disclosure of the Spatial Plan, formal consultations were held with local residents of Trnjane and representatives of the Municipality of Aleksinac. The community expressed serious concerns regarding the potential physical displacement resulting from the proposed curve correction aimed at enabling higher train speeds.

Some residents formally proposed a full relocation of the railway alignment outside the populated area of Trnjane. These suggestions were reviewed and analyzed in coordination with engineering experts and planning authorities. It was concluded that a complete relocation would not only result in greater demolition and land acquisition but would also conflict with spatial planning objectives and disrupt the integration of nearby stations, particularly Korman and Donji Adrovac.

The project team emphasized transparent communication of technical constraints and explained the rationale for selecting the proposed solution. Engagement with local stakeholders will continue throughout the project implementation process, in accordance with the Stakeholder Engagement Plan (SEP) and Resettlement Policy Framework (RPF).

Final Decision and Justification

Based on technical feasibility, alignment with project objectives, and the outcomes of stakeholder engagement, Variant 1 – realignment of the S-curve while maintaining the route trough current location of Trnjane Station – has been confirmed as the final and selected solution.

This variant supports the design speed of 160 km/h required to achieve the corridor's operational targets, while maintaining spatial coherence with adjacent settlements and planned infrastructure. Although the variant entails the demolition of approximately 20 residential buildings and an estimated land take of 3.5–4.0 hectares, the impact is spatially concentrated and manageable within the project's resettlement framework.

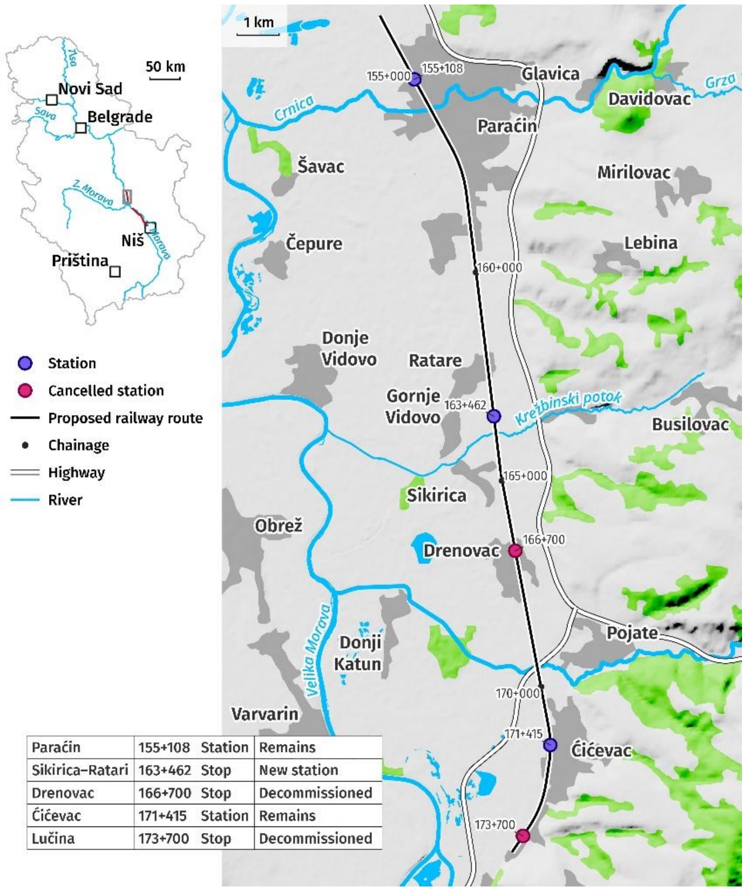
Compared to other options, this variant avoids greater environmental disturbance, higher costs, complex terrain-related construction risks and demolition of buildings associated with full relocation.

1.4.3. Location of Sikirica – Ratare Station

This section presents the analysis of the location of the planned Sikirica - Ratare station, intended to serve the wider catchment area of Ratare and nearby rural settlements. The evaluation focuses on the strategic placement of the station within the upgraded Belgrade–Niš corridor, taking into account operational design parameters for high-speed rail, spatial distribution of population, and the broader objective of minimizing environmental and social disruption. The analysis considers existing infrastructure limitations, accessibility concerns raised during the consultation process, and the technical rationale behind the final siting decision.

Introduction to Sikirica-Ratare station

The planned Sikirica–Ratare Station, located south of Paraćin and positioned between the Paraćin and Ćićevac stations, is intended to serve as a local passenger access point for surrounding settlements, including Sikirica, Ratare, Gornje Vidovo, Drenovac, and other nearby rural communities. It replaces an existing railway stop and is situated entirely within the corridor of the current railway line.



Paraćin	155+108	Station	Remains
Sikirica–Ratari	163+462	Stop	New station
Drenovac	166+700	Stop	Decommissioned
Ćićevac	171+415	Station	Remains
Lučina	173+700	Stop	Decommissioned

Figure 1-16. Location of Sikirica – Ratare station

The station's development forms part of a broader modernization strategy for the Belgrade–Niš corridor, which prioritizes the rationalization of operational points and the upgrade of select locations into fully equipped stations that meet the requirements for mixed passenger and freight operations. No additional land take is foreseen, and construction activities are confined to the existing transport corridor.

Basic infrastructure is already in place, and the planned upgrade is focused on adapting the site to accommodate higher design speeds, enable dual-track functionality, and comply with interoperability and safety standards. Given its location and scope, the environmental footprint of the intervention is negligible, and there are no sensitive receptors or protected areas in the vicinity.

Stakeholder Involvement and Consultations

During the public disclosure of the Draft Spatial Plan in 2024, residents of the settlement of Drenovac submitted a formal request proposing that the planned Sikirica–Ratare Station be relocated closer to their village. Their concern was based on the closure of the previous nearby railway stop, which they felt would reduce accessibility and connectivity for their community.

In response, the project team clarified that the siting of new stations along the Belgrade–Niš corridor is governed by technical and operational criteria, including the need to accommodate dual-track layouts, ensure compliance with safety and interoperability standards, and optimize distances between stations. The location of Sikirica–Ratare Station was selected based on its ability to serve a broader catchment area while avoiding the need for new infrastructure outside the existing corridor.

Moreover, the overall modernization strategy includes the implementation of a PARK & RIDE system, wherein passengers from outlying villages are transported via local transit or private vehicle to the nearest operational station, typically located within a 3–6 km range. In the case of Drenovac, the distance to the planned station remains within acceptable parameters for rural public transport coverage and does not necessitate changes to the current siting.

As the station development involves no new land acquisition or physical displacement, and the environmental impacts are negligible, no further alternatives were considered. Stakeholder engagement in this area will continue during the construction and operational phases, in accordance with the provisions outlined in the Stakeholder Engagement Plan (SEP).

Final Decision and Justification

The decision to establish the Sikirica–Ratare Station at its current location results from a network-wide optimization strategy that aims to consolidate dispersed railway stops into strategically positioned operational nodes. Unlike cases where multiple alignment or siting alternatives were considered due to land constraints or stakeholder objections, this decision did not require a comparative alternatives assessment, as the intervention is confined entirely to the existing railway corridor and does not introduce new physical or environmental impacts.

The location was selected based on its capacity to support technical requirements for high-speed rail and interoperability while maximizing regional coverage. Its positioning between Paraćin and Ćićevac ensures adequate spacing of operational points and maintains service accessibility for nearby settlements, including Drenovac and Ratari.

Crucially, the proposed location and upgraded role of Sikirica–Ratare Station were explicitly requested by Serbian Railways Infrastructure (SRI), with the aim of improving traffic management and ensuring the reliable operation of both passenger and freight services along the corridor. The operational concept requires all upgraded stations to support dual-track functionality and facilitate train overtaking, dispatching, and parking, functions which could not be accommodated by the old stop configuration.

Importantly, the site already functions as a rudimentary stop, meaning no additional land take or displacement is required. By enhancing an existing facility rather than developing a new one, the project minimizes construction impacts, avoids fragmentation of agricultural or natural areas, and significantly reduces cost and complexity.

The selected solution reflects a rational and proportionate response to the operational and planning needs of the corridor and aligns with best practices for sustainable infrastructure modernization.

1.4.4. Closure of Šumadijska Street Level Crossing

This section presents the assessment of the proposed access reconfiguration in the urban area of Paraćin, with specific focus on the closure of the existing level crossing at Šumadijska Street. The intervention aims to align local traffic infrastructure with the technical and safety requirements of the modernized high-speed railway corridor. The analysis considers existing spatial and infrastructural constraints, alternative access solutions, and feedback received from local stakeholders during the public consultation process.

Introduction to Šumadijska Street Level Crossing

The town of Paraćin, located in central Serbia, marks the starting point of Section 3 (Paraćin–Trupale) of the Belgrade–Niš railway corridor. As a regional railway hub, Paraćin hosts one of the most important stations along the line, positioned at approximately km 155+000, serving both passenger and freight operations.

At the southern exit of the station lies the Šumadijska Street level crossing, a long-standing at-grade intersection between the railway and the urban road network. This crossing connects residential neighbourhoods west of the railway with the town centre and eastern districts and has historically functioned as one of the primary access points within Paraćin.

As part of the planned railway modernization, which aims to facilitate high-speed train operations and improve overall traffic safety, the elimination of level crossings in urban zones has become a key design requirement. The Šumadijska Street crossing was identified as particularly problematic due to spatial constraints, proximity to dense residential development, and technical limitations that prevent the implementation of a grade-separated solution at this exact location.

This section provides an overview of the proposed access reconfiguration, summarizes concerns raised by local stakeholders, and explains the technical rationale behind the adopted solution.

Stakeholder Involvement and Consultations

During the public consultation period for the Draft Spatial Plan in 2024, concerns were raised by representatives of the local community in Paraćin, particularly from the Žabare settlement, regarding the proposed removal of the Šumadijska Street level crossing. Stakeholders highlighted that the existing crossing serves as a key access route between different parts of the town and expressed reservations about the increased distance and detour that would result from its closure.

In response, the project team clarified that constructing a grade-separated crossing at this exact location is not technically feasible due to spatial constraints. These include the immediate proximity of residential structures and the nearby intersection with State Road IIA No. 158 (Franše D'Eperea Street). The geometry and density of the area do not allow for a compliant and safe overpass or underpass without extensive demolition and associated social disruption.

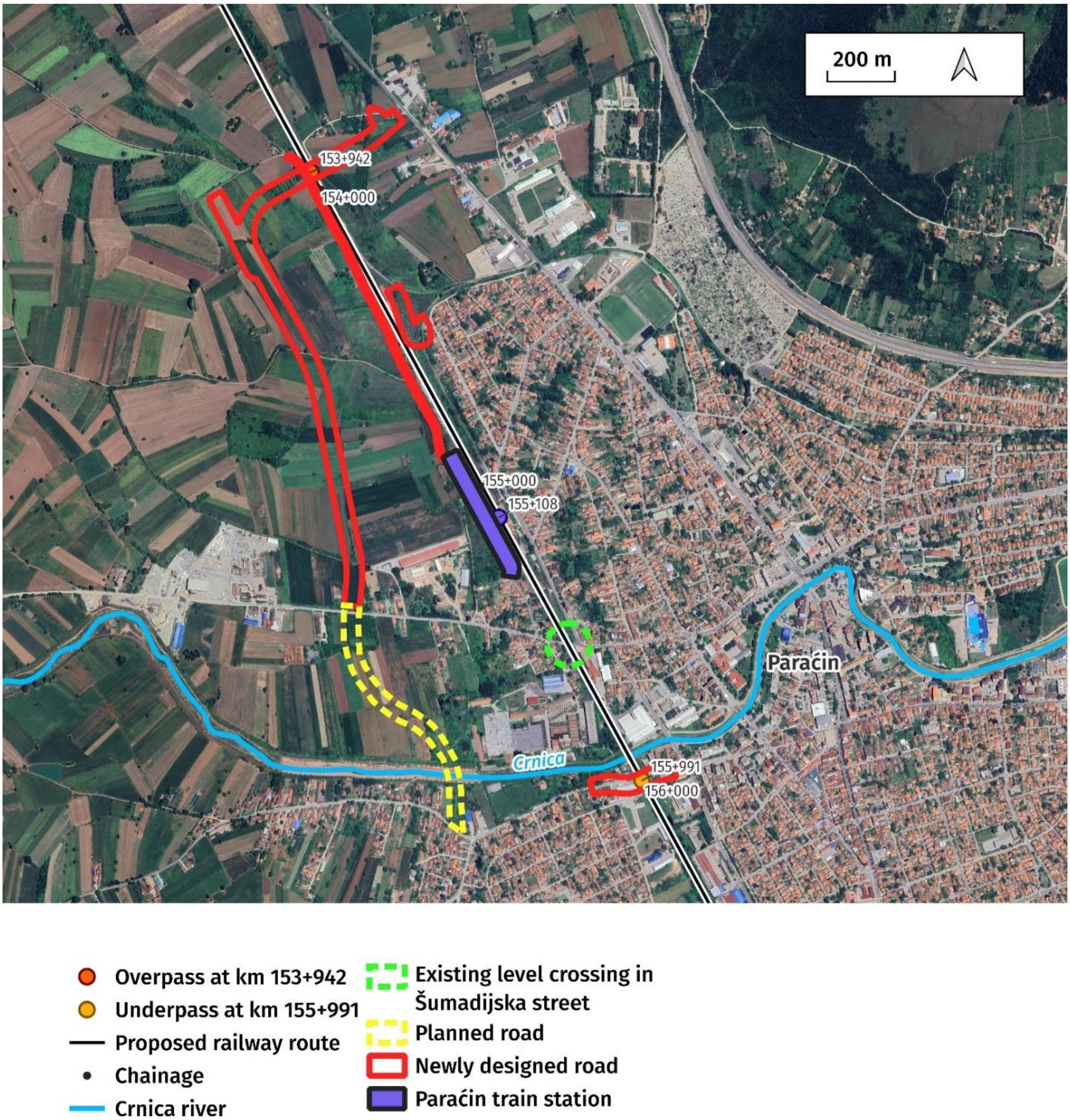


Figure 1-17. Location of Šumadijska street level crossing

Instead, the proposed solution builds on the long-term traffic development plans of the city. A newly designed road connection leads to a grade-separated overpass at km 153+942, forming part of the planned bypass road (ring road) around Paraćin, as defined in the municipal Spatial Plan. This bypass will include a future bridge over the Crnica

River and connect further south to a planned underpass at km 155+991, ensuring seamless integration with Vidovdanska Street and the southern parts of the town, including the road toward Striža.

Additionally, a pedestrian and bicycle underpass is planned at the location of the former Šumadijska Street level crossing, to preserve local non-motorized connectivity. This solution was presented and discussed with municipal representatives and has been supported by key institutional stakeholders as part of the coordinated urban and transport planning process.

Final Decision and Justification

The removal of the level crossing at Šumadijska Street in Paraćin represents a necessary design measure aligned with the technical and safety objectives of the modernized Belgrade–Niš railway corridor. While not explicitly required under EU TSIs, the replacement of at-grade crossings in densely populated areas is widely recognized as international good practice to enhance safety and support reliable operations of high-speed and mixed-traffic railway lines and is supported by national railway safety policies.

Given the spatial constraints at this location—particularly the close proximity of residential buildings and the alignment of State Road IIA No. 158—no technically feasible or socially acceptable grade-separated solution could be implemented directly at the crossing. In response, the design team developed a set of new connecting roads (shown in red on Figure 1-17) to ensure continuity of access and traffic functionality. These roads, together with the overpass and underpass, will be built as part of the Project. The proposed design solution also relies on a broader urban mobility framework defined in the Spatial Plan of the City of Paraćin, which foresees the construction of a bypass road incorporating a grade-separated overpass at km 153+942, a future bridge over the Crnica River, and a road underpass at km 155+991, connecting to Vidovdanska Street and the southern parts of the town.

Both the road underpass (km 155+991) and overpass (km 153+942) are integral components of the railway modernization project and have been fully integrated into the Spatial Plan of the City of Paraćin. Their inclusion demonstrates coordinated infrastructure planning between the railway and municipal authorities, ensuring that both railway safety and local traffic needs are addressed through a unified approach.

The adopted design solution maintains essential east–west connectivity and provides safer, more efficient alternatives for all traffic categories. A pedestrian and bicycle underpass is also planned at the location of the former level crossing to preserve walkability and non-motorized access.

The Spatial Plan for the Belgrade–Niš Railway Corridor was adopted in October 2024, and Location Conditions were issued in May 2025, confirming the spatial and technical feasibility of the selected solution. This alignment with the already adopted municipal Spatial Plan reflects a successful example of integrated and multi-level spatial planning.

Furthermore, the proposed configuration represents a first step toward diverting through-traffic, particularly heavy freight vehicles, away from the town centre, contributing to increased road safety, reduced congestion, and an improved urban quality of life. The coordinated implementation of bypass infrastructure and railway modernization will set the foundation for long-term improvements in accessibility, urban mobility and traffic safety in Paraćin. While the section of the bypass marked in yellow on Figure 1-17, including the planned new bridge over the Crnica River, is not part of this Project, its implementation is foreseen under the City of Paraćin's urban transport strategy, for which the Municipality has responsibility and at the time of this assessment, there is no formal commitment or defined timeline for its implementation. If implemented, the proposed bypass marked in yellow would significantly reduce the severance impact to the local community by reducing the travel distance from approximately 6km to 700m. However, as the bypasses execution falls outside of the scope of the Project and SRI, coordination will be required at a higher governmental level (between the implementing authorities and the Municipality of Paraćin) to ensure that the bypass is constructed. Please see the Social Impact Assessment (Chapter 19) for relevant mitigation measures regarding this.

1.5. Conclusion on Alternatives

The process of defining the alignment for Section 3: Paraćin–Trupale has evolved through multiple technical, environmental, and institutional phases, beginning with the 2007 general design and culminating in the adoption of the Spatial Plan for the Special Purpose Area of the Belgrade–Niš railway corridor in October 2024. Throughout this process, Variant II, as defined in the 2022 Pre-Feasibility Study (PFS), has served as the consistent foundation for subsequent design phases, stakeholder engagement, and environmental and social assessments.

While the general corridor alignment remained unchanged, a number of design modifications and localised alternatives were introduced based on stakeholder input and refined technical analysis. These included:

- Optimization of Aleksinac Station within the existing corridor to reduce displacement,
- Confirmation of Trnjane Station location with minimal curve correction despite proposals for full relocation,
- Introduction of Sikirica–Ratare Station as part of revised operational planning needs,
- Reconfiguration of road and pedestrian access in Paraćin, including the closure of the Šumadijska Street level crossing and integration of bypass road elements into the railway design.

These refinements were evaluated as part of the conceptual and preliminary design phases and were all implemented within the boundaries of Variant II, without requiring deviation from the approved corridor under the national Spatial Plan. The 11 route deviations were similarly developed to improve track geometry and operational safety while minimizing environmental and social impacts and were confirmed through environmental and engineering analysis.

Extensive engagement was undertaken with municipalities and affected communities during the public consultation on the Draft Spatial Plan (March–June 2024). Concerns raised included land take, displacement, station positioning, and access restrictions. While not all suggestions could be incorporated due to engineering, regulatory, or spatial limitations, the final design reflects a balanced and responsive outcome. In several instances, community concerns directly informed the selection or refinement of specific design alternatives.

The alignment and associated infrastructure presented in this ESIA are thus fully consistent with national planning instruments, informed by stakeholder dialogue, and grounded in the mitigation hierarchy. The solutions adopted are technically feasible, spatially coordinated, and environmentally and socially justified. This alignment now provides a solid foundation for permitting, land acquisition under the Resettlement Action Plan (RAP), and further project implementation.

For a full record of engagement and feedback, please refer to the Stakeholder Engagement Plan (SEP) prepared for the Project.

These examples illustrate how stakeholder input directly contributed to the refinement of several project components, leading to context-sensitive design solutions. While the broader alignment remained consistent with the PFS and Spatial Plan, the Project design team actively considered localized alternatives during the design process, ensuring that environmental and social concerns were addressed to the extent feasible. This approach reflects the integration of stakeholder feedback into final design decisions, in line with good international practice.

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RAILWAY LINE BELGRADE–NIŠ, SECTION III VELIKA Paraćin to Trupale (Niš) Environmental and Social Impact Assessment, 5. APPROACH TO ESIA

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LIST OF ABBREVIATIONS AND ACRONYMS

E&S	environmental and social
e.g	for example
ESAP	Environmental and Social Action Plan
ESIA	Environmental and Social Impact Assessment
ESMP	Environmental and Social Management Plan
i.e.	such as

CONTENTS

LIST OF TABLES

5. APPROACH TO ESIA

5.1. Objectives of this ESIA

The key objectives of this ESIA are as follows:

- To define the applicable legal framework for the Project.
- To define the Project components and technical specifications.
- To present an assessment of the alternatives for the Project.
- To establish baseline environmental and social conditions within the area that could be influenced by the construction and operation of the Project;
- To Document the consultation process (Stakeholder Engagement);
- To identify likely significant environmental and social effects during the Project design process, so that negative effects can be avoided or minimised where possible through revisions to the design.
- To identify, predict and assess the significance of potential positive and adverse, direct and indirect environmental and social impacts resulting from the construction and operation of the Project.
- To identify, predict and qualitatively assess the cumulative impacts of the Project.
- To identify suitable mitigation measures to prevent, minimise, or offset likely significant adverse environmental or social impacts, and assess the significance of residual impacts following the implementation of these measures.
- To outline the activities required to effectively monitor the environmental and social performance of the Project and whether the specified mitigation measures are effective in avoiding or minimising adverse impacts (or whether additional mitigation measures may be required to be implemented).

5.2. Impact Assessment Methodology

For all “scoped in” impacts identified in the Scoping Report, the ESIA seeks to predict what changes (impacts) Project-related activities will induce and to assess in further detail the potential scale and characteristics of those impacts. Impacts are classified either as:

- **Negative**: the impact factor causes a worsening of the environmental or socio-economic state or quality; or
- **Positive**: the impact factor causes an improvement of the environmental or socio-economic state or quality.

As well as being either:

- **Direct**: the immediate effects of the Project, or
- **Indirect**: the secondary effects of the Project that do not occur as a direct result of the Project, and occur either before or after, or at a distance from, the Project.

Certain assessments presented within this ESIA Report have adopted a bespoke, component specific methodology, including the Climate Vulnerability Risk Assessment, Landscape & Visual Assessment, Social Impact Assessment and Accidents and Disasters Assessment. The remaining components have been assessed using the methodology outlined below. Where there are any deviations from this methodology, they are presented within the relevant Chapters.

The ESIA will describe the predicted likely impacts (and quantify these to the extent practicable, which varies depending on the topic being assessed) according to a series of criteria / impact-related features, as outlined below:

- **1. Magnitude**: the severity of an impact, or extent of changes to the baseline, generally in terms of a quantifiable measure (e.g. size, scale, intensity).
- **2. Geographic extent and distribution**: the geographic scale of the impact according to the following categories:
    - Very localized/site specific
    - Wider project area – (this will be different depending on the component being assessed and will be defined within each Chapter as required). From a social perspective, this includes primarily the local communities in which people live and work along the project corridor and the municipalities to which they territorially belong.
    - Regional/National
    - International
- **3. Duration:** the length of time over which the impact occurs according to the following categories:
    - Temporary, only during construction works
    - Short term – less than 5 years
    - Medium term – between 5 and 20 years
    - Long term/Permanent – more than 20 years
- **4. Likelihood**: the probability of the impact occurring, incorporating the frequency of the occurrence (i.e. how frequently the receptor[1] will experience the impact). For example, whether the impact is considered to be certain, such as the loss of vegetation during earth works), possible, or exceptional (i.e. certain accidents). Although the magnitude of some impacts may be high, a very low probability of occurrence may diminish the overall significance of this impact. Similarly, a frequent impact must be assessed as more significant than the same impact with a rare frequency of occurrence.
- **5. Sensitivity** of the receptor: the environmental or social component's susceptibility to changes in the baseline resulting from the Project, i.e. does the receptor have characteristics (e.g. scarcity, value, vulnerability, existing levels of degradation etc.) that could increase the magnitude of an impact. Sensitivity also incorporates the notion of the reversibility of the impact.

Each impact being assessed will be graded numerically according to the five criteria listed above, as outlined in Table 5-1 to Table 5-4 below.

[1] *The environmental (e.g. water body, habitat or species) or social (e.g. community, individual or population) features that could potentially be affected by or interact with the Project.*

Table 5-1: Definition of grades for Magnitude

MAGNITUDE	GRADE
Low impact	1
Moderate impact	2
Severe impact	3
Very severe negative, or extremely beneficial, impact	4

The definition of impact magnitude (low, moderate, high or very high) is given in the methodology section of each technical component chapter of the ESIA, as this should be quantitative where possible and may vary according to the type of impact being considered.

Table 5-2: Definition of grades for Size and Duration (combined Spatiotemporal)

SPATIOTEMPORAL				
	Temporary, only during construction	Short term – less than 5 years	Medium term – between 5 and 20 years	Long term/Permanent – more than 20 years
Very localized	2	2	2	3
Wider project area	2	2	2	3
Regional / National	2	2	3	4
International / Transboundary	2	2	3	4

The spatiotemporal grades are intended to reflect the fact that temporary and short-term impacts can still be moderate, even if they occur at a localised or Project level (especially in relation to biodiversity, air quality and surface water quality).

Table 5-3: Definition of Grades for Sensitivity (Environmental and Social Receptors)

SENSITIVITY OF ENVIRONMENTAL RECEPTOR		GRADE
Low	Has low value and rareity (i.e. is very common) and is easily substituted (i.e. does not have any unique or important features or uses).	1
Moderate	Has some value, is moderately common and has the potential for substitution,	2

	or has high value but is very common and abundant in the Project area.	
High	Has high value, is rare and has limited potential for substitution (i.e. has some unique or important features or uses)	3
Very high	Has very high value, is extremely rare and cannot be substituted.	4
SENSITIVITY OF SOCIAL RECEPTOR		**GRADE**
Low	Has capacity and means to adapt to/absorb changes due to Project activities. Has easy access to alternative similar sites, services or opportunities.	1
Moderate	Has limited capacity and means to adapt to/absorb changes due to Project activities. Limited access to alternative similar sites, services or opportunities.	2
High	Is already vulnerable, with very little capacity and means to adaprt to/absorb changes due to Project activities. Very little access to alternative similar sites, services or opportunities.	3
Very high	Is already vulnerable, with no capacity and means to adapt to/absorb changes due to Project activities. No access to alternative similar sites, services or opportunities.	4

Table 5-4: Definition of Grades for Likelihood

LIKELIHOOD	GRADE

The impact has a very low probability of occurring, or will occur rarely	1
The impact will possibly occur, or will occur intermittently	2
The impact is likely to occur or will occur frequently.	3
The impact will occur with certainty.	4

5.2.1. Impact Significance

The next step in the assessment process is to establish 'impact significance'. This gives a clear indication of what the impact means in terms of its importance to society and the environment, so that stakeholders understand how much weight should be given to the particular issue in determining their view of the Project.

The impact significance score in this ESIA is calculated according to the matrix in Table 5-6, based on the final assessment grades given in Table 5-2 to Table 5-4 and using the formula: Significance = (Magnitude + Size & Duration + Sensitivity) + Likelihood.

Table 5-5. Impact Significance Score

		Effect (sum of Magnitude, Size & Duration and Sensitivity)									
		3	4	5	6	7	8	9	10	11	12
Likelihood	1	4	5	6	7	8	9	10	11	12	13
	2	5	6	7	8	9	10	11	12	13	14
	3	6	7	8	9	10	11	12	13	14	15
	4	7	8	9	10	11	12	13	14	15	16

The level of 'significance' and how the impact should be considered in terms of the Project, is defined according to Table 5-6, based on the score taken from Table 5-5.

Table 5-6. Impact significance

Significance	Description	Score
Low	An acceptable impact, where mitigation measures to avoid or minimise the impact would be preferable but are not essential for the protection of environmental and social (E&S) receptors. The impact is insufficient by itself (or in combination with other impacts) to call the Project into question.	4-7
Moderate	A significant, at most, medium term impact which definitely requires the implementation of mitigation measures (if this impact is negative) to avoid and/or reduce harm to E&S receptors. This impact is insufficient alone to call the Project into question, but could result in the Project being abandoned or e.g. the requirement for a major design change/re-route in combination with other direct or indirect impacts.	8-10
High	A serious, long-term impact which; if no mitigation measures are implemented (and if this impact is negative), can call the Project into question. This impact is predicted to result in a significant change to the baseline conditions with important environmental and/or social consequences.	11-13
Very high	A very serious, permanent/irreversible impact which, if mitigation measures are not implemented (and if this impact is negative), will be enough to call the Project into question. This impact is predicted to result in a major change to the baseline conditions with major environmental and/or social consequences.	14-16

5.2.2. Impact Mitigation

Impact assessment methodology is designed to ensure that decisions on projects are made in full knowledge of their likely environmental and social impacts and benefits. A vital step within the process is the identification of measures that can be taken to mitigate adverse impacts. The ESIA process will identify where significant impacts could occur and then define mitigation measures to reduce those impacts (if adverse) to levels that are deemed acceptable. These mitigation measures will then be included in the Environmental and Social Management Plan (ESMP) for the Project and integrated into the Environmental and Social Action Plan (ESAP) as clear commitments.

Where a significant negative impact is identified, a hierarchy of options for mitigation will be explored as follows:

- Avoid: remove the source of the impact,
- Reduce: reduce the source of the impact or reduce the level of impact at the receptor,
- Remedy: repair the damage,
- Compensate: replace in kind or with a different resource of equal value.

5.2.3. Assessing Residual Impacts

Following agreement on technically and financially feasible and cost-effective mitigation measure, the ESIA team has, where necessary, re-assessed the significance of negative impacts taking into account the mitigation commitments integrated into the design, construction and operation of the Project.

5.3. Cumulative Impacts

Cumulative impacts are those that result from the successive, incremental, and/or combined risks and impacts of a Project or activity when added to other past, existing, planned, and/or reasonably foreseeable future ones, as well as unplanned but predictable activities enabled by the Project that may occur later on.

The assessment of cumulative impacts is typically qualitative and based on existing information regarding existing and/or future activities, and the professional judgment of the ESIA team.

In this ESIA, Cumulative Impacts are presented in Chapter 20.

Republic of Serbia
Ministry of European Integration

This project is funded by the European Union

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EU PPF - PROJECT PREPARATION FACILITY

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#ЕУ ЗА ТЕБЕ

RAILWAY LINE BELGRADE–NIŠ, SECTION III
Paraćin to Trupale (Niš)
Environmental and Social Impact Assessment,
6. AIR QUALITY

EU PPF
PROJECT PREPARATION FACILITY

General

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LIST OF ABBREVIATIONS AND ACRONYMS

AoI	Area of Influence
AQ	Air Quality
AQI	Air Quality Index
As	arsenic
BaP	benzo(a)pyrene
CCF	Chain of Custody Form
Cd	cadmium
CO	Carbon Monoxide
Cu	Copper
EU	European Union
Fe	Iron
GHG	Greenhouse Gas
IBA	Important Bird Area
km	kilometre
Mn	Manganese
Ni	Nickel
NO2	Nitrogen Dioxide
NOx	nitrogen oxides
O3	Ozone
PAH	Polycyclic aromatic hydrocarbons
Pb	lead
PR	Performance Requirement
pSPA	Proposed Special Protection Area
RS	Republic of Serbia
SEPA	Serbian Environmental Protection Agency
WHO	World Health Organisation
Zn	Zinc

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1. INTRODUCTION

This chapter outlines the findings of the assessment of potential air quality impacts arising from both the construction and operational phases of the Project. It identifies the specific activities that may influence air quality and evaluates the potential consequences of these changes on human and ecological receptors, including local communities, workers, and nearby ecosystems. To address these impacts, mitigation measures are proposed to prevent, reduce, or manage negative effects on air quality. Furthermore, this chapter provides definitions of Magnitude and Sensitivity as tailored to the air quality assessment and lists the data sources that informed the analysis.

1.1. Legislative and Policy Framework

1.1.1. EU Requirements

The Ambient Air Quality Directive (2008/50/EC) and the EU Directive 2004/107/EC together provide a comprehensive framework for regulating air pollution to safeguard human health and the environment. The 2008/50/EC directive sets limits and target values for pollutants such as sulphur dioxide (SO_2), carbon monoxide (CO), nitrogen dioxide (NO_2), ozone (O_3), particulate matter (PM_{10} and $PM_{2.5}$), benzene, and lead. Complementing this, the 2004/107/EC directive focuses on hazardous pollutants including arsenic, cadmium, mercury, nickel, and benzo(a)pyrene (BaP), a marker for polycyclic aromatic hydrocarbons (PAHs). Together, these directives establish stringent thresholds for various pollutants, aiming to reduce their concentrations and mitigate their adverse effects on health and the environment.

1.1.2. EBRD Requirements

The European Bank for Reconstruction and Development outlines its expectations for managing air quality impacts across several Performance Requirements (PRs) in its Environmental and Social Policy:

- PR 3, Resource Efficiency and Pollution Prevention and Control, emphasizes the importance of minimizing pollution, including air emissions, by implementing appropriate technologies and practices. It also highlights the need for resource efficiency, encouraging projects to use energy and raw materials effectively to reduce emissions.
- PR 6, Biodiversity Conservation and Sustainable Management of Living Natural Resources, indirectly addresses air quality through ecosystem services. It recognizes the role of natural systems, such as forests and vegetation, in air purification and calls for measures to minimize negative impacts on these services.

1.1.3. EIB Requirements

The European Investment Bank outlines its requirements for air quality management within its Environmental and Social Standards, particularly in Standard 3: Resource Efficiency and Pollution Prevention. This standard emphasizes the importance of preventing and controlling emissions to air, water, and land to protect human health and the environment. It encourages the use of emerging techniques to achieve environmental quality objectives. Promoters are expected to assess the effectiveness and efficiency of their project's use of materials and natural resources, including energy, and implement measures to prevent or reduce pollution throughout the project's lifecycle. For projects located within the EU, EFTA, Candidate, and potential Candidate countries, compliance with applicable national and EU environmental legislation is mandatory.

1.1.4. National Legislative Framework

The Regulation on the Conditions for Monitoring and Air Quality Requirements ("Official Gazette of RS," Nos. 11/2010, 75/2010, Amend. 63/2013) provides a detailed framework for air quality monitoring and management in Serbia. Specifically, Attachment X, Part B, defines threshold values for sulphur dioxide (SO_2), carbon monoxide (CO), nitrogen dioxide (NO_2), particulate matter (PM_{10} and $PM_{2.5}$), and benzene, while Attachment XII establishes limits for benzo(a)pyrene (BaP), ozone (O_3), and the heavy metal and metalloid content in PM_{10} particulate matter. This regulation is implemented under the Law on Air Protection ("Official Gazette of RS," Nos. 36/2009, 10/2013, Amend. 26/2021), which provides the broader legislative basis for improving air quality, reducing pollution, and ensuring alignment with international standards for environmental and public health.

2. AIR QUALITY BASELINE

2.1. Area of influence

The area of influence (AoI) for air quality impacts of the Project during both the construction and operational phases is defined as a corridor 1,000 meters wide, encompassing 500 meters on either side of the Proposed Railway Route. The AoI was established based on studies by Sharma et al. (2009), Etyemezian et al. (2004), and Zhao et al. (2020) According to Sharma et al., pollutant concentrations decreased significantly across the total measured distance of 0–500 meters Etyemezian (2004) et al. employed the Gaussian plume model to evaluate dust dispersion from construction activities, determining that dust typically affects areas within 100 meters of the source. In contrast, Zhao et al. (2015) conducted a Wind Tunnel Experiments in a controlled environment to simulate the flow of near-ground wind fields and measure dust concentration at varying conditions, concluding that, under specific conditions, dust can disperse within 1000 meters around the construction site. The more conservative approach was therefore adopted for this assessment.

2.2. Baseline

Poor air quality is a significant issue in Serbia. Assessments from Serbian Environmental Protection Agency (SEPA)[1] reports and the 2019 Global Burden of Disease study[2], which analyzed over 40 studies and risk assessments on air pollution and health in Serbia, highlight energy production, road traffic, industrial activities, residential combustion, agriculture, windblown dust, and anthropogenic dust as primary contributors to air pollution. The European Environment Agency identifies the transportation sector, particularly road transport, as a major contributor to Serbia's air pollution[3]. Limited public transportation options and reliance on private vehicles, exacerbated by an aging vehicle fleet with an average age of 17 years, further increase emissions.

The Serbian Environmental Protection Agency is responsible for monitoring air quality, as outlined in the Law on Air Protection ("Official Gazette of RS", Nos. 36/2009, 10/2013, and 26/2021). Annex 1 provides the health-based air quality standards derived from the EU Air Quality Directives, which SEPA applies in its evaluations of air quality in Serbia. Urban areas face the most significant challenges, with primary pollutants including particulate matter (PM_{10} and $PM_{2.5}$), nitrogen dioxide (NO_2), and ground-level ozone (O_3) frequently exceeding recommended levels and posing health risks.

[1] https://sepa.gov.rs/wp-content/uploads/2024/10/Vazduh2023.pdf
[2] https://www.stateofglobalair.org/sites/default/files/documents/2022-09/soga-southeast-europe-serbia-report-english.pdf
[3] https://www.eea.europa.eu/en/analysis/maps-and-charts/serbia-air-pollution-country-2023-country-fact-sheets

Data from SEPA highlights key patterns and challenges in air quality monitoring:

- **Limit Exceedances:** Particulate matter (PM_{10} and $PM_{2.5}$) concentrations frequently surpass allowable limits, particularly in urban and industrial zones and near major traffic routes.
- **Trends:** While some areas have shown minor improvements due to regulatory actions, overall air pollution levels remain high.
- **Seasonal Variations:** Air pollution tends to increase during winter months, largely as a result of intensified heating activities.

Efforts to improve air quality are ongoing, with a focus on reducing emissions from significant sources like transportation. SEPA's annual air quality report, mandated by Article 67 of the Air Protection Act, is supported by a network of automatic air quality monitoring stations that measure concentrations of pollutants such as SO_2, NO_2, O_3, CO, PM_{10}, and $PM_{2.5}$. This network forms the backbone of Serbia's national air quality monitoring system.

Along the Project (Paraćin-Niš) route, relevant automatic air quality monitoring stations are situated in Paraćin and Niš (Figure 2-1). There is also a monitoring station in Aleksinac, however, it is not automated and primarily measures PM_{10} particles, along with SO_2 and NO_2 levels. From 2024, it is planned that the station will also measure $PM_{2.5}$ particles, although monitoring will not be conducted daily.

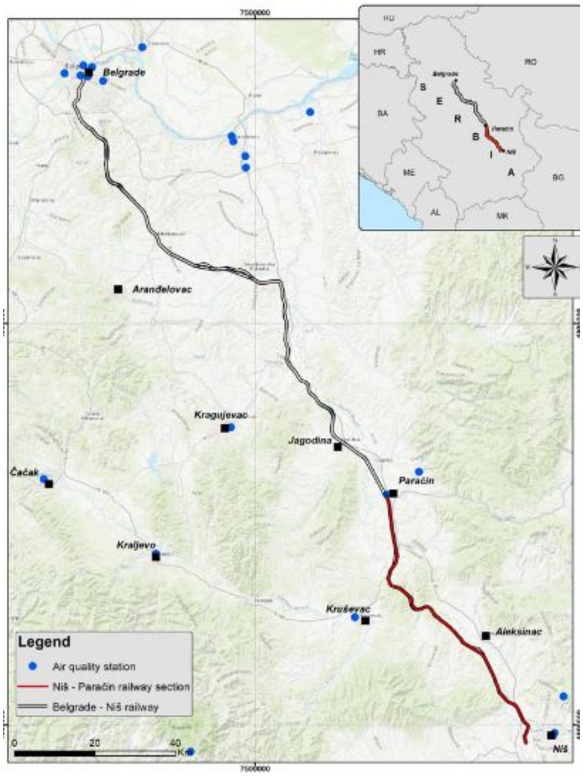


Figure 2-1. Air quality monitoring stations along the Paraćin-Niš railway route

Pursuant to Article 21 of the Law on Air Protection ("Official Gazette of RS", Nos. 36/2009, 10/2013, and 26/2021), air quality categories are determined based on pollution levels (Table 2-1). These categorisations are established using prescribed limit and tolerance values and are derived from air quality measurements.

Table 2-1. Air quality categories according to the Law on Air Protection ("Official Gazette of RS", Nos. 36/2009, 10/2013, and 26/2021)

Air quality categories	
I	clean or slightly polluted air, where limit values of pollutant levels are not exceeded
II	moderately polluted air where the limit values of nitrogen dioxide are exceeded, but the tolerance value is not exceeded and the limit values for other pollutants are not exceeded
III	excessively polluted air, where limit values for one or more polluting materials are exceeded

Table 2-2 compares the allowable annual average limit values of parameters according to World Health Organization (WHO) Global Air Quality Guidelines, the EU Ambient Air Quality Directive 2008/50/EC (Limit EU), and the "Official Gazette of RS", no. 11/2010, 75/2010 and 63/2013 (Limit RS) against measured air quality levels in 2021 from stations in areas relevant to the Project.

Table 2-2. Air quality parameters in the areas relevant to the Project and allowable limit values according to the WHO, EU and Republic of Serbia

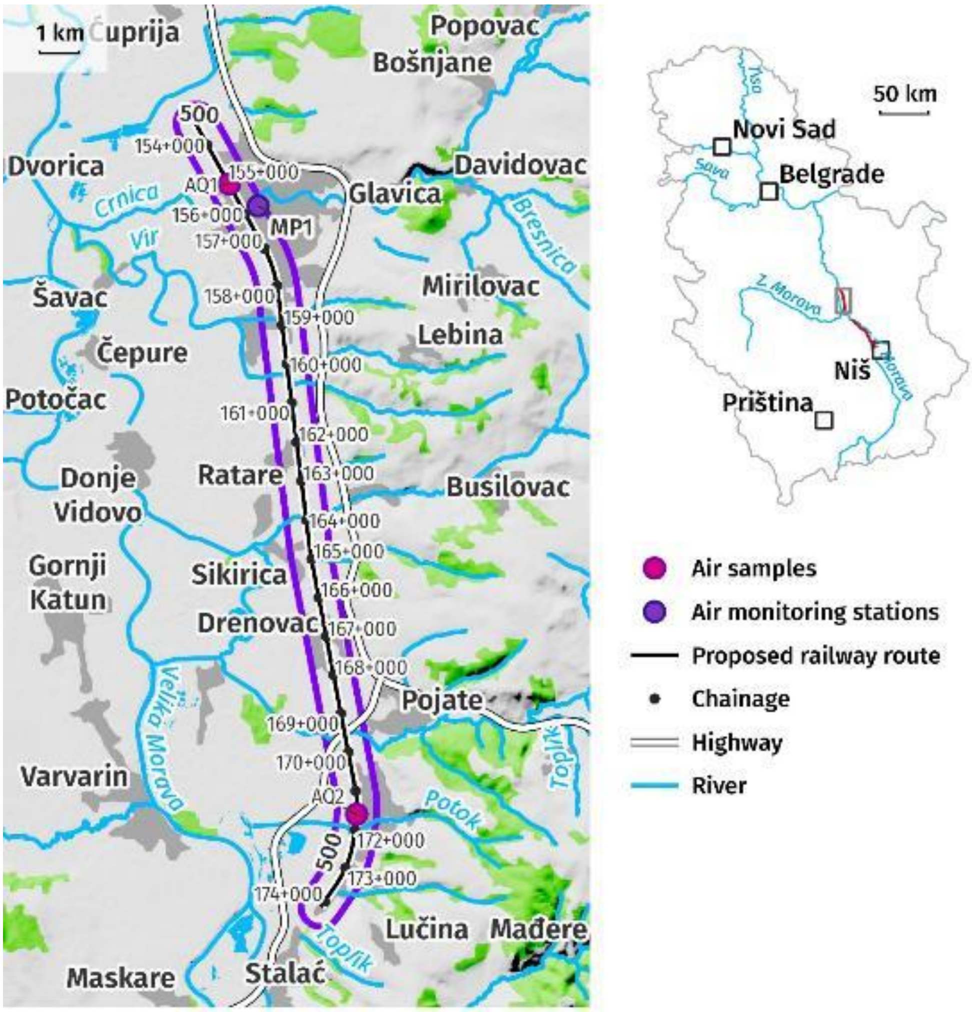
Average annual value	SO_2 µg/m³	CO mg/m³	NO_2 µg/m³	O_3 µg/m³	PM_{10} µg/m³	$PM_{2.5}$ µg/m³
Paraćin	15	0.72	16	-	-	-
Niš	14	0.78	26	71	45	24
Limit WHO	40[a]	4[a]	25[a]	100[b]	45[a]	15[a]
Limit EU	125[c]	10[b]	200[d]	120[e]	50[f]	20[g]
Limit RS	125[c]	5[a]	85[a]	120[e]	50[f]	20[g]

[a] 24-hour mean
[b] The maximum daily 8-hour mean
[c] 24-hour mean, not to be exceeded more than 3 times per calendar year
[d] 1-hour mean, not to be exceeded more than 18 times per calendar year
[e] The maximum daily 8-hour mean, not to be exceeded more than 25 times per calendar year, averaged over three years
[f] 1-year mean, not to be exceeded more than 35 times per calendar year
[g] 1-year mean

In the cities of Paraćin and Niš, the air quality was classified as Category III (excessively polluted air), due to concentrations of suspended particles (PM_{10} and $PM_{2.5}$) frequently exceeding the prescribed limit values.

2.2.1. Baseline air quality measurements

To determine baseline air quality within the AoI, measurements were taken at four locations (AQ 1 to AQ 4) as shown in Figure 2-2 and detailed in Table 2-2. These locations were strategically selected to ensure they were situated in open areas, close to residential housing and commercial buildings, and within the 500-meter buffer zone of the proposed railway route. The selection of sampling locations was based on the proximity to sensitive receptors, where human exposure is expected to be highest, and intended to capture representative air quality conditions in areas most likely to experience potential air quality impacts from the Project. Additionally, they were chosen to fill identified data gaps from the scoping phase, helping to ensure a comprehensive understanding of the baseline air quality conditions. Whilst the recorded air quality levels may be influenced by the monitoring locations, the chosen locations reflect representative exposure conditions relevant to the affected population.



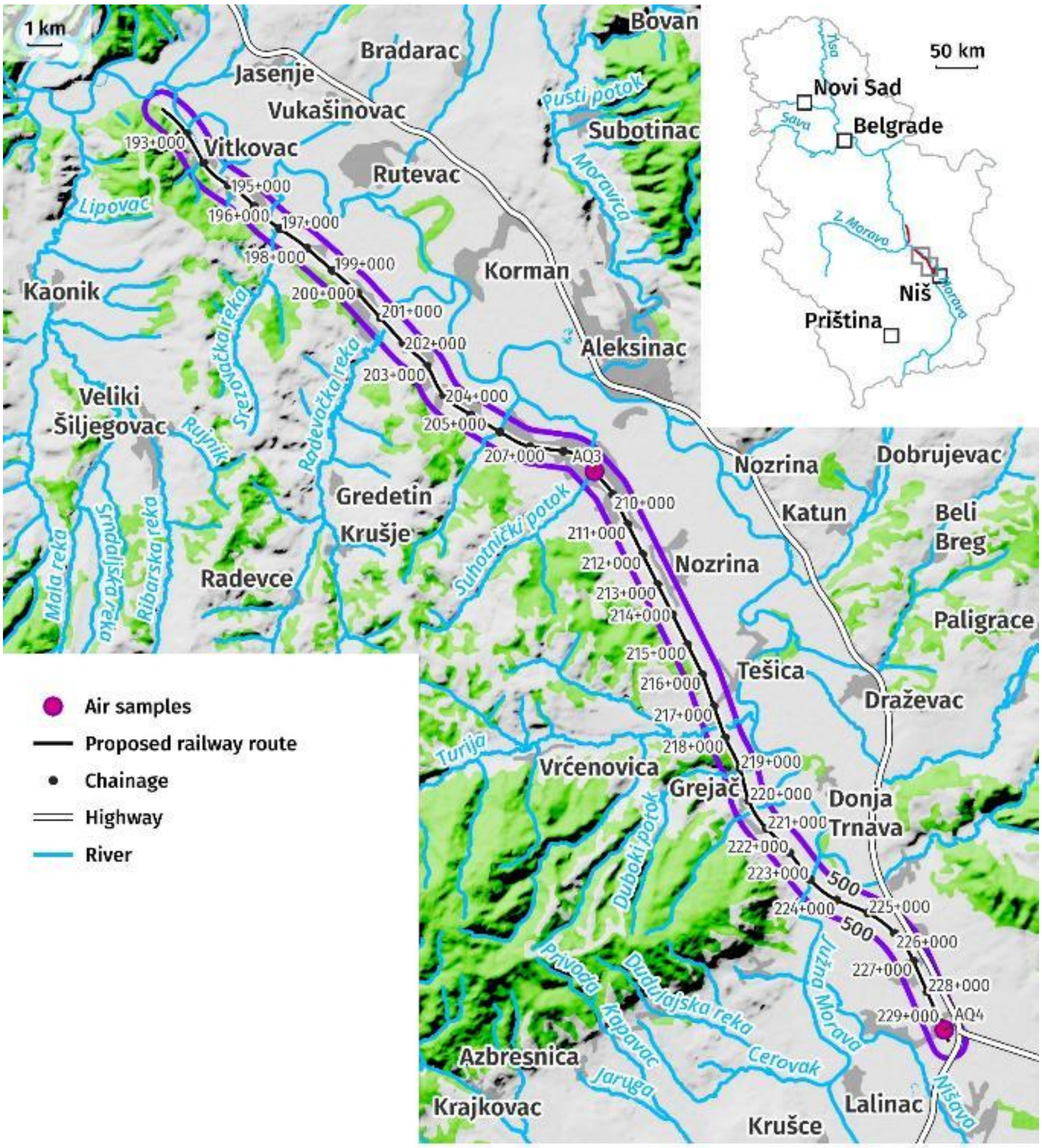


Figure 2-2. Sampling points for air quality measurements

The measurements were conducted continuously over a 24-hour period under typical traffic conditions to ensure the data accurately reflected average air quality. The measurements were carried out between December 1st and December 7th, 2023, during the time of year when air pollution in Serbia is at its highest, providing a representative overview of the air quality conditions experienced by the local population.

Table 2-3. Measuring points and their GPS coordinates

Measuring point	Settlement	Coordinates	
		N	E
AQ1	Paraćin	43.864708°	21.399148°
AQ2	Ćićevac	43.720349°	21.437932°
AQ3	Aleksinac	43.508146°	21.693705°
AQ4	Niš (Trupale)	43.357340°	21.819459°

The air quality monitoring parameters included carbon monoxide (CO), nitrogen dioxide (NO2), sulfur dioxide (SO2), ozone (O3), benzene (C6H6), benzo(a)pyrene (BaP), PM10 (particulate matter with an aerodynamic diameter of 10 µm or less), and PM2.5 (particulate matter with an aerodynamic diameter of 2.5 µm or less), all measured continuously over a 24-hour period. Additionally, concentrations of heavy metals cadmium (Cd), copper (Cu), zinc (Zn), iron (Fe), lead (Pb), manganese (Mn), and nickel (Ni), as well as the toxic metalloid arsenic (As), were analyzed in suspended PM10 particles.

The measurements were conducted by Anahem d.o.o. Laboratory, a facility with recognized national and international competence. To ensure traceability and proper documentation throughout the testing process, a Chain of Custody Form (CCF) was employed. The sampling and laboratory analysis of ambient air were conducted in accordance with standardized, validated, and accredited methods, as outlined in the Regulation on the Conditions for Monitoring and Air Quality Requirements ("Official Gazette of RS", Nos. 11/2010, 75/2010, and 63/2013; Attachment V, Part A). Detailed information on the applied methods is provided in Table 2-4.

Table 2-4. Methods used for the air quality analyses

Parameter	Method
PM_{10} fraction of the suspended particles $PM_{2.5}$ fraction of the suspended particles	SRPS EN 12341
Carbon monoxide (CO)	SRPS EN 14626
Nitrogen dioxide (NO_2)	SRPS EN 14211
Sulphur dioxide (SO_2)	SRPS EN 14212
Ozone (O_3)	SRPS EN 14625
Benzo(a)pyrene (BaP)	SRPS ISO 12884
Benzene (C_6H_6)	SRPS EN 14662
Metals and metalloid in PM_{10} fraction of the suspended particles (As, Cd, Cu, Zn, Fe, Pb, Mn, Ni)	SRPS EN 14902

Considering the World Health Organization (WHO) Global Air Quality Guidelines 2021 alongside the EU Directives 2008/50/EC and 2004/107/EC is essential when conducting an air quality study because the WHO guidelines represent the most up-to-date, evidence-based thresholds specifically designed to protect human health. While the EU Directives set legally binding standards, they often include less stringent limits due to socioeconomic and feasibility considerations. Incorporating WHO recommendations allows for a more comprehensive assessment of potential health impacts, even when pollutant concentrations are within EU legal limits. This dual consideration ensures that air quality study reflects both compliance with regulations and alignment with global health protection goals, offering a more robust foundation for mitigation strategies.

The measured concentrations of gases (SO_2, CO, NO_2, and O_3), PM_{10}, and $PM_{2.5}$, along with the allowable limit values outlined, are presented in Table 2-5.

Table 2-5. Measured concentrations of SO2, CO, NO2, O3, PM10, and PM2.5 against allowable limit values according to WHO, EU and Republic of Serbia

Location	SO_2 (µg/m³)	CO (mg/m³)	NO_2 (µg/m³)	O_3 (µg/m³)	PM_{10} (µg/m³)	$PM_{2.5}$ (µg/m3)
AQ1	4.4	0.59	12	22	**67**	**24**
AQ2	4.9	0.84	16	27	34	17
AQ3	3.7	0.92	13	26	37	19
AQ4	5.5	0.65	20	38	46	21
Limit WHO	40[a]	4[a]	25[a]	100[b]	45[a]	15[a]
Limit EU	125[c]	10[b]	200[d]	120[e]	50[f]	20[g]
Limit RS	125[c]	5[a]	85[a]	120[e]	50[f]	20[g]

[a]24-hour mean
[b] The maximum daily 8-hour mean
[c] 24-hour mean, not to be exceeded more than 3 times per calendar year
[d] 1-hour mean, not to be exceeded more than 18 times per calendar year
[e] The maximum daily 8-hour mean, not to be exceeded more than 25 times per calendar year, averaged over three years
[f]1-year mean, not to be exceeded more than 35 times per calendar year
[g] 1-year mean

As evident from the results in Table 2-4, concentrations of gaseous pollutants are well below the limits set by the WHO Global Air Quality Guidelines 2021, the European Ambient Air Quality Directive 2008/50/EC, and the Serbian Regulation. However, the measured concentrations of $PM_{2.5}$ and PM_{10} at location AQ1, near the settlement of Paraćin, exceeded the maximum allowable thresholds under all three standards. Since the 24-hour measurements showed concentrations higher than the annual average, this indicates elevated pollution levels prior to the start of the Project. For $PM_{2.5}$, the recorded levels are 20% higher than the limits established by both European and Serbian regulations and 67% above the thresholds recommended by the WHO guidelines. Similarly, for PM_{10} the concentrations are 34% higher than the European and Serbian limits and 49% above the WHO guideline values.

Concentrations of $PM_{2.5}$ at locations AQ2, AQ3, and AQ4 exceed the limits established by the WHO guidelines, while remaining within the thresholds set by European and Serbian regulations. This discrepancy arises from differing approaches and considerations. The WHO prioritizes health protection by setting lower thresholds designed to minimize health risks, often adopting a precautionary stance with stricter recommendations. Its guidelines aim to provide a global benchmark, encouraging stricter standards where feasible. In contrast, European and Serbian regulations factor in technological feasibility, economic impacts, and the need for harmonization across member states, resulting in higher allowable thresholds compared to the WHO guidelines.

The concentrations of benzene and BaP measured during the study, along with the upper limit values established by the Ambient Air Quality Directive (2008/50/EC), EU Directive 2004/107/EC, and the Regulation on Monitoring Conditions and Air Quality Requirements ("Official Gazette of RS," Nos. 11/2010, 75/2010, and 63/2013; Attachment X, Part B, and Attachment XII), are detailed in Table 2-6.

The WHO 2021 Guidelines do not specify a maximum threshold or limit value for benzene and BaP in air. Instead, they emphasize minimizing exposure to these compounds as much as possible due to their carcinogenic potential, advocating for their reduction to the lowest achievable concentrations.

Table 2-6. Measured concentrations of benzene, BaP, and maximum thresholds according to Directives 2008/50/EC and 2004/107/EC (Limit EU), and Regulation on Monitoring Conditions and Air Quality Requirements ("Official Gazette of RS", no. 11/2010, 75/2010 and 63/2013; Attachment X, Part B; and Attachment XII) (Limit RS)

Location	BaP (ng/m^3)	Benzene ($\mu g/m^3$)
AQ1	**1.4**	2.5
AQ2	0.80	<0.5
AQ3	0.89	<0.5
AQ4	**1.5**	<0.5
Limit EU	1[a]	5[a]
Limit RS	1[b]	5[a]

[a] 1-year mean
[c] The target value for the annual average concentration of suspended particles PM_{10}

The concentration of benzene remains within the established limits at all locations. However, the concentration of BaP, a marker for polycyclic aromatic hydrocarbons, exceeds the maximum allowable threshold by 40% at sampling location AQ1 and by 50% at sampling location AQ4.

Heavy metals and metalloid content in particulate matter in the PM10 range, along with maximum thresholds according to the EU Directive 2004/107/EC and Regulation on Monitoring Conditions and Air Quality Requirements ("Official Gazette of RS", no. 11/2010, 75/2010 and 63/2013; Attachment XII) are presented in Table 2-7.

As with benzene and BaP, the WHO does not set specific guideline values for heavy metals and arsenic in ambient air. Instead, the WHO emphasizes minimizing exposure to the lowest achievable levels, citing their carcinogenic properties. In contrast, while the EU and Serbia have established a defined limit for heavy metals and arsenic concentrations in ambient air, the WHO adopts a precautionary approach, prioritizing exposure reduction over prescribing exact numerical thresholds.

Table 2-7. Concentrations of heavy metals and metalloid from suspended particles of the PM10 fraction and limit values from the EU Directives 2008/50/EC and 2004/107/EC (Limit EU), and Regulation on Monitoring Conditions and Air Quality Requirements ("Official Gazette of RS", no. 11/2010, 75/2010 and 63/2013; Attachment XII) (Limit RS)

Location	As (ng/m^3)	Cd (ng/m^3)	Ni (ng/m^3)	Pb (µg/m^3)	Cu (µg/m^3)	Mn (µg/m^3)	Zn (µg/m^3)	Fe (µg/m^3)
AQ1	1.7	1.5	**23**	0.020	0.028	0.033	14	0.21
AQ2	1.8	1.2	17	0.014	0.023	0.015	12	0.15
AQ3	2.4	1.4	**34**	0.013	0.018	0.018	13	0.29
AQ4	2.1	1.4	**24**	0.015	0.022	0.019	15	0.16
Limit EU	6[a]	5[a]	20[a]	0.5[a]	-	-	-	-
Limit RS	6[b]	5[b]	20[b]	1[c]	-	-	-	-

[a] Annual mean
[b] Target value
[c] Maximum permitted value

At all measuring locations except AQ2, nickel concentrations in the PM_{10} fraction exceeded the established thresholds by 15-70%. The concentrations of other measured pollutants remained within the permissible limits according to all referenced standards.

In many countries, including the study area, key sources of $PM_{2.5}$, PM_{10}, and BaP in the air include vehicle emissions, industrial activities, residential heating, and dust generated from road surfaces and tire wear. The E-75 highway, a major traffic artery, is not near to the sampling locations, therefore elevated concentrations of these pollutants are assumed to be primarily attributable to urban traffic and residential heating. The AQ1 sampling location is situated within the city of Paraćin, the largest settlement along this section of the railway, which it is assumed explains the elevated parameter values.

In Paraćin, as in much of Serbia, residential heating predominantly relies on solid fuels such as firewood and coal, which remain common energy sources.4 The combustion of these fuels is a notable contributor to nickel emissions, as well as PM2.5 and PM10, in ambient air. This widespread reliance on solid fuels for heating is one of key factors in the elevated nickel concentrations observed in the area.

Additionally, the wear and tear of metal components, such as vehicle parts, can release nickel-containing particles into the atmosphere, further contributing to particulate pollution.

Some air pollution may also originate from industrial facilities within the study corridor. However, with only five small industrial facilities located within a 500-meter radius of the project site, their contribution to overall air pollution is expected to be minimal.

The project area encompasses a total of 159.45 km^2 of agricultural land. Consequently, activities such as ploughing, harvesting, and tilling may contribute to increased levels of particulate matter in the air.

The Air Quality Index (AQI) is a standard metric used to communicate daily air quality conditions. It reflects how clean or polluted the air is and highlights the potential health risks associated with primary air pollutants. An AQI value of 100 typically aligns with air quality standards established to safeguard public health (Figure 2-3). Values below 100 are generally regarded as acceptable. Table 2-8 presents the classification of daily samples analyzed based on the air quality index (https://waqi.info). The analysis indicates that the air quality at location AQ1 (Paraćin) is classified as "moderate," while all other locations are categorized as "good."

Table 2-8. AQI classification of the analysed air samples

Parameter	Location			
	AQ1	AQ2	AQ3	AQ4
AQI	67	42	46	46

4 https://keepwarmeurope.eu/countries-in-focus/serbia/english/

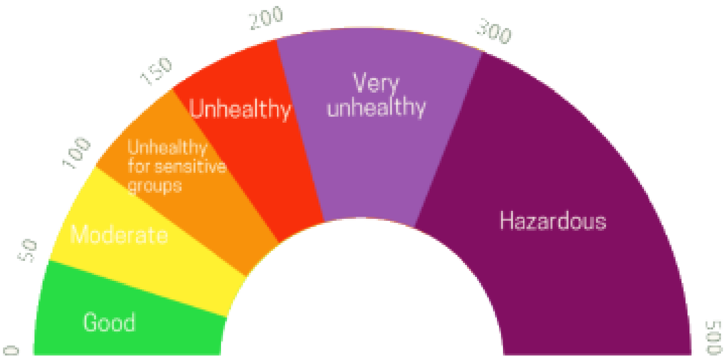


Figure 2-3. AQI classification

Figure 2-4. Survey photos for air quality measurements

3. ASSESSMENT OF POTENTIAL IMPACTS

A deterioration in air quality can significantly impact sensitive receptors, including humans, plants, and animals, by causing a range of health and environmental impacts. For humans, poor air quality may lead to respiratory and cardiovascular problems, while plants and animals may suffer from stress or damage. During construction, key air quality concerns include increased levels of fine particulate matter or dust (PM_{10} and $PM_{2.5}$), which can harm respiratory health, reduce visibility, and damage vegetation by coating leaves and inhibiting photosynthesis. Elevated concentrations of nitrogen dioxide (NO_2) can exacerbate respiratory issues in humans and animals and impair plant nutrient absorption, while hazardous pollutants like benzene and benzo(a)pyrene pose carcinogenic risks to humans and animals and can contaminate soil and water, indirectly affecting ecosystems.

During the operational phase, the transition from road-based transport to electrified rail for both passengers and freight might lead to a reduction in the number of vehicles on local roads, potentially decreasing vehicle emissions. This, in turn, could lower the concentrations of pollutants such as PM_{10}, NO_2, benzene, and benzo(a)pyrene along local road networks within the AoI, which would have a positive impact on air quality.

Assumptions and Limitations

The precise locations of certain project elements, such as laydown areas, construction camps, access roads, and spoil disposal sites, have not yet been determined. As a result, this assessment focuses solely on evaluating impacts related to the established Project footprint.

3.1. Impact Assessment Methodology

The standard methodology for assessing the impacts of the construction phase of the Project on air quality is outlined in Chapter 5 of this ESIA. Any deviations from this methodology are outlined in the following Sections of this Chapter.

3.1.1. Magnitude

In order to determine the magnitude of an impact, the methodology adopted for the assessment of air quality impacts specifically includes a qualitative evaluation of changes in levels of the pollutants NO_2, O_3, PM_{10}, and $PM_{2.5}$, compared to baseline levels, as shown in Table 3-1. This methodology is applied to both, human and ecological receptors.

Table 3-1. Determination of magnitude of impact grades for air quality

Magnitude (expected change from baseline)		NO_2 µg/m^3	PM_{10} µg/m^3	O_3 µg/m^3	$PM_{2.5}$ (optional) µg/m^3	Grade
Very low (negligible)	0–25 (%)	0–50	0–25	0–60	0–15	0
Low	25–50 (%	50–100	25–50	60–120	15–30	1
Medium	50–75 (%)	100–200	50–90	120–180	30–55	2
High	75–100 (%)	200–400	90–180	180–240	55–110	3
Very high	>100 (%)	>400	>180	>240	>110	4

3.1.2. Sensitivity

Human receptors

For the purposes of this Air Quality assessment, the definition of sensitivity for human receptors is outlined in Table 3-2 below.

Table 3-2. Determination of sensitivity of human receptors of air quality

SENSITIVITY OF SOCIAL RECEPTOR		GRADE
Low	Structures or locations not frequently occupied by people, such as storage facilities or auxiliary buildings	1
Moderate	Workplaces or commercial buildings where individuals are typically present for up to eight hours per day	2
High	Residential dwellings, hospitals, schools, and other locations where individuals spend more than eight hours per day, highlighting the importance of safeguarding human health in these environments.	3
Very high	Locations critical for vulnerable people, such as neonatal units, intensive care units, or long-term care facilities where individuals are extremely susceptible to air quality impacts and/or mitigation options are limited.	4

The analysis of human receptors involved a spatial query applied to a database of buildings sourced from OpenStreetMap, combined with a 500-meter buffer zone on each side of the railway alignment (Table 3-3). The locations of the sensitive receptors are shown in Figures Figure 8-1 to Figure 8-29 below. Whilst moderate and high sensitivity receptors are present within the AoI, there are no very high-sensitivity receptors.

See Section 4 for more details on the locations of sensitive human receptors.

Table 3-3. High and medium sensitivity human receptors within a radius of 500m from the railway (i.e the AoI)

Receptor type	Location	Receptor sensitivity	No.
Residential Dwellings	Paraćin, Sikirica, Drenovac , Ćićevac , Vitkovac, Donji Ljubeš, Srezovac, Gornji Ljubeš, Korman, Trnjane, Donji Adrovci, Prćilovica, Žitkovac, Moravac, Nozrina, Tešica, Grejač, Veliki Drenovac, Mezgraja, Vrtište , and Trupale	High	24298
Schools		High	22
Hospitals		High	4
Workplaces		Moderate	119

Ecological receptors

The third section of the railway route between Belgrade and Niš runs through the Dobrič-Nišava Important Bird Area (IBA) and Proposed Special Protection Area (pSPA), which is internationally important for bird conservation (located from km 220+315 to the end of the Project). This assessment is focused on the defined AoI (Figure 3-1), which incorporates habitat for two bird species, the Grey Partridge (*Perdix perdix)* and Black-headed Bunting (*Emberiza melanocephala)*, both of which are categorized as species of Least concern (LC) according to the IUCN Red List and therefore recognized as Moderate sensitivity ecological receptors (Table 3-3). The potential impacts of dust on plants as ecological receptors, are presented in Chapter 14 of this ESIA Report (Biodiversity).

For the purposes of this Air Quality assessment, the definition of sensitivity for ecological receptors is outlined in Table 3-4 below.

Table 3-4. Determination of sensitivity of ecological receptors of air quality impacts

SENSITIVITY OF ECOLOGICAL RECEPTOR		GRADE
Low	Widespread, resilient and invasive aquatic species or areas that are less vulnerable to disturbance, requiring minimal mitigation efforts.	1
Moderate	Species that are not threatened (least concern) but might be sensitive to changes in habitat or human activity and aquatic habitats of moderate ecological value that are relatively common or adaptable but still require effective management to avoid adverse effects	2
High	Regional conservation areas, areas with local protection status or significant biodiversity. Species at risk of becoming endangered in the near future due to population decline or habitat loss (vulnerable) or those dependent on critical habitats, such as migratory species or those in sensitive breeding areas.	3
Very high	Species facing an extremely high (critically endangered) and high risk of extinction (endangered) in the wild and protected aquatic areas, where any disturbance could cause significant or irreversible ecological damage.	4

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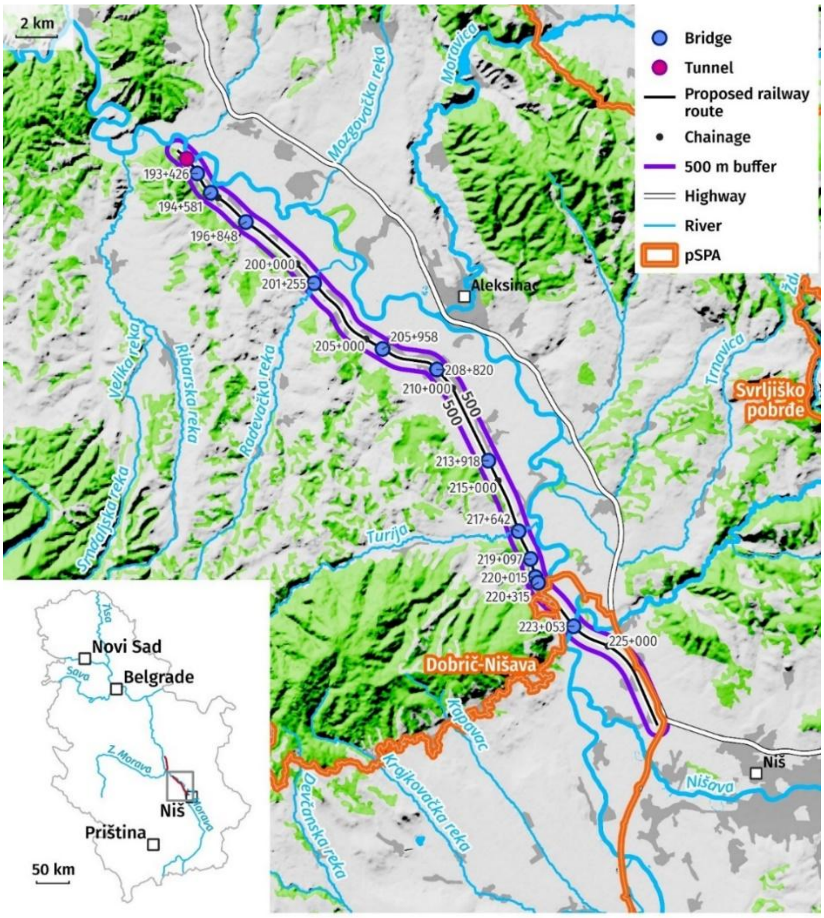

Figure 3-1. Dobrič-Nišava pSPA

3.2. Construction Phase Impacts

Railway construction projects can have negative impacts air quality, particularly during the construction phase, as a result of emissions from construction vehicles, machinery and equipment; the generation of dust; and the disturbance of contaminated land.

The potentially significant impacts on air quality during the construction phase are:

- an increase in dust levels (PM_{10} and $PM_{2.5}$)
- an increase in gaseous pollutants (NO_2)
- an increase in Benzene and benzo(a)pyrene pollutants

3.2.1. Increase in dust levels

The main sources of dust emissions during construction could include:

- **Demolition Activities:** Tearing down existing structures along the railway alignment will generate substantial volumes of particulate matter, contributing to atmospheric dust levels.
- **Earthworks and Excavations:** Processes like digging, grading, and earth moving can generate dust, especially under dry and windy conditions.
- **Material Handling and Storage**: Dust is generated during the loading, unloading, and transfer of construction materials to construction sites within the AoI such as soil, sand, and aggregates.
- **Unpaved Roads and Construction Sites:** Vehicle movements (especially heavy goods vehicles and trucks) on unpaved surfaces can generate significant volumes of dust, especially under dry and windy conditions.
- **Construction Equipment Operation:** The operation of on-site machinery and equipment, particularly if it not well-maintained, can generate dust emissions.
- **Transportation of Materials:** Heavy-duty vehicles transporting construction materials (e.g. aggregates and concrete) generate dust along transportation routes.
- **Stockpiles of Materials:** The storage of topsoil and sub-soil and aggregates on-site can contribute to increased levels of dust, especially if the stockpiles are uncovered or unstable.
- **Concrete Batching Plants:** Dust is released during the mixing and handling of concrete at batching plants.
- **Crushing and Screening Activities:** Crushing and screening materials for construction can result in localized dust emissions.

Magnitude

According to the professional judgment of the assessors and based on studies by Azarmi et al., 2016 and Wang et al, 2018, it is predicted that concentrations of air pollutants (including PM_{10} and $PM_{2.5}$) may be more than double as a result of construction activities compared to baseline measurements, i.e. will increase more than 100%. As such, construction phase impacts on dust levels are expected to be of very high magnitude (with a grade of 4). Additionally, 12 bridge construction sites are located within Section 3, where the old bridges will be demolished and subsequently rebuilt, and there are also going to be 2 new viaduct construction sites, which are expected to amplify the impact and intensify localized air quality concerns.

Spatial Extent and Duration (Spatiotemporal impact)

The approach that will be taken to the construction of the Project is unknown at the time of the assessment; however, it is expected that works on the railway tracks will be undertaken progressively along the railway line over time, rather than along the entire Project alignment at the same time. It is anticipated that activities such as replacing substructures and superstructures will proceed more rapidly compared to tasks like reconstructing bridges, underpasses, and station buildings. Consequently, the impact duration of these activities on identified receptors is expected to be shorter than on those located in areas where levelling or station construction activities are being undertaken. Overall, the impacts are assumed to be very localized and are expected to be temporary (only during construction). As such, all construction phase air quality impacts are predicted to have a spatiotemporal grade of 2.

Sensitivity

In the project AoI, three types of human receptors based on sensitivity can be identified: high-sensitivity receptors (3), locations where individuals spend more than eight hours per day, such as residential dwellings, hospitals, schools; moderate-sensitivity receptors (2), locations where individuals are typically present for up to eight hours per day, such as workplaces or commercial buildings, and low-sensitivity receptors (1), locations not frequently occupied by people, such as storage facilities or auxiliary buildings. Considering the ecological receptors, based on sensitivity only moderate-sensitivity receptors (2) are identified at protected IBA-area (Dobrič-Nišava) which is internationally important for bird conservation.

'Sensitivity' as explained above is the same for each impact and is applied to all other construction and operations phase impacts below. Impact Assessments have been conducted separately for each category of sensitive receptor.

Likelihood

It is considered certain that there will be changes in air quality due to construction activities within the AoI (Abbasi et al., 2013). As such, construction phase impacts on dust levels are predicted to have a likelihood grade of 4.

Assessment of the significance of the impact of increased dust on Human Receptors

The assessment of negative impacts on human receptors due to predicted changes in dust levels during the construction phase of the Project has been conducted separately for all high, moderate, and low sensitivity receptors within the Project AoI.

The assessment of the significance of the impacts of an increase in dust levels on human receptors during the construction phase of the Project is summarised in Table 3-5 below.

Table 3-5. Assessment of the Significance an increase in dust levels on Human Receptors During the Construction Phase

Receptors	Magnitude	Spatiotemporal impact	Sensitivity	Likelihood	Overall significance
High sensitivity receptors as identified in Table 3-2 and Figures	Dust emissions may double at construction sites, with bridge demolitions significantly	The impact is very localized and temporary (only	High sensitivity human receptors are present near some sections of the railway, mostly schools	A deterioration in air quality as a result of construction	M (4) + ST (2) + S(3) + L(4) = 13 (High)

Receptors	Magnitude	Spatiotemporal impact	Sensitivity	Likelihood	Overall significance
Figure 3-1 to Figure 8-29.	amplifying impacts and intensifying localized air quality concerns (4).	during construction) (2)	and residential dwellings (3)	activities is considered to be certain (4)	
Moderate sensitivity receptors as identified in Table 3-2 and Figures Figure 3-1 to Figure 8-29.	Dust emissions may double at construction sites, with bridge demolitions significantly amplifying impacts and intensifying localized air quality concerns (4).	The impact is very localized and temporary (only during construction) (2)	Moderately sensitive human receptors (workplaces) are present near some sections of the railway (2)	A deterioration in air quality as a result of construction activities is considered to be certain (4)	M (4) + ST (2) + S(2) + L(4) = 12 (High)
Low sensitivity receptors	Dust emissions may double at construction sites, with bridge demolitions significantly amplifying impacts and intensifying localized air quality concerns (4).	The impact is very localized and temporary (only during construction) (2)	Low sensitivity human receptors (i.e structures or locations not frequently occupied by people) are only sporadically present within the AoI (1)	A deterioration in air quality as a result of construction activities is considered to be certain (4)	M (4) + ST (2) + S(1) + L(4) = 11 (High)

Assessment of the significance of the impact of increased dust on Ecological Receptors

The assessment of negative impacts on ecological receptors due to predicted changes in dust levels during the construction phase of the Project has been conducted for one protected area, where receptors are recognized as having Moderate sensitivity. Dust can be harmful to birds, affecting their health, feeding patterns, and behaviour.

The assessment of the significance of the impacts of an increase in dust levels on ecological receptors during the construction phase of the Project is summarised in Table 3-6 below.

Table 3-6. Assessment of the Significance of an increase in dust levels on Ecological Receptors During the Construction Phase

Magnitude	Spatiotemporal impact	Sensitivity	Likelihood	Overall significance
Dust emissions may double at construction sites, with bridge demolitions significantly amplifying impacts and intensifying localized air quality concern (4).	The impact is very localised and temporary (only during construction) (2)	Moderately sensitive ecological receptors (Grey Partridge (*Perdix perdix)* and Black-headed Bunting (*Emberiza melanocephala))* are present near some sections of the railway (2)	A deterioration in air quality as a result of construction activities is considered to be certain (4)	M (4) + ST (2) + S(2) + L(4) = 12 (High)

3.2.2. An increase in gaseous pollutants

The primary sources of nitrogen dioxide (NO_2) at construction sites include:

- **Construction Machinery and Equipment**: Diesel-powered engines used in construction equipment, including bulldozers, excavators, and cranes.
- **Transportation Vehicles:** Heavy-duty trucks and other vehicles involved in moving materials to and from the construction site.
- **Generators and Other Fuel-Consuming Equipment:** On-site generators and various equipment that rely on fossil fuel combustion.
- **Plant and Equipment Operations in Construction Compounds:** The operation of stationary facilities, such as asphalt and batching plants within construction compounds, can contribute to localized emissions of NO_2

Magnitude

According to the professional judgment of the assessors and based on studies Giunta. (2020) and Wang et al, 2018, it is predicted that concentrations of NO_2 may be more than double as a result of construction activities compared to baseline measurements, i.e. will increase more than 100%. As such, construction phase impacts on NO_2 concentrations in the air are expected to be of very severe negative impact (with a grade of 4).

Spatial Extent and Duration (Spatiotemporal impact)

The approach that will be taken to the construction of the Project is unknown at the time of the assessment; however, it is expected that works on the railway tracks will be undertaken progressively along the railway line over time, rather than along the entire Project alignment at the same time. It is anticipated that activities such as replacing substructures and superstructures will proceed more rapidly compared to tasks like reconstructing bridges, underpasses, and station buildings. Consequently, the impact duration of these activities on identified receptors is expected to be shorter than on those located in areas where levelling or station construction activities are being undertaken. Overall, the impacts are assumed to be very localized and are expected to be temporary (only during construction). As such, all construction phase air quality impacts are predicted to have a spatiotemporal grade of 2.

Likelihood

It is considered certain that there will be changes in air quality due to construction activities within the AoI (Abbasi et al., 2013). As such, construction phase impacts on NO_2 concentrations in the air are predicted to have a likelihood grade of 4.

Assessment of the significance of the impact of increased gaseous pollutants on Human Receptors

The assessment of negative impacts on human receptors due to predicted changes in NO_2 concentrations in the air during the construction phase of the Project has been conducted separately for all high, moderate, and low sensitive receptors along Section 3.

The assessment of the significance of the impacts of an increase in NO_2 concentrations in the air on human receptors during the construction phase of the Project is summarised in Table 3-7 below.

Table 3-7. Assessment of the Significance of an increase in NO2 concentrations on Human Receptors During the Construction Phase

Receptors	Magnitude	Spatiotemporal impact	Sensitivity	Likelihood	Overall significance
High sensitivity receptors as identified in Table 3-2 and Figures Figure 3-1 to Figure 8-29.	NO2 emissions may double at construction sites, significantly amplifying impacts and intensifying localized air quality concern (4).	The impact is very localised and temporary (only during construction) (2)	High sensitivity human receptors are present near some sections of the railway, mostly schools and residential dwellings (3)	A deterioration in air quality as a result of construction activities is considered to be certain (4)	M (4) + ST (2) + S(3) + L(4) = 13 (High)
Moderate sensitivity receptors as identified in Table 3-2 and Figures Figure 3-1 to Figure 8-29.	NO2 emissions may double at construction sites, significantly amplifying impacts and intensifying localized air quality concern (4).	The impact is very localised and temporary (only during construction) (2)	Moderately sensitive human receptors (workplaces) are present near some sections of the railway (2)	A deterioration in air quality as a result of construction activities is considered to be certain (4)	M (4) + ST (2) + S(2) + L(4) = 12 (High)
Low sensitivity receptors	NO2 emissions may double at construction sites, significantly amplifying impacts and intensifying localized air quality concern (4).	The impact is very localised and temporary (only during construction) (2)	Low sensitivity human receptors (i.e structures or locations not frequently occupied by people) are only sporadically present within the AoI (1)	A deterioration in air quality as a result of construction activities is considered to be certain (4)	M (4) + ST (2) + S(1) + L(4) = 11 (High)

Assessment of the significance of the impact of increased gaseous pollutants on Ecological Receptors

The assessment of negative impacts on ecological receptors due to predicted changes in NO2 concentrations in the air during the construction phase of the Project has been conducted for one protected area where receptors are recognized as having moderate sensitivity. Increased concentrations of NO2 in the air can be harmful to birds, affecting their health, feeding patterns, and behaviour.

The assessment of the significance of the impacts of an increase in concentrations of NO2 in the air on ecological receptors during the construction phase of the Project is summarised in Table 3-8 below.

Table 3-8. Assessment of the Significance of an increase in NO2 concentrations on Ecological Receptors During the Construction Phase

Magnitude	Spatiotemporal impact	Sensitivity	Likelihood	Overall significance
NO2 emissions may double at construction sites, significantly amplifying impacts and intensifying localized air quality concern (4).	The impact is very localised and temporary (only during construction) (2)	Moderately sensitive ecological receptors (Grey Partridge (*Perdix perdix)* and Black-headed Bunting (*Emberiza melanocephala)*) are present near some sections of the railway (2)	A deterioration in air quality as a result of construction activities is considered to be certain (4)	M (4) + ST (2) + S(2) + L(4) = 12 (High)

3.2.3. An increase in benzene and benzo(a)pyrene pollutants

The primary sources of Benzene and benzo(a)pyrene emissions at construction sites include:

- **Combustion-Related Construction Activities**: Emissions generated by diesel engines and power generators.
- **Asphalt-related operations, and tar application:** Heating and applying these materials can release polycyclic aromatic hydrocarbons (PAHs), including benzo(a)pyrene, into the air**.**

Magnitude

Asphalt-related operations are not expected to be too intensive during the railway construction. However, the extensive use of diesel engines and power generators is anticipated. Based on the professional judgment of the assessors and supported by findings from Srogi (2007), which indicate significantly higher PAH concentrations in areas with heavy traffic compared to low-traffic areas, it is predicted that PAH concentrations in the construction area could increase by more than 50% (but not exceed 75%). As such, construction phase impacts on polycyclic aromatic hydrocarbons (PAHs), including benzo(a)pyrene concentrations in the air are expected to be of Medium negative impact (with a grade of 2).

Spatial Extent and Duration (Spatiotemporal impact)

The approach that will be taken to the construction of the Project is unknown at the time of the assessment; however, it is expected that works on the railway tracks will be undertaken progressively along the railway line over time, rather than along the entire Project alignment at the same time. It is anticipated that activities such as replacing substructures and superstructures will proceed more rapidly compared to tasks like reconstructing bridges, underpasses, and station buildings. Consequently, the impact duration of these activities on identified receptors is expected to be shorter than on those located in areas where levelling or station construction activities are being undertaken. Overall, the impacts are assumed to be very localized and are expected to be temporary (only during construction). As such, all construction phase air quality impacts are predicted to have a spatiotemporal grade of 2.

Likelihood

It is considered certain that there will be changes in air quality due to construction activities within the AoI (Abbasi et al., 2013). As such, construction phase impacts on PAHs concentrations in the air are predicted to have a likelihood grade of 4.

Assessment of the significance of the impact of increased Benzene and benzo(a)pyrene emissions on Human Receptors

The assessment of negative impacts on human receptors due to predicted changes in PAHs concentrations in the air during the construction phase of the Project has been conducted separately for all high, moderate, and low sensitive receptors along the Section 3.

The assessment of the significance of the impacts of an increase in PAHs concentrations in the air on human receptors during the construction phase of the Project is summarised in Table 3-9 below.

Table 3-9. Assessment of the Significance of Air Quality Impacts on Human Receptors During the Construction Phase

Receptors	Magnitude	Spatiotemporal impact	Sensitivity	Likelihood	Overall significance
High sensitivity receptors as identified in Table 3-2 and Figures Figure 3-1 to Figure 8-29.	PAHs emissions are expected to increase more than 50% (but not exceed 75%) at construction sites, significantly amplifying impacts and intensifying localized air quality concern (2).	The impact is very localised and temporary (only during construction) (2)	High sensitivity human receptors are present near some sections of the railway, mostly schools and residential dwellings (3)	A deterioration in air quality as a result of construction activities is considered to be certain (4)	M (2) + ST (2) + S(3) + L(4) = 11 (High)
Moderate sensitivity receptors as identified in Table 3-2 and Figures Figure 3-1 to Figure 8-29.	PAHs emissions are expected to increase more than 50% (but not exceed 75%) at construction sites, significantly amplifying impacts and intensifying localized air quality concern (2).	The impact is very localised and temporary (only during construction) (2)	Moderately sensitive human receptors (workplaces) are present near some sections of the railway (2)	A deterioration in air quality as a result of construction activities is considered to be certain (4)	M (2) + ST (2) + S(2) + L(4) = 10 (Moderate)
Low sensitivity receptors	PAHs emissions are expected to increase more than 50% (but not exceed 75%) at construction sites, significantly amplifying impacts and intensifying localized air quality concern (2).	The impact is very localised and temporary (only during construction) (2)	Low sensitivity human receptors (i.e structures or locations not frequently occupied by people) are only sporadically present within the AoI (1)	A deterioration in air quality as a result of construction activities is considered to be certain (4)	M (2) + ST (2) + S(1) + L(4) = 9 (Moderate)

Assessment of the significance of the impact of increased Benzene and benzo(a)pyrene emissions on Ecological Receptors

The assessment of negative impacts on ecological receptors due to predicted changes in dust levels during the construction phase of the Project has been conducted for one protected area where receptors are recognized of a moderate sensitivity. PAHs can be harmful to birds influencing their health, feeding and behaviour.

The assessment of the significance of impacts from increased PAH concentrations in the air on ecological receptors during the construction phase of the Project is summarised in Table 3-10 below.

Table 3-10. Assessment of the Significance of Air Quality Impacts on Ecological Receptors During the Construction Phase

Magnitude	Spatiotemporal impact	Sensitivity	Likelihood	Overall significance
PAHs emissions are expected to increase more than 50% (but not exceed 75%) at construction sites, significantly amplifying impacts and intensifying localized air quality concern (2).	The impact is very localised and temporary (only during construction) (2)	Moderately sensitive ecological receptors (Grey Partridge (*Perdix perdix)* and Black-headed Bunting (*Emberiza melanocephala)*) are present near some sections of the railway (2)	A deterioration in air quality as a result of construction activities is considered to be certain (4)	M (2) + ST (2) + S(2) + L(4) = 10 (Moderate)

3.3. Operational Phase Impacts

During the operational phase, positive impacts on air quality are expected as the Project will enable a transition from road-based transport to electrified rail for both passengers and freight, which might reduce the number of vehicles on local roads and associated vehicle emissions. In an ideal scenario, this shift is expected to decrease the concentrations of pollutants including PM_{10}, $PM_{2.5}$ NO_2, benzene, and benzo(a)pyrene along local road networks within the AoI.

Negative impacts on air quality from increased PM_{10} and $PM_{2.5}$ emissions during Project operations, as a result of rail and brake wear, have been scoped out of the assessment. Electrified rail systems contribute minimally to PM_{10} and $PM_{2.5}$ emissions, but it is expected that the overall impact on air quality would be negligible and not significant.

Negative impacts on air quality may arise during Project operations as a result of maintenance activities that generate PM_{10} and $PM_{2.5}$ emissions. Such maintenance activities may include rail grinding, ballast cleaning and renewal, tamping, sleeper replacement, rail welding and replacement, switch and crossing maintenance, signal system upkeep, and maintenance of overhead line equipment, amongst others. While these activities will generate similar impacts, such as dust emissions, they will be of a smaller scale compared to those occurring during the construction phase.

3.3.1. Improved air quality through a reduction in vehicle emissions

Magnitude

To estimate avoided emissions of air pollutants (*i.e.* nitrogen oxides (NO_x) and fine particulate matter ($PM_{2.5}$) due to a modal shift from road to rail transport the same traffic assumptions and modal shift data as used in the Greenhouse Gas (GHG) assessment have been used (see Annex 2 to this ESIA Report 'Greenhouse Gas Assessment', Tables 2-5 to 2-9).

The calculation is based on the number of road vehicle-kilometres avoided as a result of the projected shift from road to rail transport by 2028. Specifically:

- An estimated increase of 300,000 passengers using rail in 2028 compared to the "no-project" scenario (Table 2-5), and
- An increase of approx. 815,000 tonnes of freight transported by rail in the same period (Table 2-6).

These data were used to estimate the reduction in road traffic volumes, assuming an average trip length of 65 km (Paraćin–Trupale), 3 persons per car, and 10 tonnes per freight truck. Standard emission factors were applied to calculate the avoided emissions:

- Passenger vehicles (diesel): 0.3 g/km NO_x and 0.02 g/km $PM_{2.5}$
- Heavy-duty trucks (diesel): 6.5 g/km NO_x and 0.2 g/km $PM_{2.5}$

The results, shown in Table 3-11 below, indicate a reduction of approximately 36.4 tonnes of NO_x and 1.2 tonnes of $PM_{2.5}$, annually due to the predicted modal shift by 2028.

Table 3-11. Estimated annual avoided emissions of key air pollutants (NO_x and $PM_{2.5}$) for the year 2028, resulting from the predicted modal shift from road to rail transport. These calculations are based on vehicle-kilometres avoided, as derived from the projected increase in rail passenger and freight transport, and standard emission factors.

Pollutant	Avoided Emissions (Passenger) [t]	Avoided Emissions (Freight) [t]	Total Avoided Emissions [t]
NO_x	1.950	34.433	36.383
$PM_{2.5}$	0.130	1.059	1.189

These estimations are not intended to represent specific changes in local air quality concentrations, as dispersion modelling was not undertaken. However, they serve to illustrate the project's broader benefits in reducing emissions of key air pollutants at the regional level.

According to the estimated annual avoided emissions of key air pollutant and the professional judgment of the assessors and studies from similar projects, it is anticipated that the predicted transition from road to rail transport will result in a decrease in concentrations of air pollutants, including PM_{10}, $PM_{2.5}$, NO_2, benzene, and benzo(a)pyrene of 50%-75%, compared to baseline conditions (Buonaurio et al., 2022, Schiavo et al., 2022, Valerio et al., 2009); with a Magnitude grade of 2, particularly along local road networks previously impacted by high levels of vehicular traffic. These improvements are expected to enhance local air quality and contribute to broader environmental benefits.

Spatial Extent and Duration (Spatiotemporal impact)

During the operational phase, the transition enabled by the Project from road-based transport to electrified rail is anticipated to bring substantial, long-term improvements to air quality. On a temporal scale, these benefits are categorized as long-term, with a projected duration of more than 20 years. This sustained improvement arises from the permanent reduction in vehicle emissions, resulting in decreased concentrations of pollutants such as PM_{10}, NO_2, benzene, and benzo(a)pyrene. On a spatial scale, the positive impacts are expected affect the Wider Project Area (defined as up to 2 km for this assessment). This broader influence is due to the widespread reduction in road traffic emissions along local and regional road networks, resulting in air quality improvements that benefit both urban and rural settings across the area. This comprehensive impact underscores the significance of the Project in promoting environmental and public health over an extensive geographic and temporal range (with a spatiotemporal grade of 4).

Likelihood

The anticipated improvement in air quality during the operational phase is considered to have a high likelihood of occurring. This assessment is supported by evidence from similar projects, as detailed by da Fonseca-Soares et al. (2024), where a transition to electrified rail consistently resulted in significant reductions in vehicle emissions and corresponding improvements in air quality. This high level of certainty (with a grade of 3) is attributed to the direct and well-documented relationship between reduced road traffic and decreased concentrations of pollutants such as PM_{10}, NO_2, benzene, and benzo(a)pyrene.

Assessment of the significance of the impact of improved air quality on Human Receptors

The assessment of the significance of improved air quality through a reduction in vehicle emissions on human receptors during the operational phase of the Project is summarised in Table 3-12 below.

Table 3-12. Assessment of the Significance of improved air quality through a reduction in vehicle emissions on Human Receptors During the Operational Phase

Receptors	Magnitude	Spatiotemporal impact	Sensitivity	Likelihood	Overall significance
High sensitivity receptors as identified in Table 3-2 and Figures Figure 3-1 to Figure 8-29.	High as concentrations of air pollutants could be substantially reduced at certain sites during the operational phase given experience in other projects (2)	The impact is long-term (more than 20 years) and expected to affect the wider project area (2 km) (4)	High sensitivity human receptors are present near some sections of the railway, mostly schools and residential dwellings (3)	The positive change in air quality is considered to happen with a high likelihood during operational phase (3)	M (2) + ST (4) + S (3) + L(3) = 12 (High - beneficial)
Moderate sensitivity receptors as identified in Table 3-2 and Figures Figure 3-1 to Figure 8-29.	High as concentrations of air pollutants could be substantially reduced at certain sites during the operational phase given experience in other projects (2)	The impact is long-term (more than 20 years) and expected to affect the wider project area (2 km) (4)	Moderately sensitive human receptors (workplaces) are present near some sections of the railway (2)	The positive change in air quality is considered to happen with a high likelihood during operational phase (3)	M (2) + ST (4) + S (2) + L (3) = 11 (High-beneficial)
Low sensitivity receptors	High as air pollutants could be substantially reduced at certain sites during the operational phase given experience in other projects (2)	The impact is long-term (more than 20 years) and expected to affect the wider project area (2 km) (4)	Low sensitivity human receptors (i.e structures or locations not frequently occupied by people) are only sporadically present within the AoI (1)	The positive change in air quality is considered to happen with a high likelihood during operational phase (3)	M (2) + ST (4) + S (1) + L (3) = 10 (Moderate-beneficial)

Assessment of the significance of the impact of improved air quality on Ecological Receptors

The assessment of the significance of improved air quality through a reduction in vehicle emissions on ecological receptors during the operational phase of the Project is summarised in Table 3-13 below.

Table 3-13. Assessment of the Significance of improved air quality through a reduction in vehicle emissions on Ecological Receptors During the Operational Phase

Magnitude	Spatiotemporal impact	Sensitivity	Likelihood	Overall significance
High as concentrations of air pollutants could be substantially reduced at certain sites during the operational phase given experience in other projects (2)	The impact is long-term (more than 20 years) and expected to affect a wider project area (2 km) (4)	Moderately sensitive ecological receptors (Grey Partridge (*Perdix perdix)* and Black-headed Bunting (*Emberiza melanocephala)*) are present near some sections of the railway (2)	The positive change in air quality is considered to happen with a high likelihood during operational phase (3)	M (2) + ST (4) + S (2) + L (3) = 11 (High-beneficial)

3.3.2. Deterioration in air quality as a result of maintenance activities

Magnitude

The magnitude of air quality impacts during the operational phase range from very low (0) to low (1), depending on the type and frequency of maintenance activities. Very low impacts that result in a 0-25% change in baseline air quality levels are associated with routine inspections or minor adjustments, such as signal system upkeep or overhead line maintenance, which generate negligible emissions or dust. Low impacts that result in a 25–50% change in baseline air quality levels occur during more intensive activities, such as rail grinding, ballast cleaning and renewal, tamping, sleeper replacement, rail welding, and switch maintenance, which can result in temporary and localized increases in PM_{10} emissions only.

Spatial Extent and Duration (Spatiotemporal impact)

The spatiotemporal impact of maintenance activities is minimal due to their small scale, short duration, and spatial confinement. These activities are localized to specific sections of the railway, typically addressing targeted areas such as rail segments, ballast, or switches. The lack of prolonged presence of construction machinery on-site further limits the extent and duration of emissions or disturbances. Consequently, the impacts are temporary and geographically restricted (with a grade of 2), ensuring minimal disruption to surrounding areas and sensitive receptors.

Likelihood

It is certain that maintenance activities, involving machinery operations to repair and service the railway, will result in changes in air quality within the immediate maintenance area and the adjacent AoI (Abbasi et al., 2013). These activities do not involve construction but are focused solely on maintaining and repairing the existing railway infrastructure. As such, all operational phase air quality impacts are predicted to have a likelihood grade of 3.

Assessment of the significance of the impact of a deterioration in air quality as a result of maintenance activities on Human Receptors

The assessment of the significance of air quality impacts as a result of maintenance activities on human receptors during the operational phase of the Project is summarised in Table 3-14 below.

Table 3-14. Assessment of the Significance of Air Quality Impacts due to maintenance activities on Human Receptors During the Operational Phase

Receptors	Magnitude	Spatiotemporal impact	Sensitivity	Likelihood	Overall significance
High sensitivity receptors as identified in Table 3-2 and Figures Figure 3-1 to Figure 8-29.	Very low-low depending on the type of maintenance activities performed (0-1)	The impact is short term (less than 5 years) and expected to be very localized (2)	High Sensitivity human receptors are present near some sections of the railway, mostly schools and residential dwellings (3)	The change in air quality is considered to happen with high likelihood during the operational phase. (3)	M (0-1) + ST (2) + S(3) + L(3) = 8-9 (Moderate)
Moderate sensitivity receptors as identified in Table 3-2 and Figures Figure 3-1 to Figure 8-29.	Very low-low depending on the type of maintenance activities performed (0-1)	The impact is short term (less than 5 years) and expected to be very localized (2)	Moderately sensitive human receptors (workplaces) are present near some sections of the railway (2)	The change in air quality is considered to happen with high likelihood during the operational phase.(3)	M (0-1) + ST (2) + S(2) + L(3) = 7-8 (Low - Moderate)
Low sensitivity receptors	Very low-low depending on the type of maintenance activities performed (0-1)	The impact is short term (less than 5 years) and expected to be very localized (2)	Low sensitivity human receptors (i.e structures or locations not frequently occupied by people) are only sporadically present within the AoI (1)	The change in air quality is considered to happen with high likelihood during the operational phase (3).	M (0-1) + ST (2) + S(1) + L(3) = 6-7 (Low)

Assessment of the significance of the impact of a deterioration in air quality as a result of maintenance on Ecological Receptors

The assessment of the significance of air quality impacts as a result of maintenance activities on ecological receptors during the operational phase of the Project is summarised in Table 3-15 below. Dust or emissions of pollutants can be harmful to birds, affecting their health, feeding patterns, and behaviour.

Table 3-15. Assessment of the Significance of Air Quality Impacts due to maintenance activities on Ecological Receptors During the Operational Phase

Magnitude	Spatiotemporal impact	Sensitivity	Likelihood	Overall significance
Very low-low depending on the type of maintenance activities performed (0-1)	The impact is short term (less than 5 years) and expected to be very localized (2)	Moderately sensitive ecological receptors (Grey Partridge (*Perdix perdix)* and Black-headed Bunting (*Emberiza melanocephala)*) are present near some sections of the railway (2)	The change in air quality is considered to happen with high likelihood during the operational phase. (3)	M (0-1) + ST (2) + S(2) + L(3) = 7-8 (Low - Moderate)

3.4. Summary of impacts

Table 3-16. Summary of Impact assessment of Air Quality

Phase	Receptor	Impact	Positive/Negative	Impact significance before mitigation measures are implemented
Construction	High sensitivity receptors	An increase in dust levels (PM_{10} and $PM_{2.5}$)	Negative	High
		An increase in gaseous pollutants (NO_2)		High
		An increase in benzene and benzo(a)pyrene pollutants		High
	Moderate sensitivity receptors	An increase in dust levels (PM_{10} and $PM_{2.5}$)		High
		An increase in gaseous pollutants (NO_2)		High
		An increase in benzene and benzo(a)pyrene pollutants		Moderate
	Low sensitivity receptors	An increase in dust levels (PM_{10} and $PM_{2.5}$)		High
		An increase in gaseous pollutants (NO_2)		High
		An increase in benzene and benzo(a)pyrene pollutants		Moderate
Operation	High sensitivity receptors	Improved air quality through a reduction in vehicle emissions	Positive	High
		Deterioration in air quality as a result of maintenance activities	Negative	Moderate
	Moderate sensitivity receptors	Improved air quality through a reduction in vehicle emissions	Positive	High
		Deterioration in air quality as a result of maintenance activities	Negative	Moderate/Low
	Low sensitivity receptors	Improved air quality through a reduction in vehicle emissions	Positive	Moderate
		Deterioration in air quality as a result of maintenance activities	Negative	Low

4. MITIGATION MEASURES

The mitigation strategies were conducted by dividing the railway corridor into three different 'Sensitivity Zones', based on the density of receptors of different sensitivities within the following 16 settlements located adjacent to the Project alignment.

- Paraćin
- Sikirica
- Drenovac
- Ćićevac
- Vitkovac
- Donji Ljubeš
- Srezovac and Gornji Ljubeš
- Korman
- Trnjane
- Donji Adrovci-Prćilovica-Žitkovac-Moravac
- Nozrina
- Tešica
- Grejač-Veliki Drenovac
- Mezgraja
- Vrtište
- Trupale

The sensitivity zones, containing high- and medium-sensitivity receptors (very high-sensitivity receptors are not present in the study) that could be impacted during the construction and operational phases of the railway project were determined according to their location:

- Highly sensitive zones are areas with a high density of residential dwellings (i.e. more than 50 dwellings per hectare) of sensitive receptors within the abovementioned 16 settlements. These are identified as being from: km 154.500 to km 155.700 and from km 156.000 to km156.500, from km 165.00 to km 165.500, from km 166.500 to km 168.000, from km 171.500 to km 173.000, from km 193.800 to km 194.300, from km 195.000 to km 196.500, from km 197.000 to km 198.700, from km 200.00 to km 201.000, from km 202.000 to km 204.000, from km 206.000 to km 211.000, from km 212.000 to km 2014.000, from km 216.700 to km 217.500, from km 219.000 to km 222.000, from km 224.000 to km 224.200, from km 227.000 to km 228.000, and from km229.000 to km 229.600.

- Moderately sensitive zones are areas that only contain sites representing workplaces or commercial buildings (moderately sensitive receptors), usually located in the industrial parts of the abovementioned settlements and protected areas. In this study we recognized these zones within the following sections of the Project alignment: from km 153.400 to km 154.500, from km 155.700 to km 156.000, from km 156.500 to km 159.300, from km 161.700 to km 162.000, from km 163.700 to km 164.000, from km 170.000 to km 171.500, from km 173.000 to km 174.500, from km 222.000 to km 224.000, from km 224.200 to km 227.000, from km 227.200 to km 229.000. Moderately sensitive zones having a high density of moderately sensitive ecological receptors are located from km 222.000 to km 224.000, from km 224.200 to km 227.000, from km 227.200 to km 229.000.
- The non-sensitive zones are areas with a low density of residential dwellings (i.e. fewer than 10 dwellings per hectare) of receptors, located outside the above mentioned settlements (from km 159.300 to at km 161.700, from km 162.000 to at km 163.700, from km 164.000 to at km 165.000, from km 165.500 to at km 166.500, from km 168.000 to at km 170.500, from km 191.950 to at km 193.800, from km 194.300 to at km 195.000, from km 196.500 to at km 197.000, from km 198.700 to at km 200.000, from km 201.000 to at km 202.000, from km 204.000 to at km 206.000, from km 210.000 to at km 212.000, from km 214.000 to at km 216.700, from km 217.500 to at km 219.000).

The distribution of sensitivity zones along the Project route is illustrated in Figure 4-1.

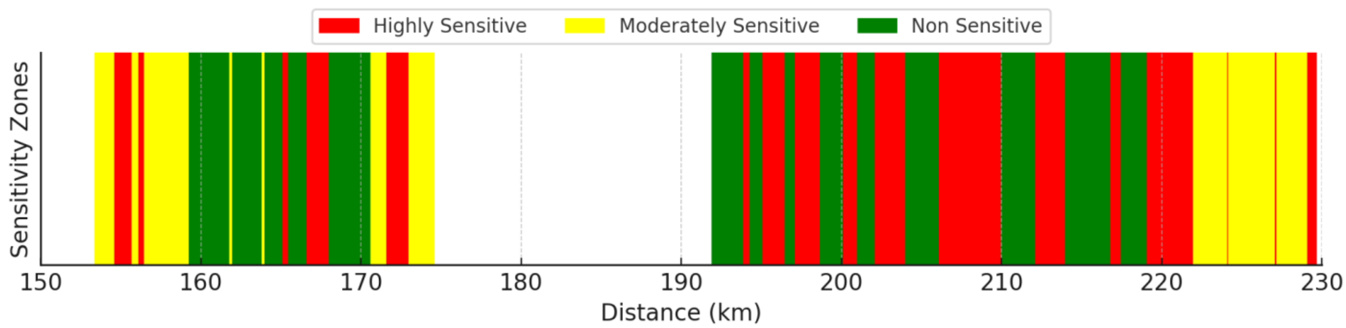

Figure 4-1. Distribution of Sensitive Zones Along the Railway

4.1. Mitigation strategies during the construction phase

Mitigation strategies during the construction phase aim to safeguard sensitive receptors by implementing measures to control emissions and limit dust dispersion, and to ensure compliance with regulatory air quality standards.

The Contractor will develop:

- **A Construction Air Quality Management Plan,** outlining the measures that must be implemented to mitigate the adverse impacts of railway construction on air quality, tailored to the sensitivity of the location.
- **A Construction Traffic Management Plan** to effectively manage the transportation of goods, materials and the workforce during construction in an environmentally sustainable way. The plan will aim to minimize traffic-related air emissions by optimizing traffic logistics and will include the measures that must be implemented to mitigated the adverse impacts of construction traffic on air quality. Please also see the Major Accidents and Disasters, and Social Impact Assessment Chapters.

Table 4-1 defines the mitigation measures proposed to mitigate the identified impacts grouped according to the relevant Sensitivity Zone, and which should, as a minimum, be included in the Construction Air Quality and Traffic Management Plans to be developed and implemented by the Contractor.

Table 4-1. Proposed Mitigation Measures during Construction Phase for all impacts according to sensitivity zone

Location	Mitigation measures
Highly sensitive zones	**Construction Air Quality and Dust Management Plan:** ▪ Siting of construction facilities and equipment (including concrete and asphalt batching plants, rock crushing plants, and construction camps) will be prohibited within 500 m of any residential area or sensitive receptor (school, hospital, church, etc.) and at least two kilometres from protected areas for biodiversity where possible. ▪ The siting of construction facilities and equipment must consider the prevailing wind direction. ▪ Truck-washing facilities must be provided at all construction sites to prevent the track-out of mud and dust ▪ A community Grievance Mechanism must be maintained to track trends in air quality complaints and additional mitigation implemented where required. This will be incorporated into the Stakeholder Engagement Plan for the Project; ▪ The application of dust suppression measures, including water spaying, will be increased when activities with a high potential to produce dust are being carried out and/or during prolonged dry or windy conditions; ▪ Sand and gravel materials need to be transported in covered trucks; vehicles transporting materials will not be overloaded; ▪ Drop heights from conveyors will be minimised, loading shovels, hoppers and other loading or handling equipment and fine water sprays will be used on such equipment wherever appropriate; ▪ Vehicle speeds on construction sites and access roads will be limited to 25 km per hour; ▪ Machines and vehicles to be used for construction activities must have valid use/operation permits; ▪ Machines and vehicles to be used in construction activities must be regularly maintained; ▪ Vehicles and equipment that emit smoke will not be used for construction activities or delivering materials to site. ▪ High quality fossil fuels (with a low percentage of sulphur and lead) must be used as fuel for vehicles, machinery and equipment;

Location	Mitigation measures
	▪ All vehicle operators will switch off engines when stationary – no idling vehicles. ▪ Bonfires and the burning of waste is prohibited on all construction sites; ▪ Where practicable, the site will be fully enclosed with a dust screen where there is a high potential for dust production and the site is active for an extensive period; ▪ Earthworks and exposed areas/soil stockpiles will be revegetated to stabilise surfaces as soon as practicable; ▪ Mixing of large quantities of concrete and bentonite will be undertaken in enclosed or shielded areas; ▪ Earth stockpile surface areas will be minimised to reduce area of surfaces exposed to wind pick-up; ▪ Where practicable, stockpiles of soils and materials will be located as far as possible from sensitive properties, taking account of the prevailing wind direction; ▪ During dry or windy weather, material stockpiles and exposed surfaces will be dampened down using a water spray to minimise the potential for wind pick-up. ▪ Scabbling (roughening of concrete surfaces) will be avoided if possible; ▪ Bulk cement and other fine powder materials will be delivered in enclosed tankers and stored in silos with suitable emission control systems to prevent escape of material and overfilling during delivery; ▪ For smaller supplies of fine powder materials bags will be sealed after use and stored appropriately to prevent dust; ▪ In case of demolition operations, effective dust suppression measures will be used to limit dust generation. ▪ Water-assisted dust sweeper(s) will be used regularly on access roads and local roads, to remove, as necessary, any material tracked out of the site. ▪ Dry sweeping of large areas will be avoided; ▪ On-site haul routes will be regularly inspected for integrity and necessary repairs made to the surface as soon as reasonably practicable; ▪ The use of diesel- or petrol-powered generators should be minimised whenever feasible, and cleaner alternatives such as mains electricity or battery-powered equipment should be used; ▪ Any stationary emission sources (e.g., portable diesel generators, compressors, etc.) will be positioned as far as is practical from sensitive receptors ▪ Compaction of unpaved road surfaces should be undertaken where possible.

Location	Mitigation measures
	Construction Traffic Management Plan: ▪ Ensure that the timing of large-scale vehicle movements and the scheduling of deliveries avoids peak traffic times and congested periods on the local road network; ▪ Disclose the timetable for the movement of any large construction vehicles, particularly any wide or long loads that may require additional road space to help avoid local congestion; ▪ Ensure that all public roads used for the Project are regularly cleaned, removing any debris caused by the movement of vehicles and materials for the Project; ▪ Promote shared transportation for the workforce.
Moderately sensitive zones	**Construction Air Quality and Dust Management Plan:** ▪ The application of dust suppression measures, including water spaying, will be increased when activities with a high potential to produce dust are being carried out and/or during prolonged dry or windy conditions; ▪ Sand and gravel materials need to be transported in covered trucks; vehicles transporting materials will not be overloaded; ▪ Vehicle speeds on construction sites and access roads will be limited to 25 km per hour; ▪ Machines and vehicles to be used for construction activities must have valid use/operation permits; ▪ Machines and vehicles to be used in construction activities must be regularly maintained; ▪ High quality fossil fuels (with a low percentage of sulphur and lead) must be used as fuel for vehicles, machinery and equipment; ▪ Equipment will be maintained to be readily available on site to clean any dry spillages and clean up spillages as soon as reasonably practicable after the event using wet cleaning methods; ▪ All vehicle operators will switch off engines when stationary – no idling vehicles. ▪ Bonfires and the burning of waste is prohibited on all construction sites; ▪ Earthworks and exposed areas/soil stockpiles will be revegetated to stabilise surfaces as soon as practicable; ▪ Mixing of large quantities of concrete and bentonite will be undertaken in enclosed or shielded areas; ▪ Earth stockpile surface areas will be minimised to reduce area of surfaces exposed to wind pick-up;

<table>
<tr><th>Location</th><th>Mitigation measures</th></tr>
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Where practicable, stockpiles of soils and materials will be located as far as possible from sensitive properties, taking account of the prevailing wind direction;
Bulk cement and other fine powder materials will be delivered in enclosed tankers and stored in silos with suitable emission control systems to prevent escape of material and overfilling during delivery;
For smaller supplies of fine powder materials bags will be sealed after use and stored appropriately to prevent dust;
Water-assisted dust sweeper(s) will be used regularly on access roads and local roads, to remove, as necessary, any material tracked out of the site.;
The use of diesel- or petrol-powered generators should be minimised whenever feasible, and cleaner alternatives such as mains electricity or battery-powered equipment should be used;

Construction Traffic Management Plan:

Reducing idle time and minimizing stop-and-go traffic patterns
Ensure that all public roads used for the Project are regularly cleaned, removing any debris caused by the movement of vehicles and materials for the Project;
Use of alternative transportation methods such as off-peak deliveries, route optimization, and promoting shared transportation

</td></tr>
<tr><td>Non-sensitive zones</td><td>
Construction Air Quality and Dust Management Plan:

The application of dust suppression measures, including water spaying, will be increased when activities with a high potential to produce dust are being carried out and/or during prolonged dry or windy conditions;
Sand and gravel materials need to be transported in covered trucks; vehicles transporting materials will not be overloaded;
Vehicle speeds on construction sites and access roads will be limited to 25 km per hour;
Machines and vehicles to be used in construction activities must have valid use/operation permits;
Machines and vehicles to be used in construction activities must be regularly maintained;
High quality fossil fuels (with a low percentage of sulphur and lead) must be used as fuel for vehicles, machinery and equipment;
Equipment will be maintained to be readily available on site to clean any dry spillages and clean up spillages as soon as reasonably practicable after the event using wet cleaning methods;

</td></tr>
</table>

Location	Mitigation measures
	▪ All vehicle operators will switch off engines when stationary – no idling vehicles. ▪ Bonfires and the burning of waste is prohibited on all construction sites; ▪ Mixing of large quantities of concrete and bentonite will be undertaken in enclosed or shielded areas; ▪ Earth stockpile surface areas will be minimised to reduce area of surfaces exposed to wind pick-up; ▪ Implementing Alternative Power Sources. This strategy involves minimizing the use of diesel- or petrol-powered generators whenever feasible and opting for cleaner alternatives such as mains electricity or battery-powered equipment; **Construction Traffic Management Plan**: ▪ Reducing idle time and minimizing stop-and-go traffic patterns ▪ Ensure that all public roads used for the Project are regularly cleaned, removing any debris caused by the movement of vehicles and materials for the Project; ▪ Use of alternative transportation methods such as off-peak deliveries, route optimization, and promoting shared transportation.

4.2. Mitigation strategies during the Operational phase

There may be some localized, short-term negative impacts on air quality as a result of maintenance activities. The SRI must develop and implement an Operational Dust and Air Quality Management Plan to address potential air quality impacts from maintenance activities that should as a minimum include those outlined in Table 4-2 below.

Table 4-2. Proposed Mitigation Measures during Operational Phase for all negative impacts according to sensitivity zone

Locations	Mitigation measures
Highly sensitive zones	▪ Maintenance and reconstruction works should be carried out during specific weather conditions that minimize dust dispersion, such as periods of low wind speed, high humidity, or after rainfall, in order to limit the spread of dust; ▪ Sand and gravel materials must be transported in covered trucks; ▪ Maintenance vehicles must obey all speed limits. ▪ Maintenance machines and vehicles to must have valid use/operation permits;

Locations	Mitigation measures
	▪ Maintenance machines and vehicles must be regularly maintained; ▪ High quality fossil fuels (with a low percentage of sulphur and lead) must be used as fuel for vehicles, machinery and equipment; ▪ All vehicle operators will switch off engines when stationary – no idling vehicles. ▪ Bonfires and the burning of waste will be prohibited; ▪ In case of demolition operations, effective water suppression measures will be used to limit dust generation. ▪ Regular maintenance and inspection of brake systems on trains should be undertaken to ensure they are functioning efficiently ▪ Planting should be maintained along railway corridors to minimise the distribution of particulate matter from rail and train brake wear.
Moderately sensitive zones	▪ Sand and gravel materials must be transported in covered trucks; ▪ Maintenance vehicles must obey all speed limits. ▪ Maintenance machines and vehicles to must have valid use/operation permits; ▪ Maintenance machines and vehicles must be regularly maintained; ▪ High quality fossil fuels (with a low percentage of sulphur and lead) must be used as fuel for vehicles, machinery and equipment; ▪ All vehicle operators will switch off engines when stationary – no idling vehicles. ▪ Bonfires and the burning of waste will be prohibited; ▪ In case of demolition operations, effective water suppression measures will be used to limit dust generation. ▪ Regular maintenance and inspection of brake systems on trains should be undertaken to ensure they are functioning efficiently.

4.3. Monitoring

Regular air quality monitoring should be conducted throughout both the construction and operational phases of the Project to ensure compliance with the Environmental and Social Management Plans, the EIB and EBRD policies, and the commitments outlined in the ESIA. Monitoring helps verify that mitigation measures implemented by the construction contractor and SRI effectively prevent or minimize significant negative impacts. Additionally, it enables early detection of deviations from baseline environmental and social conditions, allowing for adaptive management responses. If monitoring results indicate that impacts are occurring despite compliance with management plans, these plans should be revised accordingly to enhance effectiveness. This proactive approach ensures that potential risks are identified, addressed, and minimized, safeguarding both environmental and social sustainability throughout the project lifecycle.

Along the Paraćin–Niš project route, SEPA operates automatic air quality monitoring stations in Paraćin and Niš, providing continuous pollutant concentration measurements. Additionally, the Aleksinac station monitors PM_{10}, SO_2, and NO_2, with plans to include $PM_{2.5}$ from 2024, though not daily. Given their strategic locations, these SEPA monitoring stations should be integrated into the project's air quality monitoring framework to improve data reliability, ensure compliance, and support a broader assessment of ambient air quality trends. Their inclusion will enhance impact evaluation and mitigation planning, ensuring that air quality is effectively managed throughout construction and operation.

The monitoring activities detailed in Table 4-3 outline the proposed air quality monitoring measures for both the construction and operational phases of the Project.

Table 4-3. Proposed Air Quality Monitoring Activities for the Construction and Operational Phases

Monitoring Requirement	Frequency	Location	Method
Construction Phase			
Carbon monoxide (CO), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), ozone (O3), benzene, benzo(a)pyrene, suspended particles of the PM_{10} fraction, suspended particles of the $PM_{2.5}$ fraction, metals and metalloid from of suspended particles of the PM10 fraction (As, Cd, Cu, Zn, Fe, Pb, Mn, Ni).	Monthly, and additionally as needed in response to community complaints.	Urban areas along the railway corridor. Residential and industrial zones within 500 m on either side of the railway line. All Project Facilities and worksites, and Project landfill sites.	Air quality measurements are conducted by an accredited testing laboratory authorized by the competent Ministry.
Operational Phase			
Carbon monoxide (CO), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), ozone (O_3), benzene, benzo(a)pyrene, suspended particles of the PM_{10} fraction, suspended particles of the $PM_{2.5}$ fraction, metals and metalloid from of suspended particles of the PM_{10} fraction (As, Cd, Cu, Zn, Fe, Pb, Mn, Ni).	During heavy maintenance operations, and additionally in response to any community complaints	Urban areas along the railway corridor. Residential and industrial zones within 500 m on either side of the railway line. Areas with potential railway maintenance activities. Major train stations and depots. High-traffic railway crossings.	Air quality measurements are conducted by an accredited testing laboratory authorized by the competent Ministry.

5. RESIDUAL IMPACTS ASSESSMENT

Table 5-1 presents an assessment of the significance of residual negative air quality impacts, during both the construction and operational phases of the Project, following implementation of the mitigation measures defined in Tables Table 4-1 and Table 4-2.

Table 5-1. Residual Impact Assessment on air during Construction and Operational Phases

Phase	Impact	Negative or Positive	Receptor sensitivity	Overall significance before mitigation	Summary of mitigation	Assessment of impacts after mitigation	Overall significance after mitigation
Construction	Increase in dust levels during construction Increase in gaseous pollutant levels during construction	Negative	'High' sensitivity receptors	High	Proximity avoidance, wind consideration, regular monitoring, truck washing, grievance mechanism, water spraying, covered transport, height minimization, speed limitation, permit validation, regular maintenance, emission control, clean fuel, idling prohibition, fire banning, dust screening, surface stabilization, shielded mixing, stockpile reduction, sensitive placement, wind dampening, scabbling prevention, enclosed delivery, sealed storage, demolition suppression, dust sweeping, surface repair, cleaner generators, emission distancing, road compaction, traffic scheduling, delivery disclosure, debris removal, shared transportation.	*Magnitude is low as pollutant emissions will be substantially decreased by mitigation measures (1); the impact is short term (less than 5 years) and expected to be very localized (2); high sensitivity receptors are present near some sections of the railway (3); the change in air quality is considered to happen with very low likelihood after the mitigation measures (1)*	*Low* *M (1) + ST (2) + S (3) + L (1) = 7*
			'Moderate' sensitivity receptors	High	Dust reduction, covered transport, speed limitation, permit validation, regular maintenance, clean fuel, wet cleaning, idling prohibition, fire banning, surface stabilization, shielded mixing, stockpile minimization, sensitive placement, enclosed delivery, sealed storage, frequent sweeping, alternative power, traffic smoothing, debris removal, route optimization.	*Magnitude is low as pollutant emissions will be substantially decreased by mitigation measures (1); the impact is short term (less than 5 years) and expected to be very localized (2); moderate sensitivity receptors are present near some sections of the railway (2); the change in air quality is considered to happen with very low likelihood after the mitigation measures (1)*	*Low* *M (1) + ST (2) + S (2) + L (1) = 6*

Phase	Impact	Negative or Positive	Receptor sensitivity	Overall significance before mitigation	Summary of mitigation	Assessment of impacts after mitigation	Overall significance after mitigation
			'Low' sensitivity receptors	High	Dust reduction, covered transport, speed limitation, permit validation, regular maintenance, clean fuel, wet cleaning, idling prohibition, fire banning, shielded mixing, stockpile minimization, alternative power, traffic smoothing, debris removal, route optimization.	*Magnitude is low as pollutant emissions will be substantially decreased by mitigation measures (1); the impact is short term (less than 5 years) and expected to be very localized (2); low sensitivity receptors are present near some sections of the railway (1); the change in air quality is considered to happen with very low likelihood after the mitigation measures (1)*	*Low* *M (1) + ST (2) + S (1) + L (1) = 5*
	Increase in Benzene and benzo(a)pyrene pollutants levels during construction		'High' sensitivity receptors	High	*Proximity avoidance, wind consideration, regular monitoring, truck washing, grievance mechanism, water spraying, covered transport, height minimization, speed limitation, permit validation, regular maintenance, emission control, clean fuel, idling prohibition, fire banning, dust screening, surface stabilization, shielded mixing, stockpile reduction, sensitive placement, wind dampening, scabbling prevention, enclosed delivery, sealed storage, demolition suppression, dust sweeping, surface repair, cleaner generators, emission distancing, road compaction, traffic scheduling, delivery disclosure, debris removal, shared transportation.*	*Magnitude is low as PAHs emissions will be substantially decreased by mitigation measures (1); the impact is short term (less than 5 years) and expected to be very localized (2); high sensitivity receptors are present near some sections of the railway (3); the change in air quality is considered to happen with very low likelihood after the mitigation measures (1)*	Low M (1) + ST (2) + S (3) + L (1) = 7
			'Moderate' sensitivity receptors	Moderate	Dust reduction, covered transport, speed limitation, permit validation, regular maintenance, clean fuel, wet cleaning, idling prohibition, fire banning, surface stabilization, shielded mixing, stockpile minimization, sensitive placement, enclosed delivery, sealed storage, frequent sweeping, alternative power, traffic smoothing, debris removal, route optimization.	*Magnitude is low as PAHs emissions will be substantially decreased by mitigation measures (1); the impact is short term (less than 5 years) and expected to be very localized (2); moderate sensitivity receptors are present near some sections of the railway (2); the change in air quality is considered to happen with very low likelihood after the mitigation measures (1)*	Low M (1) + ST (2) + S (2) + L (1) = 6

Phase	Impact	Negative or Positive	Receptor sensitivity	Overall significance before mitigation	Summary of mitigation	Assessment of impacts after mitigation	Overall significance after mitigation
			'Low' sensitivity receptors	Moderate	Dust reduction, covered transport, speed limitation, permit validation, regular maintenance, clean fuel, wet cleaning, idling prohibition, fire banning, shielded mixing, stockpile minimization, alternative power, traffic smoothing, debris removal, route optimization.	*Magnitude is low as PAHs emissions will be substantially decreased by mitigation measures (1); the impact is short term (less than 5 years) and expected to be very localized (2); low sensitivity receptors are present near some sections of the railway (1); the change in air quality is considered to happen with very low likelihood after the mitigation measures (1)*	Low M (1) + ST (2) + S (1) + L (1) = 5
Operational	Deterioration in air quality during maintenance works	Negative	'High' sensitivity receptors	Moderate	Weather consideration, covered transport, speed limitation, permit validation, regular maintenance, clean fuel, idling prohibition, fire banning, water suppression, particle reduction, brake inspection, vegetation maintenance.	*Magnitude is low as pollutant emissions will be substantially decreased by mitigation measures (1); the impact is short term (less than 5 years) and expected to be very localized (2); high sensitivity receptors are present near some sections of the railway (3); the change in air quality is considered to happen with very low likelihood after the mitigation measures (1)*	*Low* *M (1) + ST (2) + S (3) + L (2) = 7*
			'Moderate' sensitivity receptors	Moderate	Weather consideration, covered transport, speed limitation, permit validation, regular maintenance, clean fuel, idling prohibition, fire banning, water suppression, particle reduction, brake inspection, vegetation maintenance.	*Magnitude is low as pollutant emissions will be substantially decreased by mitigation measures (1); the impact is short term (less than 5 years) and expected to be very localized (2); moderate sensitivity receptors are present near some sections of the railway (3); the change in air quality is considered to happen with low likelihood after the mitigation measures (2)*	*Low* *M (1) + ST (2) + S (2) + L (1) = 6*
			'Low' sensitivity receptors	Low	Not Applicable	No impact is expected after implementation of prescribed mitigation measures	Not Applicable

6. CONCLUSION

The baseline air quality assessment highlighted existing pollution challenges along the Project corridor, with current levels of key pollutants such as PM10, PM2.5, and benzo(a)pyrene exceeding recommended thresholds, particularly in urban areas including Paraćin and Niš. These results reflect the fact that air pollution in the region is already affected by emissions from urban traffic, residential heating, and local industrial activities, echoing broader trends observed in Serbia's air quality monitoring data.

Without the implementation of appropriate and adequate mitigation measures, the construction phase of the Project is predicted to have significant negative impacts on air quality. The primary pollutants of concern are PM_{10}, $PM_{2.5}$ (dust), nitrogen dioxide (NO2), benzene, and benzo(a)pyrene, primarily generated by construction machinery, demolition activities, and material handling. Sensitive zones with the highest receptor densities include settlements such as Paraćin, Sikirica, Drenovac, Ćićevac, Vitkovac, Donji Ljubeš, Srezovac, Gornji Ljubeš, Korman, Trnjane, Donji Adrovci, Prćilovica, Žitkovac, Moravac, Nozrina, Tešica, Grejač, Veliki Drenovac, Mezgraja, Vrtište, and Trupale. However, construction phase impacts on air quality are expected to be short-term and highly localized, except at locations of bridges/viaducts and station demolition and construction activities.

Mitigation measures will be included in the Construction Air Quality and Dust Management Plan and Construction Traffic Management Plan to be developed and implemented by the construction contractor. These will include the best practice measures such as the use of dust suppression techniques (e.g. water sprinkling), covering loose materials and soil, optimizing traffic patterns, using high-quality fuels and maintaining machinery/vehicles/equipment that must be implemented to avoid or limit negative impacts on air quality. The mitigation measures should be tailored to the sensitivity of receptors, with Project areas located within 500 m of high sensitivity receptors subject to more stringent mitigation measures.

During the operational phase, the project is predicted to improve air quality overall due to facilitating a modal shift from road-based to electrified rail transport, reducing vehicle emissions of PM_{10}, NO_2, benzene, and benzo(a)pyrene. However, there may be short-term, localised negative impacts on air quality as a result of maintenance activities, which should be mitigated through the development and implementation of an Operations Phase Dust and Air Quality Management Plan.

Regular and on-demand air quality monitoring will be required throughout the construction and operations phases of the Project to ensure that the mitigation measures being implemented by the construction contractor and SRI to prevent or limit potentially significant negative impacts are adequate and effective. Where monitoring indicates that negative impacts are occurring despite the requirements of Management Plans being met, additional mitigation measures may be required, and Management Plans revised accordingly to safeguard human and ecological health across the Project area.

Integrating regular air quality monitoring undertaken by SEPA into the project monitoring framework will ensure compliance with Serbian environmental policies and enhance the effectiveness of mitigation measures. The use of SEPA monitoring stations along the Paraćin–Niš route will strengthen data reliability, support informed decision-making, and contribute to maintaining air quality standards throughout the project lifecycle.

7. LITERATURE

Abbasi, S., Jansson, A., Sellgren, U., & Olofsson, U. (2013). Particle emissions from rail traffic: A literature review. Critical reviews in environmental science and technology, 43(23), 2511-2544.

Azarmi, F., Kumar, P., Marsh, D., & Fuller, G. (2016). Assessment of the long-term impacts of PM 10 and PM 2.5 particles from construction works on surrounding areas. Environmental Science: Processes & Impacts, 18(2), 208-221

Buonaurio, F., Borra, F., Pigini, D., Paci, E., Spagnoli, M., Astolfi, M. L., ... & Tranfo, G. (2022). Biomonitoring of exposure to urban pollutants and oxidative stress during the COVID-19 lockdown in Rome residents. Toxics, 10(5), 267.

da Fonseca-Soares, D., Eliziário, S. A., Galvincio, J. D., & Ramos-Ridao, A. F. (2024). Greenhouse gas emissions in railways: Systematic review of research progress. Buildings, 14(2), 539.

Giunta, M. (2020). Assessment of the impact of CO, NOx and PM10 on air quality during road construction and operation phases. Sustainability, 12(24), 10549.

Etyemezian, V., Ahonen, S., Nikolic, D., Gillies, J., Kuhns, H., Gillette, D., & Veranth, J. (2004). Deposition and removal of fugitive dust in the arid southwestern United States: measurements and model results. Journal of the Air & Waste Management Association, 54(9), 1099-1111.

Schiavo, B., Morton-Bermea, O., Arredondo-Palacios, T. E., Meza-Figueroa, D., Robles-Morua, A., García-Martínez, R., ... & Gonzalez-Grijalva, B. (2022). Analysis of COVID-19 Lockdown Effects on Urban Air Quality: A Case Study of Monterrey, Mexico. *Sustainability*, *15*(1), 642.

Sharma, A., Massey, D. D., & Taneja, A. (2009). Horizontal gradients of traffic related air pollutants near a major highway in Agra, India. *92.60. Sz*.

Srogi, K. (2007). Monitoring of environmental exposure to polycyclic aromatic hydrocarbons: a review. Environmental chemistry letters, 5, 169-195.

Valerio, F., Stella, A., Pala, M., Balducci, D., Piccardo, M. T., & Cipolla, M. (2009). The effect of EURO-0 vehicle substitution on polycyclic aromatic hydrocarbon and carbon monoxide concentrations in an urban area. *Atmospheric Environment*, *43*(8), 1520-1526.

Wang, B. Z., Zhu, Z. H., Yang, E., Chen, Z., & Wang, X. H. (2018). Assessment and management of air emissions and environmental impacts from the construction industry. Journal of environmental planning and management, 61(14), 2421-2444

Zhao, J., Shao, S., Ni, D., Shang, X., Liu, X., Zhang, Q., & Yu, X. (2020). Analysis of the impact of road construction dust on glacier environment. In E3S Web of Conferences (Vol. 145, p. 02048). EDP Sciences.

8. APPENDIX

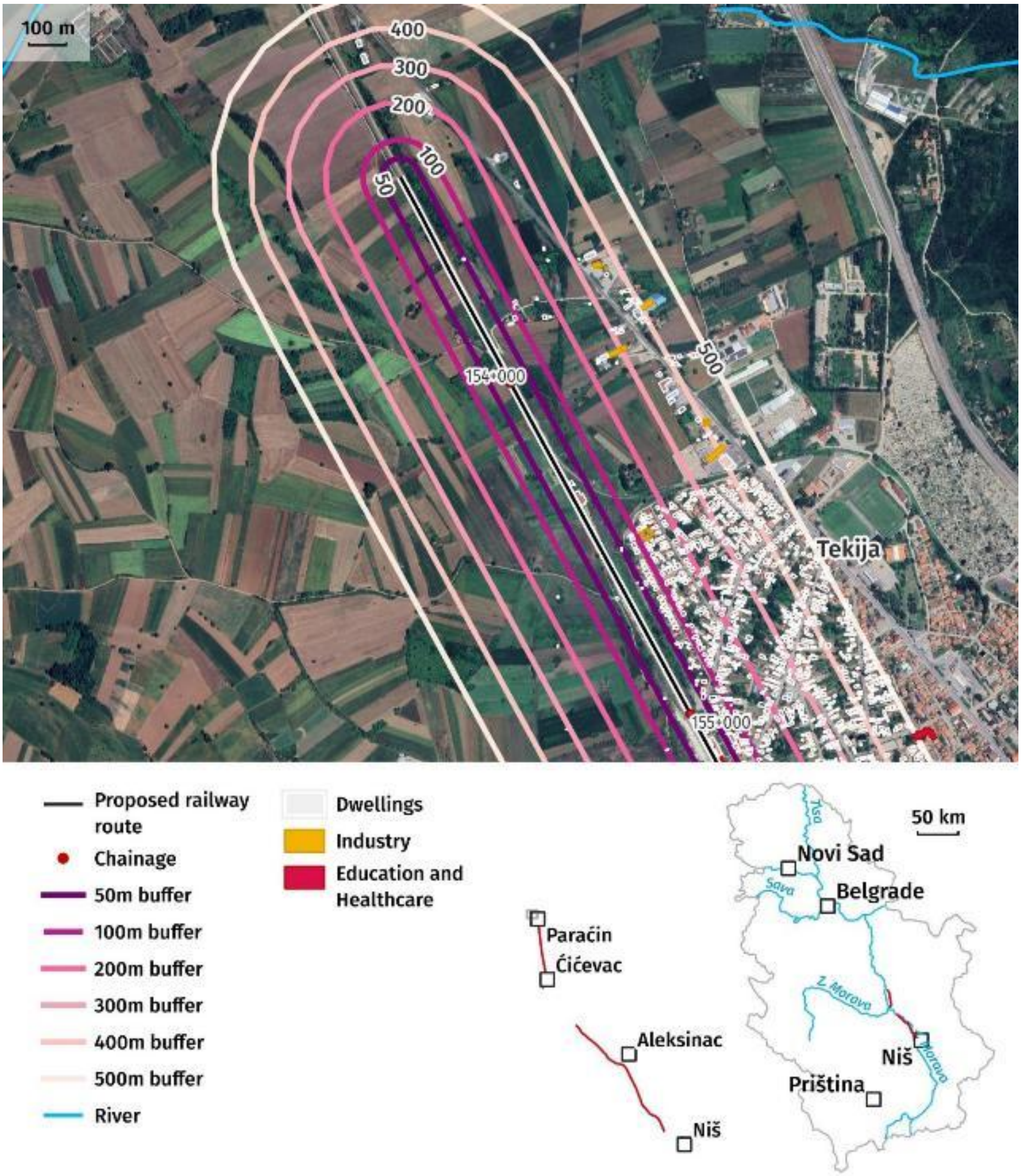


Figure 8-1. The distribution of human receptors in sensitive zone Paraćin (a)

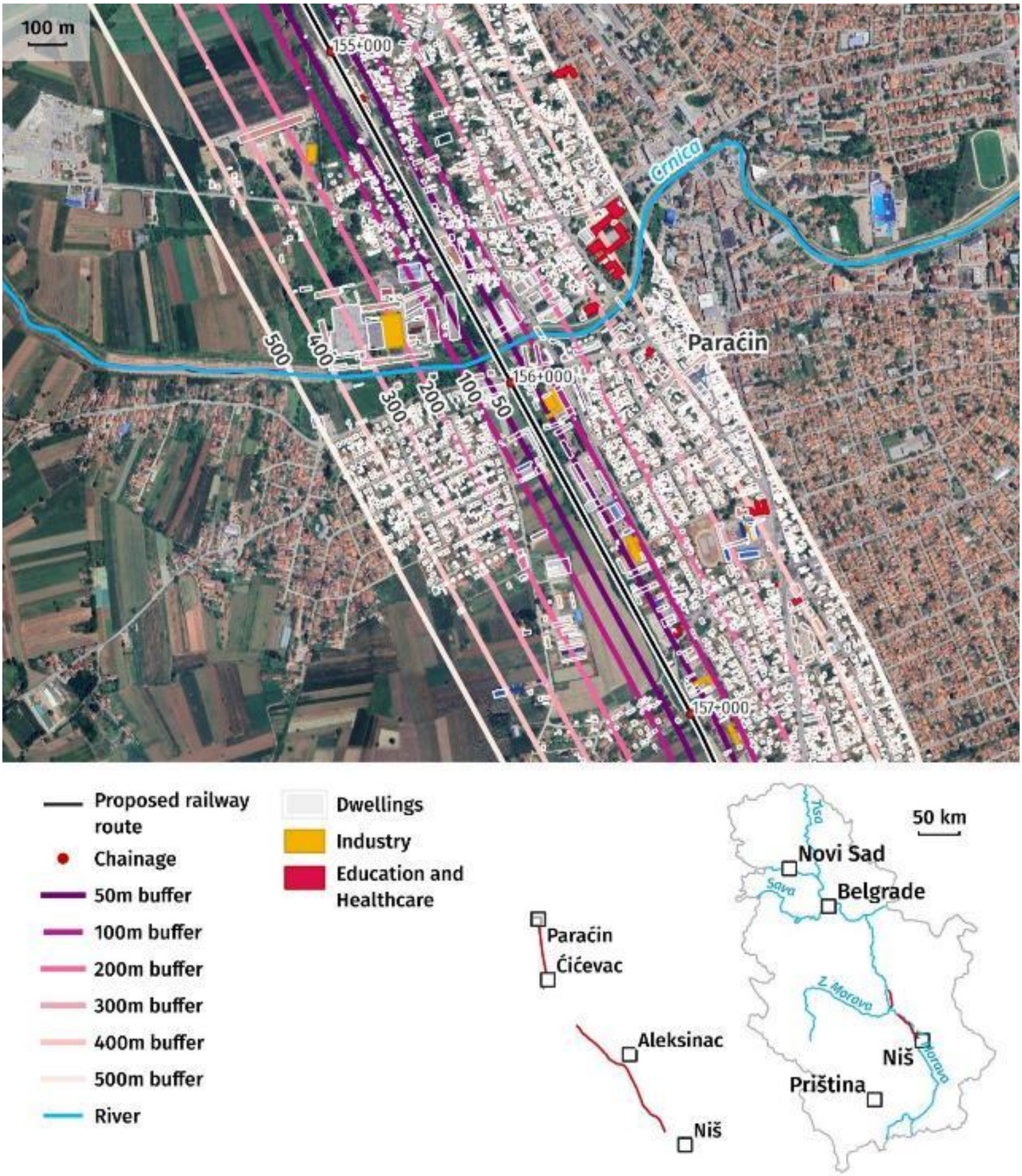


Figure 8-2. The distribution of human receptors in sensitive zone Paraćin (b)

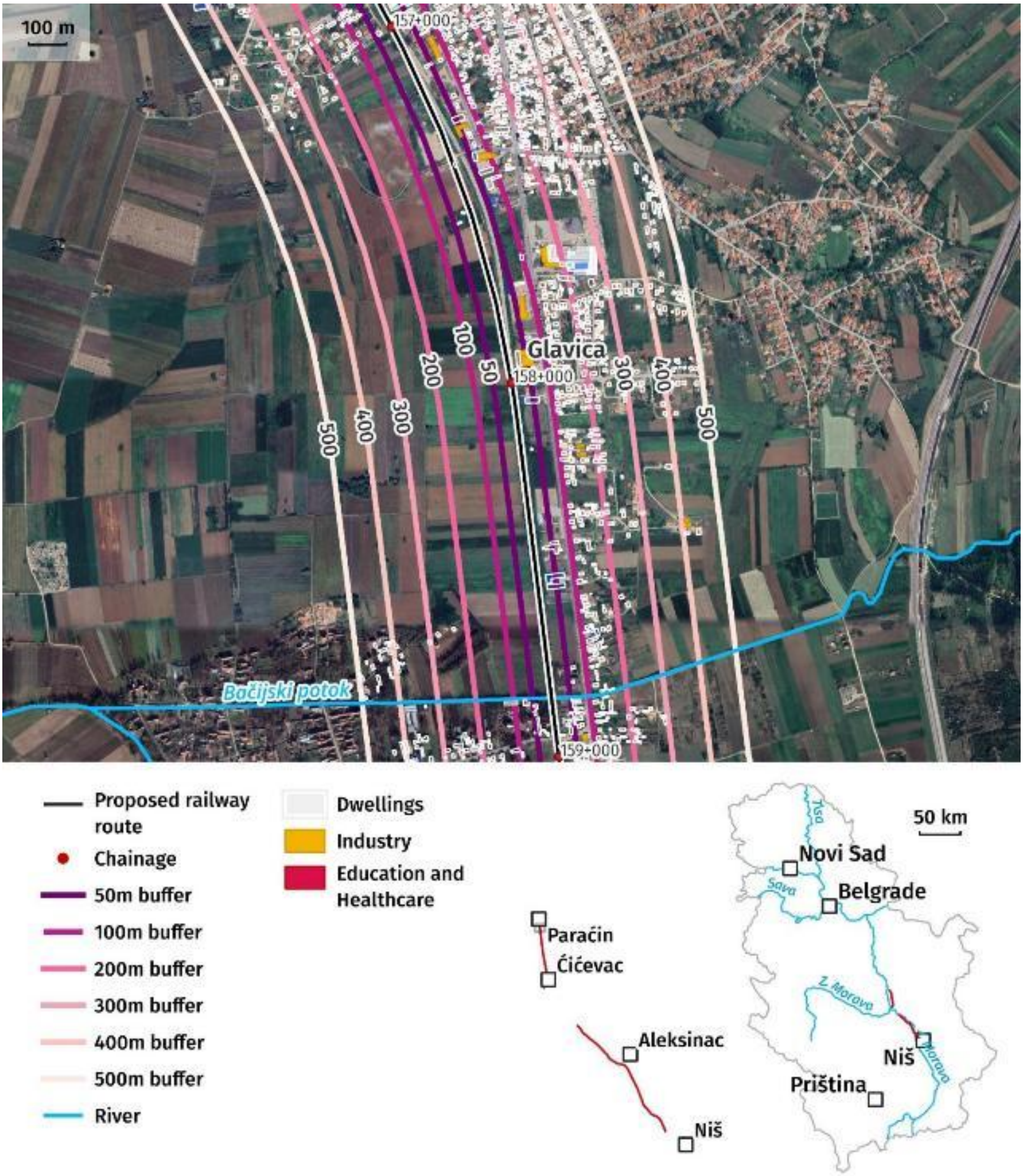


Figure 8-3. The distribution of human receptors in sensitive zone Paraćin (c)

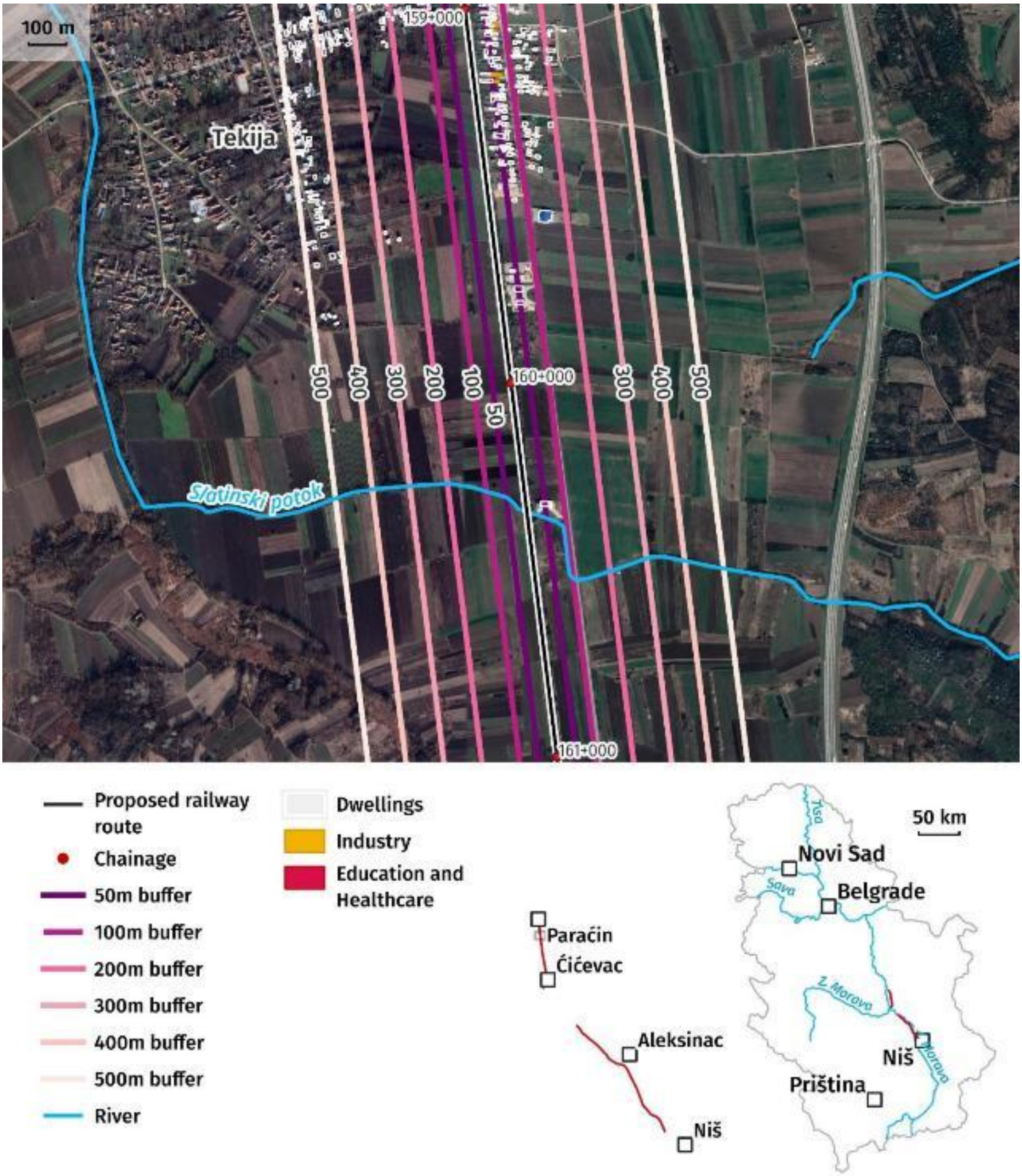


Figure 8-4. The distribution of human receptors in sensitive zone Paraćin (d)

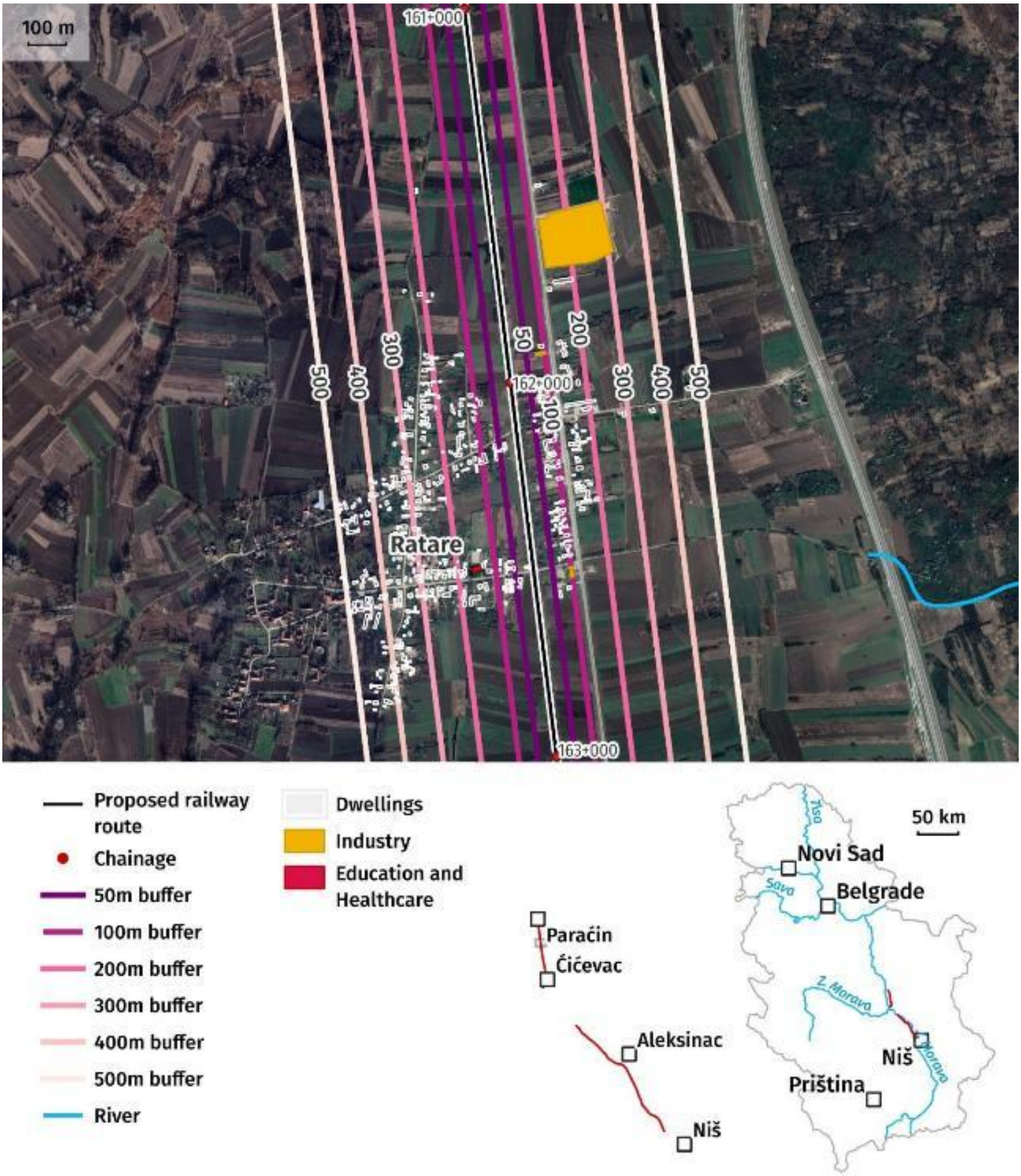


Figure 8-5. The distribution of human receptors in sensitive zone Ratare

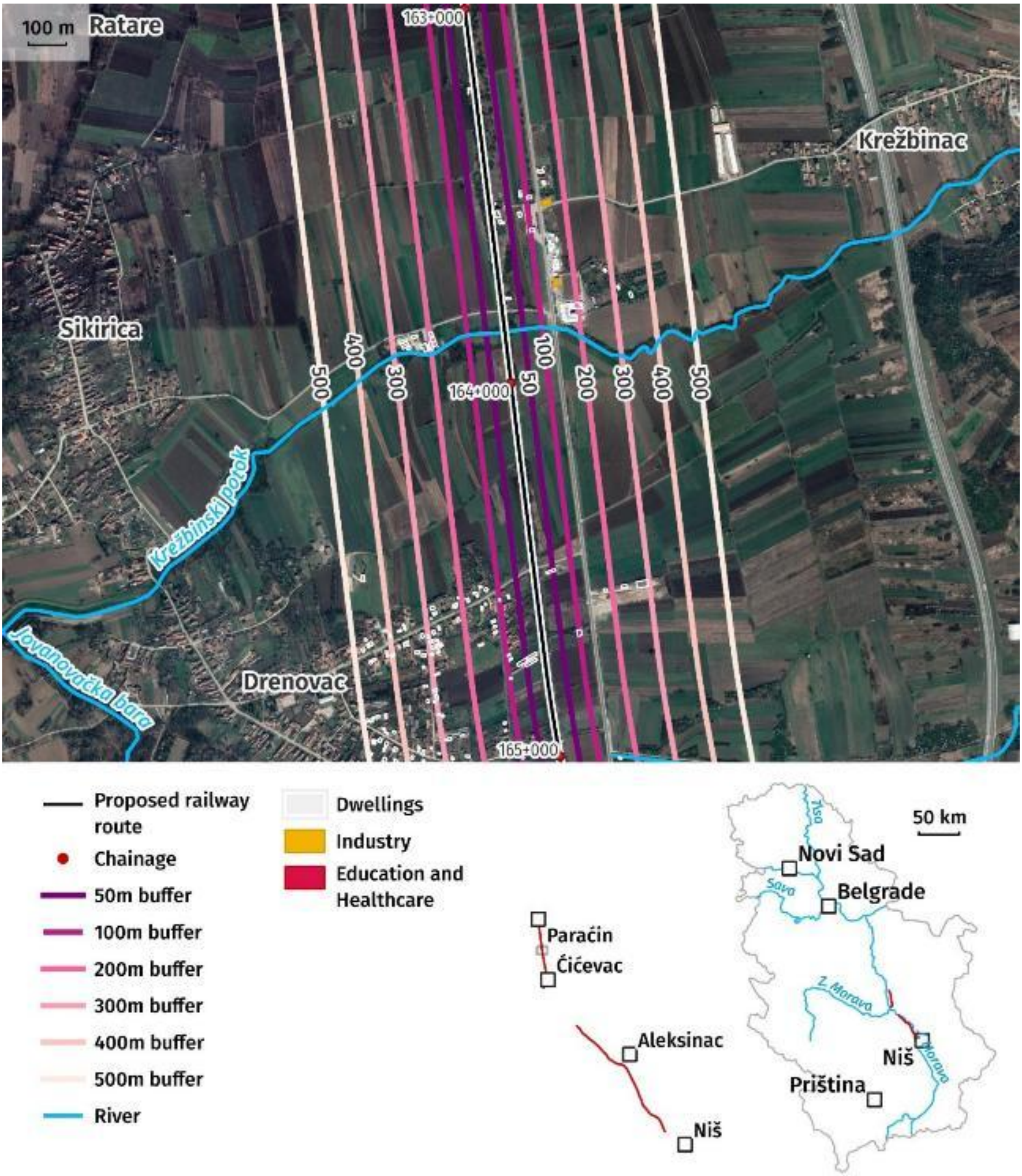


Figure 8-6. The distribution of human receptors in sensitive zone Sikirica

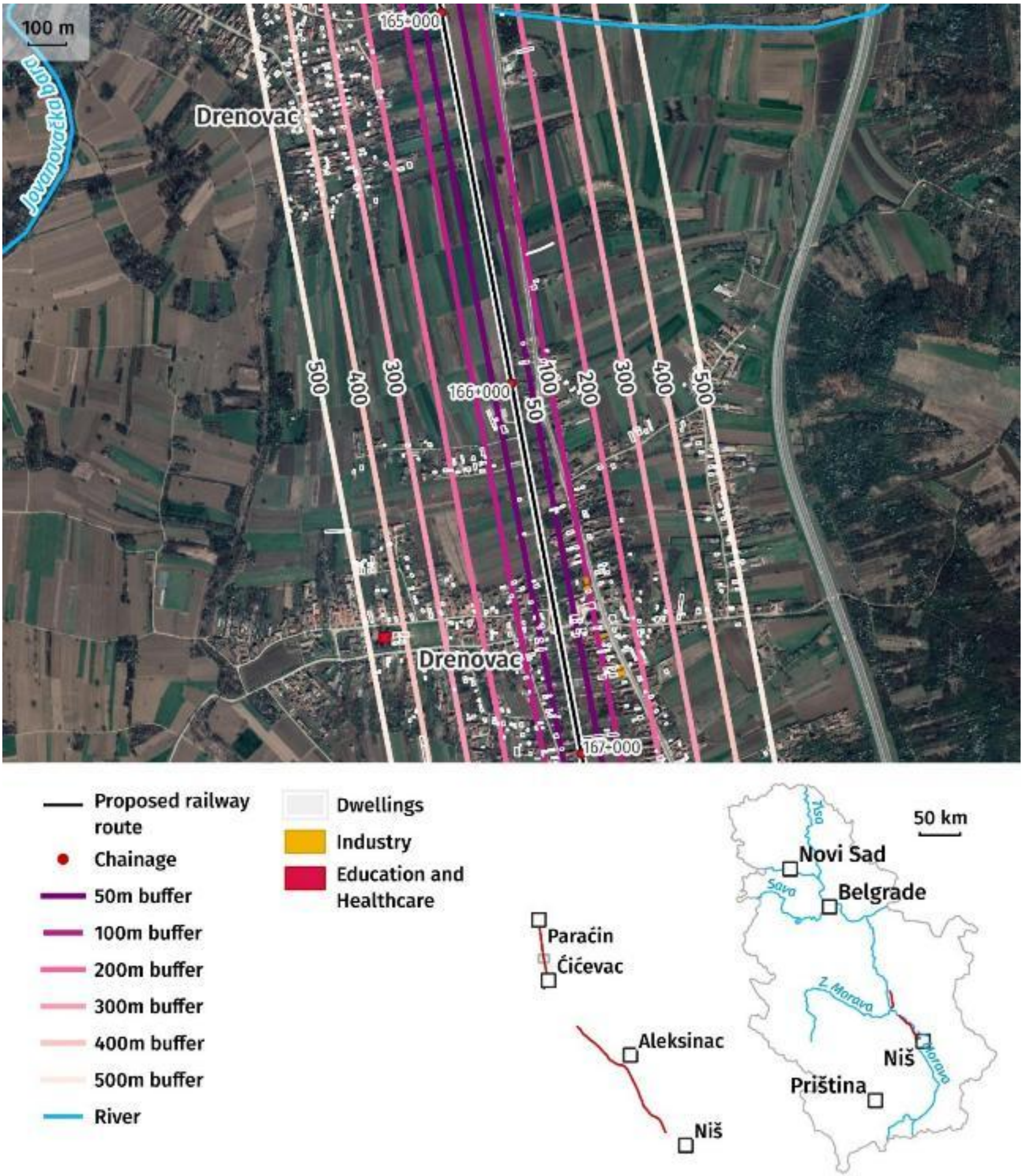


Figure 8-7. The distribution of human receptors in sensitive zone Drenovac (a)

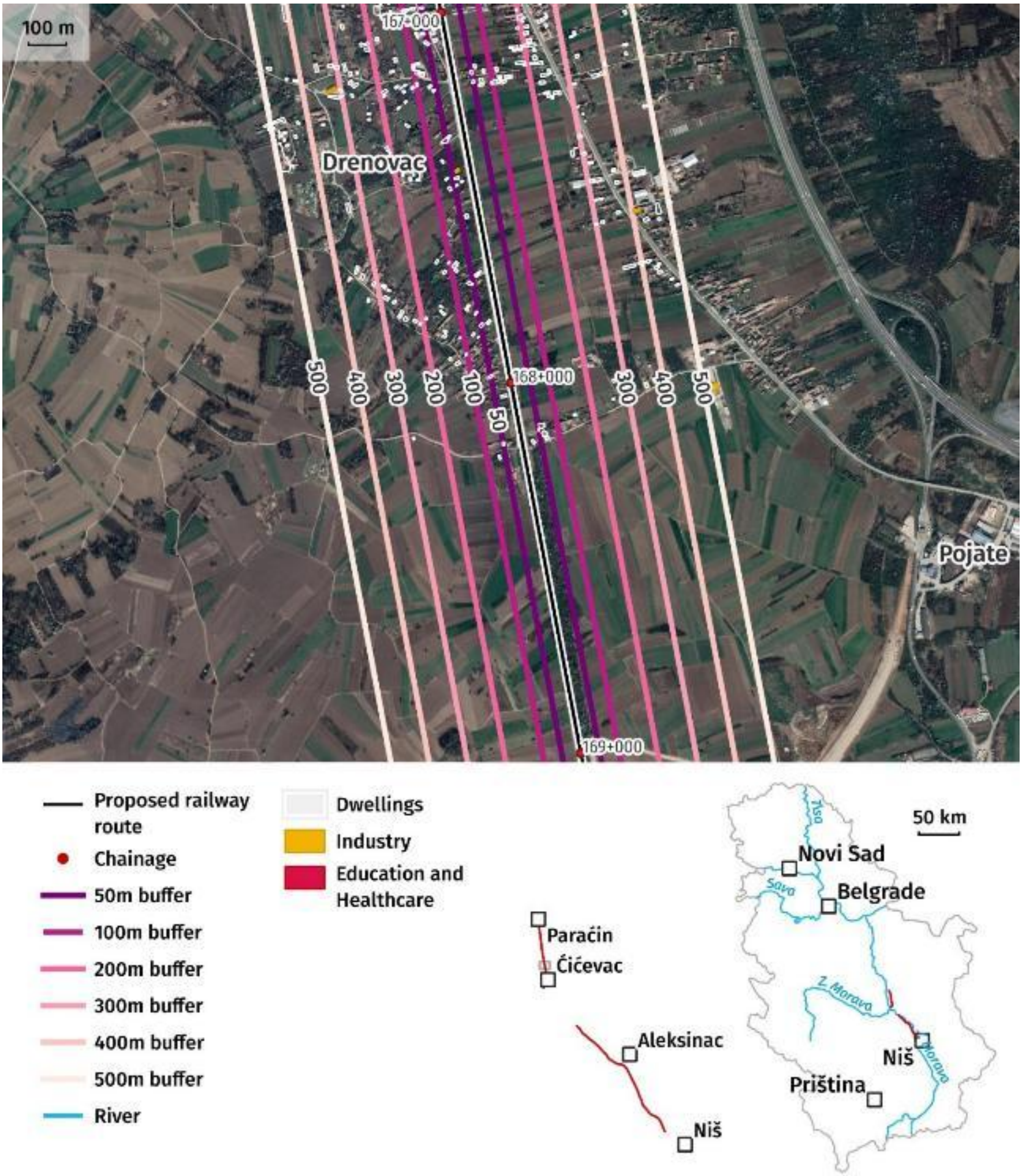


Figure 8-8. The distribution of human receptors in sensitive zone Drenovac (b)

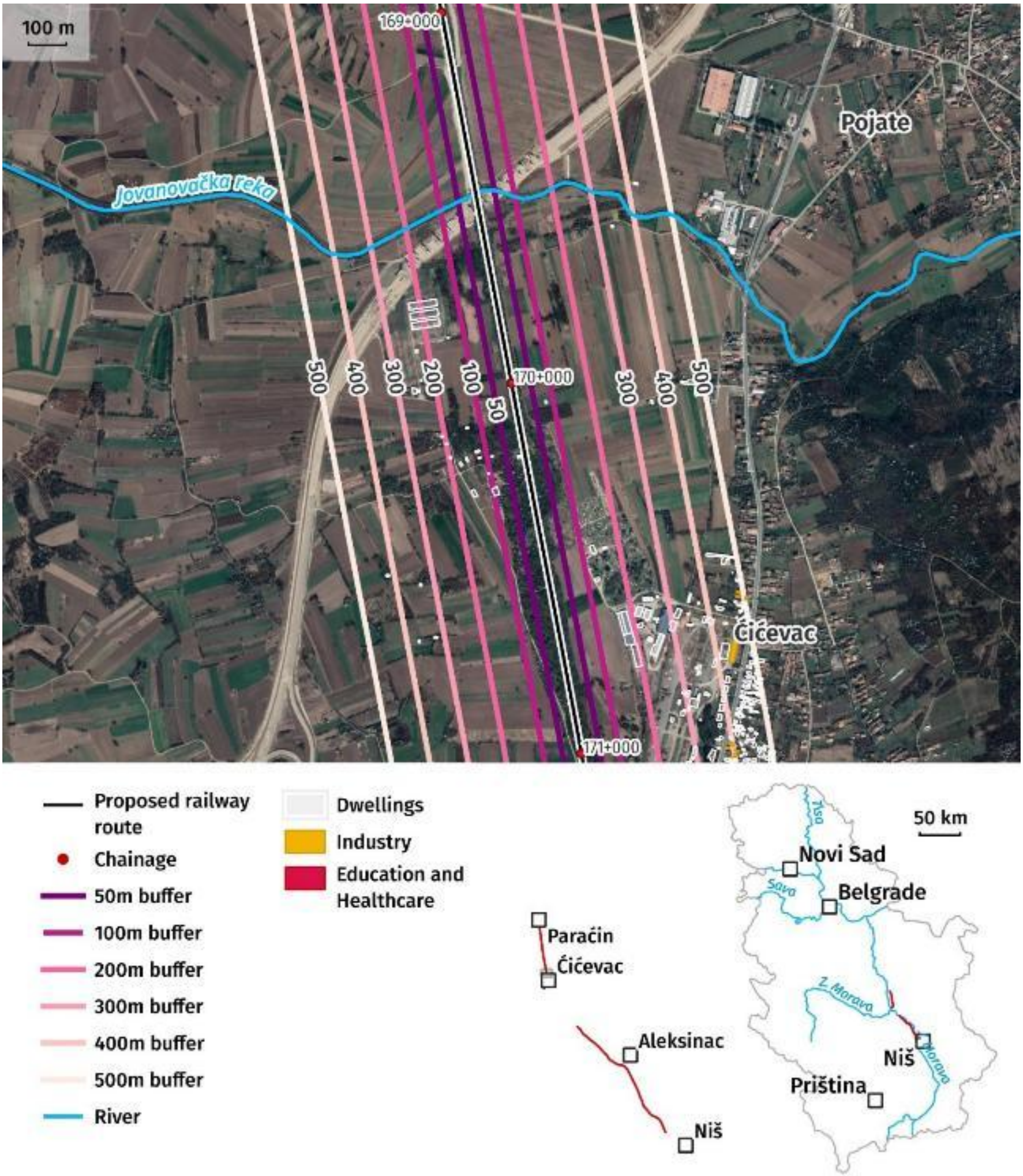


Figure 8-9. The distribution of human receptors in sensitive zone Ćićevac (a)

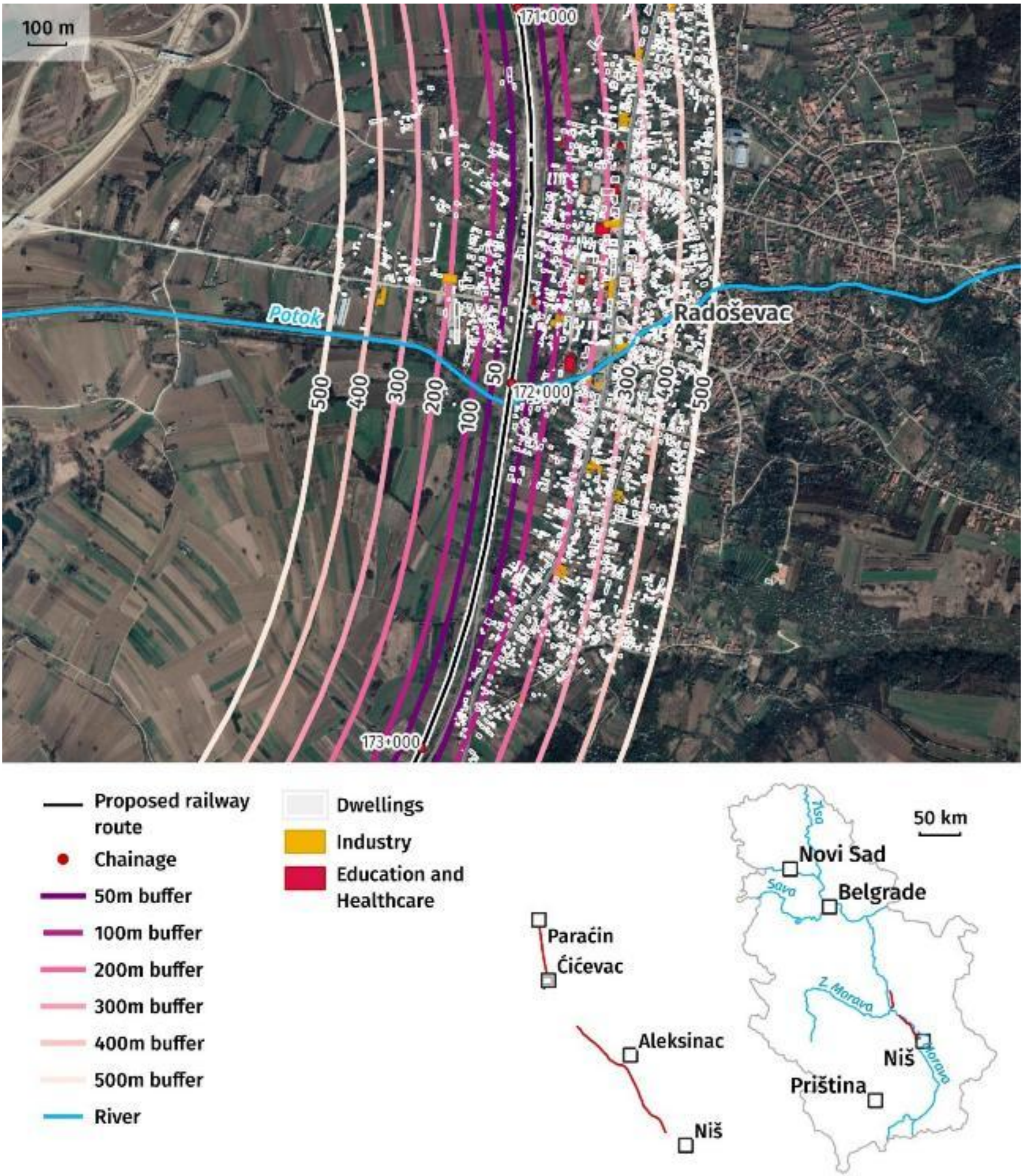


Figure 8-10. The distribution of human receptors in sensitive zone Ćićevac (b)

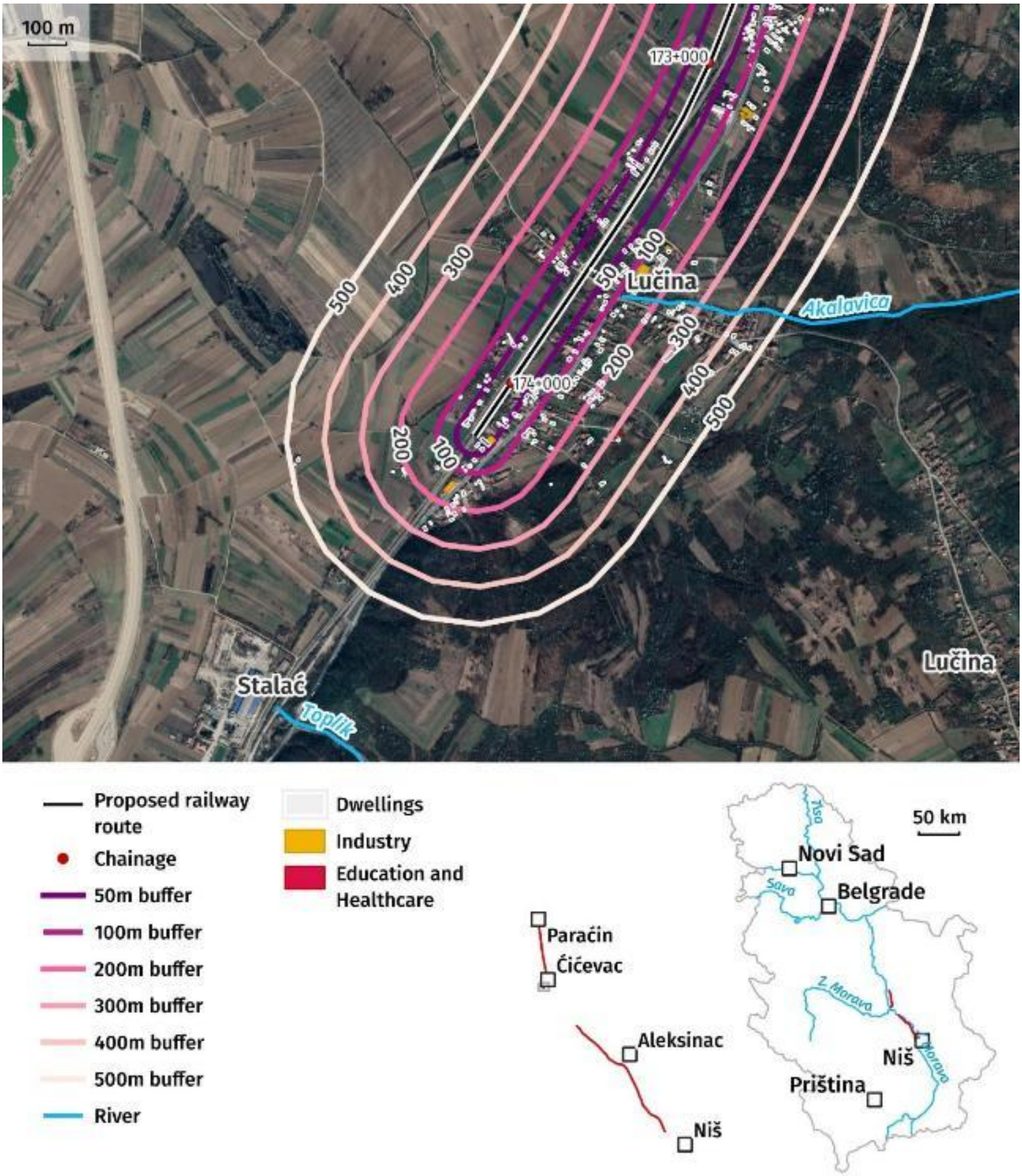


Figure 8-11. The distribution of human receptors in sensitive zone Ćićevac (c)

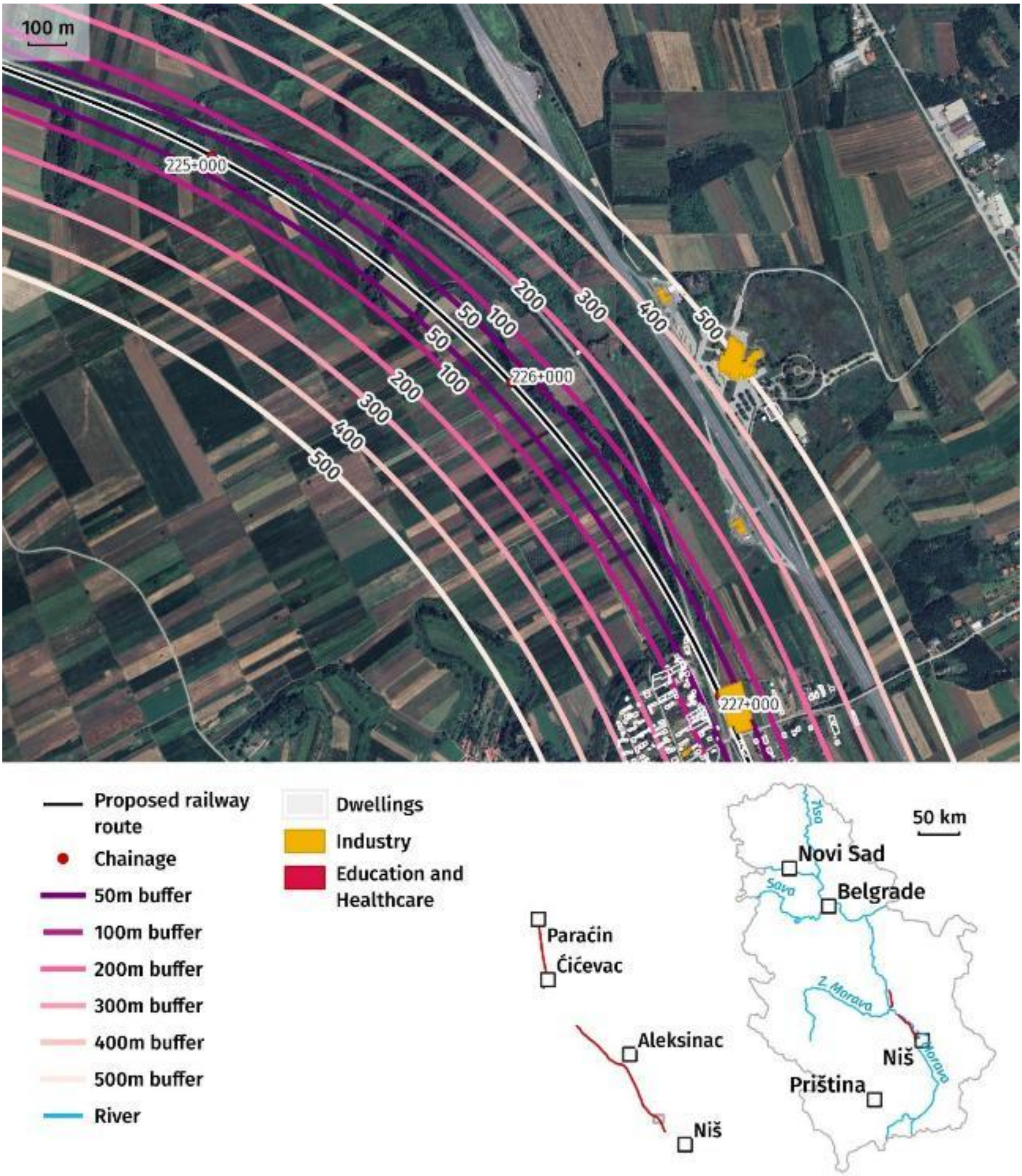


Figure 8-12. The distribution of human receptors in sensitive zone Vitkovac (a)

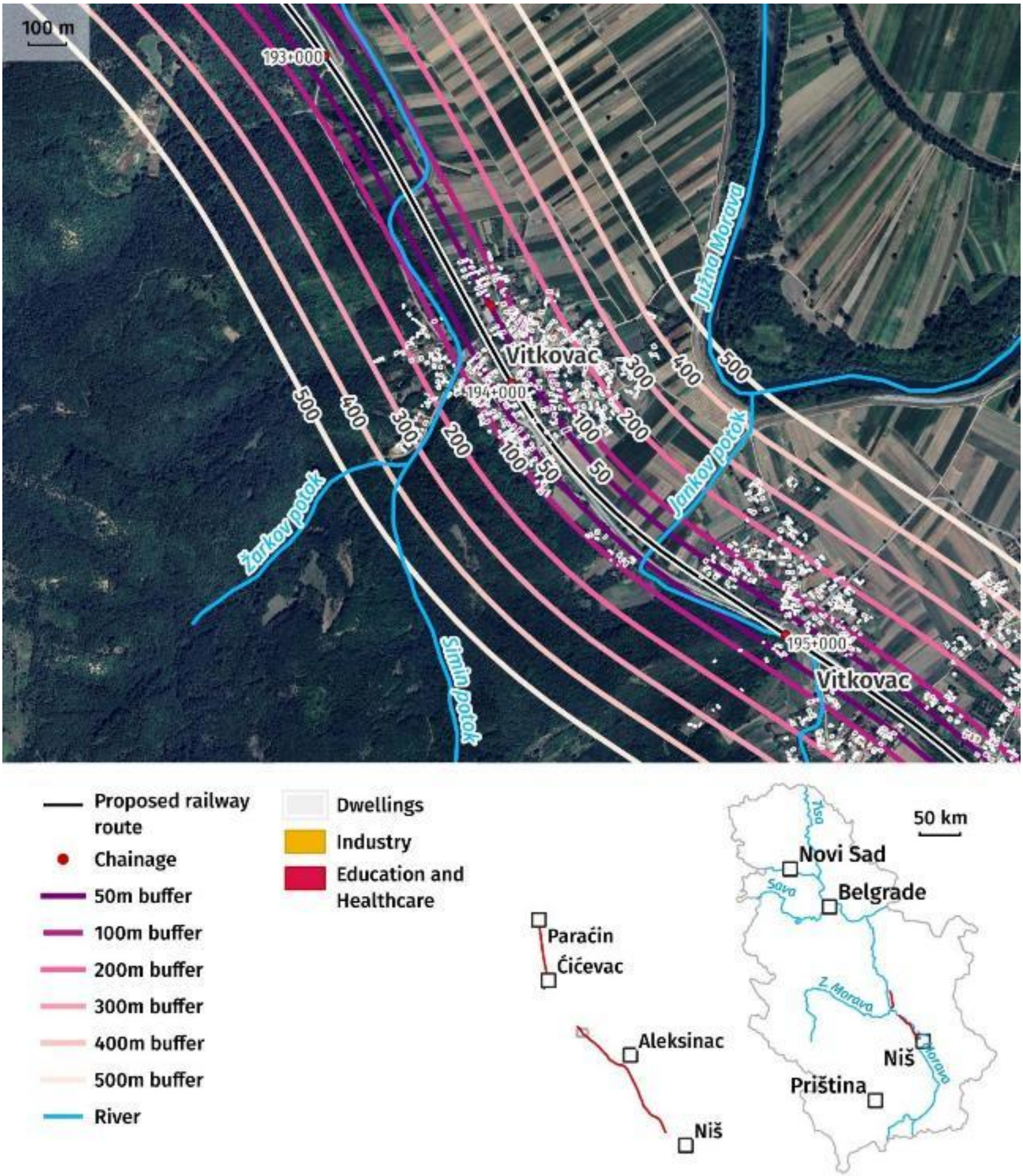


Figure 8-13. The distribution of human receptors in sensitive zone Vitkovac (b)

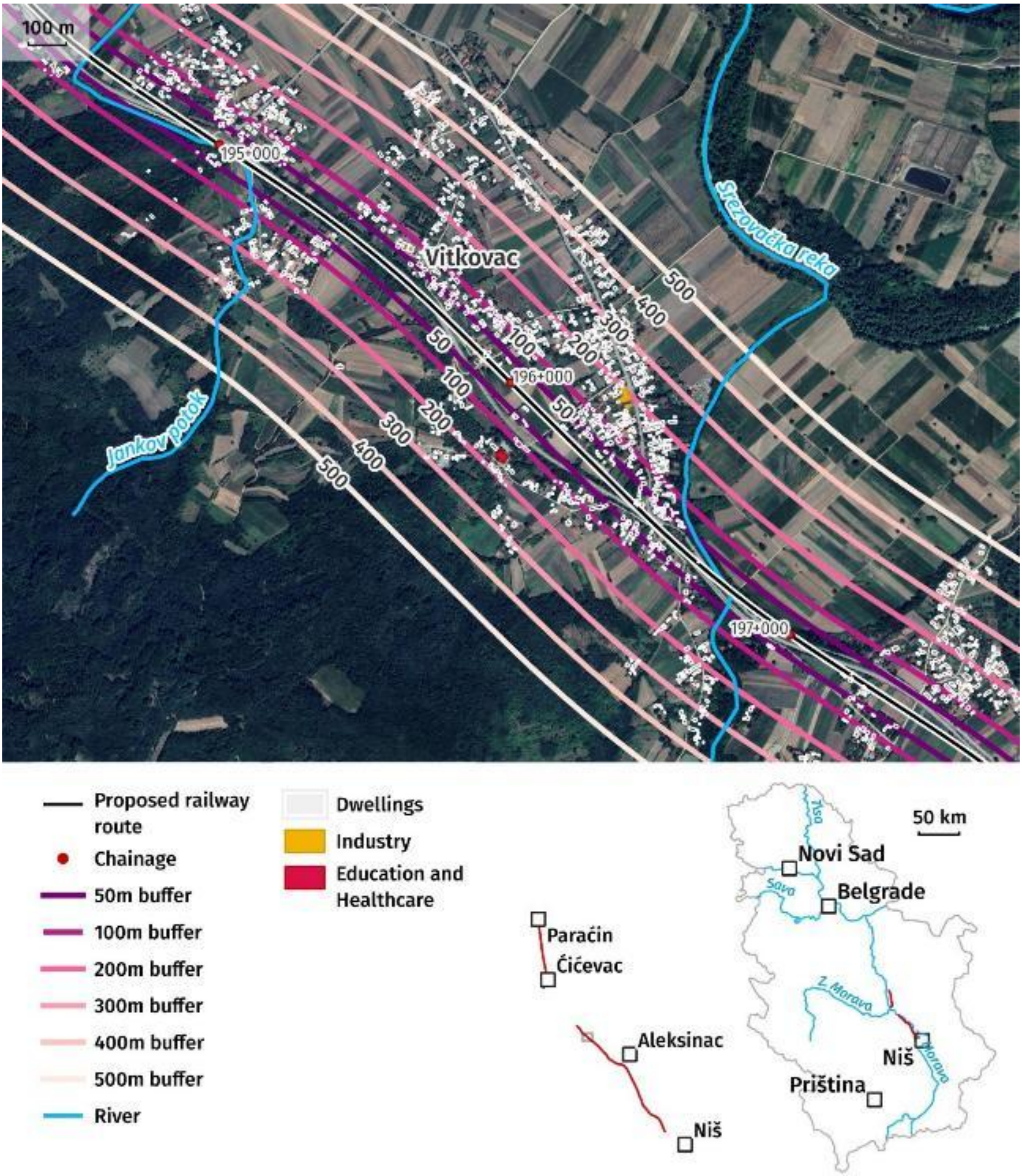


Figure 8-14. The distribution of human receptors in sensitive zone Vitkovac (c)

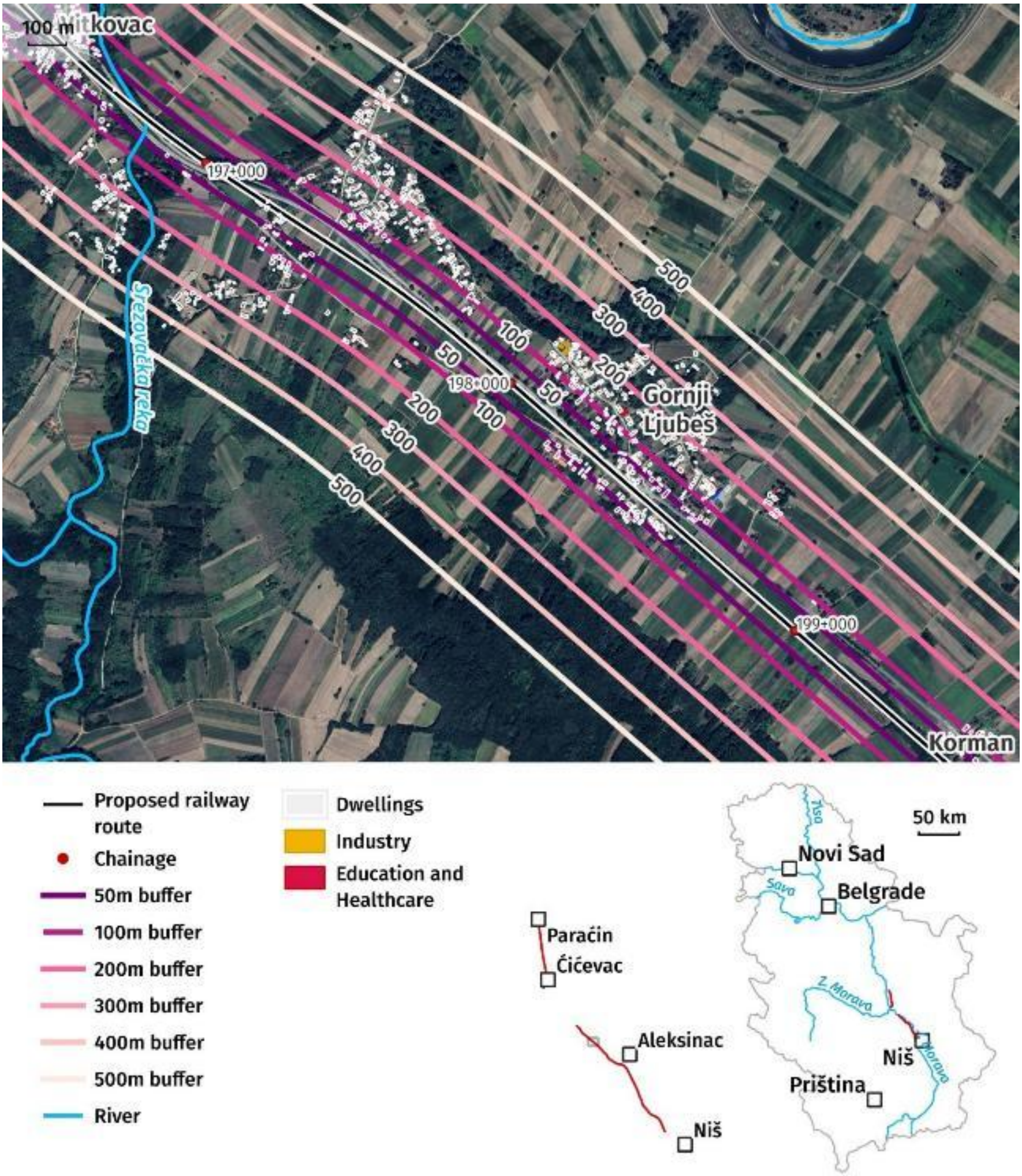


Figure 8-15. The distribution of human receptors in sensitive zone Gornji Ljubeš

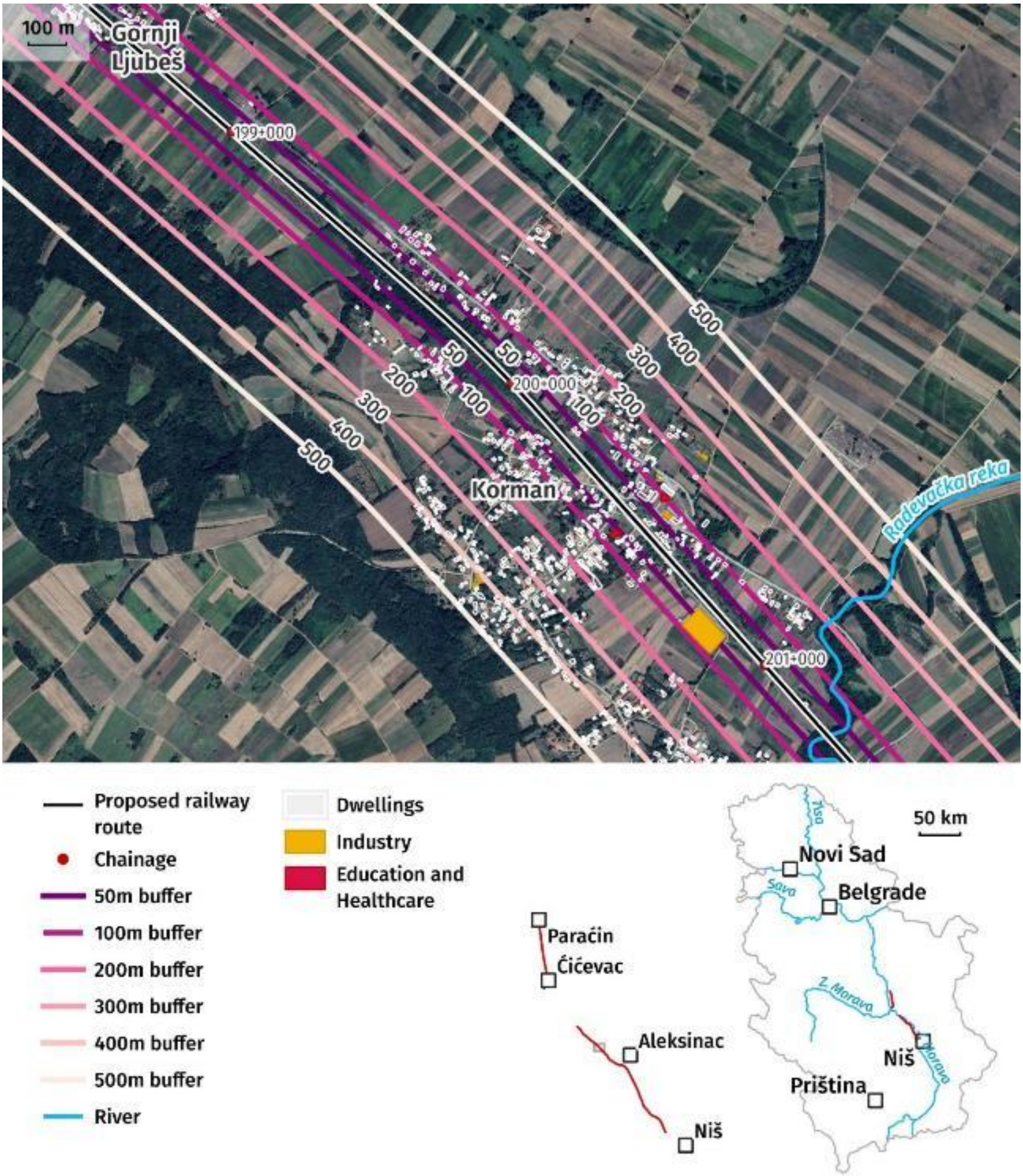


Figure 8-16. The distribution of human receptors in sensitive zone Korman

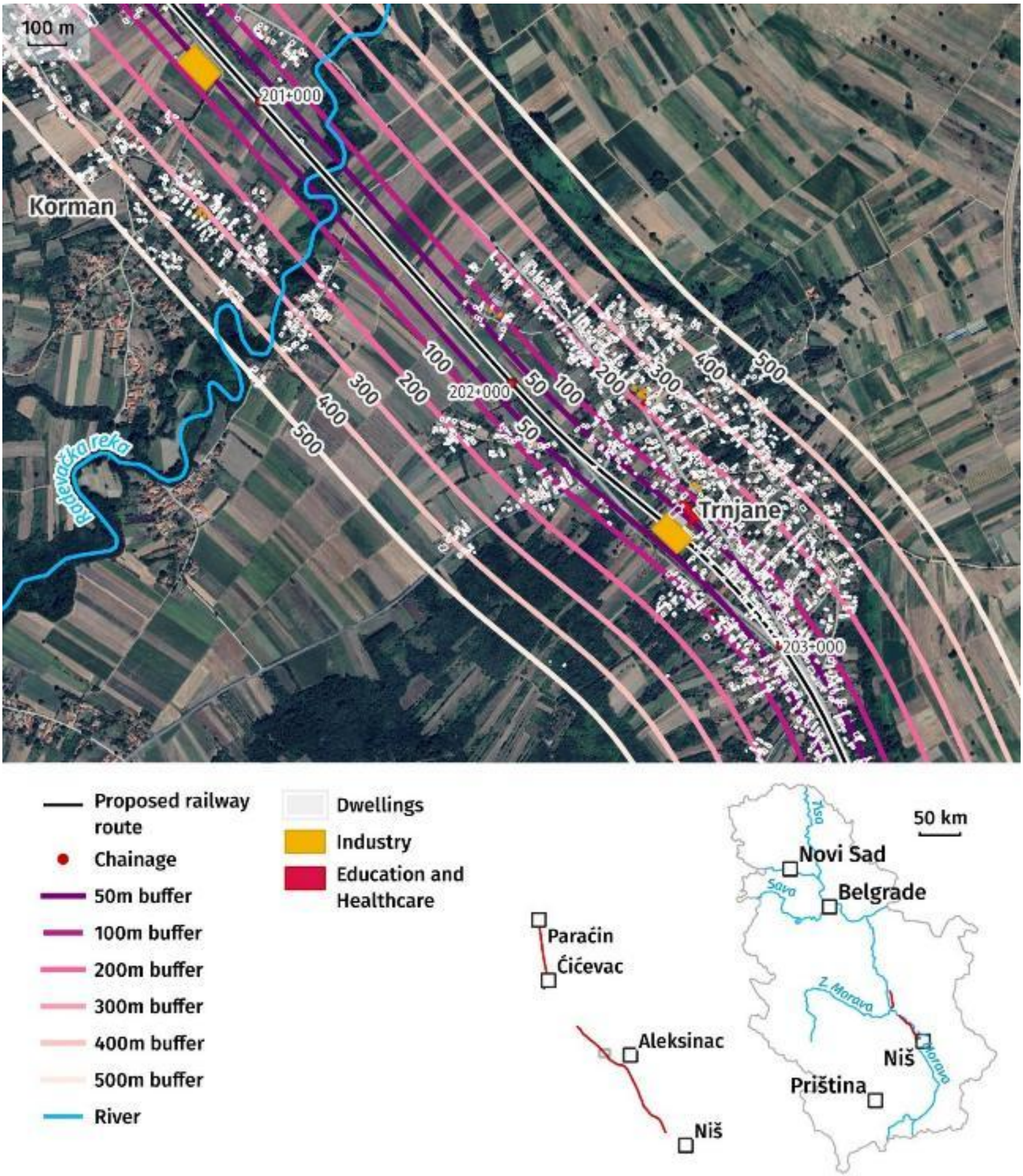


Figure 8-17. The distribution of human receptors in sensitive zone Trnjane (a)

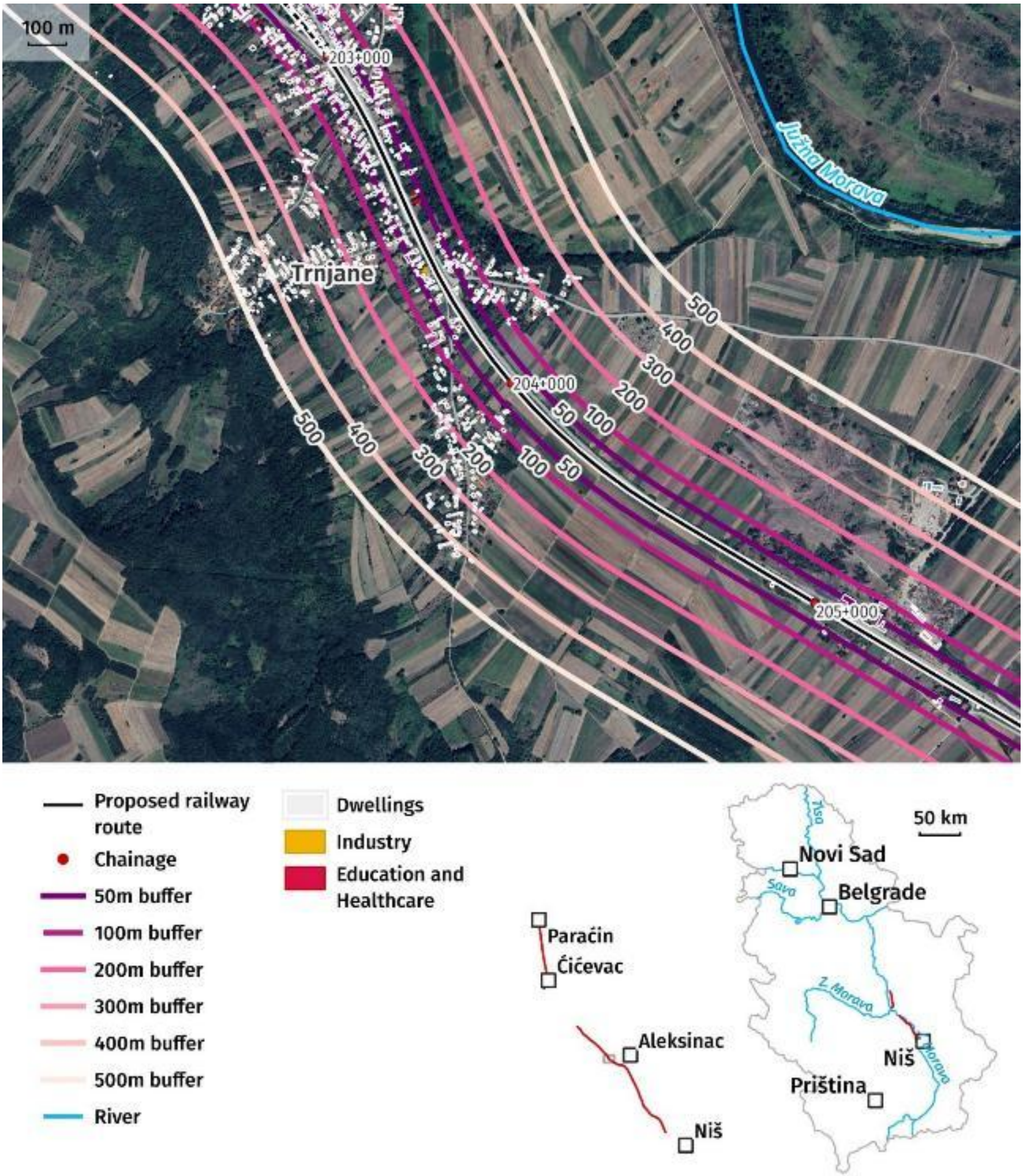


Figure 8-18. The distribution of human receptors in sensitive zone Trnjane (b)

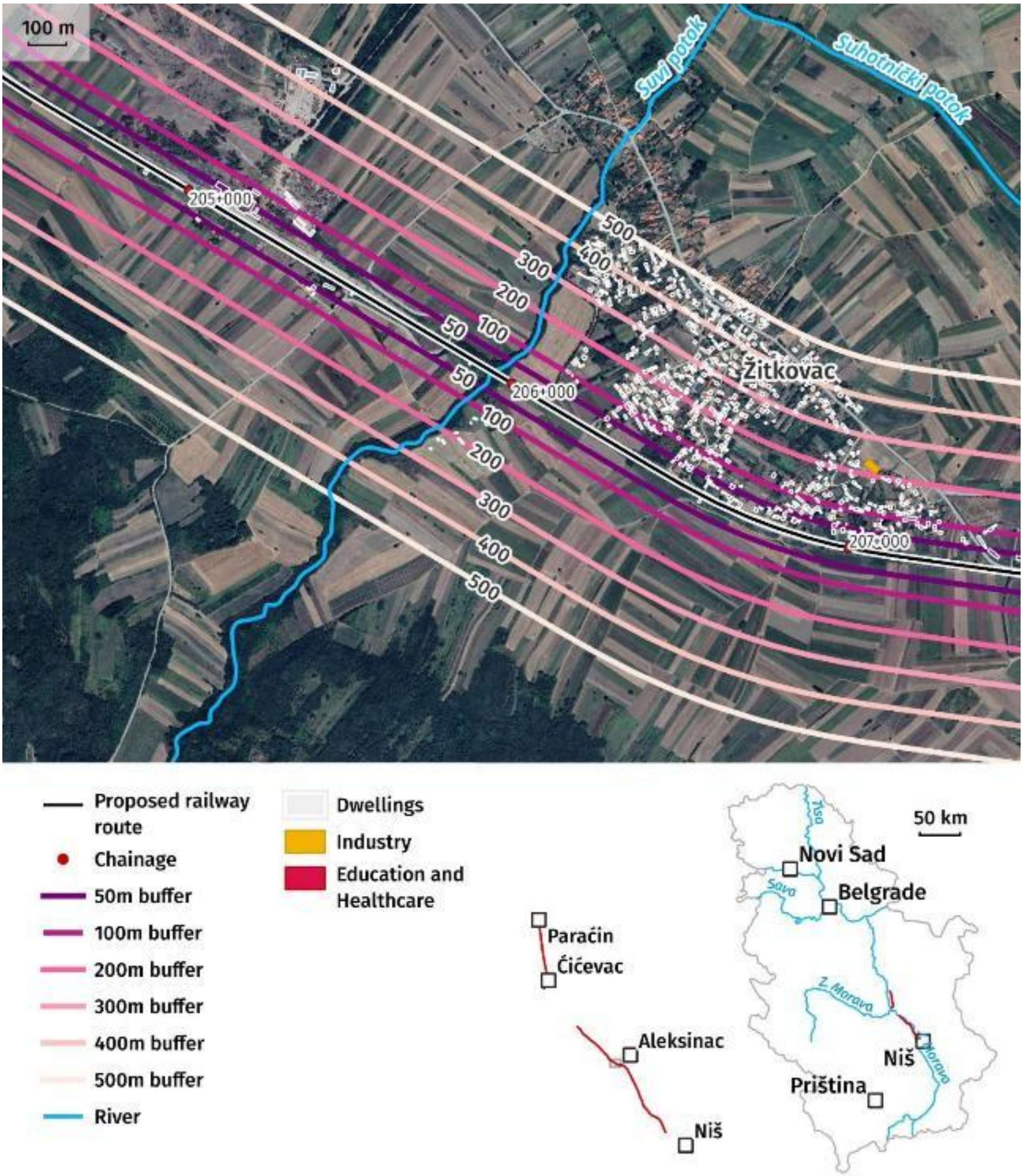


Figure 8-19. The distribution of human receptors in sensitive zone Žitkovac

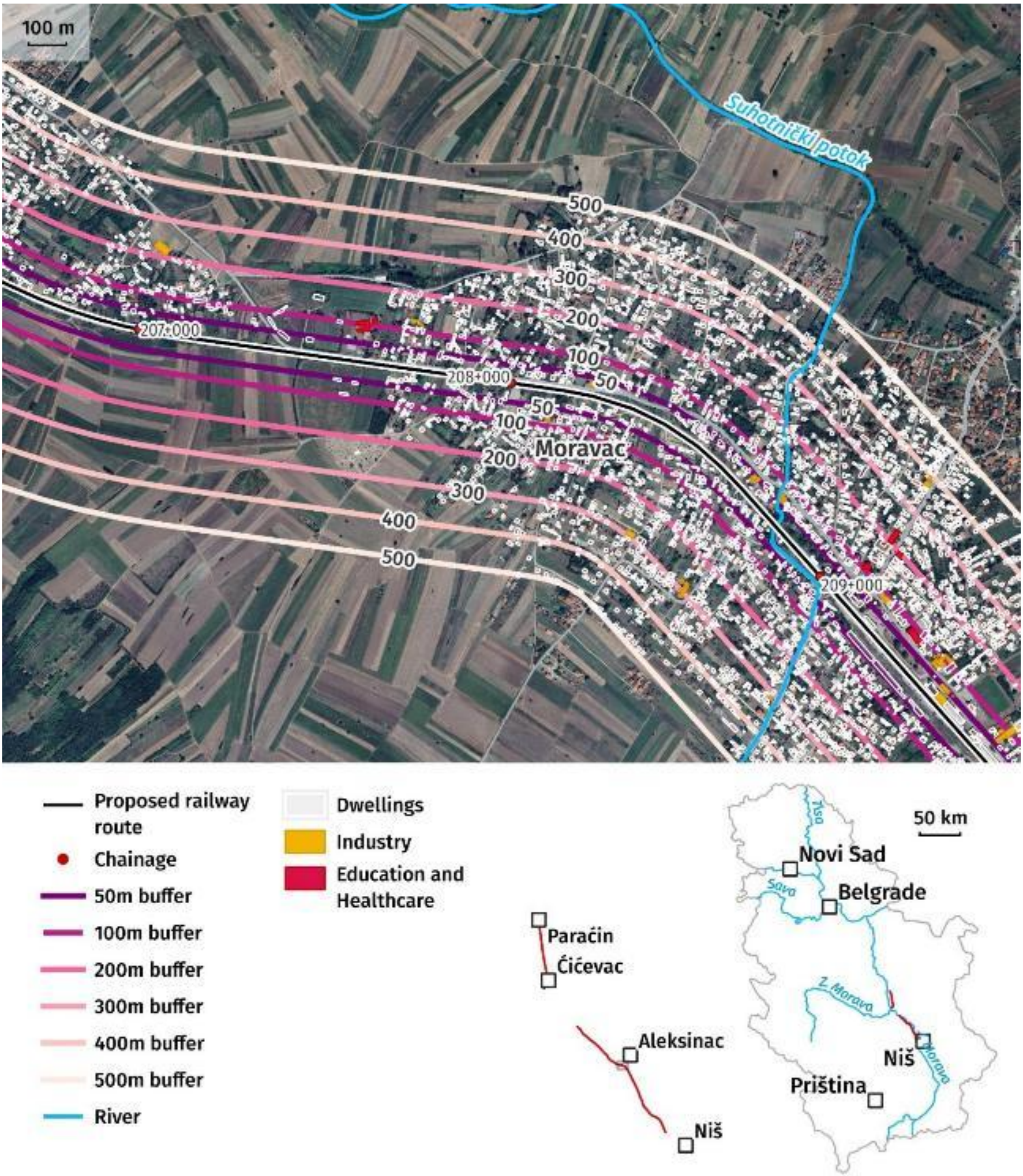


Figure 8-20. The distribution of human receptors in sensitive zone Moravac (a)

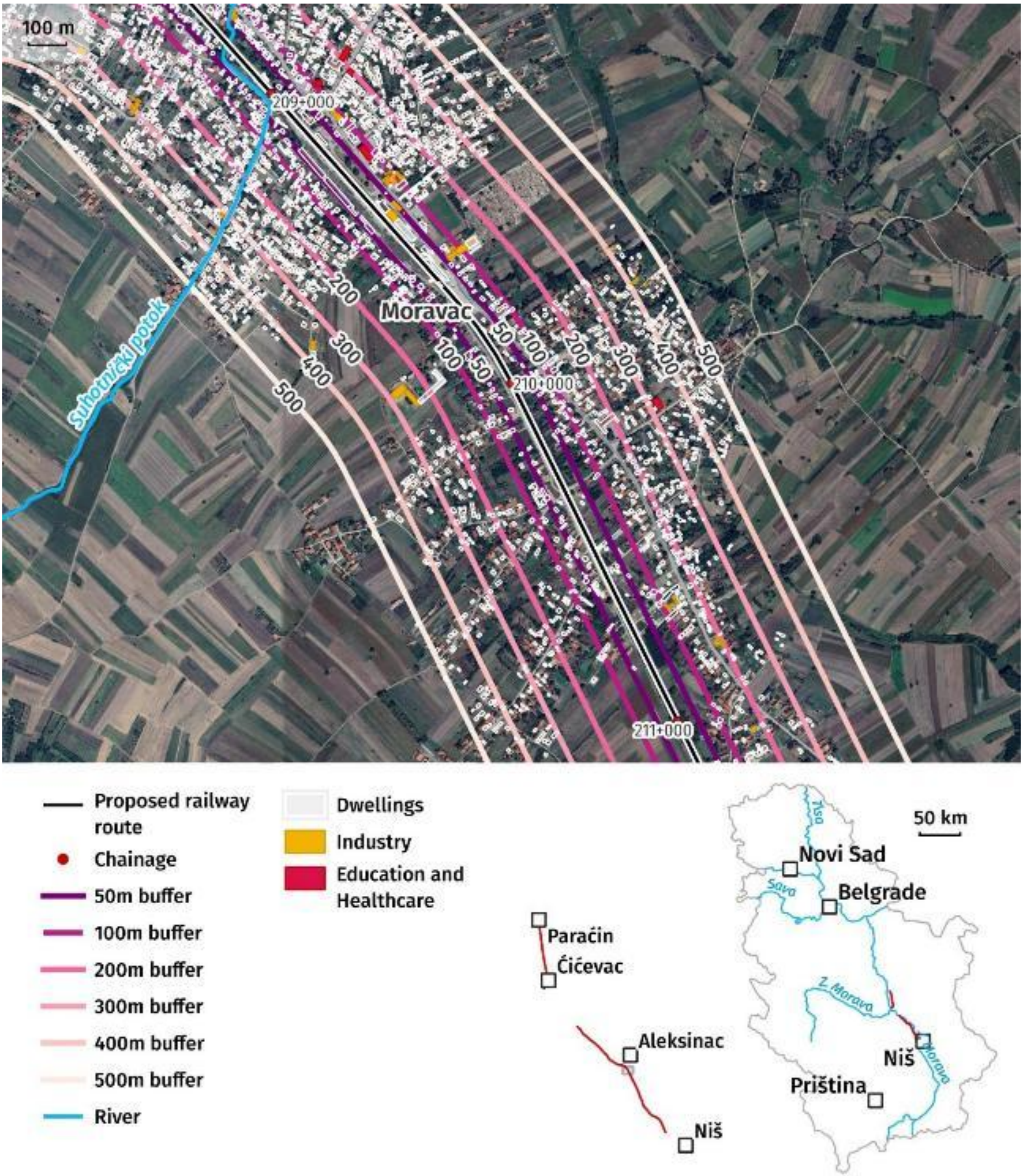


Figure 8-21. The distribution of human receptors in sensitive zone Moravac (b)

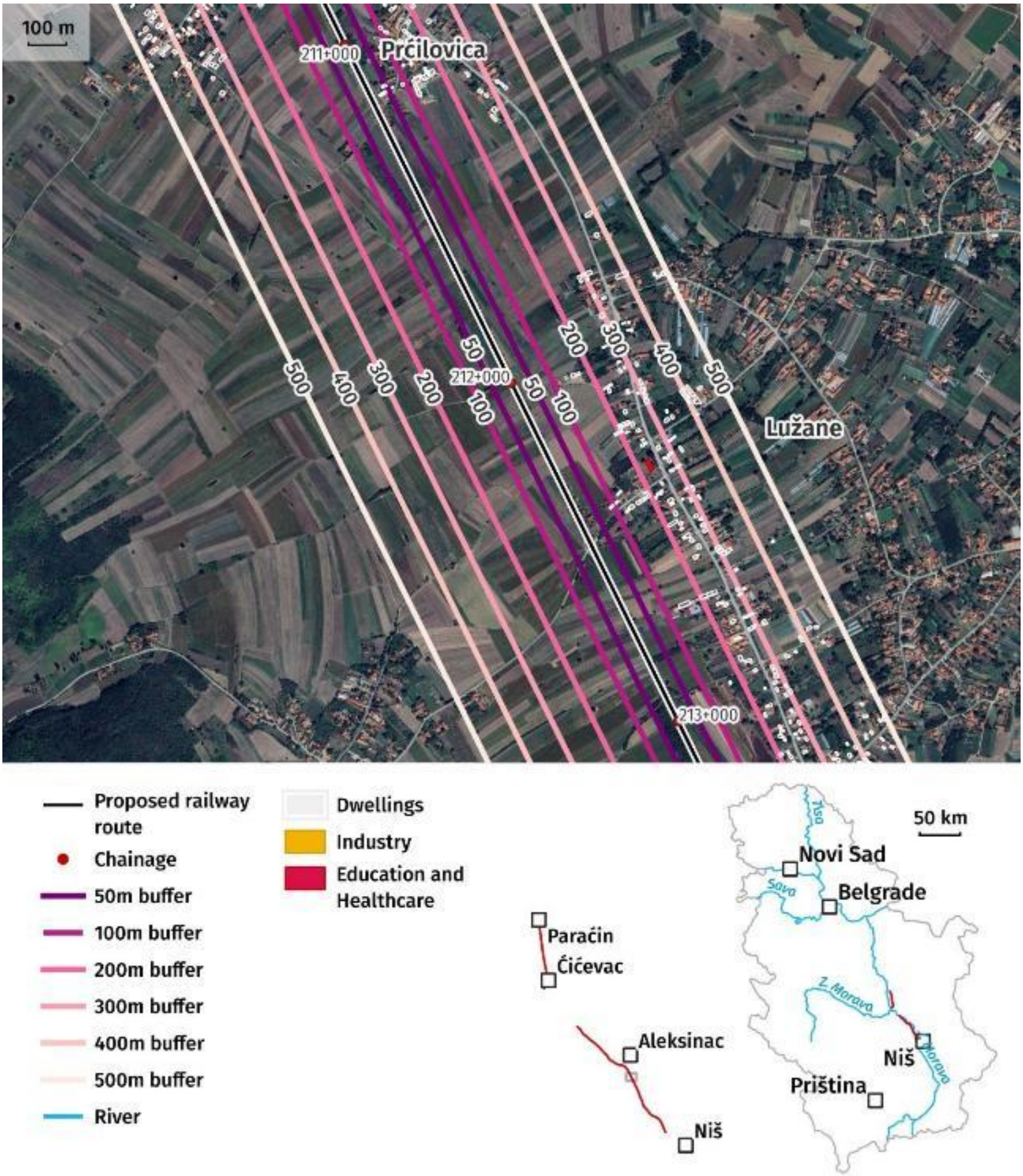


Figure 8-22. The distribution of human receptors in sensitive zone Prćilovica

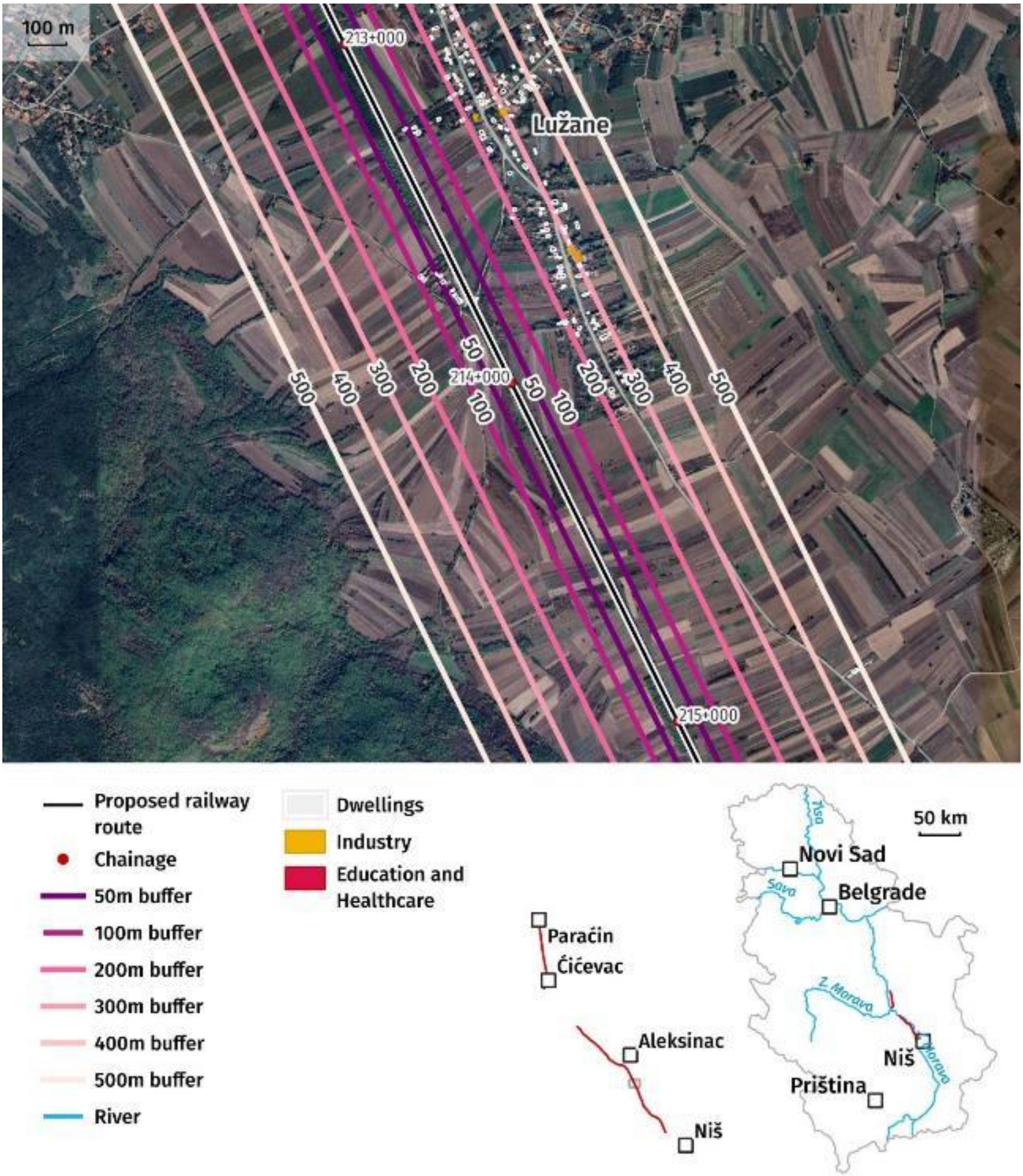


Figure 8-23. The distribution of human receptors in sensitive zone Lužane

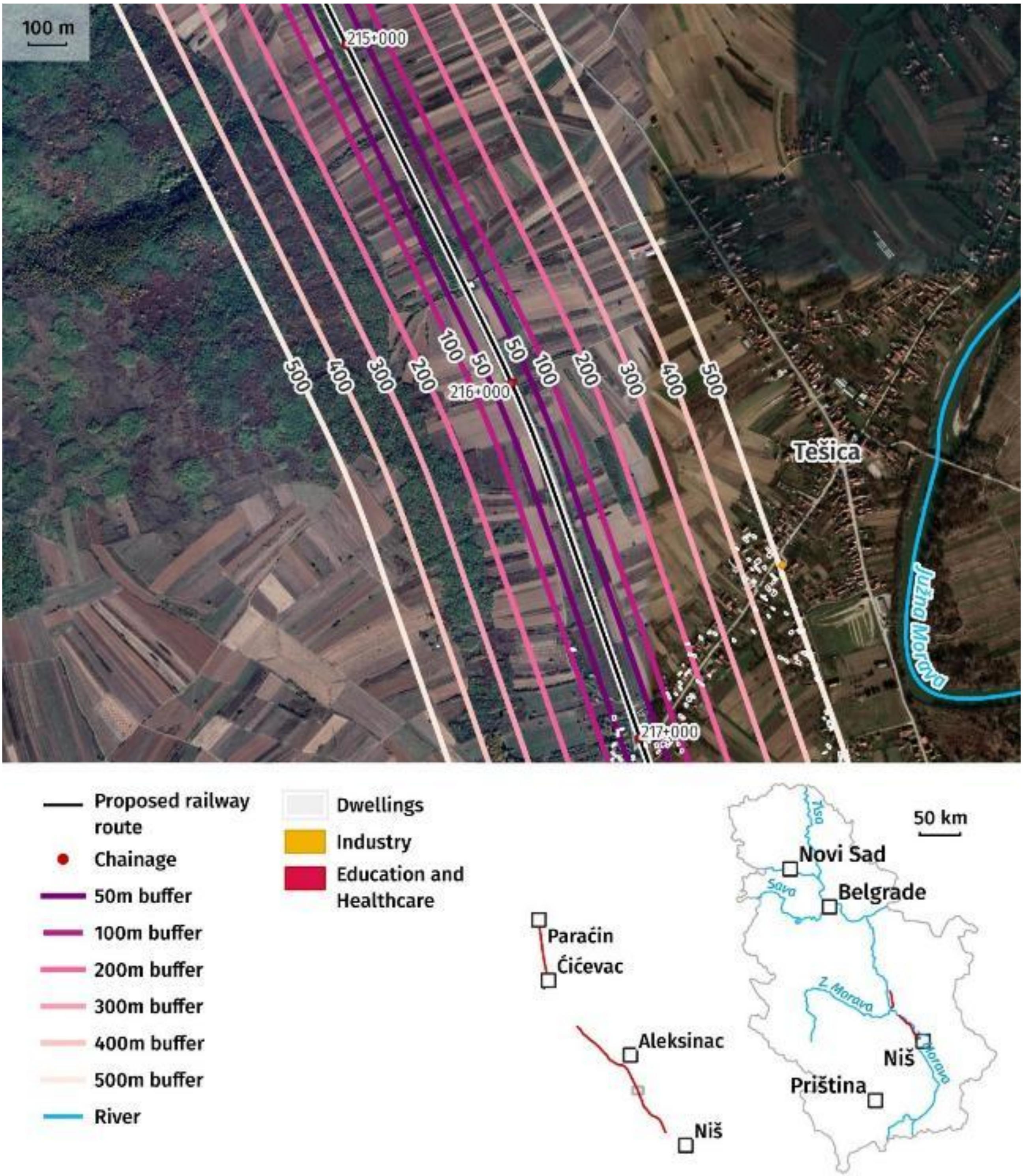


Figure 8-24. The distribution of human receptors in sensitive zone Tešica

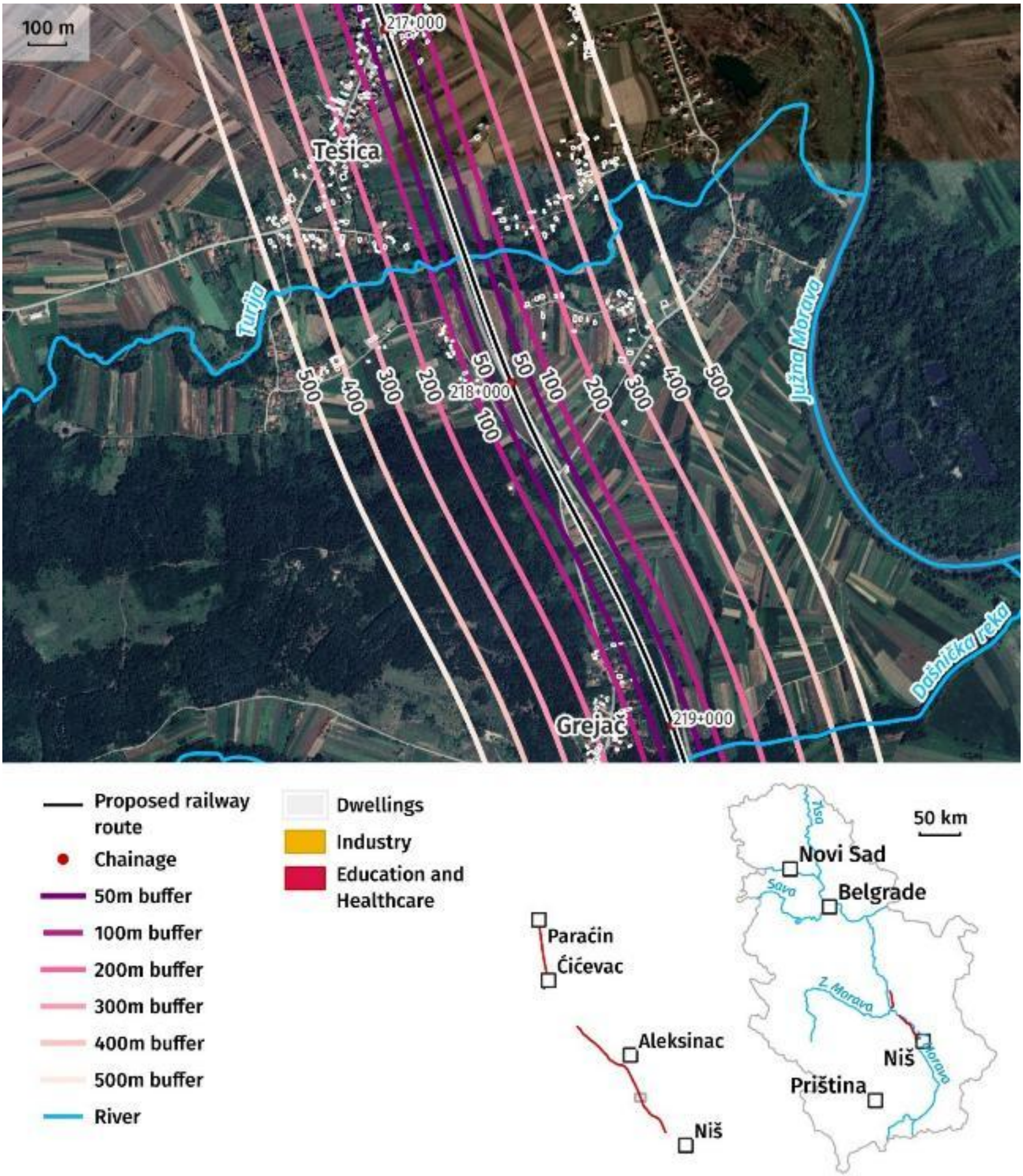


Figure 8-25. The distribution of human receptors in sensitive zone Grejač (a)

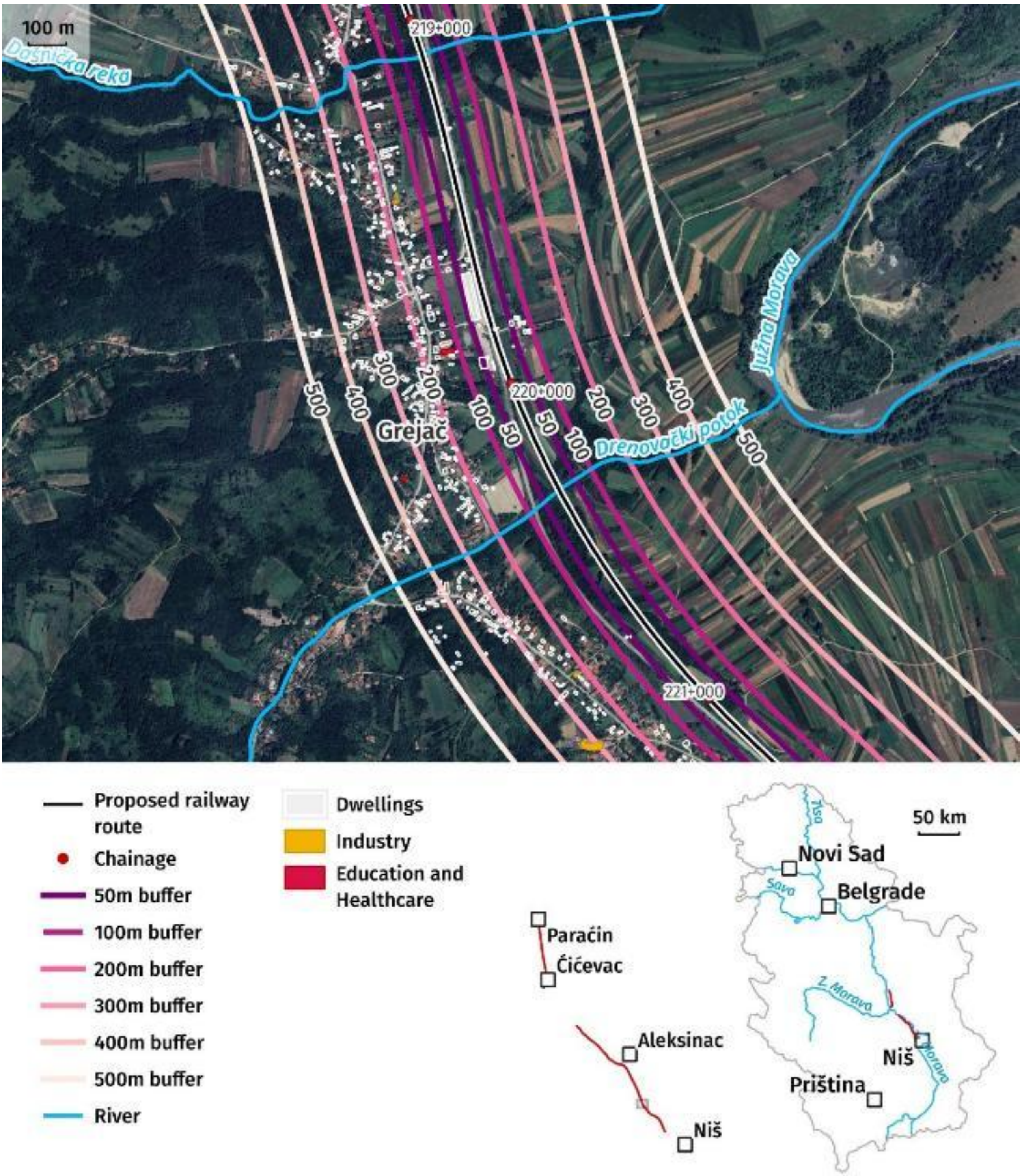


Figure 8-26. The distribution of human receptors in sensitive zone Grejač (b)

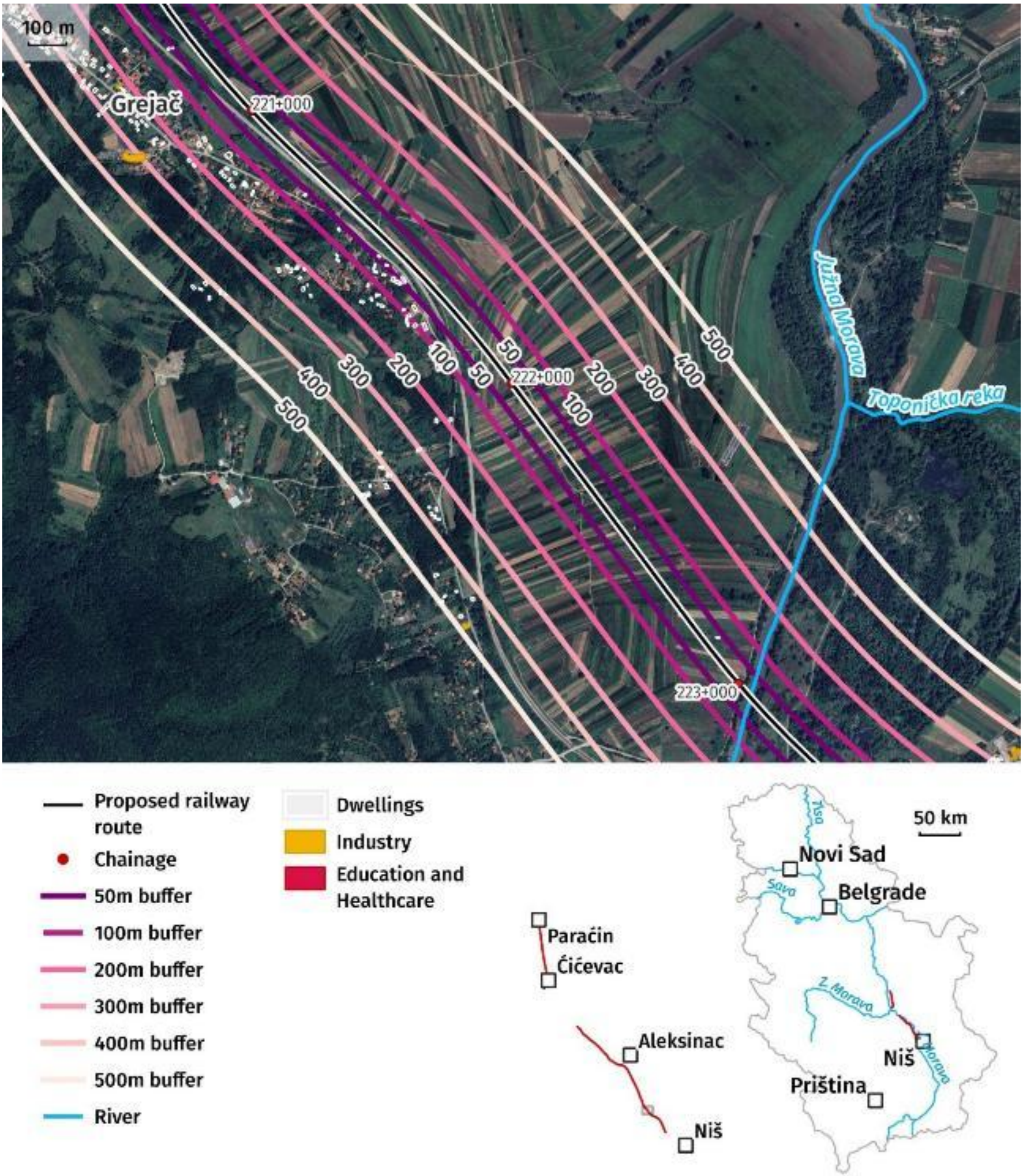


Figure 8-27. The distribution of human receptors in sensitive zone Grejač (c)

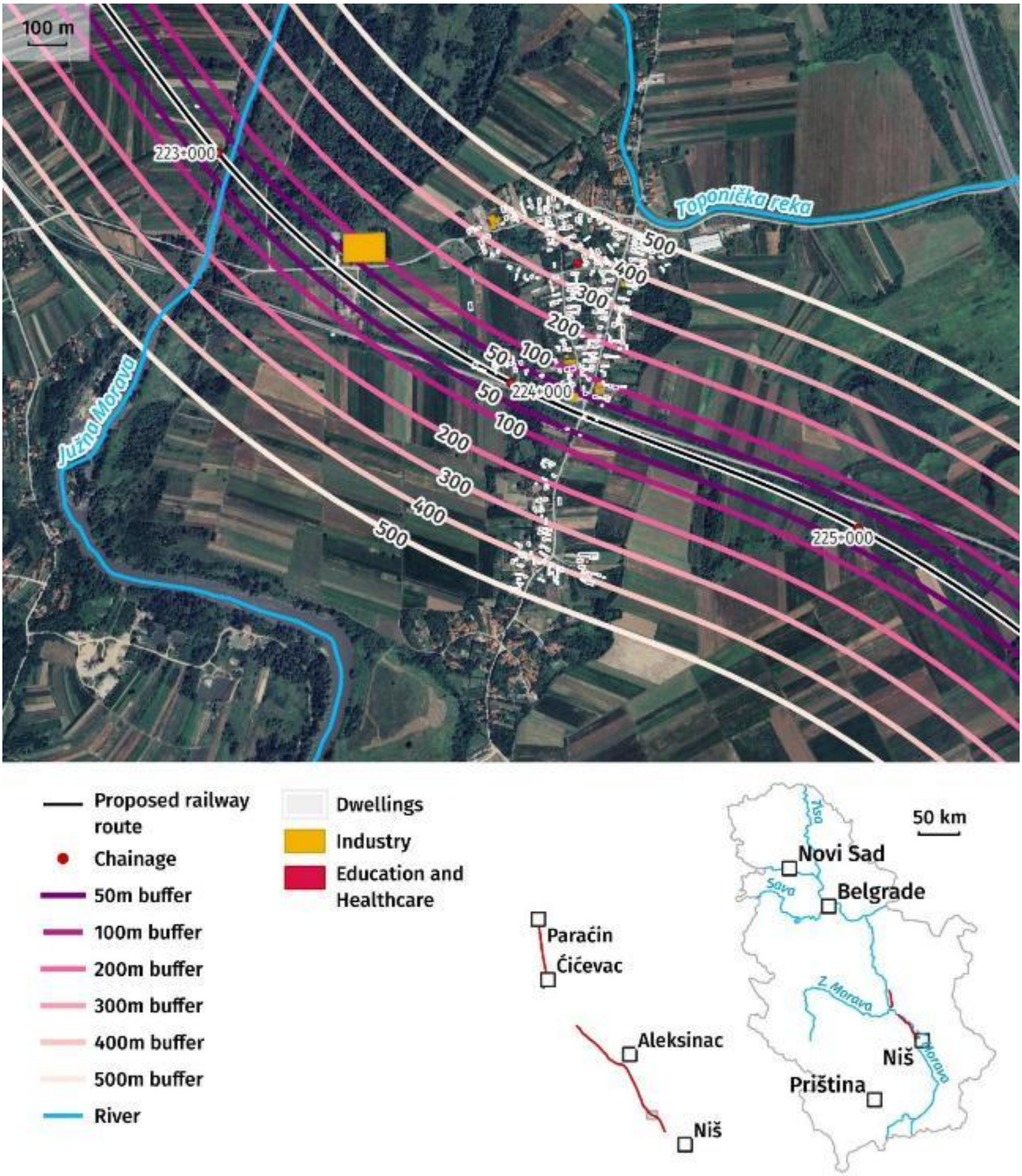


Figure 8-28. The distribution of human receptors in sensitive zone Vrtište

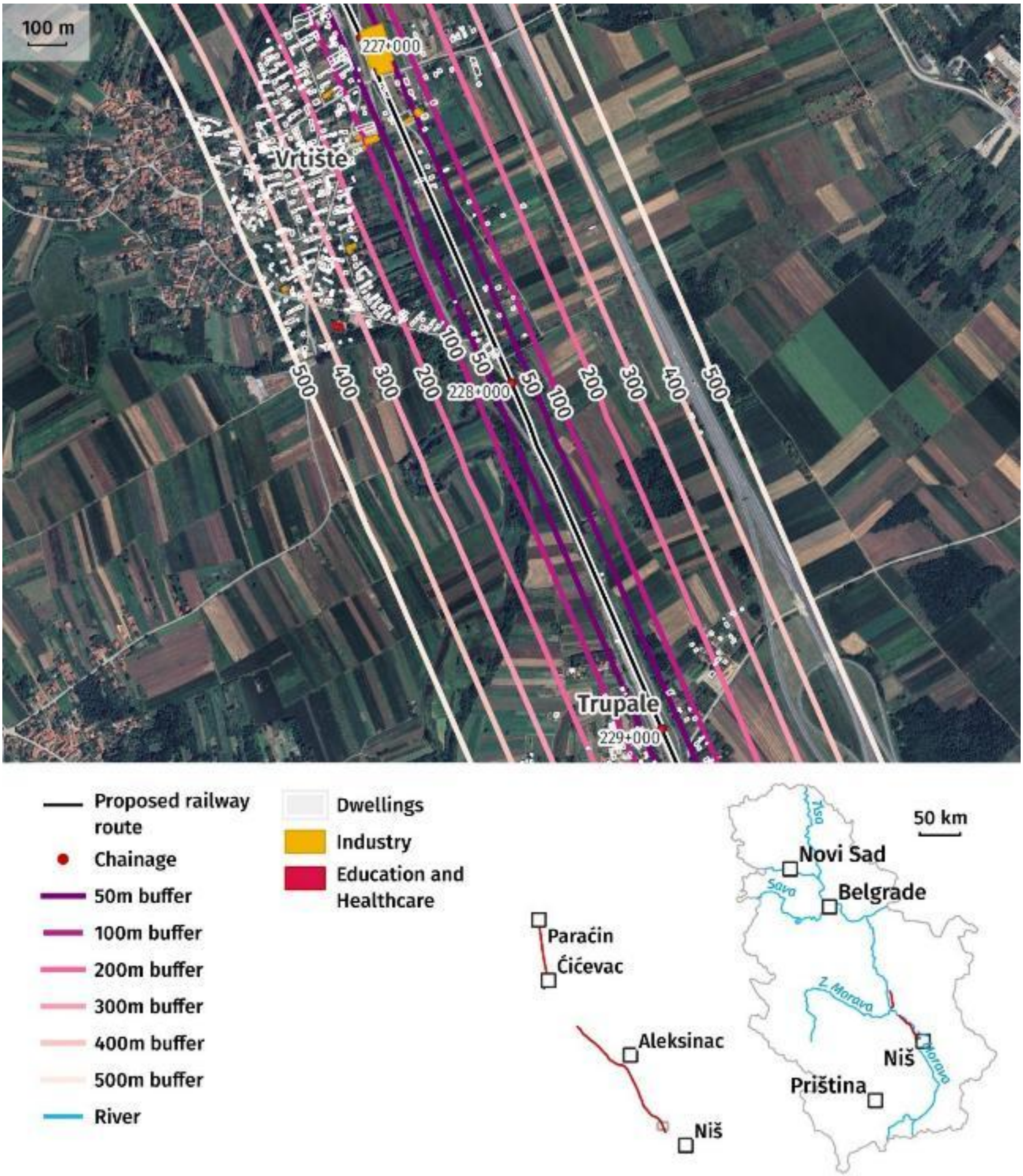
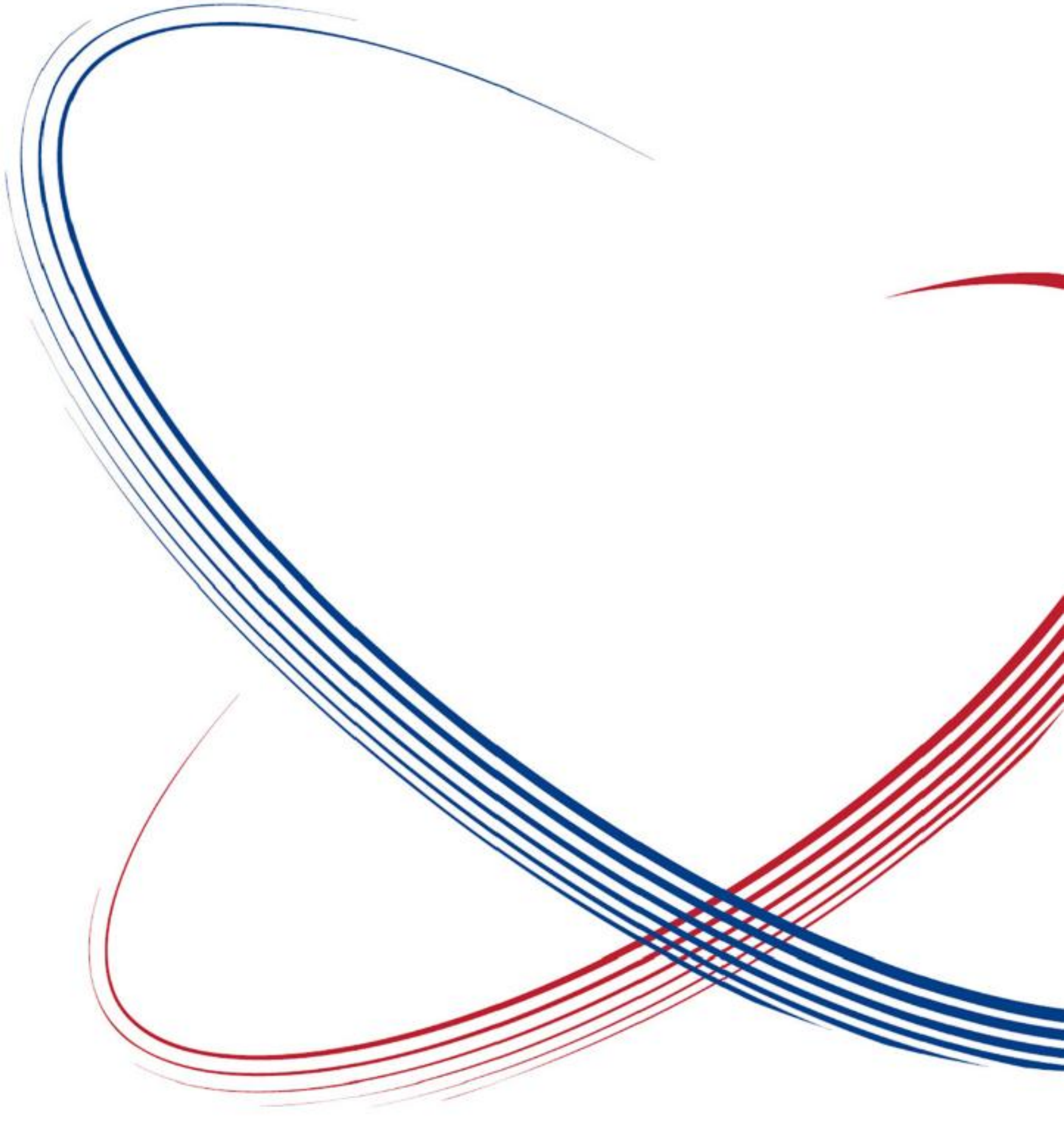


Figure 8-29. The distribution of human receptors in sensitive zone Trupale



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#ЕУ ЗА ТЕБЕ

RAILWAY LINE BELGRADE–NIŠ, SECTION III PARAĆIN TO TRUPALE (NIŠ), Environmental and Social Impact Assessment, 7. SOIL

EU PPF
PROJECT PREPARATION FACILITY

Republic of Serbia
Ministry of European Integration

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LIST OF ABBREVIATIONS AND ACRONYMS

Environmental and Social Standards	ESSs
Serbian Environmental Protection Agency	SEPA
Chain of Custody Form	CCF
Maximum Allowable Concentration	MDK
polychlorinated biphenyls	PCBs
polycyclic aromatic hydrocarbons	PAHs
aromatic hydrocarbons	BTEX
volatile organic compounds	VOCs
Proposed Special Protection Area	pSPA
Important Bird and Biodiversity Areas	IPAs
Least concern	LC
International Union for Conservation of Nature	IUCN
Magnitude	M
Spatial and temporal size	ST
Receptor sensitivity	S
Impact likelihood	L
Area of influence	AoI
Environmental and social impact assessment	ESIA
European Investment Bank	EIB
Serbian Railway Infrastructure	SRI

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1 INTRODUCTION

This chapter presents the assessment of potentially significant impacts on soil associated with both the construction and operational phases of the Project. It identifies the activities likely to affect the condition of soil and evaluates the subsequent impacts on human receptors, where relevant. The analysis considers the ways in which soil may be altered, whether through physical disturbance, contamination, or other mechanisms, and explores the broader implications of these changes. Mitigation measures are proposed to prevent or minimize adverse effects on soil. Additionally, the chapter outlines the methodologies employed in the assessment and details the data sources utilized to ensure a robust and evidence-based evaluation.

1.1 Legislative and Policy Framework

1.1.1 EU Requirements

Soil protection within the European Union is guided by the EU Soil Strategy for 2030 and the proposed Soil Monitoring and Resilience Law, which aims to establish a harmonized and legally supported framework for ensuring soil health across EU. These initiatives focus on preventing soil degradation, promoting remediation where needed, and maintaining the ecological, social, and economic functions of soil. Key threats addressed include erosion, contamination, compaction, and the loss of organic matter. However, no binding EU-wide threshold values for soil contaminants have yet been adopted.

1.1.2 EBRD Requirements

The relevant EBRD Performance Requirements (PRs) focus on preventing soil degradation, protecting human health, conserving biodiversity, and promoting sustainable management of natural resources to ensure soil quality is maintained throughout the project lifecycle. In particular, PR3 - Resource Efficiency and Pollution Prevention and Control focuses on sustainable resource use and the prevention of soil contamination. It requires measures to avoid or minimize pollutant releases, particularly from hazardous substances and materials, to prevent soil degradation. Projects must adopt practices that ensure the responsible management of resources and control of emissions to safeguard soil quality.

1.1.3 EIB Requirements

The relevant Environmental and Social Standards (ESSs) of the EIB emphasize the importance of preventing soil degradation, promoting resource efficiency, conserving biodiversity, and ensuring sustainable management of natural resources to maintain soil quality throughout the project lifecycle:

- Standard 1 – Assessment and Management of Environmental and Social Impacts and Risks: This standard emphasizes the importance of a thorough assessment of potential environmental and social impacts associated with a project. It requires promoters to identify, assess, and manage risks throughout the project lifecycle, ensuring that adverse effects are avoided, minimized, or mitigated. The standard also highlights the need for continuous monitoring and stakeholder engagement to maintain transparency and accountability.

- Standard 3 – Resource Efficiency and Pollution Prevention: Standard 3 focuses on promoting sustainable resource use and preventing pollution. It mandates that projects implement measures to improve resource efficiency, reduce waste generation, and prevent the release of pollutants into the environment. This includes adopting best practices for energy and water use, as well as managing emissions to air, water, and land; to protect environmental quality.

1.1.4 National Legislative Framework

The Law on Soil Protection ("Official Gazette of RS," No. 112/2015) serves as Serbia's primary legislative framework for safeguarding soil. Enacted to promote the sustainable use and protection of soil resources, the law aligns with European Union (EU) standards and practices. It incorporates key principles and requirements from EU legislations, including the Soil Framework Directive (2006/21/EC), which aims to ensure comprehensive soil protection across the EU. The law provides guidelines for soil management, the prevention of soil degradation, and the remediation of contaminated areas.

Complementing this legislation, the Regulation on Limit Values of Pollutants, Harmful and Hazardous Substances in Soil ("Official Gazette of RS," Nos. 30/2018 and 64/2019) establishes specific threshold values for pollutants, harmful substances, and hazardous materials in soil. These limits are designed to ensure compliance with environmental standards and to preserve soil quality effectively.

2 BASELINE CONDITIONS

2.1 Area of Influence

The Area of Influence (AoI) for impacts on Soil resulting from Project activities during the construction and operations phases is defined as a corridor 1000 meters wide, extending 500 meters on each side of the proposed railway route.

The locations of construction access roads, asphalt/concrete batching plants, lay down areas, accommodation camps, spoil disposal areas and temporary waste storage areas (as applicable) are not known at the time of this assessment and are not incorporated within the Ao. However, impacts on soil are also likely to occur in these areas during the construction phase of the Project.

2.2 Soil Types

The Soil Map of Serbia (Figure 2-1) illustrates a diverse range of soil types and sub-classes, each defined by unique morphological, chemical, and hydro-physical characteristics, as well as differing levels of production potential.

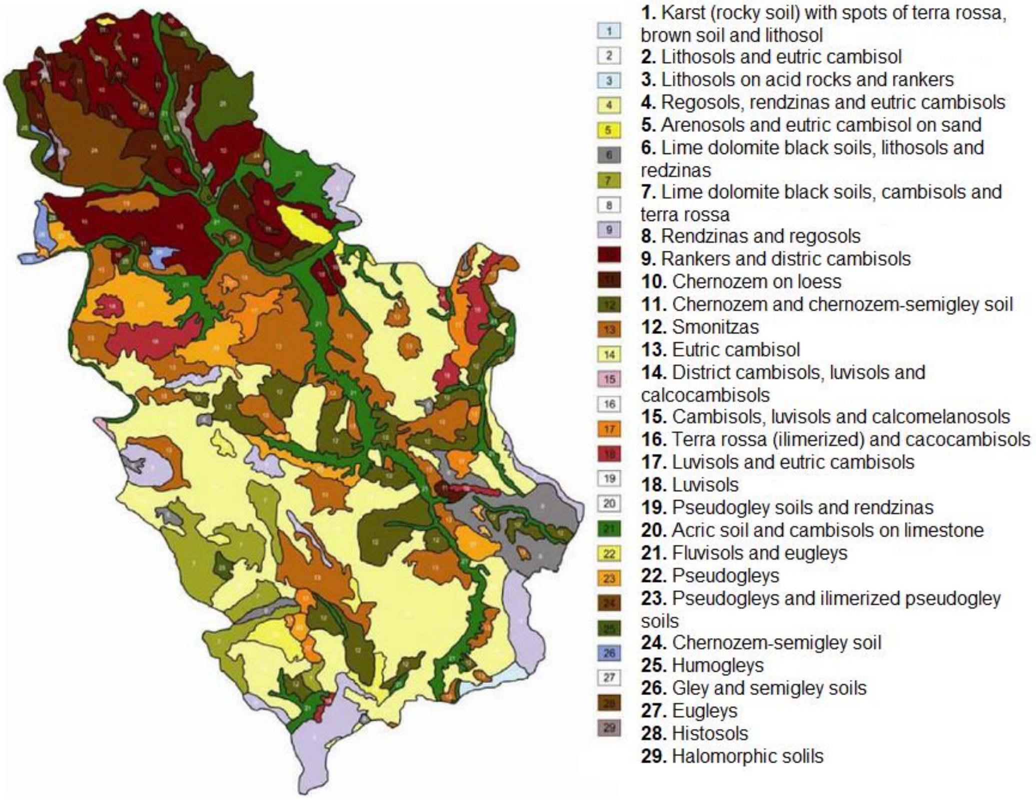


Figure 2-1. The Soil Map of Serbia (SEPA, 2015)

Throughout the region surrounding the railway corridor, the dominant soil types are fluvial and fluviogley soils, characterized by an azonal nature, varying levels of development, and differences in fertility (as shown in Figure 2-1). These characteristics are influenced by factors such as flooding duration, pedogenetic processes, and the composition of deposited materials. The soils exhibit high moisture levels, sourced from atmospheric precipitation, surface flooding, and groundwater. Seasonal groundwater fluctuations, often linked to river levels, promote soil oxygenation, while floodwaters deposit suspended materials that enrich the soil with allochthonous content.

The AoI is predominantly composed of fluvisols, or alluvial soils, which are highly valued for agriculture in the Velika and Južna Morava valleys. These soils support crop growth due to their favorable morphological, physical, and chemical properties and are classified as second-class agricultural land within the project boundaries. Additional soil types include reforested alluvium, alluvial smonica (meadow soil), smonica in reforestation, gajnjača, and deluvium in reforestation. These soils are geomorphologically homogeneous and fertile, making them highly suitable for agriculture. Barren land is virtually absent in the region.

Valley soils (in the Velika and Južna Morava valleys), including fluvisols and humofluvisols, show variability in their morphological, physical, and chemical characteristics.

Loess and lake terraces below 500 meters in elevation are present in some areas, accounting for 5% of the railway corridor's length. Their productivity varies based on humus content, soil depth, and substrate composition. Terraces on wood and tertiary sediments are particularly fertile and ideal for fruit cultivation and viticulture, while terraces on eruptive rocks are more suitable for forestry. Alluvial meadow soils, found in the Velika Morava Valley, range from gravelly to fine clay particles. These soils are highly versatile, supporting both agricultural activities and natural habitats of willow and poplar forests.

Gajnjača and smonica soils, common in the Južna Morava basin, differ in fertility. Gajnjača, a compact clay soil, is moderately fertile, while smonica, characterized by its black color and high humus content, is among the most fertile soils in Serbia. Both types support various agricultural uses, with smonica being particularly valuable.

The railway corridor passes through diverse landscapes, including agricultural lowlands, hilly terrains with orchards and vineyards, and gardens near residential areas. Woody vegetation along the railway includes fruit trees, walnuts, and conifers, which are primarily found near train stations. Vegetation along watercourses is influenced by agricultural activities in the surrounding area.

2.3 Land use

In addition to the railway tracks, the Railway Law ("Official Gazette of RS" Nos. 41/2018 and 62/2003) defines additional zones where specific land use restrictions apply. These include an infrastructure zone extending 25 meters from the outer track, in which existing structures may remain, while new construction is permitted only if included in local urban plans and approved by the Serbian Railways Infrastructure (SRI). Fire safety zones are also established:

an 18-meter-wide buffer on forested land where vegetation must be regularly cleared, and a 13-meter-wide buffer on agricultural land where mature crops must be harvested in a timely manner and fire prevention measures applied. As the railway corridor largely follows the existing route, these restrictions are already in place for most of the route. However, in locations where the Project alignment will deviate from the existing rail corridor, these zones and their associated restrictions will come into effect once the new railway section becomes operational. The Paraćin–Stalać sub-section of the Project follows the existing railway alignment without significant deviation. However, the Đunis–Trupale sub-section includes sections where the existing curvature does not meet the requirements for a 200 km/h design speed. In these areas, the alignment has been revised to increase curve radii and reduce turning angles. The chainages and lengths of the affected segments are provided in Table 2-1.

Table 2-1. Alignment Deviations on the Đunis–Trupale Sub-Section

From km	To km	Section length (m)
192+100.00	193+200.00	1100.00
194+150.00	195+100.00	950.00
195+700.00	196+500.00	800.00
196+700.00	197+750.00	1050.00
202+150.00	203+050.00	900.00
218+150.00	219+150.00	1000.00
220+000.00	221+300.00	1300.00
221+650.00	228+200.00	6550.00

Deviations in the railway alignment will result in a change in land use along these sections, predominantly affecting agricultural land and some forested areas. Current land use in these areas is outlined below and land cover in the Area of Influence (AoI) is depicted in Figure 2-2.

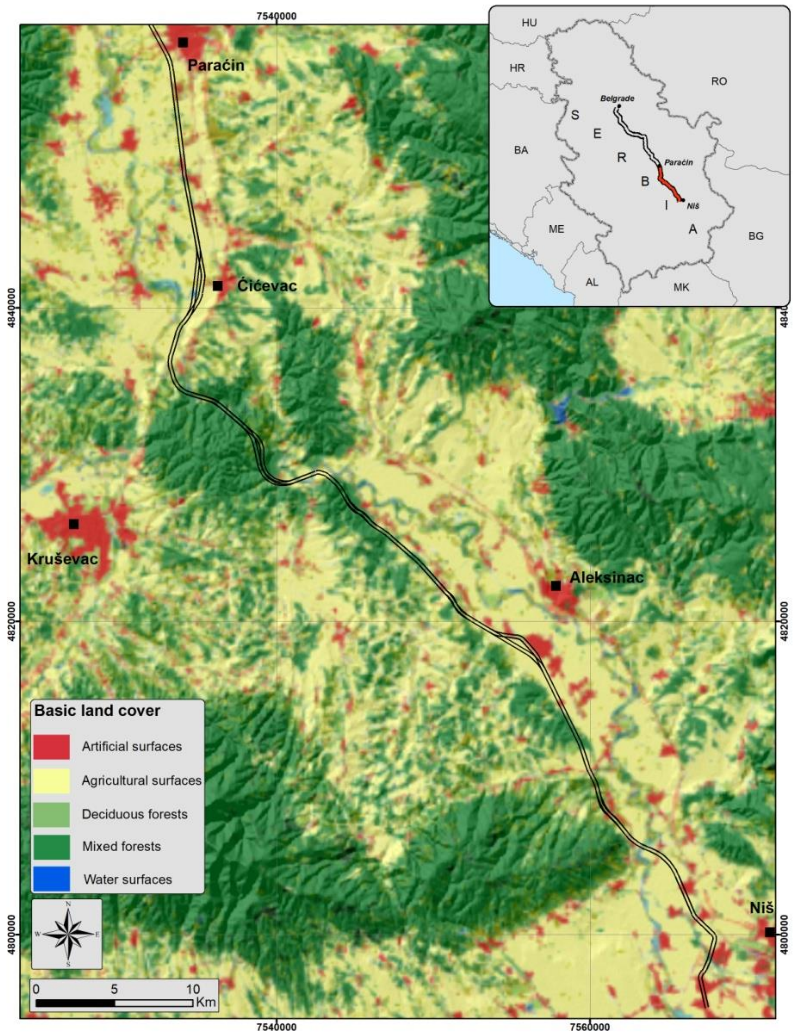


Figure 2-2. Basic land cover within the Project AoI (https://a3.geosrbija.rs)

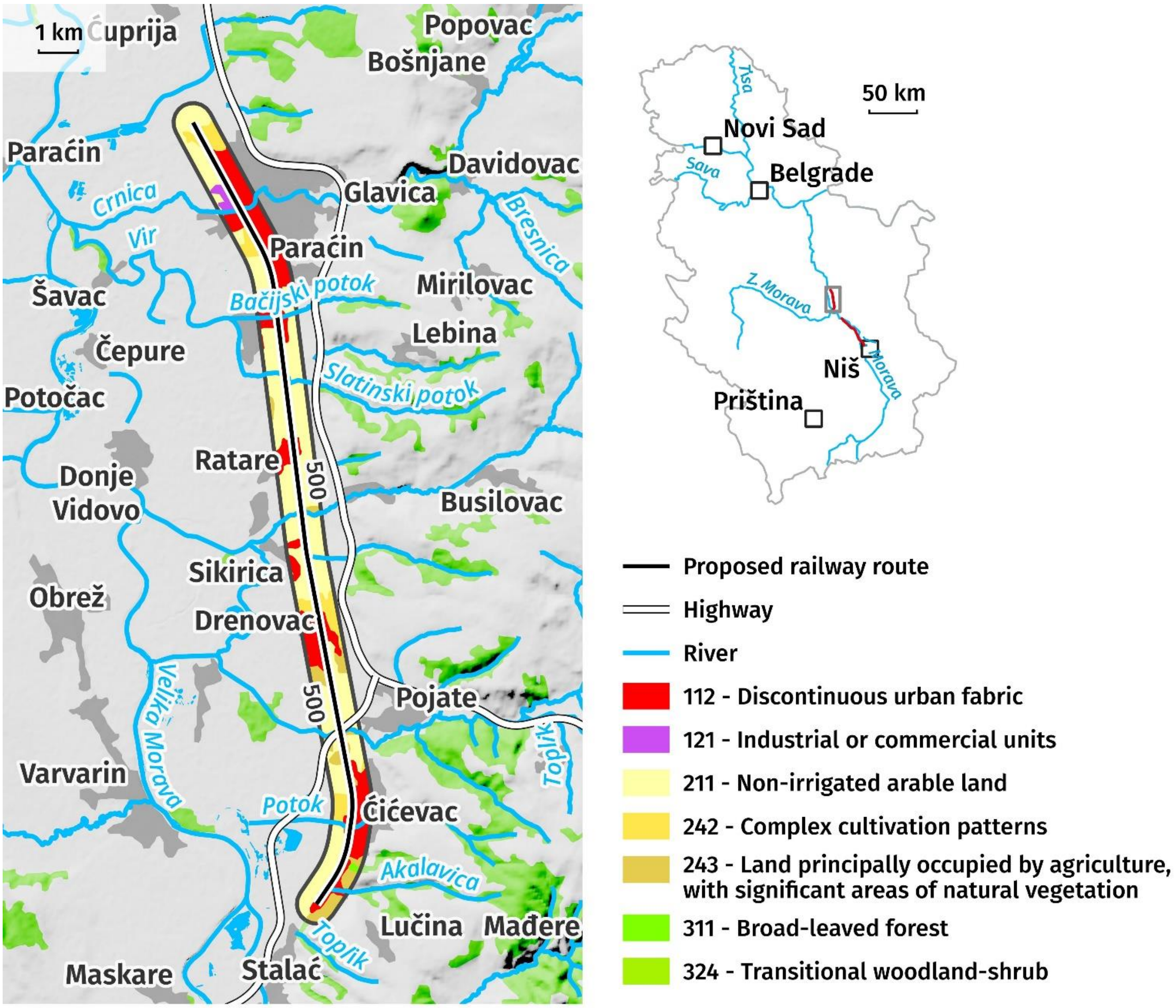
Agricultural land dominates the Project AoI, with forested areas being the second most prevalent land type. Approximately 99% of the agricultural land in this area is privately owned. The majority of arable land is concentrated in the Morava River valley, which is ideal for crop and vegetable production. The gentle slopes are utilized for viticulture, while the hilly and mountainous areas offer extensive grassy terrain, providing excellent opportunities for improving livestock farming.

The total area designated as agricultural land in the AoI amounts to 159.45 km2. This area includes the following zones:

- Code 211 – Non-irrigated arable land, 88.42 km^2
- Code 221 – Vineyards, 0.13 km^2

- Code 222 - Fruit trees and berry plantations, 1.22 km^2
- Code 242 – Complex cultivation patterns, 48.23 km^2
- Code 243 – Land principally occupied by agriculture with significant areas of natural vegetation, 21.45 km^2.

Maps of existing land use within the Area of Influence are presented in Figure 2-3.



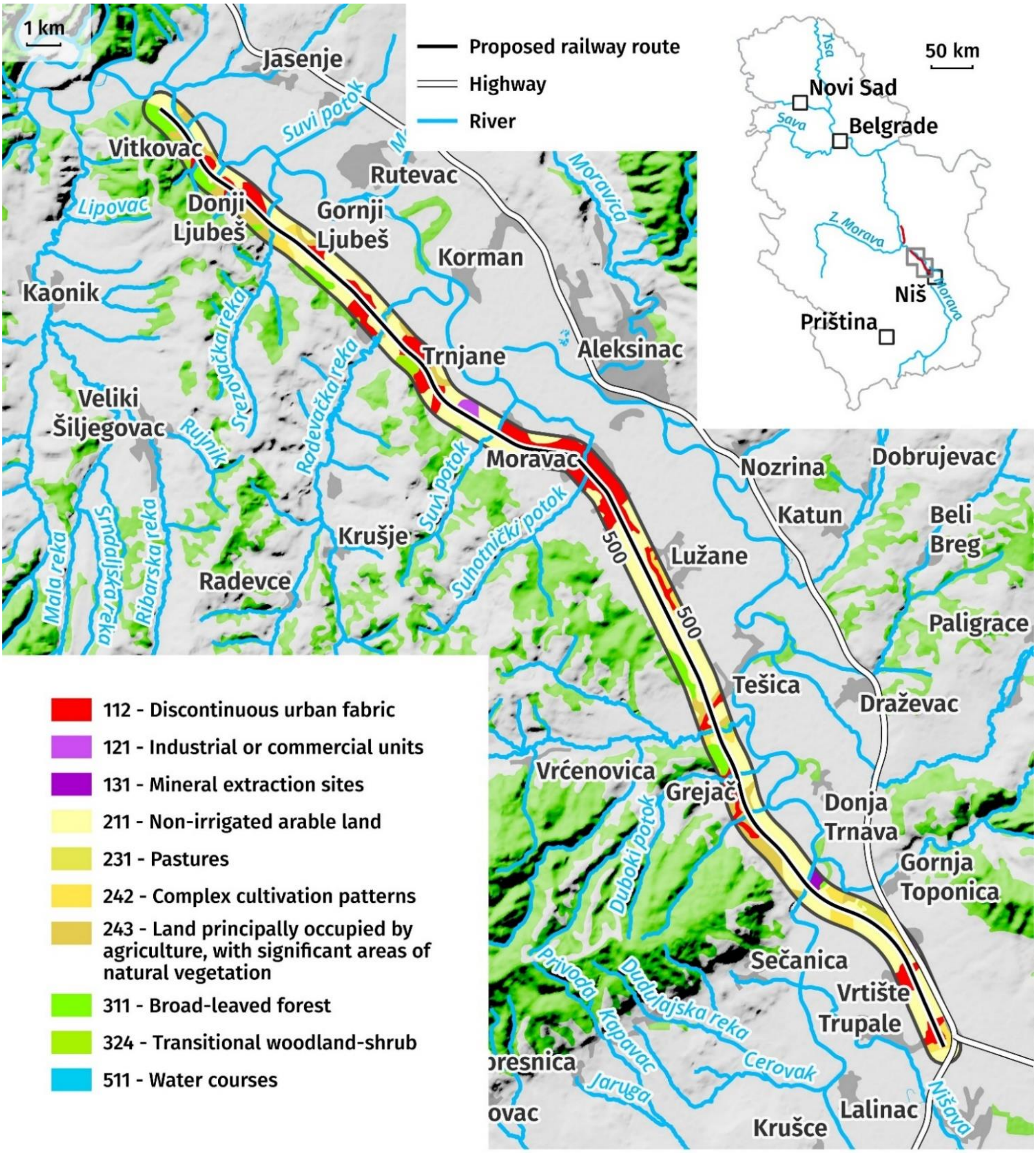


Figure 2-3. Land use within the Project AoI (CORINE 2018 Land Use Map)

2.4 Existing Soil Conditions

Soils in the Republic of Serbia face a range of significant pressures, including urban sprawl, pollution from agricultural practices and industrial activities, uncontrolled waste disposal, and transportation, as well as land take for development and landscape fragmentation. Additional challenges include low crop diversity, soil erosion, and the growing impacts of extreme weather events driven by climate change. According to the Serbian Environmental Protection Agency (SEPA), soil erosion is a significant driver of soil degradation, especially in the coastal areas of major rivers, central regions of Serbia, and hilly-mountainous terrains. This issue is especially pronounced along the Velika Morava River, where high water levels can significantly alter the riverbed's morphology.

SEPA plays a critical role in monitoring soil quality and publishes detailed reports on soil conditions, including the levels of various contaminants. These monitoring efforts focus on assessing chemical pollution, particularly in urban and industrial areas. Monitoring of soil contamination in urban areas is conducted by local authorities, emphasizing the need for continued management and mitigation to preserve the region's soil resources. While these initiatives represent important steps forward, a fully integrated nationwide soil quality monitoring program has only recently begun to take shape. As of February 7, 2025, the National Soil Information System has become operational. This platform enables the submission and management of soil quality data based on obligations defined in the Law on Soil Protection (“Official Gazette of RS”, No. 112/15) and relevant by-laws, marking a significant advancement in the institutional framework for soil protection in Serbia.

According to SEPA’s Report on the State of Soil in the Republic of Serbia for 2018 and 2019, concentrations of copper, zinc, nickel, cobalt, cadmium, lead, and mercury in soils across the Paraćin–Niš area were reported to exceed the regulatory limit values prescribed by the Regulation on Limit Values of Pollutants, Harmful and Hazardous Substances in Soil (“Official Gazette of RS”, Nos. 30/2018 and 64/2019). However, these concentrations remained below intervention thresholds that would trigger mandatory remediation. Notably, in the urban area of Niš, soil samples from industrial zones, traffic corridors, and recreational areas exceeded threshold values for several contaminants, including cadmium, zinc, copper, nickel, chromium, and arsenic. In a limited number of samples, arsenic levels surpassed remediation thresholds, particularly in sensitive zones such as school grounds and water supply protection areas.

In addition to contamination levels, SEPA’s 2019 agricultural land fertility control data indicates that soils in the region typically exhibit low organic carbon content, a factor that can influence the mobility and retention of heavy metals.

The study “Background and Threshold Values of Potentially Toxic Elements in Soil at Central Part of Republic of Serbia” (Mrvić et al., 2019) established baseline and threshold values for arsenic, chromium, copper, nickel, lead, and zinc based on more than 5,000 topsoil samples. The study identified particularly high concentrations of nickel and chromium in areas underlain by serpentine geology and recommended the use of differentiated background values for soils developed on ultramafic rocks. Although such geological formations occur in parts of central and southern Serbia, available geological mapping indicates they do not occur within the immediate Project AoI. However, the map provided in the referenced study shows some sampling locations with elevated nickel and chromium concentrations are situated near the broader Project area. It is therefore plausible that localized increases in these elements within the AoI could result from regional atmospheric deposition, surface runoff, or agricultural practices—such as frequent tillage—that redistribute trace elements from nearby serpentine-rich zones into adjacent soils.

Additional insight is provided by the study "Factors Influencing the Distribution of Heavy Metals in the Alluvial Soils of the Velika Morava River Valley, Serbia" (Jakovljević et al., 1997), which examined approximately 110,000 hectares of intensively cultivated land. This research reported elevated concentrations of nickel, lead, and arsenic, particularly in younger alluvial soils such as humofluvisols. In these soils, sedimentary deposition processes and proximity to infrastructure appeared to influence the distribution of contaminants. The study emphasizes the combined influence of natural geochemical enrichment and anthropogenic sources, noting that metal concentrations generally decrease in older and more weathered soils.

Complementing these findings, the study "Heavy Metals in the Cultivated Soils of Central and Western Serbia" (Djalović et al., 2024) analyzed surface soils from five localities, including areas of Central Serbia, for concentrations of iron, manganese, zinc, copper, nickel, and lead. Elevated levels of zinc and copper were identified in several locations, suggesting that naturally elevated background concentrations of certain heavy metals may occur because of local geological conditions and historical land use.

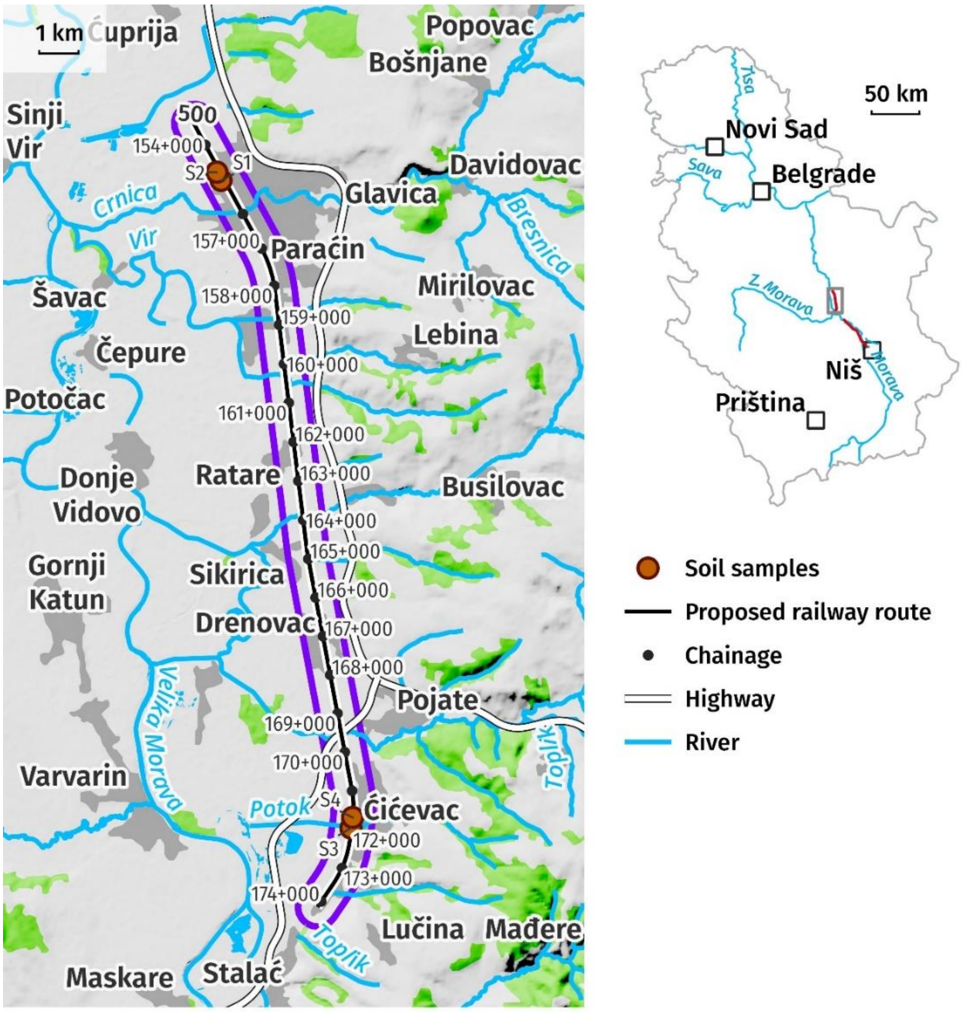
The cited studies indicate that background concentrations of certain heavy metals may be naturally elevated in parts of central and southern Serbia, even in areas where the geological formations typically associated with such enrichment are not present. This may be attributed to the redistribution of naturally enriched soils from the broader region through atmospheric deposition, surface runoff, or agricultural practices. At the same time, the occurrence of elevated concentrations in areas adjacent to the existing railway line, along with contaminant profiles that closely resemble those reported in international studies (Vaiškūnaitė & Jasiūnienė, 2020; Frühwirt et al., 2025), suggests that railway operations are also a likely source of contamination within the immediate Project AoI.

2.5 Soil quality

Baseline soil quality was additionally determined through soil sampling conducted from December 1 to December 7, 2023. The sampling process and field measurements were specifically designed to ensure that the collected samples accurately reflect the conditions in areas targeted for activities that may affect soil quality, or near worksites with potential contamination risks. To achieve this, considerations such as land use, soil type, and potential contamination sources were factored in to ensure thorough and reliable results.

Soil quality sampling involved the collection of composite soil samples from within and beyond the designated protection zone of the proposed railway corridor, adhering to the sanitary protection zone guidelines. This protection zone includes the infrastructural strip on both sides of the railway, extending 25 meters from the axis of the outermost track. The primary purpose of this zone is to facilitate the use, maintenance, and technological enhancement of railway infrastructure. Soil samples were taken from a depth of 0.0 to 0.3 meters. In addition to the three sampling points (S4, S5, and S6) within the protection zone, five samples were collected from agricultural land located on the periphery of settlements. Together with the available data referenced in Section 2.4, this approach was felt to provide a representative sample for assessing soil quality.

A total of eight pre-selected locations were therefore sampled, with their specific positions illustrated in Figure 2-4 and detailed in Table 2-2.



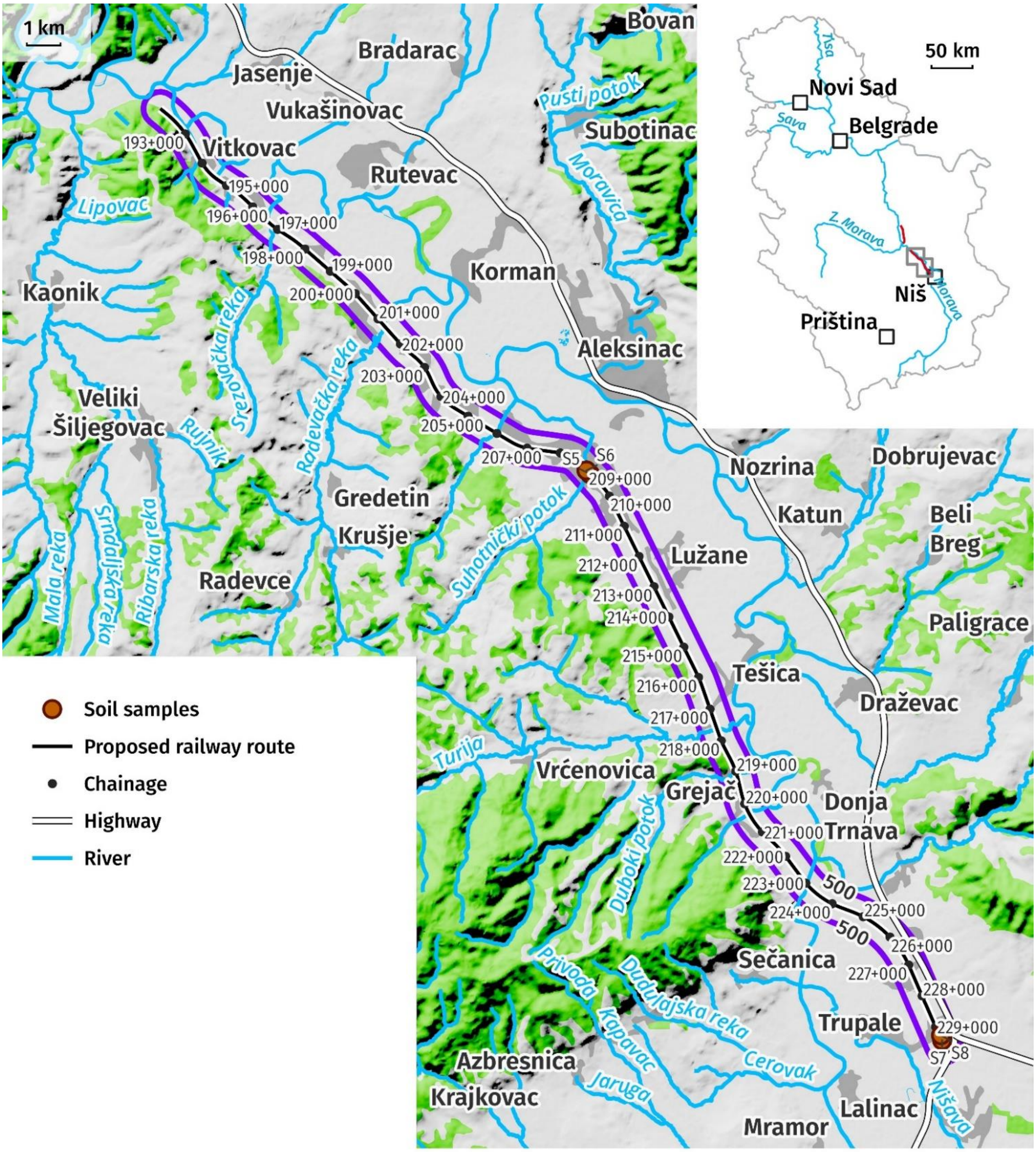


Figure 2-4. Sampling points for soil quality measurements

Table 2-2. List of sampling points and GPS coordinates

Sampling point	Near settlement	GPS coordinates		Approximate distance from the railway tracks	Type of land
		N	E		
S1	Paraćin	43.865546°	21.397232°	65 m	Agricultural land
S2		43.867433°	21.395905°	55 m	Agricultural land
S3	Ćićevac	43.717153°	21.437228°	15 m	Agricultural land
S4		43.719592°	21.437773°	10 m	Non-agricultural land within the settlement
S5	Aleksinac	43.507910°	21.693292°	7 m	Non-agricultural land within the settlement
S6		43.508874°	21.692006°	25 m	Non-agricultural land within the settlement
S7	Niš (Trupale)	43.355651°	21.820444°	16 m	Agricultural land
S8		43.357034°	21.820033°	35 m	Agricultural land

Baseline soil quality conditions were assessed based on the following parameters: pH, moisture content, organic matter content (determined by loss on ignition), granulometric composition, concentrations of mineral oils (C_{10}-C_{40}), heavy metals and toxic metalloid concentrations (cadmium (Cd), chromium (Cr), copper (Cu), nickel (Ni), lead (Pb), zinc (Zn), barium (Ba), cobalt (Co), molybdenum (Mo), antimony (Sb), mercury (Hg), and arsenic (As)), concentrations of polychlorinated biphenyls (PCBs: PCB 28, PCB 52, PCB 101, PCB 138, PCB 153, PCB 180, and total PCBs), aromatic hydrocarbons (BTEX: benzene, toluene, ethylbenzene, and xylene), polycyclic aromatic hydrocarbons (PAHs: anthracene, benzo(a)anthracene, benzo(k)fluoranthene, benzo(a)pyrene, chrysene, phenanthrene, indeno[1,2,3-cd]pyrene, fluoranthene, naphthalene, benzo[ghi]perylene, benzo(b)fluoranthene, dibenzo(ah)anthracene, acenaphthylene, acenaphthene, fluorene, pyrene, and total PAHs), and volatile organic compounds (VOCs).

The laboratory analyses were conducted by Anahem d.o.o. Laboratory in Belgrade, Serbia, a facility recognized for both national and international competence. To maintain traceability and ensure rigorous documentation throughout the testing process, a Chain of Custody Form (CCF) was utilized to track each step until the final results were obtained.

Soil sampling adhered to the ISO 18400 standard, ensuring consistency and reliability in the process. Methods used for laboratory testing are detailed in Table 2-3.

Table 2-3. List of methods used for the soil analysis

Parameter	Method
pH	SRPS ISO 10390
Moisture content	ISO 11465
Organic matter content by loss of ignition	EN TC WI:2003
Granulometric composition	SRPS EN ISO 17892-4
Mineral oils C_{10}-C_{40}	BS ISO 16703
Metals and metalloid: cadmium (Cd), chromium (Cr), copper (Cu), nickel (Ni), lead (Pb), zinc (Zn), arsenic (As), barium (Ba); cobalt (Co) molybdenum (Mo); antimony (Sb)	EPA 3051A/ EPA 6010d
Mercury (Hg)	EPA 3051A/SRPS EN 1483
Polychlorinated biphenyls (PCB): PCB 28, PCB 52, PCB 101, PCB 138, PCB 153, PCB 180, PCBs (total)	ISO 10382
Aromatic hydrocarbons (BTEX): benzene, ethylbenzene, toluene, xylene, styrene	EPA 5021
Polycyclic aromatic hydrocarbons: anthracene, benzo(a)anthracene, benzo(k)fluoranthene, benzo(a)pyrene, chrysene, phenanthrene, indeno[1,2,3-cd]pyrene, fluoranthene, naphthalene, benzo[ghi]perylene, benzo(b)fluoranthene, dibenzo[ah]anthracene, acenaphthylene, acenaphthene, fluorene, pyrene, PAH (total)	EPA 3550C/8270D
Volatile organic compounds	ISO 22155

Table 2-4 presents the results of the soil samples taken to inform the assessment, detailing pH levels, moisture content, organic matter content, and granulometric composition.

Table 2-4. Test results of soil samples for pH, moisture content, organic matter content, and granulometric composition

Sampling point	pH	Moisture content, %	Organic matter content, %	Granulometric composition		
				Clay content, %	Silt content, %	Sand content, %
S1	7.1	23	7.3	29.8	56.8	13.4
S2	7.2	20	6.9	20.0	61.3	18.7
S3	8.1	22	17	23.0	44.2	32.8
S4	7.9	18	12	21.0	52.4	26,6
S5	7.9	17	4.9	20.1	46.2	33.7
S6	7.7	15	3.5	18.0	42.4	39.6
S7	7.9	18	5.0	11.3	37.4	51.3
S8	7.3	14	6.2	13.0	32.8	54.2

The soils analyzed exhibit a slightly neutral to mildly alkaline pH range (7.1 to 8.1). Moisture content varies from 14% to 23%, with higher values suggesting better water retention, possibly due to higher clay content, while lower values may indicate reduced water-holding capacity. Organic matter content ranges from 3.5% to 17%, with higher levels providing greater fertility and soil structure benefits, while lower levels may indicate reduced nutrient and moisture retention capabilities. The granulometric composition shows significant variation, with clay content ranging from 11.3% to 29.8%, silt content dominating at 32.8% to 61.3%, and sand content varying between 13.4% and 54.2%. These variations in texture influence the soils' drainage, water retention, and susceptibility to erosion or compaction. This textural diversity results in soils with low to medium permeability and water retention capacity; finer-textured soils with higher clay and silt content tend to retain more water but are more susceptible to compaction, while sandier soils offer better drainage yet are more prone to erosion.

Table 2-5 presents the results of the metal content analysis in soil samples, while Table 2-6 outlines the associated limit and remediation values. As specified in the Regulation on Limit Values of Pollutants, Harmful and Hazardous Substances in Soil ("Official Gazette of RS", Nos. 30/2018 and 64/2019), these limits, remediation thresholds, and significant contamination levels for metals and arsenic (excluding antimony and molybdenum) are adjusted based on the soil's clay content and organic matter percentage.

Table 2-5. Test results of the soil samples for metal content in mg/kg of soil

Sampling point	Sb	As	Cu	Ba	Zn	Cr total	Cd	Co	Ni	Mo	Pb	Hg
S1	<1.2	12	33	**190**	93	66	0.21	**14**	**60**	0.26	32	0.037
S2	<1.2	11	29	131	93	66	0.51	**16**	**55**	0.36	40	0.0028
S3	<1.2	7.2	26	**151**	83	46	0.17	**12**	**44**	0.46	22	0.034
S4	<1.2	9.5	25	**144**	95	53	0.23	**14**	**39**	0.55	31	0.025
S5	<1.2	7.6	25	**143**	78	42	0.079	**13**	**37**	0.21	23	0.025
S6	<1.2	9.3	26	121	82	52	0.099	**15**	**31**	0.29	35	0.039
S7	<1.2	8.6	**30**	**136**	**120**	42	0.14	**12**	**38**	0.32	25	0.066
S8	<1.2	8.6	25	**111**	91	50	0.19	**17**	**29**	0.39	31	0.079

Table 2-6. Corrected limit and remediation values for metals and arsenic depending on clay and organic matter in mg/kg (MDK[1]-corrected limit value; MDK[2]- corrected remediation value)

Sampling point		Sb	As	Cu	Ba	Zn	Cr total	Cd	Co	Ni	Mo	Pb	Hg
S1	MDK[1]	3	30	37	181	148	108	0.77	10	39	3	86	0.31
	MDK[2]	15	56	194	706	761	410	11.6	270	234	200	538	10.3
S2	MDK[1]	3	26	31	134	120	90	0.7	8	30	3	77	0.28
	MDK[2]	15	49	164	524	619	342	10.47	203	180	200	479	9.26
S3	MDK[1]	3	31	39	150	145	96	0.94	8	33	3	90	0.31
	MDK[2]	15	59	206	585	743	365	14.0	225	198	200	561	10.2
S4	MDK[1]	3	28	35	139	131	92	0.81	8	31	3	83	0.29
	MDK[2]	15	53	184	544	674	349.6	12.2	210	186	200	518	9.66
S5	MDK[1]	3	25	30	134	117	90	0.66	8	30	3	75	0.27
	MDK[2]	15	47	158	524	604	342	9.8	203	180	200	467	9.15
S6	MDK[1]	3	24	28	124	109	86	0.61	7	28	3	72	0.27
	MDK[2]	15	45	147	484	562	327	9.16	188	168	200	446	8.85
S7	MDK[1]	3	21	25	88	91	72	0.59	5	21	3	66	0.24
	MDK[2]	15	41	130	343	465	274	8.9	135	126	200	412	8.1
S8	MDK[1]	3	23	27	98	98	76	0.63	6	23	3	69	0.25
	MDK[2]	15	43	140	383	506	288.8	9.5	150	138	200	431	8.44

In compliance with the aforementioned Regulation, the analysis revealed that barium concentrations exceeded the prescribed limit value at several locations, specifically S1, S3, S4, S5, S7, and S8. Additionally, elevated concentrations of zinc and copper were identified at location S7. Furthermore, in all analyzed samples, the concentrations of cobalt and nickel were found to surpass the established limit values. These values are shown in bold in Table 2-5.

It is important to note, however, that none of the detected metal concentrations in the soil samples exceeded the remediation thresholds outlined in the Regulation. This indicates that, while certain metals are present at levels exceeding prescribed limits, they do not yet require remedial interventions under the current regulatory framework. Nickel concentrations exceeded threshold values in all analyzed samples, which is consistent with existing data on soil quality in the region (Mrvić et al., 2019; Jakovljević et al., 1997, SEPA's report for 2018 and 2019). The elevated concentrations of cobalt observed in all analyzed samples are consistent with findings reported in SEPA's Report on the State of Soil in the Republic of Serbia for 2018 and 2019. Similarly, the elevated concentrations of zinc and copper observed in one sample align with regional baseline information (Djalović et al., 2024, SEPA's report for 2018 and 2019).

In addition to naturally increased concentrations of certain heavy metals, proximity to railways can also contribute to elevated heavy metal concentrations in soils, primarily due to factors such as the wear and tear of railway tracks and trains, the use of lubricants and other chemicals to minimize wear, maintenance activities, atmospheric deposition, and the application of pesticides on embankments (Fruhwirt et al., 2025; Vaiškūnaitė & Jasiūnienė, 2020 and the references cited within). The heavy metals detected at elevated concentrations in the Project AoI correspond to those reported in several studies cited in the referenced papers, suggesting a consistency between the findings of this assessment and previously documented contamination patterns associated with railway operations. This may also explain the elevated concentrations of barium detected in several samples, as barium compounds are commonly used in railway-related activities (Fruhwirt et al., 2025). Overall, the results indicate that the elevated concentrations of heavy metals observed in the Project AoI may be attributed to a combination of natural geochemical conditions and anthropogenic influences associated with the existing railway infrastructure.

Tables 2-7 to 2-10 display the test results for polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), aromatic hydrocarbons (BTEX), and volatile organic compounds (VOCs). Corresponding limit and remediation values, as defined by the Regulation on Limit Values for Pollutants, Harmful, and Hazardous Substances in Soil ("Official Gazette of RS", Nos. 30/2018 and 64/2019), are provided in Table 2-11.

Table 2-7. Concentrations of polychlorinated biphenyls in soil samples for the content

Sampling point	Polychlorinated biphenyls, mg/kg						
	PCB 28	PCB 52	PCB 101	PCB 138	PCB 153	PCB 180	PCBs total
S1	<0.003	<0.003	<0.003	<0.002	<0.002	<0.002	<0.015
S2	<0.003	<0.003	<0.003	<0.002	<0.002	<0.002	<0.015
S3	<0.003	<0.003	<0.003	<0.002	<0.002	<0.002	<0.015
S4	<0.003	<0.003	<0.003	<0.002	<0.002	<0.002	<0.015
S5	<0.003	<0.003	<0.003	<0.002	<0.002	<0.002	<0.015
S6	<0.003	<0.003	<0.003	<0.002	<0.002	<0.002	<0.015
S7	<0.003	<0.003	<0.003	<0.002	<0.002	<0.002	<0.015
S8	<0.003	<0.003	<0.003	<0.002	<0.002	<0.002	<0.015

Table 2-8. Concentrations of polycyclic aromatic hydrocarbons in soil samples

Sampling point	Polycyclic aromatic hydrocarbons, mg/kg																
	Naphthalene	Acenaphthylene	Acenaphthene	Fluorene	Phenanthrene	Anthracene	Fluoranthene	Pyrene	Chrysene	Benzo (a) anthracene	Benzo (b) fluoranthene	Benzo (k) fluoranthene	Benzo (a) pyrene	Indeno[1.2.3-cd] pyrene	Dibenzo [ah] anthracene	Benzo[ghi] perylene	PAH (total)
S1	<0.001	<0.01	<0.01	<0.01	<0.005	<0.001	<0.001	<0.01	<0.09	<0.003	<0.02	<0.02	<0.003	<0.06	<0.08	<0.08	<0.45
S2	<0.001	<0.01	<0.01	<0.01	0.011	<0.001	<0.001	<0.01	<0.09	<0.003	<0.02	<0.02	<0.003	<0.06	<0.08	<0.08	<0.45
S3	<0.001	<0.01	<0.01	<0.01	0.006	<0.001	<0.001	<0.01	<0.09	<0.003	<0.02	<0.02	<0.003	<0.06	<0.08	<0.08	<0.45
S4	<0.001	<0.01	<0.01	<0.01	0.011	<0.001	<0.001	<0.01	<0.09	<0.003	<0.02	<0.02	<0.003	<0.06	<0.08	<0.08	<0.45
S5	<0.001	<0.01	<0.01	<0.01	<0.005	<0.001	0.007	0.012	<0.09	<0.003	<0.02	<0.02	<0.003	<0.06	<0.08	<0.08	<0.45
S6	<0.001	<0.01	<0.01	<0.01	0.011	<0.001	<0.001	<0.01	<0.09	<0.003	<0.02	<0.02	<0.003	<0.06	<0.08	<0.08	<0.45
S7	<0.001	<0.01	<0.01	<0.01	0.011	<0.001	<0.001	<0.01	<0.09	<0.003	<0.02	<0.02	<0.003	<0.06	<0.08	<0.08	<0.45
S8	<0.001	<0.01	<0.01	<0.01	0.011	<0.001	<0.001	<0.01	<0.09	<0.003	<0.02	<0.02	<0.003	<0.06	<0.08	<0.08	<0.45

Table 2-9. Concentrations of aromatic hydrocarbons (BTEX) in soil samples

Sampling point	Aromatic hydrocarbons (BTEX), μg/kg					
	Benzene	Toluene	Ethylbenzene	*m*- and *p*-xylene	*o*-xylene	Styrene
S1	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
S2	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
S3	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
S4	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
S5	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
S6	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
S7	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
S8	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

Table 2-10. Concentrations of VOC in soil samples

	Volatile organic substances (VOC), µg/kg													
Sampling point	Vinyl chloride	Dichloromethane	1,1-dichloroethane	1,2-dichloroethane	1,1-dichloroethene	1,2-dichloroethene	dichloropropane	Chloroform	1,1,2-trichloroethane	Trichloroethene	Tetrachloroethene	Chlorbenzene	Dichlorobenzene	Trichlorobenzene
S1	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	4.6	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
S2	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	4.0	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
S3	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	3.8	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
S4	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	3.6	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
S5	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	4.0	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
S6	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	4.2	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
S7	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	4.4	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
S8	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	3.9	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

Table 2-11. Limit and remediation values for aromatic hydrocarbons, volatile organic compounds and polychlorinated biphenyls, PAH and PCBs total according to the Regulation on Limit Values for Polluting, Harmful, and Hazardous Substances in Soil ("Official Gazette of RS", Nos. 30/2018 and 64/2019) (MDK¹- corrected limit value; MDK²- corrected remediation value)

Aromatic hydrocarbons, µg/kg	MDK¹	MDK²
Benzene	10	1000
Toluene	10	130000
Ethylbenzene	30	50000
Styrene	30	100000
Xylene	100	25000
Volatile organic compounds, µg/kg		
Vinyl chloride	10	100
Dichloromethane	400	10000
1,1-dichloroethane	20	15000
1,2-dichloroethane	20	4000
1,1-dichloroethene	10	300
1,2-dichloroethene	200	1000
Dichloropropane	2	2000
Chloroform	20	10000
1,1,2-trichloroethane	400	10000

Trichloroethene	100	60000
Tetrachloroethene	2	4000
PAH total*, mg/kg	1000	40000
PCBs total, mg/kg	20	1000

*Sum of: anthracene, benzo(a)anthracene, benzo(k) fluoranthene, benzo(a)pyrene

chrysene, phenanthrene, Indeno[1,2,3-cd]pyrene, fluoranthene, naphthalene, benzo[ghi] perylene

The measured concentrations of polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), aromatic hydrocarbons (BTEX), and volatile organic compounds (VOCs) were all found to be within the acceptable limit values specified by the Regulation on Limit Values for Pollutants, Harmful, and Hazardous Substances in Soil. These results indicate that the levels of these substances in the analyzed soil samples do not pose a risk under current regulatory standards. This compliance with established thresholds reflects the absence of significant contamination by these compounds at the tested locations.

Table 2-12 presents the results of soil sample testing for mineral oil content, along with the adjusted limit and remediation values.

Table 2-12. Concentration of mineral oils (C10-C40) and adjusted limit and remediation values (MDK[1] – limit value*, MDK[2]- remediation value*, * Correction of the limit and remediation values for mineral oils according to the Regulation on Limit Values for Polluting, Harmful, and Hazardous Substances in Soil ("Official Gazette of RS", Nos. 30/2018 and 64/2019) is carried out based on the organic matter content in the soil)

Sampling point	Mineral oils	MDK[1]	MDK[2]
S1	1.6	36.5	3650
S2	1.2	34.5	3450
S3	0.25	85.0	8500
S4	1.0	60.0	6000
S5	1.4	24.5	2450
S6	0.98	17.5	1750
S7	0.24	25.0	2500
S8	0.65	31	3100

Concentrations of mineral oils (C_{10}-C_{40}) in analysed soil samples do not exceed limit values.

3 ASSESSMENT OF POTENTIAL IMPACTS

A reduction in soil quality can have significant health and livelihood impacts on humans. Poor soil conditions can lead to reduced agricultural productivity, resulting in lower crop yields and poorer nutritional quality of food, which may contribute to malnutrition, especially in communities dependent on subsistence farming. Furthermore, the economic hardship caused by soil degradation can result in a loss of income for farmers. Direct exposure to contaminated soil can impact human health through inhalation, ingestion or dermal contact with contaminants present in the ground.

Contaminated soil can also leach chemicals and heavy metals into ground or surface waters, which can contaminate potable water supplies and lead to associated human health issues.

Soil degradation can also significantly impact flora, fauna, and habitats, reducing biodiversity and disrupting ecosystems. Poor soil quality can hamper plant growth, lead to decreased plant diversity and cause the loss of critical ecosystem services like carbon sequestration, water filtration, and soil stabilization. Any reduction in plant life can threaten herbivores that rely on specific vegetation for food, which, in turn, can disrupt food chains and endanger higher-level predators. Furthermore, degraded soils can contribute to a reduction in vital habitats, such as wetlands or forests, reducing the ability of some species to survive by limiting the availability of the resources they need to survive. A reduction in soil health can also diminish the land's resilience to climate change, making ecosystems more vulnerable to extreme weather events like droughts and floods.

Assumptions and Limitations

At the time of the assessment, the locations of laydown areas, construction camps, access roads, and spoil disposal sites are not known. As a result, the assessment is solely focused on impacts directly associated with the established Project AoI. However, the mitigation measures proposed will also apply to these Project components and should ensure the effective management of soil quality risks and impacts.

3.1 Impact Assessment Methodology

The standard methodology for assessing the impacts of the construction phase of the Project on soil quality is outlined in Chapter 5 of this ESIA. Any deviations from this methodology are outlined in the following Sections of this Chapter.

3.1.1 Magnitude

Magnitude defines the severity of an impact, or extent of changes to the baseline. To determine the magnitude of an impact, the methodology adopted for this assessment specifically includes an impact evaluation on human (human health, livelihoods, water supply, and flood risks) and ecological receptors (biological species, habitat integrity, biodiversity, and ecosystem services), and whether the impact is reversible or irreversible. For the purposes of this assessment, the different grades of the Magnitude of potential impacts on Soil have been defined as outlined in Table 3-1 below.

Table 3-1. Definition of grades for Magnitude

MAGNITUDE	Definition	GRADE
Low impact	Minimal disturbance with negligible long-term effects. The land remains functional and can recover easily. No significant change in land use or ecosystem function is expected.	1
Moderate impact	Moderate disturbance (e.g., soil contamination, compaction, or erosion) with effects that are manageable through standard intervention. Land use may shift slightly (e.g., reduced productivity or change in vegetation type), but the overall function remains recoverable with proper management.	2
High impact	Significant degradation that affects soil health, water retention, and productivity. Land use may need to change (e.g., from agricultural to non-productive or remedial use). Recovery requires active restoration efforts. Ecosystem services are noticeably reduced.	3
Very high impact	Severe, often irreversible damage, with long-term or permanent loss of land productivity and ecosystem function. Land use is fundamentally altered or rendered unusable for its original purpose. Recovery is extremely difficult and requires extensive, often uncertain restoration.	4

These magnitude grades are applied to both human and environmental receptors.

3.1.2 Sensitivity

For the purposes of the Soil Quality assessment, the definition of sensitivity for environmental and human receptors are outlined in Tables 3-2 and 3-3 below.

Table 3-2. Definition of grades for Sensitivity of environmental receptors

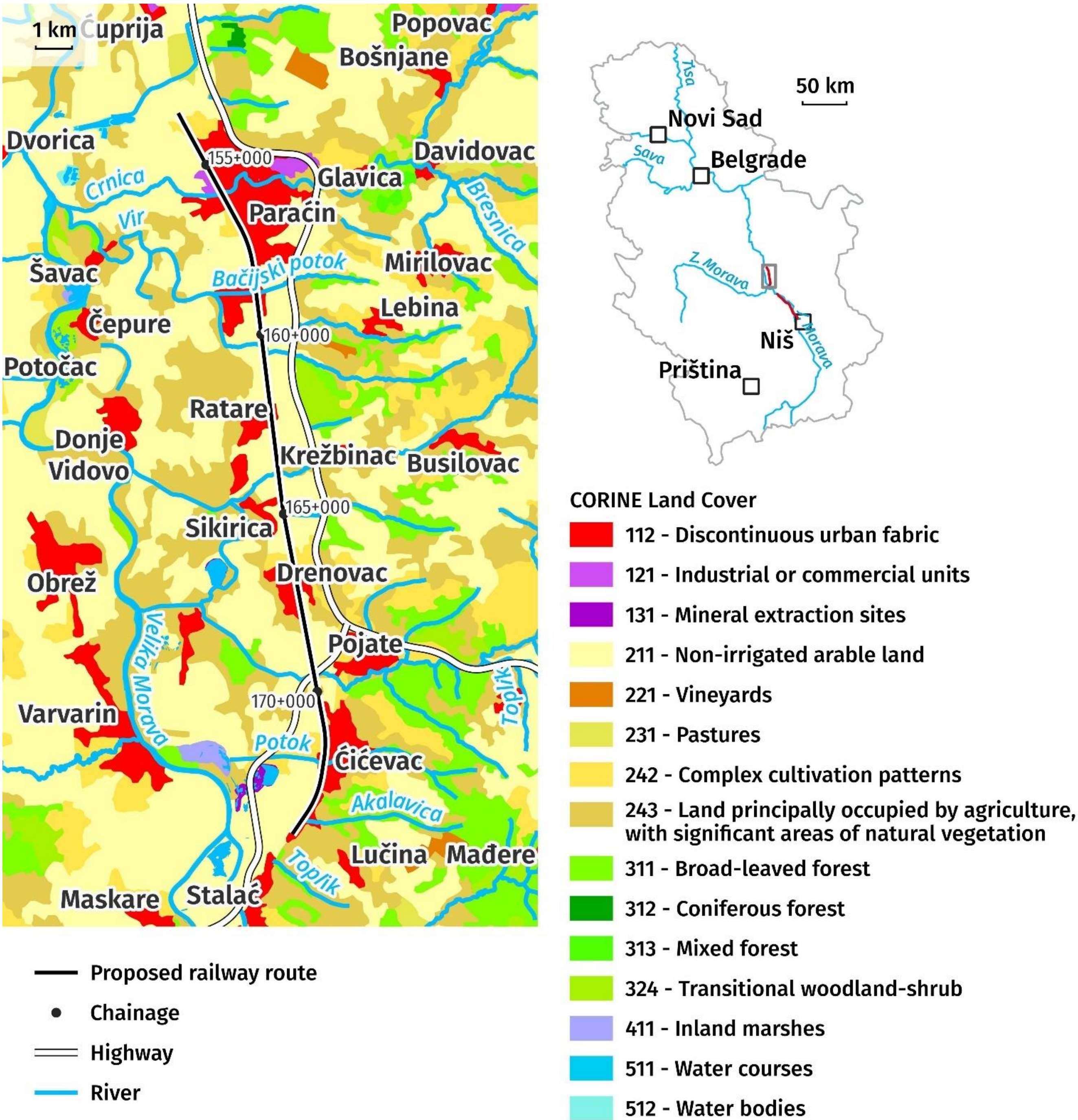
SENSITIVITY OF ENVIRONMENTAL RECEPTOR		GRADE
Low	Soils resistant to degradation, often in heavily altered or urbanized environments, with minimal biological activity (e.g., poorly vegetated desert soils or highly compacted industrial zones)	1
Moderate	Soils that are resilient, recover quickly from disturbance, and are found in areas with moderate fertility or industrial zones (e.g. sandy soils, urban soils, or non-ecologically sensitive areas)	2
High	Soils that can tolerate some disturbance but may require management for recovery (e.g., fertile agricultural soils, grasslands, and non-sensitive forests).	3
Very high	Soils that are highly vulnerable to disturbance, difficult to recover, and often found in sensitive ecosystems (e.g., wetlands, peat bogs, rare agricultural land, protected ecosystems)	4

The Project alignment runs through the Dobrič-Nišava IBA-protected area from km 220+315 to the end of Section 3, which is internationally important for bird conservation and a Proposed Special Protection Area (pSPA). This area is categorised as **Very-highly sensitive receptor** in this assessment. **High sensitivity receptors** include fertile agricultural soils, grasslands, and forests, while **Moderate sensitivity receptors** include urban soils within the Project AoI. Low sensitivity receptors are not present within the project area.

Table 3-3. Definition of grades for Sensitivity of human receptors

SENSITIVITY OF SOCIAL RECEPTOR		GRADE
Low	Communities least affected by land use changes, often in urbanized areas or those not reliant on specific land resources.	1
Moderate	Communities with some capacity to adapt to moderate disruptions, such as people in mixed-use areas. These areas are moderately sensitive to land use changes that could affect the quality of life.	2
High	Communities highly dependent on land for livelihood (farmers who rely on agricultural areas), who can experience significant impacts in land use change.	3
Very high	Communities highly dependent on land of cultural significance (e.g., indigenous communities, valuable old agricultural seedlings), with severe consequences from land use changes.	4

Considering the Project area, (the Paraćin–Ćićevac and Đunis–Trupale (Niš) sub-sections), three types of receptors regarding sensitivity may be distinguished: **High-sensitivity receptors** include farmers who rely on the agricultural land as a highly fertile type of soil and who may be significantly affected if land use changes; **Moderate- sensitivity receptors** include populations within rural settlements relying on the mixed-use land areas and who are moderately sensitive to land use changes but may still be affected in terms of economic activities or working conditions **Low-sensitivity receptors** are communities least affected by land use changes, often in urbanized areas who are reliant on specific land resources. **Very-high-sensitivity receptors** are not present in the AoI (Figure 3-1). It should be noted that potential impacts to the workforce from exposure to contaminated soils are addressed in the Occupational Health and Safety Chapter of this ESIA Report (Chapter 18).


1 km
Ćuprija
Popovac
Bošnjane
Dvorica
Davidovac
155+000
Glavica
Crnica
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Paraćin
Bresnica
Šavac
Bačijski potok
Mirilovac
Lebina
Čepure
160+000
Potočac
Ratare
Donje Vidovo
Krežbinac
Busilovac
165+000
Sikirica
Obrež
Drenovac
Velika Morava
Pojate
Varvarin
170+000
Toplik
Potok
Ćićevac
Akalavica
Lučina
Mađere
Toplik
Maskare
Stalać
Proposed railway route
Chainage
Highway
River
Tisa
50 km
Novi Sad
Sava
Belgrade
Z. Morava
Niš
Morava
Priština
CORINE Land Cover
112 - Discontinuous urban fabric
121 - Industrial or commercial units
131 - Mineral extraction sites
211 - Non-irrigated arable land
221 - Vineyards
231 - Pastures
242 - Complex cultivation patterns
243 - Land principally occupied by agriculture, with significant areas of natural vegetation
311 - Broad-leaved forest
312 - Coniferous forest
313 - Mixed forest
324 - Transitional woodland-shrub
411 - Inland marshes
511 - Water courses
512 - Water bodies

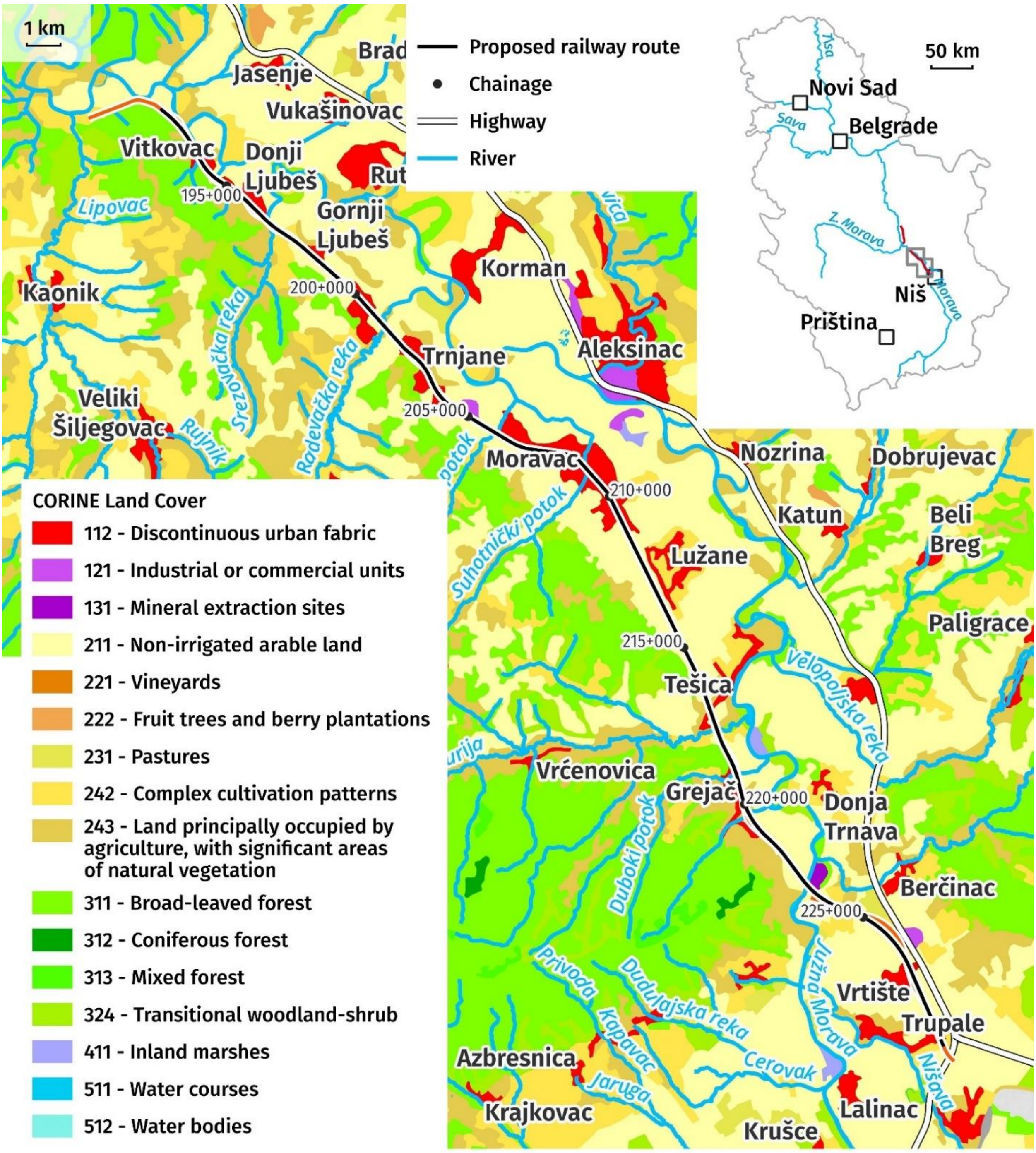

Figure 3-1. Land use for Paraćin–Ćićevac and Đunis–Trupale Sections

3.2 Construction Phase Impacts

Soil quality during railway construction can be impacted through compaction, which reduces soil porosity and water infiltration; erosion, which can lead to the loss of topsoil and nutrients; contamination, potentially from chemicals, waste, or construction materials; and alterations to soil structure, which can disrupt the natural composition and fertility. The creation of temporary access roads, construction camps, and improper waste management can also contribute to soil degradation, either through direct contamination or the disturbance of natural soil processes. Soil degradation can lead to reduced agricultural productivity. Soil compaction and erosion can damage habitats, reducing food availability and shelter, while contamination can introduce toxic substances into the environment. Additionally, altered soil structure can affect plant growth and biodiversity, which can disrupt the broader ecosystem. Finally, soil compaction and erosion can increase the risk of further issues, especially in areas with steep slopes. This could impact both the natural environment and human infrastructure.

Potential negative impacts on soil during the construction phase as a result of Project activities include:

- Contamination of soil
- Topsoil removal
- Soil compaction
- Change in land use
- Soil erosion

These potential impacts are assessed in the remainder of this Section. There are not expected to be any positive impacts on soil during construction.

3.2.1 Impact of soil contamination

Accidental soil contamination may occur during construction through direct spillage or leakage of hazardous materials, such as chemicals, oils, fuels, lubricants, and hydraulic fluids. These contaminants can leak from materials storage areas, containers, vehicles, or machinery. Additionally, soil contamination can be caused by mobilized contaminants in surface run-off, for example, from washing construction vehicles, or from untreated sanitary wastewater from construction camps. Improper handling or transport of hazardous materials and waste can further result in direct soil contamination, which poses a significant risk to both soil health and the surrounding environment.

3.2.1.1 Magnitude

The magnitude of impact from soil contamination is moderate to high, as contaminants such as oils, chemicals, and wastewater (generated as a result of concrete and cement mixing, vehicle and equipment washing, construction site runoff etc.) can significantly, even severely degrade soil quality. These substances can alter soil structure, pH, and microbial activity, and introduce toxic materials that harm plant and ecosystem health. Improper handling and maintenance of equipment (such as excavators, bulldozers, and cranes), as well as incorrect disposal of materials (such as asphalt and concrete), can further exacerbate contamination. As shown in Table 2-5, regulatory limit values of barium are already exceeded within the Project AoI, in addition to existing contamination from zinc, copper, cobalt, and nickel. The magnitude of the impact is considered to be moderate (grade 2) to 'High' (grade 3), depending on the receptors sensitivity, due to existing soil contamination, which could worsen as a result of construction activities, further increasing risks to human health and ecosystems.

3.2.1.2 Spatiotemporal impact

The influence of soil contamination is spatially localized but medium to high in temporal terms. Whilst contamination is expected to be localized to construction sites (Brooks, 2004; Chaiklieng, 2021; Qiao et al., 2023; Di Guardo et al., 2020; Li et al., 2012), its effects can last over 20 years, due to the persistence of pollutants like PAHs, BTEX, heavy metals, PCBs, and hydrocarbons (Doick et al., 2025; Yan et al., 2020). Based on the laboratory analysis of selected soil samples, which are in close proximity to railway track (where the highest input of contaminants is expected) the pollutants are unlikely to spread significantly beyond the immediate construction areas due to the low to medium permeability of the soil (see Table 2-4) and the localized nature of contamination. However, the medium- to long-term impacts on soil health can be severe if not mitigated, since low to medium permeable soil types are also present (Chapter 2.3). The spatiotemporal grade is 2 (localized, medium-term) to **3** (localized, long-term) depending on soil permeability.

3.2.1.3 Sensitivity

Three types of environmental receptors based on sensitivity are found within the AoI: very high-sensitivity receptors (4) are identified within the protected IBA-area (Dobrič-Nišava), high-sensitivity receptors (3), refer to the agricultural soils, grasslands, and forests, and moderate sensitivity receptors encompass urban soils.

'Sensitivity' of environmental receptors as explained above is the same for each impact and is applied to all other construction and operations phase impacts below. Impact Assessments have been conducted separately for each category of sensitive receptor.

3.2.1.4 Likelihood

The likelihood of soil contamination during the construction phase is high, driven by activities like wastewater discharge (from runoff, vehicle washing, concrete mixing), hazardous materials storage on site (fuels, oils, solvents, paints, and cement), and the use of chemicals. Improper storage and spills of these materials can introduce pollutants such as oils, solvents, and construction debris into the soil, leading to contamination, altering pH, reducing fertility, and harming soil organisms. Such substances can alter the soil's pH, nutrient content, and overall health, affecting not only the immediate environment but also the broader ecosystem and potentially human health through the food chain.

Impacts on environmental receptors due to soil contamination

The assessment of the significance of the impact of soil contamination on environmental receptors during the construction phase of the Project is summarised in Table 3-4 below.

Table 3-4. Significance of the impact of soil contamination on environmental receptors

Receptors	Magnitude	Spatiotemporal scale	Sensitivity	Likelihood	Overall significance
'Very high' sensitivity receptors	The magnitude of soil contamination is high due to the potential for severe degradation of soil quality. (3)	Soil contamination is localized to the construction site but has medium-term lasting effects (2).	Dobrič-Nišava IBA-protected area is very highly sensitive receptor (4)	The soil contamination during construction is likely (3)	M (3) + ST (2) + S (4) + L (3) = 12 (High)
'High' sensitivity receptors	The magnitude of soil contamination is high due to the potential for severe degradation of soil quality. (3)	Soil contamination is localized to the construction site but has medium-term lasting effects (2).	High sensitivity receptors (fertile agricultural soils, grasslands, and forests) (3)	The soil contamination during construction is likely (3)	M (3) + ST (2) + S (3) + L (3) = 11 (High)
'Moderate' sensitivity receptors	The magnitude of the impact is moderate due to the fact that urban soils are likely to have already been degraded by human activities, so the change in baseline contamination levels is expected to be less extensive. (2)	Soil contamination is localized to the construction site but has long-lasting effects as the permeability of soils within urban areas is higher (3).	Moderate sensitivity receptors (sandy and urban soils) (2)	The soil contamination during construction is likely (3)	M (2) + ST (3) + S (2) + L (3) = 10 (Moderate)

3.2.2 Impact of Topsoil Removal

Digging trenches and removing soil for track foundations and other infrastructure can lead to the removal of topsoil, which is vital for plant growth due to its high nutrient content and organic matter. The loss of topsoil during construction can range from 0.5% to 10% of the total soil volume. The impact of agricultural topsoil, which is expected to be removed during construction, is particularly significant because it contains the majority of the soil's organic matter, nutrients, and biological activity. This layer is essential for plant growth and agricultural productivity. The removal of topsoil can lead to a significant decrease in soil fertility, as organic matter content may be 2.6 to 8.8 times lower than in pre-disturbance conditions (Dai et al. 2022). Without substantial remediation efforts such as soil restoration, amendment with organic materials, or the reintroduction of soil microorganisms, this loss of fertility is unlikely to be temporary.

3.2.2.1 Magnitude

The magnitude of impact for the removal of topsoil can considered as high for very high and high sensitivity receptors, due to the likely significant effect on soil fertility and structure. However, the impact on urban soil is considered to be low as this soil is likely to already have been degraded by human activity. The loss of topsoil can lead to a reduction in organic matter, nutrients, and microbial activity, which are essential for plant growth and soil health. This impact is long-lasting if not mitigated properly, potentially leading to severe degradation of soil quality. The magnitude of the impact is low (grade 1) or high (grade 3) depending on the sensitivity of the receptors.

3.2.2.2 Spatiotemporal impact

Whilst the loss of topsoil can significantly affect the fertility and structure of the soil, this impact will be confined to the immediate areas of the construction site. The temporal aspect of the impact will depend on whether remediation efforts (like soil restoration) are implemented, but the impact can potentially last for 5-20 years (Medium term). The spatiotemporal impact grade is **2**.

3.2.2.3 Likelihood

Topsoil removal (at least temporarily) during the construction phase is considered certain due to activities such as excavations, and the creation of accommodation camps, laydown areas, storage areas etc. Excavation processes involve the removal of surface soil layers to make way for foundations, utilities, or other infrastructure. Since topsoil is the most fertile layer of soil, its removal can significantly affect the soil's ability to support vegetation and impact the surrounding ecosystem. The likelihood grade is **4**.

Impacts on environmental receptors due to topsoil removal

The assessment of the significance of the impact topsoil removal on environmental receptors during the construction phase of the Project is summarised in Table 3-5 below.

Table 3-5. Significance of the impact of topsoil removal on environmental receptors

Receptors	Magnitude	Spatiotemporal scale	Sensitivity	Likelihood	Overall significance
'Very high' sensitivity receptors	The impact of topsoil removal is high, as it significantly affects soil fertility, structure, and microbial activity (3)	The impact of topsoil removal is moderate and localized (2).	Dobrič-Nišava IBA-protected area is very highly sensitive receptor (4)	Topsoil removal during construction is certain (4)	M (3) + ST (2) + S (4) + L (4) = 13 (High)
'High' sensitivity receptors	The impact of topsoil removal is high, as it significantly affects soil fertility, structure, and microbial activity (3)	The impact of topsoil removal is moderate and localized (2).	High sensitivity receptors (fertile agricultural soils, grasslands, and forests) (3)	Topsoil removal during construction is certain (4)	M (3) + ST (2) + S (3) + L (4) = 12 (High)
'Moderate' sensitivity receptors	The impact is low due to topsoil in urban areas being likely to already have been degraded by human activities, so the change in baseline fertility and structure conditions is expected to be much less extensive (1)	The impact of topsoil removal is moderate and localized (2).	Moderate sensitivity receptors (sandy and urban soils) (2)	Topsoil removal during construction is certain (4)	M (1) + ST (2) + S (2) + L (4) = 9 (Moderate)

3.2.3 Impact of Soil compaction

Soil compaction occurs when vehicles and construction equipment move across the site, especially in wet conditions. The use of heavy construction machinery, such as bulldozers and excavators, compresses the soil, reducing its porosity and negatively affecting water retention, root growth, and soil aeration. This results in soil particles being pressed together, reducing the soil's porosity. Clay-dominated soils are particularly susceptible to compaction. Compaction limits the amount of oxygen available to plant roots, reduces the soil's ability to absorb water, and increases surface run-off. In wet conditions, this can lead to waterlogging. Compaction also heightens the potential for soil erosion and restricts plant root growth, all of which contribute to a decrease in soil health and agricultural productivity.

3.2.3.1 Magnitude

The impact from soil compaction is also considered moderate (in soils with lower baseline quality and sensitivity) to high (in soils with higher sensitivity), as compaction significantly affects soil porosity, water retention, and root growth. It reduces oxygen availability to plant roots and increases the risk of erosion and waterlogging. If not managed properly, compaction can lead to long-term degradation of soil structure, negatively affecting agricultural productivity. The magnitude of influence is moderate (grade 2) to high (grade 3), depending on receptor sensitivity.

3.2.3.2 Spatiotemporal impact

The impact of soil compaction is expected to be localized, affecting areas used frequently by heavy machinery and construction vehicles and equipment. The compaction could last for a considerable period (5-20 years (Nawaz et al., 2013)), especially if the soil is not restored or rehabilitated post-construction. The spatiotemporal grade is 2 (localized, medium-term).

3.2.3.3 Likelihood

Soil compaction is likely to occur during the construction phase, primarily due to the anticipated use of heavy machinery and equipment such as bulldozers, trucks, and cranes, which will exert significant pressure on the soil, compress soil particles and reducing porosity. The impact of machinery on the soil's structure is a common and expected consequence of construction activities

Impacts on environmental receptors due to the soil compaction

The assessment of the significance of the impact of soil compaction on environmental receptors during the construction phase of the Project is summarised in Table 3-6 below.

Table 3-6. Significance of the impact of soil compaction on environmental receptors

Receptors	Magnitude	Spatiotemporal scale	Sensitivity	Likelihood	Overall significance
'Very high' sensitivity receptors	The impact of soil compaction is high, as it reduces soil porosity, water retention, and root growth (3)	The impact of soil compaction is localized to areas affected by construction activities, lasting several years (2).	Dobrič-Nišava IBA-protected area is very highly sensitive receptor (4)	Soil compaction is likely to occur during construction due to the use of heavy machinery (3)	M (3) + ST (2) + S (4) + L (3) = 12 (High)
'High' sensitivity receptors	The impact of soil compaction is high, as it reduces soil porosity, water retention, and root growth (3)	The impact of soil compaction is localized to areas affected by construction activities, lasting several years (2).	High sensitivity receptors (fertile agricultural soils, grasslands, and forests) (3)	Soil compaction is likely to occur during construction due to the use of heavy machinery (3)	M (3) + ST (2) + S (3) + L (3) = 11 (High)
'Moderate' sensitivity receptors	The impact of soil compaction is moderate as urban soils may already have experienced some level of compaction or degradation due to human activities, so that the change in the baseline condition of the soil is expected to be less extensive (2)	The impact of soil compaction is localized to areas affected by construction activities, lasting several years (2).	Moderate sensitivity receptors (sandy and urban soils) (2)	Soil compaction is likely to occur during construction due to the use of heavy machinery (3)	M (2) + ST (2) + S (2) + L (3) = 9 (Moderate)

3.2.4 Impact of change in Land use

The impact on land use during railway construction can be significant, involving the transformation of natural or agricultural land. The resulting changes in land use may be permanent (to facilitate the realignment of the railway (see Table 2-1); as a result of which previously undeveloped or differently utilized land may be converted for use by the Project, and sections of the existing route may be abandoned, repurposed, or redeveloped) or temporary (as a result of the installation of construction access roads and camps etc., but whose locations are still undetermined).

3.2.4.1 Magnitude

The magnitude of the impact on land use during railway construction is moderate (grade 2) to very high (grade **4**) since land will be permanently taken for new tracks (where the route will need to deviate from the current alignment), stations, and infrastructure, as well as temporarily for construction access roads, camps, lay down areas etc. This will result in permanent changes in the condition of soil and use of the land, as well as temporary changes, that even following reinstatement may result in a short to medium term loss of soil condition.

3.2.4.2 Spatiotemporal impact

The spatiotemporal impact on land use during railway construction is localized but long-term/permanent (grade **3**). Spatially, the impact will affect areas used for tracks, stations, depots, and infrastructure (it is expected that mainly agricultural land will be affected). Temporally, the construction phase itself typically lasts several years, but the land use changes are permanent, with long-term consequences for the surrounding areas. These changes can persist for decades or even centuries, as the altered landscape and new urban or industrial developments continue to influence land use patterns well after construction is completed.

3.2.4.3 Sensitivity

In addition to the environmental receptors outlined in Section 3.2.1.3, there are additionally three types of human receptor based on sensitivity within the AoI that will be impacted by changes in land use: high-sensitivity receptors (3), which are farmers dependent on fertile agricultural land for their livelihoods; moderate-sensitivity receptors (2), which are populations relying to the mixed-use land areas; and low-sensitivity receptors (1) which are populations in urban areas.

3.2.4.4 Likelihood

The likelihood of the impact on land use during railway construction is considered as certain (Grade **4**) as it is known that land will need to be taken to accommodate deviations in the route alignment. Furthermore, land will need to be temporarily re-purposed for construction access roads, camps, lay down areas, storage areas etc.

Impacts on environmental receptors due to change in land use

The assessment of the significance of the impact of change in land use on environmental receptors during the construction phase of the Project is summarised in Table 3-7 below.

Table 3-7. Significance of the impact of change of land use on environmental receptors

Receptors	Magnitude	Spatiotemporal scale	Sensitivity	Likelihood	Overall significance
'Very high' sensitivity receptors	The impact of railway construction on land use is very high, causing permanent habitat loss within a protected area for birds and ecosystem disruption (4)	The impact of railway construction on land use is localized and long-lasting (3).	Dobrič-Nišava IBA-protected area is very highly sensitive receptor (4)	The impact on land use during railway construction is certain, as it requires large land transformations (4)	M (4) + ST (3) + S (4) + L (4) = 15 (High)
'High' sensitivity receptors	The impact of railway construction on land use is high, causing permanent loss of agricultural soils, grasslands and forests (3)	The impact of railway construction on land use is localized and long-lasting (3).	High sensitivity receptors (fertile agricultural soils, grasslands, and forests) (3)	The impact on land use during railway construction is certain, as it requires large land transformations (4)	M (3) + ST (3) + S (3) + L (4) = 13 (High)

Receptors	Magnitude	Spatiotemporal scale	Sensitivity	Likelihood	Overall significance
'Moderate' sensitivity receptors	The impact is moderate as urban soils or soils in non-ecologically sensitive zones are less valuable, and their loss is unlikely to impact agricultural productivity or ecosystem function to higher extent (2)	The impact of railway construction on land use is localized and long-lasting (3).	Moderate sensitivity receptors (sandy and urban soils) (2)	The impact on land use during railway construction is certain, as it requires large land transformations (4)	M (2) + ST (3) + S (2) + L (4) = 11 (High)

Impacts on human receptors due to change in land use

The assessment of the significance of the impact of change in land use on human receptors during the construction phase of the Project is summarised in Table 3-8 below.

Table 3-8. Significance of the impact of change of land use on human receptors

Receptors	Magnitude	Spatiotemporal scale	Sensitivity	Likelihood	Overall significance
'High' sensitivity receptors	The impact of railway construction on land use is very high, causing permanent loss of fertile agricultural soils. (4)	The impact of railway construction on land use is localized and long-lasting (3).	Communities that rely on agricultural areas for their livelihoods have high sensitivity (3)	The impact on land use during railway construction is certain, as it requires large land transformations (4)	M (4) + ST (3) + S (3) + L (4) = 14 (High)
'Moderate' sensitivity receptors	The impact of railway construction on land use is high, causing permanent change in land use that will reduce the area of available productive land. (3)	The impact of railway construction on land use is localized and long-lasting (3).	Communities relying on mixed-use land areas have moderate sensitivity. (2)	The impact on land use during railway construction is certain, as it requires large land transformations (4)	M (3) + ST (3) + S (2) + L (4) = 12 (High)
'Low' sensitivity receptors	The impact of railway construction on land use is moderate as the land use will permanently change, however, urban communities are not reliant on specific land resources, e.g. for agricultural purposes. (2)	The impact of railway construction on land use is localized and long-lasting (3).	Communities least affected by land use changes, often in urbanized areas (1)	The impact on land use during railway construction is certain, as it requires large land transformations (4)	M (2) + ST (3) + S (1) + L (4) = 10 (Moderate)

3.2.5 Impact of Soil Erosion

Soil erosion can occur following vegetation removal during construction, especially on slopes where surface runoff can mobilize loose sediment. This is most likely to occur at the entrance and exit portals to the Dunis Tunnel.

Excavation and piling activities required for foundation work (for underpasses, overpasses, bridges and viaducts) can also disturb the soil structure, potentially leading to soil erosion (Chandio et al., 2017, Suryanto & Lim, 2018, Huang & Zhao, 2019).

The causes and potential locations of soil erosion during the construction phase are therefore expected to include:

- The construction of the Dunis tunnel (the entrance portal is at km 192+274, and the exit portal is at km 192+854).
- The Construction of overpasses at km 153+941.53, km 169+150, km 170+132, km 172+515, km 193+051, km 210+360, km 212+668, km 214+249, km 219+404, km 221+359, and km 227+126
- The Construction of underpass at km 155+991.45, km 156+851, km 158+955, km 162+505, km 164+502, km 166+669, km 171+793, km 173+134, km 194+665, km 196+164, km 197+383, km 200+277, km 202+340, km 205+802, km 206+821, km 208+746, km 217+044, km 223+500, and km 229+419.
- The construction and/or reconstruction of bridges and viaducts at km 155+908.80, km 163+861.90, km 169+425.70, km 172+051.85, km 173+709.21, km 193+426.23, km 196+848.21, km 201+255.67, km 205+958.44, km 217+642.36, km 219+097.12, km 220+544.70, km 223+054.78, km 223+205.49.

3.2.5.1 Magnitude

The construction of bridges, viaducts, overpasses, and underpasses will increase the risk of soil erosion due to vegetation removal, soil disturbance, and changes in surface water drainage and runoff patterns. When vegetation is removed, the soil is left unprotected and becomes more susceptible to wind and water erosion. Thus, considering the planned project activities, the magnitude of soil erosion is considered as moderate during the railway constructions (with a grade of **2**), or high for very sensitive receptors (grade 3).

3.2.5.2 Spatiotemporal impact

According to the data provided in Chapter 8 of this ESIA (Geology), the Project AoI is mainly within geological units 96 and 98 that are considered vulnerable to soil erosion. As such, the impact of soil erosion during railway construction is short-term and expected to occur throughout the Project AoI wherever vegetation is removed or soil is disturbed for the construction of bridges, crossings etc. but will be very localized to the immediate vicinity of the construction sites. During construction, especially when vegetation is removed, soil is exposed to rainfall and wind, resulting in short-term increased risks of erosion. However, after construction is completed, erosion impacts are expected to cease, as the land will stabilise and revegetation will occur in the medium term. Thus, during the construction phase there is predicted to be a spatiotemporal impact grade of **2**.

3.2.5.3 Likelihood

Construction activities, such as excavation, embankment building, and soil compaction, expose soil to environmental factors like rainfall and wind, which increases the risk of erosion. In areas with unstable soil, steep slopes, or altered hydrological conditions, the disturbance caused by these activities can exacerbate soil erosion, leading to sediment runoff and further instability. According to the data provided in Chapter 8 of this ESIA (Geology), the Project AoI is mainly within geological units 96, 98 that are considered vulnerable to soil erosion. Thus, soil erosion during railway construction is considered to be likely (grade **3**).

Impacts on environmental receptors due to a change in baseline terrain stability

The assessment of the significance of soil erosion on environmental receptors during the construction phase of the Project is summarised in Table 3-9 below.

Table 3-9. Significance of the impact of soil erosion on environmental receptors

Receptors	Magnitude	Spatiotemporal scale	Sensitivity	Likelihood	Overall significance
'Very high' sensitivity receptors	The magnitude of the impact is high as excavation and piling activities during the construction of overpasses, underpasses, bridges and viaducts are expected to cause significant soil erosion and degradation within a protected area (3)	The impact is expected to be short term – less than 5 years and very localized since activities causing the impact will only occur during railway construction (2).	Dobrič-Nišava IBA-protected area is very highly sensitive receptor (4)	Soil erosion is considered likely to happen during construction (Pereira et., 2015) (3)	M (3) + ST (2) + S (4) + L (3) = 12 (High)
'High' sensitivity receptors	The magnitude of the impact is moderate as excavation and piling activities during the construction of the tunnel, overpasses, underpasses, bridges and viaducts are expected to cause soil erosion that results in moderate, but not unmanageable disturbance, (2)	The impact is expected to be short term – less than 5 years and very localized since activities causing the impact will only occur during railway construction (2).	High sensitivity receptors (fertile agricultural soils, grasslands, and forests) (3)	Soil erosion is considered likely to happen during construction (Pereira et., 2015) (3)	M (2) + ST (2) + S (3) + L (3) = 10 (Moderate)
'Moderate' sensitivity receptors	The magnitude of the impact is moderate due to the fact that soil erosion is not expected to have an extensive impact on productivity or the function of the land in urban areas (2)	The impact is expected to be short term – less than 5 years and very localized since activities causing the impact will only occur during railway construction (2).	Moderate sensitivity receptors (sandy and urban soils) (2)	Soil erosion is considered likely to happen during construction (Pereira et., 2015) (3)	M (2) + ST (2) + S (2) + L (3) = 9 (Moderate)

3.3 Operations Phase Impacts

During the operations phase of the railway, ongoing impacts on soil can include compaction (both directly beneath the rail tracks and in adjacent areas) from the constant weight and vibration of trains, which reduces soil porosity and drainage capacity, and direct pollution from leaking/spilled oil, fuel, and particulate matter deposited by the trains as well as the application of herbicides. These factors can degrade soil quality, harm plant growth, and disrupt microbial communities. Additionally, repetitive stresses as a result of the factors listed above on the soil can lead to erosion or instability, particularly on embankments or near access points.

The main impacts of concern on soil quality during the operational phase are:

- Contamination of soil
- Soil erosion.

3.3.1 Impact of soil contamination

The main cause of soil contamination during the operational phase is direct soil contamination, which primarily results from maintenance activities such as track maintenance and railway infrastructure repairs. Additionally, stormwater runoff, waste disposal, and the application of herbicides contribute to soil degradation. Herbicides, used in railway construction and maintenance to control unwanted vegetation along tracks, construction zones, and surrounding areas, include chemicals such as Glyphosate, Atrazine, 2,4-D, Dicamba, and Paraquat. These chemicals help prevent plant growth that could obstruct rail infrastructure, reduce visibility, or pose safety risks. However, the unnecessary overuse of herbicides increases the risk of these chemicals leaching into the soil and groundwater, posing significant environmental and health risks.

3.3.1.1.1 Magnitude

The magnitude of impacts on soil contamination due to maintenance activities is considered to be low (grade 1) to moderate (grade **2**). While these activities are typically routine, they can still introduce contaminants into the soil. Proximity to railways leads to increased heavy metal concentrations in soil, mainly due to mechanical wear, chemical use, maintenance, and pesticide application (Fruhwirt et al., 2025; Vaiškūnaitė & Jasiūnienė, 2020 and the references cited within). The types of heavy metals found in the Project area align with those reported in previous studies, indicating consistency with known contamination patterns from railway activities. For example, the use of chemicals in track maintenance or infrastructure repairs, as well as the disposal of waste or stormwater runoff, can degrade soil quality over time. These activities might not cause immediate or severe contamination but can gradually affect the soil's structure, microbial activity, and fertility if not properly managed. This is consistent with findings from Stojic et al. (2017), who reported that concentrations of copper, cobalt, and nickel in soils near railways were around 20–30% higher than baseline levels—supporting the classification of the impact magnitude as moderate.

3.3.1.1.2 Spatial Extent and Duration (Spatiotemporal impact)

The spatiotemporal scale of impacts of soil contamination during the maintenance activities are short-term (less than 5 years) and very localized (grade **2**). In contrast to the construction phase where there are expected to be intensive activities using heavy machinery that could result in spills/leaks of contaminants, during the maintenance phase a significantly lower quantity and variety of contaminants are expected to present a risk to soil quality. Chemicals such as herbicides (that may be used for railway maintenance) can affect localized areas, with persistence ranging from a few days to several months, depending on soil type, weather, and microbial activity. Fuels and lubricants, which may spill or be used in maintenance, can have longer-lasting impacts compared to chemicals, with diesel and oils persisting for months to over a year. De-icing agents can have an indefinite presence in the soil, particularly in areas with frequent applications. They play a crucial role in maintaining safe and efficient railway transport during winter conditions by preventing the formation of ice on tracks, switches, and other infrastructure (e.g. bridges are more prone to freezing, and de-icing agents are used to ensure that ice doesn't form and cause disruptions). For all types of chemicals, impacts are typically confined to the immediate area of the spill, making them localized.

3.3.1.1.3 Likelihood

The likelihood of the impact of soil contamination during the operational phase and routine railway maintenance is considered possible. Maintenance activities generally cause minimal disturbance to the soil, with the primary risks being occasional spills of fuel or lubricants. These routine activities typically do not result in significant soil degradation, as any spills are usually rare and can be managed quickly. Grade **2**.

Impacts on environmental receptors due to a change in baseline soil quality due to maintenance activities

Impacts of soil quality on birds as environmental receptors cause decrease in biodiversity, and harm wildlife habitats by altering nutrient availability and contaminating the soil with harmful substances.

The assessment of the significance of impacts on sensitive receptors due to a reduction in soil quality due to maintenance activities during the operational phase of the Project is summarised in Table 3-10 below.

Table 3-10. Significance of the impact of soil contamination on environmental receptors

Receptors	Magnitude	Spatiotemporal scale	Sensitivity	Likelihood	Overall significance
'Very high' sensitivity receptors	The use of chemicals in track maintenance or infrastructure repairs can noticably degrade soil quality. The magnitude is moderate (2)	The impact is expected to be short-term (less than 5 years) and very localized (2)	Dobrič-Nišava IBA-protected area is very highly sensitive receptor (4)	A change in soil quality is considered possible during the operational phase (2) (Davenport and Switalski, 2006)	M (2) + ST (2) + S (4) + L (2) = 10 (Moderate)
'High' sensitivity receptors	The use of chemicals in track maintenance or infrastructure repairs can noticeably degrade soil quality. The magnitude is moderate (2)	The impact is expected to be short-term (less than 5 years) and very localized (2)	High sensitivity receptors (fertile agricultural soils, grasslands, and forests) (3)	A change in soil quality is considered possible during the operational phase (2) (Davenport and Switalski, 2006)	M (2) + ST (2) + S (3) + L (2) = 9 (Moderate)
'Moderate' sensitivity receptors	The use of chemicals in track maintenance or infrastructure repairs will have low magnitude (1)	The impact is expected to be short-term (less than 5 years) and very localized (2)	Moderate sensitivity receptors (sandy and urban soils) (2)	A change in soil quality is considered possible during the operational phase (2) (Davenport and Switalski, 2006)	M (1) + ST (2) + S (2) + L (2) = 7 (Low)

3.3.2 Impacts on Soil erosion

The operational phase of a railway can affect soil erosion, although the impacts are generally less extensive than during the construction phase. The main factors influencing soil erosion during railway operation include:

- Water Drainage Alterations: Railways can alter natural drainage patterns, especially if proper drainage systems are not in place. This can lead to increased surface runoff or changes in groundwater levels, potentially leading to erosion or destabilizing slopes.
- Maintenance Activities: Continuous maintenance, such as track adjustments or repairs, can also disturb the ground, leading to localized soil erosion or compaction around the railway infrastructure

While the operations phase tends to result in more gradual impacts compared to the construction phase, long-term effects on soil erosion should still be monitored and managed, particularly in areas with challenging topography or sensitive soils.

3.3.2.1 Magnitude

The magnitude of the impact of soil erosion during the operational phase of a railway is estimated as as low to moderate based on data provided in Chapter 8 of this ESIA Report (Table 8-2 and Figure 8-4). These indicate that the Project AoI is mainly comprised of geological units 1, 96, and 98 (Figure 8-4). . While unit 1 poses minimal erosion risk, units 96 and 98 present significant (moderate to high) susceptibility to erosion and instability, especially under conditions of altered surface drainage and ongoing railway maintenance. During this phase, factors such as the vibrations from passing trains, the constant weight and pressure from the trains, and changes to the natural drainage patterns and affect the terrain stability (Gutiérrez & Martínez, 2010). These impacts can disrupt the stability of the ground, affecting the railway's safety and surrounding infrastructure, but can be managed with basic restoration efforts.

3.3.2.2 Spatial Extent and Duration (Spatiotemporal impact)

The spatiotemporal scale of the impact of soil erosion during railway maintenance is long-term (over 20 years) and very localized. The spatial extent is usually limited to the railway corridor itself and possibly a small surrounding area (as the railway embankments and drainage systems are expected to contain the impact within the immediate railway corridor.) The duration of these impacts can span over several decades, with a gradual deterioration in terrain stability being possible without proper management, such as drainage system and track maintenance.

3.3.2.3 Likelihood

Soil erosion is likely to occur to some extent over time, especially in areas with softer or poorly compacted soils, or in regions with frequent and heavy train traffic. The main areas that are vulnerable to the erosion within the Project AoI belong to the geological units 98 and 96 (See Chapter 8, Geology: Table 8-2 and Figure 8-4). However, the impacts are typically manageable with proper maintenance, including effective drainage systems, routine track monitoring, and soil stabilization efforts. In well-maintained environments with stable soil and minimal disturbances, the likelihood of significant soil erosion is relatively low, but some degree of localized compaction or erosion may still occur gradually over the long term.

Impacts on environmental receptors due to soil erosion

The assessment of the significance of impacts on sensitive receptors due to soil erosion during the operational phase of the Project is summarised in Table 3-11 below.

Table 3-11. Significance of the impact of soil erosion on environmental receptors

Receptors	Magnitude	Spatiotemporal scale	Sensitivity	Likelihood	Overall significance
'Very high' sensitivity receptors	The magnitude of the impact of soil erosion is moderate (2)	The impact is expected to be medium term (5 - 20 years) and very localized (2)	Dobrič-Nišava IBA-protected area is very highly sensitive receptor (4)	Soil erosion is considered possible to occur during the operations phase (2)	M (2) + ST (2) + S (4) + L (2) = 10 (Moderate)
'High' sensitivity receptors	The magnitude of the impact of soil erosion is moderate (2)	The impact is expected to be medium term (5 - 20 years) and very localized (2)	High sensitivity receptors (fertile agricultural soils, grasslands, and forests) (3)	Soil erosion is considered possible to occur during the operations phase (2)	M (2) + ST (2) + S (3) + L (2) = 9 (Moderate)
'Moderate' sensitivity receptors	The magnitude of the impact of soil erosion is low (1)	The impact is expected to be medium term (5 - 20 years) and very localized (2)	Moderate sensitivity receptors (sandy and urban soils) (2)	Soil erosion is considered possible to occur during the operations phase (2)	M (1) + ST (2) + S (2) + L (2) = 7(Low)

3.4 Summary of impacts

Table 3-12. Summary of Significance of Construction and Operations Phase Impacts on Soil

Project Phase	Impact	Positive/Negative	Receptor sensitivity	Overall significance before mitigation measures are implemented
Construction	Impact of soil contamination	Negative	'Very High' sensitivity receptors	High
			'High' sensitivity receptors	High
			'Moderate' sensitivity receptors	Moderate
Construction	Impact of topsoil removal	Negative	'Very high' sensitivity receptors	High
			'High' sensitivity receptors	High
			'Moderate' sensitivity receptors	Moderate

Project Phase	Impact	Positive/Negative	Receptor sensitivity	Overall significance before mitigation measures are implemented
Construction	Impact of soil compaction	Negative	'Very high' sensitivity receptors	High
			'High' sensitivity receptors	High
			'Moderate' sensitivity receptors	Moderate
Construction	Impact of change in land use	Negative	'Very high' sensitivity receptors	High
			'High' sensitivity receptors	High
			'Moderate' sensitivity receptors	High
			'Low' sensitivity receptors	Moderate
Construction	Impact of soil erosion	Negative	'Very high' sensitivity receptors	High
			'High' sensitivity receptors	Moderate
			'Moderate' sensitivity receptors	Moderate
Operation	Impact of soil contamination	Negative	'Very high' sensitivity receptors	Moderate
			'High' sensitivity receptors	Moderate
			'Moderate' sensitivity receptors	Low
Operation	Impact of soil erosion	Negative	'Very high' sensitivity receptors	Moderate
			'High' sensitivity receptors	Moderate
			'Moderate' sensitivity receptors	Low

4 MITIGATION MEASURES

To ensure adequate and targeted implementation of mitigation measures, different sensitivity zones have been defined based on the location of receptors of different sensitivities.

During the impact assessment study, three sensitivity zones within a 500-meter buffer around the railway were identified as relevant for this assessment.

'**Very-highly Sensitive Zones**' with a high density of very-highly sensitive receptors are located within the Dobrič-Nišava IBA-protected area, which is internationally important for bird conservation and Proposed Special Protection Area (pSPA) from km 220+315 to the end of Section 3.

'**Highly Sensitive Zones**' with a high density of highly sensitive receptors are located in the cultivated areas along the Velika and Južna Morava River. These zones include: from km 159+000 to km170+000, from km 191.950 to km 206+000, from km 211+000 to km 224+000.

'**Moderate Sensitivity Zones**' refer to areas within the Project AoI that are part of urban and rural settlements. These moderate sensitivity zones are located between the following: from km 154+000 to km 159+000, from km 170+000 to km 173+000, from km 206+000 to km 211+000.

4.1 Construction Phase

The mitigation strategies during the construction phase are aimed at protecting sensitive receptors by controlling sources and causes of soil loss, pollution, degradation and erosion.

The Contractor will develop a Construction Water and Soil Management Plan that will outline the measures that must be implemented to mitigate the negative impacts of railway construction activities on soil (as well as water). As needed monitoring of heavy metals (especially Co and Ni concentrations whose values have been already exceeded limits according to baseline study) should be organized in response to accidents resulting in land contamination during the construction stage,

Table 4-1 defines the mitigation measures proposed to mitigate the identified impacts on soil, which should, as a minimum be included in the Construction Water and Soil Management Plan to be developed and implemented by the Contractor.

Table 4-1. Proposed Soil Mitigation Measures during Construction Phase

Impact	Mitigation measures
Impact of soil contamination on very highly sensitive zones	- Establish a Spill Response Team led by a Spill Response Coordinator to oversee spill containment and cleanup. - Respond to spills immediately to limit contamination. - Excavate contaminated soil carefully and store it in sealed containers to avoid further contamination. - Transport contaminated soil to licensed disposal sites equipped for hazardous waste. - Ensure proper documentation of waste disposal and follow regulations for safe transport and handling. - Drip trays are to be placed beneath any stationary construction equipment to catch leaks of fuel/oil. - Appropriately and adequately stocked spill kits are to be available at all construction sites to clear up any accidental spills/leaks of fuel/oil/chemicals. - Work activities must immediately be interrupted in case of an uncontrolled spillage of fuel, engine oil, chemicals, etc., and remediation of the contaminated soil undertaken by removing the contaminated soil layer from the site to be further treated as hazardous waste and restoring the new soil layer. - No servicing, washing, or maintenance, re-fuelling of trucks and construction machines will be carried out on bare ground but in dedicated areas with impermeable surfaces. - Fuel must be stored in designated areas only, in double-skinned containers or tanks placed within a protected separation pit equipped with an oil-resistant cover. The volume of this pit must exceed the maximum capacity of the barrel/tank placed in the pit by at least 10% in case of leakage. - Hazardous liquids (including chemicals and oils) must be stored in designated hazardous materials storage areas only, in clearly labelled containers within secondary containment (110% of the volume of the container). - Waste must only be stored in designated areas on construction sites/camps with underlying impermeable surfaces and never on bare soil. - If monitoring indicates impacts, additional measures and revised plans will be implemented, including on-demand monitoring of heavy metals (Co, Ni) and soil quality in nearby agricultural fields for early contamination detection and remediation.
Impact of soil contamination on highly sensitive zones	- Establish a Spill Response Team led by a Spill Response Coordinator to oversee spill containment and cleanup. - Respond to spills immediately to limit contamination. - Excavate contaminated soil carefully and store it in sealed containers to avoid further contamination. - Transport contaminated soil to licensed disposal sites equipped for hazardous waste. - Ensure proper documentation of waste disposal and follow regulations for safe transport and handling.

Impact	Mitigation measures
	■ Drip trays are to be placed beneath any stationary construction equipment to catch leaks of fuel/oil. ■ Appropriately and adequately stocked spill kits are to be available at all construction sites to clear up any accidental spills/leaks of fuel/oil/chemicals. ■ No servicing, washing, or maintenance, re-fuelling of trucks and construction machines will be carried out on bare ground but in dedicated areas with impermeable surfaces. ■ Waste must only be stored in designated areas on construction sites/camps with underlying impermeable surfaces and never on bare soil. ■ If monitoring indicates impacts, additional measures and revised plans will be implemented, including on-demand monitoring of heavy metals (Co, Ni) and soil quality in nearby agricultural fields for early contamination detection and remediation.
Impact of soil contamination on moderately sensitive zones	■ Establish a Spill Response Team led by a Spill Response Coordinator to oversee spill containment and cleanup. ■ Excavate contaminated soil carefully and store it in sealed containers to avoid further contamination. ■ Appropriately and adequately stocked spill kits are to be available at all construction sites to clear up any accidental spills/leaks of fuel/oil/chemicals. ■ Waste must only be stored in designated areas on construction sites/camps with underlying impermeable surfaces and never on bare soil.
Impact of topsoil removal on very highly sensitive zones	■ Store topsoil in designated, well-drained areas where it is shielded from wind and water erosion. Utilize temporary barriers like silt fences or windbreaks to minimize erosion risk. ■ If topsoil is to be stored for longer than 3 months, the soil must be turned at monthly intervals to aerate the soil. ■ During dry conditions, topsoil stockpiles must be watered to maintain moisture levels and preserve the soil's microbial life and fertility. ■ Avoid compaction of topsoil stockpiles by preventing encroachment by heavy machinery or equipment with fencing. ■ The top layer of soil will be removed (preferably in dry conditions) and stored separately to prevent mixing with sub-soil, until construction works are completed, ■ Topsoil stockpiles will be located at least 50 m distance from any watercourses to avoid water siltation. ■ Topsoil stockpiles should not be located adjacent to future planned excavations. ■ The height of the stockpiles should not exceed 2 m. ■ The gradient of topsoil stockpile slopes should not exceed 25º. ■ Topsoil stockpiles will be clearly labelled as such. ■ Topsoil stockpiles will be covered to avoid soil erosion where natural revegetation has not occurred.

Impact	Mitigation measures
	Drainage channels will be installed around the base of topsoil stockpiles if required to direct run-off away from the stockpile. Specifically designated areas for temporary stockpiling of excavated material to be reused or for spoil disposal must be identified that exclude sensitive biodiversity habitats, sloping areas, and river flood plains. Excavated material must be re-used where possible. Excess material that cannot be reused will be disposed of at a designated spoil disposal site only.
Impact of topsoil removal on highly sensitive zones	Store topsoil in designated, well-drained areas where it is shielded from wind and water erosion. Utilize temporary barriers like silt fences or windbreaks to minimize erosion risk. In dry conditions, water stored topsoil to maintain moisture levels and preserve the soil's microbial life and fertility. Prevent compaction of stored topsoil by avoiding heavy machinery or equipment from operating on topsoil stockpiles. If needed, provide a buffer layer of gravel or other material to minimize compression. Topsoil stockpiles will be located at least 50 m distance from any watercourses to avoid water siltation. Topsoil stockpiles should not be located adjacent to future planned excavations. The height of the stockpiles should not exceed 2 m. The gradient of topsoil stockpile slopes should not exceed 25º. Topsoil stockpiles will be clearly labelled as such. Drainage channels will be installed around the base of topsoil stockpiles if required to direct run-off away from the stockpile. Specifically designated areas for temporary stockpiling of excavated material to be reused or for spoil disposal must be identified that exclude sensitive biodiversity habitats, sloping areas, and river flood plains. Excavated material must be re-used where possible. Excess material that cannot be reused will be disposed of at a designated spoil disposal site only.
Impact of topsoil removal on moderately sensitive zones	Store topsoil in designated, well-drained areas where it is shielded from wind and water erosion. Utilize temporary barriers like silt fences or windbreaks to minimize erosion risk. If topsoil is to be stored for longer than 3 months, the soil must be turned at monthly intervals to aerate the soil During dry conditions, topsoil stockpiles must be watered to maintain moisture levels and preserve the soil's microbial life and fertility. Avoid compaction of topsoil stockpiles by preventing encroachment by heavy machinery or equipment with fencing. Topsoil stockpiles should not be located adjacent to future planned excavations.

Impact	Mitigation measures
	■ Topsoil stockpiles will be clearly labelled as such. ■ Drainage channels will be installed around the base of topsoil stockpiles if required to direct run-off away from the stockpile. ■ Excavated material must be re-used where possible. ■ Excess material that cannot be reused will be disposed of at a designated spoil disposal site only.
Impact of soil compaction on very highly sensitive zones	■ Minimize the areas where heavy machinery operates to reduce the extent of soil compaction. Define and clearly mark construction zones to avoid unnecessary disturbance. ■ Construction access roads and designated areas for parking/turning of construction vehicles and machinery will be clearly delineated to minimise soil compaction. ■ Where possible, maintain existing vegetation or restore it after construction to protect the soil and reduce compaction. ■ Where feasible, employ lighter machinery or vehicles to reduce the pressure exerted on the soil, thus reducing the degree of compaction. ■ After construction, where soil compaction has occurred, use soil aeration techniques, such as subsoiling or deep ploughing, to break up compacted layers and improve water infiltration. ■ Topsoil stockpiles will be fenced to prevent access and compaction by Project vehicles. ■ Agricultural and forestry soils will be handled and stored separately, particularly distinguishing between topsoil and subsoils.
Impact of soil compaction on highly sensitive zones	■ Minimize the areas where heavy machinery operates to reduce the extent of soil compaction. Define and clearly mark construction zones to avoid unnecessary disturbance. ■ Construction access roads and designated areas for parking/turning of construction vehicles and machinery will be clearly delineated to minimise soil compaction. ■ Where possible, maintain existing vegetation or restore it after construction to protect the soil and reduce compaction. ■ Topsoil stockpiles will be fenced to prevent access and compaction by Project vehicles. ■ Agricultural and forestry soils will be handled and stored separately, particularly distinguishing between topsoil and subsoils.
Impact of soil compaction on moderately sensitive zones	■ Implement soil aeration to alleviate surface compaction. This can be done through techniques like spiking or shallow tilling to improve water infiltration, root penetration, and microbial activity. In more severely compacted areas, use deep ripping to break up compacted layers deeper in the soil profile. ■ Construction access roads and designated areas for parking/turning of construction vehicles and machinery will be clearly delineated to minimise soil compaction. ■ Topsoil stockpiles will be fenced to prevent access and compaction by Project vehicles.
Impact of change in land	■ Ensure that access roads do not pass through sensitive land areas ■ Avoid prime agricultural lands within the IBA and prioritize areas that are already disturbed or less fertile. Where agricultural land is affected, ensure compensation, relocation, or assistance to affected farmers.

Impact	Mitigation measures
use on very highly sensitive zones	▪ Maintain buffer zones along rivers, streams, and wetlands to protect water quality and prevent siltation from construction activities. ▪ Work with local authorities to plan for sustainable land use post-construction. ▪ Establish revegetation programs to restore disturbed land.
Impact of change in land use on highly sensitive zones	▪ Ensure that access roads do not pass through sensitive land areas ▪ Avoid prime agricultural lands and prioritize areas that are already disturbed or less fertile. Where agricultural land is affected, ensure compensation, relocation, or assistance to affected farmers. ▪ Work with local authorities to plan for sustainable land use post-construction. ▪ Establish revegetation programs to restore disturbed land.
Impact of change in land use on moderately sensitive zones	▪ Work with local authorities to plan for sustainable land use post-construction. ▪ Establish revegetation programs to restore disturbed land.
Impact of soil erosion on very highly sensitive zones	▪ Areas cleared of vegetation, or of bare soil must be covered to prevent erosion and reinstated and revegetated immediately upon completion of the construction works, especially slopes, to stabilise the soil and minimise soil erosion. ▪ Effective surface water drainage systems must be installed, especially on slopes, to prevent soil saturation and erosion from surface run-off. ▪ Limit excavation through precise methods and controlled construction sequences to reduce soil disruption. ▪ Reinforce soil with geogrids, soil nailing, or in-situ soil improvement techniques to enhance soil strength.
Impact of soil erosion on highly sensitive zones	▪ Areas cleared of vegetation, or of bare soil must be covered to prevent erosion and reinstated and revegetated immediately upon completion of the construction works, especially slopes, to stabilise the soil and minimise soil erosion. ▪ Effective surface water drainage systems must be installed, especially on slopes, to prevent soil saturation and erosion from surface run-off. ▪ Limit excavation through precise methods and controlled construction sequences to reduce soil disruption.
Impact of soil erosion on moderately sensitive zones	▪ Effective surface water drainage systems must be installed, especially on slopes, to prevent soil saturation and erosion from surface run-off. ▪ Limit excavation through precise methods and controlled construction sequences to reduce soil disruption.

4.2 Operations Phase

The mitigation strategies during the operational phase are aimed at protecting sensitive receptors by controlling sources and causes of soil pollution, degradation and erosion and ensuring proper monitoring of soil quality in compliance with applicable standards.

SRI will develop an Operations Water and Soil Management Plan that will outline the measures that must be implemented to mitigate the negative impacts on soil (as well as water) during the operation and maintenance of the railway. An Emergency Preparedness and Response Plan must also be developed and implemented by SRI that should outline the measures to be taken in the event of a major spill of hazardous materials (e.g. due to a rail accident).

Table 4-2 defines the mitigation measures proposed to mitigate the identified impacts on soil, which should, as a minimum be included in the Operations Water and Soil Management Plan.

During any future construction works, Construction Contractors should apply the same mitigation measures as for the construction phase to prevent soil contamination and terrain instability.

Table 4-2. Proposed Soil Mitigation Measures during Operations Phase

Impact	Mitigation measures
Impacts of soil contamination on very highly sensitive zones	▪ Prohibit the dumping of waste and undertake regular visual inspections of obvious dumping sites. Inspections will be carried out by the site supervisor. Any evidence of dumping or soil contamination will be reported to the Environmental Manager within 24 hours for action. ▪ The application of herbicides will be carefully managed to prevent over application and minimise the risk of chemicals leaching into groundwater from the soil. Only selective, low-toxicity herbicides approved by national regulations (e.g., glyphosate-based products, excluding persistent or bio-accumulative substances) may be used. Application is prohibited during rainfall, when heavy rain is forecast within 24 hours, or when wind speeds exceed 15 km/h. ▪ Areas where the use of herbicides is prohibited (such as sensitive vegetation areas and zones near rivers) will be clearly defined and communicated. These consider areas within 20 meters of rivers, streams, wetlands, and areas with sensitive vegetation, and should be clearly defined in site plans and communicated to maintenance personnel. ▪ Perform maintenance activities in dry weather as far as practicable to prevent contamination from surface run-off. ▪ Where possible, limit the use of de-icing chemicals during cold weather, giving preference to mechanical means such as scrubbers and snow ploughs. ▪ Hazardous and potentially contaminating materials required for maintenance activities must be stored in accordance with the Construction Phase Hazardous Waste and Materials Management Plan. This plan will update and replace the Construction Phase version, incorporating operational risks, site-specific procedures, staff responsibilities, and emergency spill response measures. Regular training and inspections will be conducted to ensure compliance.

Impact	Mitigation measures
	■ Regular control and maintenance of the surface water drainage system and structures must be undertaken, including the removal of accumulated sediments and debris, and cleaning of oil/water separators, to avoid blockages, overflow and direct discharge of contaminated runoff onto the surrounding soil.
Impacts of soil contamination on highly sensitive zones	■ Prohibit the dumping of waste and undertake regular visual inspections of obvious dumping sites. Inspections will be carried out by the site supervisor. Any evidence of dumping or soil contamination will be reported to the Environmental Manager within 24 hours for action. ■ The application of herbicides will be carefully managed to prevent over application and minimise the risk of chemicals leaching into groundwater from the soil. Only selective, low-toxicity herbicides approved by national regulations (e.g., glyphosate-based products, excluding persistent or bio-accumulative substances) may be used. Application is prohibited during rainfall, when heavy rain is forecast within 24 hours, or when wind speeds exceed 15 km/h. ■ Areas where the use of herbicides is prohibited (such as sensitive vegetation areas and zones near rivers) will be clearly defined and communicated. These consider areas within 20 meters of rivers, streams, wetlands, and areas with sensitive vegetation, and should be clearly defined in site plans and communicated to maintenance personnel. ■ Where possible, limit the use of de-icing chemicals during cold weather, giving preference to mechanical means such as scrubbers and snow ploughs. ■ Hazardous and potentially contaminating materials required for maintenance activities must be stored in accordance with the Construction Phase Hazardous Waste and Materials Management Plan. This plan will update and replace the Construction Phase version, incorporating operational risks, site-specific procedures, staff responsibilities, and emergency spill response measures. Regular training and inspections will be conducted to ensure compliance.
Impacts on soil erosion on very highly sensitive zones	■ Regular maintenance of vegetation should be undertaken in cuttings and on embankments to ensure slope stability and along affected waterways to minimise soil erosion and reduce suspended matter in surface run-off. ■ Implement proper drainage systems (culverts, ditches) to manage water runoff and avoid ground saturation that could destabilize terrain. Drainage systems must be inspected seasonally (at minimum before and after the rainy season), with accumulated silt, debris, and vegetation removed to ensure flow capacity. Storm-readiness measures, including functional checks of culverts and emergency overflow routes, must be conducted ahead of predicted heavy rainfall. ■ In areas identified as geotechnically unstable, elevation and reinforcement of tracks and embankments may be undertaken as part of major maintenance interventions or deferred design upgrades. This measure will only be triggered based on erosion monitoring data or significant terrain movement detected during inspections, and it will be coordinated with engineering assessments
Impacts on soil erosion on highly sensitive zones	■ Regular maintenance of vegetation should be undertaken in cuttings and on embankments to ensure slope stability and along affected waterways to minimise soil erosion and reduce suspended matter in surface run-off. ■ In areas identified as geotechnically unstable, elevation and reinforcement of tracks and embankments may be undertaken as part of major maintenance interventions or deferred design upgrades. This measure will only be triggered based on erosion monitoring data or

Impact	Mitigation measures
	significant terrain movement detected during inspections, and it will be coordinated with engineering assessments

4.3 Monitoring

Regular monitoring should be conducted throughout the construction and operational phases of the Project to ensure compliance with the E&S Management Plans, Lenders' Policies, and ESIA commitments. Additionally, any changes to baseline environmental conditions should be monitored to verify that the mitigation measures implemented by the construction contractor and SRI effectively prevent or minimize significant negative impacts. If monitoring indicates that negative impacts are occurring despite adherence to the Management Plans, additional mitigation measures may be required, and the plans revised accordingly.

The monitoring activities outlined in Table 4-3 below, related to Soil Quality, are proposed for both the construction and operational phases.

Table 4-3. Proposed Soil Quality Monitoring Activities for the Construction and Operations Phases

Monitoring Requirement	Frequency	Location	Method
Construction Phase			
Heavy metals and metalloid concentrations (Cd, Cr, Cu, Ni, Pb, Zn, Ba, Co, Mo, Sb, Hg, and As) in soil.	In response to incidents.	Areas with soil disturbance, construction material storage sites, and locations within 500 m of the railway corridor.	Soil sampling and analysis by an accredited laboratory authorized by the competent Ministry.
Concentrations of industrial and petroleum-derived organic contaminants (PCBs, BTEX, PAHs, and VOCs) in soil.	Quarterly and as needed in response to spills.	Areas around fuel storage, maintenance depots, and construction sites where heavy machinery is used.	Soil sampling and analysis by an accredited laboratory authorized by the competent Ministry.
Erosion and sediment deposition	Monthly and after heavy rainfall events.	Areas prone to erosion along the railway corridor, near watercourses, and at cut-and-fill sections	Visual inspection and topographic surveys.
Operations Phase			
Heavy metals and metalloid concentrations (Cd, Cr, Cu, Ni,	In response to contamination concerns.	Areas where spills or contamination risks exist	Soil sampling and analysis by an accredited laboratory authorized by the competent Ministry

Monitoring Requirement	Frequency	Location	Method
Pb, Zn, Ba, Co, Mo, Sb, Hg, and As) in soil.			
Concentrations of industrial and petroleum-derived organic contaminants (PCBs, BTEX, PAHs, and VOCs) in soil.	In response to spills	Areas around train maintenance and refuelling stations, as well as railway depots	Soil sampling and analysis by an accredited laboratory authorized by the competent Ministry
Erosion and sediment deposition	Quarterly and after extreme weather events.	Railway embankments, drainage channels, and areas with slope instability.	Visual inspection and topographic surveys

5 RESIDUAL IMPACTS ASSESSMENT

Table 5-1 presents an assessment of the residual significance of impacts on Soil, during both the construction and operational phases of the Project, following implementation of the mitigation measures defined in Tables 4-1 and 4-2.

Table 5-1. Significance of Impacts on Soil After Mitigation

Phase	Impact	Negative or Positive	Receptor sensitivity	Overall significance before mitigation	Summary of mitigation	Assessment of impact after mitigation	Overall significance after mitigation
Construction	**Soil contamination**	Negative	'Very high' sensitivity receptors	High	Drip trays, Spill kits, Immediate interruption, Dedicated areas, Designated storage, Hazardous storage, Designated waste, Contamination monitoring	the risk of soil contamination will be substantially decreased by mitigation measures at certain sites (2), the impact is medium term – between 5 to 20 years and expected to be very localized (2), very high sensitivity receptors (4), soil contamination is considered to happen with very low likelihood (1) after the mitigation measures	M (2) + ST (2) + S (4) + L (1) = 9 (Moderate)
			'High' sensitivity receptors	High	Drip trays, Spill kits, Dedicated areas, Designated waste, Contamination monitoring	the risk of soil contamination will be substantially decreased by mitigation measures at certain sites (2), the impact is medium term – between 5 to 20 years and expected to be very localized (2), high sensitivity receptors (3), soil contamination is considered to happen with very low likelihood (1) after the mitigation measures	M (2) + ST (2) + S (3) + L (1) = 8 (Moderate)
			'Moderate' sensitivity receptors	Moderate	Spill kits, Designated waste	the risk of soil contamination will be substantially decreased by mitigation measures at certain sites (1), the impact is long term – more than 20 years and expected to be very localized (3), moderate sensitivity receptors (2), soil contamination is considered to happen with very low likelihood	M (1) + ST (3) + S (2) + L (1) = 7 (Low)

Phase	Impact	Negative or Positive	Receptor sensitivity	Overall significance before mitigation	Summary of mitigation	Assessment of impact after mitigation	Overall significance after mitigation
						(1) after the mitigation measures	
Construction	**Topsoil removal**	Negative	'Very high' sensitivity receptors	High	Topsoil removal, Stockpile location, Excavation adjacency, Stockpile height, Stockpile gradient, Stockpile labelling, Erosion prevention, Drainage channels, Designated stockpiles, Material reuse, Spoil disposal	the risk of topsoil removal will be substantially decreased by mitigation measures at certain sites (2), the impact is medium term – 5 - 20 years and expected to be very localized (2), very high sensitivity receptors (4), topsoil removal is considered to happen possibly (2) after the mitigation measures	M (2) + ST (2) + S (4) + L (2) = 10 (Moderate)
			'High' sensitivity receptors	High	Stockpile distance, Excavation adjacency, Stockpile height, Stockpile gradient, Stockpile labelling, Drainage channels, Designated stockpiles, Material reuse, Spoil disposal	the risk of topsoil removal will be substantially decreased by mitigation measures at certain sites (2), the impact is medium term – 5 - 20 years and expected to be very localized (2), high sensitivity receptors (3), topsoil removal is considered to happen possibly (2) after the mitigation measures	M (2) + ST (2) + S (3) + L (2) = 9 (Moderate)
			'Moderate' sensitivity receptors	Moderate	Excavation adjacency, Stockpile labelling, Drainage channels, Material reuse, Spoil disposal	the risk of topsoil removal will be substantially decreased by mitigation measures at certain sites (1), the impact is medium term – 5 - 20 years and expected to be very localized (2), moderate sensitivity receptors (2), topsoil removal is considered to happen possibly (2) after the mitigation measures	M (1) + ST (2) + S (2) + L (2) = 7 (Low)

Phase	Impact	Negative or Positive	Receptor sensitivity	Overall significance before mitigation	Summary of mitigation	Assessment of impact after mitigation	Overall significance after mitigation
Construction	**Soil compaction**	Negative	'Very high' sensitivity receptors	High	Minimize machinery, Delineated zones, Maintain vegetation, Lighter machinery, Soil aeration, Fenced stockpiles, Separate soils	the risk of soil compaction will be substantially decreased by mitigation measures at certain sites (2), the impact is medium term – 5 - 20 years and expected to be very localized (2), very high sensitivity receptors (4), soil compaction is considered to happen possibly (1) after the mitigation measures	M (2) + ST (2) + S (4) + L (2) = 10 (Moderate)
			'High' sensitivity receptors	High	Minimize machinery, Delineated roads, Maintain vegetation, Fenced stockpiles, Separate soils	the risk of soil compaction will be substantially decreased by mitigation measures at certain sites (2), the impact is medium term – 5 - 20 years and expected to be very localized (2), high sensitivity receptors (3), soil compaction is considered to happen possibly (2) after the mitigation measures	M (2) + ST (2) + S (3) + L (2) = 9 (Moderate)
			'Moderate' sensitivity receptors	Moderate	Delineated roads, Fenced stockpiles	the risk of soil compaction will be substantially decreased by mitigation measures at certain sites (1), the impact is medium term – 5 - 20 years and expected to be very localized (2), moderate sensitivity receptors (2), soil compaction is considered to happen possibly (1) after the mitigation measures	M (1) + ST (2) + S (2) + L (2) = 7 (Low)
Construction	**Change in Land Use**	Negative	'Very high' sensitivity environmental receptors	High	Avoid sensitive land areas, Agricultural land, Maintain buffer zones, Wildlife corridors, Habitat offset, Sustainable land use, Revegetation programs	mitigation measures will reduce the magnitude of impact to some extent (3), the impact is long term – more than 20 years and expected to be localized (3), very high sensitivity receptors (4), change in land use will occur intermittently (2) after the mitigation measures	M (3) + ST (3) + S (4) + L (2) = 12 (High)

Phase	Impact	Negative or Positive	Receptor sensitivity	Overall significance before mitigation	Summary of mitigation	Assessment of impact after mitigation	Overall significance after mitigation
			'High' sensitivity environmental receptors	High	Avoid sensitive land areas, Agricultural land, Habitat offset, Sustainable planning, Revegetation programs	mitigation measures significantly will reduce the magnitude of impact to some extent (2),, the impact is long term – more than 20 years and expected to be localized (3), high sensitivity receptors (3), change in land use will occur intermittently (2) after the mitigation measures	M (2) + ST (3) + S (3) + L (2) = 10 (Moderate)
			'Moderate' sensitivity environmental receptors	High	Sustainable planning, Revegetation programs	mitigation measures significantly will reduce the magnitude of impact at certain sites (1), the impact is long term – more than 20 years and expected to be localized (3), moderate sensitivity receptors (2), change in land use will occur intermittently (2) after the mitigation measures	M (1) + ST (3) + S (2) + L (2) = 8 (Moderate)
Construction	**Change in land use**	Negative	High sensitivity human receptors	High	Avoid sensitive land areas, Agricultural land, Habitat offset, Sustainable planning, Revegetation programs	mitigation measures significantly will reduce the magnitude of impact to some extent (2), the impact is long term – more than 20 years and expected to be localized (3), high sensitivity receptors (3), change in land use will occur intermittently (2) after the mitigation measures	M (2) + ST (3) + S (3) + L (2) = 10 (Moderate)
			Moderate sensitivity human receptors	High	Sustainable planning, Revegetation programs	mitigation measures significantly will reduce the magnitude of impact at certain sites (1),, the impact is long term – more than 20 years and expected to be localized (3), moderate sensitivity receptors (2), change in land use will occur intermittently (2) after the mitigation measures	M (1) + ST (3) + S (2) + L (2) = 8 (Moderate)
			Low sensitivity human receptors	Moderate	Sustainable planning	mitigation measures significantly will reduce the magnitude of impact at certain sites (1),, the impact is long term – more than 20 years and	M (1) + ST (3) + S (1) + L (2) = 7 (Low)

Phase	Impact	Negative or Positive	Receptor sensitivity	Overall significance before mitigation	Summary of mitigation	Assessment of impact after mitigation	Overall significance after mitigation
						expected to be localized (3), low sensitivity receptors (1), change in land use will occur intermittently (2) after the mitigation measures	
Construction	**Soil erosion**	Negative	'Very high' sensitivity receptors	High	Erosion control, Drainage systems, Deep foundations, Controlled excavation, Soil reinforcement	the risk of soil erosion will be substantially decreased by mitigation measures at certain sites (2), the impact is short term – less than 5 years and expected to be very localized (2), very high sensitivity receptors (4), soil erosion is considered to happen with very low likelihood (1) after the mitigation measures	M (2) + ST (2) + S (4) + L (1) = 9 (Moderate)
			'High' sensitivity receptors	Moderate	Erosion prevention, Drainage systems, Deep foundations, Controlled excavation	the risk of soil erosion will be substantially decreased by mitigation measures at certain sites (1) the impact is short term – less than 5 years and expected to be very localized (2), high sensitivity receptors (3), soil erosion is considered to happen with very low likelihood (1) after the mitigation measures	M (1) + ST (2) + S (3) + L (1) = 7 (Low)
			'Moderate' sensitivity receptors	Moderate	Drainage systems, Deep foundations, Excavation control	the risk of soil erosion will be substantially decreased by mitigation measures at certain sites (1), the impact is short term – less than 5 years and expected to be very localized (2), moderate sensitivity receptors (2), soil erosion is considered to happen with very low likelihood (1) after the mitigation measures	M (1) + ST (2) + S (2) + L (1) = 6 (Low)
Operation	**Soil contamination**	Negative	'Very high' sensitivity receptors	Moderate	Waste prohibition, Herbicide management, Herbicide zones, Dry weather maintenance, De-icing	the risk of soil contamination will be substantially decreased by mitigation measures at certain sites (1), the impact is short term – less than 5 years and expected to be very localized (2), very high	M (1) + ST (2) + S (4) + L (1) = 8 (Moderate)

Phase	Impact	Negative or Positive	Receptor sensitivity	Overall significance before mitigation	Summary of mitigation	Assessment of impact after mitigation	Overall significance after mitigation
					reduction, Hazardous material storage, Drainage maintenance	sensitivity receptors (4), soil contamination is considered to happen with very low likelihood (1)	
			'High' sensitivity receptors	Moderate	Waste prohibition, Herbicide management, Herbicide zones, De-icing reduction, Material storage	the risk of soil contamination will be substantially decreased by mitigation measures at certain sites (1), the impact is short term – less than 5 years and expected to be very localized (2), high sensitivity receptors (3), soil contamination is considered to happen with very low likelihood (1)	M (1) + ST (2) + S (3) + L (1) = 7 (Low)
			'Moderate' sensitivity receptors	Low	Not applicable		
Operation	**Soil erosion**	Negative	'Very high' sensitivity receptors	Moderate	Vegetation maintenance, Drainage systems, Reinforced embankments	the risk of soil erosion will be substantially decreased by mitigation measures at certain sites (1 the impact is medium term – 5 - 20 years and expected to be very localized (2), very high sensitivity receptors (4), soil erosion is considered to happen with very low likelihood (1) after the mitigation measures	M (1) + ST (2) + S (4) + L (1) = 8 (Moderate)
			'High' sensitivity receptors	Moderate	Vegetation maintenance, Reinforced embankments	the risk of soil erosion will be substantially decreased by mitigation measures at certain sites (the impact is medium term – 5 - 20 years and expected to be very localized (2), high sensitivity receptors (3), soil erosion is considered to happen with very low likelihood (1) after the mitigation measures	M (1) + ST (2) + S (3) + L (1) = 7 (Low)
			'Moderate' sensitivity receptors	Low	Not applicable		

6 CONCLUSION

Construction of the Project is expected to result in potentially significant, negative impacts on soil quality and terrain stability. The removal of vegetation and excavations to facilitate construction exposes soil and increases erosion potential. Additionally, the movement of construction vehicles and equipment can lead to soil compaction, which limits the amount of oxygen available to plant roots, reduces the capacity of the soil to absorb water (leading to increased surface run-off and potential waterlogging in wet conditions), increases soil erosion potential and restricts plant root growth. Soil contamination may occur during construction through the direct spillage/leakage of hazardous materials (chemicals, oils, fuels, lubricants and hydraulic fluids); from mobilized contaminants in surface run-off (e.g. improperly managed wash water from construction vehicles) and untreated sanitary wastewater from construction camps. Additionally, the improper handling or transport of hazardous materials and waste can result in direct soil contamination.

Mitigation measures will be included in the Construction Water and Soil Management Plan to be developed and implemented by the construction contractor. These will include best practice measures such as the placement of drip trays beneath any stationary construction equipment to catch leaks of fuel/oil; the availability of appropriately and adequately stocked spill kits at all construction sites to clear up any accidental spills/leaks of fuel/oil/chemicals; the installation of effective surface water drainage systems especially on steep slopes; and covering areas of bare soil to prevent erosion, that must be implemented to avoid or limit negative impacts on soils. Identified zones with a high density of high sensitivity receptors (located within 500m of the railway) will be subjected to more stringent, targeted mitigation measures compared to zones with moderate sensitivity receptors.

During the operations phase, the Project is predicted to have potentially significant negative impacts on soil, including as a result of direct contamination during maintenance activities (e.g. from track maintenance, railway infrastructure repairs, the application of herbicides, and spillages of hazardous materials following a rail accident. These impacts should be mitigated through the development and implementation of an Operations Phase Water and Soil Management Plan and Emergency Preparedness and Response Plan.

Despite the implementation of comprehensive mitigation measures, moderate residual impacts on soil are expected to persist, particularly in areas with very-high and high-sensitivity receptors such as protected natural habitats and fertile agricultural land. Proposed mitigation strategies significantly reduce the severity and likelihood of soil impacts. However, in locations where the soil has high ecological or agricultural value, even minimized impacts remain significant.

On-demand monitoring of soils will be required throughout the construction and operations phases of the Project to ensure that the mitigation measures being implemented by the construction contractor and SRI to prevent or limit potentially significant negative impacts are adequate and effective. Where monitoring indicates that negative impacts are occurring despite the requirements of Management Plans being met, additional mitigation measures may be required, and Management Plans revised accordingly to safeguard human and environmental health across the

Project area. This should include on-demand monitoring of heavy metals, particularly cobalt (Co) and nickel (Ni), as baseline concentrations have already exceeded regulatory limits. Additionally, on-demand soil quality monitoring in agricultural fields adjacent to the Project will help to detect contamination early and enable timely remediation efforts.

7 LITERATURE

1. Brooks, K. M. (2004). *Polycyclic aromatic hydrocarbon migration from creosote-treated railway ties into ballast and adjacent wetlands* (Vol. 617). US Department of Agriculture, Forest Service, Forest Products Laboratory.

2. Chaiklieng, S. (2021). Risk assessment of workers' exposure to BTEX and hazardous area classification at gasoline stations. PLoS One, 16(4), e0249913.

3. Dai, S., Ma, Y. and Zhang, K., 2022. Land degradation caused by construction activity: Investigation, cause and control measures. International Journal of Environmental Research and Public Health, 19(23), p.16046.

4. Davenport, J.O.H.N. and Switalski, T.A., 2006. Environmental impacts of transport, related to tourism and leisure activities. The ecology of transportation: Managing mobility for the environment, 333, p.333.

5. Di Guardo, A., Raspa, G., Terzaghi, E., Vergani, L., Mapelli, F., Borin, S., ... & Armiraglio, S. (2020). PCB vertical and horizontal movement in agricultural soils of a highly contaminated site: Role of soil properties, cultivation history and PCB physico-chemical parameters. *Science of the Total Environment*, *747*, 141477.

6. Djalovic, I., Prasad, P. V., Pezo, L., Janić Hajnal, E., Saulic, M., Dugalić, M., & Kolarić, L. (2024). Heavy Metals in the Cultivated Soils of Central and Western Serbia. *Agronomy*, *14*(8), 1836.

7. Doick, K.J., Klingelmann, E.V.A., Burauel, P., Jones, K.C. and Semple, K.T., 2005. Long-term fate of polychlorinated biphenyls and polycyclic aromatic hydrocarbons in an agricultural soil. Environmental science & technology, 39(10), pp.3663-3670.

8. Fruhwirt, D., Nöst, T., Leonhardt, P., Leitner, M., Brunnhofer, P., Bode, G., Michael, S. & Rodler, J. (2025). Emission characteristics of railway tread brakes. *Atmospheric Environment: X*, *25*, 100320.

9. Håkansson, I. and Voorhees, W.B., 2020. Soil compaction. In Methods for assessment of soil degradation (pp. 167-179). CRC Press.

10. Huang, S., & Zhao, W. (2019). "Effects of bridge foundation excavation on slope stability and terrain morphology." Journal of Applied Geology, 43(1), 39-49.

11. Jakovljevic, M. D., Kostic, N. M., Stevanovic, D., Blagojevic, S., Wilson, M. J., & Martinovic, L. (1997). Factors influencing the distribution of heavy metals in the alluvial soils of the Velika Morava River valley, Serbia. *Applied Geochemistry*, *12*(5), 637-642.

12. Li, Y.S., Hu, X.J., Yang, J.S., Song, X.Y., Hou, Y.X. and Chen, H.L., 2012. Simulated study on the migration of petroleum hydrocarbons in the soil. *Advanced Materials Research*, *518*, pp.2802-2805.

13. Mrvić, V., Sikirić, B., Jaramaz, D., Koković, N., & Nikoloski, M. (2019). Background and threshold values of potentially toxic elements in soil at Central part of Republic of Serbia. *Ratar. Povrt*, *56*(1), 1-6.

14. Nawaz, M. F., Bourrie, G., & Trolard, F. (2013). Soil compaction impact and modelling. A review. Agronomy for sustainable development, 33, pp.291-309.

15. Pereira, P., Gimeìnez-Morera, A., Novara, A., Keesstra, S., Jordán, A., Masto, R.E., Brevik, E., Azorin-Molina, C. and Cerdà, A., 2015. The impact of road and railway embankments on runoff and soil erosion in eastern Spain. Hydrology and Earth System Sciences Discussions, 12(12), pp.12947-12985.

16. Qiao, P., Wang, S., Li, J., Zhao, Q., Wei, Y., Lei, M., ... & Zhang, Z. (2023). Process, influencing factors, and simulation of the lateral transport of heavy metals in surface runoff in a mining area driven by rainfall: A review. *Science of the Total Environment*, *857*, 159119.

17. Suryanto, A., & Lim, T. K. (2018). "Bridge Construction and its Effects on the Surrounding Environment." International Journal of Geotechnical Engineering, 12(3), 235-244.

18. Vaiškūnaitė, R., &Jasiūnienė, V. (2020). The analysis of heavy metal pollutants emitted by railway transport. Transport, 35(2), 213-223.

19. Xu, X. L., Liu, W., Kong, Y. P., Zhang, K. L., Yu, B. F., and Chen, J. D.: Runo and water erosion on road side-slopes: effects of rainfall characteristics and slope length, Transport Res. DTr. E., 14, 497–501, 2009. Chandio, A. H., et al. (2017). "Impact of bridge construction on soil stability and erosion: A review." Engineering Geology, 217, 45-57.

20. Xu, X., Zhang, K., Kong, Y., Chen, J., and Yu, B.: Effectiveness of erosion control measures along the Qinghai–Tibet Highway, Tibetan Plateau, China, Transport Res. D-Tr. E., 11, 302 309, 2006.

21. Gutiérrez, M., & Martínez, R. (2010). "Slope Stability and Maintenance of Railway Tracks in Mountainous Areas". Transportation Geotechnics, 1(2), 85-98.

22. Stojic, N., Pucarevic, M., & Stojic, G. (2017). Railway transportation as a source of soil pollution. Transportation Research Part D: Transport and Environment, 57, 124-129.

23. Wang, R., Yuan, Z., Zheng, J., Li, C., Huang, Z., Li, W., ... & Duan, L. (2020). Characterization of VOC emissions from construction machinery and river ships in the Pearl River Delta of China. Journal of Environmental Sciences, 96, 138-150.

24. Yan, A., Wang, Y., Tan, S.N., Mohd Yusof, M.L., Ghosh, S. and Chen, Z., 2020. Phytoremediation: a promising approach for revegetation of heavy metal-polluted land. Frontiers in plant science, 11, p.359.

8 ANNEX

Figure 8-1. Survey photos for soil quality measurements

Republic of Serbia
Ministry of European
Integration

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the European Union

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ЗА ТЕБЕ

RAILWAY LINE BELGRADE–NIŠ, SECTION III PARAĆIN TO TRUPALE (NIŠ), Environmental and Social Impact Assessment, 8. GEOLOGY

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LIST OF ABBREVIATIONS AND ACRONYMS

AoI	Area of Influence
ELSUS	European Landslide Susceptibility Map
ESS	Environmental and Social Standard
EU	European Union
km	kilometre
m.a.s.l	metres above sea level
PR	Performance Requirement
RMR	Rock Mass Rating
SRI	Serbian Rail Infrastructure

CONTENTS

8. GEOLOGY

This Chapter presents the findings of the assessment of potential impacts on Geological features during both the construction and operations phases of the Project. The activities that could result in changes to the existing geological conditions are identified, with an assessment of the potential impacts of those changes on environmental receptors. Mitigation measures to avoid or minimise negative impacts, are proposed. The methodologies and data sources used are listed.

8.1. Legislative and Policy Framework

8.1.1. EU Requirements

Various European Union (EU) standards and requirements related to geological features must be adhered to during the preparation of an ESIA. These standards address issues such as land use, resource extraction, seismic activity, and more. Below are key EU requirements relevant to geological features in the context of preparing an ESIA:

- Environmental Impact Assessment Directive (2011/92/EU as amended by 2014/52/EU): If the project is located in an area with known seismic or geological hazards (e.g., landslides, sinkholes, flooding, etc.), these risks need to be assessed; Assess the effects of the project on the stability of the land.
- The Habitats Directive (92/43/EEC): While primarily focused on the conservation of natural habitats and wild species, this directive can be relevant for geological features, especially where geological formations contribute to habitat creation (e.g., caves, rock formations, wetlands); Projects must evaluate the potential impacts on natural features that may have geological origins, such as karst systems, caves, and coastal features.
- Water Framework Directive (2000/60/EC): Projects involving mining, tunnelling, or deep excavation may require a more detailed evaluation of the interaction between geological features and water resources (e.g., groundwater flow, water table shifts).
- Groundwater Directive (2006/118/EC): ensures the protection of groundwater from pollution and deterioration, and aims to protect groundwater flow, which could be disrupted by railway embankments or tunnelling. Also requires addressing soil liquefaction risks in areas with high water tables and emphasizes the need to ensure that construction does not lead to excessive soil erosion or destabilization.
- Floods Directive (2007/60/EC): requires assessment of landslide risks related to high groundwater levels, flooding, or water erosion.
- Land Use and Spatial Planning Regulations: Any development project should consider geological mapping and planning that takes into account the stability of the land, especially in regions prone to seismic activity, landslides, or other geohazards; Land Degradation and Erosion: The project should evaluate how the land will be altered and whether the surrounding geological conditions might lead to erosion or other forms of land degradation.
- EIA for Mining and Extractive Industries: For projects that require deep excavation or tunnelling, a thorough geotechnical assessment is often mandatory to evaluate the risks to local geological features and geohazards.

8.1.2. EBRD Requirements

The EBRD Environmental and Social Policy outlines various Performance Requirements (PRs) that provide a framework for managing the environmental and social impacts of projects. Several of the PRs specifically address the need for the proper management of geological resources, protection from geological hazards, and ensuring that projects are designed to mitigate their impact on the environment and communities.

- PR 3: Resource Efficiency and Pollution Prevention: PR 3 requires appropriate pollution prevention and control methods to be applied to the Project. This can include pollution from soil erosion.
- PR 4: Health, Safety and Security: In protecting the health and safety of workers and managing health and safety risks to affected communities, projects should address risks related to geological hazards such as landslides, earthquakes, soil erosion, and ground subsidence which includes evaluating the geological conditions at the project site and implementing measures to reduce or eliminate these risks. Whilst this Chapter highlights the geological aspects of such risks, a detailed discussion of health and safety impacts is provided in Chapter 18, Occupational Health and Safety.
- PR 8: Cultural Heritage: PR 8 applies if the Project "involves significant excavations, demolitions, movement of earth, drainage, flooding or other changes in the physical environment". Certain geological formations or landscapes (e.g., rock formations, caves, ancient mineral resources) may have cultural or spiritual significance to local communities. The project must assess the potential impacts on such features and take steps to avoid or mitigate harm; In regions with significant fossil records or paleontological sites, the project should assess the potential impact of its activities on these geological and cultural heritage resources. Proper management measures must be put in place to preserve such sites. A more detailed discussion on cultural heritage considerations is provided in Chapter 15, Cultural Heritage.
- PR 10: Stakeholder Engagement and Information Disclosure: This PR requires that where the Project has E&S impacts, relevant information will be disclosed to help stakeholders (including affected communities) understand the risks and impacts. This should include potential risks relating to geohazards. Whilst this Chapter outlines geological risks, stakeholder engagement strategies and communication related to these issues are discussed in the Stakeholder Engagement Plan.

8.1.3. EIB Requirements

The relevant Environmental and Social Standards (ESSs), specifically those addressing geological concerns, cover a range of environmental and social issues, from natural resource management to geohazards, biodiversity, and pollution prevention.

- ESS 1: Environmental and Social Impact Assessment and Management: Annex 2a of ESS 1 requires "A description of the expected significant environmental, climate and/or social adverse effects deriving from the vulnerability of the project to risks of major accidents and/or disasters that are relevant to the project concerned."
- ESS 3: Resource Efficiency and Pollution Prevention: ESS 3 focus is primarily on the sustainable use of resources, minimization of pollution, and effective management of environmental impacts. Construction projects might be located in areas susceptible to geohazards such as earthquakes, landslides, erosion or floods, which could affect the stability of the land or cause further geological risks. ESS 3 encourages the identification and assessment of such risks during the ESIA process. The goal is to avoid or minimize negative impacts through proper mitigation measures and appropriate engineering solutions.
- ESS 4: Biodiversity and Ecosystems: Certain geological formations—such as karst systems, wetlands, or caves—are critical for maintaining biodiversity and ecosystem services. ESS 4 requires that projects consider the impacts on these geological features, ensuring that the project does not negatively affect areas that are vital for biodiversity or ecosystem functions; If the project site is home to important geological heritage (e.g., unique rock formations, fossils, or other geologically significant areas), the project must take steps to protect these features from disruption or degradation. Further discussion on biodiversity impacts is provided in Chapter 14, Biodiversity.

- ESS 5: Climate Change: Climate change can exacerbate the frequency and intensity of certain geohazards such as landslides, flooding. The standard encourages the assessment and management of such geohazards, particularly in regions where they may be triggered or intensified by climate change factors (e.g., more intense rainfall leading to erosion or landslides). The increased frequency of extreme weather events (e.g., heavy rainfall, storms, or drought) due to climate change may affect the geological stability of an area, making it more prone to events like rock falls, which in turn can have significant consequences for biodiversity, infrastructure, and local communities. Further discussion on climate resilience and adaptation measures is provided in Chapter 11, CRVA.
- ESS 8: Labour Rights: Workers involved in construction, or infrastructure projects in geologically sensitive areas are potentially exposed to geological hazards such as landslides, soil erosion, flooding, rockfalls, or earthquakes. These risks can affect worker safety, especially if proper geotechnical assessments and safety measures are not in place. The standard requires that health and safety measures be implemented to protect workers from such risks, and more detailed discussion on worker safety is provided in Chapter 19, Occupational Health and Safety.
- ESS 9: Health, Safety and Security: Projects located in geologically sensitive areas (e.g., earthquake-prone zones, areas prone to erosion, rockfalls or areas with a high risk of landslides) must assess and mitigate potential risks to community safety. This could involve conducting geological surveys and studies to understand and reduce the likelihood of geohazards; The standard requires the implementation of safety measures to protect workers, local communities, and other stakeholders from potential geological risks, such as the impacts of land subsidence, soil erosion, rockfalls. The standard requires that projects be prepared to respond to such events through comprehensive emergency preparedness and response plans. A more detailed analysis of health and safety risks and emergency preparedness is provided in Chapter 19, Occupational Health and Safety and Chapter 17, Major Accidents and Disasters.

8.1.4. National Legislative Framework

In Serbia, geological features are governed by a combination of laws and regulations that address various aspects of geological exploration, environmental protection, and natural resource management.

- Law on Environmental Protection: Requires assessment of soil stability and landslide risks for projects that significantly alter landforms, such as railway construction. Mandates consideration of geotechnical risks, particularly in areas with steep slopes, soft soils, or seismic activity. The project developer must propose mitigation measures to prevent soil instability.
- Law on Spatial Planning: Regulates land development and spatial planning, ensuring that infrastructure projects, including railway construction, consider geological constraints and land-use planning requirements. It defines zoning regulations and restrictions to prevent construction in geohazard-prone areas.
- Regulations on Geological Data: In Serbia, the Ministry of Mining and Energy is responsible for the collection, storage, and distribution of geological data. Regulations govern the reporting and sharing of exploration data, ensuring transparency and oversight.
- Regulation on the Protection of Geological Heritage: Some geological formations and sites are recognized as protected natural heritage, and this regulation aims to ensure their preservation while allowing for scientific research and geological exploration.

8.2. Baseline Conditions

8.2.1. Area of Influence

The Area of Influence (AoI) for the assessment of impacts on geological features is a corridor 1000 meters wide, with 500 meters on each side of the Proposed Railway alignment.

8.2.2. Baseline

For the purpose of this Project, geotechnical surveys of the AoI and exploratory drilling were conducted by “Geomehanika” d.o.o in 2023/2024[1]. The obtained data were used to inform the preparation of this assessment.

The geological structure of the Project AoI has been defined on the basis of the research conducted (2023-2024, as well as a review of publicly available documentation; Basic geological map in 1:100 000[2], Interpreter for the Paraćin[3] and Aleksinac[4] paper,

Regional geological context

The largest geological formation comprises the wide alluvial plain of the Great Morava River, which consists of Quaternary age deposits in the form of river terraces, as well as river facies (beds, floods and floodplains).

The geological structure of the Project route (Paraćin–Trupale (Niš), has been determined according to the Basic Geology Map – Paraćin[5] and Aleksinac sheet[6]. On this sheet, through the middle of which the South Morava River flows in a northwest-southeast direction, there are the mountains Devica, Ozren, Leskovik, Mali Jastrebac and parts of Veliki,Jastrebac and Poslon mountains. There are sections on the northern, western and southern parts of the sheet, Sokobanja, Krusevac and Toplica basins.

The oldest rocks are of Proterozoic age - they represent the so-called crystalline slates. "the lower one complex" of the Serbian-Macedonian mass discovered in the western part of the sheet on Veliki Jastrepac, Poslonska planina and Đuniski vis. These are metamorphosed highly crystalline rocks to the garnet-amphibolite facies (staurolite-almandine subfacies), in places and eclogitic facies, often with pronounced potassic metasomatosis. Within these rocks, which belong to the core of the Serbian Macedonian massif, are andesine gneisses, amphibolites and amphibole gneisses, eclogites, marbles and migmatites (Mi) see Figure 8-1.

Neogene sediments are widely distributed. They were deposited in tectonics basins filled with lake or terrestrial sediments. Depending on the pre-Neogen geological formations, as well as young tectonic movements, basins were

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[1] *Geomehanika doo, (2024), Elaborate on geotechnical conditions for the reconstruction of the railway route*

[2] *Basic geological map in 1:100 000, https://geoliss.mre.gov.rs/prez/OGK/RasterSrbija/*

[3] *Dolić, D., Kalenić, M., Marković, B., Dimitirijević, M., Radoičić, R., Lončarević Č. (1981). Interpreter for the Paraćin paper, K 34-7. Belgrade: Federal Geological Institute*

[4] *Krstić, B., Veselinović, M., Divljan, M., & Rakić, M. (1980b). Interpreter for the Aleksinac paper, K 34-20. Belgrade: Federal Geological Institute*

[5] *Dolić, D., Kalenić, M., Marković, B., Dimitirijević, M., Radoičić, R., Lončarević Č. (1981). Interpreter for the Paraćin paper, K 34-7. Belgrade: Federal Geological Institute*

[6] *Krstić, B., Veselinović, M., Divljan, M., & Rakić, M. (1980b). Interpreter for the Aleksinac paper, K 34-20. Belgrade: Federal Geological Institute*

formed in the area of Great and Western Morava, Levče and Belica river and various types of Miocene sediments were deposited in them. The Miocene is represented by lower and middle Miocene freshwater sediments and marine brackish sediments Paratethys sediments of Tortonian and Sarmatian age. During the Miocene, there were also minor occurrences of pyroclastic rocks.

The youngest formations are located in the Moravian Basin. They are presented Upper Pliocene-Pleistocene, Pleistocene and Holocene deposits. In the Quaternary sediments, the youngest sedimentary formations are represented on the ground in the entire research area, in the form of slope deluvial and proluvial sediments and river alluvial and terrace deposits (a, alt, am, pr, dpr, t_1, t_2). Organogenic-marsh sediments (b) are deposited in abandoned river meanders. Sediments of the bed facies (pr) build deeper parts of the terrain, and their composition includes slightly gravelly sands, sands of different granulations and slightly clayey sands. Over these sediments lie sediments of the flood facies (dpr) - which make up the surface parts of the terrain and are composed of silt and silty-sandy clays that are humified or covered with a layer of loose material in their highest part. See Figure 8-1.

Description of geological formations

Based on Figure 8-1 below, it can be seen that the Project route along its entire length in the sub-section from Paraćin to Stalać passes through deluvial-proluvial and proluvial sediments. In the sub-section from Đunis to Trupale, the railway starts from migmatites, then passes through Miocene deposits to alluvial, terrace, and proluvial deposits, which are dominant along most of this subsection.

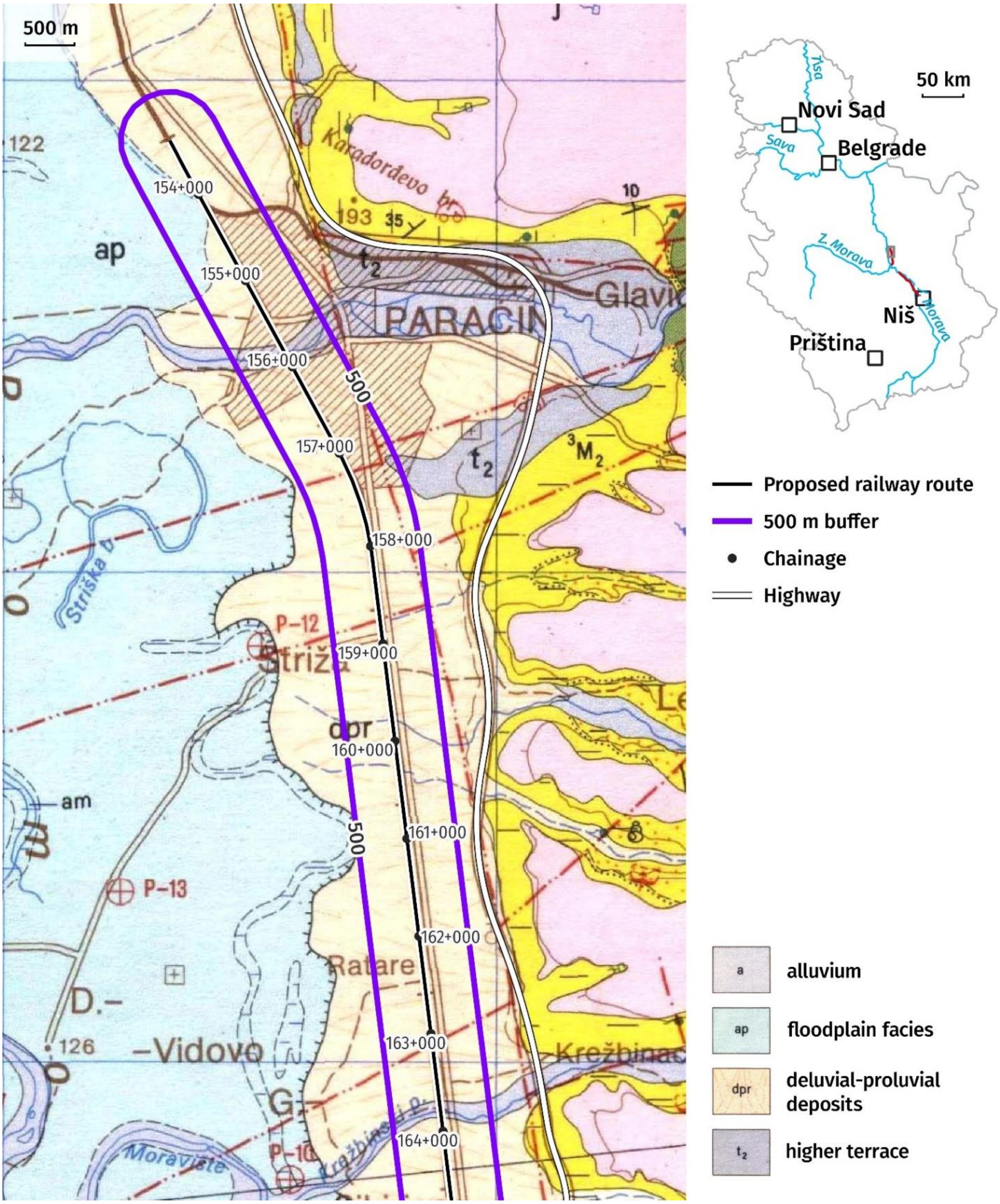
Deposits that are present within the 500m zone around the Project route (Project AoI) are presented in Table 8-1 and Figure 8-1 below, according to the chainage of the railway by distance.

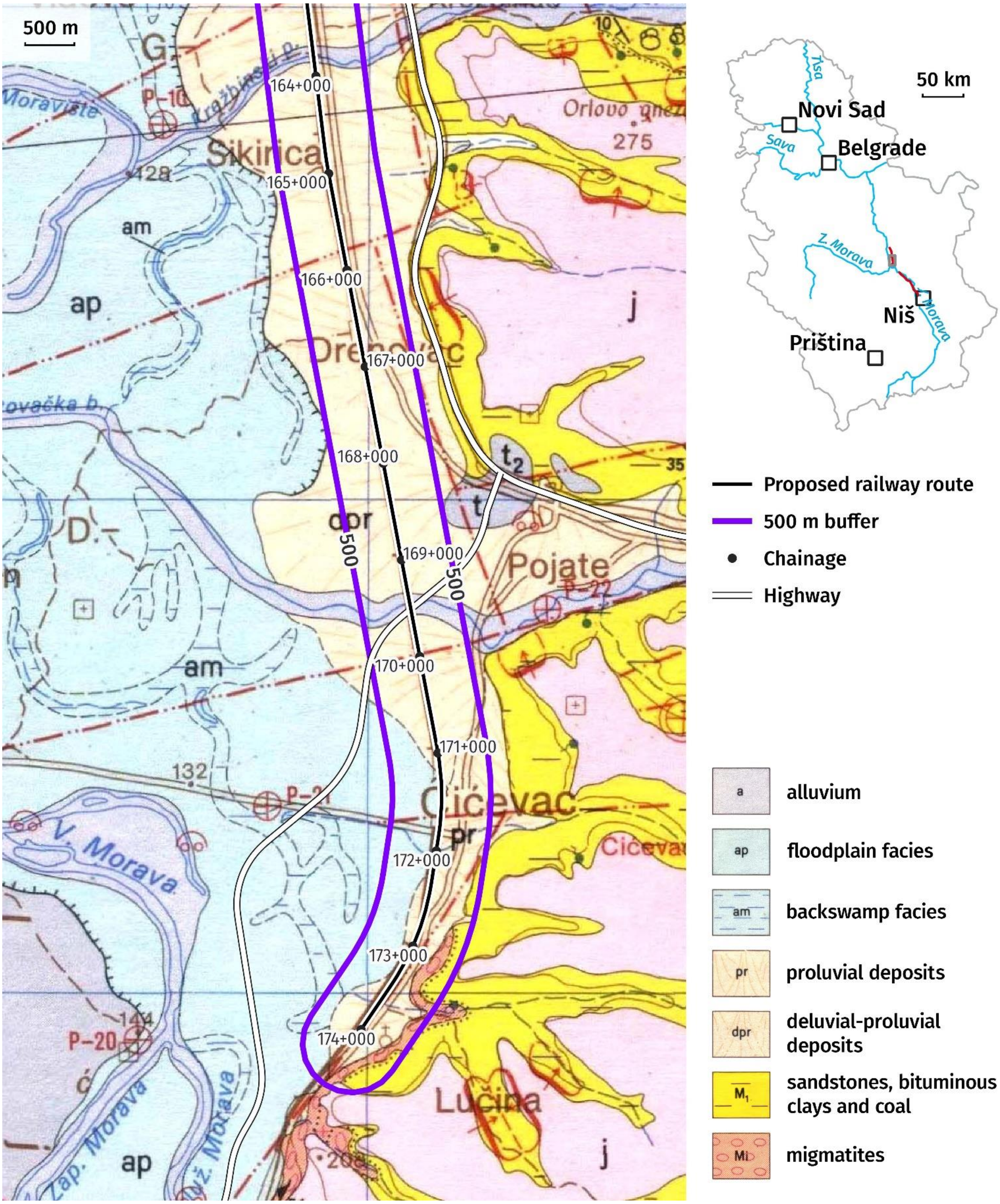
Table 8-1. Sediments in Geological formations present along the Project route

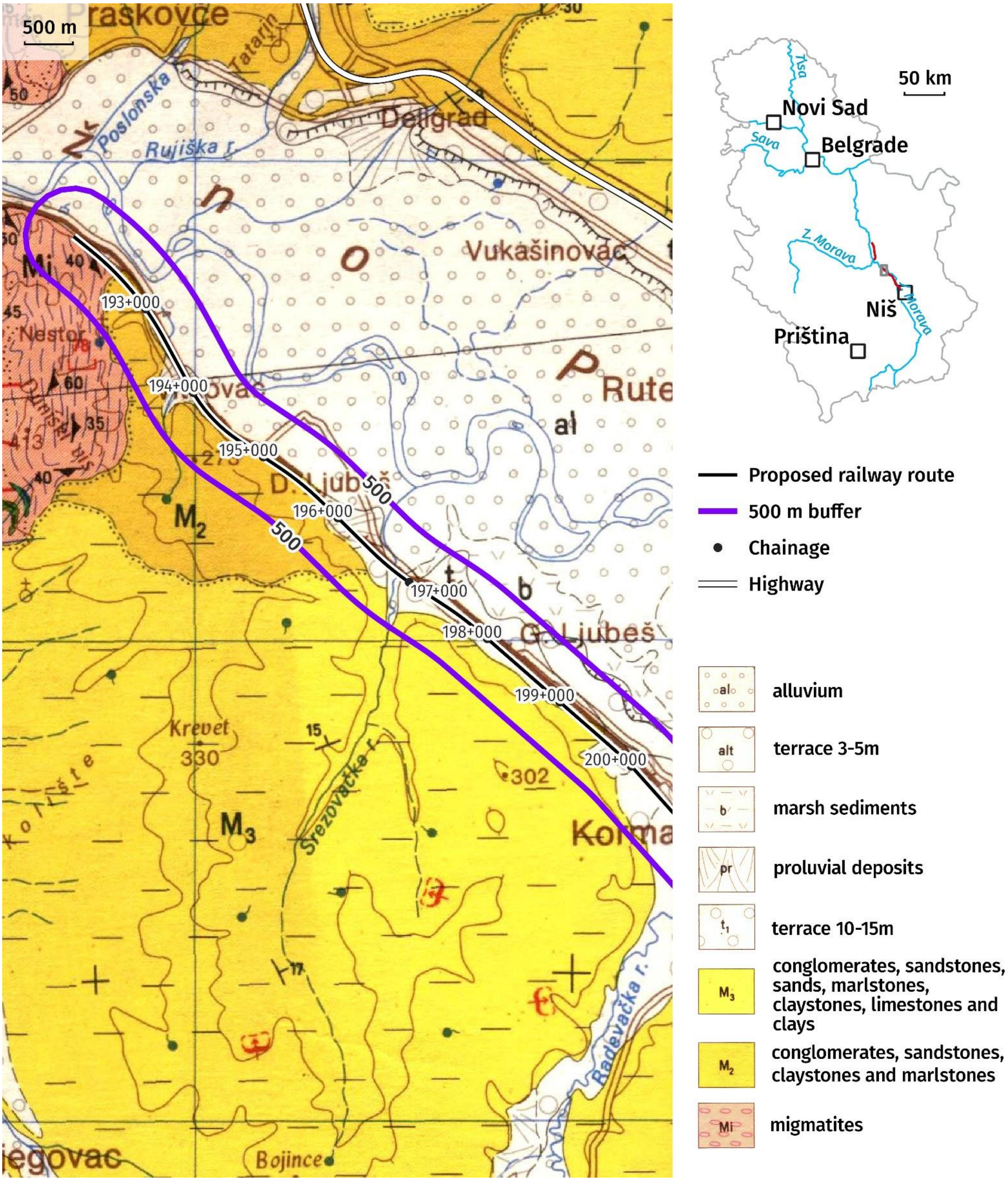
Chainage (km)	Geological formations	Litostratigraphic characteristics
153+380–155+900	dpr	Gravels, sands, silts, clayey sands
155+900–156+000	a	Gravels and sands
156+000–163+800	dpr	Gravels, sands, silts, clayey sands
163+800–164+100	a	Gravels and sands
164+100–169+400	dpr	Gravels, sands, silts, clayey sands
169+400–169+500	a	Gravels and sands
169+500–171+100	pr	Gravels, sands, silts, clayey sands
171+100–172+000	am	Silts, clayey sands
172+000–174+000	pr	Gravels, sands, silts, clayey sands
192+300–192+700	Mi	Migmatites

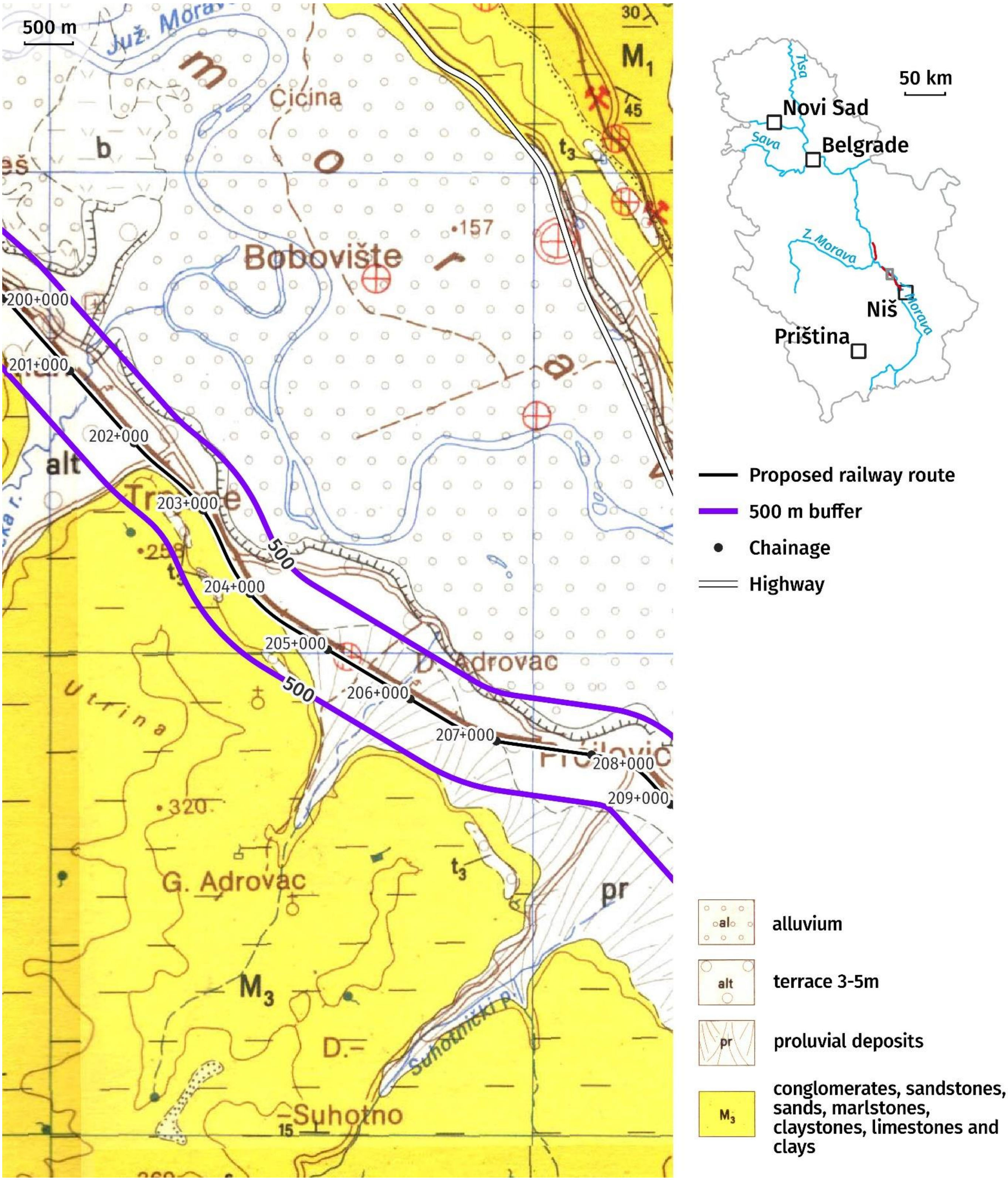
192+700–193+600	M_2	Conglomerates, sandstones, claystones, limestones
193+600–194+100	al	Gravels and sands
194+100–196+000	M_2	Conglomerates, sandstones, claystones, limestones
196+000–200+000	t_1	Terrace sediments
200+000–204+800	alt	Terrace sediments
204+800–207+000	pr	Gravels, sands, silts, clayey sands
207+000–222+000	alt	Terrace sediments
222+000–227+000	al	Gravels and sands
227+000–229+642	t_2	Terrace sediments

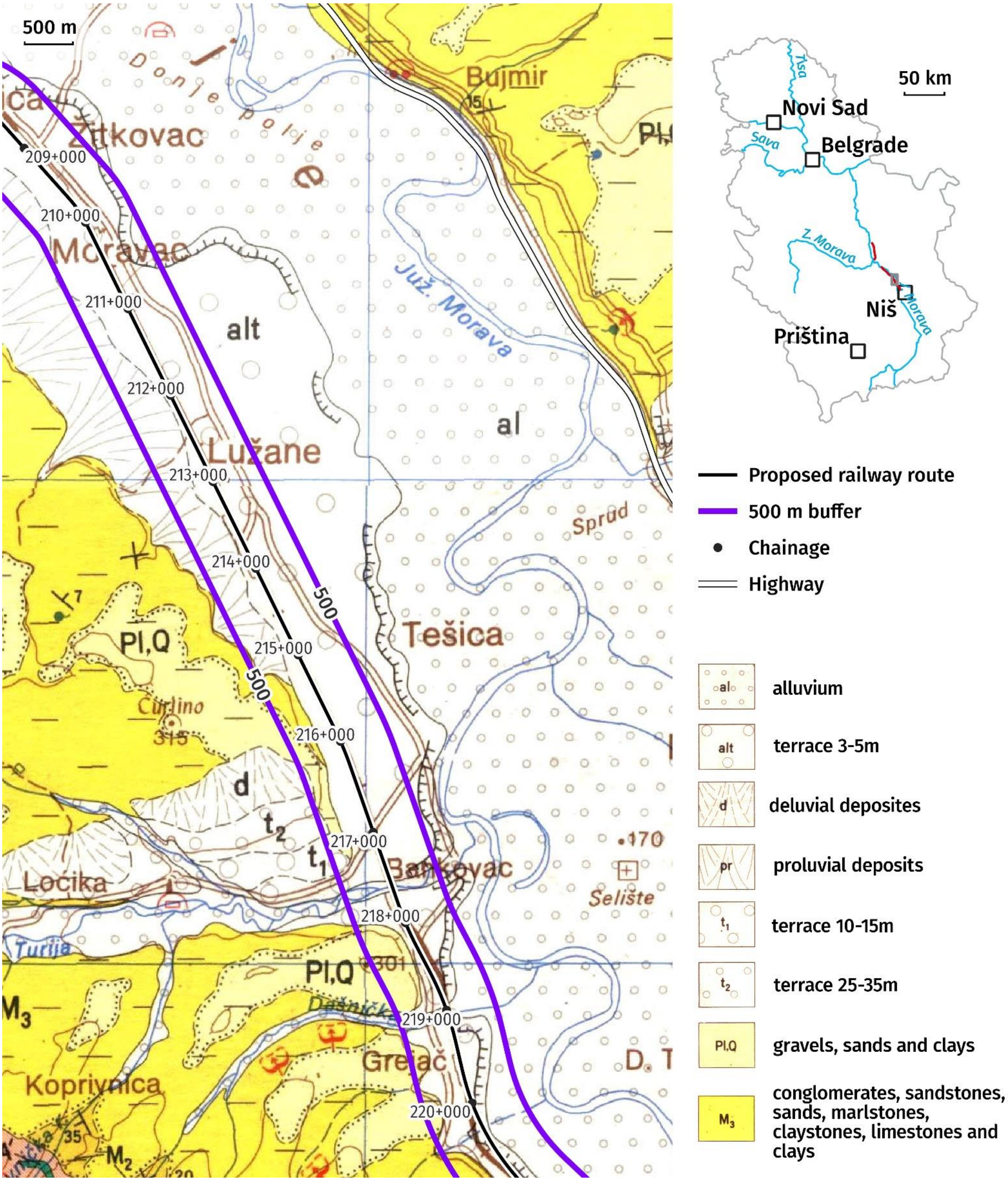
For more detailed information regarding the geological structure of Project AoI, geological map at a scale 1:100.000 is shown on Figure 8-1.


500 m
50 km
Novi Sad
Belgrade
Niš
Priština
Tisa
Sava
Z. Morava
Morava
154+000
155+000
156+000
157+000
158+000
159+000
160+000
161+000
162+000
163+000
164+000
500
ap
dpr
am
PARAĆIN
Glavi
Striža
Ratare
D.-Vidovo
Krežbinac
P-12
P-13
Moravište
Striška b.
Karađorđevo br.
Proposed railway route
500 m buffer
Chainage
Highway
alluvium
floodplain facies
deluvial-proluvial deposits
higher terrace


500 m
164+000
165+000
166+000
167+000
168+000
169+000
170+000
171+000
172+000
173+000
174+000
500
500
Sikirica
Drenovac
Pojate
Ćićevac
Lučina
Moravište
V. Morava
Zap. Morava
Juž. Morava
ap
am
dpr
pr
j
t
t_2
P-10
P-22
P-2
P-20
128
132
144
275
Orlovo gnezdo
50 km
Tisa
Novi Sad
Sava
Belgrade
Z. Morava
Niš
J. Morava
Priština
Proposed railway route
500 m buffer
Chainage
Highway
a alluvium
ap floodplain facies
am backswamp facies
pr proluvial deposits
dpr deluvial-proluvial deposits
M_1 sandstones, bituminous clays and coal
Mi migmatites


500 m
Praskovce
Poslonska
Rujiška r.
Deligrad
Vukašinovac
Rute
al
Mi
Nestor
M2
M3
D. Ljubeš
G. Ljubeš
Krevet
330
302
Srezovačka r.
Radevačka r.
Korma
Bojince
193+000
194+000
195+000
196+000
197+000
198+000
199+000
200+000
500
500
50 km
Novi Sad
Belgrade
Niš
Priština
Tisa
Sava
Z. Morava
Morava
Proposed railway route
500 m buffer
Chainage
Highway
alluvium
terrace 3-5m
marsh sediments
proluvial deposits
terrace 10-15m
conglomerates, sandstones, sands, marlstones, claystones, limestones and clays
conglomerates, sandstones, claystones and marlstones
migmatites


500 m
Juž. Morava
Čičina
Bobovište
•157
200+000
201+000
202+000
203+000
204+000
205+000
206+000
207+000
208+000
209+000
500
500
alt
M$_1$
M$_3$
t$_3$
pr
D. Adrovac
G. Adrovac
Utrina
•320
Suhotno
50 km
Novi Sad
Belgrade
Niš
Priština
Tisa
Sava
Z. Morava
Morava
Proposed railway route
500 m buffer
Chainage
Highway
alluvium
terrace 3-5m
proluvial deposits
conglomerates, sandstones, sands, marlstones, claystones, limestones and clays


500 m
Donje polje
Bujmir
Žitkovac
Moravac
alt
Juž. Morava
al
Lužane
Sprud
Tešica
PI,Q
Ćurlino
315
d
t_2
t_1
Bankovac
•170
Selište
Locika
Turija
PI,Q
Dašnička
Grejač
D. T
M_3
Koprivnica
M_2
500
209+000
210+000
211+000
212+000
213+000
214+000
215+000
216+000
217+000
218+000
219+000
220+000
50 km
Tisa
Novi Sad
Sava
Belgrade
Z. Morava
Niš
Morava
Priština
Proposed railway route
500 m buffer
Chainage
Highway
al alluvium
alt terrace 3-5m
d deluvial deposites
pr proluvial deposits
t_1 terrace 10-15m
t_2 terrace 25-35m
Pl,Q gravels, sands and clays
M_3 conglomerates, sandstones, sands, marlstones, claystones, limestones and clays

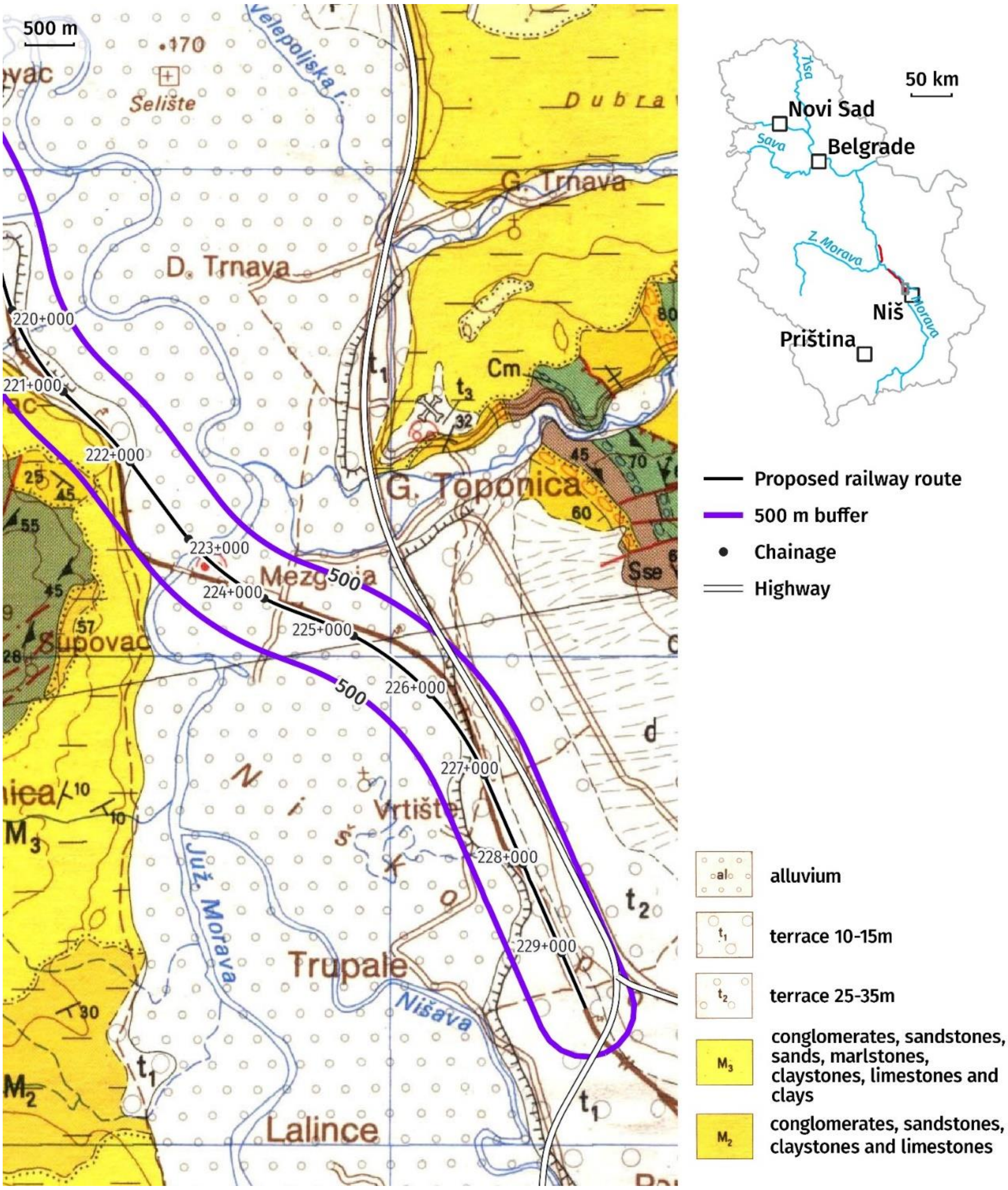


Figure 8-1. Geological map of the Project AoI at a scale of 1:100.000 (showing the 500m buffer zone along the railway line)[7]

[7] *Basic geological map in 1:100 000, sheets Paraćin (K34-7) and Aleksinac (K34-20), https://geoliss.mre.gov.rs/prez/OGK/RasterSrbija/*

Geomorphological characteristics

The Project area is located, for the most part, within the alluvial plain of the Great and South Morava River.

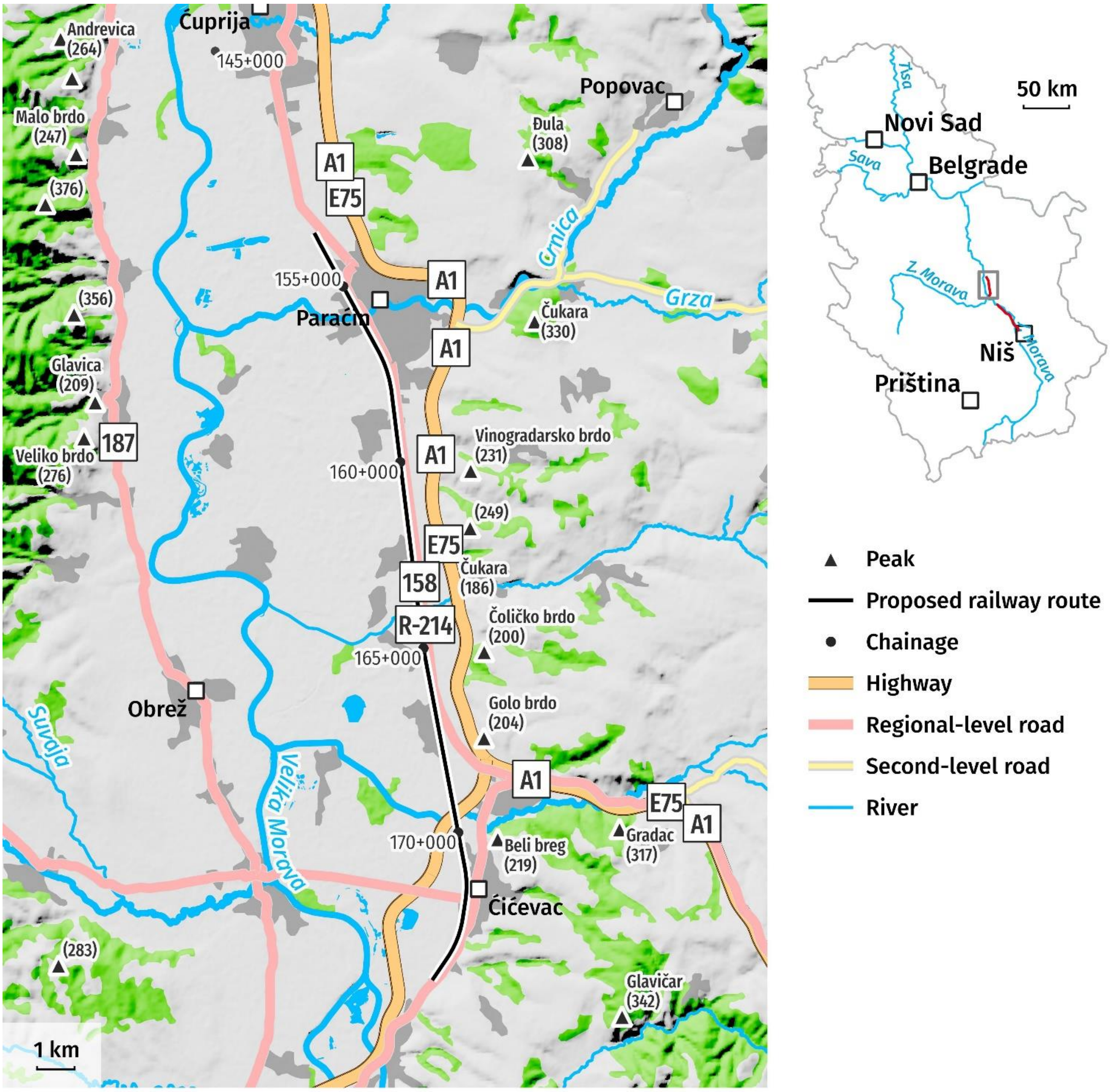
In geomorphological terms, an alternation between flatland and hilly-rolling terrain types is observed. The basic morphological forms of the terrain were created for the most part by alluvial-lacustrine processes. These forms were created by planar and linear erosion, which is still reflected in the work of streams and rivers, while the modern relief is in the immediate area of the existing railway created by works on the construction of the railway.

Morphologically, the area where the existing railway route is located predominantly represents the alluvial plain of the Great and South Morava rivers. Along these rivers, there are numerous intermittent and permanent watercourses, such as Crnica river, Bačijski stream, Slatinski stream, Simin stream, Jankov stream, Srezovačka river, and Radevacka river (more about watercourses can be found in Chapter 9, Surface Waters).

The Great and South Morava rivers, along with their tributaries, have formed zones of alluvial and terrace deposits, classifying most of the Project AoI as flatland terrain. Hilly-rolling terrains are present along the peripheral parts of the river valley, where the terrain begins to "rise." This type of relief is found within unconsolidated to weakly consolidated Miocene-aged sediments. Hilly terrain is observed at the beginning of the Đunis-Trupale sub-section, where the construction of the Đunis tunnel is planned.

The highest points (Figure 8-2) are within mountainous areas, including the peaks of Manjin kam (1186 m) and Koviljak (1138 m) on the Devica mountain; Jezerski stolovc (1129 m) and Leskovik (1174 m) on the Ozren mountain, and the highest peaks of the Veliki Jastrebac mountain, namely: Turka Karaula (1140 m) and Anatema (1075 m). The rest of the area (Pomoravlje) is predominantly flat or hilly with an occasional low mountain.

The absolute elevations of the terrain in the geodetic survey zone along the existing Paraćin–Stalać sub-section of the Project route are within the limits of 124–140 metres above sea level (m.a.s.l), whilst along the Đunis–Trupale (Niš) sub-section of the Project route, elevations are around 147–193 m.a.s.l. Elevation map is provided at Figure 8-3.


Ćuprija
Andrevica
(264)
145+000
Popovac
Malo brdo
(247)
Đula
(308)
(376)
A1
E75
Crnica
155+000
A1
Grza
(356)
Paraćin
Čukara
(330)
A1
Glavica
(209)
187
Veliko brdo
(276)
160+000
A1
Vinogradarsko brdo
(231)
(249)
E75
Čukara
(186)
158
R-214
Količko brdo
(200)
165+000
Obrež
Golo brdo
(204)
Suvaja
Velika Morava
A1
E75
A1
170+000
Beli breg
(219)
Gradac
(317)
Ćićevac
(283)
Glavičar
(342)
1 km
50 km
Tisa
Novi Sad
Sava
Belgrade
Z. Morava
Niš
Morava
Priština
Peak
Proposed railway route
Chainage
Highway
Regional-level road
Second-level road
River

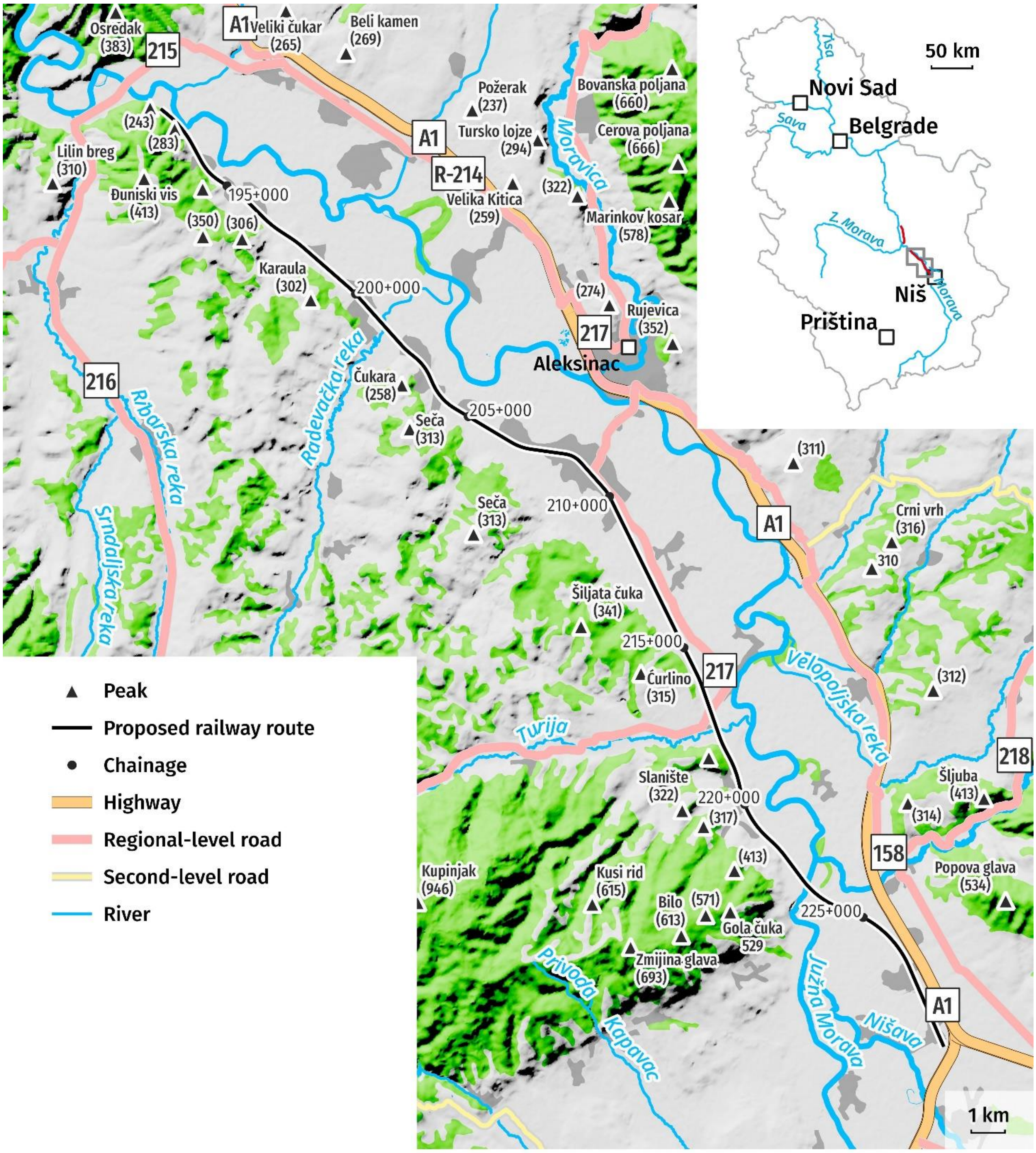
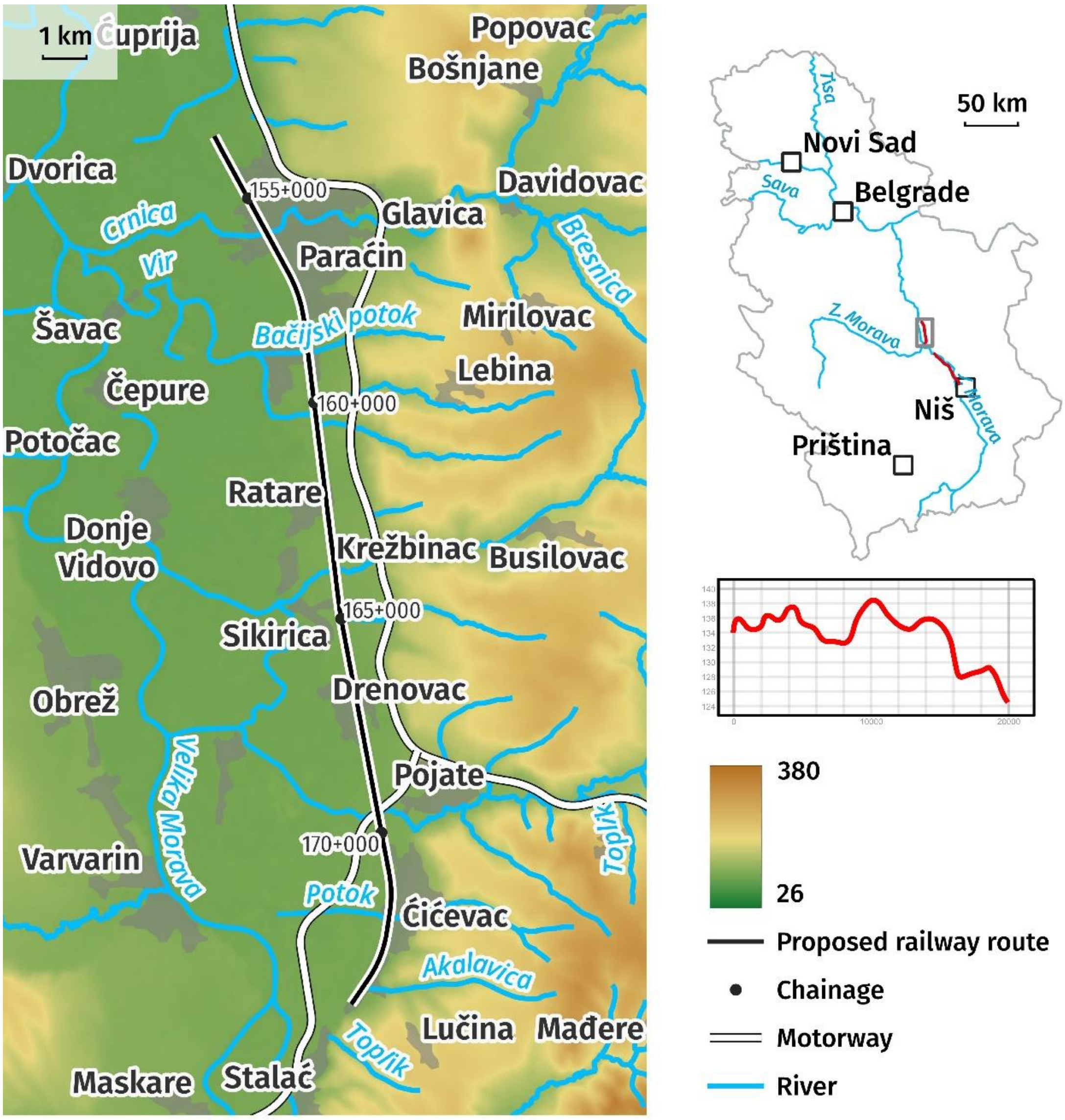


Figure 8-2. The highest peaks along the railway line


1 km
Ćuprija
Popovac
Bošnjane
Dvorica
155+000
Davidovac
Glavica
Crnica
Vir
Paraćin
Bresnica
Šavac
Bačijski potok
Mirilovac
Čepure
Lebina
160+000
Potočac
Ratare
Donje Vidovo
Krežbinac
Busilovac
165+000
Sikirica
Obrež
Drenovac
Velika Morava
Pojate
Toplik
Varvarin
170+000
Potok
Ćićevac
Akalavica
Lučina
Mađere
Toplik
Maskare
Stalać
Tisa
50 km
Novi Sad
Sava
Belgrade
Z. Morava
Niš
Morava
Priština
380
26
Proposed railway route
Chainage
Motorway
River

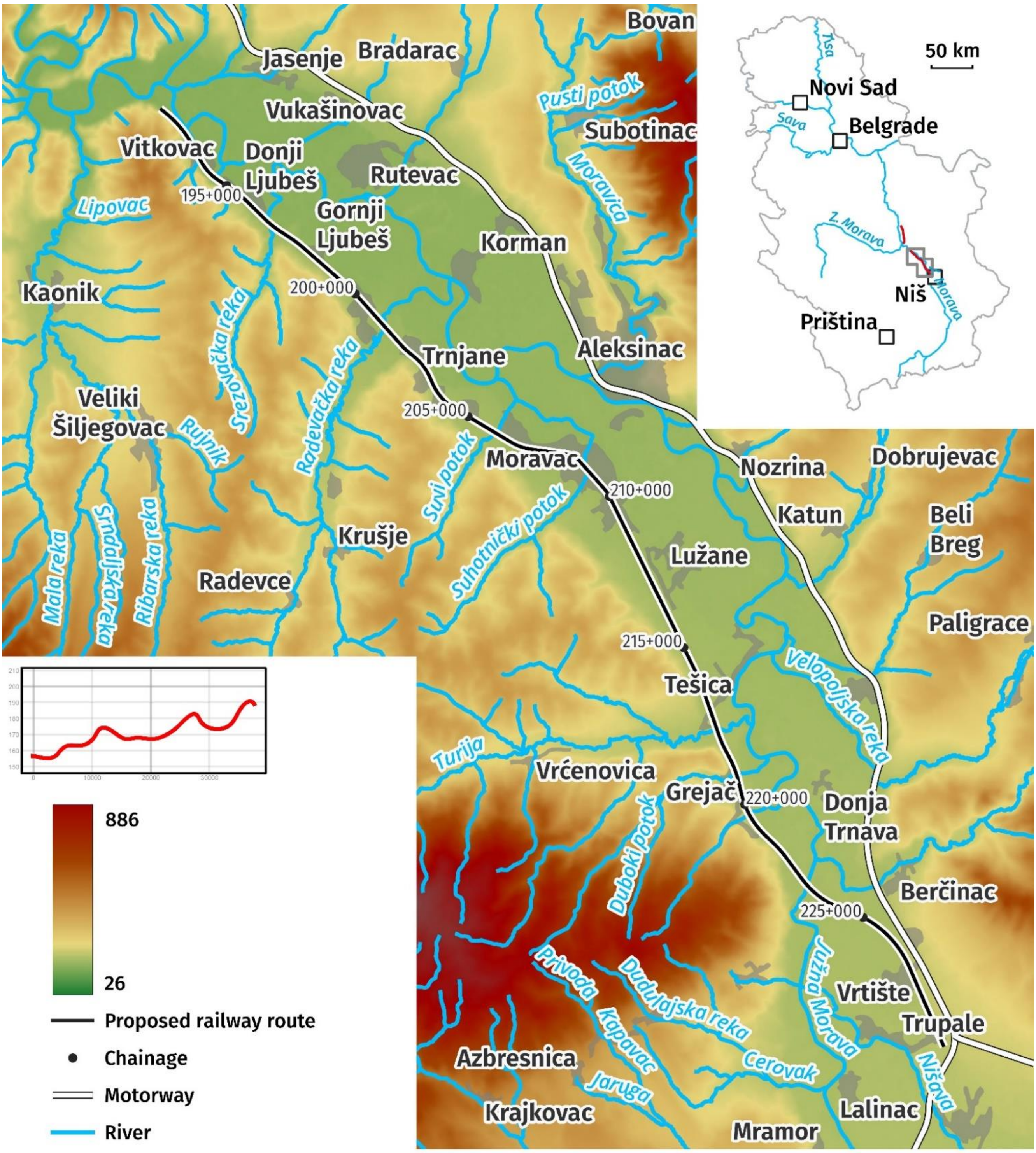


Figure 8-3. Elevation map along the railway line

Engineering geological conditions

This section provides an overview of the key engineering-geological units, their spatial distribution, and their implications for project construction. Figure 8-4 presents the spatial distribution of these units within the AoI.

The engineering geological conditions within the Project Area of Influence (AoI) are characterized by a diverse range of lithological and geo-mechanical properties, as outlined in Table 8-2.

The project AoI passes through various geological units with distinct characteristics. Loose and soft Quaternary deposits (sands, gravels, and clays) exhibit large deformability and occasional erosion or waterlogging, which may require stabilization measures. Heterogeneous lake deposits (sands, clays, marls) show medium to high deformability and waterlogging risks, demanding dewatering and stabilization in certain areas. Artificial embankments, made of clays, sands, and gravels, are generally stable but may experience settlement, requiring monitoring. Crystalline metamorphic rocks (gneisses and micaschists) provide a stable foundation with low deformability, though excavation can be challenging.

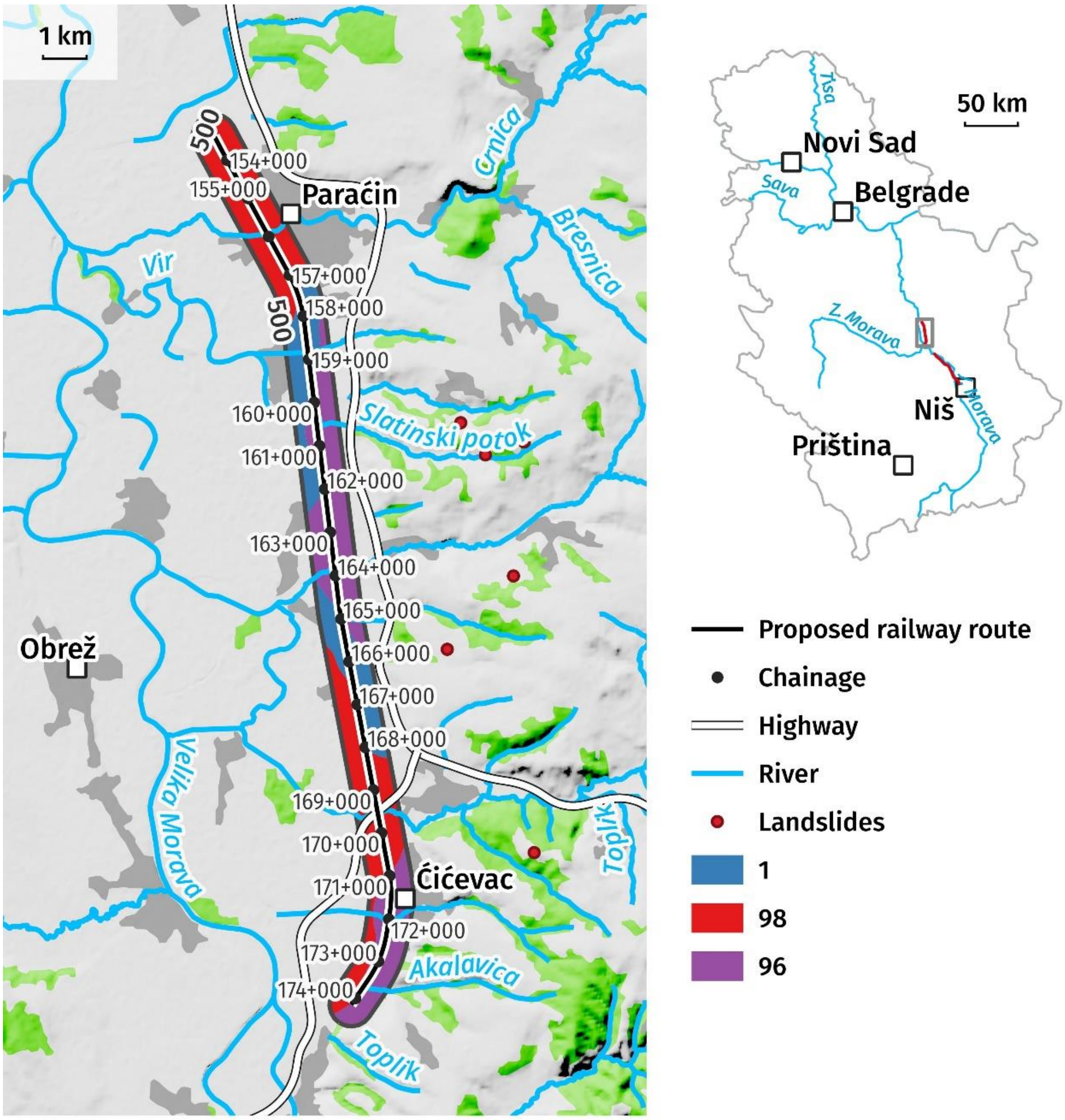
Table 8-2. Engineering geological units and their basic characteristics

105	Basic features: The unevenness in terms of the composition of the complex is pronounced, such as the unevenness of occasional or permanent erosion and torrential activity; the water content of the environment is mostly constant Complexes: Complexes of loose and soft Quaternary deposits Deformability: Mostly large deformability Genetic affiliation: Slope and slope-fluvial deposits Lithogenetic type: Alluvial-proluvial sediments Lithogenetic description: Gravels, sands, sandy and silty clays
1	Basic properties: Predominantly well-composed, well-consolidated, less watered, well-drained and stable environment Complexes: Complexes of loose and soft Quaternary deposits Deformability: Mostly large deformability Genetic affiliation: Slope and slope-fluvial deposits Lithogenetic type: River-terrace sediments-complex hypsometrically and facies unbroken down Lithogenetic description: Sands, gravels and sandy clays
96	Basic properties: The environment is extremely heterogeneous in terms of composition and engineering geological properties, with very uneven quantitative and qualitative participation and relationships of individual members of the complex; uneven composition and occasional waterlogging in the upper zone may be the main cause of the possible occurrence and development of landslides, as well as the sporadic development of erosion

	Complexes: Heterogeneous complexes of lake deposits Deformability: Medium to high deformability Genetic affiliation: Clay - clastic and carbonate sediments Lithogenetic type: Highly heterogeneous complex of lake sediments Lithogenetic description: Sands, clays, marls, marlstones, gravels, sandstones, conglomerates, agglomerates, limestones, tuffs, coals
114	Basic properties: The environment is of uneven compressibility, periodically highly watered in the upper zone, subject to changes and minor deformations under load; loessoid-marsh and marshy soils are generally of high compressibility Complexes: Heterogeneous complexes of lake deposits Deformability: Medium to high deformability Genetic affiliation: Clay - clastic and carbonate sediments Lithogenetic type: Grabel-sand complex of lake and river-lake deposits Lithogenetic description: Sands, gravels, subordinate to clays
111	Basic characteristics: The environment is uniform composition, well composed and sufficiently compacted and consolidated. Medium uniform composition, well composed and sufficiently compacted and consolidated Complexes: Complexes of loose and soft Quaternary deposits Deformability: Mostly large deformability Genetic affiliation: Anthropogenic creations Lithogenetic type: Artificial embankments Lithogenetic description: Clays, sands, gravels, gravel
98	Basic properties: An environment of great facies diversity, heterogeneous in terms of composition and uneven engineering-geological properties, which is determined by the degree of dynamic development of the alluvial environment, the relationship of individual members in the complex, the water content of the environment, as well as the activity of fluvial erosion and torrents Complexes: Complexes of loose and soft Quaternary deposits Deformability: Mostly large deformability Genetic affiliation: Slope and slope-fluvial deposits Lithogenetic type: Alluvial sediments-flood facies Lithogenetic description: Silty-sandy clays
121	Basic properties: Rock mass anisotropic in terms of composition, strength, cracking and disintegration, uneven stability and erodibility Complexes: Complexes of less solid to very solid sedimentary rocks Deformability: Medium to low deformability Genetic affiliation: Shale metamorphic rocks

	Lithogenetic type: Highly crystalline metamorphic rocks Lithogenetic description: Gneisses, micaschists, leptinolites...

It should be noted that despite geological unit No.96 being a possible cause of the occurrence and development of landslides, and being present within the Project AoI (as shown in Figure 8-4), no active landslides have been observed within the Project AoI, which is considered to be geologically stable (based on geological investigations undertaken in the period November 2023–January 2025 for the purposes of this Project).



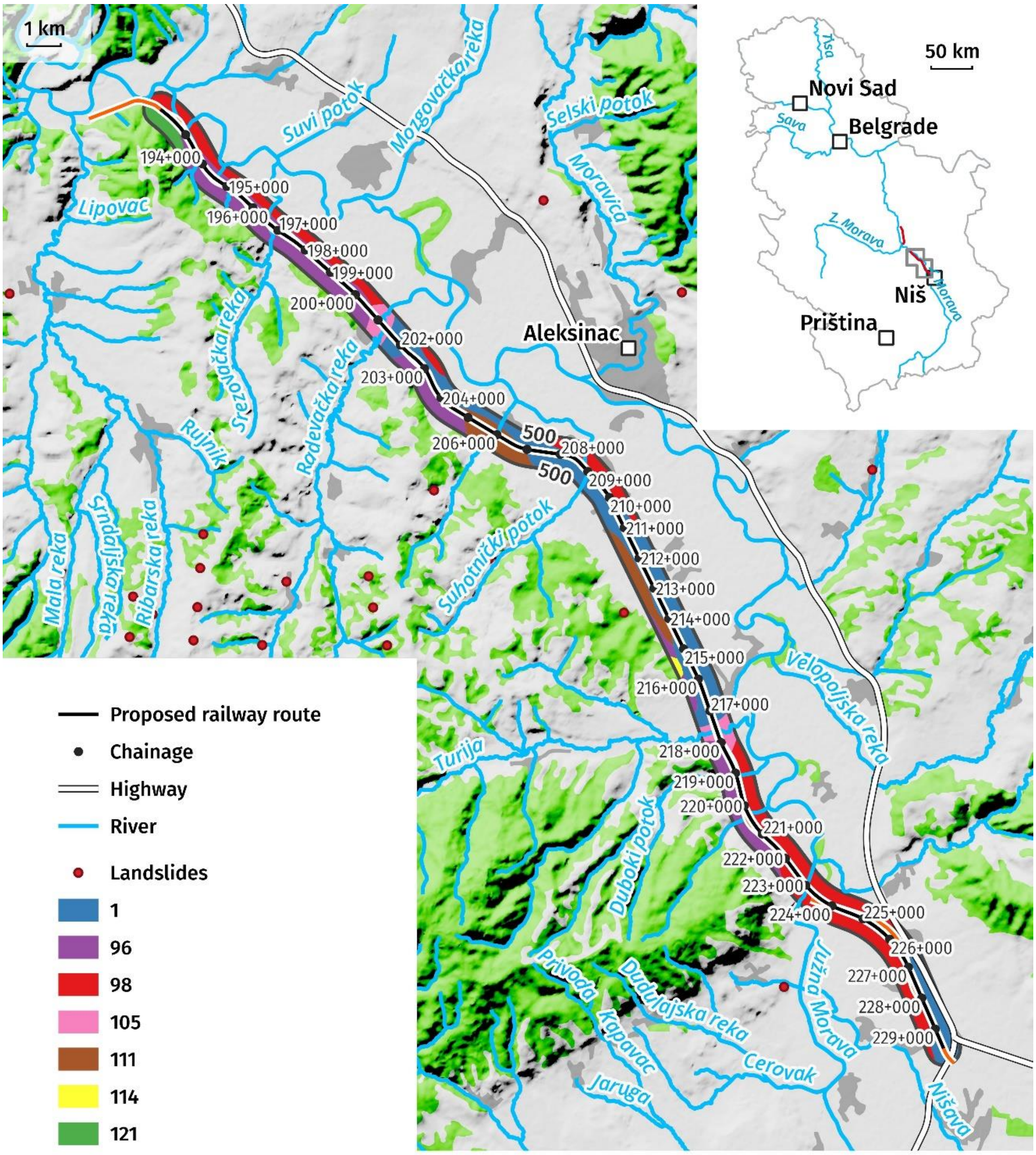


Figure 8-4. Engineering geologic map of research area[8]

[8] *Engineering geological map of Yugoslavia, M 1:500,000 (Geological and Geophysical Research Institute, Belgrade, 1969).*

Existing and potential geodynamic processes

In accordance with the lithological composition and morphology of the Paraćin–Stalać sub-section of the Project AoI, no significant occurrences of modern geodynamic processes and phenomena (i.e. the ongoing processes and phenomena that are shaping and modifying the Earth's surface such as tectonic activity, soil erosion and landslides) were identified based on the results of field research conducted by Geomehanika from November 2023–January 2025 for the purpose of this Project in the Geotechnical elaborate[9], which was prepared based on the field investigations conducted.

Along the Project route from Đunis to Trupale (Niš), there are two categories of terrain:

- stable terrains
- conditionally stable terrains

The 'stable terrains' are part of extensive alluvial and terrace-accumulation plains, composed of loess-like clayey and sandy-gravel materials, as well as cones of alluvial-proluvial deposits. The geological formation in this category is the wide alluvial plain characterized by Quaternary-age deposits, including river terraces and river facies (beds, floods, and floodplains) - a, alt, am, pr, dpr, t_1, t_2 (Figure 8-1). In these areas, the construction of planned facilities is possible without significant limitations, except for the need to consider the maximum centennial flood levels in the floodplain (Pl-Q) of the South Morava River when properly dimensioning embankments. Within the alluvial plateaus, in certain sections, the occurrence of waterlogged areas or fossil riverbeds of meandering rivers is possible. In these zones (organogenic-marsh sediments (b) often indicate old river meanders and waterlogged areas, see Figure 8-1), the presence of low-bearing capacity material in the subsoil may occur. The construction of embankments over such terrain requires ameliorative interventions to improve the soil through drainage, material replacement, soil strengthening using geocomposites, and other methods.

The 'conditionally stable terrains' mainly encompass the sloping areas of the terrain, consisting of deluvial deposits and the residual weathered material of Miocene complexes (M_2, M_3) (Figure 8-1). These deposits vary in thickness. Under natural conditions, these terrains are in a state of marginal equilibrium. Excavations for cuts and embankments depend on the physical-mechanical properties of the present lithological units, but in principle, the creation of deep cuts and embankments with uniform continuous slopes will be avoided due to the risk of destabilization and uncontrolled sliding and rockfalls. This means that the slopes of cuts and embankments must be dimensioned based on the defined geotechnical properties of the environments in which they will be executed. The sides of deeper cuts

[9] *Geomehanika doo, (2024), Elaborate on geotechnical conditions for the reconstruction of the railway route*

should be protected considering proposed designed measures. The following table lists the cuts and embankments with locations and the design measures along the railway.

Table 8-3. Tunnel portals, cuts and embankments along the route and design measures

No.	Type	from km	to km	Position in relation to the route	Lenght (m')	Design measures
1	Tunnel approach (Entrance portal)	192+010.00	192+305.00	right	295.00	The excavation on both sides of the tunnel is designed with a 5:1 slope and will be protected with a layer of reinforced shotcrete and systematic anchors. The slopes of the entrance and exit tunnel approaches will be protected by a pile structure.
2	Tunnel approach (Exit portal)	192+830.00	192+979.00	right	149.00	
3	cut	193+050.00	193+250.00	right	200.00	Slope protection by installing reinforced geomats and hydroseeding, the reinforcement of the geomat to the slope is done using rebar anchors Ø16, length L=1 m.
4	cut	195+140.00	195+250.00	right	110.00	
5	cut	195+630.00	195+717.00	right	87.00	
6	cut	199+200.00	199+453.00	right	253.00	
7	cut	199+850.00	200+100.00	right	363.00	
8	cut	200+100.00	200+200.00	left	100	
9	cut	218+198.00	218+250.00	right	52.00	
10	cut	226+842.00	226+900.00	right	58.00	
1	emabnkment	193+350.00	193+600.00	left	250.00	Embankment greater than 3m. Resolved by flattening the slopes.

2	emabnkment	194+250.00	194+700.00	the entire railway body	450.00	
3	emabnkment	195+800.00	196+400.00	the entire railway body	600.00	
4	emabnkment	206+800.00	206+850.00	the entire railway body	50.00	
5	emabnkment	221+150.00	221+400.00	left	250.00	
6	emabnkment	221+850.00	223+000.00	the entire railway body	1150.00	
7	emabnkment	223+300.00	223+950.00	the entire railway body	650.00	
8	emabnkment	226+450.00	226+750.00	the entire railway body	300.00	

The following modern geodynamic processes/phenomena are known to occur within the Đunis to Trupale (Niš) sub-section of the Project AoI:

- Earthquakes
- Gully erosion and
- Rockfalls

The Project is located within an area prone to earthquakes (based on the seismological hazard map (RSZ 2010) for a return period of 475 years, the Project area is located in zone VIII° MSK scale (http://www.seismo.gov.rs), with a seismicity coefficient of between 0.10 and 0.20). The last strong earthquake affecting the Project AoI occurred in Krusevac (May 10, 2022) and was of magnitude 4.6. Several minor earthquakes were also registered in the period 21–26 June 2022 in the area of Kragujevac with a maximum intensity of 3.2. In accordance with legal requirements, all Project components must be designed and constructed in accordance with Eurocode 8 and the associated National Annex (to ensure that in the event of earthquakes human lives are protected; damage is limited; and structures important for civil protection remain operational). The impact of an earthquake on the Project has been assessed in the Major Accidents and Disasters Chapter of this ESIA Report (Chapter 17).

For the purpose of developing the Preliminary Design, a certain number of investigation works were conducted. Based on the available scope and obtained results, an analysis of the railway reconstruction was carried out from a geotechnical perspective. When reviewing the results, for the next design phase (Main Design), it will be necessary to undertake more detailed investigations in areas of the terrain that are more demanding for construction, particularly in sections with high embankments and deep cuts (Table 8-3). If the terrain conditions or existing site conditions require steeper and higher cuts, it will be necessary to provide slope protection using gabion walls or protective mesh in combination with anchors. Additionally, slope revegetation and hydroseeding should be planned. These measures have been included in the Project design, and therefore no negative impacts are expected at these locations.

The gully erosion process is prevalent in the location where the Đunis Tunnel is planned to be constructed (the entrance portal is at km 192+010, and the exit portal is at km 192+830). Most gullies are just a few meters deep. The gully erosion process is typical of terrains with high levels of surface weathering, considering that the underlying bedrock consists of relatively hard metamorphic rock (or gneiss). The gully erosion process is a significant factor when constructing tunnels, particularly around the tunnel portals, as there is the potential for rapid gravitational movement of large, solid blocks of rock (detached from a larger mass of rock due to erosion, weathering or tectonic forces), as well as the occurrence of torrential flows of saturated material (i.e. soil, rocks, vegetation) during intense rainfall or sudden snowmelt.

In the terrain designated for tunnel construction, the process of material rockfall is present. On these slopes, the typical development of the weathering of surface crust can be observed, with deluvial and eluviual covers of the underlying rock mass, which itself varies in terms of alteration and fracturing. The steep slopes of the hills in the area of the future tunnel are covered with vegetation, although material from the surface weathering zone of the rock may be prone to erosion, especially during intense rainfall. According to Table 8-2, unit 121 highlights the presence of highly crystalline metamorphic rocks such as gneisses and micaschists, which, despite being harder, can be weathered and fractured along existing planes of weakness. These fractured sections could lead to rockfalls, particularly on the steep slopes in the area. Inadequate and unprotected cutting of slopes may lead to rockfalls, so specific designed protection measures have been planned for these locations (Table 8-3).

Given that the terrain designated for the future tunnel is covered with dense vegetation and that steep slopes rise immediately next to the existing railway, it was extremely difficult to access the planned borehole locations. However, two exploratory boreholes were drilled, along with geophysical investigations and dilatometer testing in the boreholes. It was concluded that the material is heterogeneous both in composition and in its physical-mechanical parameters. In such materials, it is important to emphasize that the stabilization of future slopes must be carried out simultaneously with the excavation, meaning that each excavation stage must be secured as quickly as possible. If an open slope (or part of it) is left unsecured for a prolonged period, exposure to atmospheric conditions may lead to a weakening of the predicted geomechanical parameters of the soil or rock mass[10]. Considering that only a minimal amount of

[10] *Geomehanika doo, (2024), Elaborate on geotechnical conditions for the reconstruction of the railway route*

investigation was carried out due to the inaccessibility of the location, it is necessary in the next phase of investigations to plan for clearing the terrain and constructing adequate access roads to enable the execution of further investigation works.

The Scoping Report for the Project identified that the landslide risk along the railway route is not significant and that there are no large-scale unstable slopes. A site visit was recommended to confirm this. Following the subsequent geological investigations done in the period from November 2023–January 2025, no active landslides were observed within the Project AoI.

8.3. Assessment of potential impacts

This chapter assesses how the construction and operation of the Project could impact existing geological conditions and how geological conditions may impact construction and operation. It also details the mitigation measures that should be implemented to avoid or minimise negative impacts on geological features during both the construction and operational phases.

The northern part of the Project route (Paraćin–Stalać) goes through the Velika Morava valley and the southern part (Đunis–Trupale (Niš)) goes through the South Morava valley, where the land is flatter. Although ELSUS predicts a medium risk of landslides along the Project route, the elevation gradient is generally insufficient for the occurrence of landslides. Furthermore, based on the engineering geological map (Figure 8-3), known active and dormant landslides are outside of the Project AoI and therefore the impact of the Project on increasing the potential for landslides was scoped out of the assessment for both the construction and operations phases.

Two additional geohazards have been identified within in the AoI that may be impacted by the construction and/or operation of the Project: gully erosion in area of the Đunis tunnel, but with a low likelihood of impact, as the gullies are present on the ground surface, above the tunnel structure and rockfalls with a low likelihood of occurrence, as slope stabilization measures have been incorporated into the design for the cuttings and tunnel portals. The following assessment is therefore focused on how Project activities are predicted to exacerbate these geohazards, and any associated impacts on identified sensitive receptors.

Assumptions and Limitations:

The specific placement of various Project components including laydown areas, construction camps, access roads, and spoil disposal areas, are yet to be finalized. Therefore, this assessment focuses solely on evaluating impacts linked directly to the current known Project footprint. The assessment assumes that the natural recovery and attenuation processes within geological systems will function as anticipated. However, unexpected environmental shifts, such as extreme weather events or significant land use changes, have the potential to impact the assessment's accuracy.

Any significant modifications to the Project's design or operation in the future will not have been considered in this assessment. Nevertheless, the assessment outlines mitigation measures to be implemented for Project components where specific details are currently unknown. It also identifies avoidance measures where applicable and indicates the necessity for further assessments during detailed design phases. The effectiveness of all proposed mitigation measures in reducing environmental impacts is contingent upon their successful implementation.

8.3.1. Impact assessment methodology

The standard methodology for assessing the impacts of the Project on geological features is outlined in Chapter 5 of this ESIA. Any deviations from this methodology are outlined in the following Sections of this Chapter.

Magnitude

Magnitude defines the severity of an impact, or extent of changes to the baseline. In order to determine the magnitude of an impact, the methodology adopted for this assessment specifically includes an evaluation of scale of the gully erosion/rockfall and their impacts on geological formations. These are defined in Table 8-4 below.

Table 8-4. Definition of grades for magnitude

MAGNITUDE	Definition	GRADE
Low impact	Minor, local disturbances without significant disruption of geological formations and no impact on terrain stability; easily mitigated by impementation of erosion control and stabilization measures.	1
Moderate impact	Limited damage to soil or surface layers, potential formation of more pronounced gullies or minor rockfalls that locally affect terrain morphology but without broader destabilization, and manageable with standard mitigation measures.	2
Severe impact	More significant rockfalls or gully formation affecting the stability of cuttings/embankments or slopes, disturbing the natural structure of the soil and geological formations, requiring extraordinary or additional engineering stabilization and remediation measures.	3

Very severe impact	Very serious rockfalls or substantial soil loss with the potential for permanent terrain destabilization, long-term or irreversible changes to the geological structure and soil characteristics.	4

Sensitivity

For the purposes of this assessment, the sensitivity of environmental receptors that could be impacted by changes in the geological baseline has been defined as outlined below.

'Very high' sensitivity receptors include geological units that are prone to destabilization due to poor consolidation and high-water content (units 96, 114).

'**High' sensitivity receptors** include poorly to moderately consolidated sediments of alluvial and deluvial origin found in floodplain areas of rivers and streams. These units have a potential for destabilization, especially under conditions of water saturation or increased loading due to construction activities (units 105, 98).

'Moderate' sensitivity receptors encompass moderately consolidated terrace sediments, artificial embankments, as well as slope sediments. While local instabilities may occur, these units are generally stable, with a moderate risk of destabilization, particularly if construction work and drainage are properly managed (units 1, 111).

'Low' sensitivity receptors are characterized by high resistance to degradation and good consolidation, often with low natural porosity and reduced permeability. Metamorphic rocks (gneisses, migmatites) represent a solid, stable material that is resistant to destabilization processes (unit 121). However, their behaviour is highly dependent on structural features such as foliation, presence of tectonic and fault zones, and degree of weathering.

The Table 8-5 presents the locations along the railway line where cuts, embankments, and the tunnel are designed, and which have been identified as potential areas of impact in terms of rockfalls and gully erosion. For each location, chainages, basic characteristics and degree of deformability according to the engineering-geological map (Figure 8-4) and sensitivity grade are provided. In defining receptor sensitivity, all engineering-geological units in Project AoI and their characteristics were considered, with particular attention to deformability. However, the following table highlights only those locations where potential impacts are expected due to the combination of engineering interventions and natural ground conditions.

Table 8-5. Tunnel portals, cuttings and embankments in relation to the engineering-geological map and receptor sensitivity grades

No.	Type	from km	to km	Position of „type“ in relation to sensitive geological formations	Sensitivity grade of receptors

				according to engineering-geological map	
1	Tunnel approach (Entrance portal)	192+010.00	192+305.00	121 - Medium to low deformability, the anisotropic nature and uneven stability make this unit prone to destabilization 96 - Medium to high deformability, high deformability and heterogeneity, with waterlogging and the potential for erosion, make this unit prone to destabilization 98 - Mostly large deformability, highly heterogeneous in composition and engineering-geological properties and prone to destabilization due to the large deformability and the dynamic nature of its environment	High (3)
2	Tunnel approach (Exit portal)	192+830.00	192+979.00	121 - Medium to low deformability, the anisotropic nature and uneven stability make this unit prone to destabilization	High (3)

				96 - Medium to high deformability, high deformability and heterogeneity, with waterlogging and the potential for erosion, make this unit prone to destabilization 98 - Mostly large deformability, highly heterogeneous in composition and engineering-geological properties and prone to destabilization due to the large deformability and the dynamic nature of its environment	
3	cut	193+050.00	193+250.00	96 - Medium to high deformability, high deformability and heterogeneity, with waterlogging and the potential for erosion, make this unit prone to destabilization	Very high (4)
4	cut	195+140.00	195+250.00	96 - Medium to high deformability, high deformability and heterogeneity, with waterlogging and the potential for erosion,	Very high (4)

				make this unit prone to destabilization	
5	cut	195+630.00	195+717.00	96 - Medium to high deformability, high deformability and heterogeneity, with waterlogging and the potential for erosion, make this unit prone to destabilization	Very high (4)
6	cut	199+200.00	199+453.00	96 - Medium to high deformability, high deformability and heterogeneity, with waterlogging and the potential for erosion, make this unit prone to destabilization	Very high (4)
7	cut	199+850.00	200+100.00	96 - Medium to high deformability, high deformability and heterogeneity, with waterlogging and the potential for erosion, make this unit prone to destabilization	Very high (4)
8	cut	200+100.00	200+200.00	96 - Medium to high deformability, high deformability and heterogeneity, with waterlogging and the potential for erosion,	Very high (4)

				make this unit prone to destabilization	
9	cut	218+198.00	218+250.00	105 - Mostly large deformability, large deformability and variability in composition, combined with erosion and torrential activity, make this unit highly prone to destabilization	High (3)
10	cut	226+842.00	226+900.00	98 - Mostly large deformability, highly heterogeneous in composition and engineering-geological properties and prone to destabilization due to the large deformability and the dynamic nature of its environment	High (3)
1	emabnkment	193+350.00	193+600.00	121 - Medium to low deformability, the anisotropic nature and uneven stability make this unit prone to destabilization	Low (1)
2	emabnkment	194+250.00	194+700.00	96 - Medium to high deformability, high deformability and heterogeneity, with waterlogging and the potential for erosion,	Very high (4)

				make this unit prone to destabilization	
3	emabnkment	195+800.00	196+400.00	96 - Medium to high deformability, high deformability and heterogeneity, with waterlogging and the potential for erosion, make this unit prone to destabilization	Very high (4)
4	emabnkment	206+800.00	206+850.00	111 - Mostly large deformability, well-compacted and consolidated, the large deformability and potential for instability in artificial embankments make this unit susceptible to destabilization	Moderate (2)
5	emabnkment	221+150.00	221+400.00	98 - Mostly large deformability, highly heterogeneous in composition and engineering-geological properties and prone to destabilization due to the large deformability and the dynamic nature of its environment	High (3)
6	emabnkment	221+850.00	223+000.00	98 - Mostly large deformability, highly heterogeneous in	High (3)

				composition and engineering-geological properties and prone to destabilization due to the large deformability and the dynamic nature of its environment	
7	emabnkment	223+300.00	223+950.00	98 - Mostly large deformability, highly heterogeneous in composition and engineering-geological properties and prone to destabilization due to the large deformability and the dynamic nature of its environment	High (3)
8	emabnkment	226+450.00	226+750.00	98 - Mostly large deformability, highly heterogeneous in composition and engineering-geological properties and prone to destabilization due to the large deformability and the dynamic nature of its environment	High (3)

All four categories of environmental receptor in terms of sensitivity may be impacted within the Project AoI.

The locations of receptors of different 'Sensitivity' as explained above is the same for each impact being assessed and is applied to all other construction and operations phase impacts below. Impact assessments have been conducted separately for each category of sensitive receptor, as relevant.

8.3.2. Construction Phase Impacts

Railway construction Projects (including construction of the track and stations, underpasses, overpasses and tunnels) can exacerbate geohazards, which can result in negative effects on sensitive receptors. The impacts of concern on geohazards during the construction phase are:

- An increase in the probability of rockfalls and
- An increase in the occurrence and extent of gully erosion.
- Impact on terrain stability at the tunnel portals

Impact of an increase in probability of rockfalls

Rockfalls can be a significant geohazard, and their impacts can arise from several sources related to construction activities. The main sources of an increase in the probability of rockfalls during the construction phase may include:

- Large-scale excavations, which can destabilize slopes and increase the risk of rockfalls, especially if the soil or rock structure is weak or fractured.
- Natural slopes around the tunnel portals may be destabilized due to vibrations caused by the use of heavy equipment, or tunnelling machines. The use of heavy construction machinery can generate vibration that may trigger rockfall in nearby unstable slopes or areas with loose soil.
- The construction of drainage systems or changes in surface water flow (such as creating new channels) can exacerbate rockfall risk. Improper drainage can lead to water infiltration, which may weaken rock layers and trigger rockfalls.
- Removal of vegetation during the construction process can destabilize slopes. Plants play a role in anchoring soil and rock in place, and their removal can make slopes more vulnerable to erosion and rockfalls.

Magnitude

During construction of the tunnel, cuttings and embankments, rockfalls can occur due to excavations and vegetation removal, which increases the risk of soil destabilization. It is assumed that rockfalls will be of low intensity, with minor and local disturbances to terrain morphology but without broader destabilization due to designed protection measures for each structural object (Table 8-3). As such, this impact is considered to have a 'Moderate' magnitude (Grade 2).

Spatiotemporal impact (Spatial Extent and Duration)

Given that the Project terrain is predominantly flat, with no pronounced morphological differences in terms of elevation, the area that is vulnerable to an increase in the probability of a rockfall is limited to the hilly terrain around tunnel portals near Đunis, from km 192+010.00 to km 192+830.00, and at the locations of future cuttings and embankments (chainages shown in Table 8-3). In forested areas, the presence of vegetation usually helps stabilize slopes. However, vegetation clearance during construction may increase vulnerability to rockfalls.

The risk of a rockfall is most significant during excavation and preparation of the tunnel portals and cuttings. Once the portals and cutting slopes are stabilized, the risk of rockfalls decreases significantly, limiting the temporal extent of the impact. Furthermore, potential rockfalls will be localized to the construction zone and will not affect urban areas.

Based on this, the impact of an increased probability of rockfalls is assumed to be very localized and temporary (only during construction). As such, this impact is considered to have a spatiotemporal grade of 2.

Likelihood

A combination of excavation activities, slope destabilization, vibration from machinery, and required removal of vegetation may increase the likelihood of a rockfall occurring at the tunnel portals and cuts during construction. The likelihood of rockfall occurrence has a very low probability of occurring, as slope stabilization measures have been implemented at deeper cuttings and tunnel portals based on geological investigations and obtained data, with the design measures specifically aimed at preventing such events. Based on this, an increase in the probability of rockfalls has a very low probability of occurring, and this impact has a likelihood grade of 1.

The assessment of the significance of the impact of an increase in probability of rockfalls on environmental receptors during the construction phase of the Project is summarised in Table 8-6 below.

Table 8-6. Significance of impact of rockfall on environmental receptors during the construction phase

Location	Magnitude	Spatio-temporal impact	Sensitivity	Likelihood	Overall significance
All Very High Sensitivity Receptors as outlined in Table 8-5	The impact is negative and consider to be of moderate magnitude, i.e. minor, local disturbances (2)	The impact is very localised and temporary (only during construction) (2)	Geological units that are prone to destabilization due to poor consolidation and high water content have very high sensitivity (4)	The impact has a very low proability of occuring since design measures have been implemented to prevent such events (1)	M (2) + ST (2) + S(4) + L(1) = 9 *Moderate*
All High Sensitivity Receptors as outlined in Table 8-5	The impact is negative and consider to be of moderate magnitude, i.e. minor, local disturbances (2)	The impact is very localised and temporary (only during construction) (2)	Poorly to moderately consolidated sediments of alluvial and deluvial origin found in floodplain areas of rivers and streams with potential for destabilization,	The impact has a very low proability of occuring since design measures have been implemented to	M (2) + ST (2) + S(3) + L(1) = 8 *Moderate*

			especially under conditions of water saturation have high sensitivity (3)	prevent such events (1)	
All Moderate Sensitivity Receptors as outlined in Table 8-5	The impact is negative and consider to be of low magnitude, i.e. minor, local disturbances (2)	The impact is very localised and temporary (only during construction) (2)	Moderately consolidated terrace sediments, artificial embankments, generally stable units with a moderate risk of destabilization have moderate sensitivity (2)	The impact has a very low proability of occuring since design measures have been implemented to prevent such events (1)	M (2) + ST (2) + S(2) + L(1) = 7 Low

Impact of an increase in occurrence and extent of gully erosion

Eroded soil can clog engineered drainage systems (such as culverts and stormwater channels) and natural drainage paths, leading to localized flooding and further instability. Continuous erosion undermines slopes and can trigger rockfalls. Increased sediment loads in nearby ecosystems can smother vegetation and reduce biodiversity. Erosion-related issues can slow down construction, increase costs, and require additional mitigation measures.

The main causes of gully erosion during the construction phase may include:

- Construction activities (for example excavations) that have the potential to disrupt natural surface water drainage patterns, resulting in altered water flow dynamics and accumulation of water, concentrating runoff, and further eroding the soil, forming or deepening gullies in area of the Đunis tunnel.
- Clearing of forests and vegetation along the railway route in the area of the Đunis tunnel can expose soil and increase the risk of soil erosion, especially on steep slopes and/or during heavy rainfall events.
- Excavations for Đunis tunnel may expose areas of bare soil, which can increase the risk of erosion, particularly if the natural slope of the land is disturbed.
- Heavy rainfall events, particularly during the rainy season, can increase the speed and volume of surface runoff, leading to the formation or expansion of gullies in area of the Đunis tunnel, particularly if proper erosion control measures are not in place.

Magnitude

Construction activities in the area of the planned tunnel are expected to include excavations, which will involve digging into slopes to create the tunnel portals, removing soil for foundation stabilization, and forest clearing, which can lead to localized soil erosion. While the tunnel site lies within a metamorphic geological unit that would typically be classified as low-sensitivity, the degree of weathering, fracturing, and heterogeneity observed in field investigations increased its vulnerability to construction-related disturbance. However, this impact is unlikely to be on the scale of severe geological disturbances due to implementation of designed protective measures, and therefore we consider it will have low impact. (1)

Spatiotemporal impact (Spatial Extent and Duration)

Gully erosion is a significant factor in the construction of tunnels, especially in the vicinity of tunnel portals (at km 192+010.00 and km 192+830.00). Namely, gullies represent locations where the possibility of rapid gravitational movement of solid blocks of rock is increased, as well as the occurrence of torrential flows during intense atmospheric precipitation or sudden atmospheric precipitation. Given that the Project terrain is predominantly flat, with no pronounced morphological differences in terms of elevation, the area that is vulnerable to an increase in the probability of a gully erosion is limited to the hilly terrain around tunnel portals near Đunis, from km at 192+010 to km 192+830[11].

Once the tunnel portals are stabilized (e.g., through retaining walls or slope reinforcements), the risk of erosion is greatly reduced as the soil is held in place, preventing slippage and ensuring that surface water run-off does not create rills and gullies, therefore limiting the spatial extent of the impact. Since the tunnel will be constructed in a remote forested area without human settlements, potential erosion will not extend to urban areas, roads, or other critical infrastructure, further localizing the effect. Construction activities are highly controlled and confined to specific zones. Excavation, grading, and slope modifications will not extend beyond the immediate work area, ensuring that the impacts remain localized.

The construction phase is temporary by design, lasting only for the duration of excavation, slope preparation, and associated activities at the tunnel portals. Once the tunnel is completed and stabilization measures are in place (e.g., revegetation, slope reinforcement, erosion control measures), the risk of erosion diminishes significantly.

Based on this, erosion is assumed to be very localized (in the area of the tunnel portals) and is expected to be temporary (only during construction). As such, gully erosion is predicted to have a spatiotemporal grade of (2).

Likelihood

In forested areas, the presence of vegetation usually helps stabilize slopes and prevent soil erosion. However, vegetation clearance to facilitate construction may increase the likelihood of soil erosion (and the formation of gullies). Tunnel construction often involves excavation, and slope modifications, which can destabilize surrounding soil and rock formations, particularly at the tunnel portals. Although gullies are present in the area near the tunnel, they are

[11] *"Geomehanika" d.o.o, Elaborate on geotechnical conditions for the reconstruction of the railway line (under preparation)*

located on the surface above the future tunnel structure, and since the excavation will be performed by face drilling method, with no surface works planned, the likelihood of impacts associated with gullies is considered to be very low. Additionally, protective design measures have been planned for the tunnel construction (also mentioned in Table 8-3), which will further reduce the likelihood of any potential impacts and therefore the likelihood has a grade of 1.

The assessment of the significance of geohazards on environmental receptors during the construction phase of the Project is summarised in Table 8-7 below.

Table 8-7. Significance of impact of gully erosion on environmental receptors during the construction phase

Location	Magnitude	Spatio-temporal impact	Sensitivity	Likelihood	Overall significance
High Sensitivity Receptor as outlined in Table 8-5	The impact is negative and consider to be of low magnitude i.e. minor, local disturbances without significant disruption of geological formations and no impact on terrain stability (1)	The impact is very localised and temporary (only during construction) (2)	The geological profile at the tunnel portal area is composed of three dominant units wich have a varying levels of geomechanical stability and therefore different degrees of environmental sensitivity in the context of terrain instability risk. Therefore, for the purpose of impact assessment, the overall sensitivity of geological receptors in the tunnel portal area is rated as High.	Gully erosion is considered to have a very low likelihood of occuring due to designed protective measures and the prescribed face drilling method with no surface works planned (1)	M (1) + ST (2) + S(3) + L (1) = 7 *Low*

Location	Magnitude	Spatio-temporal impact	Sensitivity	Likelihood	Overall significance
			(3)		

Impact on terrain stability at the tunnel portals

Although no active large-scale landslides were observed, the tunnel area is characterized by other forms of terrain instability. This is due to the presence of steep vegetated slopes, fractured metamorphic rocks, and poor-quality rock masses. According to the GN-200 classification, the geological conditions at the tunnel site fall into excavation categories IV and V, indicating unstable rock masses. Rock Mass Rating (RMR) values are below 22, and Q-values are low (<0.04)[12], confirming challenging geotechnical conditions for excavation. These factors require targeted stabilization measures during construction, particularly near tunnel portals. Therefore, it is necessary to further assess these risks, considering stabilization measures included in the current design, but also to evaluate additional mitigation measures that may be applied to minimize the impact on the surrounding terrain and ensure safety during construction.

Magnitude

The magnitude of impact related to terrain instability during tunnel construction is assessed as low. Although the risk of large-scale landslides has been deemed negligible, localized terrain instability—particularly rockfall and minor slope failure—may occur in the tunnel portal area (km 192+010.00 to km 192+830.00), due to poor rock mass quality and the presence of fractured metamorphic rocks and steep vegetated slopes.

During construction of the tunnel, excavations and vegetation removal may increase the risk of soil destabilization. It is assumed that this impact will be of low intensity, with minor and local disturbances. Designed protection measures - the excavation face on both sides of the tunnel is designed with a 5:1 slope and will be protected with a layer of reinforced shotcrete and systematic anchors; the slopes of the entrance and exit cut will be secured with a pile wall structure are expected to effectively control and mitigate instability risks. Impact is therefore considered to have a 'Low' magnitude (Grade 1).

Spatiotemporal impact (Spatial Extent and Duration)

The area susceptible to terrain instability at the tunnel site is confined to the tunnel portals, specifically between km 192+010.00 and km 192+830.00. The highest risk of instability occurs during the excavation and preparation phases of the tunnel portals. However, once stabilization measures are implemented, the risk is expected to decrease

[12] *"Geomehanika" d.o.o, Elaborate on geotechnical conditions for the reconstruction of the railway line (under preparation)*

substantially, thereby limiting the duration of the impact. In addition, any potential instability will remain confined to the construction zone and is not expected to affect nearby urban areas.

Based on this, the impact is assumed to be very localized and temporary (only during construction). As such, this impact is considered to have a spatiotemporal grade of 2.

Likelihood

Considering the implemented design measures and the geological characteristics of the area, the overall probability of terrain instability during tunnel construction is assessed as low. The geological profile at the tunnel site includes fractured metamorphic rocks which indicate poor rock mass quality and increased susceptibility to localized slope failures during excavation. However, the adopted stabilization measures—such as reinforced shotcrete, systematic anchoring, and pile wall structures—are appropriate for the identified conditions and are expected to effectively mitigate these risks.

The excavation faces are designed with stable 5:1 slope, and continuous geotechnical monitoring (inclinometers) will be conducted to detect any ground movements in a timely manner. Given these designed measures, the likelihood of large-scale instability is significantly reduced and has a grade of 1.

Table 8-8. Impact on terrain stability at the tunnel portals on environmental receptors during the construction phase

Location	Magnitude	Spatio-temporal impact	Sensitivity	Likelihood	Overall significance
High Sensitivity Receptor as outlined in Table 8-5	The impact is negative and consider to be of low magnitude i.e. minor, local disturbances without significant disruption of geological formations (1)	The impact is very localised and temporary (only during construction) (2)	The geological profile at the tunnel portal area is composed of three dominant units wich have a varying levels of geomechanical stability and therefore different degrees of environmental sensitivity in the context of terrain	Impact is considered to have a very low likelihood of occuring due to designed protective measures (1)	M (1) + ST (2) + S(3) + L (1) = 7 *Low*

Location	Magnitude	Spatio-temporal impact	Sensitivity	Likelihood	Overall significance
			instability risk. Therefore, for the purpose of impact assessment, the overall sensitivity of geological receptors in the tunnel portal area is rated as High (3)		

8.3.3. Operations Phase Impacts

During the operational phase, a railway can induce or exacerbate geohazards through various mechanisms, primarily due to its long-term impact on geological, hydrological, and geotechnical conditions. The main geohazard that can occur during the operational phase of a railway is increase in probability of gully erosion.

Impact of an increase in occurrence and extent of gully erosion

Gully erosion near the Đunis tunnel portals during the operational phase of a railway line can result from a combination of natural factors, such as topography, rainfall, and soil type, as well as human-induced factors including poor drainage management, vegetation removal, and land use changes. Both natural and anthropogenic sources interact to shape the severity and progression of gully erosion, making it important to address the underlying causes through proactive mitigation strategies.

By monitoring and managing these sources effectively, it is possible to reduce the impact of gully erosion.

Some of the sources of impacts in relation to gully erosion during the operation phase may include:

- Clearing vegetation near tunnel portals without replanting or providing erosion control measures can leave the soil unprotected, making it more susceptible to erosion from rainfall or wind.
- Intense rainfall events, especially during seasonal storms, can significantly increase surface runoff. When large volumes of water flow over the land, they can erode the soil, creating or worsening existing gullies. This is particularly problematic near tunnel portals, where surface water drainage needs to be carefully managed to avoid undermining the tunnel entrance and surrounding infrastructure.
- Regular maintenance of railway infrastructure sometimes requires clearing vegetation, which, if not properly managed, can lead to soil erosion.

- If erosion control measures (e.g., slope stabilization or vegetation planting) are not properly maintained or are inadequate, gullies can form or expand over time. Failing to monitor and update these measures during the operational phase can result in further destabilization of the terrain near tunnel portals.

Magnitude

If adequate drainage is installed around the tunnel portals (as planned), and the Project is constructed with adequate erosion control measures such as proper drainage, vegetation cover, and slope stabilization, the magnitude of gully erosion in the operations phase will be low. (1).

Spatiotemporal impact (Spatial Extent and Duration)

Gully erosion is most likely to occur from km at 192+010.00 to km 192+830.00 in the area of the Đunis tunnel, which is considered to be more vulnerable to soil erosion due to earlier excavations to facilitate construction, and the removal of vegetation in the construction zone. If erosion occurs, it is likely to be addressed during routine maintenance cycles, where drainage systems are checked, vegetation cover is managed, and any erosion-prone areas are repaired, thereby limiting the duration of the impact from a few years to several months, if erosion is addressed promptly. Therefore, it is expected that gully erosion will have a very localized and short-term impact during the operation phase of the railway. (2)

Likelihood

The operations phase primarily involves train movements and maintenance activities that do not require extensive excavations or alterations to the landscape, and regular operations such as train runs and maintenance checks are unlikely to cause gully erosion. The likelihood of low-impact gully erosion during the operation phase of a railway line depends on factors such as the design and maintenance of drainage systems, soil stability, topography, vegetation. The implementation of all planned design and land reclamation measures is expected to enhance soil stability and reduce the likelihood of gully erosion. Therefore, we assume there is a very low probability of occurring, or it will occur rarely. (1)

Table 8-9. Significance of impact of gully erosion on environmental receptors during the operation phase

Location	Magnitude	Spatio-temporal impact	Sensitivity	Likelihood	Overall significance
High Sensitivity Receptors as outlined in Table 8-5	The impact is negative and consider to be of low magnitude i.e. minor, local disturbances without significant	The impact is very localised and short term – less than 5 years (2)	The geological profile at the tunnel portal area is composed of three dominant units wich have a varying levels of	Implemented design and land reclamation measures will enchance soil stability and result in a very low	M (1) + ST (2) + S(3) + L(1) = 7 *Low*

	disruption of geological formations and no impact on terrain stability (1)		geomechanical stability and therefore different degrees of environmental sensitivity in the context of terrain instability risk. Therefore, for the purpose of impact assessment, the overall sensitivity of geological receptors in the tunnel portal area is rated as High. (3)	likelihood of this impact occurring (1)	

8.4. Summary of Impacts

Table 8-10. Summary of significance of construction and operation phase geohazards

Project phase	Impact	Sensitivity of receptors	Positive/Negative	Overall significance before mitigation measures are implemented
Construction phase	Impact of an increase in probability of rockfall	Very high	Negative	Moderate
		High	Negative	Moderate
		Moderate	Negative	Low
Construction phase	Impact of an increase in occurrence and extent of gully erosion	High	Negative	Low

Construction phase	Impact on terrain stability at the tunnel portals	High	Negative	Low
Operation phase	Impact of an increase in occurrence and extent of gully erosion	High	Negative	Low

8.5. Mitigation measures

8.5.1. Construction phase

The Contractor should develop and implement a ***Construction Water and Soil Management Plan***, which must include details of how vegetation clearance should be managed to prevent or limit soil erosion and outline the measures that will be taken to ensure the stability of steep slopes (including railway embankments/cuts) and effectively manage surface water drainage to prevent/limit soil erosion and rockfalls.

Mitigation measures that should (as a minimum) be included in the Water and Soil Management Plan are presented below.

Table 8-11. Mitigation measures proposed to mitigate possible impacts of rockfall in construction phase

Impact	Mitigation measures
Impact of an increase in probability of rockfall	▪ Prior to construction, rock scaling (removing loose and unstable rocks) should be performed along slopes and rock faces adjacent to the railway to reduce the chance of falling debris and ensure that only stable rock remains. ▪ Before construction begins, conduct thorough geotechnical assessments to identify unstable slopes and high-risk areas where rockfalls are most likely. ▪ During construction, install gravity retaining walls or anchored walls around areas like tunnel portals and steep cuts and embankments. For sections where space constraints exist, cantilevered walls can be employed to provide additional stability and prevent rockfalls. ▪ In areas with deeper cuts, the sides of the cuts should be protected through appropriate stabilization measures, which may include retaining structures (such as retaining walls or gabions), anchoring systems, rockfall protection nets, drainage solutions, or revegetation techniques, depending on site-

	specific conditions. The selection of stabilization methods will be guided by the results of detailed geotechnical investigations. - Install rockfall barriers made from high-tensile mesh or rigid barriers to catch or deflect falling rocks, especially around the tunnel portals. - Deploy wire mesh over any exposed rock faces to prevent loose rock from falling. - At embankments reshape steep slopes to a gentler angle to reduce rockfall risk. - During excavation, use a progressive approach, removing material in stages. This reduces the exposure of large areas of unstable rock, which can trigger rockfalls. - Use temporary coverings (such as tarps or mesh) to protect areas under active construction from rockfall until permanent stabilization methods can be applied - Do not undertake unnecessary clearance of vegetation, especially in areas where it helps stabilize slopes. - Plan construction activities to avoid working during periods of heavy rainfall or stormy weather, which can increase the risk of rockfall due to surface water runoff and the destabilizing effect of wet soil and rock - Ensure proper surface drainage is designed and implemented to divert water away from slopes, reducing water infiltration that could destabilize rock masses.

Table 8-12. Mitigation measures proposed to mitigate possible impacts of gully erosion in construction phase

Impact	Mitigation measures
Impact of an increase in occurrence and extent of gully erosion	- Surface water drainage systems must be installed around the railway line and tunnel portals, to direct water away from vulnerable slopes and gullies. - The front of the excavation on both sides of the tunnel (entrance portal at km 192+010 to exit portal at km 192+830) must be built with a 5:1 slope and protected by a layer of reinforced shotcrete and system anchors. The slopes of the entrance and exit of the pre-section must be protected by a pile structure.

	- Use geo-grids and geotextiles to reinforce the soil, improve slope stability, and reduce the potential for soil movement and erosion around the tunnel portals (at km 192+010 and at km 192+830). - Limit the amount of vegetation clearance, especially in areas with steep slopes around the tunnel portals. Priority should be given to preserving vegetation to naturally reduce erosion risks. - Avoid excessive excavation or disruption of the soil structure in areas that are not directly needed for construction, particularly near the tunnel portals (entrance portal at km 192+010 to exit portal at km 192+830). - Use hydroseeding techniques to quickly establish vegetation over disturbed slopes at the tunnel portals (entrance portal at km 192+010 to exit portal at km 192+830). - In addition to hydroseeding, directly seed or plant fast-growing vegetation, such as grasses or legumes, on disturbed areas to establish plant roots that will hold the soil together and reduce erosion risks. - Use native plant species to revegetate disturbed areas. These plants are well-suited to the local environment and will develop strong root systems that provide long-term stabilization. - Use erosion control mats (e.g., coir mats, jute mesh) or blankets to cover exposed soil around the tunnel portals. These materials protect against surface erosion, especially in areas with steep slopes or where vegetation is not yet established. - Use temporary slope drains to redirect runoff water from the slopes and reduce erosion during the construction phase - Install appropriate monitoring equipment such as inclinometers in the zone of the pile structure in the zone of tunnel portals (to monitor ground movements) - Schedule construction activities to avoid working in high-risk weather conditions (e.g., heavy rainfall) to reduce the likelihood of soil erosion

Table 8-13. Mitigation measures proposed to mitigate possible impacts of terrain stability at tunnel portals in construction phase

Impact	Mitigation measures

Impact on terrain stability at the tunnel portals	- Perform ongoing visual assessments of slopes to detect early signs of instability such as cracking, minor slips, or vegetation movement - Vegetation should only be cleared to the extent necessary for construction activities, in order to retain root systems that contribute to natural slope stability - Surface water drainage systems must be installed around the tunnel portals, to direct water away from vulnerable slopes and gullies - Excavated soil and rock must not be stockpiled on or near natural slopes to avoid additional loading that could compromise stability - Excessive excavation and shaping of slopes must be avoided; where reshaping is necessary, stable slope angles must be maintained - If any signs of instability appear during construction, localized stabilization measures should be implemented, such as geotextiles, mesh, or temporary anchors

8.5.2. Operations phase

It is the responsibility of Serbian Railway Infrastructure (SRI) to develop and implement an Operational Water and Soil Management Plan. This should define the mitigation measures that must be implemented and required maintenance activities (including maintenance of drainage structures, sediment traps, and railway infrastructure).

The SRI should also develop and implement an Operational Emergency Preparedness and Response Plan, which details the emergency response principles and protocols to be implemented in the event of an emergency. For more details about this Plan, please refer to Chapter 17 Major Accidents and Disasters.

Table 8-14. Mitigation measures proposed to mitigate possible impacts of gully erosion in operations phase

Impact	Mitigation measure
Impact of an increase in occurrence and extent of gully erosion	- Ensure installed drainage systems (closed rainwater evacuation system and drainage channels, designed to manage water flow along the railway route) are regularly cleared of debris and sediment to maintain their capacity to manage water flow. Where needed, reinforce vulnerable slopes with soil stabilization techniques such as geo-grids, geotextiles, or soil

	nailing to prevent erosion and maintain slope stability. - Use erosion control blankets or geotextile mats on disturbed or exposed slopes to prevent erosion and allow vegetation to be established - Revegetate disturbed areas, particularly those prone to erosion, with native grasses, shrubs, and trees. Establish deep-rooted vegetation to help bind the soil, preventing erosion and stabilizing slopes. Regularly maintain vegetation cover to ensure continued erosion resistance. - Allow for the natural regrowth of vegetation where possible, as this will strengthen soil cohesion and reduce gully erosion risks over time. - In critical areas where vegetation is slow to establish, install erosion control mats or blankets to protect soil from water erosion - After heavy rainfall or storms, conduct inspections to assess any potential damage to slopes or drainage systems. Immediate repairs can prevent further erosion and gully formation before they become major issues. - Ensure SRI's maintenance crews are trained in identifying early signs of erosion and understand the importance of maintaining erosion control measures.

8.5.3. Monitoring

Regular monitoring should be undertaken throughout the construction and operations phases of the Project to ensure that the requirements of the E&S Management Plans, Lenders' Policies, and ESIA commitments are being met. Furthermore, any changes to baseline environmental and social conditions should be monitored, to verify that the mitigation measures being implemented by the construction contractor and SRI to prevent or limit potentially significant negative impacts are adequate and effective. Where monitoring indicates that negative impacts are occurring despite the requirements of Management Plans being met, additional mitigation measures may be required, and Management Plans revised accordingly.

The monitoring activities outlined in Table 8-15 below in relation to geohazards are proposed for the construction and operations phases.

Table 8-15. Proposed monitoring activities

Monitoring Requirement	Frequency	Location	Method
Construction Phase			
Inclinometer: Monitoring of ground movements in the area of the pile structure (Đunis tunnel)	To be defined by the monitoring program	Tunnel portals: behind the piles, on the berms, at intervals of 100 meters.	Installation of inclinometers to measure ground displacement. Regular data logging and analysis for any signs of instability. The measurement results will be submitted to the Supervising Engineer and the Designer for interpretation.
Rockfall: Visual inspection for rockfall risk (e.g., loose rocks, fractures)	Not less than monthly	High risk rockfall areas (tunnel portals and cuttings)	Continuous visual inspections. Documentation of findings with photographs and notes.
Rockfall: Monitoring of rockfall accumulation (e.g., fallen debris)	Monthly or after heavy rain	High risk rockfall areas (tunnel portals and cuttings)	On-site inspections with detailed reporting of rockfall events.
Gully erosion: Inspection of gully erosion progression (e.g., fallen debris, rock size)	Not less than monthly	High-risk gully erosion areas (near tunnel portals)	Visual inspections, topographic surveys to monitor changes in gully depth and width.
Gully erosion: Installation of erosion control measures (e.g., temporary barriers, drainage improvements)	As needed	Vulnerable gully areas prone to rapid erosion (tunnel portals)	Site documentation, and monitoring the effectiveness of control measures (e.g., after heavy rainfall).
Rockfall and Gully erosion: Ground stabilization activities (e.g., netting, retaining walls)	As needed	Cuttings and tunnel portals	Recording and inspection of stabilization efforts.
Operations Phase			
Gully erosion: Monitoring of erosion progression (e.g., widening or deepening of gullies)	Not less than every 6 months	Areas susceptible to erosion	Visual inspections, topographic surveys, and recording changes in gully morphology.

Monitoring Requirement	Frequency	Location	Method
Gully erosion: Monitoring of drainage systems (e.g., water flow impact on erosion)	After significant rainfall events or as needed	Areas downstream of known gully erosion zones	Use of flow gauges and recording of rainfall data, visual inspection for signs of further erosion.
Rockfall and Gully erosion: Evaluation of effectiveness of long-term mitigation measures (e.g., netting, reinforced embankments)	Annually or as needed	Areas with previous mitigation interventions	Site inspections, stability checks, and reports on the effectiveness of mitigation strategies.

8.6. Residual Impacts Assessment

Table 8-16 presents an assessment of the residual significance of impacts on geological features, during both the construction and operational phases of the Project, following implementation of the mitigation measures defined in Table 8-11, Table 8-12–and Table 8-14.

Table 8-16. Significance of impacts on geohazards after mitigation

Phase	Impact	Negative or Positive	Receptor sensitivity	Overall significance before mitigation	Summary of mitigation	Assessment of impact after mitigation	Overall significance after mitigation
Construction	Impact of an increase in probability of rockfall	Negative	Very high	Moderate	*Retaining walls and structure barriers, Wire mesh, Slope stabilization, Controlled excavation techiniques, Temporary protective structures, Erosion control, Minimazing vegetation clearance, drainage systems for diverting water away from slopes*	*Implementing rockfall-related measures during the construction phase, magnitude of impact will be minimal and defined as low (1), the impact is temporary only during the construction and expected to be very localized (2), sensitive receptors are geological units that are prone to destabilization due to poor consolidation and high-water content and therefore the sensitivity of environmental receptors is very high (4), the impact considered has a very low probability of happening (1)*	*M (1) + ST (2) + S (4) + L (1) = 8 Moderate Following the implementation of the recommended mitigation measures, the magnitude/extent of the impact is reduced to grade 1 (Low). However, the likelihood remains grade 1 (Low), and the*

Phase	Impact	Negative or Positive	Receptor sensitivity	Overall significance before mitigation	Summary of mitigation	Assessment of impact after mitigation	Overall significance after mitigation
							spatiotemporal nature of the impact and sensitivity of the receptor are also unchanged. As such, whilst the overall significance score is reduced from 9 to 8, the impact is still of 'moderate' significance in accordance with the methodology used in this ESIA (see Chapter 5).

Phase	Impact	Negative or Positive	Receptor sensitivity	Overall significance before mitigation	Summary of mitigation	Assessment of impact after mitigation	Overall significance after mitigation
		Negative	High	Moderate	*Slope stabilization, Controlled excavation techiniques, Temporary protective structures, Erosion control, Minimazing vegetation clearance, drainage systems for diverting water away from slopes*	*Implementing rockfall-related measures during the construction phase, magnitude of impact will be minimal and defined as low (1), the impact is temporary only during the construction and expected to be very localized (2), sensitive receptors are geological units that are prone to destabilization due to poor consolidation and high-water content and therefore the sensitivity of environmental receptors is high (3), the impact considered has a very low probability of happening (1)*	*M (1) + ST (2) + S (3) + L (1) = 7 Low*
		Negative	Moderate	Low	*Slope stabilization, Controlled excavation techiniques, Temporary*	*No impact is expected*	Not applicable

Phase	Impact	Negative or Positive	Receptor sensitivity	Overall significance before mitigation	Summary of mitigation	Assessment of impact after mitigation	Overall significance after mitigation
					protective structures, Erosion control, Minimazing vegetation clearance, drainage systems for diverting water away from slopes		
Construction	Impact of an increase in occurrence and extent of gully erosion	Negative	Low	Low	*Drainage systems, The front of the excavation on both sides of the tunnel must be built with a 5:1 slope and protected by a layer of reinforced shotcrete and system anchors. The slopes of the entrance and exit of the pre-section must be protected by a pile*	*No impact is expected*	Not applicable

Phase	Impact	Negative or Positive	Receptor sensitivity	Overall significance before mitigation	Summary of mitigation	Assessment of impact after mitigation	Overall significance after mitigation
					structure. Reduce the amount of vegetation clearance, Hydroseeding, Install inclinometers in zone of the pile structure in zone of tunnel portals.		
Construction	Impact on terrain stability at the tunnel portals	Negative	High	Low	*Drainage systems, The front of the excavation on both sides of the tunnel must be built with a 5:1 slope and protected by a layer of reinforced shotcrete and system anchors. The slopes of the entrance and exit of the pre-section must be*	*No impact is expected*	Not applicable

Phase	Impact	Negative or Positive	Receptor sensitivity	Overall significance before mitigation	Summary of mitigation	Assessment of impact after mitigation	Overall significance after mitigation
					protected by a pile structure. Reduce the amount of vegetation clearance, Hydroseeding, Install inclinometers in zone of the pile structure in zone of tunnel portals.		
Operation phase	Impact of an increase in occurrence and extent of gully erosion	Negative	Low	Low	*Ensure installed drainage are regularly cleared, soil stabilization techniques, erosion control blankets or geotextile mats on disturbed or exposed slopes, Revegetate disturbed areas,*	*No impact is expected*	Not applicable

8.7. Conclusion

There are known geohazards in the Project AoI, including rockfalls, gully erosion and terrain instability at the tunnel site. Sensitive receptors that could be impacted by increased geohazard risks during the construction and operation phase include – geological formations prone to destabilization, particularly due to poor consolidation, high deformability, heterogeneous composition, and the presence of water-saturated zones, which reduces overall slope stability and increases susceptibility to gully erosion or rockfalls.

During the construction phase, the development and implementation of a Water and Soil Management Plan by the Contractor, which will define the mitigation measures that must be implemented, should effectively manage geohazard risks. These measures will include the careful management of vegetation removal, installation of drainage systems to manage surface water run-off and prevent soil saturation during construction, and implementing soil erosion control measures, especially on steep slopes.

During the operational phase, SRI will be responsible for developing and implementing an equivalent Operational Water and Soil Management Plan that will define that measures that must be implemented to avoid or limit any increased risk of rockfalls or gully erosion due to the operation of the railway and associated maintenance activities.

The implementation of terrain stabilization and additional mitigation measures is expected to reduced the risk of rockfalls during the construction phase. In areas with very highly and highly sensitive receptors, the effectiveness of these measures has resulted in the overall impact significance being reduced to low. Literature

1. Basic geological map in 1:100 000, https://geoliss.mre.gov.rs/prez/OGK/RasterSrbija/
2. Bahrekazemi, Mehdi; Bodare, Anders; Andréasson, Bo; and Smekal, Alexander, "Mitigation of Train- Induced Ground Vibrations; Lessons from the Ledsgård Project" (2004). International Conference on Case Histories in Geotechnical Engineering. 6.
3. Dolić, D., Kalenić, M., Marković, B., Dimitirijević, M., Radoičić, R., Lončarević Č. (1981). Interpreter for the Paraćin paper, K 34-7. Belgrade: Federal Geological Institute
4. Engineering geological map of Yugoslavia, M 1:500,000 (Geological and Geophysical Research Institute, Belgrade, 1969).
5. "Geomehanika" d.o.o, Elaborate on geotechnical conditions for the reconstruction of the railway line (under preparation)
6. Krstić, B., Veselinović, M., Divljan, M., & Rakić, M. (1980b). Interpreter for the Aleksinac paper, K 34-20. Belgrade: Federal Geological Institute

Republic of Serbia
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#ЕУ ЗА ТЕБЕ

RAILWAY LINE BELGRADE–NIŠ, SECTION III PARAĆIN–NIŠ,
Environmental and Social Impact Assessment,
9. SURFACE WATERS

EU PPF
PROJECT PREPARATION FACILITY

General

DOCUMENT CONTROL SHEET

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LIST OF ABBREVIATIONS AND ACRONYMS

AOH	Adsorbing organic halogen
AoI	Area of influence
AWB	Artificial water body
AQC	Average annual concentration
BOD5	Biochemical oxygen demand
ESIA	Environmental and social impact assessment
EQS	Environmental quality standard
ES	Environmental sensitivity
L	Impact likelihood
M	Magnitude
MDK	Maximum allowed concentration
SMWB	Significantly modified water body
STS	Spatial and temporal size
TOC	Total Organic Carbon
WFD	Water Framework Directive

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9. SURFACE WATERS

This chapter presents an assessment of potentially significant impacts on surface water resources during both the construction and operational stages of the Project. The activities that have the potential to affect surface water resources are identified, and the possible consequences of these activities on both water quality and quantity, and the surrounding ecosystem are assessed. To mitigate any adverse impacts, several strategies and measures are proposed. The methodologies and data sources employed in this analysis are also outlined.

9.1. Legislative and Policy Framework

9.1.1. EU Requirements

Below is a list of key EU requirements that should be considered in the preparation of an ESIA related to surface waters:

- Water Framework Directive (WFD) 2000/60/EC
- Directive 2007/60/EC on the Assessment and Management of Flood Risks (Floods Directive)
- Directive 91/271/EEC on Urban Wastewater Treatment (UWWT Directive)
- Directive 2008/105/EC on Environmental Quality Standards (EQS) for Water
- Nitrates Directive (91/676/EEC)

9.1.2. EBRD Requirements

- PR 3: Resource Efficiency and Pollution Prevention: Requires the application of pollution prevention and control techniques consistent with the mitigation hierarchy to minimise potential adverse impacts on human health and the environment (including surface water resources) while remaining technically and financially feasible and cost effective.
- PR 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources: Projects are required to assess potential impacts on biodiversity (including surface water dependent ecosystems) and manage those risks in accordance with the mitigation hierarchy and good international practice.

9.1.3. EIB Requirements

The European Investment Bank (EIB) Environmental and Social Standards (ESS) outline the key principles and criteria for managing environmental and social impacts of projects funded by the EIB. While Surface Water is addressed within broader environmental management criteria, certain EIB Environmental and Social Standards (ESS) specifically relate to the management and protection of surface waters, ecosystems, and water resources.

- ESS 3: Resource Efficiency and Pollution Prevention and Control: Requires the Project to assess and take measures to avoid, prevent, or offset significant adverse effects on the environment, including surface waters and to implement relevant monitoring.
- ESS 4: Biodiversity and Ecosystem Services: Requires a baseline analysis that considers threats to freshwater habitats, and an assessment of impacts on the integrity of ecosystems (regardless of their protection or degree of degradation).

9.1.4. National Legislative Framework

Serbia's legal framework for surface waters is aligned with EU directives and international best practices, with an emphasis on protecting water quality, preventing pollution, and promoting sustainable water use. Key legislative instruments such as the Water Law, Environmental Protection Law set out detailed requirements for water management, monitoring, pollution control. Projects that may affect surface waters must comply with these regulations, including obtaining necessary permits, conducting environmental impact assessments, and implementing mitigation measures to protect water resources and aquatic ecosystems.

Serbia, as a candidate for EU membership, is aligning its water management practices with EU standards. The Water Framework Directive is a cornerstone of Serbia's water management policy and is reflected in national laws such as the Water Law and Regulation on Water Quality Standards.

Serbia has also signed several international agreements, including the Danube River Protection Convention and the Sava River Basin Agreement, which govern transboundary water management and pollution prevention in the Danube and Sava River basins.

- Water Law (Official Gazette of the Republic of Serbia, No. 30/2010, 93/2012, 101/2016):
  - Water Protection: Surface waters, including rivers, lakes, and groundwater, must be protected from pollution, degradation, and misuse. The law specifies measures for the prevention of water pollution, particularly from industrial, agricultural, and urban sources.
  - Water Quality: The law requires that surface water bodies meet specific water quality standards set for different categories of use (drinking, recreation, agriculture, etc.).
  - Water Management Plans: The law mandates the creation of river basin management plans (RBMP) in line with the EU Water Framework Directive (2000/60/EC), which ensures an integrated and sustainable approach to water management, including pollution control, habitat preservation, and flood prevention.
  - Monitoring: Regular monitoring of surface water quality is required, with reporting obligations for the government to evaluate the state of water resources and the success of water protection measures.
  - Permits and Licenses: Projects that use or discharge into surface waters must obtain the relevant water use and wastewater discharge permits from the Ministry of Agriculture, Forestry, and Water Management. These permits ensure that activities comply with environmental standards.
- The Environmental Protection Law (Official Gazette of the Republic of Serbia, No. 135/2004, 36/2009, 72/2009, 43/2011, 14/2016): It aligns with international conventions and the EU Water Framework Directive for the management of water bodies, requiring the protection of aquatic ecosystems and the prevention of contamination of surface waters.
- Regulation on Water Quality Standards (Official Gazette of the Republic of Serbia, No. 50/2011): This regulation defines surface water quality parameters (such as chemical, physical, and biological indicators) that must be met for different uses of water (e.g., drinking water, recreation, industrial use). It establishes the maximum permissible concentrations of various pollutants, including heavy metals, organic pollutants, and nutrients (e.g., nitrogen and phosphorus), in surface waters.
- Regulation on the Methods for Establishing the Water Status of Surface Water Bodies (Official Gazette of the Republic of Serbia, No. 50/2011): It outlines the criteria for classifying surface waters based on ecological status (e.g., the health

of aquatic ecosystems) and chemical status (e.g., the level of pollutants). The regulation is used to guide the implementation of river basin management plans and to set priorities for water protection and restoration efforts.

- Regulation on the Classification of Surface Water Quality (Official Gazette of the Republic of Serbia, No. 50/2011): the regulation classifies surface waters into different categories based on their quality for specific uses (e.g., category I for drinking water, category II for recreational use, category III for industrial use). It establishes the criteria for assessing biological, chemical, and physical water parameters, with specific requirements for the protection of aquatic life and biodiversity.

Based on the Law on Waters ("Official Gazette of RS", Nos. 30/2010, 93/2012, 101/2016, 95/2018 and 95/2018 – other law), the procedure for obtaining a Water Permit for the Project is as follows:

- Water Requirements for the Spatial Plan – Based on which the Conceptual Design is prepared,
- Water Requirements for the unified procedure for obtaining Location Conditions – Issued based on the Conceptual Design, in accordance with the "Law on Planning and Construction" ("Official Gazette of RS", Nos. 72/2009, 81/2009 – correction, 64/2010 – Constitutional Court decision, 24/2011, 121/2012, 42/2013 – Constitutional Court decision, 50/2013 – Constitutional Court decision, 98/2013 – Constitutional Court decision, 132/2014, 145/2014, 83/2018, 31/2019, 37/2019 – other law, 9/2020, 52/2021 and 62/2023),
- Water Consent – Issued for the Main Design,
- Water Permit – Issued after the construction of the hydrotechnical project is completed.

Water Requirements: are issued during the preparation of technical documentation for the construction of new structures, reconstruction of existing structures (except for state roads of category I and II, culverts and bridges on them, categories of railway lines, culverts and bridges on them), extension of existing structures, and for performing other works that may permanently, periodically, or temporarily affect changes in the water regime or jeopardize environmental objectives. They are also issued for the development of spatial planning documents, management of fishing and protected areas, and forest management. Water Requirements define the technical and other conditions that must be met during the construction, extension, and reconstruction of structures, preparation of planning documents, and execution of other works referred to in paragraph 1 of this Article, in order to ensure compliance with the provisions of this Law and regulations adopted on the basis thereof[1]. Water Requirements for the structures and works referred to in Article 117, items 1) to 19) of this Law are issued by the Ministry, and in the territory of the autonomous province, by the competent authority of the autonomous province. Water Requirements from Article 117, items 20) to 35) and 39) of this Law are issued by the public water management company. Water Requirements from Article 117, items 36) to 38) of this Law are issued by the competent authority of the local government unit[2].

The *Water Consent* referred to in paragraph 1 of this Article confirms that the technical documentation for the structures, works, and planning documents in paragraph 1 of this Article has been prepared in accordance with the

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[1] *Law on Waters ("Official Gazette of RS", Nos. 30/2010, 93/2012, 101/2016, 95/2018 and 95/2018 – other law*

[2] *Law on Waters ("Official Gazette of RS", Nos. 30/2010, 93/2012, 101/2016, 95/2018 and 95/2018 – other law*

issued Water Requirements. The Water Consent is issued by the authority, or the public water management company, that issued the Water Requirements.

Water Permit defines the method, conditions, and extent of water usage, the method, conditions, and extent of wastewater discharge, the storage and discharge of hazardous and other substances that may pollute water, as well as the conditions for other works that affect the water regime. The Water Permit is issued by the authority or public water management company responsible for issuing the Water Requirements. Before the issuance of a Water Permit for structures and works for which the Water Permit is issued by the Ministry or the competent authority of the autonomous province, the applicant must obtain a report from the public water management company regarding the fulfilment of the conditions from the Water Requirements, Water Consent, or Water Permit. The Water Permit is issued for a specified period, up to a maximum of 15 years.

While the reconstruction of the existing railway line itself generally does not require water permits, according to the Law of Waters, any new construction works, such as the building of new bridges, culverts, or other hydrotechnical structures, will trigger the requirement for specific water permits.

Based on current project plans, the following components are expected to require water permits:

- New bridges or culverts crossing surface water bodies
- New drainage or stormwater infrastructure that discharges into surface water
- New facilities or embankment modifications within regulated water zones

For these components, the water permitting process includes:

- Water Requirements – During the preparation of conceptual design or spatial planning documents, to define technical and environmental constraints related to water.
- Water Consent – During preparation of the main design, confirming it aligns with previously issued Water Requirements.
- Water Permit – After construction, prior to operation, confirming compliance with all applicable conditions for water usage, discharge, or impact.

9.2. Baseline Conditions

9.2.1. Area of Influence (AoI)

Jandová et al. (2020) claim that a corridor 1000 meters wide, extending 500 meters on either side of the proposed railway alignment, is adequate for assessing direct impacts on surface water bodies. Accordingly, the AoI for this assessment encompasses surface water features within 0.5 km on both sides of the railway that have the potential to be affected directly by the proposed works (i.e. the run-off of pollutants directly into a surface feature). However, due to the potential for pollution spread downstream from wastewater discharges and other potential impacts, an

Extended Area of Influence (EAoI) has been defined to include areas downstream of the discharge points, taking into account the potential dispersion of pollutants. For larger watercourses, such as the Južna Morava River, the influence zone is extended to 5–10 km downstream, while for smaller streams and tributaries, the extended AoI will be 1–3 km downstream. This approach ensures an adequate assessment of both direct and indirect impacts on aquatic ecosystems and water quality.

9.2.2. Baseline

In the center of the Balkan Peninsula is the Velika Morava river basin, the right tributary of the Danube, covering almost the entire central and southern part of Serbia. The Velika Morava is a slow plain river. The width of the riverbed is variable, ranging from 73–325 m, while the depth ranges from 4.8–11 m. The area of the Južna and Velika Morava catchments that are intersected by the existing railway, exhibits relatively flat terrain and a dense network of streams, as shown in Figure 9-1.

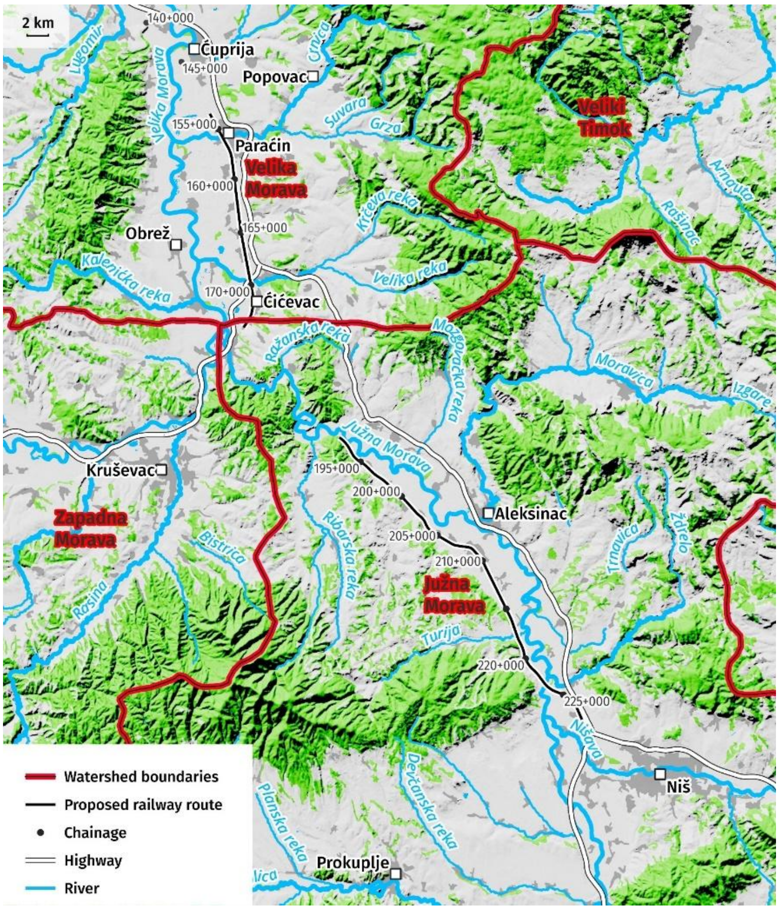
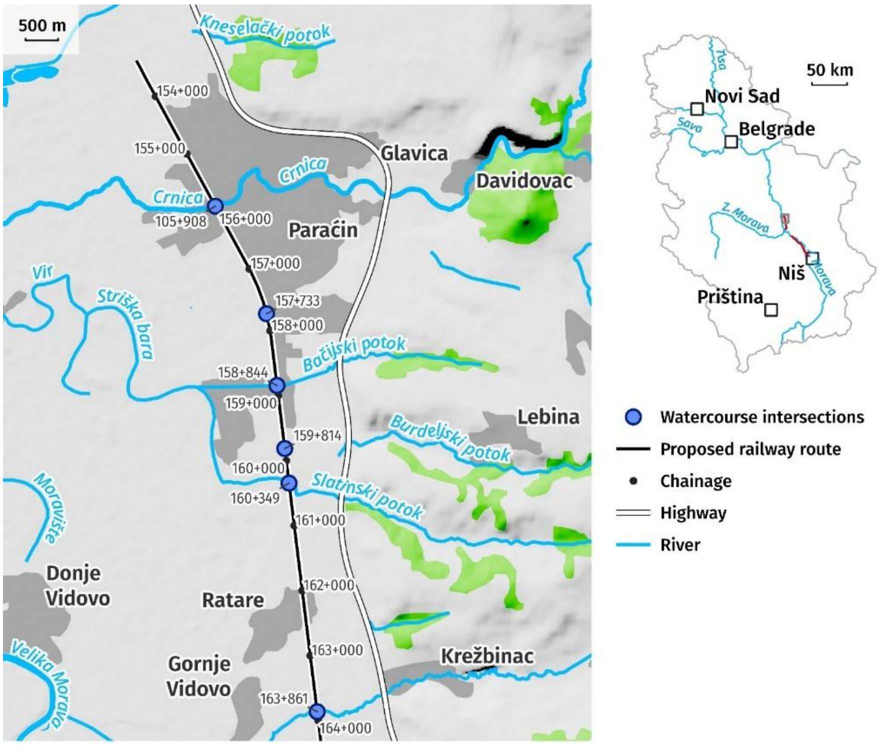


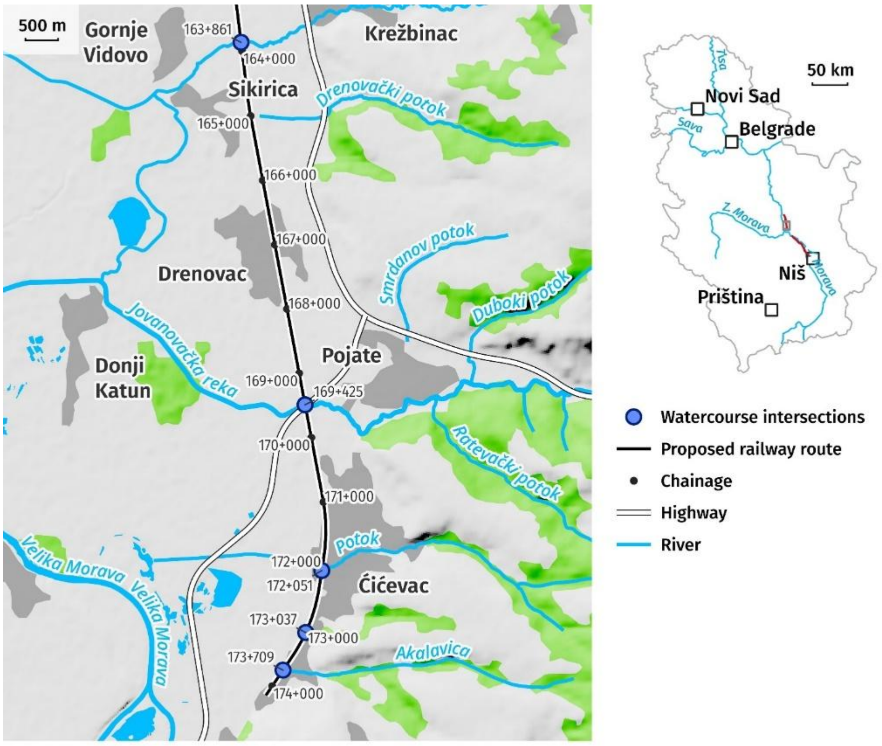
Figure 9-1. Morava River basin

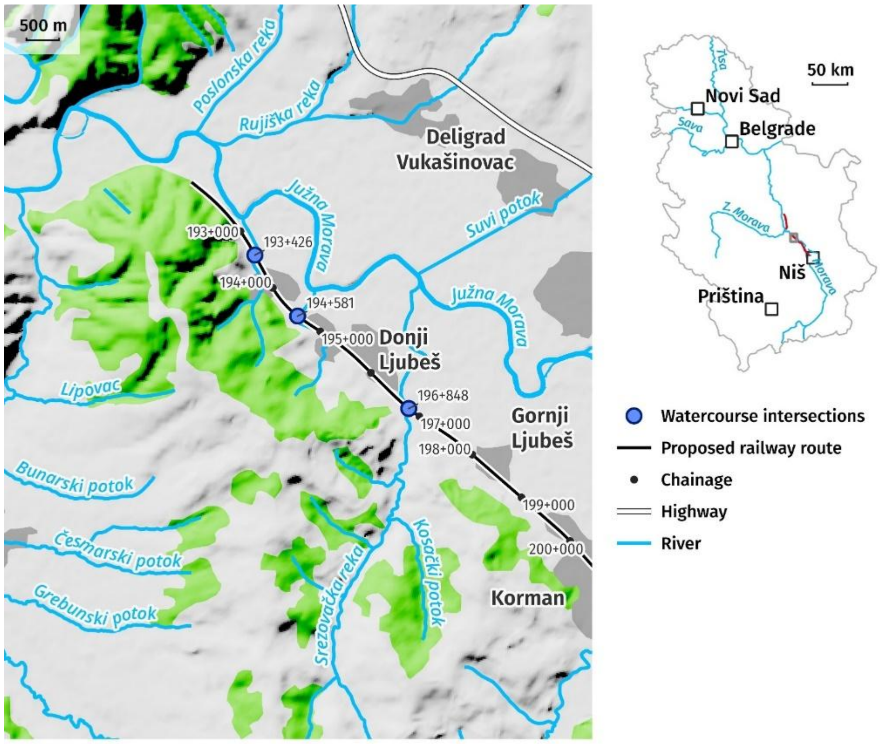
In terms of morphology, for the most part, the Project is located within the alluvial plain of the Velika Morava River. Along the existing route of the Paraćin–Stalać sub-section of the railway, especially where it runs along the right side of the Velika Morava River, there are a large number of occasional and permanent streams and rivers that are crossed by the railway, such as the Crnica River, Tekijski stream, Bačijski stream, Burdeljski stream, Slatinski stream, Planski stream, Jovanovačka River, Kočanski stream, Bezimeni stream and Akalavica River. The area where the existing Đunis–Trupale sub-section is located mainly consists of the alluvial plain of the Južna Morava River. Along this river, there are also numerous (intermittent and permanent) streams, such as the Simin Stream, Jankov Stream, Srezovačka River, Radevačka River, Suvi Stream, Suhotnički Stream, Mlada Belja, Turija River, Dašnička River, and Grejač Stream, Drenovački stream, Južna Morava River (Figure 9-2). These streams are crossed by the railway, so they are regulated by culverts or bridges. The planned reconstruction of the railway includes the restoration of existing culverts and bridges, as well as the construction of new ones. The locations of existing bridges along the Project route are shown in Figure 9-3.

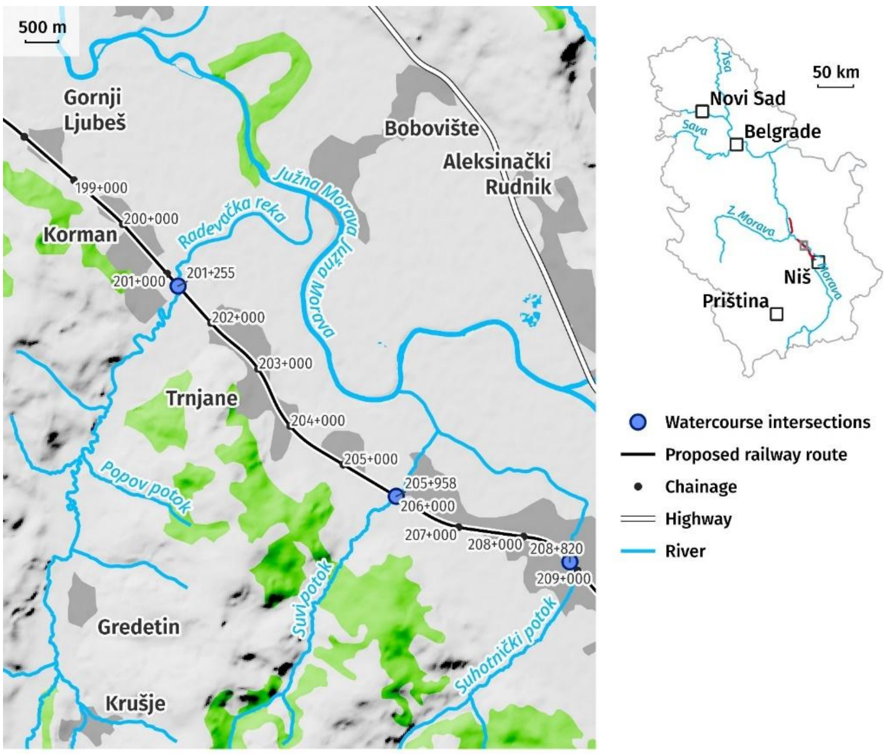
The section of the Project along the Južna Morava represents fertile alluvial soil, which is considered the best quality and most fertile soil in the Nišava district. Alluvial deposits in the Južna Morava valley and favourable conditions for irrigation have led to a large portion of the population along the route of the railway engaging in agriculture. More than 60% of the area of the municipality of Aleksinac, with its associated villages, is agricultural, but formal irrigation systems are not established. Additionally, based on communication with authorized representatives of local water management companies, we obtained information indicating that there are no irrigation systems along the railway line within the Project Area of Influence (AoI). Instead, farmers use alternative methods for irrigation, such as manually diverting water from surface streams, as the simplest method, although it depends on the proximity of the stream and the availability of water in the rivers.

The Project crosses, or is in close proximity to, 22 surface watercourses. A summary of the location of these watercourses according to the chainages of the proposed Project, and a description of proposed works relevant to each watercourse are provided in Table 9-1.


500 m
Kneselački potok
154+000
155+000
Glavica
Davidovac
Crnica
Crnica
105+908
156+000
Paraćin
157+000
Vir
Striška bara
157+733
158+000
Bačijski potok
158+844
159+000
Lebina
159+814
Burdeljski potok
160+000
160+349
Slatinski potok
Moravište
161+000
Donje
Vidovo
Ratare
162+000
163+000
Krežbinac
Velika Morava
Gornje
Vidovo
163+861
164+000
50 km
Isa
Novi Sad
Sava
Belgrade
Z. Morava
Niš
Morava
Priština
Watercourse intersections
Proposed railway route
Chainage
Highway
River


500 m
Gornje
Vidovo
163+861
164+000
Krežbinac
Sikirica
Drenovački potok
165+000
166+000
167+000
Smrdanov potok
Drenovac
Duboki potok
168+000
Jovanovačka reka
Pojate
Donji
Katun
169+000
169+425
170+000
Ratevački potok
171+000
Potok
Velika Morava
Velika Morava
172+000
172+051
Ćićevac
173+037
173+000
173+709
Akalavica
174+000
50 km
Isa
Novi Sad
Sava
Belgrade
Z. Morava
Niš
Morava
Priština
Watercourse intersections
Proposed railway route
Chainage
Highway
River


500 m
Poslonska reka
Rujiška reka
Deligrad
Vukašinovac
Južna Morava
Suvi potok
193+000
193+426
194+000
194+581
195+000
Donji
Ljubeš
Južna Morava
Lipovac
196+848
197+000
198+000
Gornji
Ljubeš
Bunarski potok
199+000
Česmarski potok
200+000
Grebunski potok
Srezovačka reka
Kosački potok
Korman
50 km
Tisa
Novi Sad
Sava
Belgrade
Z. Morava
Niš
Morava
Priština
Watercourse intersections
Proposed railway route
Chainage
Highway
River


500 m
Gornji
Ljubeš
Bobovište
Aleksinački
Rudnik
199+000
200+000
Korman
Radevačka reka
Južna Morava
201+000
201+255
202+000
203+000
Trnjane
204+000
205+000
Popov potok
205+958
206+000
207+000
208+000
208+820
209+000
Suvi potok
Suhotnički potok
Gredetin
Krušje
50 km
Tisa
Novi Sad
Sava
Belgrade
Z. Morava
Niš
Morava
Priština
Watercourse intersections
Proposed railway route
Chainage
Highway
River

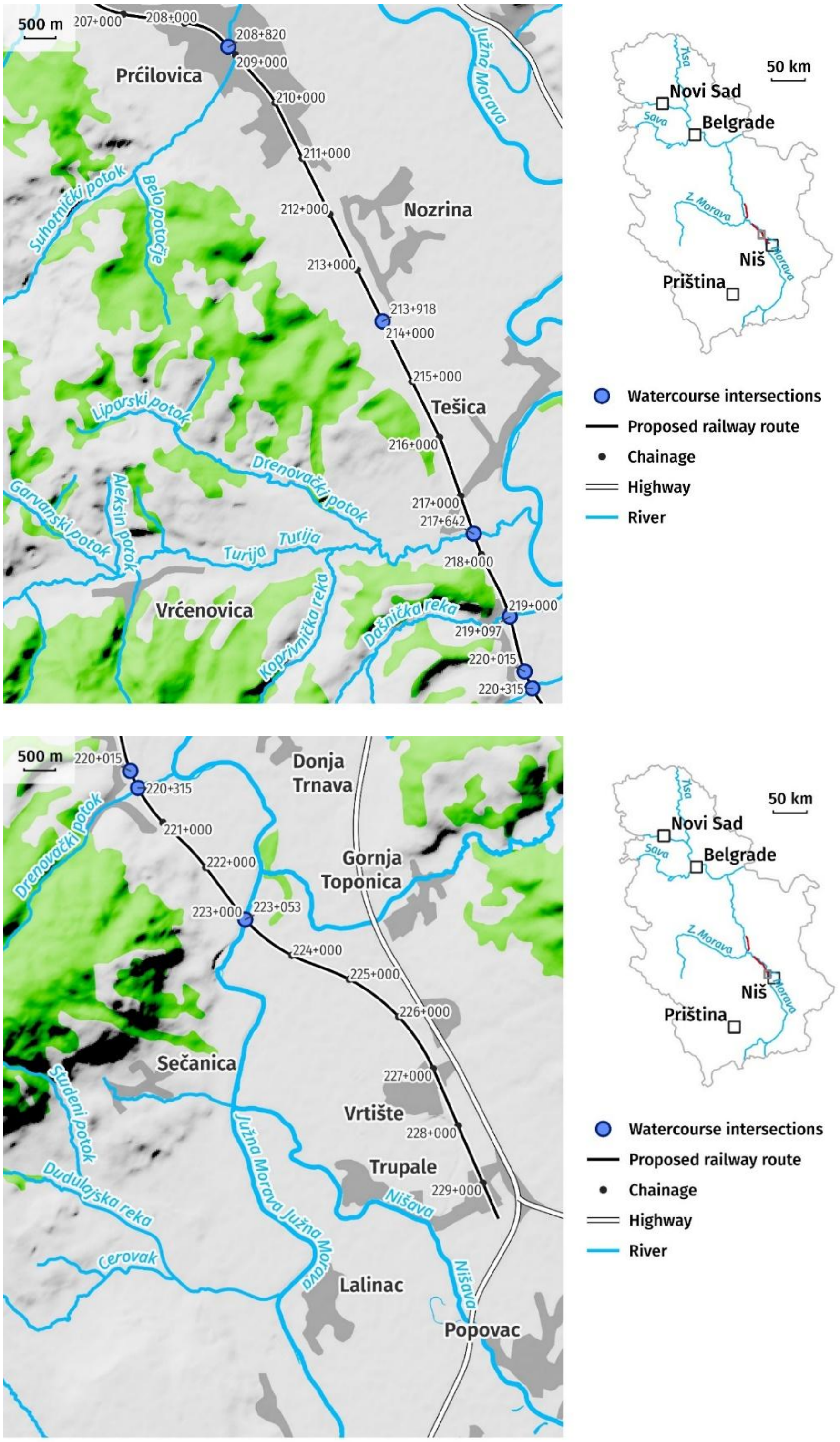


Figure 9-2. Rivers and intermittent and permanent streams in Project AoI

Table 9-1. Watercourses crossed by or located close to the Project, and proposed regulation works

No.	Chainage (km)	Watercourse	Description of regulation work
Paraćin–Stalać sub-section			
1	155+908	Crnica river	km 155+908.65 - in order to meet the conditions for the flow of high water (control and authoritative high water), in the area of the bridge structure, the regulation of the Crnica river is planned in the following sections: - n Section 1, from km 0+713 to km 0+605, with a total length of 108 meters, it is planned to demolish the existing regulation and construct a new minor and major riverbed, as well as retaining walls at the ends of the major riverbed. At the beginning of the regulation, a cascade structure with a height of 0.50 meters is planned. The cascade structure will be made of gabions (1.0x1.0 meters). The width of the minor riverbed is 10.0 meters, while the width of the major riverbed is 12.0 meters. The minor riverbed will be lined with stone in concrete, 0.25 meters thick, which will be laid on a previously prepared tamping layer of 0.10 meters. On the sides of the minor riverbed, reinforced concrete foundation blocks and walls are planned. The major riverbed will be grassed and humusized. Due to the integration with the existing downstream and natural riverbed, the designed longitudinal slope of the entire regulation is 0.22%. At the railway chainage km 155+908.80, or at the regulation chainage km 0+648.34, a reinforced concrete bridge with a clear span of 35.0 meters is planned. In the major riverbed, two reinforced concrete pillars, 1.0 meter wide, are planned. Downstream from the proposed bridge, at km 0+605, a transition section is planned. The length of the transition section is 22.0 meters. The width of the minor and major riverbeds in the downstream part of the transition section, at km 0+583.46, is 30 meters. At the beginning and end of the transition section, stabilization thresholds made of gabions are planned. At the end of the transition section, Section 2 begins (from km 0+583.46 to km 0+185), with a length of 398.46 meters. The width of the minor riverbed is 10.00 meters, and the width of the major riverbed is 2x10.00 meters. The lining method for the minor riverbed is the same as in Section 1. Reinforced concrete walls are planned at the ends of the major riverbed. Stabilization thresholds are planned at the beginning and end of Section 2. The designed longitudinal slope of the regulated riverbed is 0.22%. In Section 3 (from km 0+185 to km 0+000), earthworks are planned for cleaning and profiling the existing riverbed of the Crnica River. The width of the riverbed is 10 meters, the slope of the riverbed banks is 1:1.5, and the height is approximately 2.80 meters. At the transition from Sections 2 and 3, a stabilization threshold is planned. The longitudinal slope of the cleaned riverbed is 0.22%. The project includes a total of 4 circular curves. Throughout the entire section of the regulated Crnica Riverbed, a total of 7 stabilization thresholds and 1 cascade structure are planned. In addition to the beginning and end of the transition sections, stabilization thresholds are planned at the beginning and end of the circular curves.
2	157+733	Tekijski stream	km 157+733.11 – a new culvert is planned at the intersection of the planned railway with the watercourse; According to the conceptual design, the relocation of the Tekijski Stream is planned at the intersection with the designed high-speed railway alignment at km 157+733.11. The total length of the regulated section is approximately 89.0 meters. The conceptual design includes a trapezoidal channel. The bottom width of the channel is 1.50 meters, with a depth of 1.0 meter and a side slope of 1:50. The channel will be lined with Reno mattresses with a thickness of 0.23 meters.

No.	Chainage (km)	Watercourse	Description of regulation work
			Beneath the Reno mattresses, geotextile will be placed on a 0.20-meter-thick sand bedding layer. The total length of the section lined with Reno mattresses is 40.75 meters. At the intersection of the regulated stream and the designed railway alignment, a culvert with a clear opening of 3.0 x 2.0 meters is planned. In the culvert zone, a reinforced concrete channel is designed, including layers of lean concrete and subbase with a thickness of 0.10 meters. The total length of the concrete-lined section of the regulated channel is 44.23 meters. At the beginning and end of the regulated section, as well as at the transition between the concrete section and the Reno mattress-lined section, a total of four stabilization sills are planned.
3	158+844	Bačijski stream	km 158+844.06 – a new bridge is planned at the intersection of the planned railway with the watercourse. Regulation works are foreseen in the length of about 60.00 m. A bridge with a clear span of 5.0 meters is planned at the intersection of the regulated stream and the railway alignment. In the bridge zone, a trapezoidal channel with a 0.20-meter-thick concrete lining is planned. Upstream and downstream of the concrete channel, the channel will be lined with Reno mattresses with a thickness of 0.23 meters. The bottom width of the regulated channel is 1.50 meters, the depth is 1.0 meter, and the side slopes are 1:1.50. The designed longitudinal gradient of the regulation is 0.62%. A total of two horizontal curves are planned. Stabilization sills are foreseen at the transition points between the concrete-lined channel and the Reno mattress-lined sections, as well as at the beginning and end of the regulated section.
4	159+814	Burdeljski stream	km 159+814.25 – a new bridge is planned at the intersection of the planned railway with the watercourse. In the area of the bridge, regulation works are planned in the length of about 37.00 m. A bridge with a clear span of 5.0 meters is planned at the intersection of the regulated stream and the railway alignment. In the bridge zone, a trapezoidal channel with a concrete lining 0.20 meters thick is proposed. Upstream and downstream of the concrete channel, the streambed will be lined with Reno mattresses with a thickness of 0.23 meters. The bottom width of the regulated channel is 1.0 meter, with a depth of 1.0 meter and side slopes of 1:1.50. The designed longitudinal gradient of the regulation is 0.69%. A total of one horizontal curve is planned. Stabilization sills are foreseen at the transition between the concrete channel and the Reno mattress-lined section, as well as at the beginning and end of the regulated section.
5	160+349	Slatinski stream	km 160+349.47 – a new bridge is planned at the intersection of the planned railway with the watercourse. In the area of the bridge, regulationworks are planned in the length of 57.91 m. A bridge with a clear span of 5.0 meters is planned at the intersection of the regulated stream and the railway alignment. In the bridge zone, a trapezoidal channel with a concrete lining 0.20 meters thick is proposed. Upstream and downstream of the concrete channel, the streambed will be lined with Reno mattresses with a thickness of 0.23 meters. The bottom width of the regulated channel is 2.0 meters, with a depth of 1.0 meter and side slopes of 1:1.50. The designed longitudinal gradient of the regulation is 1.24%. A total of three horizontal curves are planned. Stabilization sills are foreseen at the transition between the concrete channel and the Reno mattress-lined section, as well as at the beginning and end of the regulated section.
6	163+861	Planski stream	km 163+861.84 – a new bridge is planned at the intersection of the planned railway with the watercourse. In the area of the bridge, regulation works are planned in the length of about 82.47 m. A bridge with a clear span of 10.0 meters

No.	Chainage (km)	Watercourse	Description of regulation work
			is planned at the crossing point of the regulated stream and the railway alignment. In the bridge zone, a trapezoidal channel with a concrete lining and bedding layer with a total thickness of 0.50 meters is proposed. Upstream and downstream of the concrete channel, the streambed will be lined with Reno mattresses with a thickness of 0.30 meters at the bottom and 0.23 meters on the slopes. The bottom width of the regulated channel is 2.20 meters, with a depth of 2.0 meters and side slopes of 1:1.50. The designed longitudinal gradient of the regulation is 0.72%. A total of two horizontal curves are planned. Stabilization sills are foreseen at the transition between the concrete channel and the Reno mattress-lined section, as well as at the beginning and end of the regulated section.
7	169+425	Jovanovačka river	km 169+404.27 - a new bridge is planned at the intersection of the planned railway with the watercourse. The relocation of the Jovanovačka River involves the construction of a new riverbed with inundation areas and embankments. The length of the new regulation and relocation of the river is 1,801 meters. At the intersection of the relocated Jovanovačka River course and the projected high-speed railway route, a reinforced concrete bridge with a clear span of approximately 145.0 meters is planned. The inundation areas are designed with reinforced concrete pillars, spaced 10.40 meters apart. The width of the bottom of the regulated minor riverbed is 5.0 meters. The minor riverbed and slopes will be lined with Reno mattresses of 0.30 meters thickness. The height of the lining in the minor riverbed will be 1.0 meter, and the slope gradient is 1:1.5. At the junction of the slopes and the minor riverbed, gabions (0.80x0.80 meters) are planned. The slope of the regulated riverbed is 0.23%. At the minor riverbed at km 1+464, the project regulation intersects with the overpass of the constructed E-763 highway (Pojate-Preljina). When setting the axis of the regulated riverbed, care was taken to ensure that the minor riverbed passes between the existing bridge supports. Before and after the bridge structure for the projected railway, stabilization thresholds are planned. Stabilization thresholds are also planned at the beginning and end of the section, as well as at locations of circular curves. In total, there are 7 circular curves. The project foresees a total of 17 stabilization thresholds (1.0x1.0 meters). The inundation areas are designed with a cross slope of 0.50% towards the minor riverbed. The length of the inundation areas varies, ranging from 90 to 110 meters. The inundation surfaces will be humusized and grassed. According to the geotechnical report, the thickness of the humus to be removed is 0.20 meters. At the ends of the inundation areas, embankments are planned. The left embankment is 1,710 meters long, while the right embankment is 1,690.33 meters long. The embankments are constructed from coherent material sourced from borrow pits. Before the material is placed, the Investor is required, based on previous geophysical and geomechanical investigations, to provide an adequate borrow pit for the material. The material for embankment construction must have appropriate geomechanical and impermeability characteristics. The width of the embankment crown is 4.0 meters, with slope gradients of 1:50. The height of the embankments varies, ranging from 1 to 3.0 meters. A service road with a width of 3.0 meters is planned along the top of the embankment. The service road will be constructed from non-coherent material with sizes of 0-31 mm (d=0.15 m) and 0-63 mm (d=0.20 m).

No.	Chainage (km)	Watercourse	Description of regulation work
8	172+051	Kočanski stream	km 172+051.85 – at the intersection of Kočanski Stream and the projected high-speed railway route, stream regulation is planned. The length of the regulation is approximately 130 meters. At the intersection of the projected regulation and the proposed railway route, a bridge with a clear span of 10.0 meters is planned. The regulation of the stream involves the construction of a reinforced concrete (RC) minor riverbed and RC walls on both sides of the minor riverbed. The width of the riverbed at the bottom is 6.60 meters, and the height of the RC walls is approximately 2.40 meters. The minor riverbed has a cross slope of 2.0%. At the beginning of the minor riverbed, an RC cascade with a height of 0.50 meters is planned. The designed longitudinal slope of the regulation in the upstream section is 0.60%, while in the downstream section it is 0.40%. The regulation route includes a total of 4 curves.
9	173+037	Bezimeni stream	km 173+037.94 – at the intersection of the unnamed stream and the projected high-speed railway route, stream regulation is planned. The length of the regulation is 505.11 meters. The unnamed stream will be regulated with a reinforced concrete (RC) channel, 2.50 meters wide at the bottom and 0.80 meters high. The longitudinal slope of the regulation is 0.30%. At the intersection of the regulation and the proposed railway route, a culvert measuring 2.50x2.0 meters is planned. At the chainage of the regulated riverbed, km 0+24.68, the designed regulation intersects with a road bridge. At this section, a concrete lining for a trapezoidal riverbed is planned. The hydraulic calculation for the discharge capacity of the road bridge has been designed for a 2% return period flood. Upstream of the regulation, two cascade structures, each with a height of 1.0 meter, are planned.
10	173+709	Akalavica stream	km 173+709.21 – a new bridge is planned at the intersection of the planned railway with the watercourse. At the intersection of the Akalavica stream and the projected high-speed railway route, stream regulation is planned. The length of the regulation is 107.68 meters. At the beginning of the regulation, a cascade structure with a height of 0.65 meters is planned. The cascade structure will be made of gabions. At the intersection of the regulation and the proposed railway route, a railway bridge with a clear span of 10.0 meters is planned. Additionally, immediately downstream of the railway bridge, a road bridge is planned, which will have the same clear span as the railway bridge and a width of 5.50 meters. In the area of both bridges, a trapezoidal riverbed with a concrete lining and embankment is planned. The length of the regulation with the concrete riverbed is 30.80 meters. The thickness of the concrete lining is 0.30 cm, and it will be placed on a 0.10-meter gravel layer. In front of and behind the concrete riverbed, the bed will be lined with Reno mattresses. The thickness of the Reno mattress at the bottom is 0.30 meters, and on the slopes, it is 0.23 meters. The width of the regulated riverbed at the bottom is 2.0 meters, the height is 2.0 meters, and the slope of the banks is 1:2. The designed slope of the regulation is 0.60%. The length of the riverbed covered with Reno mattresses is 76.78 meters. At the junction of the concrete riverbed and the riverbed lined with Reno mattresses, stabilization thresholds made of gabions are planned. At the chainage of the regulated riverbed, km 0+37.82, the designed regulation intersects with a road bridge. At this section, a concrete lining for a trapezoidal riverbed is planned. The hydraulic calculation for the discharge capacity of the road bridge has been designed for a 2% return period flood. The projected route includes a total of 1 circular curve. In the downstream section, a stabilization threshold is planned.

No.	Chainage (km)	Watercourse	Description of regulation work
Đunis–Trupale sub-section			
1	193+426	Simin stream	km 193+426.16 -at the intersection of Simin Stream and the projected high-speed railway route, stream regulation with lining is planned, while upstream and downstream of the proposed bridge, cleaning of the riverbed and integration of the slopes into the existing natural state is planned. The length of the regulation is 78.74 meters. In the bridge area (the clear span of the bridge is 11.0 meters), for a length of 22.30 meters, the regulated riverbed will be lined with stone in concrete. The thickness of the stone in concrete with tamping is 0.40 meters. The width of the bottom of the regulated riverbed is 3.0 meters, and the height is 2.0 meters, with a slope of 1:1.50. The designed longitudinal slope of the regulation is 0.98%. At the junction of the concrete riverbed and the profiled riverbed, stabilization thresholds are planned. Stabilization thresholds are also planned at the beginning and end of the regulated section.
2	194+581	Jankov stream	km 194+581.41 -at the intersection of Jankov Stream and the projected high-speed railway route, stream regulation is planned. The length of the regulation is approximately 651 meters. At the intersection of the regulation and the projected railway route, a bridge with a clear span of 5.0 meters is planned. From km 0+00 to km 0+60.00, a reinforced concrete trapezoidal riverbed is planned. The width of the minor riverbed is 1.50 meters, the height is 1.0 meter, and the slope of the banks is 1:1.5. The designed slopes will integrate into the new embankment. The embankment should be made of incoherent material with similar characteristics to the original embankment. Before constructing the embankment, the Investor and Contractor must secure an adequate borrow pit with appropriate geomechanical soil characteristics. From chainage km 0+060 to km 0+651.25, a reinforced rectangular concrete riverbed is planned. The designed longitudinal slope of the regulated riverbed is 0.30%, 4.19%, 2.56%, and 0.60%. At the intersection of the projected regulation and the elevated intersection 2 at km 0+88.85, a reinforced concrete structure is planned. The clear span of the culvert is 2x1.70 meters. The structure is dimensioned to pass large water flows with return periods of 1% and 2%. Additionally, at km 0+570.15 and km 0+494.75, access structures for local houses are planned. The dimensions of these structures are designed to accommodate large water flows with probabilities of 1% and 2%. Stabilization thresholds are planned both upstream and downstream.
3	196+848	Srezovačka river	km 196+848.21 – At the intersection of Srezovačka River and the projected high-speed railway route, river regulation is planned. The length of the regulation is 347.73 meters. At the intersection of the regulation and the projected railway route, a railway bridge and a road bridge with a clear span of 11.0 meters are planned. In the bridge areas, a trapezoidal riverbed with a stone lining in concrete, with a total thickness of 0.35 meters, is planned. Outside the bridge areas, a trapezoidal riverbed lined with Reno mattresses, with a thickness of 0.23 meters, is planned. At the beginning of the regulation, a cascade structure with a height of h=1.50 meters made of gabions is planned. The width of the regulated concrete riverbed at the bottom is 2.0 meters, and the height is 1.50 meters, with a slope of 1:1.50. The designed slope of the regulation is 0.45%. At the junction of the stone-lined riverbed in concrete and the riverbed lined with Reno mattresses, stabilization thresholds are planned. Stabilization thresholds are also planned at the beginning and end of the regulated section.

No.	Chainage (km)	Watercourse	Description of regulation work
4	201+255	Radevačka river	km 201+255.63 – At the intersection of Radevačka River and the projected high-speed railway route, river regulation is planned. The length of the regulation is 62.47 meters. At the intersection of the regulation and the projected railway route, a bridge with a clear span of 15.60 meters and a width of 27.80 meters is planned. The riverbed is lined with Reno mattresses, with a thickness of 0.30 meters at the bottom and 0.23 meters on the slopes. The width of the regulated concrete riverbed at the bottom is 3.0 meters, the height is 2.0 meters, and the slope of the banks is 1:1.50. The designed slope of the regulation is 0.42%. Stabilization thresholds are planned at the beginning and end of the section.
5	205+958	Suvi stream	km 205+958.44 – At the intersection of Suvi Stream and the projected high-speed railway route, river regulation is planned. The length of the regulation is 106.38 meters. At the intersection of the regulation and the projected railway route, a bridge with a clear span of 10.45 meters is planned. The regulated riverbed is lined with Reno mattresses, 0.23 meters thick, while in the bridge area, a stone lining in concrete 0.40 meters thick is planned. The width of the regulated concrete riverbed at the bottom is 4.0 meters, the height is 2.0 meters, and the slope of the banks is 1:1.50. The designed slope of the regulation is 0.65%. Stabilization thresholds are planned at the transition between the riverbed lining in the bridge area and outside of it. Additionally, stabilization thresholds are planned at the beginning and end of the section.
6	208+820	Suhotnički stream	km 208+821.49 – At the intersection of the projected high-speed railway route and the river, river regulation is planned. The length of the regulation is approximately 325.63 meters. At the intersection of the regulation and the projected railway route, a bridge with a clear span of 5.0 meters is planned. Additionally, upstream, the projected regulation intersects with a local road. The clear span of both structures is 5.0 meters. The regulation of Suhotnički Stream is designed with reinforced concrete, with a bottom width of 5.0 meters, and retaining walls are planned on the sides with a height of 2.55 meters. The designed slope of the regulation is 0.60%. Upstream of the regulated stream, a cascade structure with a height of 1.50 meters is planned. Projected reinforced concrete rectangular channel is integrated into the existing concrete channel and wall.
7	213+918	Mlada Belja	km 213+918.52 – at the intersection of Mlada Belja Stream and the projected high-speed railway route, river regulation is planned. The length of the regulation is 492.45 meters. The regulation of the stream is divided into two sections. In the first section (from km 0+492.45 to km 0+414.35), a rectangular concrete channel with a width of 2.90 meters and a height of 2.0 meters is planned. At chainage km 0+440.86, the regulated channel intersects with a road bridge with a clear width of 3.0 meters. At the location where the cross-sectional profile changes, from km 0+414.35 to km 0+407.35, a transitional section is planned. The transitional section will be made of reinforced concrete. In the second section (from km 0+414.35 to km 0+000), the channel will be covered with Reno mattresses 0.23 meters thick. The riverbed width is 1.50 meters, the height is 1.0 meter, and the slope of the banks is 1:1.5. In the second section and at the intersection of the regulation and the projected railway route, a bridge with a clear span of 5.0 meters and a width of 25.90 meters is planned. Immediately before and after the bridge, and within the structure's zone, the channel will be covered with concrete 0.30 meters thick. At km 0+00, the regulated channel will connect with the existing canal. Before construction begins, the existing channel

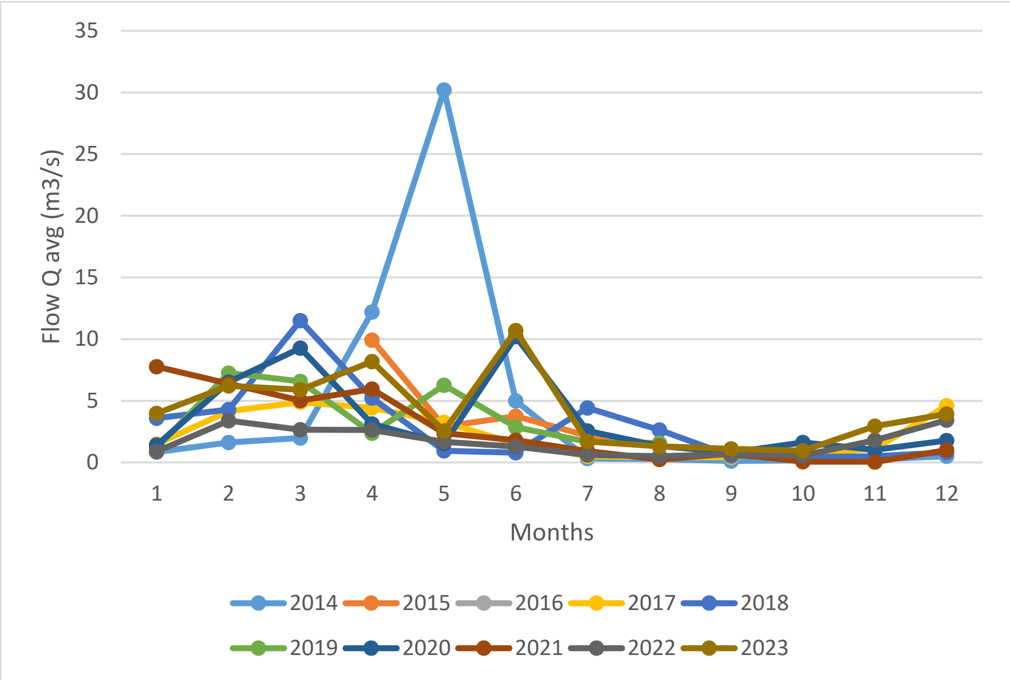
No.	Chainage (km)	Watercourse	Description of regulation work
			must be cleared, and a geodetic survey must be performed to compare elevation levels. At the locations where the channel lining changes, as well as at the beginning and end of the regulation, stabilization thresholds are planned.
8	217+642	Turija river	km 217+642.36 – at the intersection of the river and the projected high-speed railway route, river regulation is planned. The length of the regulation is 79.89 meters. At the intersection of the regulation and the projected railway route, a bridge with a clear span of 23.50 meters is planned. The project foresees that the Turija River channel will be lined with Reno mattresses and gabions. The thickness of the Reno mattresses is 0.30 meters. The Reno mattresses will be placed on the slopes with a ratio of 1:1.5. The height of the slopes is 1.50 meters. The width of the minor channel is 4.0 meters. Gabions of 1.0x1.0 meters are planned along the entire length of the regulation, including the slopes and channel bottom. The projected slope of the regulated channel is 0.55%. Stabilization thresholds are planned at the beginning and end of the regulation.
9	219+097	Dašnička river	km 219+096.95 – at the intersection of the river and the projected high-speed railway route, river regulation is planned. The length of the regulation is 89.35 meters. At the intersection of the regulation and the projected railway route, a bridge with a clear span of 15.60 meters is planned. The project foresees that the river channel will be lined with Reno mattresses. The Reno mattresses at the bottom of the channel have a thickness of 0.30 meters, and on the slopes, they are 0.23 meters thick. The slope ratio is 1:1.5. The width of the minor channel is 2.0 meters, and the height of the regulated channel is 1.0 meter. The projected slope of the regulated channel is 0.80%. Stabilization thresholds are planned at the beginning and end of the regulation.
10	220+015	Grejač stream	km 220+015.74 – at the intersection of the river and the projected high-speed railway route, river regulation is planned. The length of the regulation is approximately 40.25 meters. At the intersection of the regulation and the projected railway route, a bridge with a clear span of 5.0 meters is planned. In the bridge area, as well as immediately upstream and downstream from it, the channel will be lined with concrete, with a total thickness of 0.40 meters. Downstream and upstream of the concrete channel, the remaining part of the regulated channel will be lined with Reno mattresses. The Reno mattresses are 0.23 meters thick and will be placed on slopes with a ratio of 1:1. The width of the minor channel is 2.0 meters, and the height of the regulated channel is 1.05 meters. The projected slope of the regulated channel is 1.0%. At the beginning of the regulation, a cascade structure made of gabions, 0.65 meters high, is planned. At the lowest downstream part, a stabilization threshold is planned. Stabilization thresholds are also planned upstream and downstream of the bridge, as well as at the locations where the channel lining changes.
11	220+315	Drenovački stream	km 220+315.24 – at the intersection of the river and the projected high-speed railway route, river regulation is planned. The length of the regulation is 77.14 meters. At the intersection of the regulation and the projected railway route, a bridge with a clear span of 5.0 meters is planned. In the bridge area, the channel will be lined with concrete, with a total thickness of 0.40 meters. Outside the bridge zone, the river channel will be lined with Reno mattresses. The Reno mattresses are 0.23 meters thick and will be placed on slopes with a ratio of 1:5. The width of the minor channel is 2.0 meters, and the height of the regulated channel is 1.0 meter. The projected slopes of the regulated channel are 1.91% (downstream section) and 0.65% (in the bridge zone and upstream section).

No.	Chainage (km)	Watercourse	Description of regulation work
			Stabilization thresholds are planned at the beginning and end of the regulation, as well as at the transition points where the type of channel lining changes.
12	223+053	Južna Morava	km 223+053.38 – a new bridge is planned at the intersection of the planned railway with the watercourse. The conceptual design foresees the cleaning of the minor riverbed of the Južna Morava over a length of approximately 300 meters. At the point where the Južna Morava intersects with the planned railway, a reinforced concrete structure is designed, with a total clear span of 98.31 meters and two river piers, each 2.0 meters wide. The piers are located within the minor riverbed, aligned with the slope of the existing riverbank. The total length of the bridge (including the superstructure, piers, and abutments) is 112.68 meters, and the width is 13.30 m

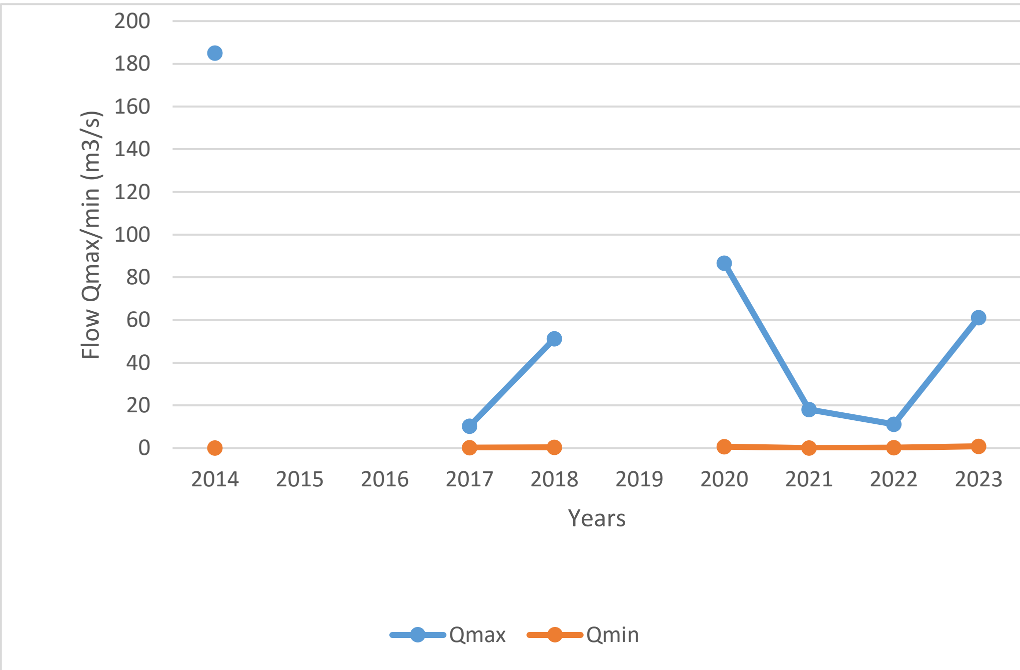
Data from hydrological stations (Paraćin on Crnica River, Mojsinje and Aleksinac on Južna Morava River) for a ten-year period were used to analyse the hydrological regime in the Južna Morava and Crnica Rivers. Additionally, data are presented for major watercourses in the AoI for which the Republic Hydrometeorological Institute conducts continuous monitoring of fluctuations in water level and flow. Mean annual flow and water level values are shown in **Error! Reference source not found.**Figure 9-3 to Figure 9-5, illustrating the range of flow and water level fluctuations during the year. The highest flow values are recorded at the beginning of spring (March–May), reflecting that this period typically experiences increased precipitation and melting of accumulated snow after the winter. Similarly, water levels are at their highest during the early spring period, correlating with the increased flow.

Towards the end of summer and the beginning of autumn (August–October), both flow and water levels decrease, due to reduced precipitation during the summer months. Additionally, during late summer, high evaporation rates may contribute to decreased water levels in surface water bodies.

The period from 2014–2023 is characteristic of water levels and flows in these watercourses. It can be noted that extreme fluctuations occur in 2014, 2015 and 2018, reflecting that Serbia experienced very heavy rainfall in these years, and peak flow and water level values occurred. Risks to the Project from flooding are covered under the Climate Risk & Vulnerability Assessment in Chapter 11 of this ESIA Report.


35
30
25
20
15
10
5
0
Flow Q avg (m3/s)
1 2 3 4 5 6 7 8 9 10 11 12
Months
2014 2015 2016 2017 2018
2019 2020 2021 2022 2023

a)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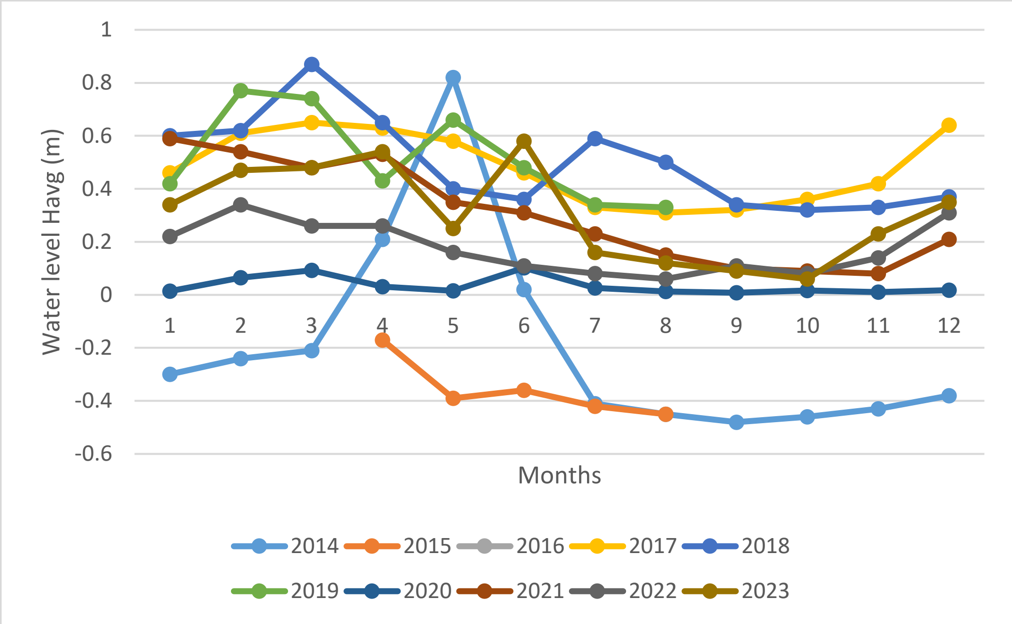
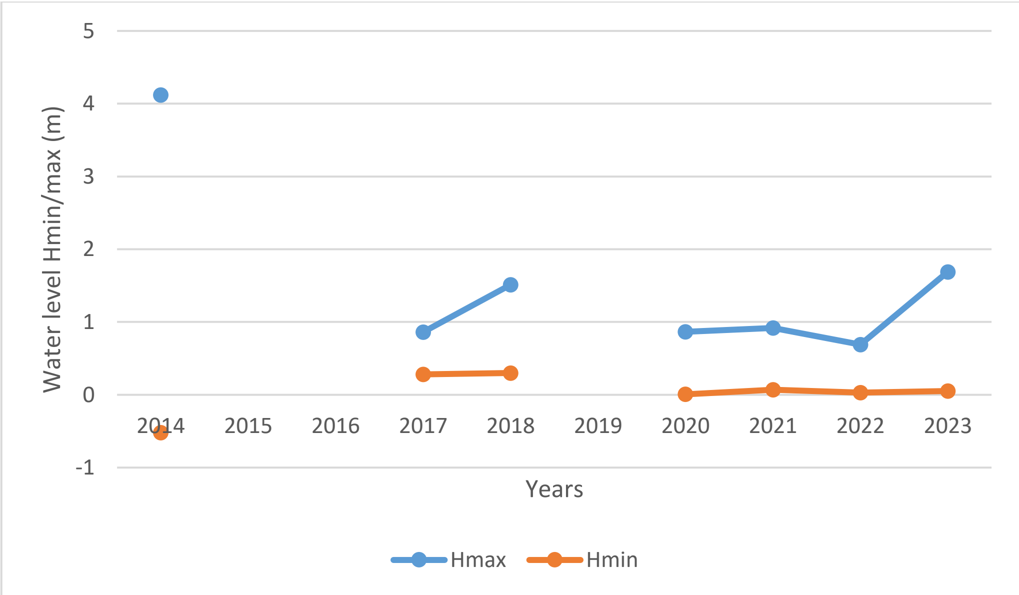
180
160
140
120
100
80
60
40
20
0
Flow Qmax/min (m3/s)
2014 2015 2016 2017 2018 2019 2020 2021 2022 2023
Years
Qmax Qmin

b)



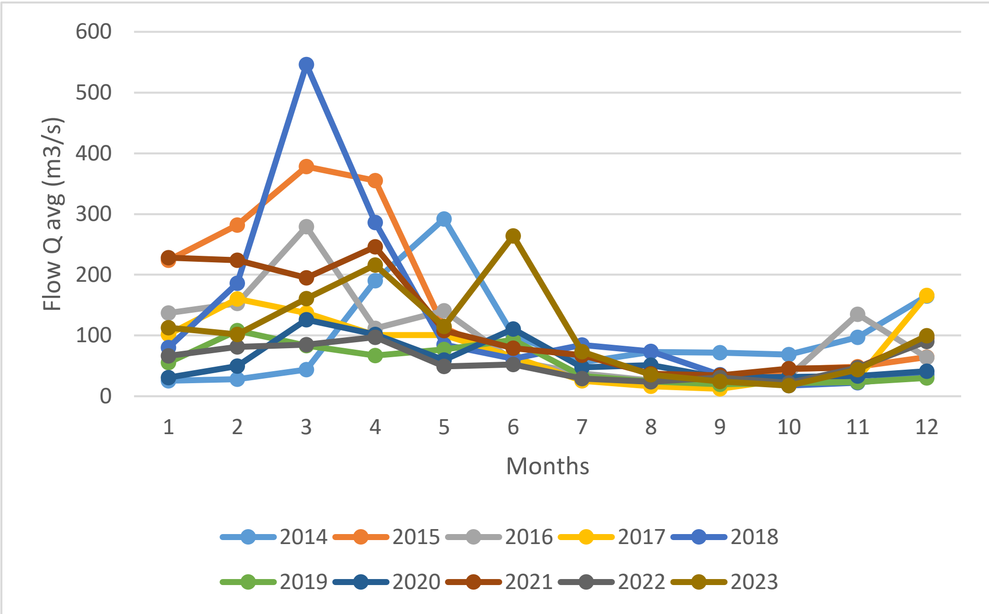
c)



d)

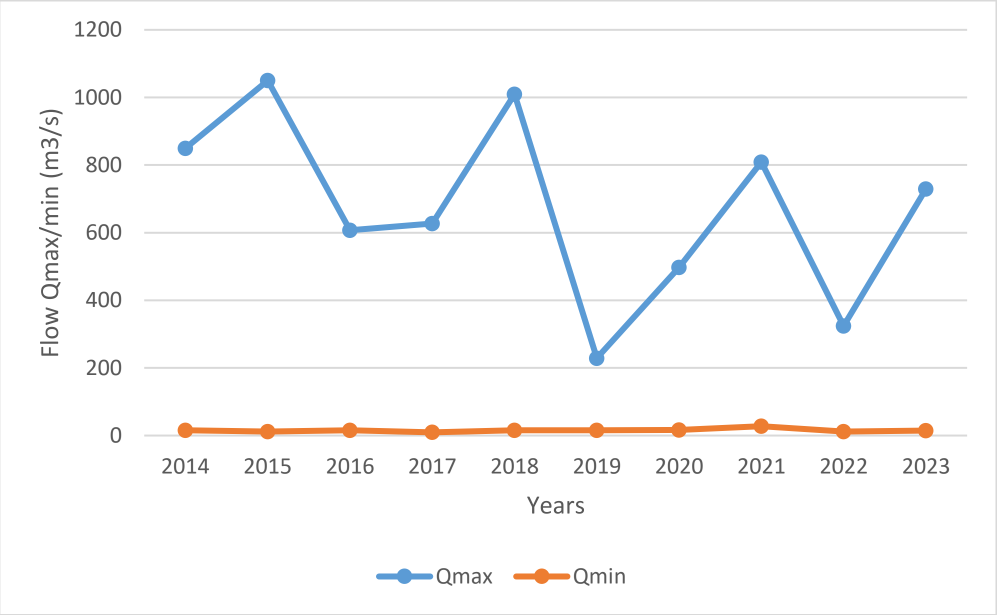
* Hydrological station Paraćin (distance from the confluence: 6.8 km, basin area: 289 km^2, elevation "0": 128.34 m.a.s.l.)

Figure 9-3. Overview of a) average monthly flow (Qavg), b) yearly maximum/minimum flow (Qmax/min), c) average water level (Havg) and d) yearly maximum/minimum water level (Hmax/min) values for the Crnica river* for the period from 2014 to 2023 3

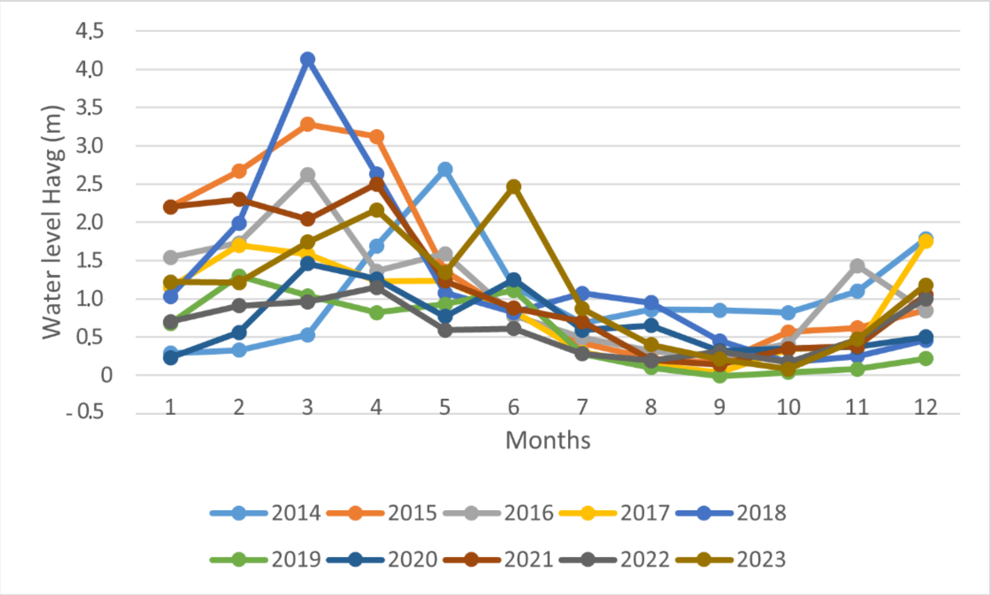


a)

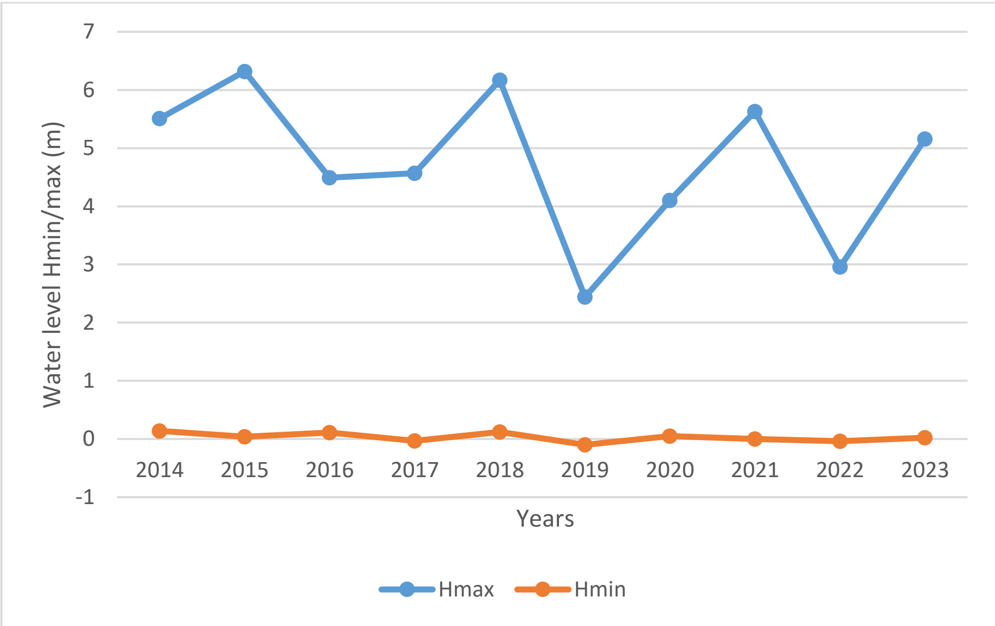
[3] *Republic Hydrometeorological Institute of Serbia, Hydrological yearbook, surface waters 2017–2021, https://www.hidmet.gov.rs/*


1200
1000
800
600
400
200
0
Flow Qmax/min (m3/s)
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
Years
Qmax
Qmin

b)


4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0
- 0.5
Water level Havg (m)
1
2
3
4
5
6
7
8
9
10
11
12
Months
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023

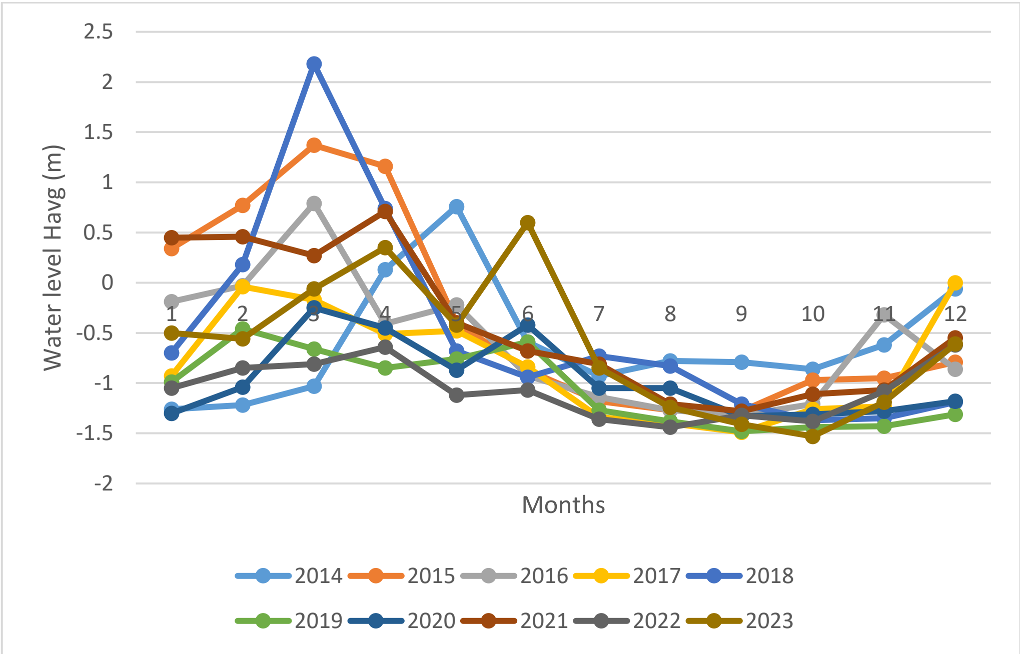
c)

d) 

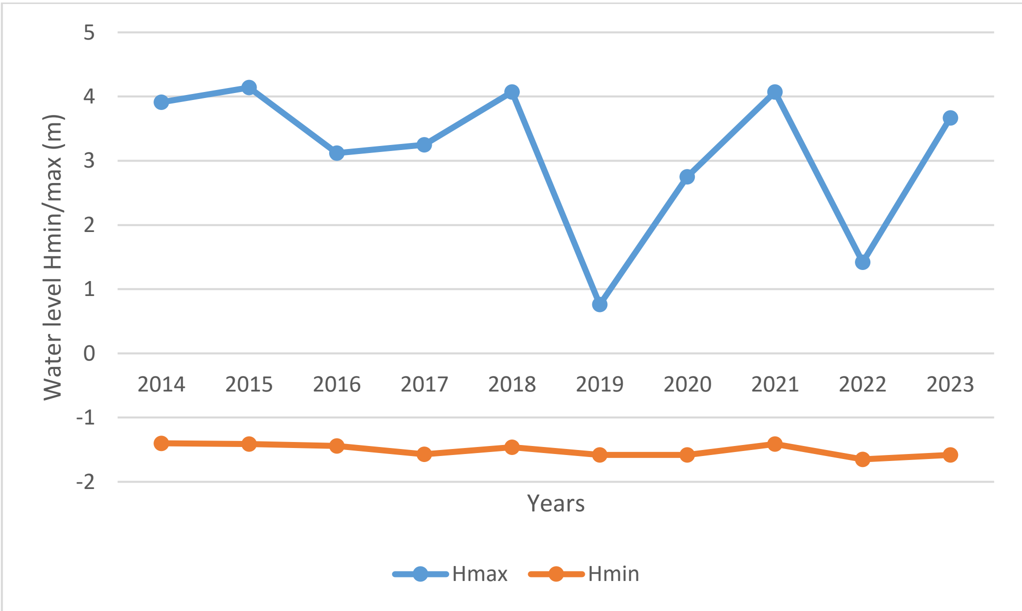
* Hydrological station Mojsinje (distance from the confluence: 16.4 km, basin area: 15390 km^2, elevation "0": 136.28 m.a.s.l.)

Figure 9-4. Overview of a) average monthly flow (Qavg), b) yearly maximum/minimum flow (Qmax/min), c) average water level (Havg) and d) yearly maximum/minimum water level (Hmax/min) values for the Južna Morava River* for the period from 2014 to 2023 4

[4] *Republic Hydrometeorological Institute of Serbia, Hydrological yearbook, surface waters 2017–2021, https://www.hidmet.gov.rs/*



a)



b)

* Hydrological station Aleksinac (distance from the confluence: 55.1 km, basin area: 14284 km^2, elevation "0": 157.63 m.a.s.l.)

Figure 9-5. Overview of a) average water level (Havg) and b) yearly maximum/minimum water level (Hmax/min) values for the Južna Morava River* for the period from 2014 to 2023 5

Surface water quality related to the proposed project

The following text provides an overview of the water quality of surface water bodies within the AoI that are covered by monitoring by the Environmental Protection Agency in the period 2017–2019 (this is the last data available, published in 2021)[6].

Quality elements for the assessment of ecological status/potential, for each category of surface water, are divided into three groups: (1) biological elements (2) hydro-morphological elements that support biological elements and (3) physico-chemical and chemical elements that support biological elements. Physical-chemical and chemical elements that support biological elements include a) General physico-chemical quality elements and b) Specific non-priority polluting substances that are discharged into the water body in significant quantities[7].

The assessment of ecological status/potential is shown in colours according to the recommendations of the Water Framework Directive of the European Parliament and of the Council (WFD) (Water Framework Directive (WFD 2000/60/EC)) (Table 9-2 and Table 9-3).

Table 9-2. Assessments of the ecological status of surface waters

Status rating	Colour	
perfect	blue	
good	green	
moderate	yellow	
weak	orange	
bad	red	

Table 9-3. Assessments of the ecological potential of surface waters*

Assessment of potential	Colour	
good and better	green	
moderate	yellow	
weak	orange	
bad	red	

* Ecological potential is the status of a significantly modified water body (SMWB) or an artificial water body (AWB)

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[5] *Republic Hydrometeorological Institute of Serbia, Hydrological yearbook, surface waters 2017–2021, https://www.hidmet.gov.rs/*

[6] *Čađo, S., Denić, Lj., Dopuđa-Glišić, T., Đurković, A., Novaković, B., Stojanović, Z., Žarić, D. (2021). Status of surface waters of Serbia during the period 2017–2019. Ministry of Environmental Protection, Environmental Protection Agency.*

[7] *Čađo et al., 2021*

To determine the status of a waterbody, in addition to the assessment of the ecological status, an assessment of the chemical status is also carried out. Environmental quality standards EQS (Environmental Quality Standards) are used to assess the chemical status of the water body. The chemical status of surface waters is determined in relation to the limit values of priority and priority hazardous substances. Chemical status of water of bodies is evaluated as "achieved good status" when not a single one is exceeded prescribed threshold value, or "good status not achieved" in the case when it is exceeded at least one prescribed limit value.

The results of the ecological status/potential assessment for surface watercourses (where this has been undertaken for surface watercourses within the Project AoI), based on monitoring conducted in 2017–2019, are shown in Table 9-4 and Figure 9-6.

Table 9-4. Assessment of the ecological status/potential of watercourses in the period 2017–2019 [8]

Watercourse	Name of the station	Year of examination	Biological elements of quality			Physico-chemical elements of quality	specific pollutants	Evaluation of ecological status/potential	Reliability level assessment
			Phytobenthos	Watery macroinvertebrates	Fish				
Jovanovačka river	Donji Katun	2019	-	-	-				low
Južna Morava	Mojsinje	2017–2019							high
Južna Morava	Klisura	2018	-	--					low
Južna Morava	Korvingrad	2017							high

[8] *Čađo et al., 2021.*

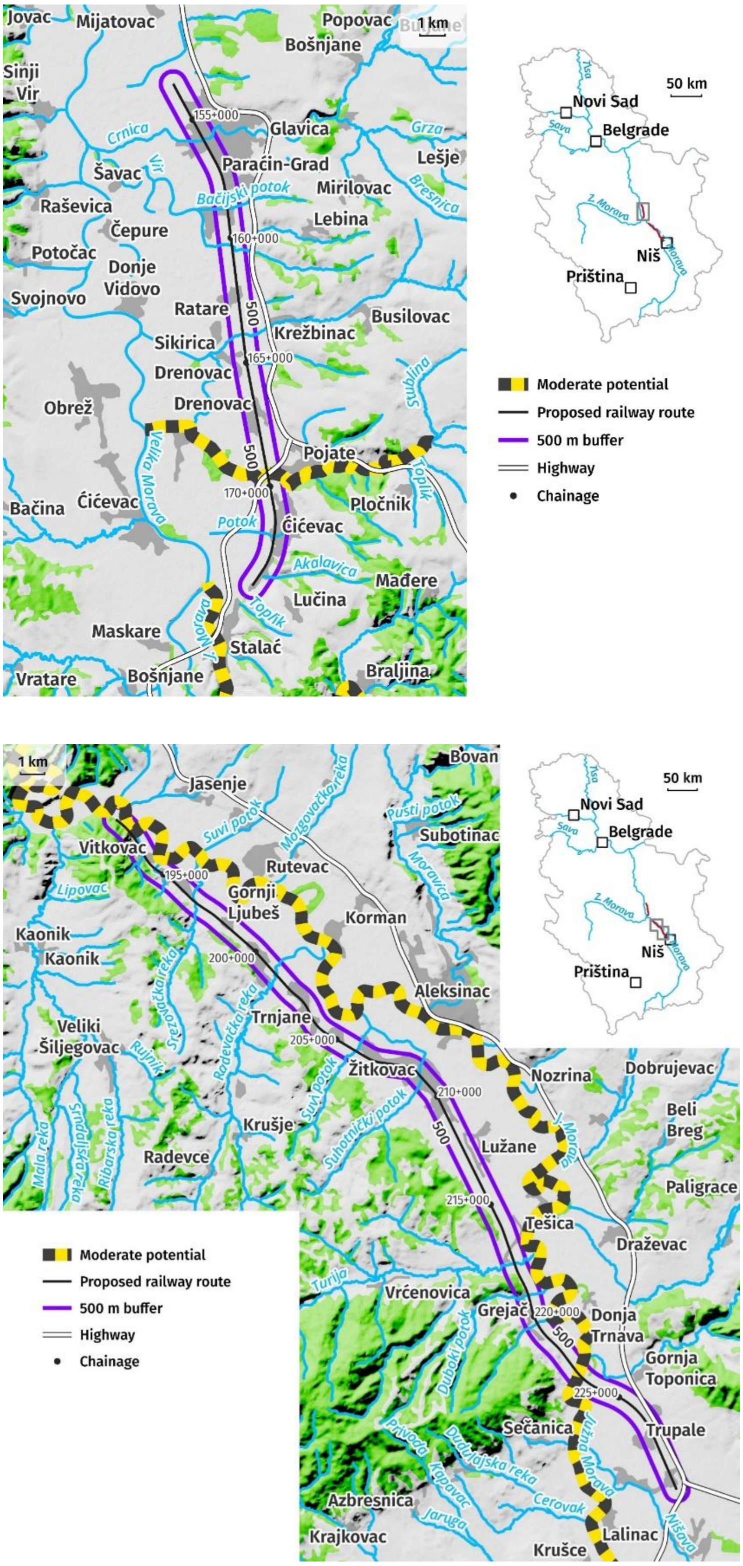


Figure 9-6. Ecological status/potential of water bodies of surface waters (watercourses) in the period 2017–2019

Status monitoring for the period 2017–2019 covered 2 rivers and 4 stations. An ecological status/potential rating indicates that good status/potential has not been established, but moderate ecological status/potential has been established in both rivers, out of 4 examined stations in this section of railway.

Status assessments were performed at the level of calendar years. For surface waters where multi-year monitoring was carried out (2017–2019), the obtained values were statistically processed on an annual level, while the evaluation of the ecological status/potential was performed by comparing multi-year averages with prescribed limit values. In the observed period, the ecological status/potential was determined with a high or medium level of reliability depending on the available indicative biological elements/parameters.

The chemical status of surface waters is determined by checking whether the environmental quality standards (EQS) for priority and priority hazardous substances are met. The chemical status of water bodies is evaluated based on the monitoring results and is expressed as "good status" and "good status not achieved", in case at least one limit value prescribed by the Regulation (Regulation on limit values of priority and priority hazardous substances that pollute surface waters) is exceeded of water and deadlines for reaching them (Official Gazette of RS No. 24/2014)) and is displayed in appropriate colours in the manner shown in Table 9-5.

Table 9-5. Assessments of the chemical status of surface waters

Status rating	colour	
good	blue	
good status not achieved	red	

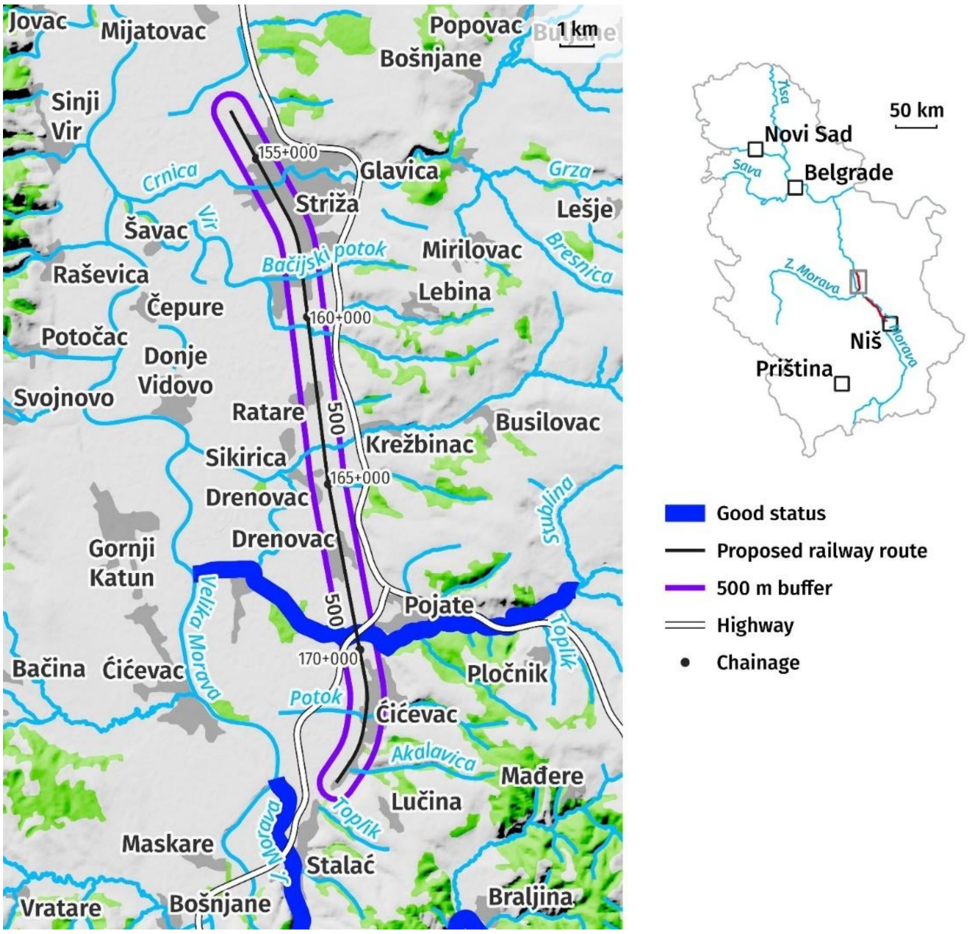
The assessment of the chemical status is carried out with a mandatory indication of the level of reliability. Level reliability of the assessment was carried out on the basis of the criteria given in the Rulebook (Rulebook on parameters of ecological and chemical status of surface waters and parameters of chemical status and quantitative status of groundwater (Official Gazette of the RS No. 74/2011)).

Based on the results of the examination of priority and priority hazardous substances, as part of the three-year monitoring program, authoritative values (average annual values and maximum measured values) were determined, which were compared with the values of the environmental quality standard (EQS), i.e. the average annual concentration (AQC) and the maximum allowed concentration (MDK) prescribed by Regulation. Only parameters where analytical methods with LOD (detection limit), which is equal to or lower than the value of 30% of the relevant environmental quality standard, are included in the assessment and presented in Table 9-6 and Figure 9-8.

Table 9-6. Chemical status of water bodies of surface waters (watercourses) in the period 2017-2019 9

Watercourse	Profile (measuring point)	Year of examination	Chemical status	Reason for not achieving good status	Annual/multi-year average concentration (µg/l)	Maximum measured concentration (µg/l)	Reliability level assessment
Jovanovačka river	Donji Katun	2019					medium
Južna Morava	Mojsinje	2017–2019					medium
Južna Morava	Klisura	2018					medium
Južna Morava	Korvingrad	2017					medium

[9] *Čađo et al., 2021.*


Jovac
Mijatovac
Popovac
Bošnjane
1 km
Sinji
Vir
155+000
Glavica
Crnica
Striža
Grza
Lešje
Šavac
Vir
Bačijski potok
Mirilovac
Bresnica
Raševica
Lebina
Čepure
160+000
Potočac
Donje
Vidovo
Svojnovo
Ratare
500
Busilovac
Sikirica
Krežbinac
165+000
Drenovac
Smugina
Drenovac
Gornji
Katun
500
Pojate
Velika Morava
Toplik
170+000
Bačina
Ćićevac
Pločnik
Potok
Ćićevac
Akalavica
Mađere
Lučina
Toplik
Maskare
J. Morava
Stalać
Braljina
Vratare
Bošnjane
Tisa
50 km
Novi Sad
Sava
Belgrade
Z. Morava
Niš
Morava
Priština
Good status
Proposed railway route
500 m buffer
Highway
Chainage

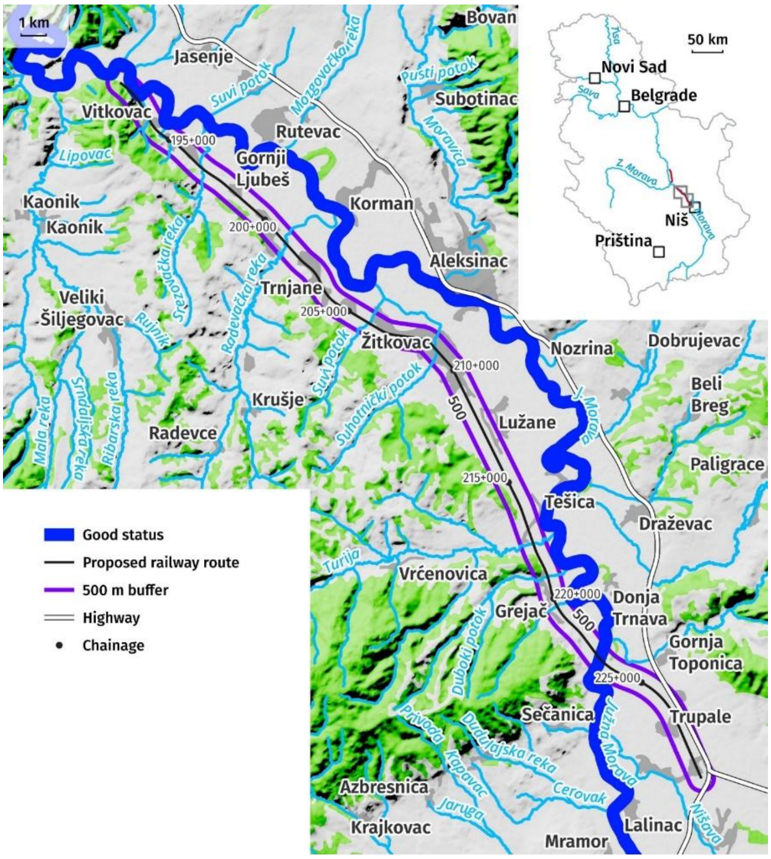


Figure 9-7. Chemical status of surface waters (watercourses) in the period 2017–2019

Table 9-7. Assessment of the ecological status/potential of watercourses based on physical and chemical elements of quality in the period 2017–2019 [10]

Watercourse	Name of the station	Dissolved oxygen (mg l^{-1}) (C 10)	pH value (C 80)	Ammonium ion (NH4-N) (mg l^{-1}) (C 80)	Nitrites (NO2-N) (mg l^{-1}) (C 80)	Nitrates (NO3-N) (mg l^{-1}) (C 80)	Total nitrogen (mg l^{-1}) (C 80)	Orthophosphates (mg l^{-1}) (C 80)	Total phosphorus (mg l^{-1}) (C 80)	Chlorides (mg l^{-1}) (C 80)	BOD5 (mg l^{-1}) (C 80)	Total Organic Carbon (TOC) (mg l^{-1}) (C 80)	Assessment of ecological status/potential
Jovanovačka river	Donji Katun	9.60	8.48	0.12	0.029	1.20	2.24	0.090	0.121	13.3	2.40	2.90	
Južna Morava	Mojsinje	7.41	8.15	0.14	0.050	1.59	2.9	0.109	0.283	13.1	3.55	7.2	

[10] *Čađo et al., 2021.*

Južna Morava	Klisura	8.21	8.30	0.10	0.035	1.38	2.4	0.084	0.267	12.0	3.30	5.5	
Južna Morava	Korvingrad	8.76	8.30	0.12	0.054	1.28	2.0	0.086	0.226	11.2	3.79	6.8	

Table 9-8. Ecological status/potential in relation to the content of specific pollutants in the period 2017–2019[11]

Watercourse	Profile (measuring point)	Ecological status/potential in relation to the content of specific polluting substances	
		Assessment of status/potential	Cause of failure to achieve good status/potential (C80)
Jovanovačka river	Donji Katun		
Južna Morava	Mojsinje		Iron Fe-total (1700.3 ug/l); Manganese Mn-total (189.4 ug/l)
Južna Morava	Klisura		Iron Fe-total (1769.7ug/l); Manganese Mn-total (115.0ug/l)
Južna Morava	Korvingrad		Iron Fe-total (1105.0ug/l)

According to the Regulation on Water Classification ("Official Gazette of SRS", No. 5/68), classes of water include:

- class I - waters that in their natural state or after disinfection can be used or exploited for supplying drinking water to settlements, in the food industry and for breeding precious species of fish (salmonids);
- class II – waters that are suitable for swimming; recreation and water sports, for breeding less noble species of fish (cyprinids), as well as water that, with normal processing methods (coagulation, filtration and disinfection), can be used to supply drinking water to the settlements and in the food industry;
- class III – water that can be used or exploited for irrigation and in industry, except for the food industry;
- class IV – water that can be used or exploited only after special treatment.

Class II waters, outside the border streams and the streams crossed by the borders of the Socialist Republic of Serbia, are divided into subclasses, namely:

- subclass IIa, which includes waters that, with normal treatment methods (coagulation, filtration and disinfection), can be used to supply drinking water to the settlements, for bathing and in the food industry, and
- subclass IIb, which includes waters that can be exploited or used for water sports, recreation, for breeding less noble species of fish (cyprinids) and for watering livestock.

According to the Regulation on Water Classification the water quality on the Crnica River is mainly categorized as I-IIa quality class. Nišava river is categorized as IIa/b quality class, and all sites located on Južna Morava River as IIa/b class[12].

In order to help establish baseline surface water quality for the purpose of the Project, water samples were taken by PPF9 team from the Crnica, Južna Morava and Nišava rivers during different seasons (autumn, winter, and spring),

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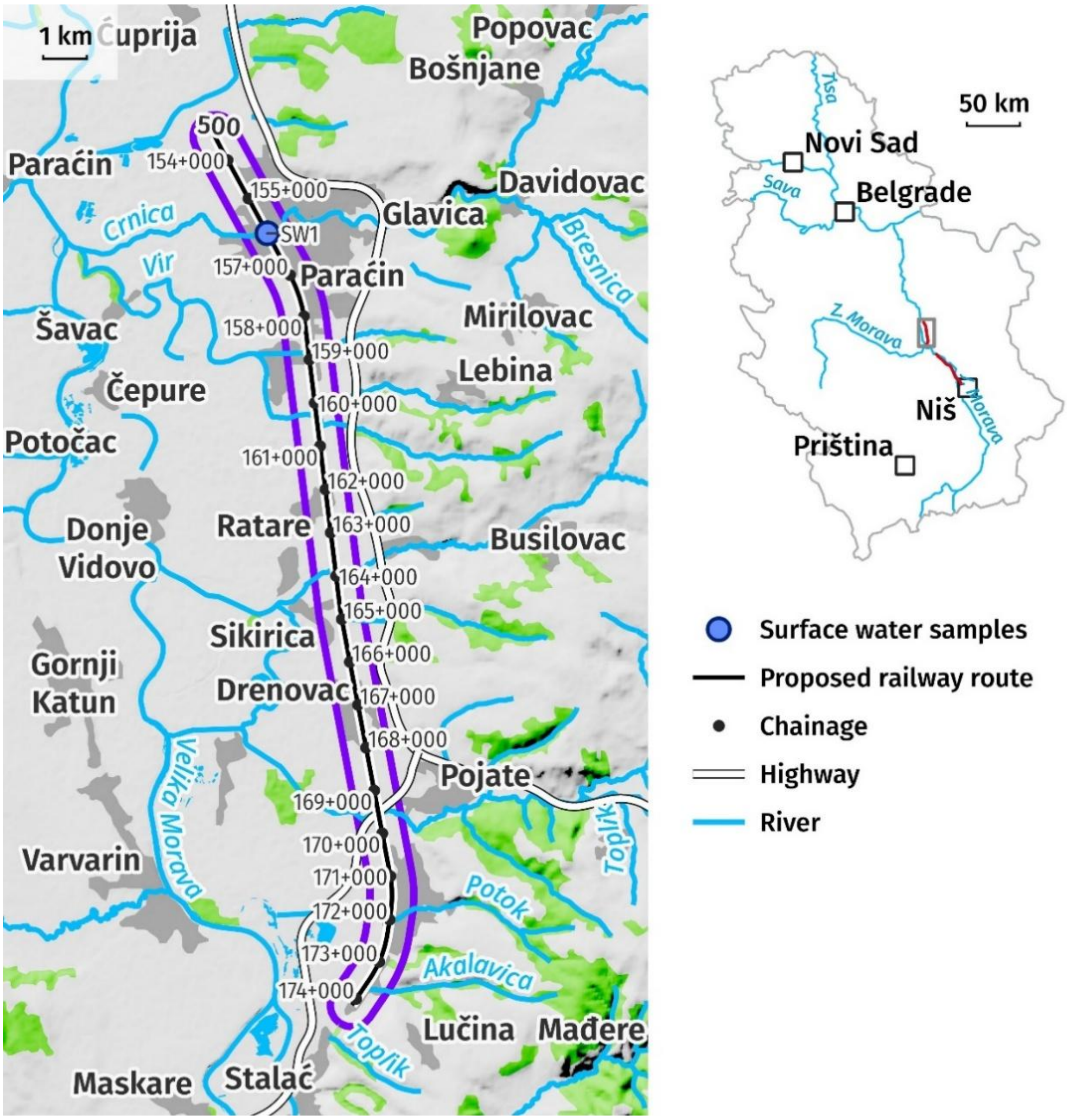
[11] *Čađo et al., 2021.*

[12] *Regulation on the categorization of watercourses (Official Gazette of the SRS, No 5/68)*

concluding in April 2024. All of the other rivers and streams within the AoI have intermittent flows and were therefore not sampled.Samples were collected at three different depths in glass containers in accordance with the standard SRPS EN ISO 5667-14:2017. Standard methods were used to determine the physical and chemical parameters of the water (APHA, 2005). At each location, selected physical and chemical parameters listed in Table 9-9 were measured. Sampling locations were chosen to demonstrate the potential impact of the Project on aquatic ecosystems, according to the currently available Project design. As such, 5 locations in close proximity to the Project were identified, as illustated in Figure 9-8, and detailed below.



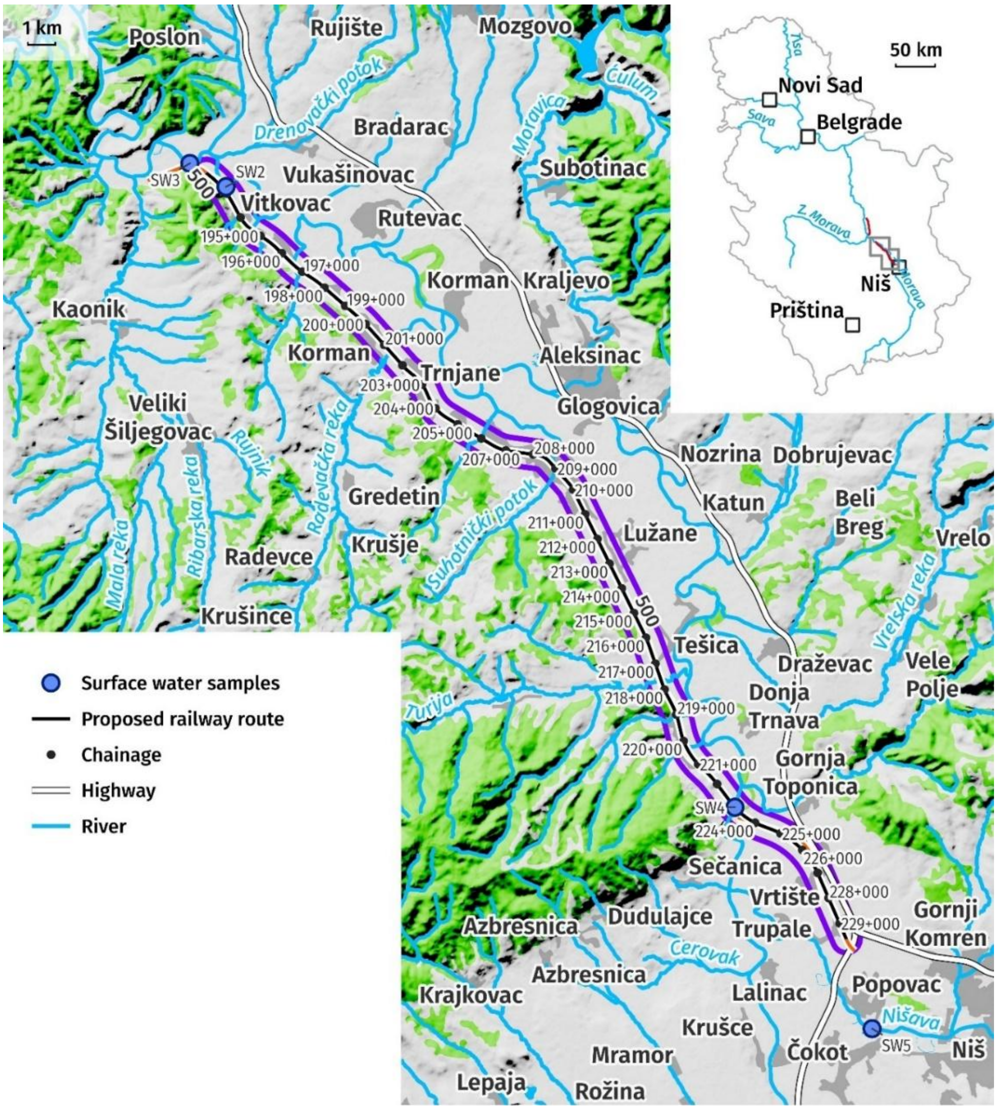


Figure 9-8. Surface water sampling locations

The Crnica River extends approximately 28 km in length. The sampling site is situated near the location where the railway intersects the river.

The Južna Morava River spans a length of 295 km. Sampling was conducted at three locations along this river. The first sampling site on this river is situated near village Cerovo in the municipality of Ražanj. The chosen sampling site is approximately 40 meters away from the railway line, situated on the left bank of the river. The second sampling site on this river is situated near village Vitkovac, belonging to the same municipality. The sampling site is approximately 3 meters away from the railway line, also on the left bank of the river. Finaly, the third sampling site is situated near village Gornja Toponica near the city of Trupale. The sampling site is near to the point where the railway intersects the river.

The Nišava River, the largest right tributary of the Južna Morava River, stretches across a length of 218 km. Sampling to assess water quality took place several hundred meters away from the railway bridge, near its confluence with the Južna Morava River.

a) Crnica river

b) Južna Morava river near Cerovo

c) Južna Morava river near Vitkovac

d) Južna Morava river near Gornja Toponica

e) Nišava river

Figure 9-9. Sampling sites on Crnica, Južna Morava and Nišava river

Several water quality parameters were selected to according to the specified criteria outlined in Annex 3 within the framework of Article 111, paragraph 3 of the Water Law ("Official Gazette of RS", number 30/10), to be measured at each sampling site. The physicochemical characteristics of water were measured in the field, simultaneously with sampling biological data using the following methods:

- water temperature (t), electro-conductivity (EC), pH concentration, concentrations of oxygen (DO-mg/l), and oxygen saturation (DO%) were determined using the WTW multi 340 I probe device (WTW GmbH, Weilheim);
- water turbidity was measured with a Lovibond PC Checkit device
- orthophosphates, nitrates, nitrites, ammonia, chlorides were determined using the Lovibond MD600
- Biochemical oxygen demand (BOD5) was estimated using the standard methodology recommended by APHA (1999).

Table 9-9. The values of measured physicochemical parameter (Fields in the table are color-coded to indicate the classification of values according to the threshold values listed in Table 9-10: Class I - green; Class II - blue; Class III - yellow; Class IV - orange; Class V – red)

	Crnica River around Paraćin SW1	Južna Morava River around Cerovo SW3	Južna Morava River around Vitkovac SW2	Južna Morava River around Gornja Toponica SW4	Nišava River around Niš SW5
Temperature (ºC)	11.1	12.1	12	12.2	12.9
Dissolved oxigen (mg/l)	11.83	9.35	9.15	9.7	11.2
Saturation (%)	109.1	88	87.1	92.7	107.9
Electro-conductivity (µS)	480	311	314	321	364
pH	7.62	7.5	7.31	7.22	7.15
Flow (m^3/s)	0.9	45	45	50	17.6
Turbidity (NTU)	5	35.5	34.5	27.4	8.93
Orthophosphates (mg/l P)	1.56	0.38	0.33	0.27	0.57

	Crnica River around Paraćin SW1	Južna Morava River around Cerovo SW3	Južna Morava River around Vitkovac SW2	Južna Morava River around Gornja Toponica SW4	Nišava River around Niš SW5
Nitrates (mg/l N)	0.54	0.33	0.35	0.11	0.83
Nitrites (mg/l N)	0.01	0.04	0.04	0.02	0.01
Ammonia (mg/l N)	0.02	0.07	0.09	0.14	0.74
Chlorides (mg/l Cl)	9.2	5.1	4.6	5.7	4
Biological oxygen demand (BOD5)	3.75	3.96	4.01	3.35	7.88

Table 9-10. Limit values of pollutants in surface waters13

Parameter	Unit of measure	Thresholds(1)				
		Class I(2)	Class II(3)	Class III(4)	Class IV(5)	Class V(6)
General						
pH(12)		6.5-8.5	6.5-8.5	6.5-8.5	6.5-8.5	<6.5 or <8.5
Suspended matter(9) (12)	mg/l	25	25	-	-	-
Oxygen mode						
Dissolved oxygen	[mg O2/l]	-(8) (or PN)	-(8)	5	4	< 4
Oxygen saturation	%					
-epilimnion (stratified water)		90-110	70-90	50-70	30-50	<30
- hypolimnion (stratified water)		70-90	70-50	30-50	10-30	<10
-unstratified water		70-90	50-70	30-50	10-30	<10
BOD5	[mg O2/l]	-(8) (or PN)	-(8)	7	25	>25
HPK (bichromatic method)	[mg O2/l]	10 (or PN)	15	30	125	>125
HPK (permanganate method)	[mg O2/l]	5 (or PN)	10	20	50	>50
Total Organic Carbon (TOC)	[mg/l]	-(8) (or PN)	-(8)	15	50	>50
Nutrients						
Total nitrogen	[mg N/l]	1 (or PN)	2	8	15	>15
Nitrates	[mg N/l]	-(8) (or PN)	-(8)	6	15	>15
Nitrites	[mg N/l]	0.01 (or PN)	0.03	0.12	0.3	>0.3
Ammonium ion	[mg N/l]	-(8) (or PN)	-(8)	0.6	1.5	>1.5
Non-Ionized Ammonia(9)	[mg/l NH3]	0.005	0.025	-	-	-
Total Phosphorus(7)	[mg P/l]	-(8) (or PN)	-(8)	0.4	1	>1

[13] *Regulation on the Limit Values of Pollutants in Surface and Groundwaters, Sediment, and the Deadlines for Their Achievement, "Official Gazette of the Republic of Serbia," No. 50/2012, Appendix 2*

Parameter	Unit of measure	Thresholds(1)				
		Class I(2)	Class II(3)	Class III(4)	Class IV(5)	Class V(6)
Orthophosphates	[mg P/l]	-(8) (or PN)	-(8)	0.2	0.5	>0.5
Salinity						
Chlorides	[mg/l]	50 (or PN)	-(8)	150	250	>250
Total Residual Chlorine(9)	[mg/l HOCl]	0.005	0.005	-	-	-
Sulfates	[mg/l]	50 (or PN)	100	200	300	>300
Total mineralization	[mg/l]	<1000 (or PN)	1000	1300	1500	>1500
Electrical conductivity at 200S	[mS/cm]	<1000 (or PN)	1000	1500	3000	>3000
Metals						
Arsenic	[µg/l]	<5 (or PN)	10	50	100	>100
Pine tree	[µg/l]	300 (or PN)	1000	1000	2500	>2500
Copper	[µg/l]	5 (T=10)22 (T=50)40 (T=100)112 (T=300)	5 (T=10)22 (T=50)40 (T=100)112 (T=300)	500	1000	>1000
Zinc	[µg/l]	30 (T=10)200 (T=50)300 (T=100)500 (T=500)	300 (T=10)700 (T=50) 1000 (T=100)2000 (T=500)	2000	5000	>5000
Chromium (Total)	[µg/l]	25 (or PN)	50	100	250	>250
Iron (Total)	[µg/l]	200	500	1000	2000	>2000
Manganese (Total)	[µg/l]	50	100	300	1000	>1000
Organic substances						
Phenolic compounds (such as C2H5OH)	[µg/l]	<1	1	20	50	>50
Petroleum hydrocarbons(9)		(10)	(10)	-	-	-
Surfactants (such as lauryl sulfate)	[µg/l]	100	200	300	500	>500
AOH (adsorbing organic halogen)	[µg/l]	10	50	100	250	>250
Microbiological parameters						
Faecal coliforms	cfu/100ml	100	1000	10000	100000	>100000
Total coliforms	cfu/100ml	500(11)	10000	100000	1000000	>1000000
Intestinal enterococci	cfu/100ml	200	400	4000	40000	>40000
Number of aerobic heterotrophs (Kohl method)	cfu/100ml	500	10000	100000	750000	>750000

T - water hardness (mg/l CaCO3)
PN - natural level
(1)Unless otherwise stated, values are expressed as total concentrations in the sample taken
(2)The description of the class corresponds to excellent ecological status according to the classification given in the rulebook that prescribes the parameters of ecological and chemical status for surface waters. Surface waters belonging to this class provide, based on the limit values of the quality elements, the conditions for the functioning of the ecosystem, the life and protection of fish (salmonids and cyprinids) and can be used for the following purposes: supply of drinking water with prior treatment by filtration and disinfection, bathing and recreation, irrigation, industrial use (process and cooling water).
(3)The description of the class corresponds to a good ecological status according to the classification given in the rulebook that prescribes the parameters of the ecological and chemical status for surface waters. Surface waters belonging to this class ensure, based on the limit values of quality elements, the conditions for ecosystem functioning, life and protection of fish (cyprinids) and can be used for the same purposes and under the same conditions as surface waters belonging to class I.
(4)The description of the class corresponds to a moderate ecological status according to the classification given in the rulebook that prescribes the parameters of the ecological and chemical status for surface waters. Surface waters belonging to this class ensure, based on the limit values of the quality elements, conditions for the life and protection of cyprinids and can be used for the following purposes: supply of drinking water with prior treatment by coagulation, flocculation, filtration and disinfection, bathing and recreation, irrigation, industrial use (process and cooling water).
(5)The description of the class corresponds to a weak ecological status according to the classification given in the rulebook that prescribes the parameters of the ecological and chemical status for surface waters. Surface waters that belong to this class based on the limit values of quality elements can be used for the following purposes: drinking water supply with the application of a combination of the aforementioned treatments and improved treatment methods, irrigation, industrial use (process and cooling water).
(6)The description of the class corresponds to poor ecological status according to the classification given in the rulebook that prescribes parameters of ecological and chemical status for surface waters. Surface waters belonging to this class cannot be used for any purpose.
(7)Total phosphorus is analyzed from the filtrate, i.e. from the dissolved phase obtained by filtration through a 0.45 mm filter.
(8)See Annex 1, Table 9-2 and Table 9-3, in which the limit values of polluting substances are given for I and II class of surface waters.
(9)The parameter is monitored only in surface waters designated as salmonid or cyprinid.
(10)Petroleum derivatives must not be present in water in such quantities that:
- form a visible film on the surface of the water or isthmus on the shores of watercourses and lakes,
- they give a recognizable "hydrocarbon" taste to fish,
- cause harmful effects in fish.
(11)Based on a 95% estimate
(12)Deviation from the limit values is allowed in case of specific geographical condition

Samples from locations on the larger rivers (Južna Morava near Cerovo, Vitkovac, and Gornja Toponica, Nišava near Trupale) exhibited moderate to low nutrient enrichment parameter values (lower conductivity values and reduced concentrations of nitrates, ammonia nitrogen, and orthophosphates). Such results were anticipated due to the greater dilution of polluting effluents in these rivers, which have higher discharge rates. However, lower nutrient enrichment values were accompanied by high turbidity values, which resulted from increased water inflow into these rivers during the sampling period.

Surface waters, specifically rivers within the Project AoI, are not used for the water supply of the population. However, it is important to note that in the southern part of the railway line, from Đunis to Trupale, the population of municipality of Aleksinac (along the line from Vitkovac to Veliki Drenovac) is supplied with water from surface water resources - Bovan reservoir. Water from this reservoir is directed to the Busje water treatment plant. Although the water is used for supply, it is worth mentioning that the distance from the Bovan reservoir to the railway line is more than 20 km, meaning there is no direct connection between the water supply and the surface waters along the railway.

When it comes to wastewater water and its discharge from existing station buildings, sewage is discharged into existing sewerage systems where they exist (Paraćin station, Signalling and telecommunication facilities in Paraćin and Ćićevac, Signaling and telecommunication facility in the official place Sikirica), or into impermeable septic tanks where there is no sewerage system (Ćićevac station, Korman station, Aleksinac station, Trupale station, Signalling and telecommunication facilities in the official places Korman, Aleksinac and Trupale, Signalling and telecommunication facilities in the official places Adrovac, Lužane and Tešica). Furthermore, sewage from all new stations that are planned will be collected in septic tanks. Taking this information into account, wastewater from the stations will have no impact on surface water because it will either be discharged into the municipal sewerage network or into septic tanks that are lined with impermeable materials.

The existing railway drainage is inadequate, with the route mostly on an embankment that obstructs stormwater flow, causing flood-prone areas. Current drainage relies mainly on unlined ditches, and stations lack proper stormwater or drainage systems.

In the new design, drainage channels are planned along the railway—either on one or both sides—depending on terrain and railway elevation. These include concrete or earthen channels to manage stormwater, especially in cut sections or where the terrain slopes toward the railway. In stations and multi-track sections, dedicated drainage systems are planned.

Stormwater from the electrified railway is treated as conditionally clean and can be discharged without treatment, except in protected areas. Discharge will go into existing watercourses, channels, or infiltration fields.

Access roads to stations will have closed pipe drainage systems with inlets and coalescing separators for oil removal (Class I, <5 mg/L hydrocarbons). Final discharge points include railway channels, streams, or infiltration fields. Specific separator models are planned at key locations, compliant with SRPS EN 858-1:2008.

9.3. Assessment of potential impacts

Surface water resources are critical to a wide range of human and ecological functions, and can be threatened by pollution and abstraction, as well as climate change. Changes to baseline conditions as a result of the Project may affect both the surface water resources themselves (primary receptors), and users of those water resources or receptors that are reliant upon them (secondary receptors – i.e. people who depend on surface waters for potable water, irrigation, recreation, employment, and aquatic flora/fauna, water dependent habitats).

Construction activities that can contribute to impacts on the surface water environment include abstraction (from surface water courses (for purposes such as dust suppression, concrete mixing, equipment cleaning, machinery cooling), wastewater discharges into receiving surface watercourses, soil excavations, the operation of machinery or vehicles that could result in oil/chemical spills and changes in river flow caused by cutting or diverting permanent and intermittent streams around the railway structures. During project operations wastewater discharges (e.g. from drainage systems) and run-off from areas of hardstanding (which could contain mobilised contaminants) could all contribute to impacts on surface water resources.

The main impacts of concern on surface waters during the construction phase are:

- Direct discharge of pollutants.
- Site runoff and wastewater
- Tunnel Water Discharge
- Increased sedimentation
- Construction of permanent structures
- River regulation works.

The impact assessments presented below reflect changes relative to the baseline conditions outlined in Section 9.2 above (i.e. environmental conditions incorporating impacts from the existing railway). The assessments consider the net impact of the proposed Project compared to the current situation.

Assumptions and Limitations

The impact assessment for construction and operational activities on surface water quality was conducted based on the known Project footprint. Certain aspects such as the specific siting of laydown areas, construction camps, access roads, and spoil disposal areas were not finalized at the time of assessment. Therefore, the evaluation is limited to assessing impacts directly related to the currently available Project footprint.

Any significant modifications to the Project's design or operation in the future will not have been considered in this assessment.

Relevant local authorities were contacted to obtain information on non-potable uses of surface waters, e.g. for irrigation. The information provided confirmed that there are no formal surface water abstractions for irrigation systems along the railway route within the Project Area of Influence (AoI). However, it is assumed that farmers use alternative, informal methods for crop irrigation, such as manually diverting water from surface streams. As such, the use of surface waters for the purpose of irrigation has been included in the assessment where relevant.

There are also indications that the Južna Morava River may be used for recreational purposes in some areas. While this is not officially documented, it has nevertheless been considered in the impact assessment where relevant, particularly in relation to surface water quality and community health and safety. Furthermore, the mitigation measures included, should protect any potential users of surface water for non-potable purposes.

Mitigation measures outlined in the assessment address procedures to be followed for these components where details are currently unavailable. The assessment also includes avoidance measures where applicable and identifies the need for further assessments during the detailed design phase. The effectiveness of all proposed mitigation measures in reducing environmental impacts is contingent upon their successful implementation.

9.3.1. Impact assessment methodology

The standard methodology for assessing the impacts of the construction phase of the Project on surface water is outlined in Chapter 9.5 of this ESIA. Any deviations from this methodology are outlined in the following Sections of this Chapter.

Magnitude

Magnitude defines the severity of an impact, or extent of changes to the baseline. To determine the magnitude of an impact, the methodology adopted for this assessment specifically includes an evaluation of the extent of impacts to human receptors (human health, livelihoods, water supply) and ecological receptors (aquatic species, habitat integrity, biodiversity, and ecosystem services). Magnitude also incorporates a consideration of whether the impact is reversible, or permanent.

For the assessment of 'magnitude', the methodology also includes a specific evaluation of anticipated changes in surface water quality, considering the following key parameters that are considered most indicative of surface water pollution relating to the Project on the basis of the criteria given in the Rulebook[14].

Table 9-11. Specific evaluation of anticipated changes in surface water quality

Magnitude (expected change from baseline)		pH	Dissolved oxygen mg/l	Biological Oxygen Demand (BOD) mg/l	Total organic carbon mg/l	Ammonium ion mg N/l	Nitrates mg N/l	Orthophosphates mg P/l	Chlorides mg/l	Total Phosphorus mg P/l	Grade
Low	0-25%	6-6.5, 8- 8.5	7-8.5	0-3	0-3	0-0.1	0-1.5	0-0.05	0-50	0-0.1	1
Moderate	25-50%	5-6, 8.5-9	5-7	3-6	3-7	0.1-0.8	1.5-6	0.05-0.2	50-100	0.1-0.4	2
Severe	50-75%	4-5	4-5	6-20	7-23	0.8-1	6-15	0.2-0.5	100-250	0.4-1	3
Very Severe	75-100%	<4, >9	<4	>20	>20	>1	>15	>0.5	>250	>1	4

Low magnitude indicates that minor changes in water quality that do not exceed 25% of baseline thresholds for key water quality parameters (e.g., pH, turbidity, nutrient levels); minor changes to watercourse morphology (e.g., small alterations to flow paths or sediment deposition).These impacts have negligible effects on aquatic habitats and are unlikely to affect human health, livelihoods or potable water supply significantly.

Moderate magnitude could result in moderate deterioration in water quality (25–50%), such as temporary increases in turbidity or pollutants, that may affect local aquatic species or human users for a limited period. Notable but

[14] *Rulebook on parameters of ecological and chemical status of surface waters and parameters of chemical status and quantitative status of groundwater (Official Gazette of the RS No. 74/2011)*

reversible changes to river morphology or flow patterns, which may affect local ecosystems temporarily, without causing long-term ecological or human harm.

Severe magnitude could result in significant and long-term degradation of water quality (50–75%), exceeding baseline water quality levels, affecting both ecological receptors (e.g., loss of aquatic biodiversity) and human receptors (e.g., contamination of drinking water sources). Major alterations to watercourse structure or flow, potentially leading to habitat loss, altered sediment transport.

Very severe magnitude will result in total degradation of water quality (75–100%), resulting in ecosystem collapse and severe long-term health risks or livelihood impacts to human populations dependent on the water source. Irreversible changes to the watercourse, causing substantial loss of habitat, disruption of hydrological processes, and significant risks to both local communities and ecosystems.

Sensitivity

For the purposes of this assessment, the sensitivity of receptors that could be impacted by changes in the surface waters baseline has been defined as outlined below.

Environmental receptors

'Very high' sensitivity receptors: Surface waters within legally protected areas such as national parks, nature reserves, or Ramsar sites. These waters often serve as habitats for endangered or rare species and may function as sources of potable water. Any impact on these receptors could result in significant ecological or regulatory consequences. Rivers within the AoI do not fall into this category, as most of Section 3 is not protected nor used as a primary drinking water source.

'High' sensitivity receptors: Water bodies that typically have good ecological status and may support recreational use such as swimming or bathing. They often serve as local fishery resources and may have some degree of ecological or community value. While not strictly protected, they warrant careful consideration due to their public and ecological functions. Ecologically valuable or locally important water bodies used for irrigation, recreation, or seasonal wildlife habitat, without formal protection. The Južna Morava River, (from km 192.000 to km 196.000 and from km 222.000 to at km 224.000), falls into this category.

'Moderate' sensitivity receptors: Surface waters of average ecological quality and moderate ecological status, not under specific legal protection, and with limited biodiversity importance. They may include irrigation systems or urban streams with some ecological function. Impacts on these waters are less critical but still relevant, especially in cumulative assessments. Crnica River (from km 155.000 to at km 157.000) is considered to have moderate ecological sensitivity. This section is ecologically valuable, occasionally used for wildlife habitats, but it is not formally protected. The river is regulated and used for various human activities, but it does not directly threaten ecosystems to the extent that would place it in the high or very high sensitivity categories. Modified or regulated watercourses with limited biodiversity and minor or occasional use by nearby communities.

'Low' sensitivity receptors: Heavily modified or artificial water bodies such as stormwater ditches, degraded canals, or industrial discharge basins. These receptors have minimal ecological value, no legal protection, and do not support sensitive species. This assessment is based on factors such as its heavily modified morphology, limited biodiversity, and the absence of significant ecological functions. The river's role is primarily related to urban drainage and stormwater management, with minimal natural habitat value. None of the rivers within AoI belong to this category.

Human receptors

'Very high' sensitivity receptors: Communities that depend entirely on surface water for drinking especially where no alternative water sources (e.g., groundwater, piped systems) exist. Changes in water quality (pollution or contamination) can have direct and severe impacts on human health.

Although the population of the southern part of the railway from Đunis to Trupale is supplied from surface water resources – the Bovan reservoir, from where the water is directed to the Busje water treatment plant, the distance of this reservoir is about 13.5 km from the railway line and therefore we believe that very high sensitivity receptors will not be threatened by this Project and thus are excluded from further assessment.

'**High' sensitivity receptors:** Communities that rely on surface water for household water use (sanitary and technical water consumption including bathing, washing and cleaning, garden irrigation and livestock comsuption). Populations that depend on surface water bodies for recreational activities (such as swimming, boating, fishing) or tourism, are also highly sensitive receptors. **High sensitivity receptors** are residents of the settlements from km 154+000 to km 159+000, from km 195+000 to km 196+000, from km 202+000 to km 203+000. The residents of these settlements are highly sensitive to any reduction in water quality due to the direct use of local watercourses for domestic needs.

'Moderate' sensitivity receptors: Communities using surface water for irrigation of agricultural land; while these communities may have some alternatives (e.g., groundwater), they still heavily rely on surface water for crop irrigation. Changes in water quality (e.g., increased salinity, pollution) or hydro-morphological changes (e.g., altered flow patterns or reduced flow) could negatively affect crop yields or irrigation efficiency. **Moderate sensitivity receptors** are farmers who rely on surface waters for their crop irrigation from km 194+000 to km 195+000, from km 204+000 to 205+000, from km 215+000 to km227+000.

'Low' sensitivity receptors: Populations that do not rely on local surface water sources for drinking, agricultural, or recreational purposes. They typically receive treated water from centralized systems, so changes in the quality or flow of surface water would have minimal direct impact on their health or lifestyle. Industries or activities that use surface water in a non-essential or minimal capacity where water quality or hydro-morphological changes have little to no impact.

9.3.2. Construction phase impacts

Railway construction projects can significantly impact surface water quality through changes to the surface water drainage system, the accidental release of hazardous substances: i.e. from leaks or spills of fuels, oils, chemicals etc., contaminated run-off from construction sites, direct wastewater discharges, the mobilisation of contaminants within soils/sediments, and an increase in suspended sediment levels through sediment laden surface run-off, an increase in river bank/bed erosion rates, or the direct disturbance of sediments within the watercourse.

Other than the Južna Morava and Crnica rivers, all other watercourses are intermittent and therefore have not been considered in the assessments below.

The installation of bridge piers within the riverbed at km 223+054, where construction of the new bridge over the Junza Morava river will include the construction of 2 piers of 2.0m width within the riverbed at this location, has the potential to alter the hydraulic regime of the watercourse (i.e. increase or decrease the velocity and/or direction of flow) and result in an increase in erosion rates (with associated increases in sediment loads and changes in river characteristics).

Potential impacts on surface water during the construction phase are:

- Direct discharge of pollutants.
- Site runoff and wastewater
- Tunnel Water Discharge
- Increased sedimentation
- Construction of permanent structures
- River regulation works

Impact of direct discharge of pollutants on environmental receptors

During construction works like excavation, concreting, and welding, there is a significant risk of pollutants such as cement, oil, lubricants, and fuel entering nearby watercourses. These pollutants can degrade water quality by increasing turbidity, raising pH levels, introducing toxic substances, and harming aquatic ecosystems. The key impacts include physical changes (e.g., turbidity), chemical contamination (e.g., toxic hydrocarbons), and ecological disruption (e.g., loss of aquatic habitats).

Magnitude

The magnitude of the impact of reduced water quality due to the direct discharge of pollutants on environmental receptors is expected to be moderate due to its potential to affect water quality, its reversibility, localized nature, and the availability of effective mitigation measures. Although significant in potential, this impact can be managed effectively through standard mitigation practices.

Spatiotemporal impact (Spatial Extent and Duration)

The duration of the impact will be limited to the construction phase of the Project, and during works that impact individual watercourses. The impacts are also expected to be very localised and only affect nearby watercourses (Crnica and Južna Morava rivers) for a limited distance (up to 5 and 10km, respectively) downstream of the source of the impact (Rivera-Gutiérrez, 2015).

Sensitivity

Two types of environmental receptors based on sensitivity were identified: High-sensitivity environmental receptors are limited to specified locations on the Južna Morava River (3), and Moderate sensitivity environmental receptors are limited to specified locations on the Crnica river (2).

'Sensitivity' as explained above is the same for each impact on environmental receptors and is applied to all other construction and operations phase impacts below. Impact Assessments have been conducted separately for each category of sensitive receptor.

Likelihood

During railway construction, the occurrence of surface water pollution as a consequence of direct discharge of pollutants is considered to be possible, due to the potential for oil/fuel leaks from construction machinery/vehicles (either onto the ground so that they contaminate surface run-off or directly into a watercourse).

The assessment of the significance of the impact of a reduction in water quality due to the direct discharge of pollutants on environmental receptors during the construction phase of the Project is summarised in Table 9-12 below.

Table 9-12. Significance of the impact of a reduction in water quality due to the direct discharge of pollutants on environmental receptors during the construction phase

Location	Magnitude	Spatiotemporal scale	Sensitivity	Likelihood	Overall significance
Južna Morava river (from km 192.000 to km 196.000, from km 222.000 to km 224.000)	It is expected, that there could be a moderate magnitude impact on surface water quality, with a 25-50% change in baseline values of one or more key water quality parameters. (2)	The duration of the impact will be limited to the construction phase and during works on the Južna Morava river at the specified location, and for a limited distance downstream of the source of the impact. (2)	Surface water with high sensitivity to changes in water quality (2)	A change in surface water quality will possibly happen (2)	*M (2) + ST (2) + S (3) + L (2) = 9 (Moderate)*
Crnica river (from km 155.000 to at km 157.000)	It is expected, that there could be a moderate magnitude impact on surface water quality, with a	The duration of the impact will be limited to the construction phase and during works on the Crnica Morava river at the	Surface waterwith moderate Surface water with moderate	A change in surface water quality will possibly happen	*M (2) + ST (2) + S (2) + L (2) =8 (Moderate)*

Location	Magnitude	Spatiotemporal scale	Sensitivity	Likelihood	Overall significance
	25-50% change in baseline values of one or more key water quality parameters. (2)	specified location, and for a limited distance downstream of the source of the impact. (2)	sensitivity to changes in water quality (2)	(2)	

Impact of direct discharge of pollutants on human receptors

A significant reduction in surface water quality as a result of the construction phase of the Project may have a range of potentially negative impacts on local communities, including health, livelihood, and overall well-being impacts. Although no surface water bodies within the AoI are used to provide municipal water supplies, many communities are engaged in agriculture, which is especially significant in the municipality of Aleksinac. Any potential contamination of surface waters that are utilised to provide water for irrigation or livestock feeding can reach humans through water and the food chain and increase the likelihood of various diseases. The severity of these impacts is dependant upon the extent and type of the degradation in water quality and the level of reliance on surface water resources.

The main causes of a reduction in surface water quality due to the direct discharge of pollutants during the construction phase may include:

- Improper disposal of construction materials: Waste materials such as concrete, asphalt, paint, solvents, oils, and other hazardous substances can be improperly disposed of or spilled into nearby watercourses. These contaminants can significantly degrade water quality by introducing chemicals, heavy metals, and other pollutants.
- Accidental spills/leaks of hazardous substances (e.g. from storage areas, during refuelling, from construction equipment/vehicles).

Magnitude

The magnitude of the impact of reduced water quality due to the direct discharge of pollutants on environmental receptors is expected to be moderate due to its potential to affect water quality, its reversibility, localized nature, and the availability of effective mitigation measures. Although significant in potential, this impact can be managed effectively through standard mitigation practices. (2)

Sensitivity

In the project area, two types of human receptors based on sensitivity can be identified: high-sensitivity receptors (3), which consider communities that rely on surface water for household water use and recreation; and moderate-sensitivity receptors (2), which consider communities that are using surface water for irrigation of agricultural land.

'Sensitivity' as explained above is the same for each impact on human receptors and is applied to all other construction and operations phase impacts below. Impact Assessments have been conducted separately for each category of sensitive receptor.

Spatiotemporal impact (Spatial Extent and Duration)

The duration of the impact will be limited to the construction phase of the Project, and during works that impact individual watercourses. So, the expected moderate magnitude impact refers to temporary, localized changes in surface water quality due to construction activities. Localised changes would affect human users (e.g. for agricultural purposes and recreation) for a limited time, since the effects would be short-lived, as natural auto-purification processes will restore water quality within a few months. The impacts are also expected to be very localised and only affect nearby watercourses (Crnica and Južna Morava rivers) for a limited distance (up to 5 and 10km, respectively) downstream of the source of the impact. (2)

Likelihood

The likelihood of changes in surface water quality during the construction phase is defined as possible as activities such as excavation and material transportation are ongoing during construction and are expected to increase the frequency of sedimentation, pollution, or runoff entering surface waters. These impacts are anticipated to occur throughout the construction phase unless strict and effective mitigation measures are consistently implemented. (3)

The assessment of the significance of the impact of a reduction in water quality on human receptors during the construction phase of the Project is summarised in Table 9-13 below.

Table 9-13. Significance of impact of reduction in water quality due to the direct discharge of pollutants on human receptors during the construction phase

Location	Magnitude	Spatiotemporal scale	Sensitivity	Likelihood	Overall significance
All locations where there are high sensitivity receptors (from km 154+000 to km 159+000, from km 195+000 to km 196+000, from km 202+000 to km 203+000)	It is expected that there could be a moderate magnitude impact on surface water quality, with a moderate deterioration in water quality, such as temporary increases in turbidity or pollutants, that may affect human users for a limited period. (2)	The duration of the impact will be limited to the construction phase of the Project, and during works that impact individual watercourses (Crnica, Južna Morava). The impacts are also expected to be very localised and only affect specific watercourses for a limited distance downstream of the source of the impact. (2)	The residents highly dependent on local watercourses for domestic use and recreation, are highly sensitive to any reduction in water quality, as it could significantly affect their health. (3)	A change in surface water quality will possibly happen (2)	M (2) + ST (2) + S (3) + L (2) = 9 (Moderate)
All locations where there are moderate sensitivity receptors (from km 194+000 to km 195+000, from km	It is expected that there could be a moderate magnitude impact on surface water quality, with a moderate deterioration in water quality, such as	The duration of the impact will be limited to the construction phase of the Project, and during works that impact individual watercourses (Južna Morava). The impacts are also expected to be very	The residents highly dependent on agriculture and local watercourses for irrigation, are modertately sensitive to reduction in water	A change in surface water quality will possibly happen (2)	M (2) + ST (2) + S (2) + L (2) = 8 (Moderate)

Location	Magnitude	Spatiotemporal scale	Sensitivity	Likelihood	Overall significance
204+000 to 205+000, from km 215+000 to km227+000)	temporary increases in turbidity or pollutants, that may affect human users for a limited period. (2)	localised and only affect specific watercourses for a limited distance downstream of the source of the impact. (2)	quality, as it could affect environment, crops and their health. (2)		

Impact of site runoff and wastewater on environmental receptors

Runoff and wastewater discharges from accommodation camps, concrete batching plants, de-watering activities can overload water bodies with nutrients, leading to harmful algal blooms and oxygen depletion. Toxic chemicals, like heavy metals and pesticides, harm aquatic life and disrupt ecosystems. Increased sedimentation and changes in pH further degrade water quality, affecting biodiversity. Contaminated runoff degrades habitats and exposes animals to harmful chemicals, which can accumulate in the food chain. This leads to bioaccumulation and a loss of biodiversity, as pollution impacts some species more than others.

Magnitude

The magnitude of the impact of reduced water quality due to site runoff and wastewater on environmental receptors is expected to be moderate. Water pollution, caused by sediment and increased nutrient levels, can temporarily affect feeding or reproductive success. However, in the case of severe water quality deterioration, such as high toxin levels or oxygen depletion, this can lead to severe health issues, displacement, or even mortality.

Spatiotemporal impact (Spatial Extent and Duration)

The duration of the impact will be limited to the construction phase of the Project, and during works that impact individual watercourses. The impacts are also expected to be very localised and only affect nearby watercourses (Crnica and Južna Morava rivers) for a limited distance (up to 5 and 10km, respectively) downstream of the source of the impact (Rivera-Gutiérrez, 2015).

Likelihood

During railway construction, the occurrence of surface water pollution as a consequence due to the from site runoff and wastewater is considered to be likely, due to the need for excavations which can result in surface runoff carrying mobilised pollutants into nearby watercourses, the use of hazardous materials (which can be spilled onto the ground and mobilised in surface runoff or spilled directly into watercourses).

The assessment of the significance of the impact of a reduction in water quality due to the from site runoff and wastewater on environmental receptors during the construction phase of the Project is summarised in Table 9-14 below.

Table 9-14. Significance of the impact of a reduction in water quality due to the from site runoff and wastewater on environmental receptors during the construction phase

Location	Magnitude	Spatiotemporal scale	Sensitivity	Likelihood	Overall significance
Južna Morava river (from km 192.000 to km 196.000, from km 222.000 to km 224.000)	It is expected, that there could be a moderate magnitude impact on surface water quality, with a 25-50% change in baseline values of one or more key water quality parameters. (2)	The duration of the impact will be limited to the construction phase and during works on the Južna Morava river at the specified location, and for a limited distance downstream of the source of the impact. (2)	Surface waters with high sensitivity to changes in water quality (2)	A change in surface water quality is likely to happen (3)	*M (2) + ST (2) + S (3) + L (3) = 10 (Moderate)*
Crnica river (from km 155.000 to km 157.000)	It is expected, that there could be a moderate magnitude impact on surface water quality, with a 25-50% change in baseline values of one or more key water quality parameters. (2)	The duration of the impact will be limited to the construction phase and during works on the Crnica river at the specified location, and for a limited distance downstream of the source of the impact. (2)	Surface water with moderate sensitivity to changes in water quality (2)	A change in surface water quality is likely to happen (3)	*M (2) + ST (2) + S (2) + L (3) =9 (Moderate)*

Impact of site runoff and wastewater on human receptors

Runoff and wastewater water poses risks to recreational activities like swimming and fishing. Additionally, toxic substances can accumulate in aquatic food chains, posing risks to humans through bioaccumulation and biomagnification. In addition, untreated wastewater discharges from accommodation camps, concrete batching plants, de-watering of excavations contribute to the impact.

Magnitude

Without mitigation, it is expected, based on Islam et la., (2023) and Karunasena et al. (2023), that there will be a moderate magnitude impact on surface water quality due to the direct discharge of pollutants, with a 25-50% change in baseline values of one or more key water quality parameters that may affect local human users. These impacts, including potential increases in contaminants like nitrates and ammonium, could pose short-term health risks but are expected to be reversible, with no long-term harm to human health. High nitrate levels in water generally don't cause serious effects but can lead to temporary gastrointestinal issues (such as nausea and stomach cramps) if concentrations are very high. Ammonium can reduce dissolved oxygen levels in water. Although ammonium at low levels is usually not directly toxic to humans, high concentrations may cause gastrointestinal distress (like nausea and vomiting) and respiratory irritation if used for recreation or irrigation. (2)

Spatiotemporal impact (Spatial Extent and Duration)

The duration of the impact will be limited to the construction phase of the Project, and during works that impact individual watercourses. So, the expected moderate magnitude impact refers to temporary, localized changes in surface water quality due to construction activities. Localised changes would affect human users (e.g. for agricultural purposes and recreation) for a limited time, since the effects would be short-lived, as natural auto-purification processes will restore water quality within a few months. The impacts are also expected to be very localised and only affect nearby watercourses (Crnica and Južna Morava rivers) for a limited distance (up to 5 and 10km, respectively) downstream of the source of the impact. (2)

Likelihood

The likelihood of changes in surface water quality during the construction phase is defined as likely. The absence of proper wastewater management, runoff control, and pollution monitoring significantly increases the chance of harmful substances reaching surface water sources and its recreational areas (3).

The assessment of the significance of the impact of a reduction in water quality due to the from site runoff and wastewater on human receptors during the construction phase of the Project is summarised in Table 9-15 below.

Table 9-15. Significance of impact of reduction in water quality due to the from site runoff and wastewater on human receptors during the construction phase

Location	Magnitude	Spatiotemporal scale	Sensitivity	Likelihood	Overall significance
All locations where there are high sensitivity receptors (from km 154+000 to km 159+000, from km 195+000 to km 196+000, from km 202+000 to km 203+000)	It is expected that there could be a moderate magnitude impact on surface water quality, with a moderate deterioration in water quality, such as temporary increases in turbidity or pollutants, that may affect human users for a limited period. (2)	The duration of the impact will be limited to the construction phase of the Project, and during works that impact individual watercourses (Crnica, Južna Morava). The impacts are also expected to be very localised and only affect specific watercourses for a limited distance downstream of the source of the impact. (2)	The residents highly dependent on local watercourses for domestic use and recreation, are highly sensitive to any reduction in water quality, as it could significantly affect their health. (3)	Changes in surface water quality during construction are considered to be likely (3)	M (2) + ST (2) + S (3) + L (3) = 10 (Moderate)
All locations where there are moderate sensitivity receptors (from	It is expected that there could be a moderate magnitude impact on surface water quality, with a	The duration of the impact will be limited to the construction phase of the Project, and during works that impact individual	The residents highly dependent on agriculture and local watercourses for irrigation, are	Changes in surface water quality during construction are	M (2) + ST (2) + S (2) + L (3) = 9 (Moderate)

Location	Magnitude	Spatiotemporal scale	Sensitivity	Likelihood	Overall significance
km 194+000 to km 195+000, from km 204+000 to 205+000, from km 215+000 to km227+000)	moderate deterioration in water quality, such as temporary increases in turbidity or pollutants, that may affect human users for a limited period. (2)	watercourses (Južna Morava). The impacts are also expected to be very localised and only affect specific watercourses for a limited distance downstream of the source of the impact. (2)	modertately sensitive to reduction in water quality, as it could affect environment, crops and their health. (2)	considered to be likely (3)	

Impact of Tunnel Water Discharge on environmental receptors

Tunnel construction activities often result in the accumulation of water within the tunnel area, primarily due to groundwater ingress, precipitation, or construction-related processes. This water is typically laden with suspended solids, and may also contain chemical pollutants such as heavy metals, fuel residues, and concrete leachate. If discharged into nearby surface water bodies (streams, rivers, lakes) without appropriate treatment, it can have significant adverse impacts on surface water quality, aquatic habitats, and ecosystem services. It is expected that tunnel water will be discharged into the Južna Morava River.

Magnitude

The magnitude of the impact from tunnel water discharge is high due to the potential for substantial degradation of surface water quality caused by elevated levels of suspended solids, chemical pollutants (such as heavy metals and fuel residues), and alkaline substances. These contaminants can cause severe harm to aquatic life, disrupt ecosystem functions, and lead to sedimentation that damages habitats. The extent of contamination can affect a significant area, and recovery may require long-term active remediation, indicating a major impact on the receiving water bodies.

Spatiotemporal impact (Spatial Extent and Duration)

The duration of the impact will be limited to the construction phase of the Project and works on the tunnel. The impacts are also expected to be very localised and only affect the Južna Morava River for a limited distance (up to 5 and 10km, respectively) downstream of the source of the impact (Rivera-Gutiérrez, 2015).

Likelihood

The likelihood of tunnel water discharges impacting surface water receptors is likely**,** especially during active construction works on the tunnel. Therefore, preventive planning, water treatment, and real-time monitoring are critical to avoid or minimize adverse effects.

Table 9-16. Significance of impact of reduction in water quality due to the Tunnel Water Discharge on environmental receptors during the construction phase

Location	Magnitude	Spatiotemporal scale	Sensitivity	Likelihood	Overall significance
Južna Morava river (from km 192.000 to km 196.000,)	It is expected, that there could be a high magnitude impact due to the substantial degradation of surface water quality. (3)	The duration of the impact will be limited to the construction phase and during works on the Južna Morava river at the specified location, and for a limited distance downstream of the source of the impact. (2)	Surface waters with high sensitivity to changes in water quality (2)	A change in surface water quality is likely to happen (3)	*M (3) + ST (2) + S (3) + L (3) = 11 (High)*

Impact of Tunnel Water Discharge on Human Receptors

Tunnel construction activities often result in the accumulation of water within the tunnel area, which may contain suspended solids and chemical pollutants such as heavy metals, fuel residues, and alkaline substances. When this water is discharged untreated into nearby surface water bodies, it can adversely affect human receptors including those who use surface water resources for agricultural and irrigation purposes, recreational activities like swimming and bathing, fishing and associated livelihoods, as well as industrial or other non-potable applications. Contamination of these water sources poses risks to both the health and economic well-being of local communities.

Magnitude

The magnitude of the impact on human receptors is considered high due to the significant degradation of surface water quality. Pollutants can reduce the suitability of water for irrigation, potentially affecting crop health and agricultural productivity. Contamination of aquatic life, particularly fish, threatens food security and the livelihoods of those who depend on fishing. Furthermore, poor water quality can diminish the recreational value of rivers and lakes, creating potential health risks for those engaging in water-based activities.

Spatiotemporal Impact

The spatial extent of the impact is expected to be local, affecting communities and water users along the Južna Morava River. Nevertheless, the influence of pollutants may extend up to 5 to 10 kilometers downstream from the discharge points, depending on water flow and environmental conditions. The duration of the impact is primarily limited to the construction phase of the tunnel project.

Likelihood

The likelihood of tunnel water discharge impacting surface water quality and thereby affecting human receptors is likely. The frequent and continuous nature of water discharge during excavation increases the probability of contamination if treatment measures are insufficient. Preventive planning, effective water treatment before discharge, and real-time water quality monitoring are therefore critical to minimizing adverse effects on these human water uses.

Table 9-17. Significance of impact of reduction in water quality due to Tunnel Water Discharge on human receptors during the construction phase

Location	Magnitude	Spatiotemporal scale	Sensitivity	Likelihood	Overall significance
All locations where there are high sensitivity receptors (from km 192+000 to km 196+000)	It is expected, that there could be a high magnitude impact due to the substantial degradation of surface water quality. (3)	The duration of the impact will be limited to the construction phase and during works on the Južna Morava river at the specified location, and for a limited distance downstream of the source of the impact. (2)	The residents highly dependent on local watercourses for non-potable domestic use and recreation, are highly sensitive to any reduction in water quality, as it could significantly affect their health. (3)	A change in surface water quality is likely to happen (3)	*M (3) + ST (2) + S (3) + L (3) = 11 (High)*
All locations where there are high sensitivity receptors (from km 192+000 to km 196+000)	It is expected, that there could be a high magnitude impact due to the substantial degradation of surface water quality. (3)	The duration of the impact will be limited to the construction phase and during works on the Južna Morava river at the specified location, and for a limited distance downstream of the source of the impact. (2)	The residents highly dependent on agriculture and local watercourses for irrigation, are modertately sensitive to reduction in water quality, as it could affect environment, crops and their health. (2)	A change in surface water quality is likely to happen (3)	*M (3) + ST (2) + S (2) + L (3) = 10 (Moderate)*

Impact of increased sedimentation on environmental receptors

The impact of reduced water quality due to increased sedimentation on environmental receptors is significant and can affect aquatic ecosystems, wildlife, vegetation, and human activities. Sedimentation occurs when soil particles are eroded and transported by runoff into water bodies, often as a result of construction and land clearing. Clearing of vegetation along riverbanks or in catchment areas can reduce natural erosion control and increase sedimentation in the watercourses. High sediment loads increase turbidity, which reduces light penetration and affects aquatic plant growth.

Magnitude

The magnitude of the impact of reduced water quality due increased sedimentation on environmental receptors is expected to be high. Due to the scale of disturbance and proximity to watercourses, railway construction activities are likely to cause a high increase in sedimentation, leading to significant adverse effects on surface water quality and aquatic ecosystems, particularly in sensitive environments.

Spatiotemporal impact (Spatial Extent and Duration)

The duration of the impact will be limited to the construction phase of the Project, and during works that impact individual watercourses. The impacts are also expected to be very localised and only affect nearby watercourses

(Crnica and Južna Morava rivers) for a limited distance (up to 5 and 10km, respectively) downstream of the source of the impact (Rivera-Gutiérrez, 2015).

Likelihood

The likelihood of increased sedimentation during railway construction is high due to extensive earthworks, exposure of soil to rainfall, proximity to watercourses, and the linear nature of the project, which increases the potential for sediment to be transported into surface waters. Without effective mitigation, sediment mobilization is considered as likely (3).

The assessment of the significance of the impact of a reduction in water quality due to the increased sedimentation on environmental receptors during the construction phase of the Project is summarised in Table 9-18 below.

Table 9-18. Significance of the impact of a reduction in water quality due to the increased sedimentation on environmental receptors during the construction phase

Location	Magnitude	Spatiotemporal scale	Sensitivity	Likelihood	Overall significance
Južna Morava river (from km 192.000 to km 196.000, from km 222.000 to km 224.000)	It is expected, that there could be a high magnitude impact on surface water quality, with a 25-50% change in baseline values. (3)	The duration of the impact will be limited to the construction phase and during works on the Južna Morava river at the specified location, and for a limited distance downstream of the source of the impact. (2)	Surface water with high sensitivity to changes in water quality (2)	A change in surface water quality is likely to happen (3)	*M (3) + ST (2) + S (3) + L (3) = 11 (High)*
Crnica river (from km 155.000 to km 157.000)	It is expected, that there could be a high magnitude impact on surface water quality, with a 25-50% change in baseline values. (3)	The duration of the impact will be limited to the construction phase and during works on the Crnica river at the specified location, and for a limited distance downstream of the source of the impact. (2)	Surface water with moderate sensitivity to changes in water quality (2)	A change in surface water quality is likely to happen (3)	*M (3) + ST (2) + S (2) + L (3) = 10 (Moderate)*

Impact of increased sedimentation on human receptors

Increased sedimentation can significantly impact human receptors by reducing water quality. Clearing of vegetation along riverbanks or in catchment areas can reduce natural erosion control and increase sedimentation in the watercourses. In addition, construction works directly within the watercourses — such as the installation of bridge piers, channel modification, culvert installation, or bank reinforcement — may also disturb riverbed habitats and contribute to increased turbidity and altered flow regimes. It may affect recreational activities by reducing water quality and increasing health hazards. Sediment can contaminate fish thereby threatening food security, and affect irrigation systems, leading to agricultural disruptions.

Magnitude

The magnitude of the impact on human receptors is expected to be high in areas where water bodies are used for recreation, or food resources (i.e. freshwater fish) and where there are no effective sediment control measures (3). An increase in sediment loads is expected due to excavations and the need to work directly in watercourses to install the foundations for bridges/viaducts.

Spatiotemporal impact (Spatial Extent and Duration)

The duration of the impact will be limited to the construction phase of the Project, and during works that impact individual watercourses. The impacts are also expected to be very localised and only affect nearby watercourses (Crnica and Južna Morava rivers) for a limited distance (up to 5 and 10km, respectively) downstream of the source of the impact (Rivera-Gutiérrez, 2015).

Likelihood

The likelihood of increased sedimentation during railway construction is high due to extensive earthworks, exposure of soil to rainfall, proximity to watercourses, and the linear nature of the project, which increases the potential for sediment to be transported into surface waters. Without effective mitigation, sediment mobilization is considered as likely (3).

The assessment of the significance of the impact of a reduction in water quality due to the increased sedimentation on human receptors during the construction phase of the Project is summarised in Table 9-19 below.

Table 9-19. Significance of impact of reduction in water quality due to the increased sedimentation on human receptors during the construction phase

Location	Magnitude	Spatiotemporal scale	Sensitivity	Likelihood	Overall significance
All locations where there are high sensitivity receptors (from km 154+000 to km 159+000, from km 195+000 to km 196+000, from km 202+000 to km 203+000)	It is expected, that there could be a high magnitude impact on surface water quality, with a 25-50% change in baseline values. (3)	The duration of the impact will be limited to the construction phase and during works on the river at the specified location, and for a limited distance downstream of the source of the impact. (2)	The residents highly dependent on local watercourses for domestic use and recreation, are highly sensitive to any reduction in water quality, as it could significantly affect their health. (3)	A change in surface water quality is likely to happen (3)	*M (3) + ST (2) + S (3) + L (3) = 11 (High)*
All locations where there are moderate sensitivity receptors (from km 194+000 to km 195+000, from km 204+000 to 205+000, from km 215+000 to km227+000)	It is expected, that there could be a high magnitude impact on surface water quality, with a 25-50% change in baseline values. (3)	The duration of the impact will be limited to the construction phase and during works on the river at the specified location, and for a limited distance downstream of the source of the impact. (2)	The residents highly dependent on agriculture and local watercourses for irrigation, are modertately sensitive to reduction in water quality, as it could affect environment, crops and their health. (2)	A change in surface water quality is likely to happen (3)	*M (3) + ST (2) + S (2) + L (3) = 10 (Moderate)*

Impact of construction of permanent structures on environmental receptors

Construction of permanent structures within or near watercourses involves in-stream activities such as excavation, cofferdam installation, flow diversion, and sediment disturbance. These activities can cause alteration of flow patterns and temporary morphological changes to the riverbed, suspended sediments leading to increased turbidity, smothering of spawning grounds, and stress to aquatic organisms, disruption of critical life processes such as feeding, spawning, and migration due to noise, vibration, and physical barriers. Short-term habitat degradation in localized areas adjacent to construction sites.

Magnitude

The magnitude of these impacts is expected to be high, especially when bridge piers or foundations are installed directly within the active channel of the Južna Morava River. However, when structures are placed outside of the riverbed, magnitude is considerably lower and can be categorized as moderate.

Spatiotemporal impact (Spatial extent and duration)

These impacts are short-term, occurring only during the construction period, but spatially localized to areas in and near the active construction zones. The impacts are most significant in areas immediately adjacent to the railway corridor, and where infrastructure like viaducts and bridges directly interact with watercourses, for example where bridge piers are being installed within the riverbed of the Južna Morava River.

Likelihood

Given that permanent structures are placed directly in or near the watercourse, and considering typical construction activities (e.g., in-stream works, flow alteration, sediment disturbance), the occurrence of negative impacts on aquatic ecosystems is certain without effective mitigation.

Table 9-20. Significance of impact of changes in hydro-morphological characteristics of surface waters due to the construction of permanent structures on environmental receptors during the construction phase

Locations	Magnitude	Spatiotemporal scale	Sensitivity	Likelihood	Overall significance
Južna Morava River (from km 222.000 to km 224.000)	The impact is negative and consider to be of high magnitude (3)	The impacts are short-term, and spatially localized to areas in and near the active construction zones. (2)	Surface water with high sensitivity to changes in water quality (2)	Changes in hydro-morphological characteristics of surface waters due to the construction of permanent structures is certain (4)	*M (3) + ST (2) + S (3) + L (4) = 12 (High)*
Crnica River (from km 155.000 to km 157.000)	The impact is negative and consider to be of moderate magnitude (2)	The impacts are short-term, and spatially localized to areas in and near the active construction zones. (2)	Surface water with moderate sensitivity to changes in water quality (2)	Changes in hydro-morphological characteristics of surface waters due to the construction of permanent structures is possible (2)	*M (2) + ST (2) + S (2) + L (2) = 8 (Moderate)*

Impact of river regulation works

River regulation works are often carried out during railway construction to ensure the safety, stability, and functionality of the railway infrastructure when it intersects or runs near watercourses. The main causes of changes in the hydro-morphological characteristics of surface waters due to the river regulation works during the construction phase may include:

- Earthwork and excavation of soil, rock, or materials near watercourses can directly alter channel morphology, riverbeds, and flow patterns, potentially reducing water depth, changing river course, or increasing sedimentation.
- Channel reshaping and modifying the physical form and dimensions of a river or stream channel to achieve specific goals such as flood control, bank stabilization, habitat improvement, or infrastructure protection.
- Channel Lining with stone in concrete, indicating artificial reinforcement to stabilize flow and prevent erosion.
- Clearing of vegetation along riverbanks or in catchment areas can reduce natural erosion control and increase sedimentation in the watercourse, affecting the stability of the riverbanks and flow patterns.

Impact of river regulation works on environmental receptors

Changes in the hydro-morphological characteristics of surface watercourses can significantly impact environmental receptors by altering the natural flow regime, sediment load, and water quality. Activities such as excavation, rechannelling, stone/concrete lining and trenching can modify watercourses, change water velocity, and increase sedimentation, which can disrupt aquatic habitats and affect spawning sites. These changes may lead to habitat loss for fish and other aquatic species, reduce biodiversity, and hinder the natural processes of sediment and nutrient cycling.

Magnitude

The magnitude of impact from changes in hydro-morphological characteristics of surface waters during railway construction is expected to be moderate. Construction activities can lead to major alterations to the hydro-morphological characteristics of surface waters by modifying riverbeds, flow patterns, and sedimentation rates. Earthworks and excavations can reshape channels and increase sediment loads. Vegetation clearance reduces natural soil erosion control, which can lead to unstable riverbanks, and increased surface runoff from compacted soil can change flow velocity and water levels. Significant changes to the flow regime are not anticipated (with localised and changes limited to the area around construction sites and immediate vicinity of bridges). There may be some temporary increases in sediment load and turbidity that would affect local aquatic ecosystems for a short time, but these are not expected to result in long-term harm.

Spatiotemporal impact (Spatial extent and duration)

Rechannelling, stone/concrete lining, retaining walls and foundations will result in changes to watercourses that manifest over a longer period of time (more than 20 years). The impacts are most significant in areas immediately adjacent to the railway corridor and this expected to be very localized.

Likelihood

Excavations generally alter the natural flow of water, with a high likelihood of affecting water movement, sediment transport, and watercourse morphology. When soil is disturbed or vegetation removed, the exposed soil becomes more prone to erosion and runoff, carrying sediment into watercourses. Moreover, the rechannelling, stone/concrete lining, retaining walls and foundations often disrupts watercourses, causing the loss of aquatic habitats. These modifications are likely to change the natural course and shape of the watercourse, either by channelization or through scouring (Pereira et al., 2015; Nyumba et al., 2021.). It is expected that changes in the hydro-morphological characteristics of surface waters due to the river regulation works are certain to happen.

Table 9-21. Significance of impact of river regulation works on environmental receptors during the construction phase

Locations	Magnitude	Spatiotemporal scale	Sensitivity	Likelihood	Overall significance
Južna Morava river (from km 222.000 to at km 224.000)	The impact is negative and consider to be of moderate magnitude (2)	The impact is localized but with long-term changes to watercourses. (3)	Surface water with high sensitivity to changes in water quality (3)	Changes in hydro-morphological characteristics of surface waters due to the river regulation works is certain (4)	*M (2) + ST (3) + S (3) + L (4) = 12 (High)*
Crnica river (from km 155.000 to at km 157.000)	The impact is negative and consider to be of moderate magnitude (2)	The impact is localized but with long-term changes to watercourses. (3)	Surface water with moderate sensitivity to changes in water quality (2)	Changes in hydro-morphological characteristics of surface waters due to the river regulation works is certain (4)	*M (2) + ST (3) + S (2) + L (4) = 11 (High)*

Impact of river regulation works on human receptors

This impact occurs when river regulation works (e.g., rechannelling, bank reinforcement) modify the natural behaviour of a watercourse in ways that influence flood risk, water availability, water quality, or landscape value, thereby affecting human settlements, agricultural land, transport systems, and recreational use. Within the project AoI, river regulation works are planned on Crnica River and several small streams. Thus, river regulation works (see Table 9-1) are not considered to present a significant threat to human receptors in terms of increased flood risk, water availability for irrigation purposes, or landscape value, and will not be considered for further assessment.

9.3.3. Operation phase impacts

During the operational phase of the Project, surface water quality may be negatively impacted as a result of the following:

- Accidental spills/leaks of hazardous materials (e.g. fuels, oils, lubricants, chemicals) due to mechanical failures in train components, accidents, or railway maintenance equipment; or during maintenance operations (e.g. during refuelling)
- The discharge of untreated wastewater (e.g. from drainage systems) into surface water courses.
- Contaminated surface run-off from the railway, disturbed soils, maintenance and service areas.
- An increase in sediment erosion and deposition, that can locally increase water turbidity.
- The application of herbicides to manage vegetation growing along the railway and around stations.
- The impact of permanent structures such as bridges

The overall significance of impacts on receptors resulting from a reduction in surface water quality during the operational stage of the Project are summarised below.

Impact of untreated wastewater discharge and maintenance-related run-off on environmental receptors

The impact of a reduction in water quality due to the untreated wastewater discharge from stormwater runoff and runoff from maintenance areas on environmental receptors during the operational phase of a railway refers to the negative effects on aquatic ecosystems and related species caused by decreased water quality due to pollutants, such as chemicals, sediments, or nutrients, entering water bodies. These pollutants can harm or disrupt the health, behaviour, reproduction, and survival of aquatic species, as well as the species that rely on these water sources for food, habitat, or drinking water. The operational phase typically involves longer-term risks from ongoing railway activities such as runoff from tracks, maintenance facilities, or transportation of goods and passengers.

Magnitude

The magnitude of the impact of a reduction in water quality due to the untreated wastewater discharge during the operational phase, resulting from maintenance activities, can range from moderate to severe, depending on the pollutants involved, the frequency and duration of their release, and the sensitivity of the affected ecological receptors. While occasional, limited pollution events may have only a moderate impact, but prolonged or significant pollution can cause long-term ecological harm, including species mortality, habitat loss, and a reduction in biodiversity, which may take considerable time to recover from.

Spatiotemporal impact (Spatial Extent and Duration)

The temporal scale of the impact on ecological receptors is assessed as medium-term (i.e. between 5 and 20 years). Water quality may deteriorate for several months to a few years, depending on the type and concentration of the pollutants. However, without proper mitigation measures, these impacts are expected to persist for an extended period, more than 5 years, with potential longer effects. The changes in water quality would affect aquatic organisms (e.g. fish and macroinvertebrates) for a limited distance, as natural auto purification processes will restore water quality within up to 10km from the outlet (point source pollution) (2).

Likelihood

Based on impacts documented in relation to similar projects by Lacey and Cole (2003), it is expected that there will be a high likelihood of a reduction in surface water quality due to the operation of the railway. The railway's infrastructure, such as tracks, embankments, and drainage systems, can increase surface runoff, carrying sediments, oils, and chemicals into nearby water bodies, degrading water quality. The constant operation of trains can introduce pollutants like fuel, lubricants, and de-icing salts, which can accumulate in the environment and eventually reach water sources.

The assessment of the significance of Impact of reduction in water quality on ecological receptors during the operation phase of the Project is summarised in Table 9-22 below.

Table 9-22. Significance of untreated wastewater discharge and maintenance-related run-off on environmental receptors during the operation phase

Locations	Magnitude	Spatiotemporal scale	Sensitivity	Likelihood	Overall significance
Južna Morava river (Tešica stop at km 216+885)	The impact is negative and considered to be of severe magnitude (3)	The impact is medium term (between 5 and 20 years) localized (2)	Surface water with high sensitivity to changes in water quality (3)	Based on impacts documented in relation to similar projects by Lacey and Cole (2003), it is expected that there will be a high likelihood of a reduction in surface water quality due to the operation of the railway. (3)	*M (3) + ST (2) + S (3) + L (3) = 11 (High)*
Crnica river (Paraćin station at km 155+108)	The impact is negative and considered to be of severe magnitude (3)	The impact is medium term (between 5 and 20 years) and localized (2)	Surface water with moderate sensitivity to changes in water quality (2)	Based on impacts documented in relation to similar projects by Lacey and Cole (2003), it is expected that there will be a high likelihood of a reduction in surface water quality due to the operation of the railway. (3)	*M (3) + ST (2) + S (2) + L (3) = 10 (Moderate)*

Impact of untreated wastewater discharge and maintenance-related run-off on human receptors

A reduction in surface water quality due to the untreated wastewater discharge and maintenance-related run-off as a result of the operation of the Project may result in significant impacts on human receptors, particularly those who rely on surface water for potable supply, agriculture, recreation, and other uses. Rail traffic, maintenance activities, and wastewater discharges from drainage systems, may lead to a deterioration in surface water quality, including through the accidental release of pollutants (oils, fuels, chemicals), into nearby watercourses.

As none of the watercourses in the Project AoI are utilised to provide potable water supplies, this potential impact has not been considered further. Some of the key areas where reduced surface water quality can affect human receptors are:

- Impact on household water use: Populations that use surface water for sanitary and technical water consumption including bathing, washing and cleaning, garden irrigation and livestock comsuption.
- Recreational impact: Population that rely on surface water for recreational activities (such as swimming or fishing).
- Agricultural impacts: Farmers who rely on surface water for irrigation can face challenges if the water quality deteriorates. Pollutants such as excess nutrients, heavy metals, or pesticides can harm crops, reduce yields, and

contaminate food products. If surface water is used for livestock consumption, contaminated water can lead to health issues in animals, potentially causing diseases that could also be transmitted to humans through the food chain.

Magnitude

The operational activities of the railway line may lead to severe impacts on surface waters, with contamination potentially making the water unsuitable for irrigation or livestock consumption. Accidental leaks and spills of fuels, oils, lubricants, and other chemicals can contaminate surface waters, posing risks to plant health and livestock well-being. While the impacts may not be immediately catastrophic (for example as would be the case following a major accident), they could still affect crop yields and livestock and may result in localized environmental degradation. Over time, prolonged exposure could affect water quality, ecosystems, and agricultural productivity, with potential economic consequences.

Spatiotemporal impact (Spatial Extent and Duration)

The temporal scale of the impact on human receptors is assessed as medium-term (i.e. between 5 and 20 years). However, without proper mitigation measures, these impacts are expected to persist for an extended period, more than 5 years, with potential longer effects on human receptors. The changes in water quality would affect human users (e.g. for agricultural purposes and recreation) for a limited distance from the source of the impact (i.e. the Tešica stop at km 216+885 which will impact the Južna Morava River, and Paraćin station at km 155+108 that will impact the Crnica River), as natural auto purification processes will restore water quality within up to 10km from the point of discharge (2).

Likelihood

Based on impacts documented in relation to similar projects by Lacey and Cole (2003), it is expected that there will be a high likelihood of a reduction in surface water quality due to the operation of the railway. The railway's infrastructure, such as tracks, embankments, and drainage systems, oils, and chemicals into nearby water bodies, degrading water quality. The constant operation of trains is expected to introduce pollutants like fuel, lubricants, and de-icing salts, which can accumulate in the environment and eventually reach water sources. (3)

The assessment of the significance of Impact of reduction in water quality on human receptors during the operation phase of the Project is summarised in Table 9-23 below.

Table 9-23. Significance of untreated wastewater discharge and maintenance-related run-off on human receptors during the operation phase

Locations	Magnitude	Spatiotemporal scale	Sensitivity	Likelihood	Overall significance
Južna Morava river (Tešica stop at km 216+885)	The impact is negative and considered to be of severe magnitude, as it would result in contaminated water that is no longer suitable for irrigation or livestock consumption. (3)	The impact is medium term (between 5 and 20 years) and expected cover wider project area (2)	The residents highly dependent on local watercourses for domestic use and recreation, are highly sensitive to any reduction in water quality, as it could significantly affect their health. (3)	Based on impacts documented in relation to similar projects by Lacey and Cole (2003), it is expected that there will be a high likelihood of a reduction in surface water quality due to the operation of the railway. (3)	*M (3) + ST (2) + S (3) + L (3) = 11 (High)*
Crnica river (Paraćin station at km 155+108)	The impact is negative and considered to be of severe magnitude, as it would result in contaminated water that is no longer suitable for irrigation or livestock consumption. (3)	The impact is medium term (between 5 and 20 years) and expected cover wider project area (2)	The residents highly dependent on agriculture and local watercourses for irrigation, are modertately sensitive to reduction in water quality, as it could affect environment, crops and their health. (2)	Based on impacts documented in relation to similar projects by Lacey and Cole (2003), it is expected that there will be a high likelihood of a reduction in surface water quality due to the operation of the railway. (3)	*M (3) + ST (2) + S (2) + L (3) = 10 (Moderate)*

Impact of application of herbicides on environmental receptors

The use of herbicides for vegetation control along railway tracks and at operational facilities (e.g., stations, depots) presents a potential source of surface water contamination. These chemicals can be mobilized by rainfall or cleaning operations and transported via surface runoff into nearby streams, rivers, or drainage channels. Depending on the type and persistence of the herbicide, and the proximity to water bodies, these inputs may pose risks to aquatic life by altering water chemistry, reducing biodiversity, and affecting sensitive species.

Magnitude

Although herbicides can be toxic to aquatic organisms—particularly invertebrates, algae, and fish—the magnitude of impact on surface waters is assessed as moderate (2), primarily because the application is spatially limited and typically conducted in a controlled manner. However, rainfall events shortly after application can result in pulse contamination of nearby surface waters, especially in areas lacking buffer zones or vegetated strips between the railway and adjacent water bodies, increasing the risk of direct runoff. Surface waters are more immediately exposed than groundwater and can exhibit acute ecological responses even at low concentrations. Consequently, deviations from baseline water quality are expected to be moderate, particularly in sensitive receptors such as small watercourses or streams with limited dilution capacity, especially during or shortly after herbicide application periods.

Spatiotemporal impact (Spatial Extent and Duration)

The impact is spatially localized to drainage channels ditches, and nearby watercourses adjacent to treated railway zones; however, downstream transport during high-flow conditions can cause secondary contamination of larger water bodies. The temporal impact of herbicides in rivers ranges from medium-term, especially for persistent substances and under repeated applications. Impacts are often intermittent and seasonal, influenced by rainfall and flow conditions. This results in a spatiotemporal score of Grade 2, reflecting the localized yet recurrent nature of the impact during the operational phase.

Likelihood

The likelihood of contamination of surface waters due to herbicide use is considered possible (2); although application is regulated and limited, the risk of runoff increases during rainy seasons. Many rail corridors are located close to small streams, drainage canals, or wetlands, which increases the vulnerability of nearby surface waters to contamination.

The assessment of the significance of Impact of application of herbicides on environmental receptors during the operation phase of the Project is summarised in Table 9-24 below.

Table 9-24. Significance of impact of application of herbicides on environmental receptors during the operation phase

Locations	Magnitude	Spatiotemporal scale	Sensitivity	Likelihood	Overall significance
Južna Morava river (from km 192.000 to km 196.000, from km 222.000 to at km 224.000)	The impact is negative and considered to be of moderate magnitude (2)	The impact is medium-term term and expected to be localized (2)	Surface water with high sensitivity to changes in water quality (3)	The imact may possibly happen (2)	*M (2) + ST (2) + S (3) + L (2) = 9 (Moderate)*
Crnica river (from km 155.000 to at km 157.000)	The impact is negative and considered to be of moderate magnitude (2)	The impact is medium-term term and expected to be localized (2)	Surface water with moderate sensitivity to changes in water quality (2)	The imact may possibly happen (2)	*M (2) + ST (2) + S (2) + L (2) = 8 (Moderate)*

Impact of application of herbicides on human receptors

If surface waters contaminated with herbicides are used for irrigation, these chemicals can accumulate in crops, leading to dietary exposure in humans through consumption of contaminated food. Additionally, recreational activities such as swimming, fishing, or boating in polluted waters can result in direct skin contact or accidental ingestion, posing health risks over time—particularly with repeated exposure or in sensitive individuals, depending on the toxicity and concentration of the herbicides.

Magnitude

The application of herbicides along the railway corridor may lead to contamination of surface used for irrigation and recreational purposes, especially if appropriate protective measures are not in place. While the impact is localized and intermittent, the absence of proper controls could result in pollution that poses a moderate risk to human health, including potential exposure through contact with water, consumption of contaminated crops, or recreational water use. Thus, the impact is considered to be of moderate in magnitude (2).

Spatiotemporal impact (Spatial Extent and Duration)

Herbicide applications that affect surface waters during railway operation may lead to localized impacts on human receptors using affected water bodies for irrigation or recreation. These impacts are expected to be local in extent and medium-term in duration, which depends on herbicide persistence, rainfall, and water flow.

Likelihood

It is considered that it is possible that the impact will happen during herbicide application, which could lead to contamination of surface waters used by humans for irrigation or recreation, especially during rain events or in areas lacking proper controls.

The assessment of the significance of Impact of application of herbicides on environmental receptors during the operation phase of the Project is summarised in Table 9-25 below.

Table 9-25. Significance of impact of application of herbicides on human receptors during the operation phase

Locations	Magnitude	Spatiotemporal scale	Sensitivity	Likelihood	Overall significance
Južna Morava river (from km 192.000 to km 196.000, from km 222.000 to at km 224.000)	The impact is negative and considered to be of moderate magnitude (2)	The impact is medium-term term and expected to be localized (2)	Surface water with high sensitivity to changes in water quality (3)	The impact may possibly happen (2)	*M (2) + ST (2) + S (3) + L (2) = 9 (Moderate)*
Crnica river (from km 155.000 to at km 157.000)	The impact is negative and considered to be of moderate magnitude (2)	The impact is medium-term term and expected to be localized (2)	Surface water with moderate sensitivity to changes in water quality (2)	The imact may possibly happen (2)	*M (2) + ST (2) + S (2) + L (2) = 8 (Moderate)*

Impact of permanent structures on environmental receptors

Once constructed, permanent structures such as bridge piers and abutments can lead to long-term hydro-morphological changes, including altered flow regimes around structures, leading to scouring, sedimentation, and microhabitat modification. Habitat fragmentation potentially affects fish migration routes and biodiversity. Shading effects, which can reduce light availability and alter temperature profiles, impacting temperature- and light-sensitive aquatic species.

Magnitude

Impacts during the operational phase are typically moderate to high, depending on the location of structures and their interaction with flow and habitats. These are chronic impacts that may persist or evolve over time. The impact causes significant disruption to aquatic habitats and species, including the loss of spawning grounds, interruption of migration routes, and long-term degradation of biodiversity. These effects directly threaten the ecological integrity of the watercourse and can lead to lasting ecological imbalances. When piers are not placed in the riverbed, the overall environmental impact is considerably lower, especially in terms of flow alteration and aquatic habitat disruption and magnitude should be expected to be moderate.

Spatiotemporal impact (Spatial extent and duration)

Changes are localized (e.g., around bridge piers) but may persist for decades (20+ years), affecting specific microhabitats rather than the entire river ecosystem. The impacts are most significant in areas immediately adjacent to the railway corridor, and where infrastructure like viaducts and bridges directly interact with watercourses. Bridge pillars and approach structures along riverbanks cause permanent alterations to the local hydro-morphology of surface water bodies. However, these structural changes are highly localized, affecting only microhabitats around the pillars and approach structures themselves, without impacting the entire river habitat at the site. Despite this, they can still have detrimental effects on certain fish species and macroinvertebrates by modifying their microhabitats and partially disrupting migration corridors. When piers are not located in the riverbed, the spatial impact is very localized, and the temporal impact is limited to the construction period – short-term impact.

Likelihood

Given that permanent structures are placed directly in the Južna Morava River, or near watercourses, and considering typical construction activities (e.g., in-stream works, flow alteration, sediment disturbance), the occurrence of negative impacts on aquatic ecosystems is certain without effective mitigation.

Table 9-26. Significance of impact of changes in hydro-morphological characteristics of surface waters due to the construction of permanent structures on environmental receptors during the operational phase

Locations	Magnitude	Spatiotemporal scale	Sensitivity	Likelihood	Overall significance
Južna Morava river (from km 222.000 to at km 224.000)	The impact is negative and consider to be of high magnitude (3)	The impacts are permanent (more than 20 years) and localized (3)	Surface water with high sensitivity to changes in water quality (2)	Changes in hydro-morphological characteristics of surface waters due to the construction of permanent structures is certain (4)	*M (3) + ST (3) + S (3) + L (4) = 13 (High)*
Crnica river (from km 155.000 to at km 157.000)	The impact is negative and consider to be of moderate magnitude (2)	The impacts are localized and limited to the construction period – short-term impact (2)	Surface water with moderate sensitivity to changes in water quality (2)	Changes in hydro-morphological characteristics of surface waters due to the construction of permanent structures is possible (2)	*M (2) + ST (2) + S (2) + L (2) = 8 (Moderate)*

9.3.4. Summary of impacts

Table 9-27. Summary of Significance of Construction and Operations Phase Surface Waters Impacts

Project phase	Receptor	Impact	Positive/ Negative	Overall significance before mitigation measures are implemented
Construction phase	High sensitivity receptors	Direct discharge of pollutants	Negative	Moderate
	Moderate sensitivity receptors			Moderate
Construction phase	High sensitivity receptors	Site runoff and wastewater	Negative	Moderate
	Moderate sensitivity receptors			Moderate
Construction phase	High sensitivity receptors	Tunnel water discharge	Negative	High
	Moderate sensitivity receptors			Moderate
Construction phase	High sensitivity receptors	Increased sedimentation	Negative	High
	Moderate sensitivity receptors			Moderate
Construction phase	High sensitivity receptors	Construction of permanent structures	Negative	High
	Moderate sensitivity receptors			Moderate
Construction phase	High sensitivity receptors	River regulation works	Negative	High
	Moderate sensitivity receptors			High
Operation phase	High sensitivity receptors	Untreated wastewater discharge	Negative	High

Project phase	Receptor	Impact	Positive/ Negative	Overall significance before mitigation measures are implemented
	Moderate sensitivity receptors	and maintenance-related run-off		Moderate
Operation phase	High sensitivity receptors	Application of herbicidesn	Negative	High
	Moderate sensitivity receptors			Moderate
Operation phase	High sensitivity receptors	Construction of permanent structures	Negative	High
	Moderate sensitivity receptors			Moderate

9.4. Mitigation measures

9.4.1. Construction phase

The mitigation strategy during the construction phase should be designed to protect sensitive receptors, including by avoiding or minimising any surface water contamination, and disturbance to or changes in the hydraulic regime of surface watercourses. Surface water quality and flow rates should be monitored throughout the construction phase to ensure that additional mitigation measures can be implemented if necessary to prevent or limit any identified impacts.

The Contractor should develop and implement the following:

- **Construction Water and Soil Management Plan** which will include details of how construction sites must be managed to minimize any increase in sediments loads in water courses from surface run-off, and to prevent surface water contamination.
- **River Works Management Plan** which will include the control measures that must be implemented during construction works in or near surface water courses to avoid or minimise disturbance and/or erosion, or any change in the hydraulic regime, as well as other requirements that will be set in the Water Consent issued by the Ministry of Agriculture, Forestry and Water Management-Water Directorate.
- **Waste Management Plan**, which will detail the mitigation measures that must be taken to ensure the containment of waste to prevent pollution of watercourses.

Mitigation measures that should be included in the Water and Soil Management Plan and River Works Management Plan are presented below.

Table 9-28. Proposed surface water mitigation measures for direct discharge of pollutants during construction

Impact	Mitigation measures
Direct discharge of pollutants	▪ All vehicles and construction equipment will be well-maintained to prevent oil or fuel leakages. ▪ Fuelling and maintenance of vehicles/equipment must be done on hard standing in designated areas with appropriate drainage, at least 100m from watercourses. ▪ Washing and cleaning of vehicles must be performed in designated areas. ▪ Concrete mixing and washing areas must be located more than 30m from any watercourse, and wastewater will be disposed off-site. ▪ All temporary fuel tanks and fuel storage areas must be located at least 100m from surface water bodies and be double skinned. ▪ All fuel/oil/chemical containers must be stored in a secured, covered area within secondary containment (110% of the container capacity). ▪ Fuel-powered stationary equipment must have drip trays beneath to contain leaks. ▪ The discharge of untreated wastewater effluent into surface water bodies is prohibited. ▪ Treated wastewater discharges must comply with effluent quality standards and any licensing requirements. ▪ The discharge of cement-contaminated water directly into surface waters is strictly prohibited. ▪ Concrete truck washout is prohibited unless specific concrete washout areas are provided on-site. These areas should be impermeable and emptied when 75% full. ▪ Spill kits must be available at all construction sites to manage accidental spills/leaks of fuel/oil/chemicals. ▪ Septic tanks must be made of impermeable material and emptied regularly by a licensed company (see Book 3/1 Railway drainage design) ▪ Hazardous construction materials will be stored in special enclosed facilities with external cut-off drainage. No materials will be stored within 100m of a watercourse.

Table 9-29. Proposed surface water mitigation measures for site runoff and wastewater during construction

Impact	Mitigation measures
Site runoff and wastewater	▪ Drainage systems must be installed that direct runoff away from watercourses, including the retention basins, or permeable surfaces to treat and capture runoff. ▪ Ensure proper maintenance of stormwater management systems to prevent clogging and ensure effective sedimentation control. ▪ Stormwater drains and oil-water separators must be regularly serviced and maintained to ensure they remain effective and do not become blocked (see Book 3/1 Railway drainage design). ▪ Collection ponds to be constructed to regulate the flow of runoff into surface water bodies and to enable settlement of soil particles to minimize turbidity impacts.

Table 9-30. Proposed surface water mitigation measures for Tunnel water discharge during construction

Impact	Mitigation measures
Tunnel water discharge	- Water Treatment Before Discharge - Implement appropriate treatment systems such as sedimentation basins, filtration units, and chemical treatment to remove suspended solids, heavy metals, and other pollutants before discharging tunnel water into surface waters. - Sedimentation basins - must be properly sized based on expected flow rates and sediment loads, regularly maintained to remove accumulated sediments, and designed to handle variable flow conditions, including stormwater surges.

Table 9-31. Proposed surface water mitigation measures for increased sedimentation during construction

Impact	Mitigation measures
Increased sedimentation	- Foundation works for bridges and any other works adjacent to or within surface water bodies shall be conducted in periods of no or low flows as far as possible. - Use erosion control blankets or mats on exposed soils to stabilize them and prevent erosion. - Soil stockpiles should be located a minimum of 30m from any watercourse and outside flood-risk areas and should be contained with bunds or sediment fences to prevent erosion.

Table 9-32. Proposed mitigation measures for construction of permanent structures during construction phase

Impact	Mitigation measures
Construction of permanent structures	- Construct bridge pillars and support structures that create the least resistance to water runoff, hydraulically shaped and parallel to river flow. - In case of deep erosion in the riverbank zone, technical solutions must be implemented to stabilize river flow upstream, downstream of the bridge, and along the riverbed. - Watercourses must be kept clear of obstructions and debris to reduce blockage risks (important for bridge underpasses to avoid hydraulic failure). - Minimize direct access of vehicles to watercourses. Any necessary vehicle access must be inspected, and remedial measures taken to prevent oil/fuel contamination (especially relevant during bridge works over rivers)

Table 9-33. Proposed surface water mitigation measures for river regulation works during construction

Impact	Mitigation measures
River regulation works	▪ If the riverbed is disturbed, work must be avoided during fish spawning and hatching periods, to be agreed with nature protection authorities. ▪ Incorporate habitat-enhancing features into the concrete-lined channel, such as embedded natural substrate pockets, roughness elements (e.g., boulders or artificial riffles), and low-flow meanders, to mimic some ecological functions of a natural riverbed. ▪ Re-establish native riparian vegetation on affected banks to restore their natural morphology and prevent further erosion. ▪ Vegetation clearance on riverbank areas must be minimized. Where necessary, it will be done just before work commences, in agreement with relevant authorities. ▪ Limit the extraction of material from watercourses to the minimum necessary extent and prioritize the reuse of excavated material within the project area for ecological or structural purposes (e.g., bank stabilization, creation of habitat features). ▪ Minimize the creation of steep slopes and large exposed areas near rivers to prevent destabilization and erosion.

9.4.2. Operation phase

It Is the responsibility of SRI is to develop and implement an **Operational Water and Soil Management Plan.** This should define the measures that must be implemented to prevent surface water contamination, including protocols for the application of herbicides and maintenance activities (including maintenance of drainage structures, sediment traps, and railway infrastructure (tracks, bridges, culverts, stations etc. and embankments).

The SRI should also develop and implement an Operational **Emergency Preparedness and Response Plan**, which details the emergency response principles and protocols to be implemented in the event of an emergency (including a rail accident or major hazardous materials spill) to limit surface water contamination.

Table 9-34. Measures proposed to mitigate potential surface water impacts of untreated wastewater discharge and maintenance-related run-off during operation phase

Impact	Mitigation measures
Untreated wastewater discharge and maintenance-related run-off	▪ Store hazardous and potentially contaminating materials required for railway maintenance activities in accordance with the Operation Phase Water and Soil Management Plan (including within adequate secondary containment where appropriate, and the provision of spill kits). ▪ Conduct regular training for railway/maintenance staff on hazardous materials handling, transport and storage protocols. ▪ Potentially contaminated surface run-off from the station hard standing areas (e.g. car parks) will be treated using oil and silt traps prior to discharge to any receiving surface water course;

	- The integrity of the surface water drainage systems (as described in Section 2.3.9 of Chapter 2 of this ESIA) must be maintained, including the removal of accumulated sediments and cleaning of oil/water separators, to avoid blockages, overflow and direct discharge of contaminated runoff into surface water courses. - In the case of significant accidental spills/leaks of hazardous substances into watercourses, downstream stakeholders must be immediately notified of the associated risks to health. - Maintenance work on bridges will be undertaken in periods of low flows where possible; - Sanitary wastewater from the station facilities will not be discharged to surface water recipients without prior treatment. - The integrity of septic tanks at stations will be maintained and regularly checked, and tanks will be regularly emptied by local, licensed waste removal companies and the sludge disposed in accordance with national requirements; -

Table 9-35. Measures proposed to mitigate potential surface water impacts of application of herbicides during operation phase

Impact	Mitigation measures
Application of herbicides	- Establish buffer zones and no-spray areas around water bodies to prevent direct contamination. - Use environmentally safe herbicides with low aquatic toxicity and low mobility in soil. - Apply herbicides using targeted methods (e.g., spot treatment) and avoid spraying during adverse weather conditions. - Schedule applications during dry periods and avoid treatment prior to heavy rainfall. - Use herbicides that are known to be the least toxic and have the lowest persistence in the environment. - Use targeted application of herbicides rather than broad applications to minimize the quantities of herbicide used and reduce the risk of surface water contamination. - Buffer zones or strips will be established along surface water courses where herbicides must not be used, to reduce the risk of surface water contamination;

Table 9-36. Measures proposed to mitigate potential surface water impacts of construction of permanent structures during operation phase

Impact	Mitigation measures
Construction of permanent structures	- Conduct regular inspections and maintenance of bridge structures and scour protection. - Monitor structural integrity to prevent material release into water bodies. - Implement surface water quality monitoring near bridge sites. - Ensure ongoing compliance with permits and environmental regulations, with regular review of procedures.

9.5. Monitoring

Regular monitoring of surface waters should be carried out throughout the construction and operational phases of the project to ensure alignment with the Environmental and Social (E&S) Management Plans, Lenders' Policies, and commitments outlined in the Environmental and Social Impact Assessment (ESIA). Additionally, any variations from baseline surface water conditions should be regularly assessed to confirm that the mitigation measures implemented by the construction contractor and railway operator are effectively preventing or minimizing significant adverse impacts. In cases where monitoring reveals that negative impacts are occurring, despite adherence to the management plans, further corrective actions and updates to the plans may be necessary to address emerging concerns.

The monitoring activities outlined in Table 9-37 below, related to Surface waters Quality, are proposed for both the construction and operational phases.

Table 9-37. Proposed Surface Water Quality Monitoring during the Construction and Operations Phases

Monitoring Requirement	Frequency	Location	Method
Construction Phase			
Concentrations of heavy metals in surface water (Cd, Cr, Cu, Ni, Pb, Zn, Ba, Co, Mo, Sb, Hg, and As)	Quarterly and in response to incidents (e.g., spills, major rainfall involving materials containing heavy metals).	Water bodies near construction sites, material storage areas, and locations within 500 m of the railway corridor.	Water sampling and analysis by an accredited laboratory authorized by the competent Ministry.
Suspended solids and turbidity in surface water	Quarterly (Monthly only in high-risk areas) and after heavy rainfall exceeding 20 mm/hour or 50 mm/day	Water bodies near embankments, watercourse crossings, and cut-and-fill sections.	Turbidity meter and suspended solids measurements using filtration and gravimetric techniques.
pH, dissolved oxygen, and temperature of surface water	Quarterly and after detection of fish kill, odour, or visible stress to aquatic life.	Water bodies near construction sites, embankments, and drainage channels.	Portable meters for pH, dissolved oxygen, and temperature; laboratory analysis for additional parameters.
Erosion and sediment deposition in water bodies	Quarterly (Monthly only in high-risk areas) and after major storm events (e.g. >50 mm rainfall in 24h).	Water bodies near embankments, cut-and-fill areas, and drainage channels.	Visual inspection, sediment collection, and topographic surveys.
Petroleum hydrocarbons in surface water	Quarterly and as needed after spills or leaks greater than 20 litres.	Water bodies near fuel storage, maintenance depots, and construction zones.	Water sampling and analysis using GC-MS or similar methods to detect petroleum hydrocarbons.
Flooding and watercourse alteration impacts	As needed after significant riverbank modification or redirection of flow during bridge/tunnel works	Areas near watercourse crossings, floodplains, and embankments.	Hydrological surveys, flow rate measurements, and visual inspections.

Monitoring Requirement	Frequency	Location	Method
Impact of suspended sediments on aquatic life	Quarterly (Monthly only in high-risk areas) and after significant construction activities or storm events.	Water bodies near construction sites and sensitive aquatic ecosystems.	Biological surveys (e.g., fish and invertebrates) and sediment analysis.
Groundwater Level	Pre-construction - Monthly for at least 6 months before works begin to establish baseline conditions; During construction: - Bi-weekly; Post-construction - Monthly for at least 12 months after completion	Monitoring wells installed at strategic points along the tunnel alignment and in surrounding sensitive areas	Use of automated piezometers/data loggers with manual verification; data should be recorded, analysed for trends, and compared to baseline levels.
Turbidity and Contaminant Monitoring of Groundwaters	Pre-construction: Monthly for 3–6 months; During construction: Bi-weekly or after significant rainfall events; Post-construction: Monthly for 6–12 months	Same monitoring wells as groundwater level monitoring	Field turbidity meters, water sampling for lab analysis of suspended solids, heavy metals, hydrocarbons (e.g., EPA or ISO standards)
Drainage and Waterproofing System Verification	During construction: Monthly inspections and after significant tunnelling milestones (e.g., segment completion); Post-construction: Quarterly inspections for at least 2 years, and during/after heavy rainfall events	Inside tunnel (drainage systems), at water-proofing interfaces, and at outlet/discharge points	Visual inspection, hydrostatic testing, dye tracer tests, and flow measurements at drainage outfalls; documentation of any anomalies and corrective actions.
Operations Phase			
Concentrations of heavy metals in surface water (Cd, Cr, Cu, Ni, Pb, Zn, Ba, Co, Mo, Sb, Hg, and As)	Annually and in response to contamination concerns involving materials containing heavy metals).	Water bodies near maintenance yards, fuel storage, and areas where spills or contamination risks exist along the railway corridor.	Water sampling and analysis by an accredited laboratory authorized by the competent Ministry.
Suspended solids and turbidity in surface water	Annually and after extreme weather events exceeding 20 mm/hour or 50 mm/ or operational disturbances.	Water bodies near railway embankments, drainage channels, and areas prone to slope instability.	Turbidity meter and suspended solids measurements using filtration and gravimetric techniques.
pH, dissolved oxygen, and temperature of surface water	Annually and after significant operational disturbances or detection of fish kill, odour, or visible stress to aquatic life	Water bodies near railway depots, maintenance yards, embankments, and drainage channels.	Portable meters for pH, dissolved oxygen, and temperature; laboratory analysis for additional parameters.
Erosion and sediment deposition in water bodies	Annually and after major storm events (e.g. >50 mm rainfall in 24h) or operational disturbances.	Water bodies near embankments, drainage channels, and unstable slopes along the railway corridor.	Visual inspections, sediment collection, and topographic surveys.

Monitoring Requirement	Frequency	Location	Method
Petroleum hydrocarbons in surface water	Annually and in response to spills greater than 20 litres or operational accidents.	Water bodies near fuel storage, maintenance depots, and refuelling stations.	Water sampling and analysis using GC-MS or similar techniques to detect petroleum hydrocarbons.
Flooding and watercourse alteration impacts	As needed after major weather events, operational activities, or infrastructure changes.	Watercourses near embankments, drainage channels, and floodplains impacted by the railway.	Hydrological surveys, flow rate measurements, and visual inspections of watercourses.
Impact of suspended sediments on aquatic life	Annually and after extreme weather events or operational disturbances.	Water bodies near railway operations and sensitive aquatic ecosystems (e.g., wetlands).	Biological surveys (e.g., fish and invertebrates), sediment analysis, and impact assessment on local aquatic life.

9.6. Residual impact assessment

Table 9-38. Significance of impacts on surface waters after mitigation presents an assessment of the residual significance of impacts on surface waters, during both the construction and operational phases of the Project, after the implementation of mitigation measures.

Table 9-38. Significance of impacts on surface waters after mitigation

Phase	Impact	Negative or Positive	Receptor sensitivity	Overall significance before mitigation	Summary of mitigation	Assessment of impact after mitigation	Overall significance after mitigation
Construction	Direct discharge of pollutants	Negative	High	Moderate	Vehicle maintenance, Designated fuelling, Controlled washing, Concrete area, Fuel storage, Container containment, Drip trays, Effluent ban, Treated discharge, Cement water ban, Washout control, Spill kits, Sewage management, Septic maintenance, Hazardous storage	Magnitude is substantially decreased by mitigation measures (1); the impact is short term (less than 5 years) and expected to be very localized (2); high sensitivity receptors are present (3); the change in water quality is considered to happen with very low likelihood after the mitigation measures (1)	*M (1) + ST (2) + S (3) + L (1) = 7 (Low)*
Construction	Direct discharge of pollutants	Negative	Moderate	Moderate	Designated fuelling, Fuel storage, Container containment, Drip trays, Effluent ban, Treated discharge, Cement water ban, Washout control, Spill kits, Septic maintenance, Hazardous storage	Magnitude is substantially decreased by mitigation measures (1); the impact is short term (less than 5 years) and expected to be very localized (2); moderate sensitivity receptors are present (2); the change in water quality is considered to happen with very low likelihood after the mitigation measures (1)	*M (1) + ST (2) + S (2) + L (1) = 6 (Low)*
Construction	Site runoff and wastewater	Negative	High	Moderate	*Drainage systems, Stormwater maintenance, Oil separators, Collection ponds* *Low-flow construction, Erosion control, Soil stockpiles*	Magnitude is substantially decreased by mitigation measures (1); the impact is short term (less than 5 years) and expected to be very localized (2); High sensitivity receptors are present (3); the change in water quality is considered to happen with very low likelihood after the mitigation measures (1)	*M (1) + ST (2) + S (3) + L (1) = 7 (Low)*
Construction	Site runoff and wastewater	Negative	Moderate	Moderate	*Drainage systems, Stormwater maintenance, Oil separators, Collection ponds* *Low-flow construction*	Magnitude is substantially decreased by mitigation measures (1); the impact is short term (less than 5 years) and expected to be very localized (2); moderate sensitivity receptors are present (2); the change in water quality is considered to happen with very low likelihood after the mitigation measures (1)	*M (1) + ST (2) + S (2) + L (1) = 6 (Low)*

Phase	Impact	Negative or Positive	Receptor sensitivity	Overall significance before mitigation	Summary of mitigation	Assessment of impact after mitigation	Overall significance after mitigation
Construction	Increased sedimentation	Negative	High	High	*Low-flow construction, Erosion control, Soil stockpile*	Magnitude is substantially decreased by mitigation measures (1); the impact is short term (less than 5 years) and expected to be very localized (2); high sensitivity receptors are present (3); the change in water quality is considered to happen with very low likelihood after the mitigation measures (1)	*M (1) + ST (2) + S (3) + L (1) = 7 (Low)*
			Moderate	Moderate	*Erosion control, Soil stockpile*	Magnitude is substantially decreased by mitigation measures (1); the impact is short term (less than 5 years) and expected to be very localized (2); moderate sensitivity receptors are present (2); the change in water quality is considered to happen with very low likelihood after the mitigation measures (1)	*M (1) + ST (2) + S (2) + L (1) = 6 (Low)*
Construction	Tunnel watre discharge	Negative	High	High	*Water Treatment Before Discharge, Sedimentation basins*	Magnitude is substantially decreased by mitigation measures (1); the impact is short term (less than 5 years) and expected to be very localized (2); high sensitivity receptors are present (3); the change in water quality is considered to happen with very low likelihood after the mitigation measures (1)	*M (1) + ST (2) + S (3) + L (1) = 7 (Moderate)*
			Moderate	Moderate		Magnitude is substantially decreased by mitigation measures (1); the impact is short term (less than 5 years) and expected to be very localized (2); moderate sensitivity receptors are present (2); the change in water quality is considered to happen with very low likelihood after the mitigation measures (1)	*M (1) + ST (2) + S (3) + L (1) = 6 (Moderate)*

Phase	Impact	Negative or Positive	Receptor sensitivity	Overall significance before mitigation	Summary of mitigation	Assessment of impact after mitigation	Overall significance after mitigation
Construction	Construction of permanent structures	Negative	High	High	*Hydraulic design, Riverbank stabilization, Debris removal, Vehicle restriction*	Magnitude is substantially decreased by mitigation measures (1); the impact is short-term (less than 5 years) and expected to be very localized (2); high sensitivity receptors are present (3); it is considered to happen with very low likelihood after the mitigation measures (1)	M (1) + ST (2) + S (3) + L (1) = 7 (Low)
			Moderate	High	*Hydraulic design, Riverbank stabilization*	Magnitude is substantially decreased by mitigation measures (1); the impact is short-term (less than 5 years) and expected to be very localized (2); moderate sensitivity receptors are present (2); it is considered to happen with very low likelihood after the mitigation measures (1)	M (1) + ST (2) + S (2) + L (1) = 6 (Low)
Construction	River regulation works	Negative	High	High	*Spawning protection, Material reuse, Vegetation restoration, Controlled clearance, Watercourse avoidance, No extraction, Slope minimization*	Magnitude is substantially decreased by mitigation measures (1); the impact is long-term (more than 20 years) and expected to be very localized (3); high sensitivity receptors are present (3); it is considered to happen with very low likelihood after the mitigation measures (1)	M (1) + ST (3) + S (3) + L (1) = 8 (Moderate)
			Moderate	High	*Spawning protection, Material reuse, Vegetation restoration, Controlled clearance*	Magnitude is substantially decreased by mitigation measures (1); the impact is long-term (more than 20 years) and expected to be very localized (3); moderate sensitivity receptors are present (2); it is considered to happen with very low likelihood after the mitigation measures (1)	M (1) + ST (3) + S (2) + L (1) = 7 (Low)
Operation	Untreated wastewater discharge and maintenance-related run-off	Negative	High	High	*Hazardous storage, Staff training, Runoff treatment, Drainage maintenance, Spill notification, Wastewater treatment,*	Magnitude is substantially decreased by mitigation measures (1); (between 5 and 20 years) and localized (2); high sensitivity receptors are present (3); it is considered to happen with very low likelihood after the mitigation measures (1)	*M (1) + ST (2) + S (3) + L (1) = 7 (Low)*

Phase	Impact	Negative or Positive	Receptor sensitivity	Overall significance before mitigation	Summary of mitigation	Assessment of impact after mitigation	Overall significance after mitigation
					Septic maintenance		
			Moderate	Moderate	*Hazardous storage, Runoff treatment, Drainage maintenance, Wastewater treatment, Septic maintenance*	Magnitude is substantially decreased by mitigation measures (1); (between 5 and 20 years) and localized (2); moderate sensitivity receptors are present (2); it is considered to happen with very low likelihood after the mitigation measures (1)	*M (1) + ST (2) + S (2) + L (1) = 6 (Low)*
Operation	Application of herbicides	Negative	High	High	*Establish buffer zones and no-spray areas, Use environmentally safe herbicides avoid spraying during adverse weather conditions, Schedule applications*	Magnitude is substantially decreased by mitigation measures (1); (between 5 and 20 years) and expected cover wider project area (2); high sensitivity receptors are present (3); it is considered to happen with very low likelihood after the mitigation measures (1)	*M (1) + ST (2) + S (3) + L (1) = 7 (Low)*
			Moderate	Moderate	*Establish buffer zones and no-spray areas, Use environmentally safe herbicides*	Magnitude is substantially decreased by mitigation measures (1); the impact is long-term (more than 20 years) and expected to be very localized (2); moderate sensitivity receptors are present (2); it is considered to happen with very low likelihood after the mitigation measures (1)	*M (1) + ST (2) + S (2) + L (1) = 6 (Low)*
Operation	Construction of permanent structures	Negative	High	High	*Regular maintenance, Structural monitoring, Water monitoring,* *Regulatory compliance*	Magnitude is substantially decreased by mitigation measures (1); the impact is long-term (more than 20 years) and expected to be very localized (3); high sensitivity receptors are present (3); it is considered to happen with very low likelihood after the mitigation measures (1)	M (1) + ST (3) + S (3) + L (1) = 8 (Moderate)
			Moderate	Moderate	*Regular maintenance, Water monitoring*	Magnitude is substantially decreased by mitigation measures (1); the impact is long-term (more than 20 years) and expected to be very localized (3); moderate sensitivity receptors are present (2); it is considered to happen with very low likelihood after the mitigation measures (1)	M (1) + ST (3) + S (2) + L (1) = 7 (Low)

9.7. Conclusion

The construction of the Project is expected to result in potentially significant, negative impacts on surface water quality (without mitigation). Accidental spill/leaks of hazardous substances, the direct discharge of untreated wastewater, or an increase in sediment loads due to the disturbance of sediments within watercourses or surface run-off containing high sediment concentrations (e.g. from exposed soil, vehicle wheel washing or construction access roads) can all result in a deterioration in water quality. Additionally, construction activities are predicted to result in negative impacts on the hydro-morphological characteristics of surface water courses, including direct alterations to riverbanks or beds (i.e. due to. excavations)

The operation of the Project is also expected to result in potentially negative impacts on surface water quality and hydro-morphological characteristics of surface water courses. Impacts could result from accidental spills of hazardous materials from trains or maintenance, increased sediment erosion and turbidity, use of herbicides to manage vegetation along the railway and stations, as well as the introduction of permanent structures (such as bridges) that will impede or alter the direction and velocity of flow.

Sensitive receptors that could be affected by impacts on surface water courses include local communities/residents who are reliant on surface water resources for recreation and agricultural purposes and protected aquatic species that are vulnerable to changes in environmental conditions.

Mitigation measures will be included in the Construction Water and Soil Management Plan to be developed and implemented by the construction contractor. These will include best practice measures such as: fuelling and maintenance of vehicles/equipment must be done on hard standing in designated areas with appropriate drainage, at least 100m from watercourses, drainage systems must be installed that direct runoff away from watercourses, including the retention basins, or permeable surfaces to treat and capture runoff, and that foundation works for bridges and any other works adjacent to or within surface water bodies shall be conducted in periods of no or low flows as far as possible.

During the operational phase, SRI will be responsible for developing and implementing an equivalent Operational Water and Soil Management Plan that will define the measures that must be implemented to manage impacts on surface water, including the protocols that must be followed for the application of herbicides and undertaking maintenance activities. An Operational Emergency Preparedness and Response Plan will also be developed including a Spill Response Plan that details the emergency response principles and protocols to be implemented in the event of a rail accident or major spill of a hazardous substance to avoid/limit surface water contamination.

Regular monitoring of surface water quality and the hydraulic regime of relevant watercourses will be required throughout the construction and operations phases of the Project to ensure that the mitigation measures being implemented by the construction contractor and SRI to prevent or limit potentially significant negative impacts are adequate and effective. Where monitoring indicates that negative impacts are occurring despite the requirements of Management Plans being met, additional mitigation measures may be required, and Management Plans revised accordingly to safeguard human and ecological receptors across the Project area.

9.8. References

1. Biswas, M. and Banerjee, P., 2018. Bridge construction and river channel morphology—a comprehensive study of flow behaviour and sediment size alteration of the River Chel, India. Arabian Journal of Geosciences, 11(16), p.467.
2. Čađo, S., Denić, Lj., Dopuđa-Glišić, T., Đurković, A., Novaković, B., Stojanović, Z., Žarić, D. (2021). Status of surface waters of Serbia during the period 2017–2019. Ministry of Environmental Protection, Environmental Protection Agency.
3. Cinelli, I., Anfuso, G., Privitera, S. and Pranzini, E., 2021. An overview on railway impacts on coastal environment and beach tourism in Sicily (Italy). Sustainability, 13(13), p.7068.
4. Ifabiyi, I.P., 2008. Self-purification of a freshwater stream in Ile-Ife: lessons for water management. Journal of Human Ecology, 24(2), pp.131-137.
5. Islam, M.T., Siddeqa, M., Mukherjee, A., Bithi, S.A., Mandal, S. and Islam, M., 2023. An assessment of the potential environmental effects of bridge construction in Boga, Patuakhali, Bangladesh. Heliyon, 9(6).
6. Jandová, V., Bucková, M., Hegrová, J., Dostál, I., Huzlík, J., Effenberger, K. and Ličbinský, R., 2020. The relationship among precipitation, application of salt in winter road maintenance and the quality of waterways and soil around motorway. Water, 12(8), p.2206.
7. Karunasena, G., Gajanayake, A., Wijeratne, W. M. P. U., Milne, N., Udawatta, N., Perera, S., … Aliviano, P. (2023). Liquid waste management in the construction sector: a systematic literature review. International Journal of Construction Management, 24(1), 86–96.
8. Lacey, R.F. and Cole, J.A., 2003. Estimating water pollution risks arising from road and railway accidents. Quarterly Journal of Engineering Geology and Hydrogeology, 36(2), pp.185-192.
9. Pranzini, E., 2018. Coastal erosion and shore protection: A brief historical analysis. Journal of Coastal Conservation, 22(5), pp.827-830.
10. Regulation on the Limit Values of Pollutants in Surface and Groundwaters, Sediment, and the Deadlines for Their Achievement, "Official Gazette of the Republic of Serbia," No. 50/2012, Appendix 2
11. Republic Hydrometeorological Institute of Serbia, Hydrological yearbook, surface waters 2017–2021, https://www.hidmet.gov.rs/
12. Walker, D.B., Baumgartner, D.J., Gerba, C.P. and Fitzsimmons, K., 2019. Surface water pollution. In Environmental and pollution science (pp. 261-292). Academic Press.
13. Republic Hydrometeorological Institute of Serbia, Hydrological yearbook, surface waters 2017–2021, https://www.hidmet.gov.rs/
14. Čađo, S., Denić, Lj., Dopuđa-Glišić, T., Đurković, A., Novaković, B., Stojanović, Z., Žarić, D. (2021). Status of surface waters of Serbia during the period 2017–2019. Ministry of Environmental Protection, Environmental Protection Agency
15. Regulation on the Limit Values of Pollutants in Surface and Groundwaters, Sediment, and the Deadlines for Their Achievement, "Official Gazette of the Republic of Serbia," No. 50/2012, Appendix 2
16. Nyumba, T.O., Sang, C.C., Olago, D.O., Marchant, R., Waruingi, L., Githiora, Y., Kago, F., Mwangi, M., Owira, G., Barasa, R. and Omangi, S., 2021. Assessing the ecological impacts of transportation infrastructure development: A reconnaissance study of the Standard Gauge Railway in Kenya. PLoS one, 16(1), p.e0246248.

17. Pereira, P., Gimeìnez-Morera, A., Novara, A., Keesstra, S., Jordán, A., Masto, R.E., Brevik, E., Azorin-Molina, C. and Cerdà, A., 2015. The impact of road and railway embankments on runoff and soil erosion in eastern Spain. Hydrology and Earth System Sciences Discussions, 12(12), pp.12947-12985.

18. Rivera-Gutiérrez, J. V. (2015). Evaluation of the kinetics of oxidation and removal of organic matter in the self-purification of a mountain river. Dyna, 82(191).

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#ЕУ ЗА ТЕБЕ

RAILWAY LINE BELGRADE–NIŠ, SECTION III, PARAĆIN–TRUPALE (NIŠ)
Environmental and Social Impact Assessment, 10. GROUNDWATERS

EU PPF
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LIST OF ABBREVIATIONS AND ACRONYMS

AoI	Area of influence
BAT	Best Available Techniques
CAP	Common Agricultural Policy
PAH	Polycyclic aromatic hydrocarbons
TOC	Total organic carbon
EU	European Union
ESIA	Environmental and Social Impact Assessment
EQS	Environmental Quality Standards
M	Magnitude
STS	Spatial and temporal size
ES	Environmental sensitivity
L	Likelihood
WFD	Water Framework Directive
POP	Persistent Organic Pollutants
ESP	Environmental and Social Policy
PRs	Performance Requirements
EBRD	European Bank for Reconstruction and Development
EIB	European Investment Bank
ESS	Environmental and Social Standards
HAAs	Haloacetic acids
NTU	Nephelometric unit of turbidity

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10. GROUNDWATERS

This chapter presents the results of the assessment of potentially significant impacts on groundwaters during both the construction and operational stages of the project. The activities that have the potential to affect groundwater resources are identified, and the possible consequences of these activities on both groundwater quality and quantity, and secondary receptors are assessed. To mitigate any adverse effects, several strategies and measures are proposed. The methodologies and data sources employed in this assessment are also outlined.

10.1. Legislative and Policy Framework

10.1.1. EU Requirements

The European Union (EU) has several key Directives and regulations that govern the protection and management of groundwater resources as follows:

- Water Framework Directive (WFD) – 2000/60/EC: The directive establishes the requirement for Member States to protect groundwater in order to achieve and maintain "Good Groundwater Status" by 2027. This includes both quantitative (e.g., depletion of groundwater resources) and chemical (e.g., pollution levels) aspects; EU Member States are required to establish monitoring programs to assess the quality and quantity of groundwater resources; the WFD requires the management of water resources in an integrated manner, taking into account the needs of surface and groundwater bodies together; defines threshold values for chemical pollutants, such as nitrates and pesticides, that must not be exceeded in groundwater; member States must establish specific measures to protect groundwater, including protection zones around sensitive areas, such as drinking water sources.
- Groundwater Directive – 2006/118/EC: The directive aims to prevent the contamination of groundwater by regulating the introduction of pollutants, including hazardous substances, into groundwater bodies; Sets out quality standards for a range of pollutants, including nitrates, pesticides, and hazardous chemicals. Member States are required to identify polluted areas and take measures to restore the status of groundwater bodies; Outlines the types of pollutants that must be controlled, including substances listed as priority hazardous substances (e.g., heavy metals, organic pollutants); Requires Member States to implement measures for the protection of groundwater, especially near vulnerable zones such as drinking water abstraction points.
- Nitrates Directive – 91/676/EEC: he directive requires Member States to designate "Nitrate Vulnerable Zones" (NVZs) where groundwater pollution from nitrates is a concern; Member States must implement action programs in NVZs to limit the amount of nitrates leaching into groundwater; Regular monitoring of groundwater in NVZs to assess nitrate levels and ensure compliance with the directive's limits; The directive sets a threshold of 50 mg/L of nitrates for groundwater, above which action must be taken to reduce pollution.
- Environmental Quality Standards (EQS) Directive – 2008/105/EC (Amended by Directive 2013/39/EU): The directive includes specific chemical substances that must not exceed concentration limits in groundwater (e.g., mercury, cadmium, lead, and other harmful substances); Requires Member States to take measures to reduce pollution from hazardous substances to prevent deterioration of groundwater quality.
- Floods Directive – 2007/60/EC: Requires Member States to assess flood risks, including the potential for groundwater flooding, and implement appropriate flood risk management plans; Monitoring groundwater levels is an important aspect of managing flood risk, especially in areas with a high risk of groundwater flooding.

10.1.2. EBRD Requirements

The Environmental and Social Policy (ESP) of the European Bank for Reconstruction and Development (EBRD) includes Performance Requirements (PRs) that are designed to ensure that projects funded by the bank comply with international best practices and environmental standards.

Below is an overview of relevant Performance Requirements (PRs), excluding PR 1, that address surface water management:

- PR 3: Resource Efficiency and Pollution Prevention and Control: Requires the application of pollution prevention and control techniques consistent with the mitigation hierarchy to minimise potential adverse impacts on human health and the environment (including groundwater resources) while remaining technically and financially feasible and cost effective.
- PR 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources: Projects are required to assess potential impacts on biodiversity (including groundwater dependent ecosystems), and manage those risks in accordance with the mitigation hierarchy and good international practice.

10.1.3. EIB Requirements

The Environmental and Social Standards (ESS) published by the European Investment Bank (EIB) focus on a wide range of environmental and social factors, including the protection of groundwater resources.

- ESS 3 – Resource Efficiency and Pollution Prevention: Requires the Project to assess and take measures to avoid, prevent, or offset significant adverse effects on the environment, including groundwater and to implement relevant monitoring.
- ESS 4 – Biodiversity and Ecosystems: Requires that biodiversity and natural habitats be protected and that projects avoid significant adverse impacts on critical habitats. Although it doesn't specifically name groundwater-dependent ecosystems, aquatic ecosystems (which can include those reliant on groundwater) are considered under this standard.

10.1.4. National Legislative Framework

Serbia has a comprehensive legal framework aimed at the protection of groundwater resources, aligning with EU standards and international environmental agreements. Below is an overview of the key Serbian legislation that regulates groundwater protection and management:

- Environmental Protection Law: The law establishes the precautionary principle, the polluter pays principle, and the integrated approach to water resource management, ensuring that groundwater is managed sustainably and protected from pollution and over-exploitation. The law sets out general standards for water quality, which include parameters that are relevant for the protection of groundwater (e.g., chemical pollution, toxic substances). Establishes a system for monitoring and evaluating the quality of groundwater and other water resources. The law establishes the need for protection zones around groundwater sources, such as wells and springs, to prevent contamination.
- Water Law: This law aligns with the EU Water Framework Directive (2000/60/EC), which aims to achieve good status for all water bodies, including groundwater. The law requires the preparation of water management plans and programs of measures to protect and restore water resources, including groundwater. It also sets the rules for the sustainable use of water resources. It includes specific provisions for the protection of groundwater against pollution, stating that any activities that may cause contamination must adhere to strict regulations. The law outlines groundwater quality standards for pollutants, including nitrates, pesticides, and hazardous substances. It regulates the use of groundwater, stipulating that extraction of groundwater for public or industrial use requires a water use permit.

- Regulation on Groundwater Protection Areas: This regulation defines specific protection areas for groundwater (i.e., zones around wells, springs, and other water sources) where particular activities are restricted or regulated to prevent contamination. These zones are determined based on the type of groundwater source (e.g., public water supply, industrial use). Three levels of protection zones are defined: Zone I - Immediate protection area (very strict protection, no potentially polluting activities allowed), Zone II - Surrounding area where activities that could potentially pollute the groundwater are strictly controlled, Zone III - Wider protection area where some activities may be allowed, but they must be monitored and assessed for their potential to affect groundwater quality. Activities that can harm groundwater, such as industrial discharges, wastewater disposal, and landfills, are prohibited or strictly regulated within these zones.
- Regulation on Limit Values for Pollutants in Water: This regulation sets out the maximum permissible concentrations of pollutants in water, including groundwater. It establishes specific standards for a wide range of pollutants, including heavy metals, nitrates, and organic chemicals. The regulation specifies allowable concentrations for these pollutants in groundwater, ensuring that groundwater used for drinking, irrigation, and other purposes meets established safety standards.
- The Law on Nature Protection: This law, which implements Serbia's obligations under the Convention on Biological Diversity and other international agreements, indirectly affects groundwater through the protection of ecosystems that depend on groundwater, such as wetlands, springs, and aquatic ecosystems. It requires the identification of protected areas where groundwater resources are vital to maintaining biodiversity and natural habitats. It integrates groundwater management with broader ecosystem protection, ensuring that groundwater extraction does not negatively impact natural habitats or biodiversity.
- The Law on Environmental Impact Assessment: This law requires an Environmental Impact Assessment (EIA) for projects that might affect water resources, including groundwater. If a project could result in significant groundwater contamination or depletion, an EIA is mandatory to assess the risks and propose mitigation measures. Projects that affect groundwater must assess the potential for contamination, over-exploitation, or changes to groundwater flow and quality.
- National Strategy for Integrated Water Management: This strategy, which aligns with EU directives, promotes integrated water management across Serbia, focusing on the sustainable use and protection of groundwater. It outlines long-term goals for groundwater conservation, such as reducing over-exploitation, improving water quality, and restoring polluted groundwater bodies.
- International Agreements and EU Legislation: Serbia is working towards aligning its water policies with the EU Water Framework Directive (2000/60/EC), which requires the protection of all water bodies, including groundwater, and aims to achieve good ecological and chemical status for groundwater. Serbia is also a party to several international agreements on shared water resources, such as those with neighbouring countries regarding river basins (e.g., the Danube River Protection Convention) that regulate the protection of groundwater and surface water resources.

10.2. Baseline conditions

10.2.1. Area of Influence

Potentially significant impacts of the Project on groundwater receptors have been assessed within a 2,000m wide corridor along the railway alignment (1,000m on either side). This Area of Influence (AoI) was defined based on the precautionary principle, as may be useful for linear infrastructure projects traversing heterogeneous hydrogeological settings. The selection of this AoI reflects the need to account for variable geological and hydrological conditions along the route, particularly in sections characterized by highly permeable alluvial deposits that are hydraulically connected to major surface water bodies, such as the Južna and Velika Morava rivers. These conditions increase the potential for rapid lateral contaminant transport. The Extended Area of Influence (EAoI) for groundwater impacts extends 3-5 kilometres from potential discharge or contamination points, depending on local hydrogeological conditions. This approach ensures a comprehensive assessment of both direct and indirect impacts on the quality of surface water and groundwater. The adopted AoI ensures the inclusion of groundwater-dependent receptors that may be indirectly affected by construction or accidental pollution events. Please see Figure 10-2, Figure 10-3 and Figure 10-10.

10.2.2. Baseline

Hydrogeological features

The hydrogeological features of the Project AoI depend on both the geological structure of the terrain, and the geomorphological characteristics of the terrain.

The surface layers of the terrain, along the Paraćin–Stalać sub-section of the Project, comprises Quaternary – Holocene sediments; mainly dusty-sandy-gravels, with a clayey component, which determine the rate at which water is able to filter through to the underlying Quaternary strata. The underlying complex of quaternary sediments (i.e. geological deposits that were formed during the Quaternary period) act as an unconfined aquifer that is in direct hydraulic connection with the water levels in the Velika Morava River and its right tributaries. As such, groundwater levels fluctuate considerably, depending on the level of the Velika Morava River and its tributaries.

The aquifer is recharged through the direct percolation of precipitation through the various overlying layers of soil. Additionally, the aquifer is hydraulically connected to the Velika Morava River and therefore when the water table in the aquifer is lower than in the River, water will flow into the aquifer.

The geological composition of the Đunis to Trupale sub-section of the Project comprises gravel-sand deposits of alluvial sediments along the Južna Morava River. These sediments include permeable sandy-gravel deposits and less permeable dusty-sandy-clay layers. Groundwater levels in these deposits varies according to the natural fluctuations of water levels that depend on rainfall, evaporation and transpiration rates etc.

Packages of alluvial and terrace deposits, in the hydrogeological sense, represent a distinctly two-layered complex: at the bottom there are well-permeable sandy-gravel deposits, and at the top there are medium to less permeable dusty-sandy-clay layers. The water permeability of layers directly depends on the participation of the clayey and dusty-sandy fraction.

Deluvial and proluvial deposits (i.e. a collection of unconsolidated sediments, like soil and rock debris, that accumulate at the base of slopes primarily due to gravity-driven processes) include dusty-clay and silty sandy-pebble material, in crossed and alternating succession. These deposits can be classified as having medium to poor permeability, and as such a shallow unconfined aquifer has formed.

Medium to poorly permeable sediments are represented by the Miocene complex of gravelly-sandy-clayey sediments in which the more gravelly parts are water-bearing environments, and the clays are semi-permeable or impermeable.

The "water-permeable" rocks include fissured-cracked clayey-marly sediments and a complex of clays, siltstones and sandstones. In the weathering crust of these Miocene complexes, which can be of considerable thickness, and along larger cracks, these rocks are poorly permeable.

Conditionally waterless parts of the terrain are represented by solid and smooth, compact rock masses below the surface zone of physical-chemical degradation and cracking. Proterozoic shale rock complexes (migmatites-gneisses) build terrains without significant water-bearing environments or are practically waterless. In tectonically damaged, cracked rocks, a fractured aquifer was formed (as shown on Figure 10-2), with a weak yield. It is in this area that the Đunis tunnel is planned to be constructed. From a hydrogeological perspective, there are two we can distinguishable types of rock mass at the proposed location of the 580m long Đunis tunnel: complex of solid rock masses – gneiss and migmatite, which exhibit pronounced fractured porosity; and a complex of unconsolidated and weakly consolidated rocks – diluvium and alluvium with prominent intergranular porosity. Both of these complexes are classified as hydrogeological aquifer conductors. For the purpose of defining the geological structure of the terrain along the tunnel route, two exploration boreholes were drilled: VT-1 at the tunnel's end and VT-2 in the middle of the tunnel. The depth of the boreholes was 29m and 45m respectively, and no groundwater was encountered in either borehole. Therefore, it is assumed that the tunnel will not have an impact on groundwater, nor will groundwater have an impact on the tunnel. During tunnel construction, intermittent occurrences of groundwater may be expected, whereby rainwater could infiltrate into deeper parts of the terrain, along vertical and subvertical fractures that are present throughout the tunnel route. However, it is recommended to carry out all works during the dry period of the year with continuous operation, avoiding leaving any segment of the excavation open for extended periods under the influence of atmospheric conditions.

Through research along the alluvium of the Južna Morava and other rivers in the region, it was established that the thickest deposits of gravelly aquifers do not always lie in the zone of the current bed rivers and often are considerably distant along the perimeter of the alluvial plain.

Within the fluvial deposits of the Južna Morava River, an aquifer of intergranular type of porosity with significant amounts of groundwater was formed. It is recharged by infiltration from atmospheric precipitation and surface runoff, and ingress from the river (which is in direct hydraulic connection with the aquifer). There is also groundwater flow into the river and there are abstractions from the aquifer via drilled wells/boreholes. The groundwater levels within this aquifer also depend on the hydrological regime of the Velika Morava River, although the influence of the Velika Morava on groundwater levels weakens with distance from the river, and then climatic factors prevail. As such, during periods of intense rainfall and snow melt (especially in spring, which is the main recharge period), groundwater levels rise.

Project AoI is predominantly composed of alluvial soils, which are highly valued for agriculture in the Velika and Južna Morava valleys, so agricultural land dominates the Project AoI. Approximately 99% of the agricultural land in this area is privately owned. The soils exhibit high moisture levels, sourced from atmospheric precipitation, surface flooding, and groundwater. Seasonal groundwater fluctuations, often linked to river levels, promote soil oxygenation, while floodwaters deposit suspended materials that enrich the soil with allochthonous content. Non-irrigated arable land and land occupied by agriculture are located within the chainages: from km 154+000 to155+000, 157+000 to 157+300, 158+400 to 159+500, 160+000 to 162+000, 163+000 to 66+000, 168+000 to 173+000, km 195+000 to 200+000, 200+500 to 201+000, 211+000 to 217+000, 218+000 to 220+000, and 221+000 to 229+000. For more information regarding soil types and land use, please refer to Chapter 7, Soil.

From the aspect of hydrogeological potential, the alluvial deposits of Južna and Velika Morava (Figure 10-1) are particularly significant, where the thickness of sediments is typically 10–15 m but can be up to 50 m in the area of the Aleksinac basin, in the Bobovište-Rutevac zone, while the thickness of the sandy-gravelly sediments is typically 4–8.5 m. The yield of one individual well that was used for researching the properties of this aquifer was found to be 5–25 L/s, while the values of the filtration coefficient are of the order of 10^{-1} cm/s. Clays and sandy clays make up the bottom of the sandy-gravelly complex[1].

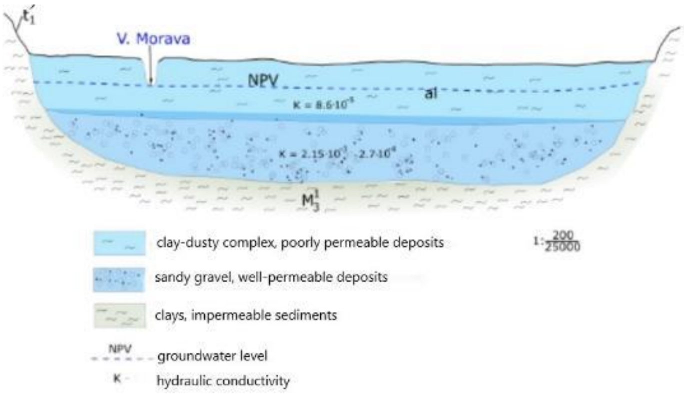


Figure 10-1. Schematized hydrogeological profile across the Velika Morava near Paraćin[2]

Based on the hydrogeological properties of the lithological environment, the following structural types of porosity can be found in this area: intergranular type, fractured type, and hydrogeological complex within the rocks of Neogene. These are illustrated on Figure 10-2.

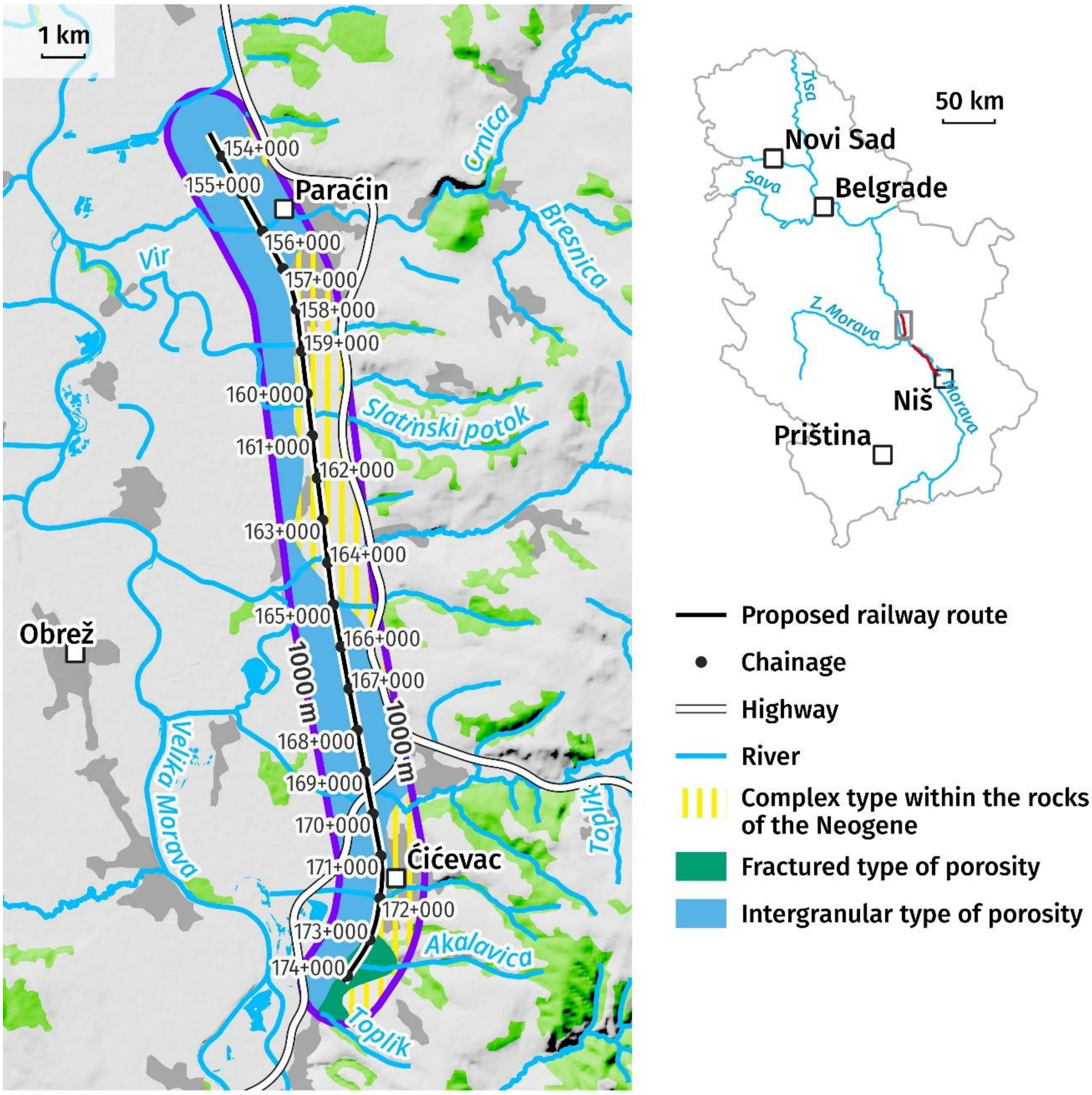
- **Intergranular type**: alluvium, facies, 'mrtavaja' facies, deluvium, proluvium; terraces, lake sediments, gravel, sand and clay;
- **Fractured type**: limestones, conglomerates, migmatites, gneisses;
- **Hydrogeological complex within the rocks of the Neogene**: conglomerates, sandstones, sands, marsh sediments, metaconglomerates and metasandstones, leptinolites and micaschists, marbles, clays.

The aquifer within the rocks of intergranular types of porosity is widely distributed within the Project AoI and was formed within the Quaternary age deposits - including alluvial, deluvial, aeolian and terrace deposits. In

[1] *Filipović, B., Krunić, O., & Lazić, M. (2005). Regional hydrogeology of Serbia. Belgrade: University of Belgrade, Faculty of Mining and Geology*

[2] *Stojadinović, D. (1992) Hydrogeological characteristics of alluvial deposits and rims of Velika Morava from the perspective of the possibility of using spring water (Doctoral dissertation). Belgrade: University of Belgrade, Faculty of Mining and Geology*

hydrogeological terms, the most significant are the alluvial deposits that occupy the vast plain on the sides of the Velika and Južna Morava rivers and their larger tributaries: Belica, Lugomir, Crnica, Jovanovačka river, Ribarska river, Radevačka river, Turija, Toponička river, etc., as well as terrace deposits of Velika Morava and Južna Morava rivers.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Obrež
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Crnica
Bresnica
Slatinski potok
Velika Morava
Akalavica
Toplik
1000 m
1000 m
50 km
Tisa
Novi Sad
Sava
Belgrade
Z. Morava
Niš
Morava
Priština
Proposed railway route
Chainage
Highway
River
Complex type within the rocks of the Neogene
Fractured type of porosity
Intergranular type of porosity

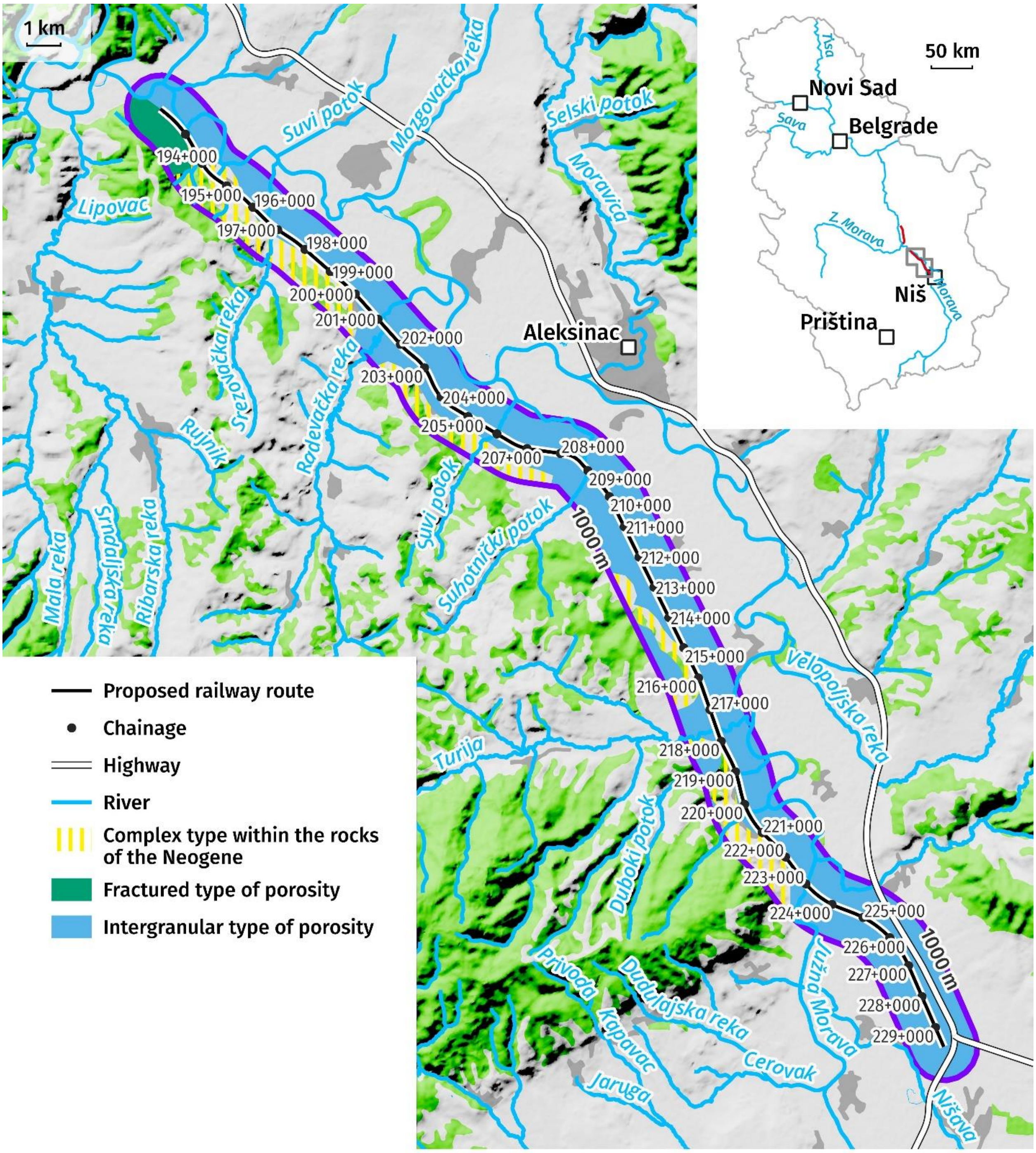
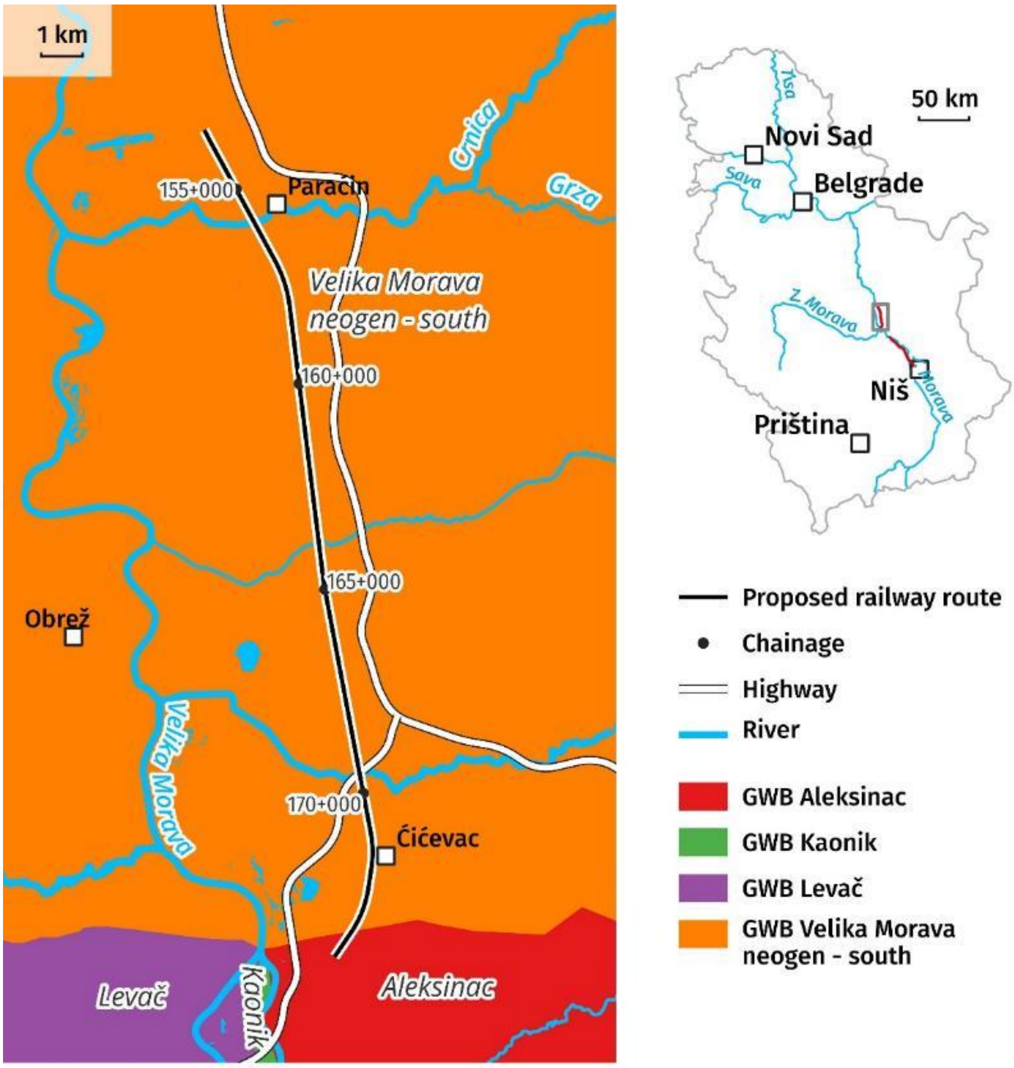


Figure 10-2. Hydrogeological map of area along the route of the railway of the section Paraćin–Niš

The largest part of the railway route passes through two groundwater bodies (i.e. large areas of groundwater that may incorporate multiple aquifers), namely the 'Velika Morava neogen-jug', and the 'Južna Morava neogen-sever'. These and all other relevant groundwater bodies are shown in Figure 10-3.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165+000
Obrež
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Ćićevac
Levač
Kaonik
Aleksinac
50 km
Tisa
Novi Sad
Sava
Belgrade
Z. Morava
Niš
Morava
Priština
Proposed railway route
Chainage
Highway
River
GWB Aleksinac
GWB Kaonik
GWB Levač
GWB Velika Morava
neogen - south

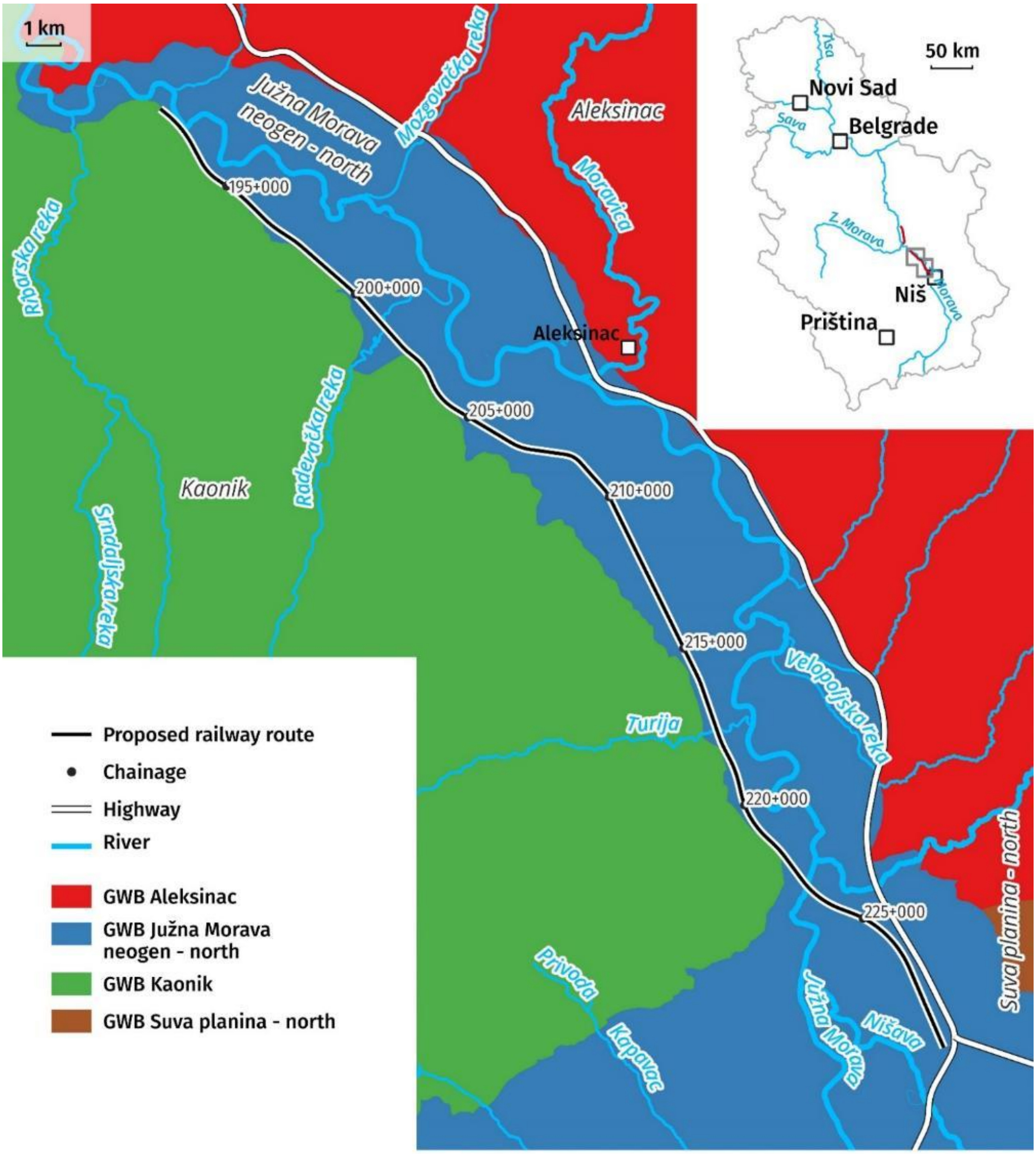


Figure 10-3. Groundwater bodies in the research area

In the territory of central Serbia, the largest groundwater reserves are located in areas of alluvial deposits, primarily in the Velika Morava valley. The filtration characteristics of the sandy-gravel layer in the alluvium deposits are favourable, and groundwater sources used for water supply are mainly formed in the area of lower Pomoravlje (a geographical area that includes the valleys of the Zapadna, Južna and Velika Morava Rivers).

Information on the use of groundwater sources by individuals or individual households is not available to inform this assessment. Although all available data on the use of groundwater was obtained from municipal representatives, this did not include specific information on the use of private wells, such as their number, locations, or the purpose of use. The settlements along the railway route are all connected to local public water supply systems, therefore, it is assumed that any private wells, if in use, serve non-potable purposes—such as irrigation, livestock watering, or other technical uses and are not used for the supply of drinking water.

Groundwater monitoring

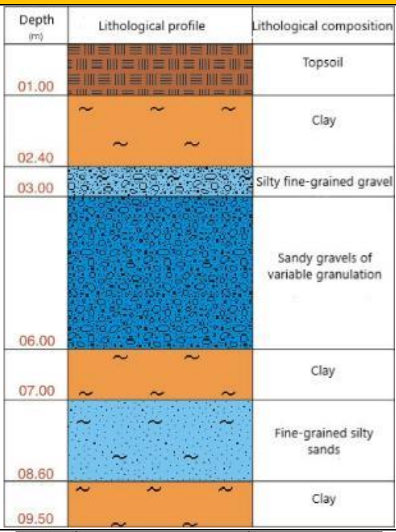
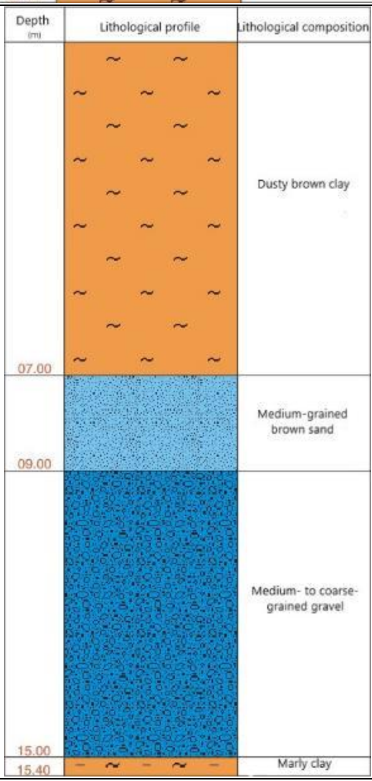
The Republic Hydrometeorological Institute – Department of Hydrology performs:

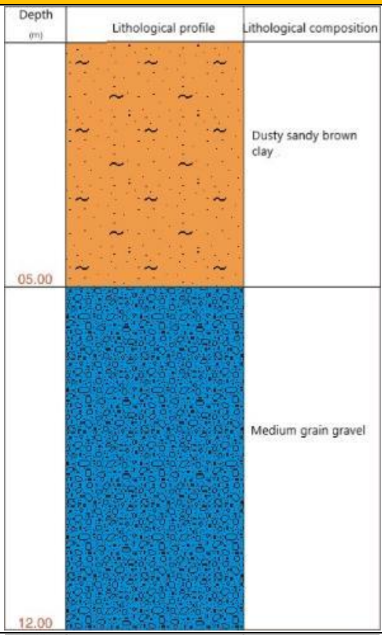
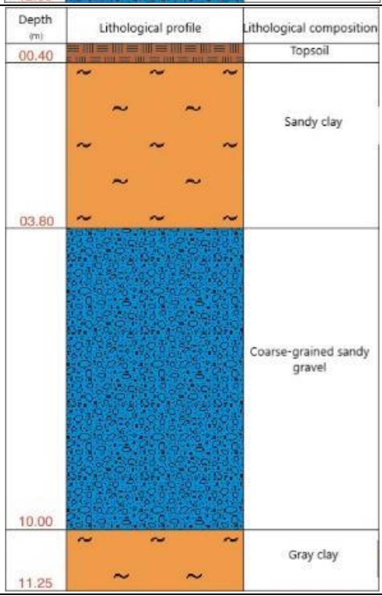
- the tasks of establishing and maintaining a network of hydrological stations for monitoring the condition of surface waters and groundwaters of the first phreatic aquifer,
- hydrometric measurements and observations of quantitative indicators of the state of surface and groundwaters, as well as taking, preparing and delivering samples for the purposes of monitoring the quality of surface and groundwaters of the first aquifer.

The hydrogeological characteristics of the alluvial aquifer were determined on the basis of observation wells, within the framework of the continuous monitoring system implemented by The Republic Hydrometeorological Institute of Serbia. This continuous groundwater monitoring system includes a number of monitoring stations within the two groundwater bodies through which the majority of the Project alignment passes (as shown in Figure 10-3), namely: Obrež-Ratare, Varvarin-Ćićevac, and Striža nova within the 'Velika Morava neogen-sever' groundwater body, and Žitkovac-RO Moravica within the 'Južna Morava neogen-sever' groundwater body.

Details of these monitoring stations is presented in Table 10-1 and their locations are shown in Figure 10-4.

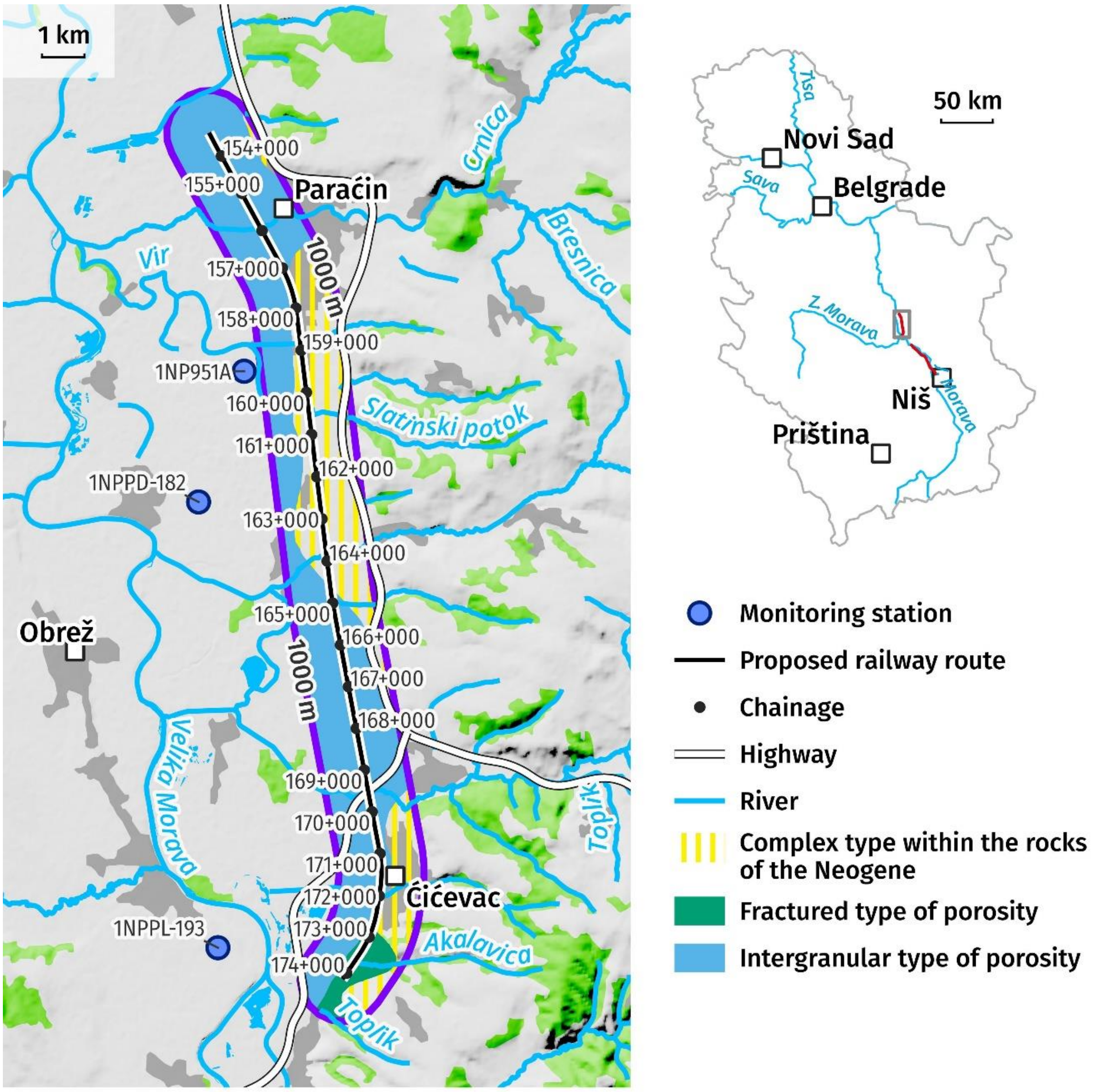
Table 10-1. Network of groundwater monitoring stations

Hydrological station code	Hydrogeological profiles	Name of the hydrological station	Station rank*	Number of monthly measurements	Geological structure	Coordinates X/Y	Water basin
1NP951A		Striža–nova	II	3	Alluvial Quaternary sediments	4853803 7532498	Velika Morava
1NPPL-193		Varvarin–Ćićevac	I	3	Alluvial Quaternary sediments of Velika Morava	4840232 7531881	Velika Morava

Hydrological station code	Hydrogeological profiles	Name of the hydrological station	Station rank*	Number of monthly measurements	Geological structure	Coordinates X/Y	Water basin
1NPPD-182		Obrež–Ratare	I	3	Alluvial Quaternary sediments	4850725 7531425	Velika Morava
3NP505		Žitkovac–RO Moravica	I	6	Alluvial Quaternary sediments of the Sava River	4820316 7557876	Južna Morava

* I - hydrological stations of the first order of piezometers are placed perpendicular to the river flow, i.e. along the line of groundwater flow

II - hydrological stations of the second order represent the addition of the stations of the basic network (I)


1 km
154+000
155+000
Paraćin
157+000
158+000
159+000
1000 m
1NP951A
160+000
161+000
162+000
1NPPD-182
163+000
164+000
165+000
166+000
167+000
168+000
Obrež
1000 m
169+000
170+000
171+000
172+000
Ćićevac
173+000
174+000
1NPPL-193
Crnica
Bresnica
Vir
Slatinski potok
Velika Morava
Toplik
Akalavica
Topik
50 km
Tisa
Novi Sad
Sava
Belgrade
Z. Morava
Niš
Morava
Priština
Monitoring station
Proposed railway route
Chainage
Highway
River
Complex type within the rocks of the Neogene
Fractured type of porosity
Intergranular type of porosity

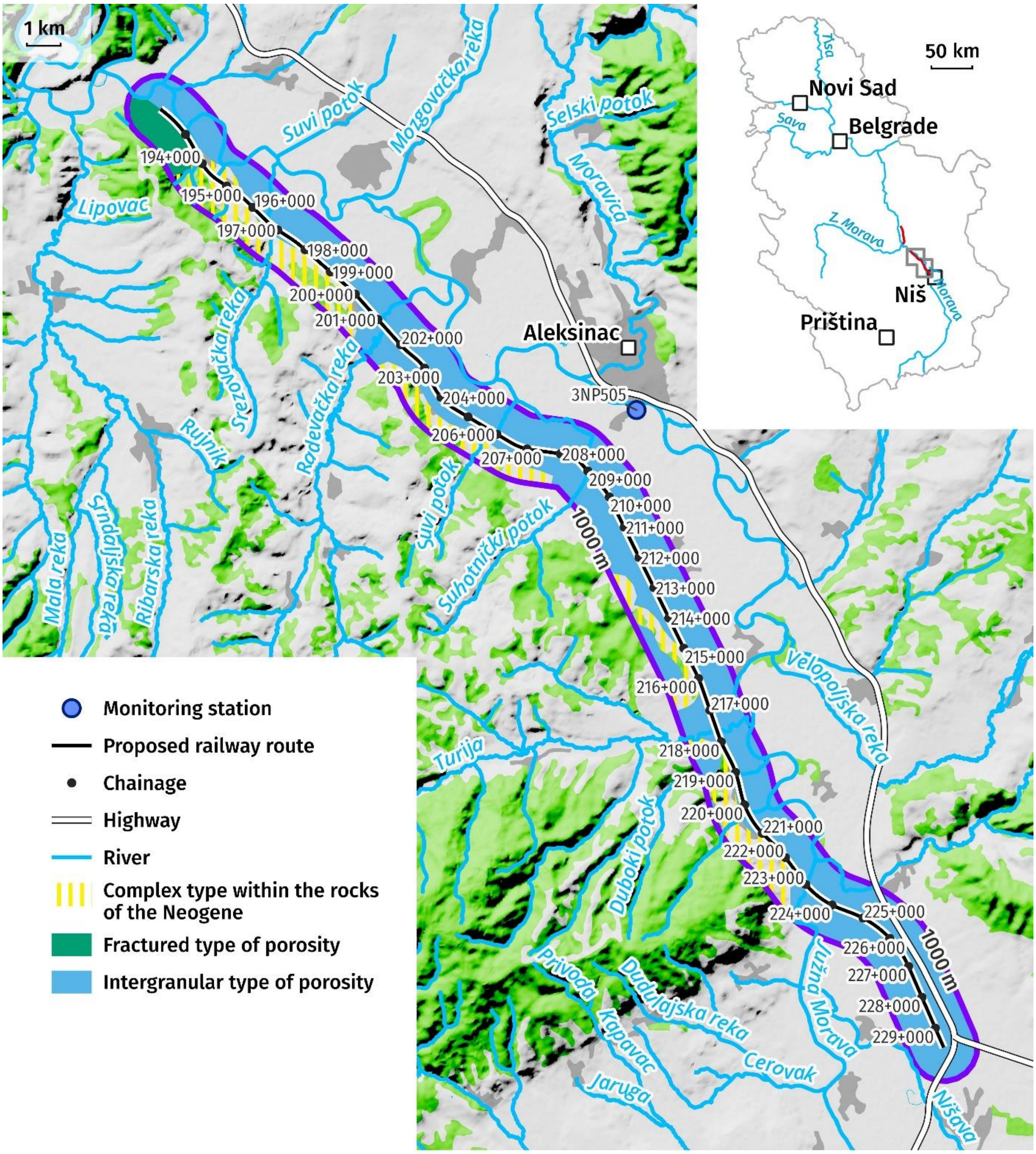
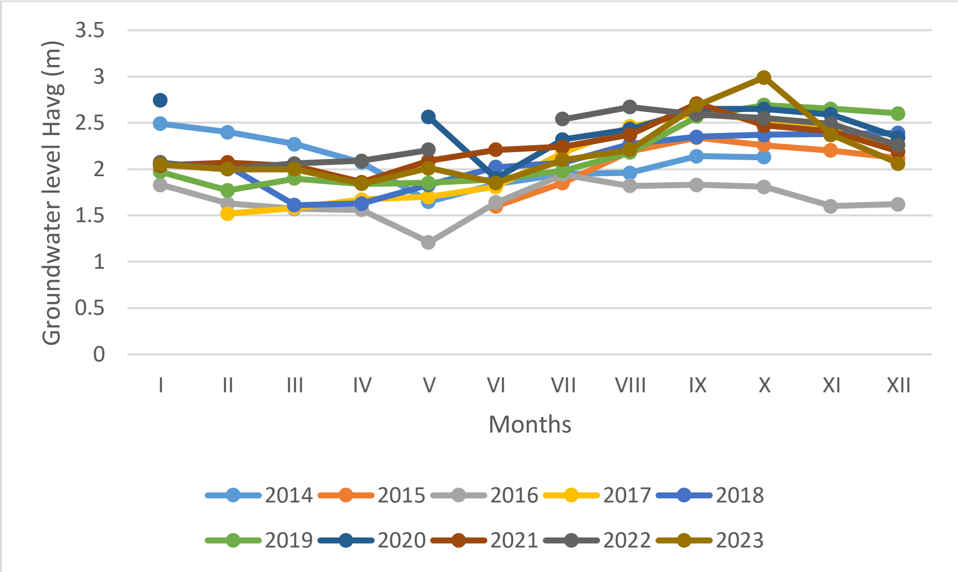
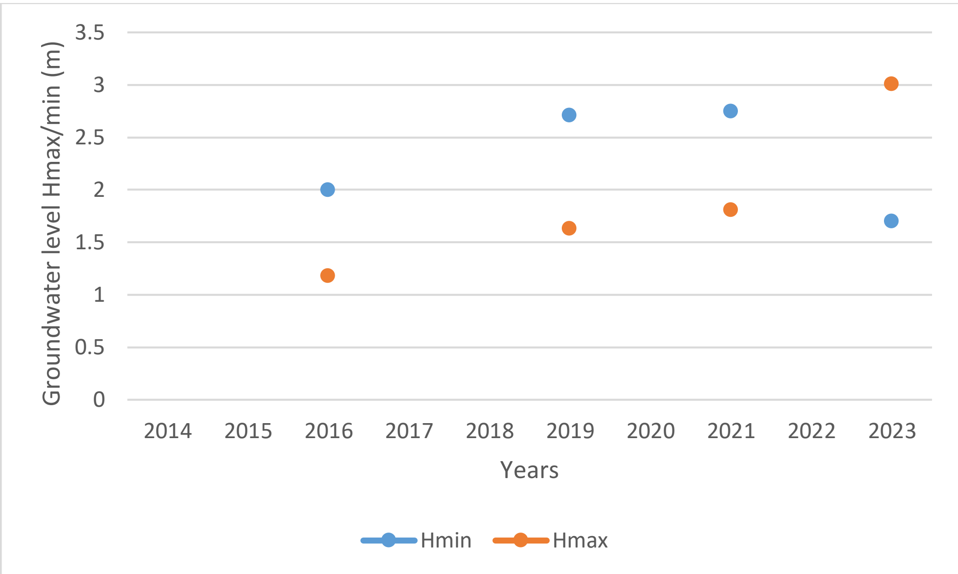


Figure 10-4. Location of groundwater monitoring stations

Data from the monitoring stations for the period 2014–2022 is presented in Figures Figure 10-4 to Figure 10-7 below showing groundwater level profiles.

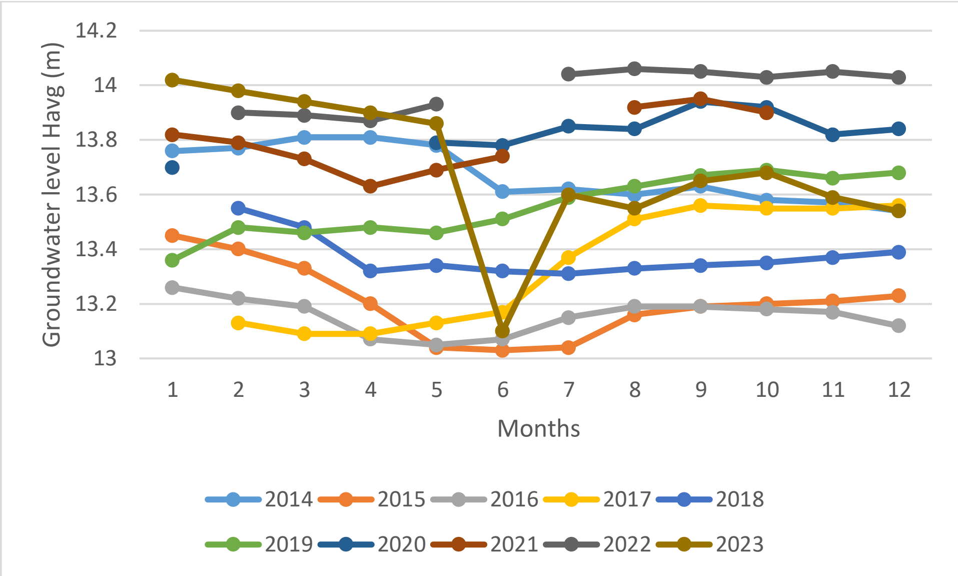


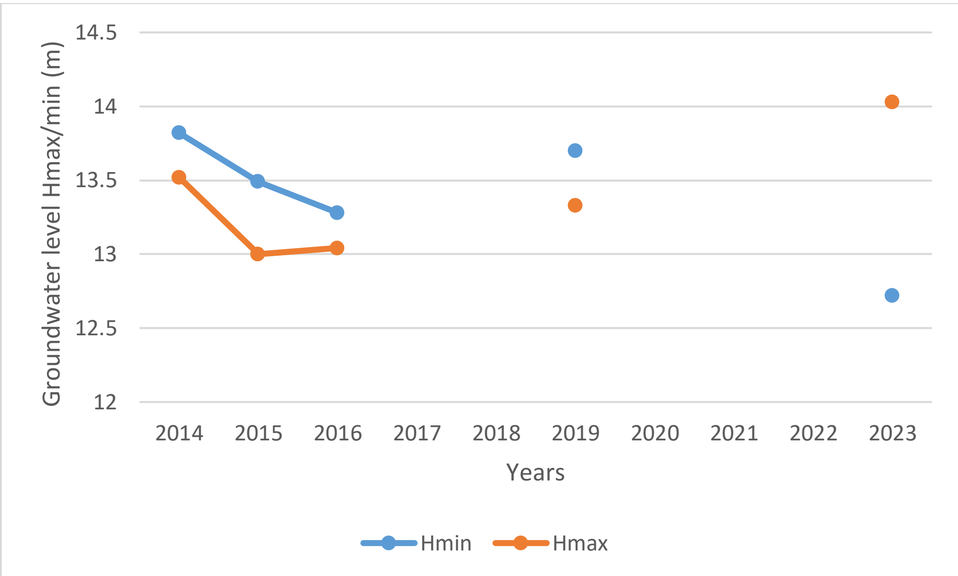


*the "0" elevation of the piezometer: 126.80 (m.a.s.l.); elevation of the terrain 126.29 (m.a.s.l.)

Figure 10-5. Groundwater level on profile Striža – nova, 951A

The groundwater levels fluctuate slightly over the course of the year but remain within a range between approximately 1.5 to 2.5 meters. In most years, the groundwater levels remain fairly stable from January to May, before starting to rise or dip slightly through the summer and autumn months (June to October). Data for 2014 and 2018 show higher groundwater levels compared to other years, especially in the early months. In summary, groundwater levels over the years 2014 to 2023 remain relatively stable with some seasonal variation, generally decreasing in the second half of the year.

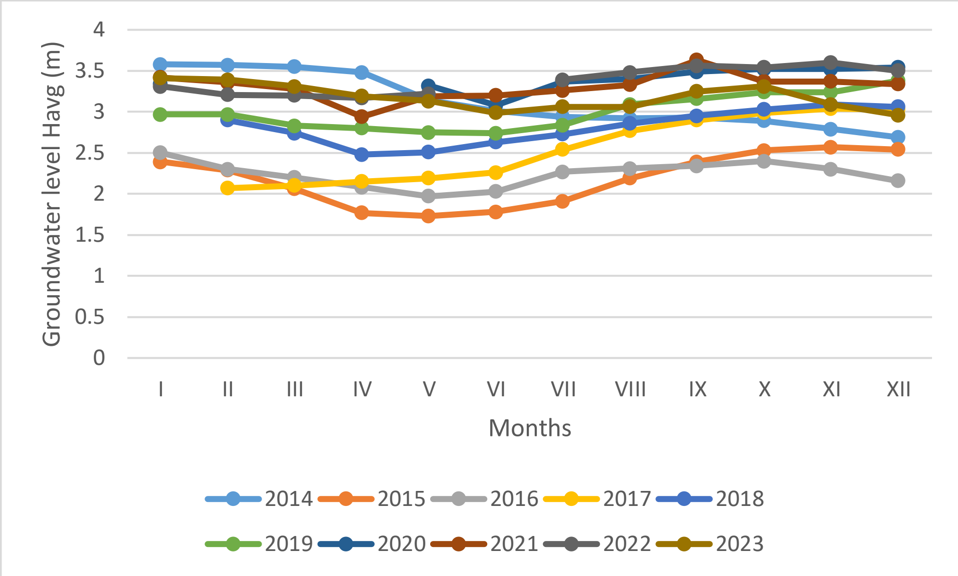


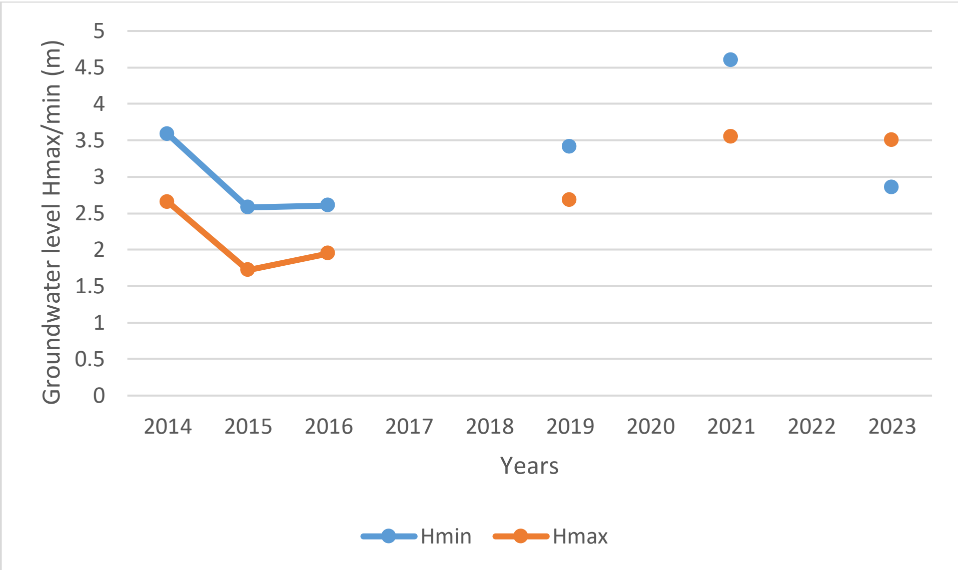


*the "0" elevation of the piezometer: 143.23 (m.a.s.l.); elevation of the terrain: -

Figure 10-6. Groundwater level on profile Varvarin–Ćićevac PL-193

The groundwater levels are within a relatively narrow band, between approximately 13.0 meters and 14.2 meters, and show fluctuations throughout the year. Most years exhibit some form of decrease in groundwater levels starting in the middle months (from May), with some recovery toward the end of the year. Data for 2016 and 2020 show more stable levels, while 2015, 2017, and 2023 have more notable changes, particularly 2015, which shows the highest levels overall. The year 2023 stands out due to the sharp rise and drop in the middle of the year, which differs significantly from the other years.

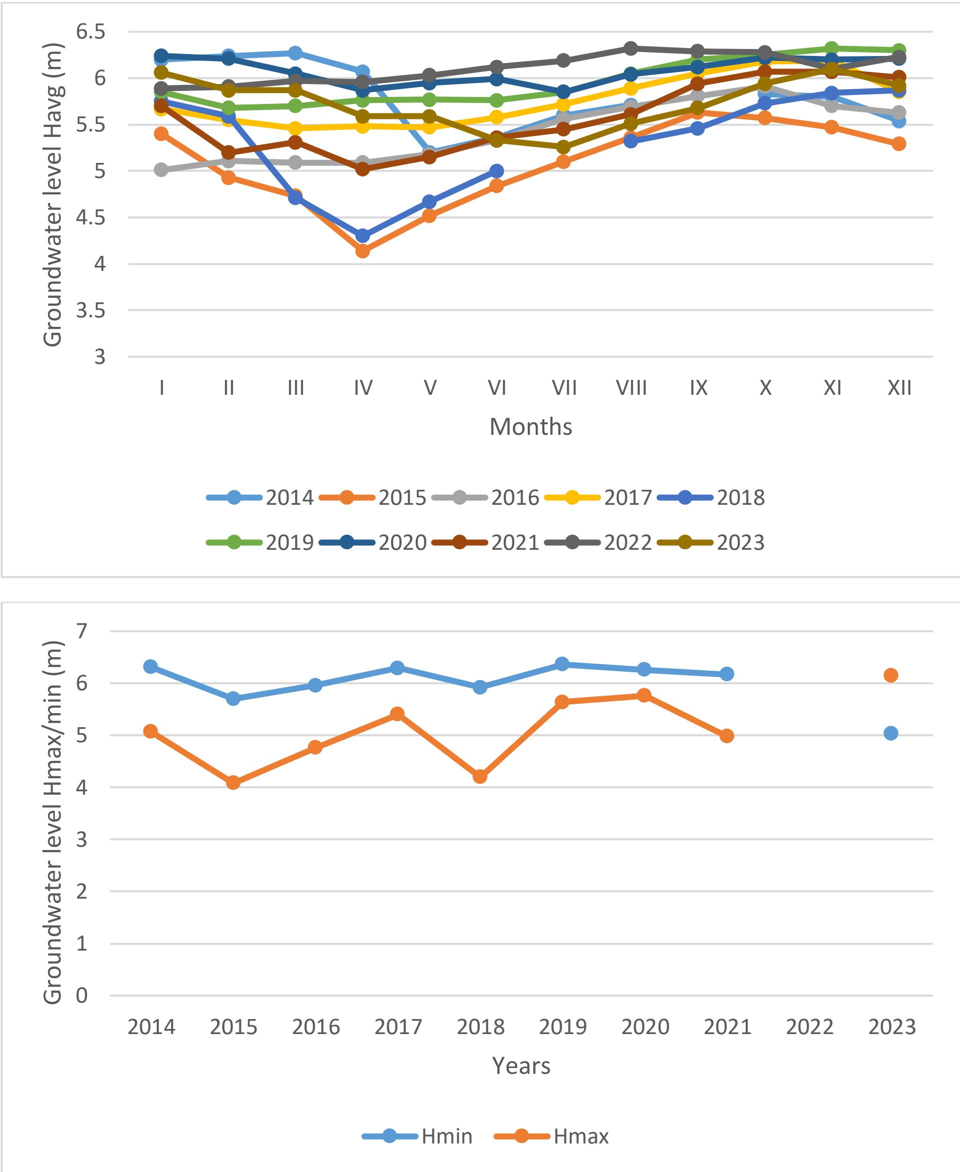




*the "0" elevation of the piezometer: 128.59 (m.a.s.l.); elevation of the terrain (m.a.s.l.): /

Figure 10-7. Groundwater level on profile Obrež–Ratare PD183

Groundwater levels generally stay within a narrow band, ranging between 2.0 and 4.0 meters below ground level, indicating a relatively shallow groundwater table compared to the previous chart on Figure 10-6. There is a consistent seasonal pattern across most years, with a slight decrease in levels after June. Data for 2015, 2016 and 2017 are marked by more significant variability, while 2023 shows the most consistent groundwater levels.



*the "0" elevation of the piezometer: 163.28 (m.a.s.l.); elevation of the terrain162.53 (m.a.s.l.)

Figure 10-8. Groundwater level on profile Žitkovac–RO Moravica, 505

Across all years, there is a clear seasonal pattern in groundwater levels. The levels typically rise during the early months of the year, particularly between February to May. This upward trend likely reflects increased rainfall and groundwater recharge, especially in 2014, 2015 and 2018 when heavy rains hit Serbia. The decrease begins around June, with groundwater levels decreasing steadily toward the latter part of the year.

In general, the highest groundwater levels are observed from February to June, while in the period from July to November, levels are observed to drop. When river levels are at higher hypsometric elevations than the groundwater levels, groundwater is recharged by the rivers. Conversely, when river levels are lower than the groundwater level (during dry periods), the rivers are replenished at the expense of the existing groundwater.

Since these monitoring stations are outside the Project AoI, observed groundwater levels in exploratory boreholes for the purpose of defining geotechnical conditions for the construction of the overpasses/underpass are provided below.

In the following Table 10-2 locations of exploratory boreholes for structures and observed groundwater level are provided.

Table 10-2. Exploratory boreholes for designed structures and groundwater level[3]

Exploratory borehole symbol	Designed structure	Depth of the borehole	Groundwater level	Maximum prognozed groundwater level	Geological formation
	Paraćin–Stalać subsection				
PSd-1, Psd-2, Psd-3	Overpass at km 153+942	21, 25, 25	1.30-2.50	0.0-0.5	dpr
Psd-2	Culvert at km 153+960	25	2.10	0.40	dpr
PSs-2, Pss-3	Pedestrian underpass at km 155+077	10., 10.0	4.40–4.90	2.70	dpr
	S&T object at km 155+250		~5.0	3.0	dpr
	PS object at km 155+372		~4.60	2.60	dpr
IB-3	Pedestrian underpass at km 156+560		5.0	3.0	dpr
IB-4	Underpass at km 155+991	20	4.70	2.70	dpr

[3] *Geomehanika" d.o.o, Elaborate on geotechnical conditions for the reconstruction of the railway line*

PSp-5	Culvert at km 156+259	6.0	1.90	0.70	dpr
PSo-1	Underpass at km 156+851	20	4.40	2.0	dpr
PSo-2	Underpass at km 156+851	20	4.10	2.0	dpr
PSp-2	Culvert at km 157+375	8.0	4.20	2.20	dpr
PSp-3	Culvert at km 157+733	8.0	3.60	1.60	dpr
PSp-10	Culvert at km 158+354	6.0	4.70		dpr
PSp-4	Bridge at km 158+844	8.0	-		dpr
PSo-3	Underpass at km 158+955	20	14.50	4.0	dpr
PSp-7, PSp-8	Bridge at km 159+814	8.0, 7.0	-		dpr
PSp-9	Bridge (culvert) at km 160+349	8.0	-		dpr
PSp-11, PSp-12	Culvert at km 161+643	8.0, 8.0	-		dpr
PSp-16	Culvert at km 162+418	6.0	4.70		dpr
PSo-4	Underpass at km 162+505	20	11.40	4.0	dpr
PSp-14	Culvert at km 162+943	8.0	-		dpr
PSs-5	S&T object at km 163+462	8.0	-		dpr
PSs-4, PSs-5	Pedestrian underpass at km 163+477	10.0, 8.0	-		dpr

PSp-18	Bridge at km 163+861	25.0	9.50	2.50	al
PSo-5	Underpass at km 164+502	20	11.40	6.30	dpr
PSo-6	Underpass at km 164+502	20	9.20	6.30	dpr
PSp-17	Culvert at km 164+652	6.0	4.70	0.70	dpr
PSs-6	PSN object at km 264+949	8.0	-		dpr
PSs-6	Culvert at km 165+000	8.0	-	1.80	dpr
PSp-21	Culvert at km 165+553	6.0	-	1.0	dpr
PSp-23	Culvert at km 166+453	8.0	4.20	1.60	dpr
PSo-7	Underpass at km 166+669	20	5.20	2.50	dpr
PSo-8	Underpass at km 166+669	20	4.50	2.50	dpr
PSp-29	Culvert at km 169+014	8.0	3.70	1.60	dpr
PSo-9	Overpass at km 169+150	25	3.40	2.0	dpr
PSo-10	Overpass at km 169+150	25	3.50	2.0	dpr
Pso-11, PSd-4, PSd-5	Bridge at km 169+490	25.0, 25.0, 25.0	3.40–4.30	0.0	al
Psd-6, Psd-7, Psd-8	Overpass at km 170+132	25	3.40–4.80	0.60–1.40	dpr
PSp-31	Culvert at km 171+250	6.0	3.10	1.60	dpr

PSs-7	S&T object at km 171+385	9.0	3.30	1.30	am
PSs-7, Pss-8	Station at km 171+415	9.0, 10.0	3.30–4.30	2.20	Am
PSs-8, PSs-9	Pedestrian underpass at km 171+450	10.0, 10.0	4.30-4.50	3.0	Am
Pss-10	Underpass at km 171+793	10	2.90	1.20	Am
PSp-37	Bridge at km 172+051	25.0	2.90		Pr
PSp-36	Bridge at km 1+004	25.0	2.80	0.50	Pr
PSp-38	Culvert at km 172+451	8.0	2.20	0.70	pr
PSo-12	Overpass at km 172+515	15	1.90	0.0–2.30	pr
PSo-13	Overpass at km 172+515	17	2.40	0.0–2.30	pr
PSp-39	Culvert at km 173+037	8.0	4.30	1.50	pr
Psn-3, Psn-4	Underpass at km 173+134	6, 4	2.90	0.80	pr
PSo-14	Pedestrian underpass at km 173+678	20	14.00		pr
Pso-16	Bridge at km 173+709	25.0	13.0	3.50	pr
	Đunis-Trupale subsection				
VT-1, VT2	Tunnel at km 192+305	29.0, 45.0	-		Mi
BP-1	Overpass at km 193+051	11.0	8.50	4.8	M2

BM-1	Bridge at km 193+426	18.0	7.40	2.60	Al
Bup-2	Pedestrian underpass at km 194+106	9.0	-		t
P-3	Culvert at km 194+364	6.0	-		M2
BM-2	Bridge at km 194+581	8.0	3.70	1.0	al
BP-2	Underpass at km 194+665	15.0	3.40	2.9	al
P-4	Culvert at km 194+850	8.0	4.30		al
P-5	Culvert at km 195+508	7.0	4.40		M2
BP-3	Underpass at km 196+164	15.0	8.30	3.60	t
BM-3	Bridge at km 196+848	22.0	9.50	5.80	Al
BP-4	Underpass at km 197+383	25.0	17.00	11.50	t
-	Pedestrian underpass at km 198+488	-	-	~9.0	
P-6	Culvert at km 199+727	8.0	4.90		t
BP-5	Underpass at km 200+277	15	9.50		alt
Ba-2	Station at km 200+741	7.0	-		Alt
Ba-3	S&T object at km 200+807	10.0	6.0		alt

BM-4	Bridge at km 201+255	23.5	6.70	4.70	Alt
-	Pedestrian underpass at km 201+424	-	-	-	Alt
BP-6	Underpass at km 202+340	15	9.30		alt
Bup-7, Bup-8	Pedestrian underpass at km 202+962	10.0, 11.0	-		Alt
P-7	Culvert at km 203+496	8.0	-		Alt
P-7	Culvert at km 203+518	8.0	5.40		Alt
P-8	Culvert at km 204+742	8.0	5.40		Alt
Ba-4	S&T object at km 205+474	10.0	-		pr
BP-7	Underpass at km 205+802	15	10.40	2.9	pr
BM-5	Bridge at km 205+958	24.0	17.0	12.5	pr
BP-8	Underpass at km 206+821	15	6.60	4.60	pr
P-9	Culvert at km 207+167	8.0	4.0		alt
-	Pedestrian underpass at km 207+920	-	-	-	
Bup-11	Culvert at km 208+379	11.0	5.50		alt
BP-9	Underpass at km 208+746	15	5.70		alt

BM-6	Bridge at km 208+820	20.0	5.70	3.70	alt
Ba-5	PS object at km 208+920	10.0	8.80		alt
Ba-5	Station at km 209+255	10.0	8.80		alt
Ba-6	Pedestrian underpass at km 209+290	10.0	9.10		alt
Ba-7	S&T object at km 209+335	10.0	8.60		alt
-	Culvert at km 210+600	-	-	~3.0	
BP-10	Overpass at km 210+360	21	7.50	5.50	alt
-	Culvert at km 211+868	-	-	~7.0	
BP-11	Overpass at km 212+668	25	7.80	5.80	alt
Ba-9	S&T object at km 213+791	10.0	-		alt
Ba-9	Pedestrian underpass at km 213+802	9.0	-		alt
BM7a	Bridge (culvert) at km 213+918	10.0	7.50	5.30	alt
BP-12	Overpass at km 214+249	20	7.90		alt
P-10	Culvert at km 215+819	8.0	7.0		alt
BP-13	Pedestrian underpass at km 216+866	15.0	11.0		alt

BP-13	S&T object at km 216+884	15.0	11.0		alt
BP-13	Underpass at km 217+044	15.0	11.00	9.00	alt
BM-8	Bridge at km 217+642	15.0	9.20	2.70	al
BM-9	PSN object at km 218+777	23.0	6.60		t
BM-9	Bridge at km 219+097	23.0	6.60	4.60	t
BP-14	Overpass at km 219+404	20	19.50	17.50	t
BM-10	Bridge at km 220+015	8.0	-		t
BM-11	Bridge (culvert) at km 220+315	8.0	-		t
BM-12, BM-13, BM-14, BM-15, BM-16, BM-17, BM-18	Viaduct at km 220+544	25.0, 25.0, 24.0, 18.0, 25.0, 19.0, 21.0	6.00–9.00	3.50	t
P-12	Culvert at km 221+020	7.0	-		t
BP-15	Overpass at km 221+359	15	7.20	5.20	t
P-13	Culvert at km 222+212	8.0	4.80		Al
BM-20, BM-19, BM-21,	Bridge at km 223+054	18.0, 25.0, 14.0	4.40–5.20		Al
BM-21	Viaduct at km 223+205	14.0	3.90		Al
BP-16	Underpass at km 223+500	14	6.40		Al

-	Pedestrian underpass at km 224+180	-	-	~3.20	al
P-14	Culvert at km 224+366	7.0	3.20		al
BP-17	Overpass at km 227+126	25	10.50	8.00	al
-	Culvert at km 228+200	-	-	~2.30	T
Ba-13	S&T object at km 228+875	8.0	-		T
Ba-14	Pedestrian underpass at km 228+918	8.0	-		T
Ba-15	Station at km 228+934	8.0	-		T
Ba-16	PS object at km 229+050	9.0	8.80		t
BP-18	Underpass at km 229+419	15	6.00		t

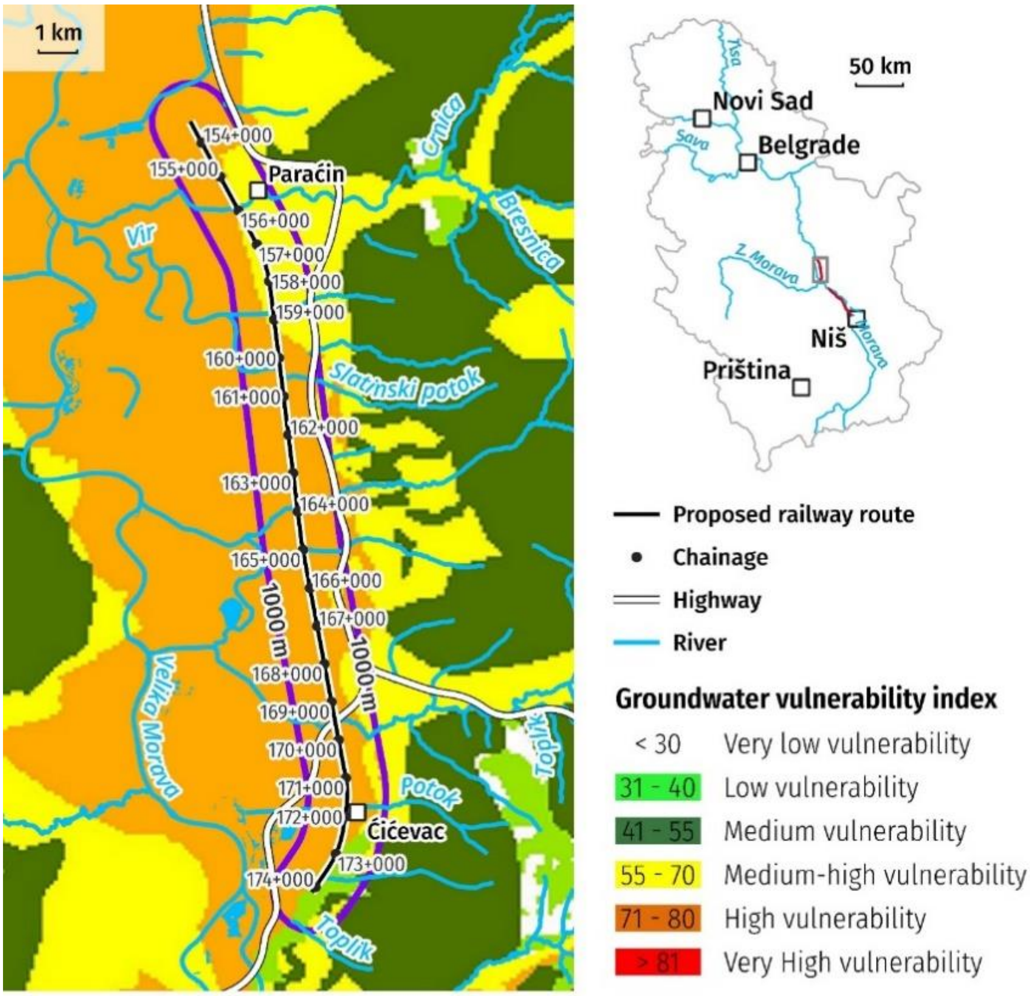
*where groundwater data is not available, the groundwater level was not observed in boreholes; some of the structures had not been designed at the time the study was conducted, so boreholes were not drilled at the exact locations of those structures, instead, groundwater levels were forecasted based on previous investigations or nearby boreholes drilled for other structures

Groundwater vulnerability

According to the hydrogeological characteristics of the Project AoI, the degree of vulnerability to groundwater varies. The least vulnerable areas are represented by pre-Paleozoic and Paleozoic formations, except for those areas where the hydrogeological complex was formed. Partially vulnerable areas represent less permeable Neogene and quaternary deposits, while extremely vulnerable areas represent alluvial and terrace deposits.

Maps of groundwater vulnerability have been produced[4] to indicate levels of groundwater vulnerability due to pollution. Separated areas, i.e., vulnerability classes, are shown in different colours, symbolizing different levels of vulnerability. Figure 10-9 is an excerpt from the groundwater vulnerability map of Serbia, which illustrates that Project AoI is in the zone of medium to high vulnerability to pollution.

Elements used in the creation of the groundwater vulnerability map of Serbia are influence of terrain slope on infiltration, the influence of soil type and vegetation cover on the threat of groundwater, the thickness of the upper layer, aquifer (i.e. geological hydrogeological characteristics of the terrain), level of groundwater, i.e. to the depth of the groundwater level).



[4] [4] *Milanović, S., Stevanović, Z., Đurić, D., Petrović, T., Milovanović, M., Mandić, M. (2011). Project: Monitoring of groundwater resources Srbije. Subproject: Creation of a map of the risk of groundwater in Serbia. https://geoliss.mre.gov.rs/prez/KartaUgrPodVodWeb/index.html*

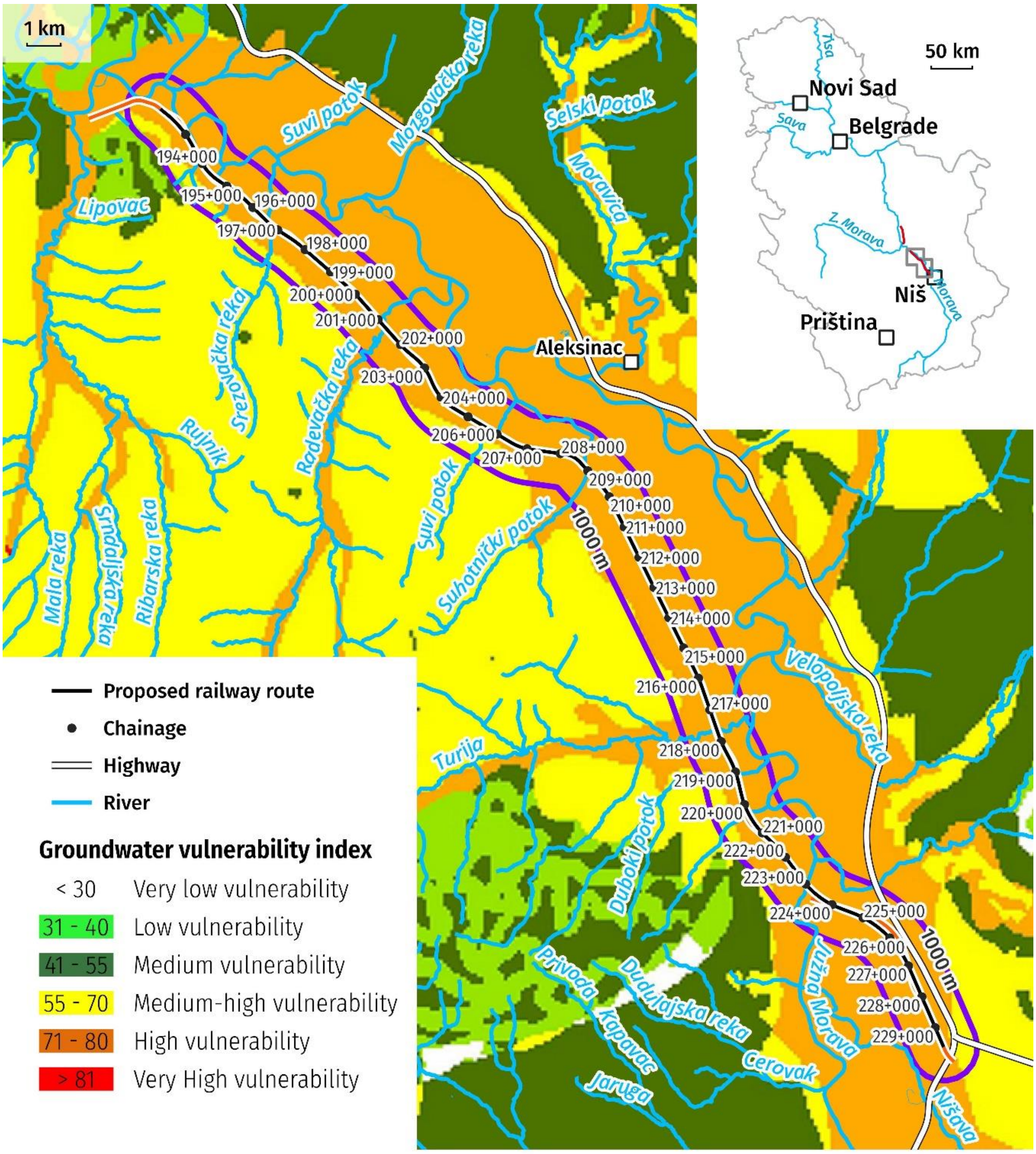


Figure 10-9. Groundwater Vulnerability Map

Sanitary protection zones

The Rulebook for the method of determining and maintaining sanitary protection zones of water supply sources[5] ("Official Gazette of RS", No. 92/2008) specifies the requirement for determining and maintaining sanitary protection zones in areas where potable water sources are located. There are three classifications of zones:

Zone I - zone of immediate sanitary protection,

Zone II - narrower zone of sanitary protection, and

Zone III - wider zone of sanitary protection.

The main restrictions within sanitary protection zones according to "Official Gazette of RS", no. 92/2008[6] are outlined below:

In zone I, buildings and facilities cannot be built or used, land cannot be used or carry out other activities, if this endangers the quality of the water at the source, namely:

- construction or use of buildings and facilities, use of land or other activities from Article 28 of this rulebook;
- installation of devices, storage of equipment and performance of activities that are not in operation of water supply;
- movement of vehicles that are in the function of water supply outside of those prepared for it traffic road, access to motorized vehicles that are not in the function of water supply, use of motor-driven vessels, maintenance of water sports and bathing of people and animals;
- livestock feeding;
- fish farming for commercial fishing.

In zone II, it is not possible to build or use buildings and facilities, use land or carry out other activities, if this endangers the quality of the water at the source, namely:

- construction or use of buildings and facilities, use of land or other activities from Article 27 of this rulebook;
- housing construction;
- use of chemical fertilizers, liquid and solid manure;
- use of pesticides, herbicides and insecticides;
- breeding, movement and grazing of livestock;
- camping, fairs and other gatherings of people;
- construction and use of sports facilities;
- construction and use of catering and other facilities for the accommodation of guests;

[5] *Official Gazette, Regulation on water classification: 5/1968-64, https://www.pravno-informacioni-sistem.rs/SlGlasnikPortal/eli/rep/sgsrs/vlada/uredba/1968/5/1/reg*

[6] *Rulebook on the method of determining and maintaining sanitary protection zones of water supply sources, "Official Gazette of RS", no. 92/2008*

- deepening of the bed and extraction of gravel and sand;
- establishment of new cemeteries and expansion of existing cemeteries.

In zone III, buildings and facilities cannot be built or used, land cannot be used or carry out other activities, if this endangers the quality of the water at the source:

- permanent underground and above-ground storage of dangerous substances and substances that cannot be mixed directly or indirectly into waters;
- production, transportation and manipulation of hazardous substances and non-hazardous substances may be introduced directly or indirectly into the waters;
- commercial storage of oil and oil derivatives;
- discharge of wastewater and water used for industrial cooling plants;
- construction of traffic roads without channels for drainage of storm water;
- exploitation of oil, gas, radioactive substances, coal and mineral raw materials;
- uncontrolled depositing of communal waste, damaged vehicles, old tires and other substances and materials from which polluting substances can be released by washing or leakage;
- uncontrolled deforestation;
- construction and use of the airport;
- surface and subsurface works, soil blasting, penetration into the layer covering the underground water and removal of the layer covering the aquifer, unless these works are not in operation of water supply;
- maintenance of car and motorcycle races.

According to data from the Ministry of Health, the Department for Inspection Affairs, the Paraćin–Stalać subsection of the Project passes through the wider zone of sanitary protection of the ‘Gorunje’ (used for water supply) and Bahus’ water sources (used for the production of bottled water). The borders of the wider protection zones of the groundwater sources Dankovo and Striža are located about 250m from the Project alignment. The locations of these are shown below in Figure 10-10.

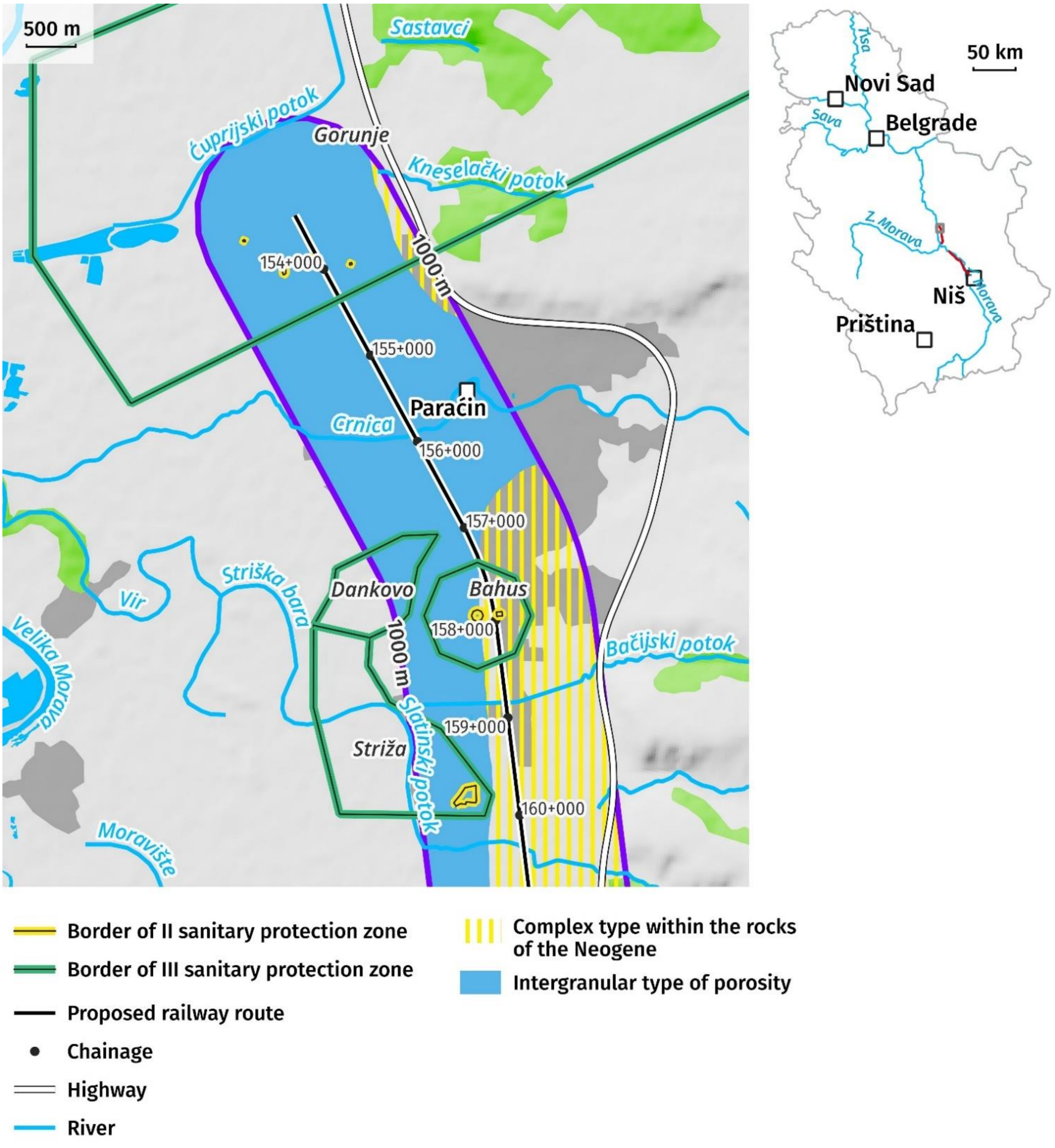


Figure 10-10. Map of the groundwater sources with sanitary protection zones in relation to the railway line

Gorunje

The Gorunje groundwater source, located in a sandy aquifer horizon of Neogene age, is well protected from surface-level pollution by an impermeable clay layer that acts as a hydrogeological insulator. The aquifer is primarily recharged by water from a distant karst-fissure aquifer and, to a lesser extent, by atmospheric precipitation infiltrating along tectonic faults. There is no direct hydraulic connection between this aquifer and the alluvial environment of the surrounding area, which further limits the risk of contamination. The natural protection provided by the impermeable layers ensures that even in the event of surface pollution, the aquifer remains protected from vertical infiltration of contaminants[7].

In the Velika Moravian Basin in the zone of Paraćin, there are two distinct aquifer environments – the one in alluvial sediments of pronounced abundance, and the one in Neogene sandy-gravel sediments of also increased abundance. The shallow alluvial aquifer is not exploited today due to existing very high levels of pollution. It does not have any communication with the deep Neogene aquifer (subarthrian aquifer) that is used today for the water supply of Paraćin. A powerful clayey Neogene confining bed separates the lower (neogene) and upper (alluvial) aquifers. In the lower and upper aquifers, completely independent aquifers exist, with clearly different regimes of piezometric levels and directions of groundwater flow.

Based on the project of sanitary protection zones[8], no protection measures were applied on the part of the railway route that passes through the wider zone of this groundwater source.

Bahus

The sources of groundwater abstraction for the needs of the Bahus company are located in the southern part of the city of Paraćin, in the Striža settlement, on cadastral plots, which are owned by the company.

Two abstraction wells were entered into the official state records under the name well *Bahus* (old name IEB-1B), and well *Ladna voda* (old name IEB-2B).

Approved groundwater reserves are:

- for well IEB-1B Q=4 l/s, groundwater of category B, hydrocarbonate-calcium-magnesium type. The well is 164.4 m deep, capturing deeper water-bearing horizons (from a depth in the interval 62–151 m) which in the bedrock have clayey and clayey-sandy impermeable sediments. It is located in a separate room of the production plant, which is physically secured and sanitary.
- for well IEB-2B Q=7 l/s, groundwater category B, hydrocarbonate-calcium type. The well is 64 m deep; water is drawn from a depth of 40–58.5m.

[7] The project of sanitary protection zones of the spring "Gorunje" - wells BV-2, BV-7, BV-P, BV-10, Public enterprise Vodovod, Paraćin, 2007.

[8] The project of sanitary protection zones of the spring "Gorunje" - wells BV-2, BV-7, BV-P, BV-10, Public enterprise Vodovod, Paraćin, 2007.

Being located in the southern part of Paraćin, the Company well generally requires a much higher degree of protection and a more complex assessment of the potential for anthropogenic pollution. An important advantage is that the well Bahus (IEB-1B) accesses the deep-water bearing horizons of the Neogene, which are naturally protected from contamination by impermeable clayey sediments.

The Ladna voda well, is protected by impermeable to poorly permeable sediments, and the favourable conditions include the fact that it was aquifer under pressure, as well as distant recharge zones and a significantly long path of water through the porous intergranular environment to the place of drainage, i.e. to the water intake. The water catchment facility is protected by an overhead facility that physically protects the well and hydromechanical equipment and is secured against unauthorized access. The building in which the well is located is made of metal construction and panels, and it is placed on a concrete slab, which protects the source from the penetration of atmospheric or wastewater, as well as any other polluting substances into the aquifer zone[9].

In the area of the Ladna voda well, the sources of potential pollution are related to activities related to the exploitation of groundwater, the collection and disposal of waste materials, as well as the collection and removal of storm water. Under the mentioned maintenance conditions, in the immediate zone of the well, that is, the source, there are no potential conditions for pollution of the aquifer zone and captured groundwater.

In order to protect the source, since the narrower protection zones of both wells are in the immediate vicinity of the railway, a closed rainwater evacuation system has been designed from the railway in a part of the wider sanitary protection zone, which consists of:

- concrete railway channels of larger capacity (the width of the channel at the bottom is 1 m) on the left and right side of the designed railway with geomembrane, under the track body, drainage and concrete channels, as protection against possible leakage of pollutants into the underground;
- At the downstream end of the canal, there are reinforced concrete receptacle structures from which water is piped to the separator. In the reception buildings, it is planned to install slide gates on the outflow pipe. This enables the complete closure of the water drain to the separators and the outlet, which in the event of an incident can mitigate the impact on the environment and protect the groundwater source;
- purification in coalescent separators of light petroleum products and pouring into the Tekijski stream. The coalescent separator should be designed and manufactured in accordance with EN 858-1:2008 and intended to be installed in the ground. Purification performance - class I (petroleum products in the output water < 5 mg/l).

Groundwater quality related to the proposed project

The groundwater quality standards that are used in Serbia are compared to applicable EU Standards in Table 10-3.

Table 10-3. Comparison of values on the hygienic suitability of drinking water in the EU and Serbia

[9] *Elaborate on sanitary protection zones for the "Ladna voda" well of the company "Bahus" in Paraćin (Paraćin municipality),2018, "Geco Engineering" doo Belgrade*

Parameters	Unit	Parametric value EU regulation[10]	Parametric value Serbian regulation[11]	Parametric value Serbian regulation[12]
Chemical parameters				
Acrylamide	µg/l	0.10	-	-
Antimony	µg/l	10	10	20
Arsenic	µg/l	10	10	60
Benzene	µg/l	1.0	-	30
Benzo(a)pyrene	µg/l	0.010	0.010	0.05
Bisphenol A	µg/l	2.5	-	-
Boron	mg/l	1.5	1.0	-
Bromate	µg/l	10	10*	-
Cadmium	µg/l	5.0	3.0	6
Chlorate	mg/l	0.25	-	-
Chlorite	mg/l	0.25	-	-
Chromium	µg/l	25	50	30
Copper	mg/l	2.0	2.0	75
Cyanide	µg/l	50	50	1500
1,2-dichloroethane	µg/l	3.0	-	900
Epichlorohydrin	µg/l	0.10	0.40	-
Fluoride	mg/l	1.5	1.0	-
Haloacetic acids (HAAs)	µg/l	60	-	-
Lead	µg/l	5	10	75
Mercury	µg/l	1.0	1.0	0.3
Microcystin-LR	µg/l	1.0	-	-
Nickel	µg/l	20	10**	75
Nitrate	mg/l	50	50	50*******
Nitrite	mg/l	0.50	0.03***	-
Pesticides	µg/l	0.10	-	-
Pesticides total	µg/l	0.50	0.50	0.01
PFAS total	µg/l	0.50	-	-
Sum of PFAS	µg/l	0.10	-	-
Polycyclic aromatic hydrocarbons	µg/l	0.10	0.20	-
Selenium	µg/l	20	10	-
Tetrachloroethene/Trichloroethene	µg/l	10	40/70	40/500
Trihalomethanes total	µg/l	100	100	-
Uranium	µg/l	30	50*	-
Vinyl chloride	µg/l	0.50	0.50	5
Microbiological parameters				

[10] *Directive (EU) 2020/2184 of the European Parliament and of the Council of 16 December 2020 on the quality of water intended for human consumption (recast)*

[11] *Rulebook on the hygienic suitability of drinking water, Official Gazette of the FRJ no. 42/98, 44/99. and Official Gazette of the RS, no. 28/2019*

[12] *Regulation on limit values of polluting, harmful, and hazardous substances in the soil, Annex 2: remediation values of polluting, harmful, and hazardous substances in aquifer ("Official Gazette of RS", no. 30/18 and 64/19)*

Parameters	Unit	Parametric value EU regulation[10]	Parametric value Serbian regulation[11]	Parametric value Serbian regulation[12]
Intestinal enterococci and E.coli;	-	Not allowed	Not allowed	
Indicator parameters				
Aluminium	µg/l	200	50**	-
Ammonium	mg/l	0,50	-	-
Chloride	mg/l	250	250	-
Colour	-	Acceptable to consumers and no abnormal change	5 degrees cobalt platinum scale	-
Conductivity	µS cm^{-1} at 20 ºC	2500	2500	-
pH	-	6.5–9.5	6.8–8.5	-
Iron	µg/l	200	50**	-
Manganese	Mg/l	50	50***	-
Odour	-	Acceptable to consumers and no abnormal change	Acceptable to consumers and no abnormal change	-
Oxidisability	mg/lO_2	5.0	12***	-
Sulphate	mg/l	250	250****	-
Sodium	mg/l	200	200	-
Taste	-	Acceptable to consumers and no abnormal change	Acceptable to consumers and no abnormal change	-
Colony count 22ºC	-	No abnormal change	-	-
Coliform bacteria	Number/100ml	0	Up to 10*****	-
Total organic carbon (TOC)	-	No abnormal change	No abnormal change	-
Turbidity	-	Acceptable to consumers and no abnormal change	Up to 1 NTU******	-

* Permitted concentrations of disinfectants and by-products of disinfection during a state of emergency

** In bottled drinking water

*** It is considered that the water is correct if in 20% of the measurements that are not consecutive during the year, the concentration value reaches 0.1 mg/l, the measurement frequency according to the current Rulebook.

**** No smell can be felt

***** Purified and disinfected water and bottled natural water

****** Turbidity up to 5 NTU (nephelometric unit of turbidity) is allowed for water pipes per 5000 inhabitants.

******* Regulation on limit values of polluting substances in surface and groundwaters and sediment and deadlines for reaching them (Official Gazette of RS, no. 50/2012), Annex 2.

EU regulations tend to be more stringent for most chemical parameters, particularly for substances like Benzene, Benzo(a)pyrene, Cyanide, 1,2-dichloroethane, and PFAS-related parameters. The EU also enforces stricter limits for lead, vinyl chloride, and coliform bacteria. Serbian regulations are more stringent for certain substances like Fluoride, Mercury, Nickel, and Iron, as well as for some microbiological and indicator parameters and turbidity. In many cases, the limits are either equal between the two regulations, such as for Nitrate and Chloride, indicating similar safety standards.

Anahem d.o.o. Laboratory from Belgrade (Serbia) conducted groundwater quality sampling and laboratory analyses to inform this ESIA. Sampling was carried out from November 30, 2023, to December 02, 2023. The samples were transported to the laboratory under controlled conditions, where the analysis was performed.

For the purposes of analyzing baseline groundwater quality, the most sensitive areas were sampled including the zones of sanitary protection of groundwater sources that are used for public water supply, for the production and/or trade of foodstuffs, or the supply of public facilities, and through which the Project directly passes is immediately adjacent to. The sampling locations are given in Table 10-4.

Table 10-4. List of sampling locations and coordinates

No.	Sampling point		Sample ID	N	E
1	Striža	BV-4/2	1311175001	43.825415	21.410753
2	Gorunje	BV-2	1311175002	43.874154	21.395798
3	Gorunje	BV-7	1311175003	43.874649	21.390687

Figure 10-11 shows the location of sampling points of groundwater.

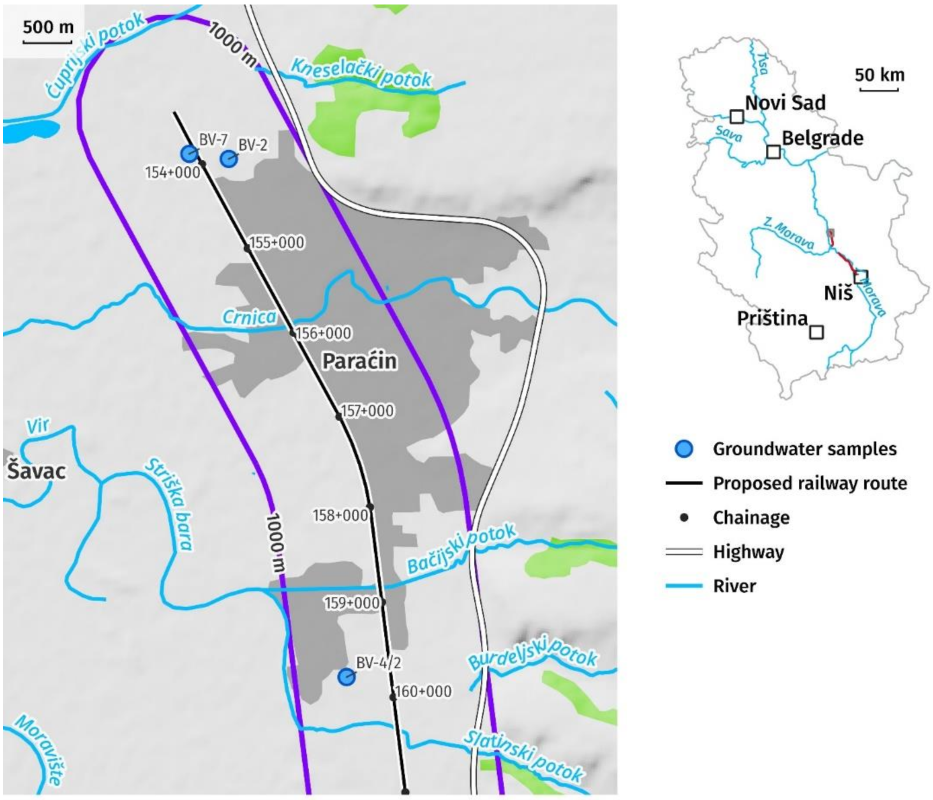


Figure 10-11. Groundwater sampling locations

Figure 10-12 shows the locations of the sampling locations.

BV-4/2

BV-2

BV-7

Figure 10-12. Survey photos for sampling groundwaters at "Striža" (BV-4/2) and "Gorunje" (BV-2 and BV-7)

Anahem performed an analysis of groundwater from the sources of Gorunje and Striža, in accordance with the Regulation on the Limit Values of Pollutants, Harmful and Hazardous Substances in Soil (Official Gazette of the Republic of Serbia, No. 30/2018 and 64/2019) and the results are presented below in Table 10-5.

Table 10-5. Results of groundwater analysis

Sample ID, xx:			01	02	03
Location:			BV-4/2	BV-2	BV-7
Parameter	GV	Unit			
Water level	-	m	12.5	21.7	21.7
pH	-	-	8.4	8.2	8.3
Nitrate	50*	mg N/L	91	8.0	8.7
Cyanides	*1500*	µg/L	<10	<10	<10
Phenol index	2000	µg/L	<2.0	<2.0	<2.0
Mineral oils	600	µg/L	<10	<10	<10
Metals					
Barium (Ba)	625	µg/L	<100	<100	<100
Cobalt (Co)	100	µg/L	<10	<10	<10
Copper (Cu)	75	µg/L	<10	<10	<10
Zinc (Zn)	800	µg/L	64	10	11
Lead (Pb)	75	µg/L	<20	<20	<20
Chromium (Cr)	30	µg/L	<10	<10	<10
Cadmium (Cd)	6	µg/L	<5	<5	<5
Nickel (Ni)	75	µg/L	6.1	6.4	5.6
Molybdenum (Mo)	300	µg/L	<10	<10	<10
Tellurium (Te)	70	µg/L	<50	<50	<50
Arsenic (As)	60	µg/L	<20	<20	<20
Antimony (Sb)	20	µg/L	<10	<10	<10
Thallium (Tl)	7	µg/L	<1	<1	<1
Mercury (Hg)	0.3	µg/L	<0.1	<0.1	<0.1
Tin (Sn)	50	µg/L	1.2	<1	<1
Silver (Ag)	40	µg/L	<20	<20	<20
Vanadium (V)	70	µg/L	<10	<10	<10
Aromatic hydrocarbons					
Benzene	30	µg/L	<0.5	<0.5	<0.5
Toluene	1000	µg/L	<0.1	<0.1	<0.1
Etiybenzene	150	µg/L	<0.5	<0.5	<0.5
Xylene	70	µg/L	<0.5	<0.5	<0.5
Styrene	300	µg/L	<0.5	<0.5	<0.5
Polycyclic aromatic hydrocarbons (PAH)					
Naphthalene	70	µg/L	<0.01	<0.01	<0.01
Anthracene	5	µg/L	<0.05	<0.05	<0.05
Phenanthrene	5	µg/L	<0.08	<0.08	<0.08
Fluoranthene	1	µg/L	<0.08	<0.08	<0.08
Benzo(a)anthracene	0.5	µg/L	<0.01	<0.01	<0.01
Chrysene	0.2	µg/L	<0.1	<0.1	<0.1

Benzo(a)pyrene	0.05	µg/L	<0.01	<0.01	<0.01
Benzo(g,h,i)perylene	0.05	µg/L	<0.05	<0.05	<0.05
Benzo(k)fluoranthene	0.05	µg/L	<0.05	<0.05	<0.05
Indeno(1,2,3-cd)pyrene	0.05	µg/L	<0.05	<0.05	<0.05
Acenaphthene	-	µg/L	<0.05	<0.05	<0.05
Benzo(b)fluoranthene	-	µg/L	<0.1	<0.1	<0.1

GV- Regulation on the Limit Values of Pollutants, Harmful and Hazardous Substances in Soil, "Official Gazette of the Republic of Serbia," No. 30/2018 and 64/2019, Annex 2: remediation values of pollutants, harmful and hazardous substances in the aquifer.
* Regulation on the Limit Values of Pollutants in Surface and Groundwaters, Sediment, and the Deadlines for Their Achievement, "Official Gazette of the Republic of Serbia," No. 50/2012, Appendix 2.

The analysis of samples was conducted in accordance with the Regulation on limit values of polluting, harmful, and hazardous substances in the soil, Annex 2: remediation values of polluting, harmful, and hazardous substances in aquifer ("Official Gazette of RS", no. 30/18 and 64/19) and the Regulation on limit values of pollutants in surface and groundwaters and sediment and deadlines for reaching them, Annex 2, Groundwater, Table 1, limit values of pollutants in groundwater ("Official Gazette of RS", No. 50/12).

Based on the results of laboratory testing, it can be concluded that the analysed parameters do not exceed the limit and remediation values defined by the Regulations.

For the Bahus groundwater source, permission was not granted to access the well and perform sampling. Alternatively, the water quality analyses from the Elaborate on sanitary protection zones for the groundwater source Bahus in Paraćin from 2010 has been used to inform this assessment. The results are presented separately in Table 10-6.

Table 10-6. Basic parameters of the physical and chemical composition of groundwater from exploration and exploitation well IEB-1B of the source "Bahus"[13]

Date	22.09.2009.
Laboratory	Institute "Dr Milan Jovanović Batut" Belgrade
Basic physical and chemical composition	
t (˚C)	16.0
pH	7.5
Turbidity (NTU)	0.34
Conductivity	590

[13] *Elaborate on sanitary protection zones for the groundwater source "Bahus" in Paraćin (Paraćin municipality), 2010, "Geco Engineering" doo Belgrade*

Dry residue (on 105˚C) (mg/l)	399
Total hardness ˚dH	18.2
KMnO4 (mg/l)	1.3
Macrocomponents	
Calcium Ca2+	91
Magnesium Mg2+	24
Natrium Na+	19.9
Potassium K+	1.43
Hydrocarbons HCO3-	/
Chlorides Cl-	15
Sulfates SO4-	22.1
Nitrates NO3-	/

According to the available data, all macro-components (substances or elements that are present in relatively high concentrations in water) are within the permitted values according to the legal regulations. The analyses did not establish the presence of concentrations of nitrates and nitrites, nor ammonia and ammonium ions, nor any other micro-components (trace elements or substances that are present in very low concentrations in water) analysed (Regulation on the hygienic suitability of drinking water, Official Gazette of the SFRJ, No. 42/98; Regulation on quality and other requirements for natural mineral water, natural spring water and table water, Official Gazette of SC, No. 53/05).

10.3. Assessment of Potential Impacts

Groundwater resources may be negatively impacted during both the construction and operations phases of the Project as a result of vegetation removal, incorrect storage and/or handling of hazardous materials and waste, rail accidents, an increase in areas of hardstanding, and excavations. Primary impacts on groundwater resources themselves (e.g. due to contamination, over abstraction or a reduction in recharge rates) can have impacts on secondary receptors, i.e. people who rely on groundwater as a source of potable water, industrial water or for crop irrigation. The main impacts of concern on groundwater sources are a reduction in aquifer yields and a reduction in groundwater quality.

Assumptions and Limitations

At the time of assessment, details such as the specific locations of laydown areas, construction camps, access roads, and spoil disposal areas were not finalized. The assessment of construction and operational activities on groundwater was therefore only conducted within the defined Project footprint.

Mitigation measures outlined in the assessment include procedures to be followed for these components where specific details were not available during the assessment phase. The assessment also incorporates avoidance measures where feasible and identifies the requirement for further assessments during the detailed design phase to address potential impacts comprehensive.

Confirmation from local authorities regarding the presence of groundwater wells on private properties along the railway route has not been obtained for either the Paraćin–Stalać or Đunis–Trupale subsections within the Project Area of Influence (AoI). However, there are informal indications that there are private wells in certain areas, where the groundwater is potentially used as a source of water for agricultural needs. Although this usage is not officially documented, it has been taken into account in the impact assessment where relevant with regard to ground water quality.

10.3.1. Impact assessment methodology

The standard methodology for assessing the impacts of the construction phase of the Project on groundwaters is outlined in Chapter 5 of this ESIA. Any deviations from this methodology are outlined in the following Sections of this Chapter.

Magnitude

In accordance with the nature of expected impacts from the Project, the magnitude of impacts on groundwater quality and quantity is assessed using a descriptive, impact-driven methodology based on three key criteria: extent of impact, severity of impact, reversibility.

Table 10-7 Definition of Magnitude of Impacts on Groundwater

Magnitude	Criteria	Grade
Low	<5% change in quality in comparison to the baseline; remains well within standards <5% change in yield; negligible or no measurable impact on flow or availability; Fully reversible; minimal risk of spread	1
Moderate	5–20% deterioration in quality in comparison to the baseline; 5–20% reduction in yield; Reversible with minor mitigation; confined to limited project area	2
High	20–40% deterioration in quality in comparison to baseline; 20–40% reduction in yield; Reversible but only	3

	with remediation or engineered measures	
Very high	>40% deterioration in key water quality parameters compared to baseline; >40% deterioration in water quality or yield; widespread or severe reduction in groundwater availability-. Irreversible without major intervention.	4

Sensitivity

For the purposes of the assessment of impacts on groundwater, the sensitivity of receptors is defined as follows:

'Very high' sensitivity receptors - Groundwater used for public water supply or critical infrastructure (e.g. hospitals, schools); no readily available alternative sources; high reliance and demand. Typically high-quality aquifers.. These include the groundwater source 'Gorunje' **from km 153+380 to 154+350** and the groundwater sources 'Dankovo' (near the Project alignment **at km 157+000**) and 'Striža' (near the Project alignment **at km 160+000**) and within the project AoI, although the railway line does not directly cross the source (see Figure 10-10). The groundwater source 'Gorunje' is naturally protected from pollution, however, since it is used as a source of municipal potable water supply it is considered as a very high sensitivity zone, since the railway line goes directly through its zone II for sanitary protection. (4)

'High' sensitivity receptors Groundwater that is important for local communities e.g. for food processing industry, moderate to high demand; quality suitable for intended use. It is significantly vulnerable to contamination and may be near, but not within, protected areas. These include the groundwater source Bahus **from km 157+350–158+400.** (3)

'Moderate' sensitivity receptors Groundwater used for agriculture or private wells with limited alternative sources; may require treatment for some uses; partial connectivity to other systems. These include the use groundwaters for crop irrigation from **154+000–155+000, 157+000 to km 157+300, from km 158+400 to 159+500, from km 160+000 to km 162+000, from km 163+000 to km 166+000, from km 168+000 to km 173+000, from km 195+000 to km 200+000, from km 200+500 to km 201+000, from km 211+000 to km 217+000, from km 218+000 to km 220+000, from km 221+000 to km 229+000. (2)**

'Low' sensitivity receptors Groundwater with poor quality (e.g. high salinity, contamination), low yield, or limited accessibility; not currently used and with low potential for future abstraction. Often found in isolated or confined systems not interacting with human use.

10.3.2. Construction Phase Impacts

Project construction activities (including construction of the track and stations, underpasses and overpasses) may result in negative impacts on groundwater quality through the introduction of contaminants into the groundwater system, either through direct infiltration or through surface runoff that eventually reaches groundwaters; and also can affect recharge rates and the yield of groundwaters (e.g. as a result of tunnelling/excavations, de-watering activities, and the removal of vegetation).

The potentially significant impacts of concern on groundwater resources during the construction phase are:

- Direct discharges of pollutants into groundwater
- Indirect discharges of pollutants via soil or surface water into groundwater
- Indirect physical impact on groundwater
- A reduction in groundwater source yield.

Impact of direct discharges of pollutants into groundwater

Direct discharges of pollutants during the construction phase of a railway line can have a range of impacts on local communities, particularly in areas where people rely on groundwater as a primary or sole source of potable water, for irrigation and/or animal husbandry purposes or industrial processes.

The main causes of impacts of direct discharge of pollutants during the construction phase may include:

- Construction machinery, equipment, and materials such as fuels, oils, lubricants, and solvents are often used in large quantities. If accidental spills or leaks occur, these chemicals can infiltrate the ground and contaminate groundwater.
- Chemicals including dust suppressants (e.g., calcium chloride or lignosulfonates), lubricants, concrete additives, solvents and paints may be used during construction. Spills/leaks of these chemicals (if not stored and handled appropriately) can seep into the soil and reach the groundwater table, causing direct contamination.

Magnitude

The impact of direct pollutant discharge on groundwater during railway construction is assessed as moderate to high, depending on pollutant type, proximity to the water table, and effectiveness of controls. It may have adverse effects on groundwater quality and human health, with the possibility of long-term impacts. Therefore, the magnitude of the impact is assessed as moderate (2) to high (3).

Spatiotemporal impact (Spatial Extent and Duration)

During the construction of structures, accidental spills/leaks of contaminants such as fuel, oil, soil stabilizers (such as calcium chloride), biocides, suspended solids or other hazardous substances from machinery and equipment could result in contamination of groundwater especially where the groundwater table is shallow and/or where deep excavations are required. For instance, the underpass excavations are designed at depths of approximately 5–7 meters, which fall within the range of the maximum recorded groundwater levels at certain locations. As such, it is expected that these excavations will come into direct contact with the groundwater table and may potentially impact it. Fuels and oils can persist in aquifers for decades, while soil stabilizers, biocides and suspended solids degrade much faster, usually within months to a year. The duration of the impact will be limited to the construction phase of the Project, and during works that impact particular sensitive areas. The impacts are also expected to be very localised but affect laterally connected waterbodies for a limited distance (3-5km) (2). As a result, any changes in groundwater quality, would be localized and medium term – between 5 and 20 years. (Grade 2)

Sensitivity

Three types of environmental receptors have been identified within the Project AoI in terms of sensitivity: very high-sensitivity receptors (4) groundwaters as a source for potable water (groundwater source 'Gorunje' **from km 153+380 to 154+350** and the groundwater sources 'Dankovo' (near the Project alignment **at km 157+000**) and 'Striža' (near the Project alignment **at km 160+000**)); high sensitivity receptors (3) groundwaters as a source for industrial purposes (groundwater source Bahus **from km 157+350–158+400**); and moderate-sensitivity receptors (2), groundwaters as a source water for irrigation of agricultural land (**154+000–155+000, 157+000 to km 157+300, from km 158+400 to 159+500, from km 160+000 to km 162+000, from km 163+000 to km 166+000, from km 168+000 to km 173+000, from km 195+000 to km 200+000, from km 200+500 to km 201+000, from km 211+000 to km 217+000, from km 218+000 to km 220+000, from km 221+000 to km 229+000**).

'Sensitivity' as explained above is the same for each impact being assessed and is applied to all other construction and operations phase impacts below. Impact Assessments have been conducted separately for each category of sensitive receptor.

It is important to note that the Bahus (IEB-1B) and Ladna voda (IEB-2B) exploration/exploitation wells are sunk into the deeper horizons of the Neogene aquifer, which are protected from leachate by impermeable confining deposits of clay. The Gorunje groundwater source is also well protected from surface-level pollution by an impermeable clay layer. However, although both groundwater sources (Gorunje and Bahus) have favourable conditions in terms of natural protection against pollutants, both sources are located in the immediate vicinity of the railway, especially the well IEB-1B of the Bahus source, the II protection zone of which is located only 20 m from the railway. Therefore, these groundwater sources are considered to be the most sensitive areas along the railway route.

Likelihood

It is considered to be possible that direct discharge of pollutants will occur as a result of Project construction activities. The construction process inherently involves a risk of accidental spills or leaks of contaminants. Since the Project AoI is in the zone of medium to high vulnerability to pollution according to the geological permeability (see Table 10-9), pollutants are likely to reach aquifers (3). Nevertheless, the Gorunje and Bahus groundwater sources are naturally protected by overlying impermeable geological deposits so pollutants will reach aquifers rarely (1).

Based on available data and site visits, the presence of contaminated land has not been identified. Due to possible accidental spills and leaks, a change in groundwater quality is a likely risk (3). The highest risk is present at chainages: km overpass at km 153+942, culvert at km 153+960, pedestrian underpass at km 155+077, pedestrian underpass at km 156+560, underpass at km 155+991, culvert at km 156+259, underpass at km 156+851, underpass at km 156+851, culvert at km 157+375, culvert at km 157+733, overpass at km 170+132, culvert at km 171+250, signal and telecommunication (S&T) object at km 171+385, station at km 171+415, pedestrian underpass at km

171+450, underpass at km 171+793.bridge at km 172+051. culvert at km 172+451, overpass at km 172+515, underpass at km 173+134, bridge at km 194+581, bridge at km 201+255, bridge at km 208+820, bridge (culvert) at km 213+918 because of high groundwater level and the presence of loose, highly permeable sediments (gravel, sand), which facilitates the easy migration of potential contaminants.

The assessment of the significance of the impact of direct discharge of pollutants during the construction phase of the Project is summarised in Table 10-8 below.

Table 10-8. Significance of the impact of direct discharge of pollutants during the construction phase

Receptors	Magnitude	Spatiotemporal scale	Sensitivity	Likelihood	Overall significance
Very-high sensitivity receptors	The magnitude of the impact from the direct discharge of pollutants to groundwater during railway construction is assessed as high (3)	The duration of the impact will be limited to the construction phase at the specified locations (2)	The Gorunje, Striža and Dankovo groundwater sources are very highly sensitive as local communities are dependent on them for potable water (4)	Pollutants are likely to reach the Striža and Dankovo aquifers (3).	M (3) + ST (2) + S (4) + L (3) = (12) High
				Pollutants will rarely reach the Gorunje aquifer since it is naturally protected (1).	M (3) + ST (2) + S (4) + L (1) = (10) Moderate

Receptors	Magnitude	Spatiotemporal scale	Sensitivity	Likelihood	Overall significance
High sensitivity receptors	The magnitude of the impact from direct pollutant discharge to groundwater during railway construction is assessed as high (3)	The duration of the impact will be limited to the construction phase at the specified location (2)	The Bahus groundwater source is highly sensitive because local communities are reliant on it for industrial purposes (3)	Pollutants will rarely reach the Bahus aquifer since it is naturally protected (1).	M (3) + ST (2) + S (3) + L (1) = (9) Moderate
Moderate sensitivity receptors	The magnitude of the impact from direct pollutant discharge to groundwater during railway construction is assessed as moderate (2)	The duration of the impact will be limited to the construction phase at the specified location (2)	Moderate sensitivity locations where local communities are using groundwater for agricultural purposes (2)	Due to the high vulnerability to pollution, pollutants are likely to reach aquifers (3).	M (2) + ST (2) + S (2) + L (3) = (9) Moderate

Indirect discharges of pollutants via soil or surface water into groundwater

This impact results from pollutants entering the soil or surface water first, and then migrating to groundwater over time through leaching, infiltration, or runoff. Construction sites can generate large amounts of hazardous waste, including old wooden rail sleepers that are contaminated with oil, paints, lubricants, oils and fuels. If hazardous waste is not properly stored, handled and disposed of, it can contaminate soil and surface water and leach into groundwater. Please see Chapter 16 – Waste and Materials for an assessment of the potentially significant impacts of waste. Stormwater runoff carrying chemicals or contaminants into infiltration zones can also represent indirect pollution pathways.

Magnitude

The magnitude of the indirect impact on groundwater via soil and surface water pathways during railway construction is assessed as low to moderate, due to the potential for leaching of hazardous substances from construction waste and surface runoff containing contaminants. (2)

Spatiotemporal impact (Spatial Extent and Duration)

The spatial extent of this impact is considered local, primarily affecting shallow aquifers in close proximity to the railway construction corridor, especially where soil permeability is high and mitigation measures are not fully effective. The duration of the impact is assessed as medium-term. In cases of persistent substances (e.g, fuel or solvent spills), groundwater quality may remain affected for several years beyond the construction phase. (2)

Likelihood

The likelihood of indirect groundwater contamination via soil and surface water pathways during railway construction is assessed as possible, given the use of hazardous materials and the potential for runoff or leaching under poor storage or drainage conditions. (Grade 2)

The assessment of the significance of the impact of indirect discharges during the construction phase of the Project is summarised in Table 10-8 below.

Table 10-9. Significance of the impact of indirect discharges during the construction phase

Receptors	Magnitude	Spatiotemporal scale	Sensitivity	Likelihood	Overall significance
Very high sensitivity receptors	The impact is negative and considered to be of moderate magnitude (2)	The impact is medium term – between 5 and 20 years and expected to be very localized (2)	The Gorunje, Striža and Dankovo groundwater sources are very highly sensitive as local communities are dependent on them for potable water (4)	It is possible that surface runoff will reach the Striža and Dankovo aquifers (2).	M (2) + ST (2) + S (4) + L (2) = (10) Moderate
				Surface runoff will rarely reach the Gorunje aquifer since it is naturally protected (1).	M (2) + ST (2) + S (4) + L (1) = (9) Moderate
High sensitivity receptors	The impact is negative and considered to be of moderate magnitude (2)	The impact is medium term – between 5 and 20 years and expected to be very localized (2)	The Bahus groundwater source is highly sensitive because local communities are reliant on it for industrial purposes (3)	Surface runoff will rarely reach the Bahus aquifers since it is naturally protected (1).	M (2) + ST (2) + S (3) + L (1) = (8) Moderate
Moderate sensitivity receptors	The impact is negative and considered to be of low magnitude (1)	The impact is medium term – between 5 and 20 years and expected to be very localized (2)	Moderate sensitivity locations where local communities are using groundwater for agricultural purposes (2)	Surface runoff is a possible risk (2).	M (1) + ST (2) + S (2) + L (2) = (7) Low

Indirect physical impact on groundwater

Excavation and tunnelling activities during construction, particularly near shallow aquifers, can expose soils and significantly increase the risk of erosion. During rainfall events, sediment-laden runoff may mobilise fine particles and surface contaminants, which can be transported into nearby water bodies, including groundwater aquifers. Although subsurface soil layers typically act as a natural filter, in areas with permeable soils or fractured rock, these fine sediments can infiltrate porous aquifers. This infiltration can increase groundwater turbidity and physically clog aquifer filtration systems, constituting an indirect physical impact on groundwater quality. While not chemical in nature, such impacts can reduce aquifer recharge efficiency and degrade the overall quality and usability of groundwater resource.

Magnitude

The magnitude of impacts from surface runoff on groundwater during railway construction is dependant on site conditions and the intensity of works, due to the potential for fine sediment infiltration into shallow aquifers near construction zones. While chemical contamination is unlikely, physical degradation through turbidity and aquifer clogging could impair water usability and recharge capacity in affected areas. If excavations extend to groundwater depths, this could provide a direct pathway for contamination. Therefore, the magnitude of the impact is assessed as low (1) to moderate (2).

Spatiotemporal impact (Spatial Extent and Duration)

Potential impacts on groundwater quality are expected to be confined to locations where excavations and dewatering activities occur (i.e. at locations where there are underlying aquifers), which are relatively limited in spatial extent (Grade 2).

The impact is expected to have a limited spatial extent at locations of the following designed structures: overpass at km 153+942, culvert at km 153+960, pedestrian underpass at km 155+077, pedestrian underpass at km 156+560, underpass at km 155+991, culvert at km 156+259, underpass at km 156+851, underpass at km 156+851, culvert at km 157+375, culvert at km 157+733, overpass at km 170+132, culvert at km 171+250, S&T object at km 171+385, station at km 171+415, pedestrian underpass at km 171+450, underpass at km 171+793.bridge at km 172+051. culvert at km 172+451, overpass at km 172+515, underpass at km 173+134, bridge at km 194+581, bridge at km 201+255, bridge at km 208+820, bridge (culvert) at km 213+918. These locations are particularly sensitive due to the presence of high groundwater levels (as shown in Table 10-2).

Likelihood

The likelihood of indirect physical impacts on groundwater quality due to sediment infiltration and aquifer clogging during railway construction is assessed as possible, given the potential for soil exposure and erosion during excavation and tunnelling. Due to the nature of construction works on designed structures, indirect physical impacts is a possible risk. The highest risk is present at chainages: km overpass at km 153+942, culvert at km 153+960, pedestrian underpass at km 155+077, pedestrian underpass at km 156+560, underpass at km 155+991, culvert at km 156+259, underpass at km 156+851, underpass at km 156+851, culvert at km 157+375, culvert at km 157+733, overpass at km 170+132, culvert at km 171+250, S&T object at km 171+385, station at km 171+415, pedestrian underpass at km 171+450, underpass at km 171+793.bridge at km 172+051. culvert at km 172+451, overpass at km 172+515, underpass at km 173+134, bridge at km 194+581, bridge at km 201+255, bridge at km 208+820, bridge (culvert) at km 213+918 because of high groundwater level and the presence of loose, highly permeable sediments (gravel, sand), which facilitates the easy migration of potential contaminants. (Grade 2)

The assessment of the significance of indirect physical impacts during the construction phase of the Project is summarised in Table 10-8 below.

Table 10-10. Significance of the impact of indirect physical impacts during the construction phase

Receptors	Magnitude	Spatiotemporal scale	Sensitivity	Likelihood	Overall significance
Very high sensitivity receptors	The impact is negative and considered to be of moderate magnitude (2)	The duration of the impact will be limited to the construction phase at the specified location (2)	The Gorunje, Striža and Dankovo groundwater sources are very highly sensitive as local communities are dependent on them for potable water (4)	Surface runoff will possibly reach the Striža and Dankovo aquifers (2).	M (2) + ST (2) + S (4) + L (2) = (10) Moderate
				Surface runoff will rarely reach the Gorunje aquifer since it is naturally protected (1).	M (2) + ST (2) + S (4) + L (1) = (9) Moderate
High sensitivity receptors	The impact is negative and considered to be of moderate magnitude (2)	The duration of the impact will be limited to the construction phase at the specified location (2)	The Bahus groundwater source is highly sensitive because local communities are reliant on it for industrial purposes (3)	Surface runoff will rarely reach the Gorunje aquifer since it is naturally protected (1).	M (2) + ST (2) + S (3) + L (1) = (8) Moderate
Moderate sensitivity receptors	The impact is negative and considered to be of low magnitude (1)	The duration of the impact will be limited to the construction phase at the specified location (2)	Moderate sensitivity locations where local communities are using groundwater for agricultural purposes (2)	Surface runoff is a possible risk (2).	M (1) + ST (2) + S (2) + L (2) = (7) Low

Impact of a reduction in groundwater source yield

There is the potential for significant impacts on environmental receptors due to a reduction in groundwater source yield during the Project construction phase, particularly in areas where people rely on groundwater as a primary or sole source of potable water, for irrigation and/or animal husbandry purposes or industrial processes.

The main causes of impacts to groundwater source yield during the construction phase may include:

- De-watering (e.g. for excavations, or foundation work in areas with high groundwater levels) can lower groundwater levels around the point of abstraction and lower yield within the area affected (the cone of depression). The locations where dewatering will be necessary according to Geotechnical study are defined as the **very high sensitivity zones**: overpass at km 153+942, culvert at km 153+960, pedestrian underpass at km 155+077, pedestrian underpass at km

156+560, underpass at km 155+991, culvert at km 156+259, underpass at km 156+851, underpass at km 156+851, culvert at km 157+375, culvert at km 157+733, overpass at km 170+132, culvert at km 171+250, S&T object at km 171+385, station at km 171+415, pedestrian underpass at km 171+450, underpass at km 171+793, bridge at km 172+051, culvert at km 172+451, overpass at km 172+515, underpass at km 173+134, bridge at km 194+581, bridge at km 201+255, bridge at km 208+820, bridge (culvert) at km 213+918.

- During the construction phase, there can be a temporary demand for water (e.g., for dust control, concrete batching, or construction camp needs). This demand can lead to an increase in localized groundwater abstraction rates (if groundwater resources are used), causing a temporary reduction in aquifer yields. However, the expected volumes of water required are not anticipated to cause significant changes in groundwater levels or yields and will be temporary. **Considering the aquifers' ability to recharge, this impact has been considered minimal and excluded from the assessment**
- The removal of vegetation, particularly trees and dense plant cover, can result in a decrease in groundwater recharge rates due to reduced interception of precipitation; vegetation acts as a natural barrier, slowing down surface water run-off rates and allowing more time for infiltration. **As the majority of Project AoI is covered by grass, with only a small portion around the tunnel portals being forested, it is not expected that this will have a significant impact, and as such, it has not been included in the impact assessment.**

It should be noted that following geotechnical investigations undertaken in relation to the Đunis tunnel (including two exploratory boreholes - VT-1 to a depth of 29 meters and VT-2 to a depth of 45 meters with no groundwater encountered), it has been determined that no de-watering will be required to facilitate the construction of the tunnel, as the groundwater table in this area is not high enough to interfere with construction activities.

Magnitude

There may be impacts on groundwater yield in underlying aquifers because of dewatering activities during construction, particularly in high-sensitivity zones (as defined in first bullet above and based on Table 10-2). Dewatering will be required to keep construction areas dry, especially in locations such as underpasses, where groundwater levels are high. This could lead to a temporary reduction in groundwater yield in these areas, as water will be actively pumped out to maintain a dry working environment. The impact on groundwater yield is expected to be limited to these specific project locations and will be temporary in nature and not affect water supply to local communities. Once construction activities are completed and dewatering ceases, the groundwater levels will return to their previous state. The disturbance to groundwater yield will be localized, and reversible. As a result, the magnitude of the impact on groundwater yield is assessed as low. (Grade 1)

Spatiotemporal impact (Spatial Extent and Duration)

During the construction phase, there will be temporary reductions in groundwater yield due to dewatering activities associated with excavations, which can disrupt the natural flow of groundwater. The impact is expected to have a limited spatial extent at locations of the following designed structures: overpass at km 153+942, culvert at km 153+960, pedestrian underpass at km 155+077, pedestrian underpass at km 156+560, underpass at km 155+991, culvert at km 156+259, underpass at km 156+851, underpass at km 156+851, culvert at km 157+375, culvert at km 157+733, overpass at km 170+132, culvert at km 171+250, S&T object at km 171+385, station at km 171+415, pedestrian underpass at km 171+450, underpass at km 171+793.bridge at km 172+051. culvert at km 172+451, overpass at km 172+515, underpass at km 173+134, bridge at km 194+581, bridge at km 201+255, bridge at km

208+820, bridge (culvert) at km 213+918 (e.g., immediate construction site with depression cones up to 50m in diameter). These locations are particularly sensitive due to the presence of a higher groundwater table. Therefore, continuous dewatering will be required during the digging of foundations pits, to maintain a dry working environment. If groundwater appears in the excavation, it will be necessary to lower it to at least 1.0 m below the excavation bottom level[14]. Since the construction phase is short term, and activities that could result in a reduction in groundwater yield will not occur at one location only (but at a number of different locations) and will be limited at each location to a few months (not more than 8), the effects are expected to be temporary, with groundwater yields expected to recover following the completion of the activities that have caused them to drop. (Grade 2)

Likelihood

The reduction in groundwater yield during dewatering and excavation is strongly influenced by the natural protection of aquifers. Well-protected aquifers are less immediately affected by dewatering. Dewatering will be required to temporarily lower the water table and facilitate the construction of designed structures in a dry working environment. Dewatering is certain to cause a local cone of depression in the groundwater table (the extent of which will at least partially depend on the rate of pumping), at locations where there are high groundwater levels. Likelihood of reduction in groundwater yield is estimated as possible (2) to certain (4).

The assessment of the significance of the impact of a reduction in groundwater yield during the construction phase of the Project is summarised in Table 10- below.

Table 10-11. Significance of the impact of a reduction in groundwater source yield during the construction phase

Receptors	Magnitude	Spatiotemporal scale	Sensitivity	Likelihood	Overall significance
Very high senisivity receptrors	The impact is negative and considered to be of low magnitude, as minor changes, not affecting the water supply, are expected (1)	The duration of the impact will be limited to the construction phase at the specified location (2)	The Gorunje, Striža and Dankovo groundwater sources are very highly sensitive as local communities are dependent on them for potable water (4)	The impact will occur with certainty in the Striža and Dankovo aquifers (4)	M (1) + ST (2) + S (4) + L (4) = (11) High

[14] *Geomehanika" d.o.o, Elaborate on geotechnical conditions for the reconstruction of the railway line*

Receptors	Magnitude	Spatiotemporal scale	Sensitivity	Likelihood	Overall significance
				The impact will occur possibly in the Gorunje aquifer since it is naturally protected (2)	M (1) + ST (2) + S (4) + L (2) = (9) Modetare
High sensitivity receptrors	The impact is negative and considered to be of moderate low magnitude, as minor changes, not affecting the water supply, to local communities are expected (1)	The duration of the impact will be limited to the construction phase at the specified location (2)	The Bahus groundwater source is highly sensitive because local communities are reliant on it for industrial purposes (3)	The impact will occur possibly in the Bahus aquifer since it is naturally protected (2)	M (1) + ST (2) + S (3) + L (2) = (8) Moderate
Moderate senisivity receptrors	The impact is negative and considered to be of moderate low magnitude, as minor changes, not affecting the water supply, to local communities are expected (1)	The duration of the impact will be limited to the construction phase at the specified location (2)	Moderate sensitivity locations where local communities are using groundwater for agricultural purposes (2)	The impact will occur with certainty (4)	M (1) + ST (2) + S (2) + L (4) = (9) Moderate

10.3.3. Operations Phase Impacts

During the operations phase of Project, potentially significant impacts on groundwater quality could result from spills or leaks of hazardous materials (for example, fuels and oils from trains) and/or the use of chemicals for maintenance activities (e.g., herbicides for vegetation control and anti-corrosion agents). Contaminants introduced to the environment can leach from soils into the underlying groundwater bodies, degrading groundwater quality over time, potentially affecting its potability, which in turn can result in impacts to human receptors, particularly if groundwater aquifers are a primary source of potable water for local communities.

Construction of underpasses and the foundations of other structures such as bridges and overpasses may introduce localized barriers to horizontal groundwater flow within aquifers, potentially causing temporary disruptions to groundwater flow paths. However, given that these structures are point-based rather than linear, they are not expected to permanently disrupt groundwater regimes and therefore have been **scoped out** from further assessment.

Project operations may require the abstraction of groundwater resources for the purposes of operating toilets in stations, sanitation, and railway maintenance activities if the use of municipal supplies for these purposes is not possible. However, the volumes of water required are not anticipated to be great enough to result in significant impacts on groundwater levels or yields and given the capacity of aquifers to recharge on an annual basis this impact has been **scoped out**.

The potentially significant impacts of concern on groundwater resources during the Operations phase is:

- spills or leaks of hazardous materials
- discharge of chemicals for maintenance activities

Impact of spills or leaks of hazardous materials

During the operations phase of the railway, accidental spills or leaks of hazardous materials such as fuels and oils from trains pose a potential risk to groundwater quality. If not properly managed, these substances may seep into the ground and eventually reach the underlying aquifers. The primary contaminants of concern include hydrocarbons from diesel and lubricants, heavy metals such as lead, mercury, arsenic, nickel, and copper released from train components, and polycyclic aromatic hydrocarbons (PAHs) generated through fuel breakdown.

Magnitude

The magnitude of this impact is considered low (1). The Gorunje and Bahus groundwater sources are naturally protected by overlying impermeable geological deposits, which serve as a barrier to vertical infiltration of surface contaminants. In addition, the railway infrastructure includes design features such as closed rainwater drainage systems, specifically intended to prevent the leaching of pollutants into the soil and groundwater.

Spatiotemporal impact (Spatial Extent and Duration)

In terms of spatiotemporal characteristics, any contamination from such spills is expected to be very localized, occurring primarily in areas such as train stations, maintenance yards, fuelling depots, or repair sites. If they reach groundwater sources, these pollutants can persist for various durations: organic compounds such as hydrocarbons and PAHs may last from several months to years, while heavy metals can remain indefinitely, though with low mobility. Based on these factors, the temporal extent of the impact is classified as medium-term, ranging from 5 to 20 years, while the spatial extent remains very limited (2) but may affect laterally connected waterbodies for a limited distance (3-5km).

Likelihood

The likelihood of significant changes in groundwater quality due to such spills is considered to be very low. This is primarily attributed to the protective nature of the geological formations overlying the aquifers and the inclusion of engineered mitigation measures in the railway's design. Given these precautions, the probability of pollutants reaching and affecting sensitive groundwater sources is minimal. Therefore, the impact's likelihood is assessed as Grade 1.The assessment of the significance of the impact of spills or leaks of hazardous materials on environmental receptors during the operations phase of the Project is summarised in Table **10**-12 below.

Table 10-12. Significance of impact of spills or leaks of hazardous materials during the operation phase

Location	Magnitude	Spatiotemporal scale	Sensitivity	Likelihood	Overall significance
Vicinity of stations, maintenance yards, or sites where repairs to the railway are necessary	Impact is considered to be of low magnitude since spills and leaks are not expected to affect groundwaters (1)	The impact is considered to be medium term -between 5 and 20 years and very localized (2)	The Gorunje, Striža and Dankovo groundwater sources are very highly sensitive as local communities are dependent on them for potable water (4)	The railway infrastructure has been designed protection measures and the natural protection provided by the impermeable layers ensures that aquifers remains protected and the impact has a very low probability of occurring (1)	M (1) + ST (2) + S (4) + L (1) = (8) Moderate
Vicinity of stations, maintenance yards, or sites where repairs to the railway are necessary	Impact is considered to be of low magnitude since spills and leaks are not expected to affect groundwaters (1)	The impact is considered to be medium term -between 5 and 20 years and very localized (2)	The Bahus groundwater source is highly sensitive because local communities are reliant on it for industrial purposes (3)	The natural protection provided by the impermeable layers and engineering design measures ensures that aquifer remains protected and the impact has a very low probability of occurring (1)	M (1) + ST (2) + S (3) + L (1) = (7) Low
Vicinity of stations, maintenance yards, or sites where repairs to the railway are necessary	Impact is considered to be of low magnitude since spills and leaks are not expected to affect groundwaters (1)	The impact is considered to be medium term -between 5 and 20 years and very localized (2)	Moderate sensitivity locations where local communities are using groundwater for agricultural purposes (2)	The railway infrastructure has been designed protection measures that will reduce the risk of contaminantion to low probability of occuring (1)	M (1) + ST (2) + S (2) + L (1) = (6) Low

Impact of discharge of chemicals for maintenance activities

The discharge of chemicals during railway maintenance activities represents another potential source of groundwater contamination. These substances include herbicides used for vegetation control along the tracks, as well as anti-corrosion agents applied to preserve rail infrastructure. If these chemicals are misapplied or if they are transported via surface runoff, they could enter the subsurface environment and pose a risk to groundwater quality.

Magnitude

Despite the potentially hazardous nature of some of these chemicals, the overall magnitude of the impact is considered moderate. This is due to the limited quantities typically used, the controlled manner in which they are applied, and the presence of design controls within the railway infrastructure that minimize the likelihood of widespread contamination. As a result, the deviation from baseline groundwater quality conditions is expected to be moderate (2).

Spatiotemporal impact (Spatial Extent and Duration)

The application of maintenance chemicals is localized to specific zones, such as the immediate trackside areas, maintenance yards, and other operational sites. Should they reach groundwater sources, the persistence of these substances can vary; herbicides and pesticides may degrade over a period of weeks to several years, depending on the specific chemical composition and environmental conditions. Given this, the contamination is anticipated to be medium-term, lasting between five and twenty years, while remaining spatially restricted. Whilst the impact is expected to be very localised, it may affect laterally connected waterbodies for a limited distance (3-5km). This leads to a Grade 2 assessment in terms of spatiotemporal extent.

Likelihood

The likelihood of significant groundwater contamination due to the discharge of maintenance chemicals is considered to be very low. In some cases, the impermeable deposits overlying the aquifers serve as a natural defence, and the use of such chemicals is typically regulated and limited in scope. For instance, the Gorunje and Bahus aquifers are naturally shielded by impermeable geological layers, reducing the chance that such chemicals would reach the groundwater. In addition, standard environmental management practices are expected to be in place to monitor and control the use of these substances. Accordingly, the likelihood of impact is very low (1).

The assessment of the significance of the impact of discharge of chemicals for maintenance activities during the operations phase of the Project is summarised in Table **10**-12 below.

Table 10-9. Significance of impact of discharge of chemicals for maintenance activities during the operation phase

Location	Magnitude	Spatiotemporal scale	Sensitivity	Likelihood	Overall significance
Vicinity of stations, maintenance yards, or sites where repairs to the railway are necessary	Impact is negative and expected to moderately affect the groundwaters; (2)	The impact is considered to be medium term - between 5 and 20 years and very localized (2)	The Gorunje, Striža and Dankovo groundwater sources are very highly sensitive as local communities are dependent on them for potable water (4)	The railway infrastructure has been designed protection measures or the natural protection provided by the impermeable layers ensures that aquifers remains protected and the impact has a very low probability of occurring (1)	M (2) + ST (2) + S (4) + L (1) = (9) Moderate
Vicinity of stations, maintenance yards, or sites where repairs to the railway are necessary	Impact is negative and expected to moderately affect the groundwaters; (2)	The impact is considered to be medium term - between 5 and 20 years and very localized (2)	The Bahus groundwater source is highly sensitive because local communities are reliant on it for industrial purposes (3)	The natural protection provided by the impermeable layers ensures that aquifer remains protected and the impact has a very low probability of occurring (1)	M (2) + ST (2) + S (3) + L (1) = (8) Moderate
Vicinity of stations, maintenance yards, or sites where repairs to the railway are necessary	Impact is negative and expected to moderately affect the groundwaters; (2)	The impact is considered to be medium term - between 5 and 20 years and very localized (2)	Moderate sensitivity locations where local communities are using groundwater for agricultural purposes (2)	The railway infrastructure has been designed proetection measures that will reduce the risk of contaminantion to low probability of occuring (1)	M (2) + ST (2) + S (2) + L (1) = (7) Low

10.3.4. Summary of impacts

Table 10-10. Summary of Significance of Construction and Operations Phase Groundwaters Impacts

Project phase	Impact	Positive/Negative	Sensitivity receptors	Overall significance before mitigation measures are implemented
Construction phase	Impact of direct discharge of pollutants	Negative	Very high	High/Moderate
			High	High
			Moderate	Moderate

Construction phase	Impact of indirect discharges via soil or surface water	Negative	Very high	Moderate
			High	Moderate
			Moderate	Low
Construction phase	Impact of indirect physical impacts	Negative	Very high	Moderate
			High	Moderate
			Moderate	Low
Construction phase	Impact of reduction in groundwater source yield on human receptors	Negative	Very high	High/Moderate
			High	Moderate
			Moderate	Moderate
Operation phase	Impact of spills or leaks of hazardous materials	Negative	Very high	Moderate
			High	Moderate
			Moderate	Low
Operation phase	Impact of discharge of chemicals for maintenance activities	Negative	Very high	Moderate
			High	Moderate
			Moderate	Low

10.4. Mitigation measures

10.4.1. Construction phase

Mitigation strategies during the construction phase aim to safeguard sensitive receptors by implementing measures to control groundwater contamination and a reduction in aquifer yields, and to ensure compliance with regulatory groundwater quality standards.

The Contractor should develop and implement the following:

- **Construction Water and Soil Management Plan**, which must include details of the measures that must be implemented to prevent or limit groundwater contamination and any reduction in aquifer yields.
- **Emergency Preparedness and Response Plan**, which outlines the procedures that must be followed for the immediate containment, cleanup and reporting of significant spills of hazardous substances to minimize their impact on the environment. Please see Chapter 17 of this ESIA Report (Major Accidents and Disasters).

Table 10-11 defines the mitigation measures proposed to mitigate the identified impacts, and which should, as a minimum, be included in the Construction Water and Soil Management Plan to be developed and implemented by the Contractor.

Table 10-11. Mitigation measures proposed to mitigate potential reductions in groundwater quality during the construction phase

Impact	Mitigation measures
Direct discharge of pollutants	■ A pre-construction inventory of users of informal groundwater wells should be carried out in areas identified as being at risk of contamination. This should include the well's location and baseline water quality data. ■ Fuels and potentially hazardous construction materials will be stored in special enclosed facilities with external cut-off drainage. ■ Waste fuels and other fluid contaminants will be collected in leak-proof containers prior to removal from site to an approved processing facility. ■ Fuelling and maintenance of construction vehicles and plant must be done on a dedicated area hard standing with cut-off drainage ■ Washing and cleaning of vehicles must also be performed on specially designated, impermeable areas with closed drainage and wastewater treatment. ■ Wastewater from concrete batching will be collected in a dedicated tank on site and disposed of off-site by a licensed contractor. ■ Appropriately and adequately stocked spill kits will be kept on site to be deployed in the event of a spillage or leak of a hazardous material. ■ Construction equipment will be regularly checked for oil and fuel leaks. ■ The discharge of untreated wastewater directly into or onto the ground is prohibited ■ Adequate portable toilets must be provided at construction site for workers ■ Site sanitary and drainage facilities must be properly operated and regularly maintained ■ Any Project septic tanks shall be made of impermeable material and will be emptied regularly by a licensed company for disposal. ■ Wastewater facilities must be established to collect/treat water draining from the Đunis tunnel during construction ■ Any hazardous materials, such as chemicals, oils, fuels, or waste, must be stored in secure, leak-proof containers with secondary containment systems. ■ Fuel storage and other chemical storage facilities should be located at least 30 meters from groundwater sources. ■ Activities that might increase the risk of contamination must be excluded from areas within 30 meters of sensitive water features.
Indirect discharges via soil or surface water	■ Suitable construction site drainage system should be provided by the Contractor including cut-off valves, ditches or drains and sustainable drainage systems, or equivalent, with suitably sized treatment facilities. ■ If required by relevant authorities, oil separators should be used. ■ Stormwater drains and oil water separators must be regularly serviced and maintained.

	▪ Use silt fences, sediment traps, and stabilize exposed soils quickly to reduce erosion. ▪ Implement diversion channels, check dams, and maintain drainage systems to control runoff and sediment transport.
Indirect physical impact on groundwater quality	▪ Suitable construction site drainage system including ditches or drains and sustainable drainage systems. ▪ The maximum width of the work corridor will be clearly defined and limitations of haul routes for material supply will be strictly limited. ▪ Any damage caused to ground and surface water infrastructure must be rectified. ▪ Construction activities are prohibited within sensitive areas, particularly around wells and springs ▪ Construction camps, machinery parking zones, spoil landfills, and storage sites should be located at least 100 meters from any sensitive zone ▪ The temporary storage of construction materials should be restricted within 30 meters of groundwater recharge areas ▪ Construction facilities are not allowed within identified groundwater sources ▪ Activities that might increase the risk of contamination must be excluded from areas within 30 meters of sensitive water features ▪ Site drainage systems: These manage both the containment of pollutants and stormwater runoff. ▪ Oil-water separators and impermeable surfaces: Prevent both direct pollution and spread via runoff. ▪ Zoning restrictions near water features: Help control both erosion and direct pollutant input.

Table 10-12. Mitigation measures proposed to mitigate potential reductions in groundwater yield during the construction phase

Impact	Mitigation measures
Reduction in groundwater source yield	■ Where users of informal groundwater wells are identified, baseline groundwater levels should be established prior to the commencement of construction in areas identified as being at risk of water table reductions. ■ Seal any open excavations that have created a pathway for groundwater flow. ■ The use of raft foundations and limiting the depths of piles or cut-off walls where possible to reduce aquifer penetration in high sensitivity zones. ■ Limit the area and duration of ground disturbance as far as possible to reduce the potential for groundwater contamination and disruption. ■ If dewatering is necessary, use controlled and monitored methods (such as sump pumping with flow regulation, flow meters, and piezometric monitoring) to prevent excessive lowering of the groundwater table.

10.4.2. Operations phase

It the responsibility of the SRI to develop and implement an **Operational Water and Soil Management Plan**. This should define that measures that must be implemented to manage the risk of groundwater contamination, including protocols for the application of herbicides.

The SRI should also develop and implement an **Operational Emergency Preparedness and Response Plan**, which details the emergency response principles and protocols to be implemented in the event of an emergency (including a major hazardous materials spill) to limit groundwater contamination.

As for the Construction phase, Table 10-13 defines the mitigation measures proposed to mitigate the identified impacts, and which should, as a minimum, be included in the Construction Water and Soil Management Plan to be developed and implemented by the SRI.

Table 10-13. Mitigation measures proposed to mitigate possible impacts on groundwater quality during the operational phase

Impact	Mitigation measures
Spills or leaks of hazardous materials	▪ Sections of the railway that pass through sanitary protection zones must have a prescribed speed limit and special transport security measures for dangerous/hazardous goods, in line with relevant regulations. ▪ Store hazardous and potentially contaminating materials required for railway maintenance in accordance with the Construction Phase Water and Soil Management Plan, including impermeable surfaces, secondary containment, and spill kits. ▪ Conduct regular training for railway staff on hazardous material handling, transport, and storage protocols. ▪ Run-off from the railway line will be contained by the track drainage system (helps manage potential contamination from leaks). ▪ Regular control and maintenance of drainage structures will be conducted to check they do not become clogged with debris or sediments (indirectly related to leak containment). ▪ Integrity of the septic tanks for sanitary wastewater in stations will be tested at regular intervals. ▪ Regularly maintain sediment traps and basins, drainage channels, and treatment systems (helps control contaminants from accidental leaks).
Discharge of chemicals for maintenance activities	▪ Where possible, limit the use of de-icing chemicals at stations during cold weather, giving preference to mechanical means. ▪ Application of herbicides will be managed to reduce unnecessary overuse and the risk of leaching into soil and groundwater. ▪ On all designed roads, drainage is carried out into the surrounding terrain, except for access roads to parking lots at stations, where a closed system, treatment via oil separators, and controlled discharge into a recipient (canal or river) is foreseen.

10.5. Monitoring

Regular monitoring should be undertaken throughout the construction and operations phases of the Project to ensure that the requirements of the E&S Management Plans, Lenders' Policies, and ESIA commitments are being met. Furthermore, any changes to baseline environmental conditions should be monitored, to verify that the mitigation measures being implemented by the construction contractor and SRI to prevent or limit potentially significant negative impacts are adequate and effective. Where monitoring indicates that negative impacts are occurring despite the requirements of Management Plans being met, additional mitigation measures may be required, and Management Plans revised accordingly.

The monitoring activities outlined in Table 10-14 below in relation to groundwaters are proposed for both the construction and operation phases.

Table 10-14. Proposed groundwater monitoring activities for the construction and operation phases

Monitoring Requirement	Frequency	Location	Method
Construction Phase			
Groundwater quality parameters	As needed (in case of accidental spill or upon of individual complaints)	All construction sites, areas of excavation (underpasses and overpasses) or groundwater sources	Instrumental monitoring at well points or boreholes, sampling, and laboratory analysis
Groundwater yield (flow rates and levels)	As needed (upon of individual complaints)	Near excavation sites, temporary dewatering areas	Monitoring well pumping tests, piezometer readings, measurement of flow rates from wells
Compliance with Water and Soil Management Plan	Continuous	All construction facilities and worksites	Visual inspections, document review for adherence to prescribed protection measures, auditing water quality monitoring reports
Pollution control and treatment measures (e.g., storage of fuels, oils, hazardous liquids, and integrity of spill kits)	Regular visual inspections throughout the construction period	Areas storing hazardous materials, fuel tanks, and construction zones with potential pollutant runoff	Visual inspections to ensure proper storage and integrity of containment systems, fuel/oil storage, and spill kits functionality
Operations Phase			
Integrity and efficiency of groundwater protection systems (e.g., geomembranes, concrete channels, drainage systems)	Regular intervals	All constructed groundwater protection systems along the railway	Visual inspections, integrity checks for any damage, performance testing, and operational assessments of drainage systems for any leaks or failures

10.6. Residual impact assessment

Table 10-9 presents an assessment of the residual significance of impacts on groundwater, during both the construction and operational phases of the Project, following implementation of the mitigation measures defined in Table 10-11–Table 10-13**Error! Reference source not found.**.

It should be noted that following the implementation of the recommended mitigation measures, in some instances the overall significance grade of the impact remains the same; 'Moderate'. This is because, despite either the magnitude or the likelihood of the impact being reduced as a result of mitigation, the spatiotemporal nature of the impact and the sensitivity of the receptors are fixed parameters, and their grades do not change. As such, even though the overall significance score is reduced (e.g. from 9 to 8) the final significance grade remains as 'Moderate'. This is in accordance with the methodology used in this ESIA (see Chapter 5).

Table 10-9. Significance of impacts on groundwaters after mitigation

Phase	Impact	Negative or Positive	Receptor sensitivity	Overall significance before mitigation	Summary of mitigation	Assessment of impact after mitigation	Overall significance after mitigation[15]
Construction	Direct discharges to groundwater	Negative	Very high	High	*Enclosed storage, Leak-proof collection, Controlled fuelling, Designated washing, Batching wastewater, Spill response, Leak checks, Discharge prohibition, Sanitary provision, Facility maintenance, Septic*	Following the implemention of mitigation measures the magnitude will be low (1), the impact will be temporary, only during construction and expected to be very localized (2), Very high sensitivity receptors (4), likelihood is very low (1)	*M (1) + ST (2) + S (4) + L (1) = (8) Moderate*

[15] Following the implementation of the recommended mitigation measures, in some instances the overall significance grade of the impact remains the same (Moderate). This is due to the fact that despite either the magnitude or the likelihood of the impact being reduced, the spatiotemporal nature of the impact and the sensitivity of the receptors are fixed parameters, and the grades do not change. As such, even though the overall significance score is reduced (e.g. from 9 to 8) the final significance grade remains as 'Moderate'. This is in accordance with the methodology used in this ESIA (see Chapter 5).

Phase	Impact	Negative or Positive	Receptor sensitivity	Overall significance before mitigation	Summary of mitigation	Assessment of impact after mitigation	Overall significance after mitigation[15]
			High	High	*integrity, Tunnel drainage, Secure containment, Storage setbacks, Contamination exclusion*	Following the implemention of mitigation measures the magnitude will be low (1), the impact will be temporary, only during construction and expected to be very localized (2), High sensitivity receptors (3), likelihood is very low (1)	*M (1) + ST (2) + S (3) + L (1) = (7) Low*
			Moderate	Moderate		Following the implemention of mitigation measures the magnitude will be low (1), the impact will be temporary, only during construction and expected to be very localized (2), moderate sensitivity receptors (2), likelihood is very low (1)	*M (1) + ST (2) + S (2) + L (1) = (6) Low*

Phase	Impact	Negative or Positive	Receptor sensitivity	Overall significance before mitigation	Summary of mitigation	Assessment of impact after mitigation	Overall significance after mitigation[15]
Construction	Indirect discharges via soil or surface water	Negative	Very high	Moderate	*Drainage system, Oil separation, Maintenance checks, Erosion control, Runoff management*	Following the implemention of mitigation measures the magnitude will be low (1), the impact will be temporary, only during construction and expected to be very localized (2), Very high sensitivity receptors (4), likelihood is very low (1)	*M (1) + ST (2) + S (4) + L (1) = (8) Moderate*
			High	Moderate		Following the implemention of mitigation measures the magnitude will be low (1), the impact will be temporary, only during construction and expected to be very localized (2), High sensitivity receptors (3), likelihood is very low (1)	*M (1) + ST (2) + S (3) + L (1) = (7) Low*
			Moderate	Low		Not applicable	

Phase	Impact	Negative or Positive	Receptor sensitivity	Overall significance before mitigation	Summary of mitigation	Assessment of impact after mitigation	Overall significance after mitigation[15]
Construction	Indirect physical impact on groundwater quality	Negative	Very high	Moderate	*Drainage infrastructure, Corridor limits, Infrastructure repair, Activity exclusion, Facility setbacks, Storage restrictions, Source protection, Contamination zoning, Stormwater control, Runoff isolation, Buffer zoning*	Following the implemention of mitigation measures the magnitude will be low (1), the impact will be temporary, only during construction and expected to be very localized (2), Very high sensitivity receptors (4), likelihood is very low (1)	*M (1) + ST (2) + S (4) + L (1) = (8)*
			High	Moderate		Following the implemention of mitigation measures the magnitude will be low (1), the impact will be temporary, only during construction and expected to be very localized (2), High sensitivity receptors (3), likelihood is very low (1)	*M (1) + ST (2) + S (3) + L (1) = (7) Low*
			Moderate	Low		Not applicable	

Phase	Impact	Negative or Positive	Receptor sensitivity	Overall significance before mitigation	Summary of mitigation	Assessment of impact after mitigation	Overall significance after mitigation[15]
Construction	Reduction in groundwater yield on human receptors	Negative	Very high	High	*Excavation sealing, Foundation limits, Disturbance minimization, Controlled dewatering*	Following the implemention of mitigation measures the impact from reduction in groundwater yield will be low (1), the impact is temporary, only during construction and expected to be very localized (2), very high sensitivity zones (4), likelihood is possible (2)	*M (1) + ST (2) + S (4) + L (2) = (9) Moderate*
			High	Moderate		Following the implemention of mitigation measures the magnitude will be low (1), the impact will be temporary, only during construction and expected to be very localized (2), High sensitivity receptors (3), low probability (1)	*M (1) + ST (2) + S (3) + L (1) = (7) Low*

Phase	Impact	Negative or Positive	Receptor sensitivity	Overall significance before mitigation	Summary of mitigation	Assessment of impact after mitigation	Overall significance after mitigation[15]
			Moderate	Moderate		Following the implemention of mitigation measures the magnitude will be low (1), the impact will be temporary, only during construction and expected to be very localized (2), moderate sensitivity receptors (2), likelihood is possible (2)	*M (1) + ST (2) + S (2) + L (2) = (7) Low*
Operation	Spills or leaks of hazardous materials	Negative	Very high	Moderate	*Hazard control Safe storage Capacity building Leak prevention Runoff containment System upkeep Waste integrity Debris management*	Following the implemention of mitigation measures the magnitude of the impact will be low (1), the impact is short term (less than 5 years) and expected to be localized (2), Very high sensitivity zones (4), likelihood is very low (1)	*M (1) + ST (2) + S (4) + L (1) = (8) Moderate*

Phase	Impact	Negative or Positive	Receptor sensitivity	Overall significance before mitigation	Summary of mitigation	Assessment of impact after mitigation	Overall significance after mitigation[15]
			High	Moderate		Following the implemention of mitigation measures the magnitude of the impact will be low (1), the impact is short term (less than 5 years) and expected to be localized (2), High sensitivity zones (3), likelihood is very low (1)	*M (1) + ST (2) + S (3) + L (1) = (7) Low*
			Moderate	Low		Not applicable	
Operation	Discharge of chemicals for maintenance activities	Negative	Very high	Moderate	*Chemical reduction Leaching prevention Controlled drainage*	Following the implemention of mitigation measures the magnitude of the impact will be low (1), the impact is short term (less than 5 years) and expected to be localized (2), Very high sensitivity zones (4), likelihood is very low (1)	*M (1) + ST (2) + S (4) + L (1) = (8) Moderate*

Phase	Impact	Negative or Positive	Receptor sensitivity	Overall significance before mitigation	Summary of mitigation	Assessment of impact after mitigation	Overall significance after mitigation[15]
			High	Moderate		Following the implemention of mitigation measures the magnitude of the impact will be low (1), the impact is short term (less than 5 years) and expected to be localized (2), High sensitivity zones (3), likelihood is very low (1)	*M (1) + ST (2) + S (3) + L (1) = (7) Low*
			Moderate	Low		Not applicable	

10.7. Conclusion

Without the implementation of appropriate and adequate mitigation measures, the construction of the Project may result in significant negative impacts on groundwater quality; through the mobilisation/leaching of contaminants in the soil (following accidental spills or leaks of hazardous substances on construction sites). Additionally, a localised reduction in groundwater yield may result from the need to dewater excavations in areas with high groundwater levels.

Sensitive receptors that could be negatively impacted by a reduction in groundwater yield and/or quality during the construction phase include local communities/businesses who rely on groundwater resources e.g. for potable water supply, crop irrigation, industrial processes or commercial products.

Mitigation measures will be included in the Construction Water and Soil Management Plan to be developed and implemented by the construction contractor, including strict protocols for vehicle/equipment refuelling, hazardous materials storage, handling and transport, and the collection and proper disposal of wastewater. The Plan will also outline the measures that must be taken to limit reductions in groundwater levels as a result of the de-watering of excavations. The mitigation measures should be tailored to the sensitivity of receptors.

During the operations phase, the Project could result in potentially significant impacts on groundwater quality without appropriate and adequate mitigation. Impacts could result from accidental spills/leaks of fuels/oils or contamination from heavy metals from brake wear and rail degradation, PAHs from fuel decomposition, pesticides and herbicides used for vegetation control, and de-icing salts.

During the operational phase, SRI will be responsible for developing and implementing an equivalent Operational Water and Soil Management Plan that will define the mitigation measures that must be implemented to manage impacts on groundwaters to limit or prevent a reduction in quality.

Groundwater quality and yield monitoring will be required throughout the construction phase in case of accidental spills/leaks or upon of individual complaints. Where monitoring indicates that negative impacts are occurring despite the requirements of Management Plans being met, additional mitigation measures may be required, and Management Plans revised accordingly to safeguard groundwaters across the Project area.

10.8. Literature

1. “Geomehanika” d.o.o, Elaborate on geotechnical conditions for the reconstruction of the railway line (under preparation)

2. Boreli-Zdravković, Đ., & Miljević, N. (2012). Chapter 4.8: Groundwater and nitrogen. In: Dimkić, M., Brauch H. J., & Kavanaugh, M. (Ed.), Groundwater management in large river basins (pp.388-429). Belgrade: Jaroslav Černi Institute for Water Management.
3. Directive (EU) 2020/2184 of the European Parliament and of the Council of 16 December 2020 on the quality of water intended for human consumption (recast)
4. Geomehanika d.o.o, Elaborate on geotechnical conditions for the reconstruction of the railway line (under preparation)
5. Milanović, S., Stevanović, Z., Đurić, D., Petrović, T., Milovanović, M., Mandić, M. (2011). Project: Monitoring of groundwater resources Srbije. Subproject: Creation of a map of the risk of groundwater in Serbia. https://geoliss.mre.gov.rs/prez/KartaUgrPodVodWeb/index.html
6. Official Gazette, Regulation on water classification: 5/1968-64, https://www.pravno-informacioni-sistem.rs/SlGlasnikPortal/eli/rep/sgsrs/vlada/uredba/1968/5/1/reg
7. Perović, M. (2019). Assessment of the influence and regional specificity of hydrogeochemical conditions on the transformation of nitrogenous compounds in groundwater (doctoral dissertation). Novi Sad: University of Novi Sad, Faculty of Technical Sciences.
8. Powers, J.P., Corwin, A.B., Schmall, P.C. and Kaeck, W.E., 2007. Construction dewatering and groundwater control: new methods and applications. John Wiley & Sons.
9. Preene, M. and Brassington, R., 2003. POTENTIAL GROUNDWATER IMPACTS FROM CIVIL-ENGINEERING WORKS. Water and Environment Journal, 17(1), pp.59-64.
10. Regulation on limit values of polluting, harmful, and hazardous substances in the soil, Annex 2: remediation values of polluting, harmful, and hazardous substances in aquifer ("Official Gazette of RS", no. 30/18 and 64/19)
11. Republic Hydrometeorological Institute of Serbia, Hydrological yearbooks, Groundwaters 2017-2022, https://www.hidmet.gov.rs/
12. Roberts, T., Preene, M. and Powrie, W., 2022, December. The changing nature of groundwater control for temporary works. In Proceedings of the Institution of Civil Engineers-Civil Engineering (Vol. 176, No. 5, pp. 11-20). Thomas Telford Ltd.
13. Rulebook on the hygienic suitability of drinking water, Official Gazette of the FRJ no. 42/98, 44/99. and Official Gazette of the RS, no. 28/2019
14. Rulebook on the method of determining and maintaining sanitary protection zones of water supply sources, "Official Gazette of RS", no. 92/2008
15. Stojadinović, D. (1992) Hydrogeological characteristics of alluvial deposits and rims of Velika Morava from the perspective of the possibility of using spring water (Doctoral dissertation). Belgrade: University of Belgrade, Faculty of Mining and Geology.
16. The project of sanitary protection zones of the spring "Gorunje" - wells BV-2, BV-7, BV-P, BV-10, Public enterprise “Vodovod”, Paraćin, 2007.
17. Wang, G.F., Lyu, H.M., Shen, J.S., Lu, L.H., Li, G. and Arulrajah, A., 2017. Evaluation of environmental risk due to metro system construction in Jinan, China. International Journal of Environmental Research and Public Health, 14(10), p.1114.
18. Woldeamanuel, B., 2014. Evaluation and Selection of Railway Station for the Case of Addis Ababa/Sebeta–Dire Dawa Network Line (Doctoral dissertation, Addis Ababa University)
19. Directive (EU) 2020/2184 of the European Parliament and of the Council of 16 December 2020 on the quality of water intended for human consumption (recast)
20. Rulebook on the hygienic suitability of drinking water, Official Gazette of the FRJ no. 42/98, 44/99. and Official Gazette of the RS, no. 28/2019
21. Regulation on limit values of polluting, harmful, and hazardous substances in the soil, Annex 2: remediation values of polluting, harmful, and hazardous substances in aquifer ("Official Gazette of RS", no. 30/18 and 64/19)

22. Rulebook on the method of determining and maintaining sanitary protection zones of water supply sources, "Official Gazette of RS", no. 92/2008
23. Milanović, S., Stevanović, Z., Đurić, D., Petrović, T., Milovanović, M., Mandić, M. (2011). Project: Monitoring of groundwater resources Srbije. Subproject: Creation of a map of the risk of groundwater in Serbia. https://geoliss.mre.gov.rs/prez/KartaUgrPodVodWeb/index.html
24. Official Gazette, Regulation on water classification: 5/1968-64, https://www.pravno-informacioni-sistem.rs/SlGlasnikPortal/eli/rep/sgsrs/vlada/uredba/1968/5/1/reg
25. Filipović, B., Krunić, O., & Lazić, M. (2005). Regional hydrogeology of Serbia. Belgrade: University of Belgrade, Faculty of Mining and Geology
26. Stojadinović, D. (1992) Hydrogeological characteristics of alluvial deposits and rims of Velika Morava from the perspective of the possibility of using spring water (Doctoral dissertation). Belgrade: University of Belgrade, Faculty of Mining and Geology

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#ЕУ ЗА ТЕБЕ

EU PPF - PROJECT PREPARATION FACILITY

RAILWAY LINE BELGRADE–NIŠ, SECTION III, Paraćin to Trupale (Niš) Environmental and Social Impact Assessment, 11. CLIMATE RISK AND VULNERABILITY ASSESSMENT

EU PPF
PROJECT PREPARATION FACILITY

General

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LIST OF ABBREVIATIONS AND ACRONYMS

BMY	Belgrade Marshalling Yard
BRJ	Belgrade Railway Junction
CA	Contracting Authority
CD	Conceptual Design
CEB	Council of Europe Development Bank
DG NEAR	Directorate-General for Neighbourhood and Enlargement Negotiations
DD	Detailed Design
EBRD	European Bank for Reconstruction and Development
EC	European Commission
EIA	Environmental Impact Assessment
EIB	European Investment Bank
ESIA	Environmental and Social Impact Assessment
ESMP	Environmental and Social Management Plan
EU	European Union
EUD	European Union Delegation
FS	Feasibility Study
GHG	Greenhouse Gas
IFI	International Financing Institution
IFICO	IFI coordination office / EU Horizontal Support to Coordination with International Financing Institutions
IPA	Instrument for Pre-accession
IPF	Infrastructure Project Facility
IPF10	Infrastructure Project Facility -Technical Assistance10, 10th (current) contract
IR	Inception Report
JASPERS	Joint Assistance to Support Projects in European Regions
LARPF	Land Acquisition and Resettlement Policy Framework
LFI	Lead Financial Institution
MCTI	Ministry of Construction, Transport and Infrastructure
MD	Main Design
MIS	WBIF Management Information System
NDC	Nationally Determined Contributions

NIPAC	National IPA Coordinator
PD	Preliminary Design
PFS	Pre-feasibility study
PIP	Project Implementation Plan
PIU	Assistance during Project Implementation
RAP	Resettlement Action Plan
RCP	Representative Concentration Pathways
SDR	Social Discount Rate
SER/SRB	Serbia
SEP	Stakeholder Engagement Plan
SNKE	Senior Non-Key Expert
SRI	Infrastructure of Serbian Railways
SRPS	Serbian Standards
SSPs	Shared Socioeconomic Pathways
TA	Technical Assistance
TEN-T	Trans-European Transport Networks
ToR	Terms of Reference
TRA	Transport sector
WBIF	Western Balkans Investment Framework

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1. INTRODUCTION

This Chapter responds directly to EIB's requirement for a Climate Risk and Vulnerability Assessment (CRVA) under ESS 5, and EBRD's requirement for an assessment of the vulnerability of the Project to risks caused by climate change under PR 4; and follows recognised European technical guidance. As such, the methodology adopted does not follow the standard ESIA methodology outlined in Chapter 5 of ESIA Report and focuses on the impacts of climate change on the Project (adaptation), rather than impacts of the Project on climate change. Impacts of the Project on the climate change are quantified through the calculation of the GHG emissions that are predicted to be generated during the construction and operations phases of the Project, please see Annex 2 of this ESIA Report. Adaptation measures to avoid or minimise the negative impacts of climate change on the Project are proposed. The methodologies and data sources used are listed.

Estimates show that the Republic of Serbia is warming more intensively and faster than the global average. While the observed increase in the global average temperature is 1.1°C, Serbia is already at 1.8°C, and in the summer, it is as much as 2.6°C. At the same time, since 2000, the Republic of Serbia has faced several significant extreme climate and weather events that have caused significant material and financial losses, as well as the loss of human lives. The total minimum material damages caused by extreme climatic and weather events in the 2000-2020 period amount to EUR 6.8 billion. More than 70% of the damages were caused by droughts and high temperatures due to climate change and extreme weather events. Another major cause of significant losses was flooding. The climate hazards frequency and intensity will continue to increase in the future, with a clear trend of change until the mid-21st century period, after which the changes depend on the success of the implementation of the climate change mitigation measures specified in the Paris Agreement, which was signed and ratified by the Republic of Serbia. The climate hazards that cause the most significant damage and losses in the Republic of Serbia and whose intensity and frequency are increasing are heat waves, intensive precipitation and droughts. Other climate hazards that are caused by climate change and manifested depending on the regional characteristics are: floods, landslides, rockfalls, fires, etc.

2. LEGISLATIVE AND POLICY FRAMEWORK

2.1 Global & EU Requirements

Serbia is a signatory to and has ratified all major international environmental agreements, including the 2030 Agenda for Sustainable Development, the UN Framework Convention on Climate Change and the Paris Agreement.

The United Nations Framework Convention on Climate Change established an international environmental treaty to combat "dangerous human interference with the climate system", in part by stabilizing GHG concentrations in the atmosphere. The Paris Agreement is a legally binding international treaty on climate change. It was adopted by 196 Parties at COP 21 in Paris on 12 December 2015, including Serbia, and entered into force on 4 November 2016. Its goal is to limit global warming to well below 2°C, preferably to 1.5°C, compared to pre-industrial levels. Operation level of Paris Accords is regulated by each signed country nationally determined contributions (NDCs).

At the EU level, the goal of climate neutrality by 2050 set by the European Green Deal was operationalized and made legally binding through EU Climate Law (reducing net GHG emissions by at least 55% by 2030, compared to 1990 levels). Fit for 55 is designed especially for this purpose and it represents a package of proposals to make the EU's climate, energy, land use, transport and taxation policies fit for planned 55%. Under Fit for 55 a number of climate-related regulations are supposed to be updated: EU ETS, Effort Sharing Regulation; Land use, land use change and forestry Regulation; Energy Efficiency Directive; Renewable Energy Directive; CO2 emissions performance standards for cars and vans, Energy Taxation Directive. Serbia has not committed to climate neutrality and the current NDC goal is -33% until 2030.

The new EU strategy on adaptation to climate change sets out how the EU can adapt to the unavoidable impacts of climate change and become climate resilient by 2050. The EU Climate Change Adaptation Strategy was adopted in February 2021, based on the previous 2013 EU Strategy, with the main goal of increasing the resilience of the EU and the Member States to climate change. Within the EU Strategy framework, Member States (not including Serbia) are invited to adopt their comprehensive strategies and provide financial resources for the implementation of identified/necessary adaptation actions and for the national adaptive capacity strengthening. The EU Strategy emphasizes in particular the necessity of establishing an effective adaptation system at the level of local self-government units under the Covenant of Mayors for Climate and Energy Initiative. In principle, the EU insists on establishing an efficient monitoring, reporting and evaluation system, prioritizing monitoring and reporting. The Strategy has four main objectives: to make adaptation smarter, swifter and more systemic, and to enhance international action on adaptation to climate change. The EU legislation, which has been implemented since in 2021. in accordance with the Paris Agreement, introduces for the first time adaptation to climate change. Regulation (EU) 2018/1999 requires the inclusion of climate change impact on the energy supply security assessment in the National Energy and Climate Plans (NECPs), primarily through the availability of cooling water for power plants and biomass availability for energy production. The biennial NECP implementation reports should contain, inter alia, information on climate change adaptation. Regulation (EU) 2018/1999 also mandates biennial reporting on national climate change adaptation planning and strategies, planned and implemented actions to facilitate adaptation to climate change, specifically:

- the main objectives and institutional organization;
- climate change scenarios, climate extremes, climate change impacts, vulnerability and risks assessment and major climate hazards;
- capacity for climate change adaptation;
- adaptation plans and strategies;
- monitoring and evaluation framework;
- implementation progress, including good practices and governance changes.

In addition, the subject of Regulation (EU) 2018/1999 is reporting on financial, technical and capacity-building assistance provided to developing countries for the implementation of climate change adaptation and mitigation measures and activities. Regulation (EU) 2020/1208 specifies the reporting format in which Member States need to submit information on their national climate change adaptation measures, in accordance with Article 19 of Regulation (EU) 2018/1999, as well as the observed climate hazards. Directive 2011/92/EU on the assessment of the effects of certain public and private projects on the environment, as amended by 2015/52/EU requires to consider the vulnerability of the project to climate change in both the screening (Annex III of the Directive) and in the EIA (Annex IV of the Directive). For the EU, the overall policy and legislation effectiveness is conditioned by the inclusion of climate change adaptation in the sectoral policies, especially in the areas of infrastructure, agriculture, forest and water management, health, and disaster risk reduction, and continued progress is required in strengthening adaptive capacity and resilience to climate change.

The European Green Deal was presented in 2019 and sets out an ambitious plan for a climate-neutral economy enabling economic growth simultaneously with GHG emission reduction and climate change adaptation. The Green Agenda for the Western Balkans envisages the climate action, including decarbonization and climate change adaptation, as one of its five pillars. The Western Balkans countries fully supported it and adopted the regional Action Plan for its implementation, based on the Sofia Declaration on the Green Agenda for the Western Balkans. Serbia adopted the Green Agenda Declaration in October 2020 at the Western Balkans Sofia Summit (Sofia Declaration) and has committed to implement its actions through the Regional Action Plan adopted in Brdo in October 2021.

2.2 EIB Requirements

The EIB's Standard 5 recognises the importance and urgency of combating climate change, which poses a major global threat and is a common concern of humankind, as rising temperatures increasingly result in severe, pervasive and irreversible negative impacts for people, economic activities, ecosystems and the regenerative capacity of the planet. This Standard sets out the responsibilities of promoters with respect to climate change mitigation and adaptation and thereby to the fight against climate change. This Standard promotes the alignment of projects supported by the EIB with the goals and principles of: (i) the Paris Agreement and (ii) the Sustainable Finance Action Plan. It does so by stipulating that climate change mitigation and adaptation considerations must be explicitly addressed and incorporated by promoters in the decision-making process of the projects that the EIB supports, in accordance with the approaches established in the EIB Group Climate Bank Roadmap and the EIB Climate Strategy. This Standard applies to all operations and the specific requirements that need to be addressed are determined during the environmental impact assessment/environmental and social impact assessment (EIA/ESIA) process (as outlined in Standard 1) and the EIB appraisal, based on the nature and scope of the project.

Where a project is determined by the EIB to be at risk from physical climate hazards, the promoter shall carry out a Climate Risk and Vulnerability Assessment (CRVA), in line with the approach adopted by the relevant EIB Standards. The CRVA shall (i) assess how climate change may affect the project and the system in which the project takes place, including the natural environment and the people potentially affected, and (ii) identify commensurate adaptation measures to reduce the risks posed by climate change to the project and the system in which it takes place. The purpose of this assessment is to meet this requirement of ESS 5.

2.3 EBRD Requirements

Specific requirements covering climate risk and vulnerability impacts are established in the following Performance Requirements (PRs).

EBRD PR 3: Resource Efficiency and Pollution Prevention and Control – This PR is also relevant in terms of a Project-level approach to climate impacts and GHG emissions. The project-related risks and impacts associated with the generation of emissions needs to be assessed in the context of project location and local environmental conditions. Appropriate mitigation measures, technologies and practices should be adopted for the reduction of GHG emissions. Projects that are expected to result in a change in GHG emissions, either positive or negative, of more than 25 kt CO2eq per year are subject to an ex-ante GHG assessment.

EBRD PR 4: Health, Safety and Security – This PR requires that the client identify and assess the potential risks caused by natural hazards, such as earthquakes, droughts, landslides or floods as these relate to the project. This may require the clients to undertake an assessment of the vulnerability of the project to risks caused by the climate change and identify appropriate climate resilience and adaptation measures to be integrated into the project design.

2.4 National Legislative Framework

The Government of Serbia, in March 2021, adopted a Law on climate change ("Official Gazette of the Republic of Serbia", No 26/2021), which sets the legal framework for future action on GHG mitigation and adaptation. The law establishes the main policies and principles related to climate change, with the aim to establish a system that leads to the reduction of GHG emissions, in order to avoid the dangers and negative effects of global climate change. Based on this law, the Government of Serbia has adopted the Strategy of the Low Carbon Development of the Republic of Serbia for the 2023-2030 period with projections until 2050. Also, the Law on climate change foresees adoption of the first National Climate Change Adaptation Programme of Serbia. With the revised Nationally Determined Contribution (NDC), which was adopted by the Government in August 2022, Serbia increased its climate ambition by three times and thereby contributed to the achievement of the global goal of reducing GHG emissions (33.3% compared to the level of emissions in 1990, in all relevant sectors).

In April 2021, Serbia adopted a package of important energy laws, including new laws on renewables and energy efficiency. In July 2024. Serbia adopted an ambitious integrated National energy and climate plan (NECP) in a transparent and effective way, translating its commitment to the Green Agenda for the Western Balkans into concrete action including on introducing carbon-pricing instruments and phasing out coal subsidies. The adoption and implementation of a climate strategy and action plan embedded in an ambitious NECP, which is consistent with the EU 2050 framework for climate and energy policies, and which addresses adaptation to climate change, is paramount for Serbia's future low carbon development.

In order to ensure the systemic implementation and monitoring of the climate change adaptation, which the Republic of Serbia committed to by signing the Paris Agreement (ratified in 2017), the Law on Climate Change, adopted in 2021, prescribes the preparation of the Climate Change Adaptation Programme with the Action Plan. The Programme (valid from 2024) was developed in accordance with the EU Climate Change Adaptation Strategy principles (adopted in 2021), which prescribe the need for "smarter", "swifter" and "systemic" adaptation implementation, with an emphasis on the importance of preserving water resources, which are considered to be particularly affected by climate change. In the course of the final drafting of the Programme, the Guidelines on Member States' adaptation strategies and plans from

June 2023 have also been taken into account. Therefore, the adoption and implementation of the 2023-2030 Climate Change Adaptation Programme is of general interest for the Republic of Serbia.

In addition, The Low Carbon Development Strategy of the Republic of Serbia for the period 2023-2030 with projections by 2050 ("Official Gazette of the RS", Number 46/23) adopted in June 2023, recognizes the risks of climate change for the sustainable development of the Republic of Serbia. In particular, the Strategy defines two specific objectives that take into account climate change adaptation – Specific Objective 4: Preserving the potential of mitigation measures, specified for the periods until 2030 and until 2050, by increasing climate change resilience in the priority sectors; and Specific Objective 5: Promoting transition to climate-neutral economy and climate-resilient society.

3. BASELINE CONDITIONS

The climate relevant to the Project'is continental to temperate-continental, and the amount of precipitation is usually up to 500-600 mm/ year, while the air humidity is moderate. It is characterized by relatively colder winters, warmer autumns than spring and moderately warm summers. More specifically, low annual precipitation dominates, while summer precipitation is characterized by stroung evaporation due to high temperatures, with frequent occurrence of summer storms and showers. Winds are a very important factor causing temperature differences, bringing precipitation or drought. Wind speed is usually low.[1]

Based on the Köppen climate classification, the Project is located in Cfb climate[2] (Figure 3-1). The temperate oceanic climate (C = warm temperate f = fully humid b = warm summer) is characterized by cool summers and mild winters, with a relatively narrow annual temperature range and few extremes of temperature. The following figure represents the Köppen-Geiger climate classification at a high 1-km resolution for historical climate conditions in periods of 1991-2020 and 1961-1990.

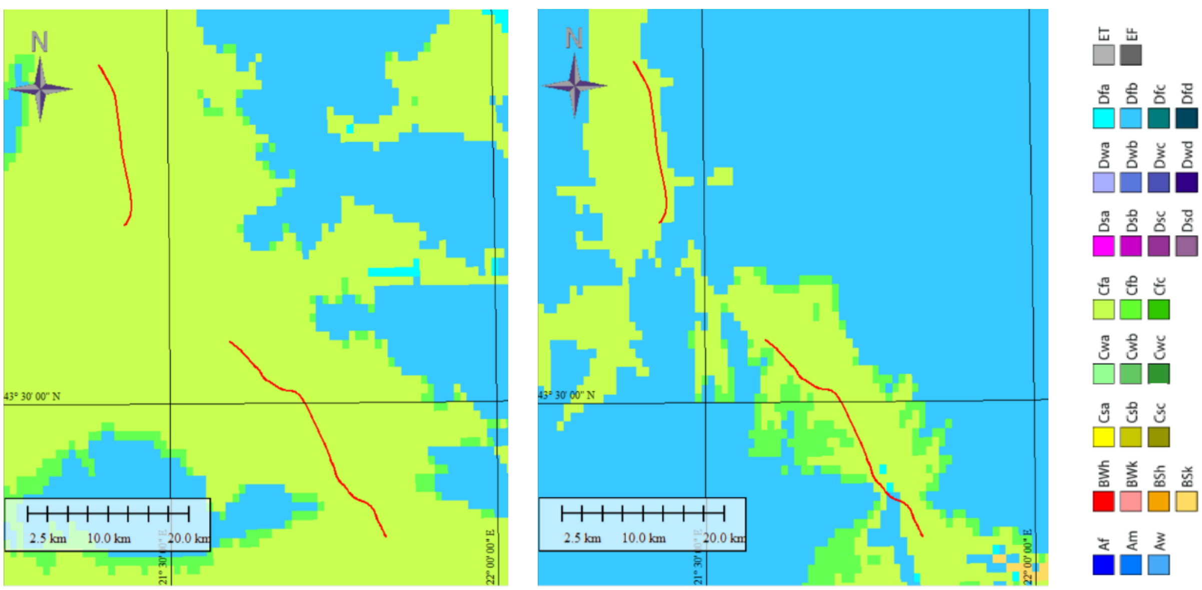


Figure 3-1. Köppen climate classification along the railway route for the period 1991-2020 (left) and 1961-1990 (right)

[1] *Ducić, V. Radovanović, M., Climate of Serbia, 2005, https://www.researchgate.net/publication/280253026_Klima_Srbije*

[2] *Beck, H. E., T. R. McVicar, N. Vergopolan, A. Berg, N. J. Lutsko, A. Dufour, Z. Zeng, X. Jiang, A. I. J. M. van Dijk, and D. G. Miralles: High-resolution (1 km) Köppen-Geiger maps for 1901–2099 based on constrained CMIP6 projections, Scientific Data.*

3.1 Meteorological statistics

Within the wider Corridor Project alignment, there are 3 meteorological stations, Ćuprija, Kruševac and Niš, which provide relevant climatic data for the Project. Additional sources of information are the Republic Hydrometeorological Service of Serbia and Meteoblue (https://www.meteoblue.com).

Ćuprija Station

The absolute maximum temperature in this area reached the value of 44.6°C (2007), and the absolute minimum temperature reached the value of -28.4°C (1956). The maximum daily precipitation was 87.8mm (1972), while maximum daily snow high was 58 cm (1987).

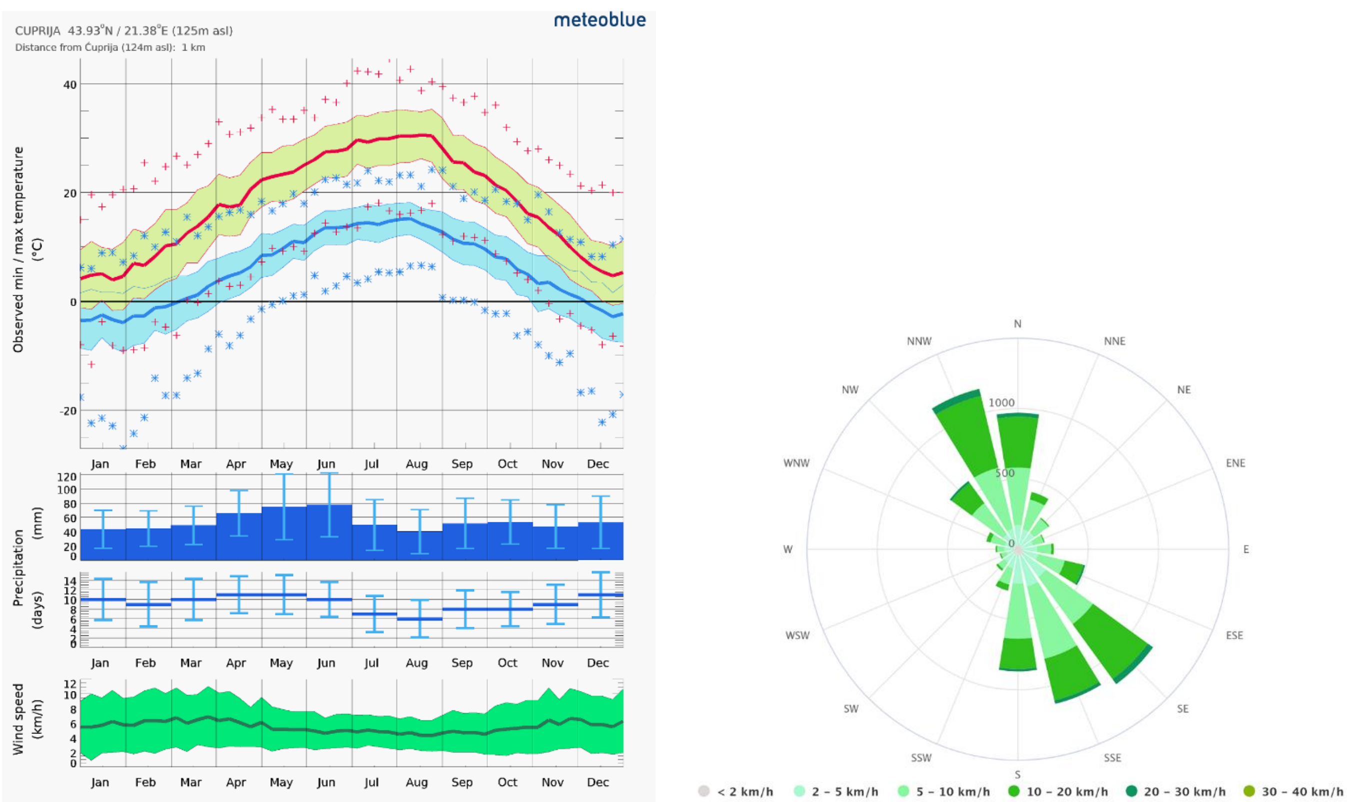


Figure 3-2. 30 years (1990-2020) historical meteorological data – Ćuprija (Meteoblue)

Table 3-1. Average monthly, annual and extreme values 1961–1990

	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec	Annual
Temp [°C]													
Average max	3,1	6,1	11,7	17,8	22,6	25,5	27,5	27,8	24,2	18,1	10,9	4,8	16,7
Average min	-4,2	-2,1	1,0	5,1	9,8	12,6	13,5	13,0	10,0	5,6	1,9	-2,0	5,4
Absolute max	20,0	23,8	28,6	32,7	35,4	38,0	40,2	39,2	38,0	31,3	28,0	20,0	40,2
Absolute min	-27,1	-25,8	-17,2	-6,8	-3,2	1,0	5,2	3,6	-3,3	-7,6	-18,6	-19,0	-27,1
Avg number of frost days	23,8	18,6	12,3	3,8	0,1	0,0	0,0	0,0	0,3	4,0	9,9	19,1	91,9
Avg number of tropical days	0,0	0,0	0,0	0,1	1,2	5,0	9,1	10,9	3,5	0,2	0,0	0,0	30,0
Relative humidity [%]													
Average	81,8	78,4	71,6	68,7	70,8	72,9	71,3	71,3	74,2	76,2	80,3	83,9	75,1
Insolation													
Average	52,8	74,4	126,5	156,1	203,3	212,4	258,7	251,0	192,8	148,0	75,7	38,1	1789,8
Number of clear days	2,9	3,4	4,5	3,6	3,9	4,2	9,3	11,6	9,7	8,1	3,7	2,5	67,4
Number of cloudy days	15,9	12,8	12,6	9,5	8,8	6,6	4,7	4,1	6,2	8,2	12,8	16,1	118,3
Precipitation [mm]													
Avg monthly sum	45,6	43,5	45,2	52,9	78,7	87,5	60,7	43,4	47,7	37,8	52,9	55,6	651,5
Max daily sum	26,1	42,0	28,2	38,2	54,3	42,8	50,5	87,8	48,2	32,3	44,0	34,1	87,8
Avg number of days >= 0.1 mm	14,4	12,8	12,9	12,7	14,3	13,4	9,6	9,0	8,3	8,5	12,5	15,3	143,7
Avg number of days >= 10.0 mm	1,0	1,0	1,3	1,4	2,4	2,9	2,2	1,0	1,7	1,3	1,7	1,5	19,4
Number of days with													
Snow	10,6	7,5	4,7	0,3	0,0	0,0	0,0	0,0	0,0	0,2	2,3	8,8	34,4
Snow cover	15,7	10,4	4,2	0,1	0,0	0,0	0,0	0,0	0,0	0,1	3,2	13,1	46,8
Fog	2,5	1,6	0,6	0,7	1,0	0,7	0,8	1,0	2,5	3,7	3,0	3,5	21,6
Hail	0,0	0,0	0,0	0,2	0,3	0,5	0,1	0,1	0,0	0,0	0,0	0,0	1,2

Table 3-2. Average monthly, annual and extreme values 1981–2010

	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec	Annual
Temp [°C]													
Average max	4,4	6,9	12,5	18,3	23,6	26,7	29,2	29,5	24,4	18,4	11,1	5,5	17,5
Average min	-3,3	-2,8	0,7	5,1	9,7	12,6	14,1	13,9	10,2	6,1	1,7	-1,9	5,5
Absolute max	20,6	23,4	29,0	33,0	35,3	40,1	44,6	42,7	38,0	32,7	28,0	21,4	44,6
Absolute min	-27,1	-25,8	-17,3	-8,1	-1,4	1,0	4,1	4,4	-0,1	-8,0	-16,2	-20,8	-27,1
Avg number of frost days	23	20	13	4	0	0	0	0	0	4	11	19	95
Avg number of tropical days	0	0	0	0	3	8	14	15	4	0	0	0	43
Relative humidity [%]													
Average	82	77	71	68	69	70	68	67	73	77	79	83	74
Insolation													
Average	68,9	94,0	146,6	180,8	235,7	261,0	297,1	282,9	205,5	154,6	92,8	58,2	2078,1
Number of clear days	3	4	4	4	4	7	11	13	9	7	4	3	73
Number of cloudy days	15	12	10	9	8	5	4	4	6	8	12	16	109
Precipitation [mm]													
Avg monthly sum	46,1	45,4	45,1	60,6	64,1	80,2	57,0	46,6	52,2	50,6	53,8	56,5	658,2
Max daily sum	28,7	42,0	25,4	44,2	48,3	106,4	50,8	73,8	50,3	42,5	33,4	31,6	106,4
Avg number of days >= 0.1 mm	15	13	12	14	13	12	10	8	10	10	12	16	146
Avg number of days >= 10.0 mm	1	1	1	2	2	3	2	2	2	2	2	2	20
Number of days with													
Snow	9	8	4	1	0	0	0	0	0	0	3	8	33
Snow cover	14	12	4	0	0	0	0	0	0	0	4	12	46
Fog	3	1	1	1	1	0	1	1	1	3	2	3	17
Hail	0	0	0	0	0	0	0	0	0	0	0	0	1

Kruševac Station

The absolute maximum temperature in this area reached the value of 43.7°C (2007), and the absolute minimum temperature reached the value of -30.0°C (1947). The maximum daily precipitation was 81.9 mm (1956), while maximum daily snow high was 59 cm (1963).

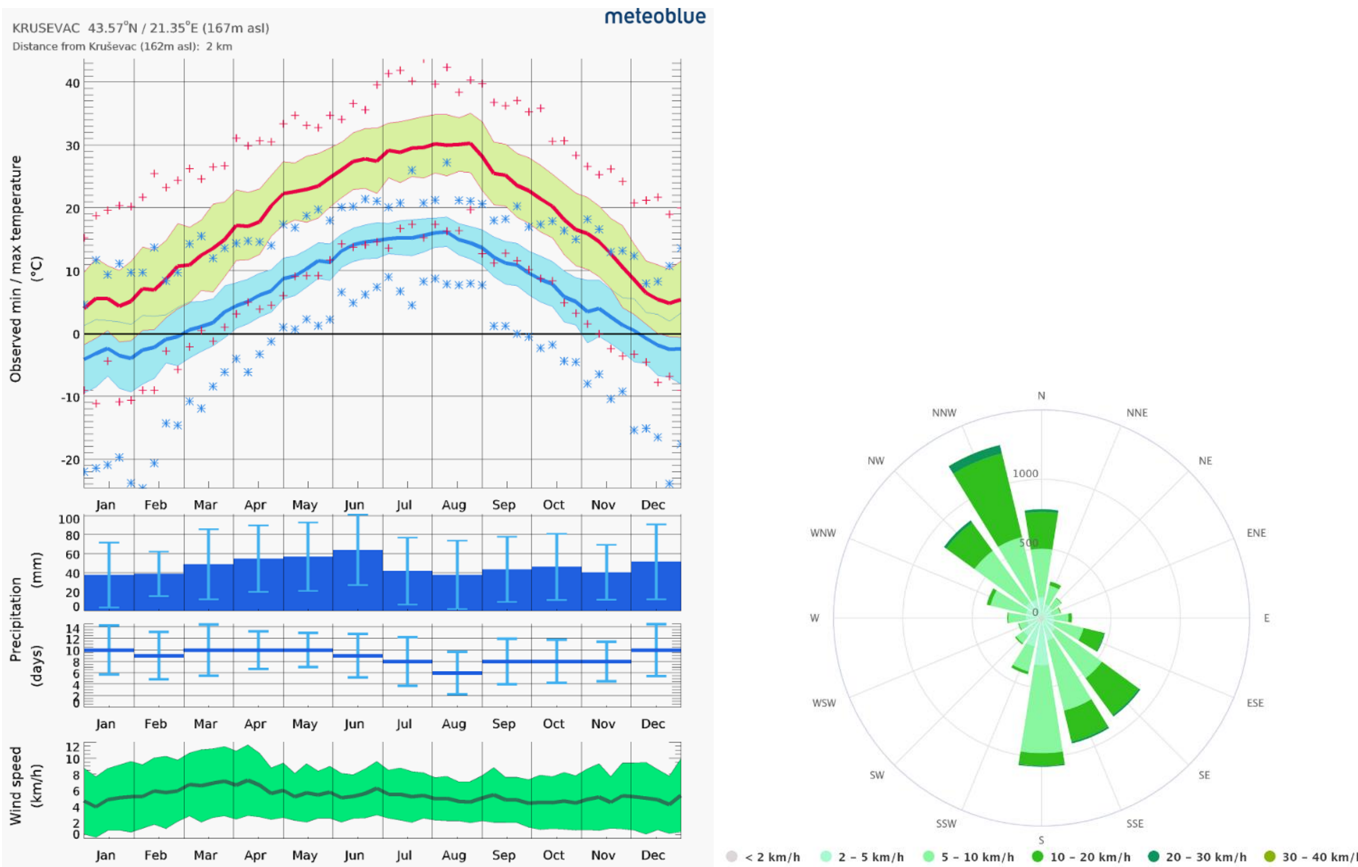


Figure 3-3. 30 years (1990-2020) historical meteorological data – Kruševac (Meteoblue)

Table 3-3. Average monthly, annual and extreme values 1961-1990

	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec	Annual
Temp [°C]													
Average max	3,4	6,6	11,7	17,7	22,4	25,3	27,3	27,6	24,1	18,3	11,3	5,2	16,7
Average min	-4,6	-2,2	1,0	5,2	9,9	12,9	14,1	13,4	10,1	5,4	1,5	-2,4	5,4
Absolute max	18,0	24,2	28,5	31,9	35,5	38,3	40,0	39,0	36,6	30,9	27,4	19,3	40,0
Absolute min	-28,1	-23,7	-17,2	-4,2	-1,1	2,9	6,9	3,0	-3,0	-7,3	-21,4	-20,0	-28,1
Avg number of frost days	24,5	18,8	11,9	2,0	0,1	0,0	0,0	0,0	0,1	3,9	10,7	20,3	92,3
Avg number of tropical days	0,0	0,0	0,0	0,0	1,1	4,6	8,8	10,3	3,2	0,2	0,0	0,0	28,2
Relative humidity [%]													
Average	83,9	80,5	74,8	71,2	73,1	74,4	72,5	71,6	75,3	78,4	82,5	85,9	77,0
Insolation													
Average	52,8	74,4	126,5	156,1	203,3	212,4	258,7	251,0	192,8	148,0	75,7	38,1	1789,8
Number of clear days	2,9	3,4	4,5	3,6	3,9	4,2	9,3	11,6	9,7	8,1	3,7	2,5	67,4
Number of cloudy days	15,9	12,8	12,6	9,5	8,8	6,6	4,7	4,1	6,2	8,2	12,8	16,1	118,3
Precipitation [mm]													
Avg monthly sum	43,9	39,4	44,1	56,4	78,8	86,0	58,6	45,1	44,2	38,3	57,7	55,0	647,5
Max daily sum	21,6	61,6	31,4	51,4	45,6	52,2	41,6	41,2	55,4	35,2	50,2	68,8	68,8
Avg number of days >= 0.1 mm	13,0	11,5	11,9	12,0	13,5	13,2	9,5	9,1	8,2	8,3	10,9	14,0	135,1
Avg number of days >= 10.0 mm	1,1	0,9	1,3	1,7	2,6	3,1	1,9	1,8	1,5	1,2	1,9	1,4	20,4
Number of days with													
Snow	9,1	7,0	4,8	0,3	0,1	0,0	0,0	0,0	0,0	0,2	2,3	7,1	30,9
Snow cover	16,8	10,3	4,0	0,1	0,0	0,0	0,0	0,0	0,0	0,0	3,4	12,3	46,9
Fog	3,0	1,6	0,2	0,5	0,7	0,6	0,5	0,9	3,0	4,3	3,9	4,0	23,2
Hail	0,0	0,0	0,0	0,1	0,1	0,1	0,0	0,1	0,0	0,0	0,0	0,0	0,4

Table 3-4. Average monthly, annual and extreme values 1981-2010

	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec	Annual
Temp [°C]													
Average max	4,6	7,2	12,5	18,0	23,1	26,4	28,7	29,0	24,1	18,5	11,4	5,6	17,4
Average min	-3,4	-2,3	1,5	5,6	10,2	13,5	14,9	14,6	10,7	6,3	1,6	-1,9	5,9
Absolute max	20,4	23,4	29,6	31,9	34,7	39,6	43,7	42,4	36,8	33,8	27,4	21,7	43,7
Absolute min	-26,0	-23,7	-15,0	-6,1	0,8	4,1	5,8	3,0	1,2	-6,6	-15,8	-23,9	-26,0
Avg number of frost days	24	19	11	2	0	0	0	0	0	3	11	19	89
Avg number of tropical days	0	0	0	0	2	7	13	13	3	0	0	0	38
Relative humidity [%]													
Average	85	79	73	71	72	72	70	69	74	79	81	85	76
Insolation													
Average	54,0	78,7	129,1	154,0	206,0	223,2	269,0	263,2	190,6	137,2	79,1	42,6	1826,7
Number of clear days	4	5	5	5	5	7	12	13	10	7	5	3	80
Number of cloudy days	15	11	11	9	7	5	4	3	6	8	12	15	105
Precipitation [mm]													
Avg monthly sum	40,3	39,2	48,4	56,6	56,9	71,2	55,0	49,8	50,0	49,3	56,2	55,1	628,1
Max daily sum	36,4	61,6	35,8	51,4	52,8	60,5	73,3	41,2	45,1	39,5	50,2	45,8	73,3
Avg number of days >= 0.1 mm	13	12	12	13	12	11	10	8	9	9	11	14	134
Avg number of days >= 10.0 mm	1	1	2	2	2	3	2	2	2	2	2	2	20
Number of days with													
Snow	8	8	4	1	0	0	0	0	0	0	3	7	31
Snow cover	14	10	4	0	0	0	0	0	0	0	4	12	44
Fog	4	2	1	1	1	0	0	1	2	5	4	5	24
Hail	0	0	0	0	0	0	0	0	0	0	0	0	0

Niš Station

The absolute maximum temperature in this area reached the value of 43.7°C (2007), and the absolute minimum temperature reached the value of -30.0°C (1947). The maximum daily precipitation (81.9 mm) is recorded in 1956, while maximum daily snow high (59 cm) is observed in 1963.

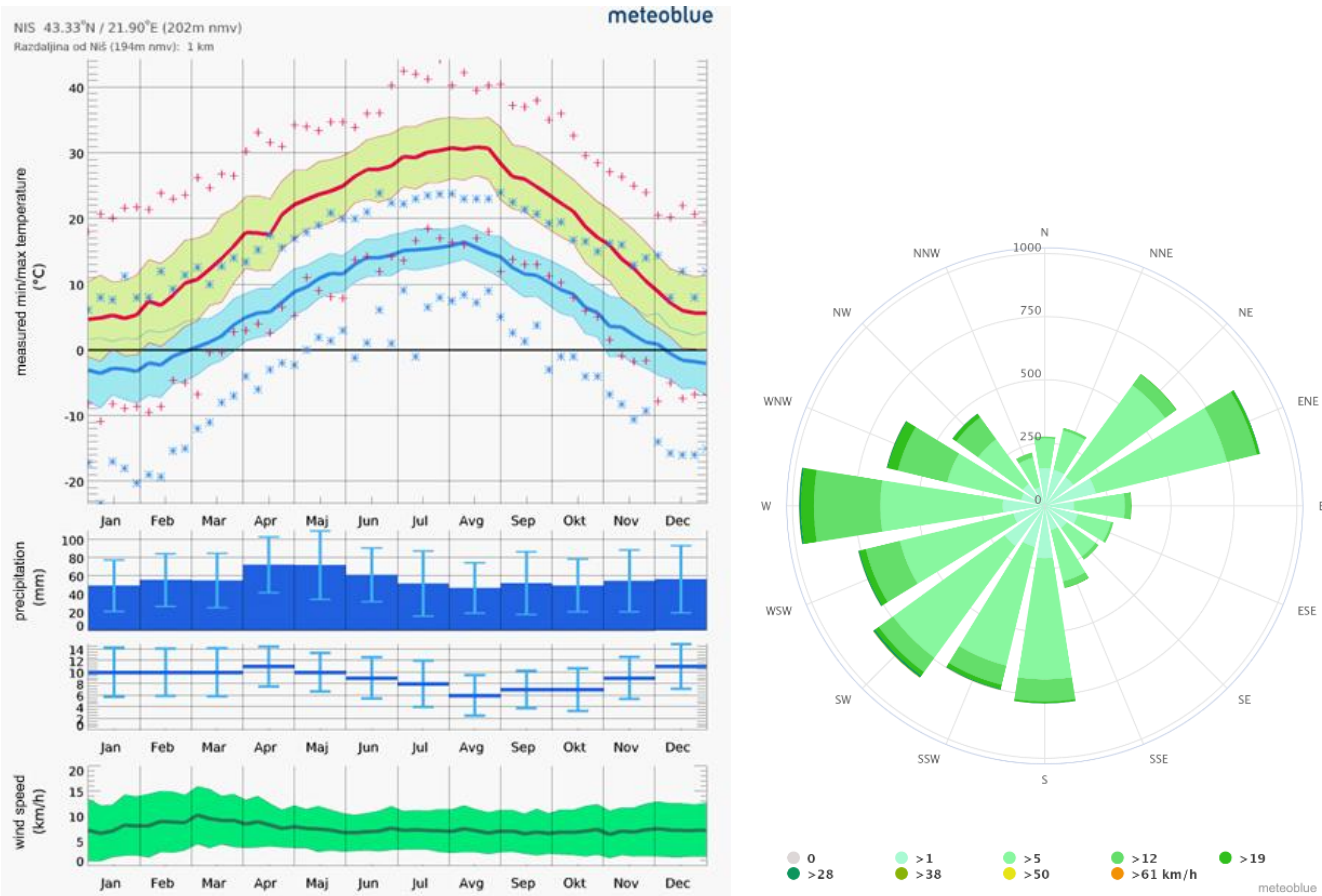


Figure 3-4. 30 years (1990-2020) historical meteorological data – Niš (Meteoblue)

Table 3-5. Average monthly, annual and extreme values 1961-1990

	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec	Annual
Temp [°C]													
Average max	3,8	7,1	12,3	18,0	22,9	25,9	28,0	28,5	24,8	18,9	11,7	5,4	17,3
Average min	-3,5	-1,3	1,8	6,1	10,4	13,4	14,5	14,4	11,1	6,5	2,4	-1,4	6,2
Absolute max	18,6	23,2	28,6	33,0	34,2	38,3	42,3	39,6	37,2	32,6	27,1	20,7	42,3
Absolute min	-23,7	-19,3	-13,2	-3,5	-1,0	4,2	7,6	4,6	-2,2	-6,8	-14,0	-15,8	-23,7
Avg number of frost days	22,8	17,1	9,3	1,2	0,0	0,0	0,0	0,0	0,1	2,2	8,5	18,5	79,7
Avg number of tropical days	0,0	0,0	0,0	0,1	1,4	6,0	10,8	12,9	4,8	0,3	0,0	0,0	36,3
Relative humidity [%]													
Average	79,8	75,2	67,7	63,7	66,2	67,5	64,0	63,2	69,0	72,2	77,9	81,7	70,7
Insolation													
Average	62,3	85,1	136,3	170,7	219,0	237,2	289,0	276,0	210,0	161,2	83,5	45,1	1975,4
Number of clear days	2,7	2,8	4,7	4,0	4,1	4,7	9,9	12,4	10,1	8,4	4,0	2,2	70,0
Number of cloudy days	15,8	13,5	12,8	10,4	8,6	6,2	3,9	3,5	5,3	7,9	13,1	16,6	117,6
Precipitation [mm]													
Avg monthly sum	41,3	40,3	45,3	51,3	66,7	69,7	43,6	43,3	43,6	34,1	56,8	53,6	589,6
Max daily sum	24,2	34,8	26,2	33,2	32,0	47,5	48,2	39,4	71,2	47,3	28,1	28,9	71,2
Avg number of days >= 0.1 mm	13,7	12,7	12,4	12,8	13,3	12,6	8,8	8,1	7,6	8,4	11,8	13,9	136,1
Avg number of days >= 10.0 mm	0,9	0,8	1,4	1,6	2,3	2,1	1,4	1,5	1,6	0,9	2,0	1,4	17,9
Number of days with													
Snow	12,0	9,0	5,5	0,4	0,0	0,0	0,0	0,0	0,0	0,1	2,9	9,6	39,5
Snow cover	15,4	10,4	4,2	0,1	0,0	0,0	0,0	0,0	0,0	0,0	3,3	11,6	45,0
Fog	2,9	1,3	0,1	0,2	0,4	0,2	0,1	0,0	0,5	1,8	2,1	4,1	13,7
Hail	0,0	0,0	0,0	0,1	0,3	0,4	0,1	0,1	0,1	0,0	0,0	0,0	1,1

Table 3-6. Average monthly, annual and extreme values 1981-2010

	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec	Annual
Temp [°C]													
Average max	5,0	7,5	13,0	18,4	23,8	27,1	29,8	30,1	25,0	19,3	11,9	6,1	18,1
Average min	-2,2	-1,4	2,3	6,4	11,0	13,8	15,4	15,4	11,5	7,4	2,6	-0,8	6,8
Absolute max	21,7	23,5	26,5	33,0	34,7	40,3	44,2	42,2	37,2	32,6	29,0	22,2	44,2
Absolute min	-23,4	-19,3	-12,2	-5,6	0,8	4,9	4,1	4,6	2,5	-6,8	-14,0	-15,8	-23,4
Avg number of frost days	22	18	10	2	0	0	0	0	0	2	9	18	80
Avg number of tropical days	0	0	0	0	3	9	15	17	5	0	0	0	49
Relative humidity [%]													
Average	80	74	66	63	65	65	61	61	69	73	77	81	70
Insolation													
Average	64,5	93,3	147,8	171,5	220,9	251,2	286,7	274,3	201,9	150,5	85,9	49,4	1997,7
Number of clear days	3	4	4	4	4	7	11	13	9	7	4	3	73
Number of cloudy days	15	12	11	9	8	5	4	3	6	9	12	15	109
Precipitation [mm]													
Avg monthly sum	38,8	36,8	42,5	56,6	58,0	57,3	44,0	46,7	48,0	45,5	54,8	51,5	580,3
Max daily sum	24,2	28,8	27,9	33,2	41,5	56,8	46,7	50,6	52,6	32,8	37,4	33,0	56,8
Avg number of days >= 0.1 mm	13	13	12	13	12	11	9	8	9	9	11	14	134
Avg number of days >= 10.0 mm	1	1	1	2	2	2	1	2	1	2	2	1	17
Number of days with													
Snow	10	9	5	1	0	0	0	0	0	0	3	8	37
Snow cover	13	10	4	0	0	0	0	0	0	0	4	10	41
Fog	3	1	0	0	0	0	0	0	0	1	2	3	11
Hail	0	0	0	0	0	0	0	0	0	0	0	0	1

3.2 Climate projections

3.2.1 Expected changes in temperatures and precipitation – Serbia-wide

The data presented in the document Observed climate changes in Serbia and projections of the future climate based on different scenarios of future emissions (UNDP, 2018) represent the most likely value from the set (ensemble) of solutions obtained using daily values of temperatures and precipitation from nine regional climate models that can be downloaded from the EURO-CORDEX database. The reference period with respect to which the change in future climatic conditions is analysed is 1986-2005 and the analysed future periods are: 2016-2035 (near future), 2046-2065 (mid-century) and 2081-2100 (end of century). The analyses were performed according to two selected GHG emission scenarios: RCP4.5 (stabilization scenario, which anticipates the stabilisation of emissions from 2040) and RCP8.5 (constant growth scenario), which are assumed to cover the likely range of possible future outcomes.

Over the future periods, an increase in temperature is expected in both scenarios compared to the 1986-2005 reference period. A more intense increase in temperature is anticipated according to RCP8.5, which is expected due to the more intense emissions of GHG and their impact on the energy balance in the climate system. In this scenario, the mean annual temperature, on average for the territory of Serbia, will increase by 1°C in the near future compared to the reference period, in the period attributed to the mid-21st century, it will rise to 2°C, and, by the end of the century, the average annual temperature will be higher by as much as 4.3°C compared to the reference period. The stabilisation scenario, RCP4.5, shows a slightly less increase in mean annual temperature by about 0.5°C compared to RCP8.5 during the first two analysed periods. In this scenario, by the end of the 21st century, the increase in the average annual temperature in the territory of Serbia will reach a much lower value than the value obtained under the RCP8.5 scenario, which is 2°C higher than the value of the reference period. A spatial analysis of changes in temperatures over future periods indicates an increase in warming from north to south. The selected results obtained from the analysis of future temperature changes are shown in next figure.

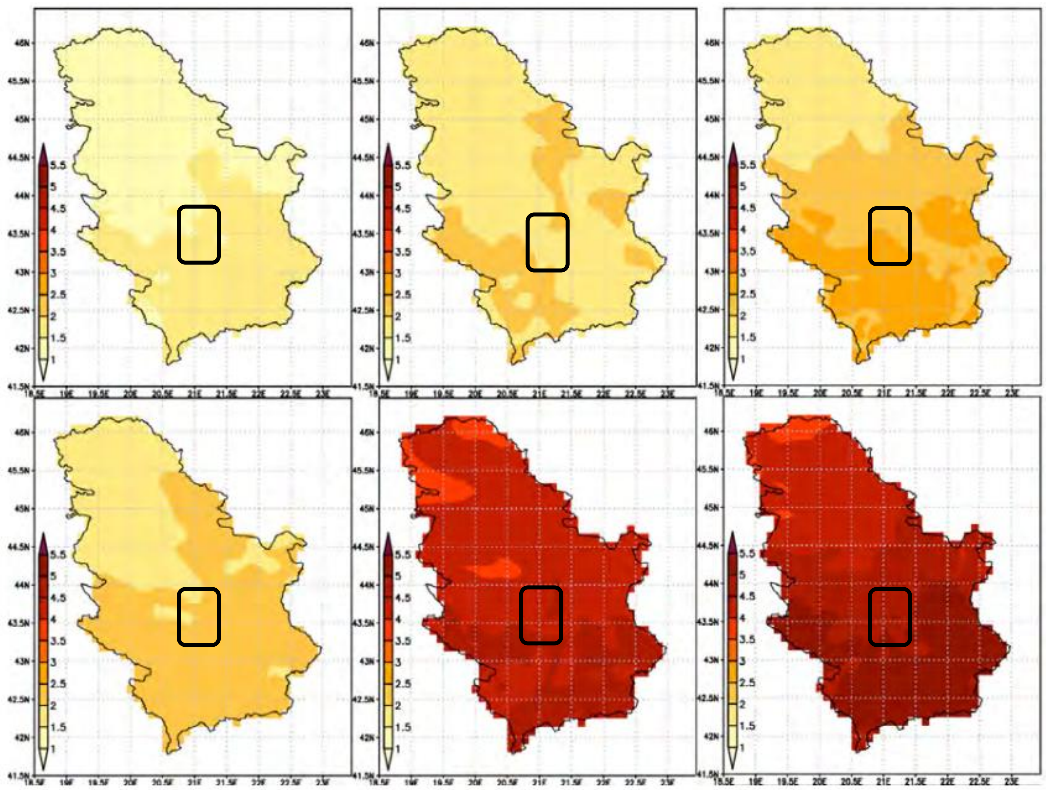


Figure 3-5. Anomaly of the mean annual temperature (°C) for the 2046-2065 period (left panel) and for the 2081-2100 period (central panel) relative to the values for the 1986-2005 reference period; anomaly of the mean maximum temperature (°C) obtained for the June-August 2081-2100 period compared to the mean maximum temperature values of this period for 1986-2005 (right panel); the results obtained according to the RCP4.5 scenario are shown in the top panels and the results obtained according to the RCP8.5 are shown in the bottom panels. Source: Climate changes observed in Serbia and future climate projections based on different scenarios of future emissions

The number of frost and ice days will progressively decrease in the future due to an increase in temperatures. In the near future, there will be almost 10 fewer frosty days on average annually in the territory of Serbia compared to the values for the 1986-2005 reference period.

The number of hot and tropical days will continue to increase under future climate conditions. In the climate of the near future, relative to the reference period, changes indicate an extension of summer season conditions by almost half a month, and in the second half of the 21st century, an extension of almost a month may occur, after which the change will stabilise according to the RCP4.5 scenario, while according to RCP8.5, by the end of the century, summer conditions will be on average nearly two months longer than during 1986-2005 period. By the end of the 21st century, the expected increase in the average annual number of tropical days will be in the range between 20, according to RCP4.5, up to almost 50 days in the RCP8.5 scenario.

Extreme heat waves in the future climate will occur on average at least 2-3 times a year, while during the 1986-2005 reference period these were very rare events. According to the RCP8.5 scenario, by the end of the 21st century, their average occurrence in the territory of Serbia will be as high as 7 occurrences during the year, and in some areas even more than 10.

The future changes in mean annual accumulated precipitation, averaged for the territory of Serbia, will not have a pronounced trend in future periods, as is the case with temperature. However, in the second half of the 21st century, according to the RCP8.5 scenario, the average annual precipitation will start to decrease and in the period at the end of the 21st century, central and especially southern Serbia will experience the largest precipitation decrease, even exceeding 10% compared to the 1986-2005 reference period. The spatial distribution of change in precipitation shows a declining trend towards the south. Precipitation decrease during the June-August period has already been observed and it will continue during future periods according to both scenarios. In the period at the end of the 21st century, according to RCP8.5, the average precipitation decrease in the territory of Serbia will be 20.5%, with a much larger decrease in the southern regions, of as much as 40%. The selected results obtained from the analysis of future precipitation changes are shown in next figure.

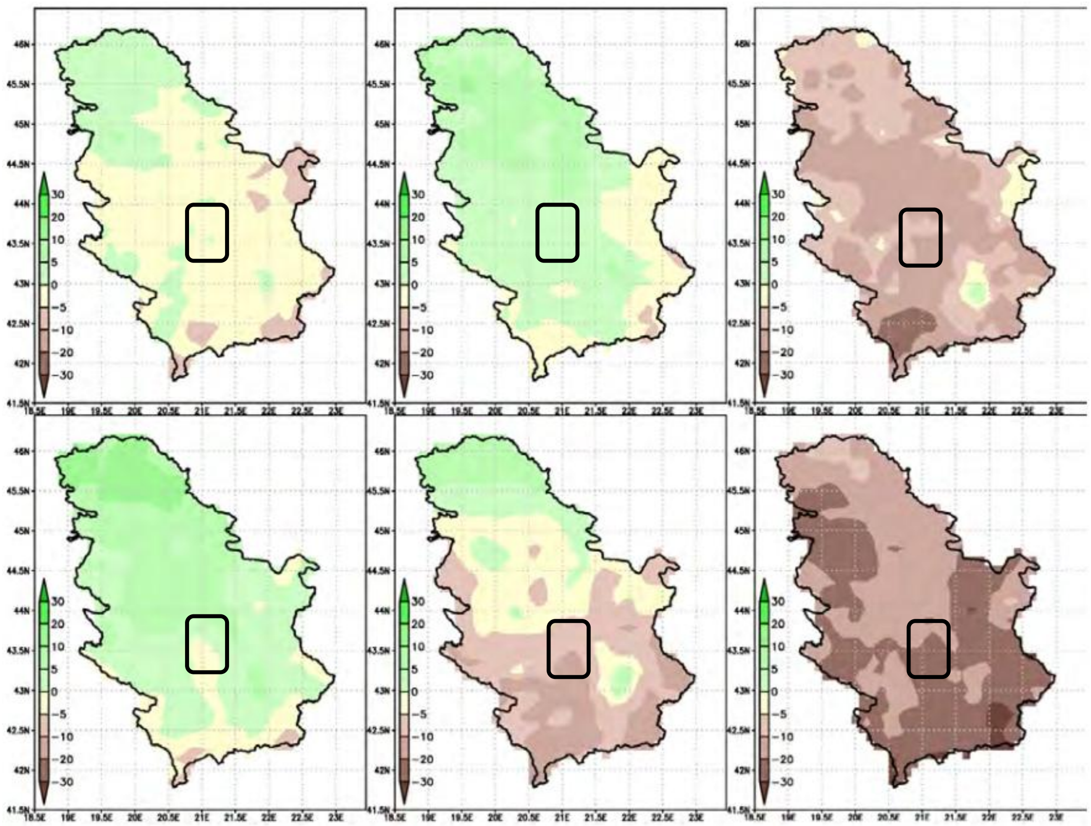


Figure 3-6. The anomaly of the mean annual precipitation sum (%) for the 2046-2065 period (left panel) and for the 2081-2100 period (central panel) relative to the values for the 1986-2005 reference period; anomaly of mean precipitation sum (%) for the June-August season for the 2081-2100 period compared to the mean seasonal value for the 1986-2005 period (right panel); the results obtained according to the RCP4.5 scenario are shown in the top panels, while the results obtained according to the RCP8.5 are shown in the bottom panels

In the 21st century, according to RCP4.5, as much as 40% more precipitation, will occur during the days when precipitation is extremely high compared to the precipitation events of the 1986-2005 reference period. According to RCP8.5, this precipitation intensity increase will reach up to 60%.

3.2.2 Project-specific climate projections

The Köppen-Geiger climate classification also gives predictions for periods 2041-2070 and 2071-2099 according to 7 shared socioeconomic pathways (SSPs). To remain consistent with „Observed climate changes in Serbia and projections of the future climate based on different scenarios of future emissions", depicted are SSP-4.5 and SSP-8.5, as the closest to RCP4.5 and RCP8.5.

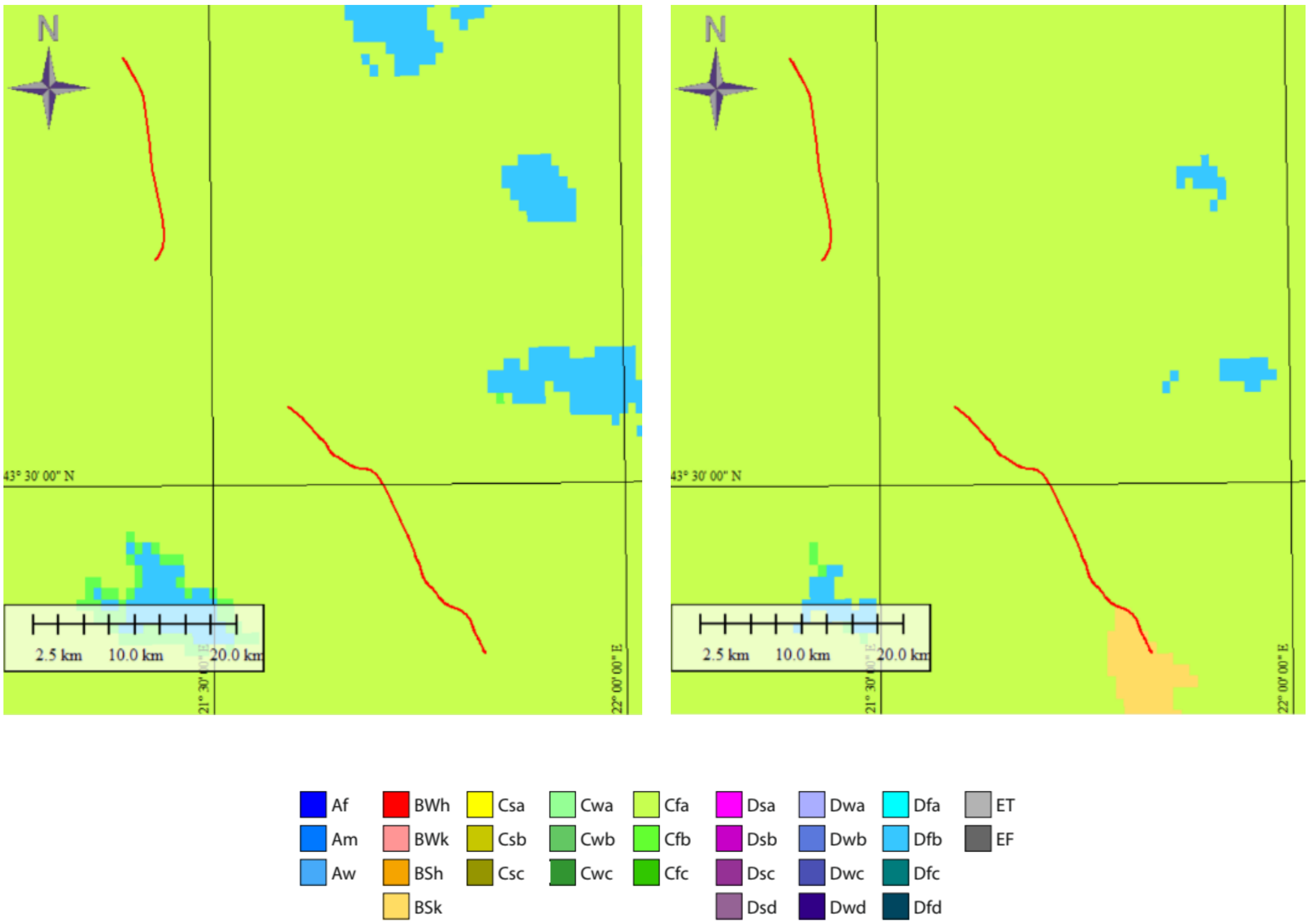


Figure 3-7. Köppen climate classification along the railway route for the period 2041-2070 and SSP-4.5 (left) and SSP-8.5 (right)

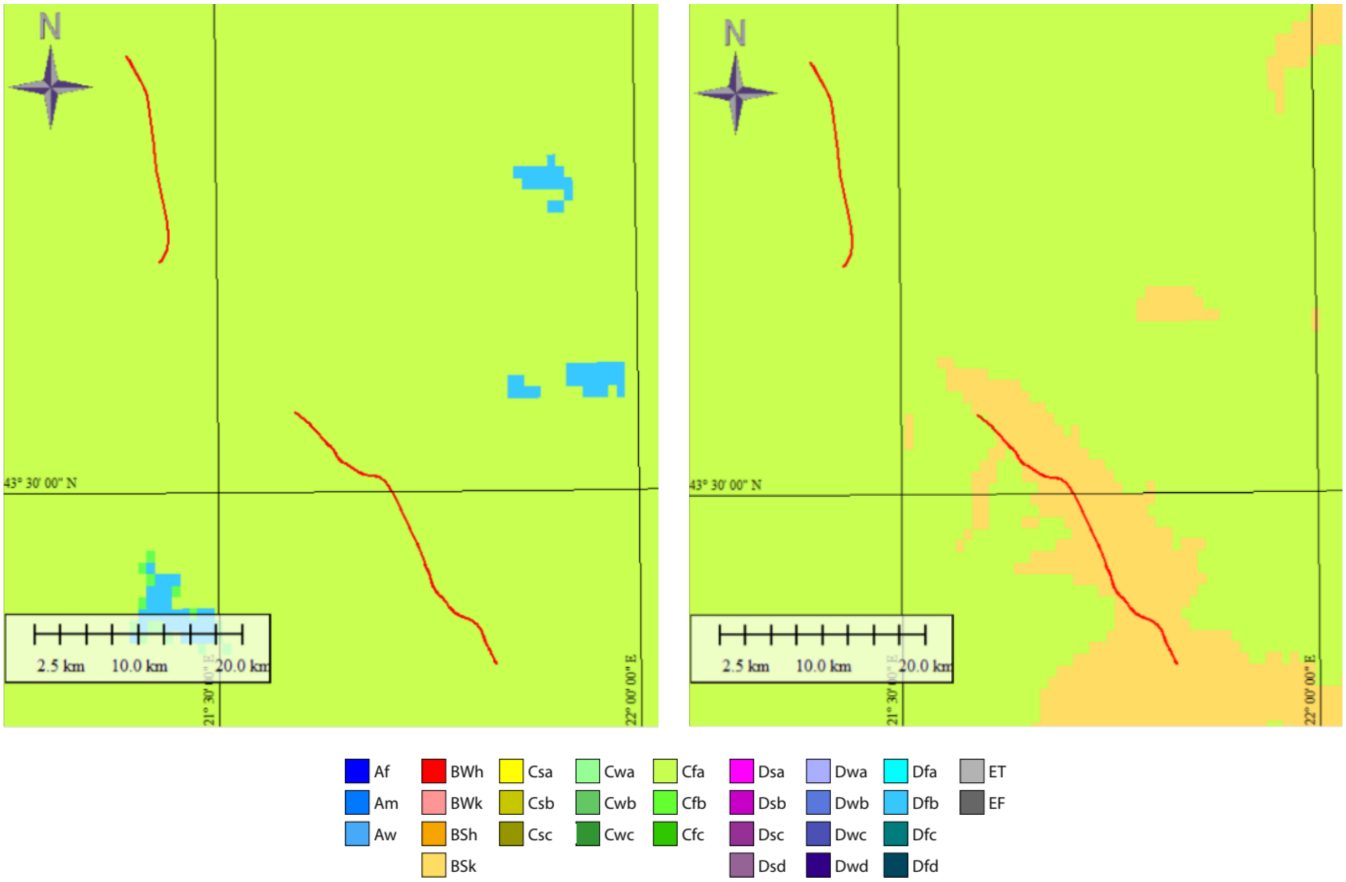


Figure 3-8. Köppen climate classification along the railway route for the period 2071-2099 and SSP-4.5 (left) and SSP-8.5 (right)

Figure 3-7 and Figure 3-8 show that, depending on the adopted climate projection, a general shift towards warmer and drier conditions is expected within the Project area. As expected, this is especially emphasized for “no mitigation” SSP-8.5. Under the “Advancing medium and long-term adaptation planning in the Republic of Serbia (NAP project)“, a Digital Climate Atlas of Serbia (web platform) has been established. Digital Climate Atlas of Serbia is based on the data provided by CORDEX the World Climate Research Programme initiative, Copernicus Climate Change Service that provides climate monitoring products for Europe based on surface in-situ observations by the Republic Hydrometeorological Service of Serbia, as well as geospatial information system of the Republic of Serbia. Digital Climate Atlas considers two possible climate scenarios- RCP4.5 (mitigation) and RCP 8.5 (no mitigation). Adopting a very conservative approach would mean using RCP8.5 in the 2071-2100 time frame. The reference period of 1986-2005 is used instead of 1971-2000 because it is, by subjective opinion, better and more uniformly reflects changes of decade-by-decade climate impacts that are experienced in Serbia.

Projections of precipitation from EUROCORDEX show a less clear difference between RCP4.5 and RCP8.5 than are apparent for temperature changes (Extreme weather and climate in Europe – EEA, 2015).

Design working life (DWL), defined as the period for which the structure will be used with anticipated maintenance but without major repair, is a major guideline for assessing a time frame of different climate scenarios. The DWL of buildings and other common structures designed using Eurocodes is 50 years, and the DWL of monumental buildings and bridges is envisaged as 100 years. Therefore, the end-of-the-century time horizon is more relevant in the case of the Project.

Figure 3-9. Administrative units map with railway route

The following Figures (Figure 3-10 to Figure 3-25) represent climate variables and indices under the RCP4.5 and RCP8.5 scenarios in the 2041-2060 and 2081-2100 time horizons, compared to the 1986-2005 reference period.

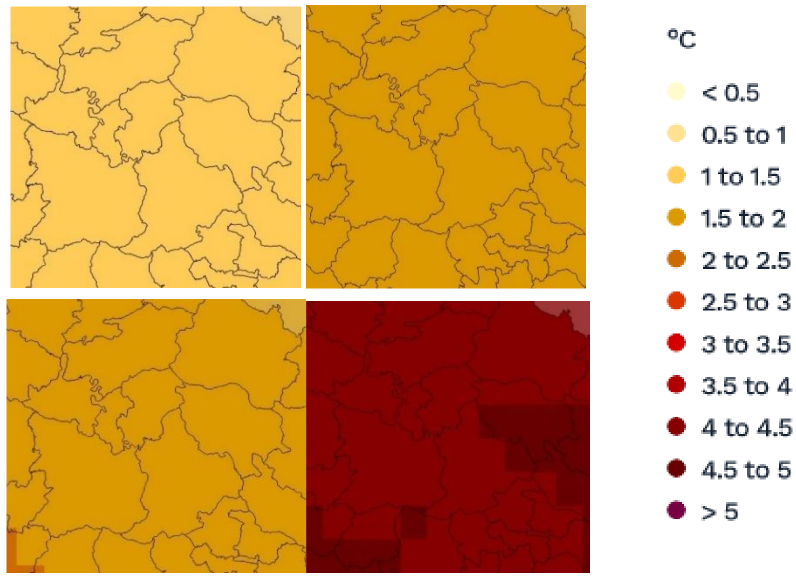


Figure 3-10. Changes in maximum daily temperature, 1986-2005 reference period, RCP4.5 scenario (above), RCP8.5 scenario (below), 2041-2060 time horizon (left), 2081-2100 time horizon (right)

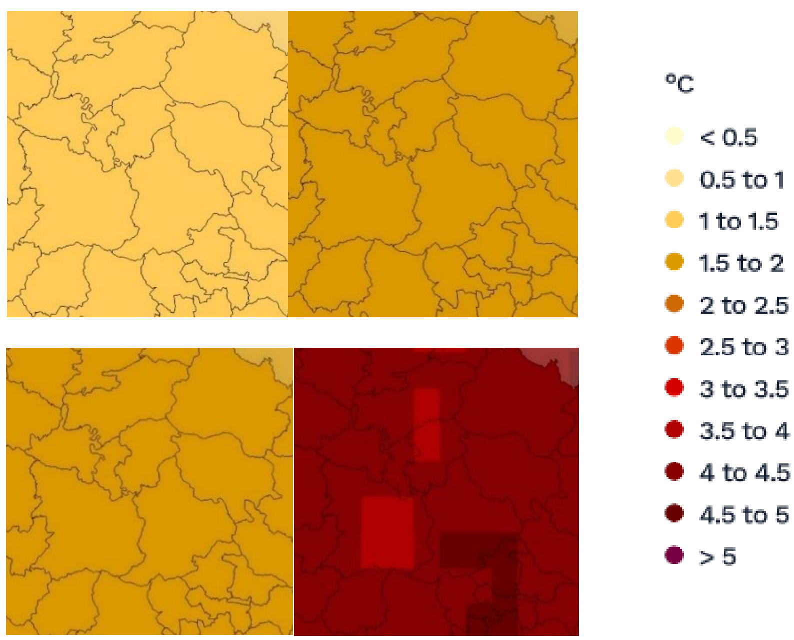


Figure 3-11. Changes in minimum daily temperature, 1986-2005 reference period, RCP4.5 scenario (above), RCP8.5 scenario (below), 2041-2060 time horizon (left), 2081-2100 time horizon (right)

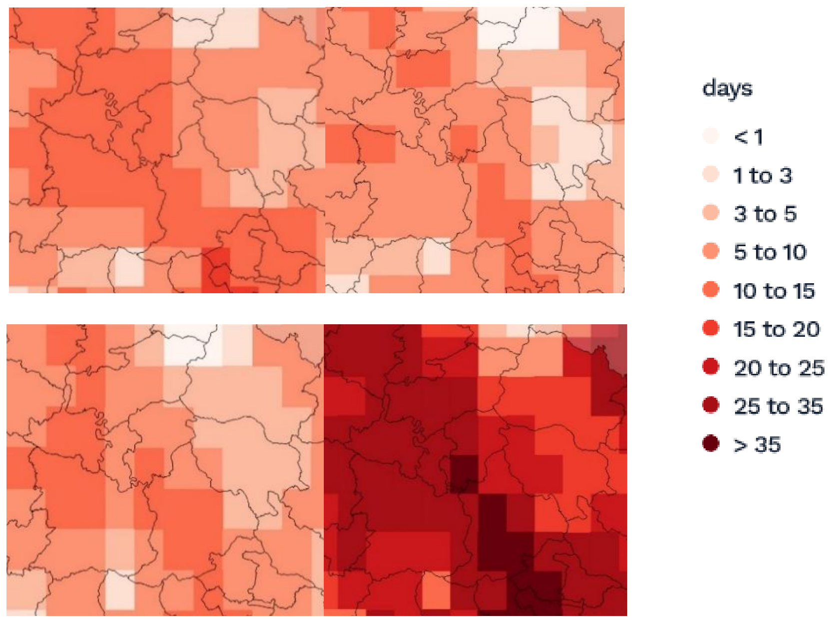


Figure 3-12. Change in the number of days with the temperature higher than 35°C, 1986-2005 reference period, RCP4.5 scenario (above), RCP8.5 scenario (below), 2041-2060 time horizon (left), 2081-2100 time horizon (right)

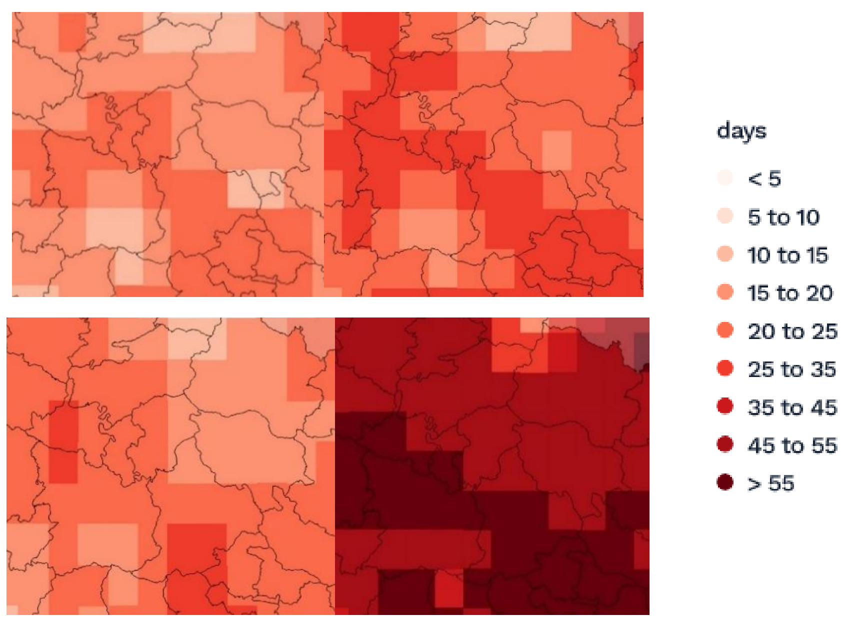


Figure 3-13. Change in the tropical days index, 1986-2005 reference period, RCP4.5 scenario (above), RCP8.5 scenario (below), 2041-2060 time horizon (left), 2081-2100 time horizon (right)

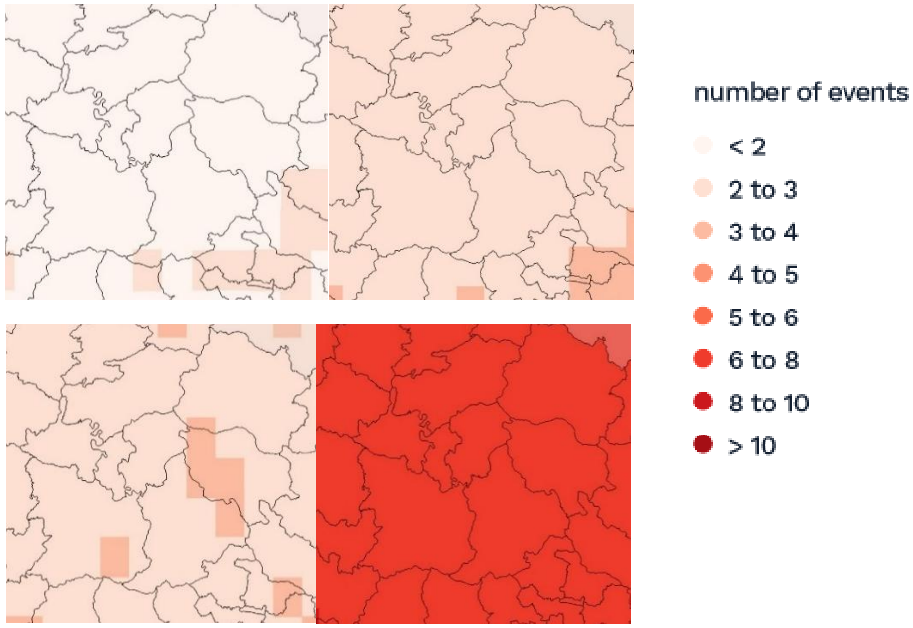


Figure 3-14. Change in the heat wave index, 1986-2005 reference period, RCP4.5 scenario (above), RCP8.5 scenario (below), 2041-2060 time horizon (left), 2081-2100 time horizon (right)

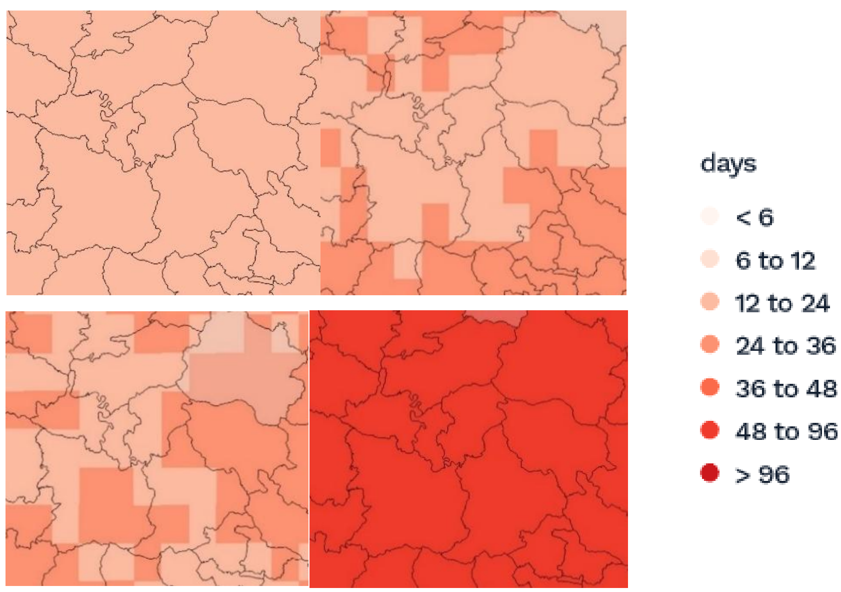


Figure 3-15. Change in length of heat waves, 1986-2005 reference period, RCP4.5 scenario (above), RCP8.5 scenario (below), 2041-2060 time horizon (left), 2081-2100 time horizon (right)

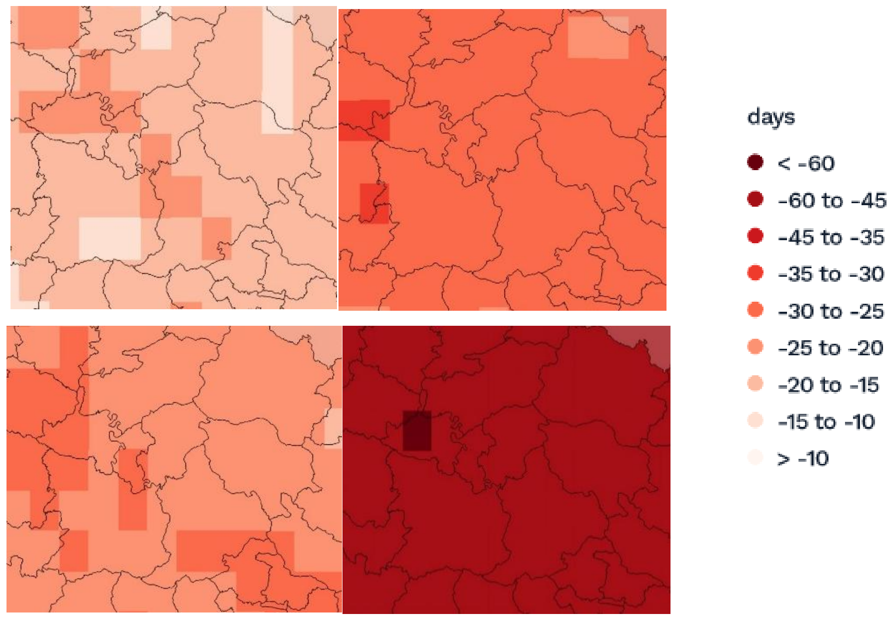


Figure 3-16. Change in the number of frost days, 1986-2005 reference period, RCP4.5 scenario (above), RCP8.5 scenario (below), 2041-2060 time horizon (left), 2081-2100 time horizon (right)

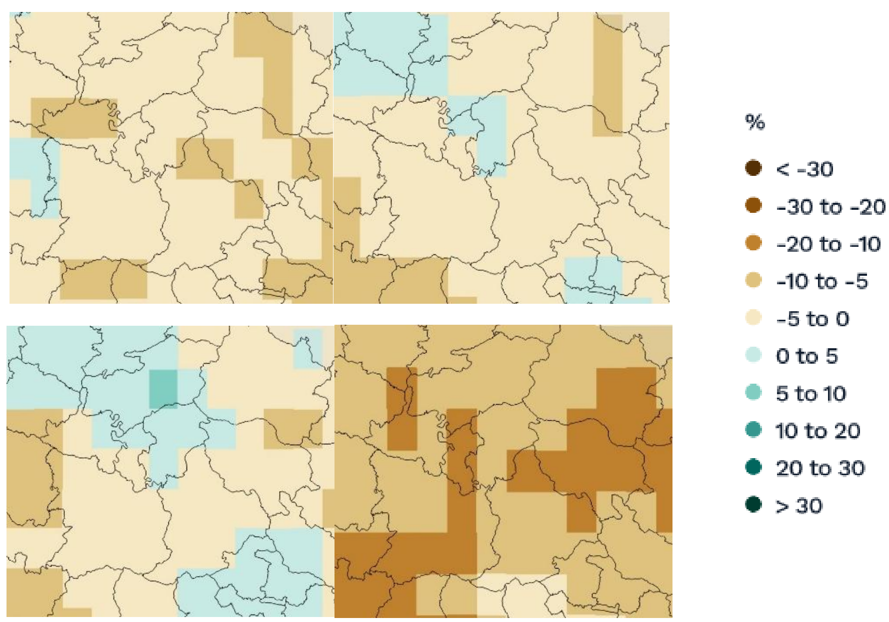


Figure 3-17. Changes in precipitation, 1986-2005 reference period, RCP4.5 scenario (above), RCP8.5 scenario (below), 2041-2060 time horizon (left), 2081-2100 time horizon (right)

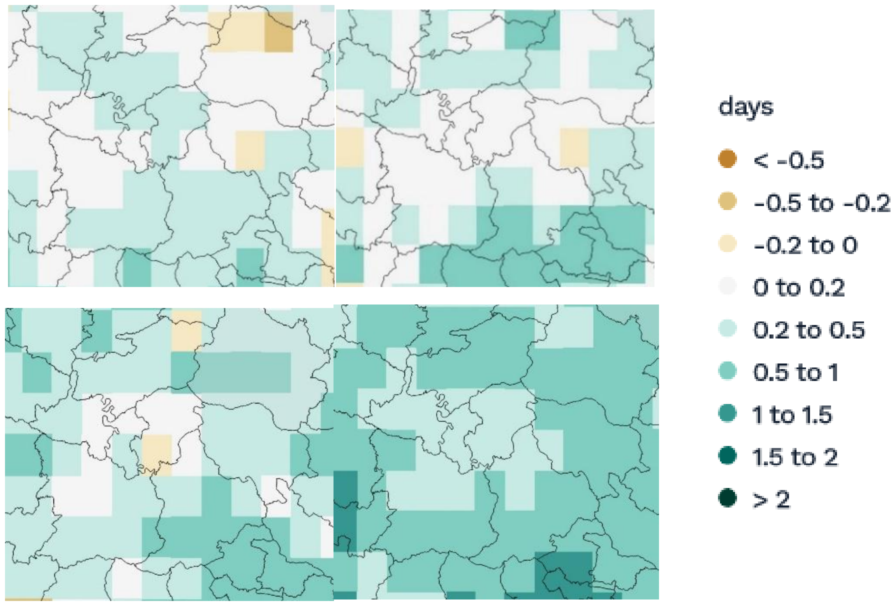


Figure 3-18. Change in the number of days with rainfall above 30mm, 1986-2005 reference period, RCP4.5 scenario (above), RCP8.5 scenario (below), 2041-2060 time horizon (left), 2081-2100 time horizon (right)

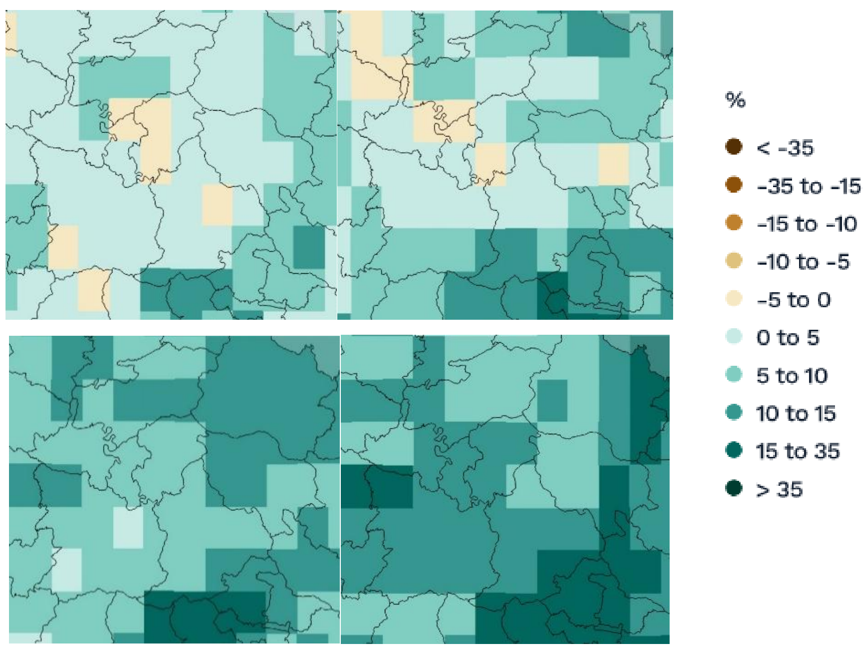


Figure 3-19. Changes in maximum 5-day precipitation, 1986-2005 reference period, RCP4.5 scenario (above), RCP8.5 scenario (below), 2041-2060 time horizon (left), 2081-2100 time horizon (right)

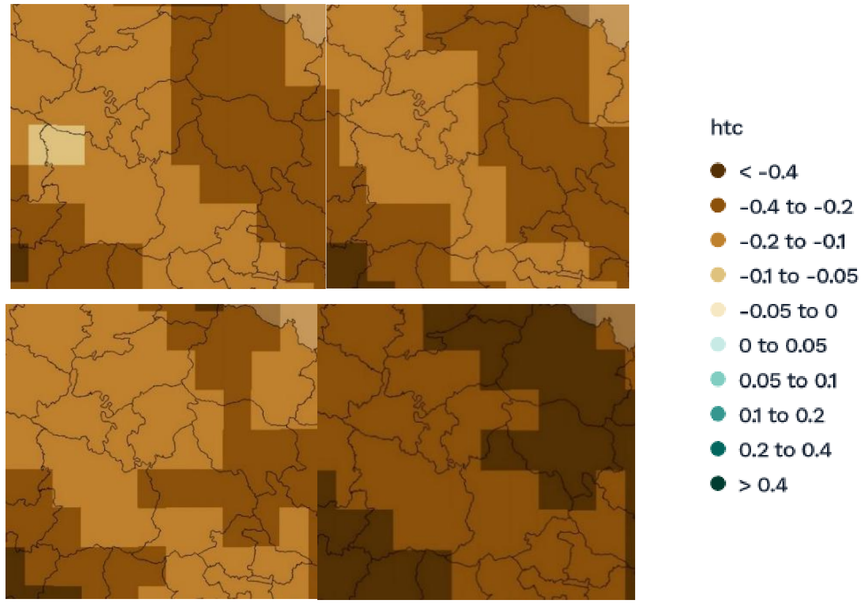


Figure 3-20. Changes in hydro-thermal coefficient of Selyaninov, 1986-2005 reference period, RCP4.5 scenario (above), RCP8.5 scenario (below), 2041-2060 time horizon (left), 2081-2100 time horizon (right)

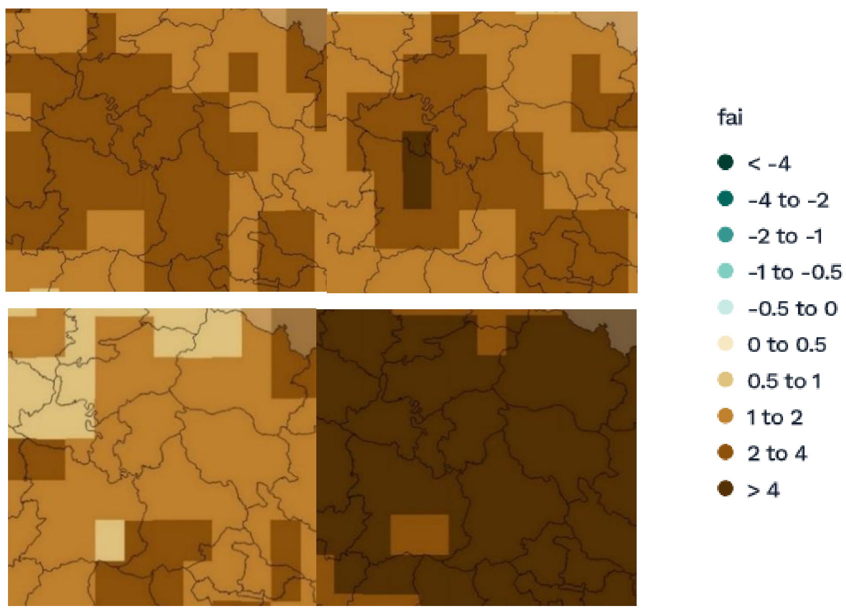


Figure 3-21. Changes in the forest aridity index (annual precipitation/ potential evapotranspiration- UNEP), 1986-2005 reference period, RCP4.5 scenario (above), RCP8.5 scenario (below), 2041-2060 time horizon (left), 2081-2100 time horizon (right)

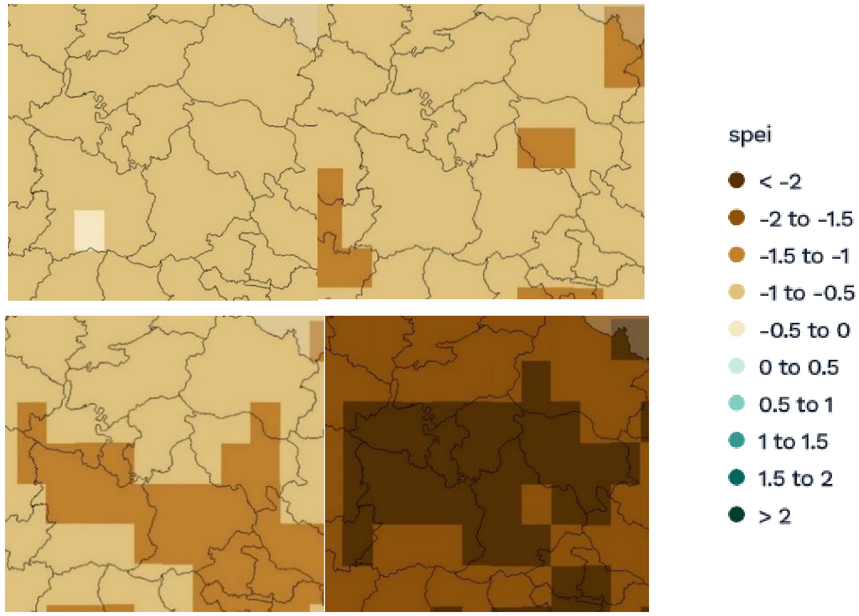


Figure 3-22. Changes in drought index SPEI, 1986-2005 reference period, RCP4.5 scenario (above), RCP8.5 scenario (below), 2041-2060 time horizon (left), 2081-2100 time horizon (right)

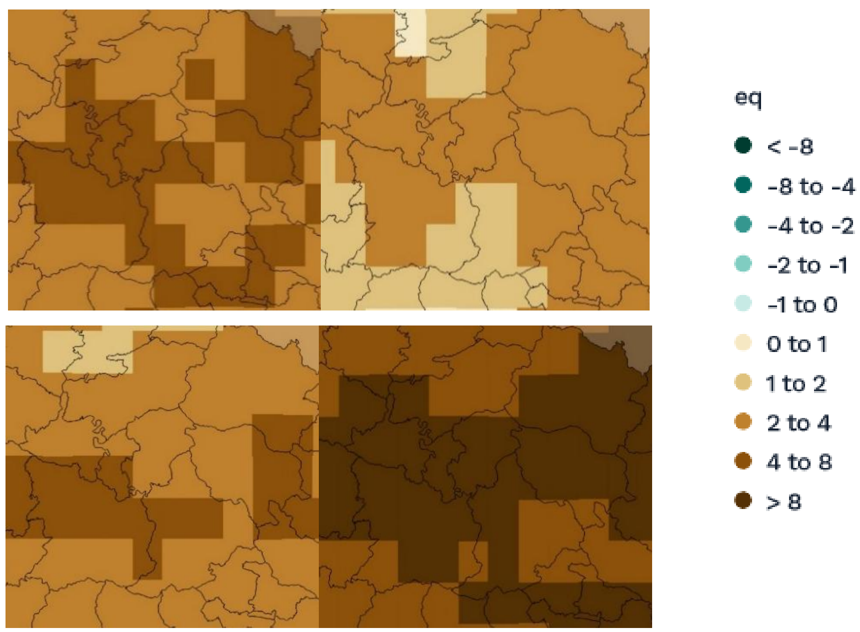


Figure 3-23. Changes in Ellenberg's climate quotient, 1986-2005 reference period, RCP4.5 scenario (above), RCP8.5 scenario (below), 2041-2060 time horizon (left), 2081-2100 time horizon (right)

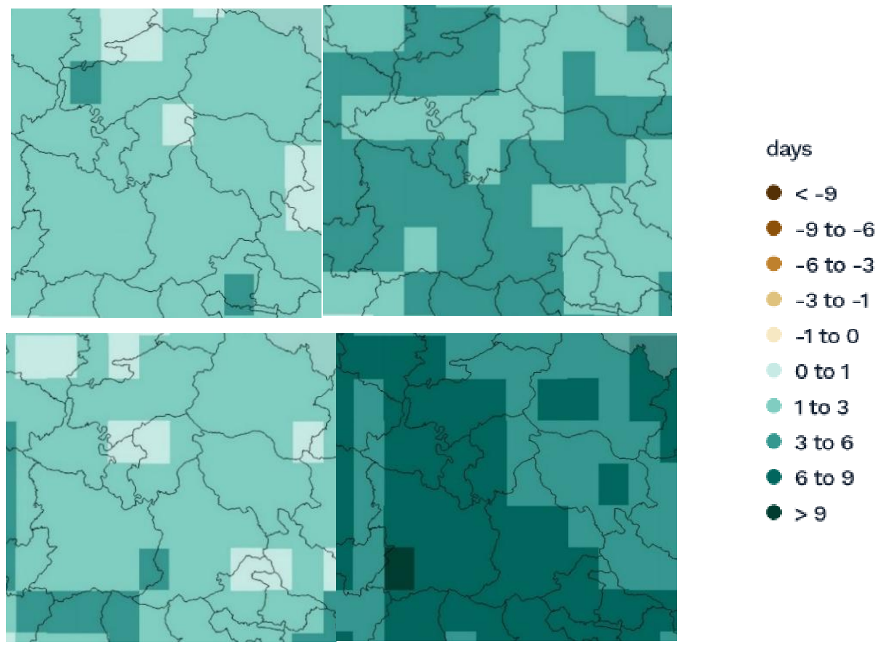


Figure 3-24. Changes in consecutive dry days index, 1986-2005 reference period, RCP4.5 scenario (above), RCP8.5 scenario (below), 2041-2060 time horizon (left), 2081-2100 time horizon (right)

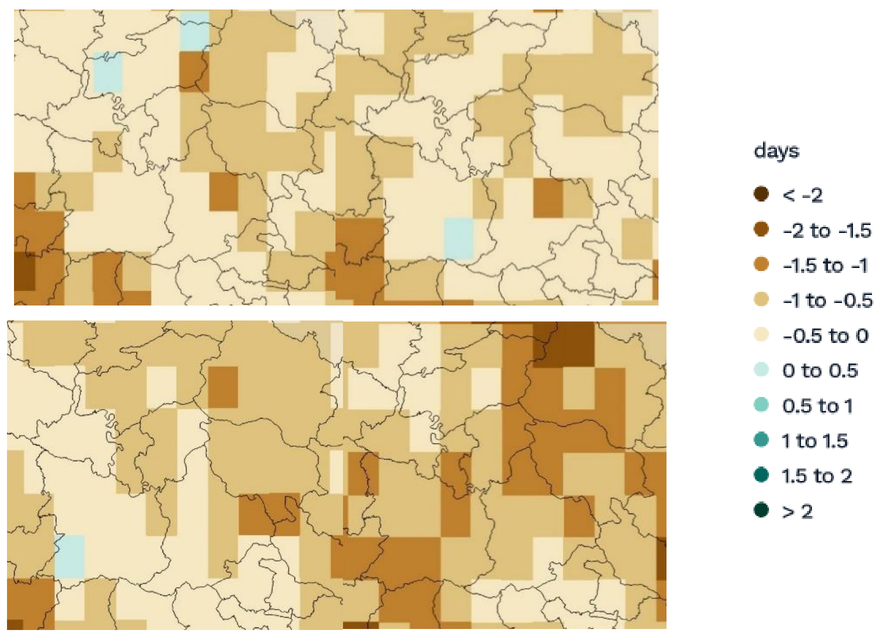


Figure 3-25. Changes in consecutive rainy days index, 1986-2005 reference period, RCP4.5 scenario (above), RCP8.5 scenario (below), 2041-2060 time horizon (left), 2081-2100 time horizon (right)

3.3 Observed rail traffic interruptions

“Serbia Railways Infrastructure” (SRI) has provided a list of all accidents and rail traffic interruptions on the Project route during the period 2004-2023, as shown in Table 3-7, differentiated by the climate cause.

Table 3-7. Historic traffic accidents and interruptions along the Project route during the period 2004-2023

Date	Location	Chainage	Cause	Length of disruption [h]	Material damage [RSD]
17.05.2011.	Between Grejač and Trupale	232+773	Thunder strike (interruption in signalling device)	/	897.252,00
15.05.2014.	Between Paraćin and Stalać	168+800 – 169+100	Flood* (damaged substructure and track)	58	1.483.965,76
10.06.2018.	Between Paraćin and Ćićevac	159+750	Storm wind (debris falling onto OCL)	/	115.783,00
28.07.2019.	Between Đunis and Korman	-	Storm (damage to parts of OCL)	/	49.997,20
03.06.2023.	Between Ćićevac and Stalać	173+745	Fluvial flood (stream overflow)	1	/
19.07.2023.	Station Đunis	194+470	Storm wind (fall of tree onto OCL)	7	50.920,00
20.08.2023.	Adrovac stop	209+890	High temperatures/ Wildfire (wooden sleepers caught fire)	1	185,00

*The cause of flooding in 2014 near the city of Pojate could be pluvial (heavy rainfall-related flooding that is independent of an overflowing body of water) or fluvial (river or riverine flooding, when levels in a river, creek or stream rise, allowing water to flow onto surrounding land). The SRI report is ambiguous. The documented extreme amount of precipitation could have caused a torrential flow from the hill to the east of the railway (Figure 3-26) or the flooding could have been caused by overflow of the Jovanovačka river (as reported in the local media).

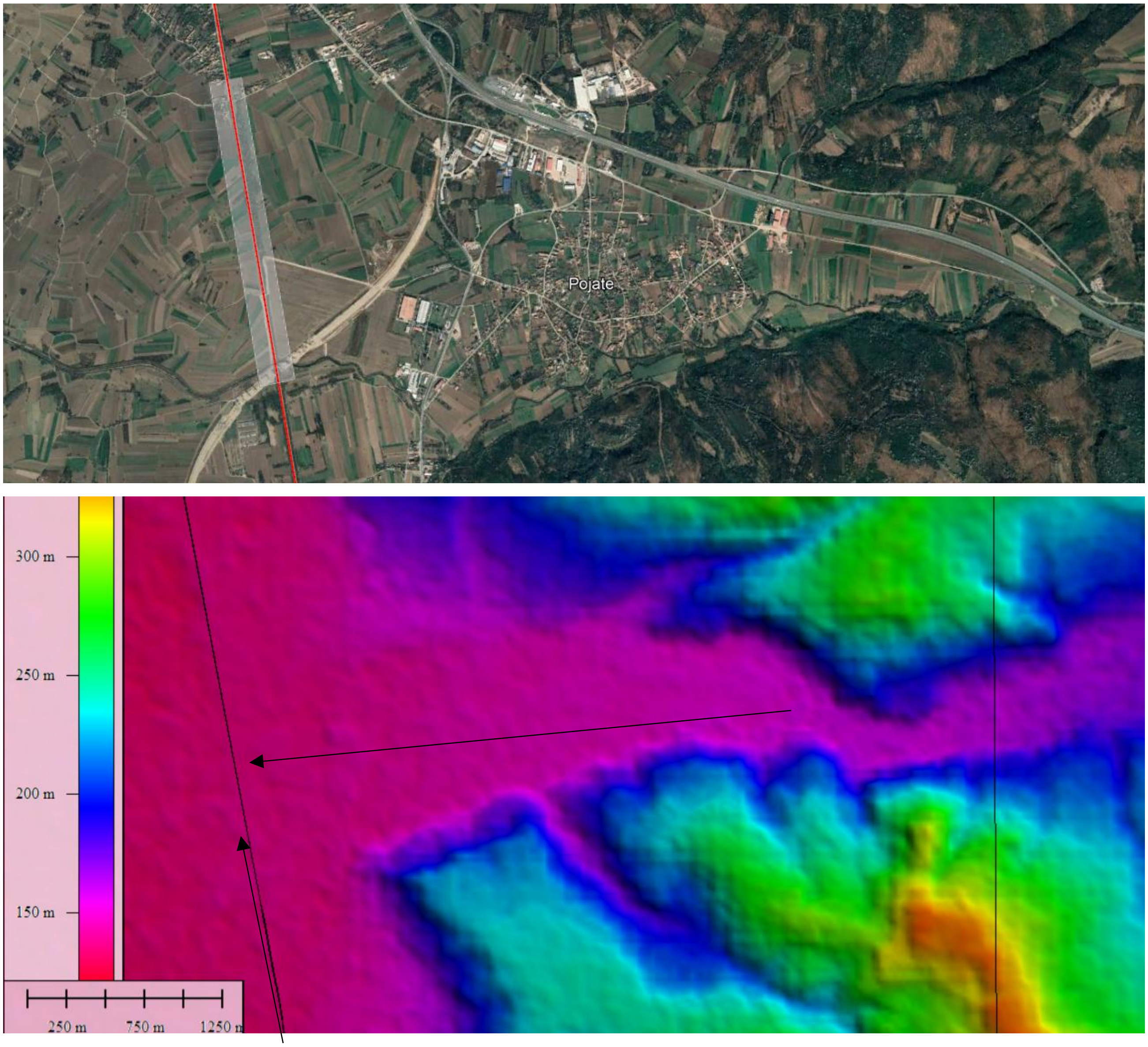


Figure 3-26. Flooded area near Pojate in 2014 (shaded area in satellite imagery) and elevation map of the same area with marked possible water flows

A comparison of videos of the actual flood event from 2014, and flood characteristics (mainly water speed) indicates that the Jovanovačka river was the cause of this event.

4. CLIMATE HAZARDS

4.1 Methodology used for climate resilience assessment

This climate risk and vulnerability assessment has been prepared in line with:

- European Commission Notice on Technical Guidance on the Climate Proofing of Infrastructure in the period 2021-2027 (further Technical guidance),
- EU Taxonomy 1st Delegated Act: Commission Delegated Regulation (EU) 2021/ of 4 June 2021 supplementing Regulation (EU) 2020/852 of the European Parliament and of the Council by establishing the technical screening criteria for determining the conditions under which an economic activity qualifies as contributing substantially to climate change mitigation or climate change adaptation and for determining whether that economic activity causes no significant harm to any of the other environmental objectives,
- European Financing Institutions Working Group on Adaptation to Climate Change (EUFIWACC) - Integrating Climate Change Adaptation into Project Development,
- European Commission- Non-paper Guidelines for Project Managers: Making vulnerable investments climate resilient,
- European Commission (2016)- Climate Change and Major Projects.

The process mostly follows the steps prescribed in the Technical guidance. A short overview of the process is given below.

Climate change adaptation measures for infrastructure projects centre around ensuring a suitable level of resilience to the impacts of climate change, which includes acute events such as more intense floods, cloudbursts, droughts, heatwaves, wildfires, storms and landslides and hurricanes, as well as chronic events such as projected sea-level rise and changes in average precipitation, soil moisture and air humidity. In addition to factoring in the climate resilience of the project, there must be measures to ensure that the project does not increase the vulnerability of neighbouring economic and social structures.

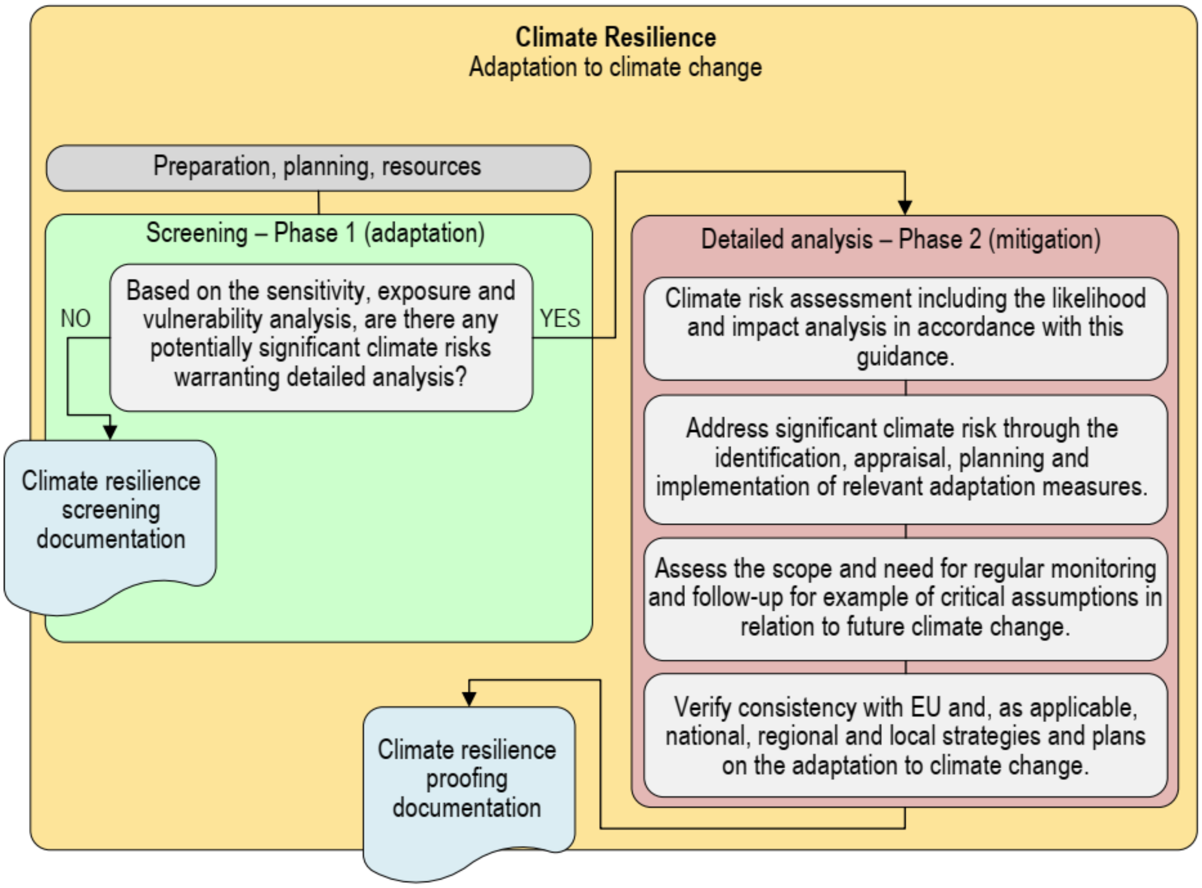


Figure 4-1. Overview of the climate adaptation-related process for climate proofing – an example

Analysing the vulnerability of a project to climate change is the first step in identifying the right adaptation measures to take and it represents the initial, 'Screening Phase', as illustrated in Figure 4-1**Error! Reference source not found.** The analysis is broken down into three steps, comprising a sensitivity analysis, an assessment of current and future exposure, and then a combination of the two for the vulnerability assessment.

The aim of the vulnerability analysis as part of the screening phase is to identify the relevant climate hazards for the given specific project type at the planned location. The vulnerability of a project is a combination of two aspects: how sensitive the project's components are to climate hazards in general (sensitivity) and the probability of these hazards occurring at the project location now and in the future (exposure). The aim of the sensitivity analysis is to identify which climate hazards are relevant to the specific type of project, irrespective of its location. Climate change indicators and climate change impact indicators (hazards) are overviewed in numerous documents (i.e. https://www.eea.europa.eu/ims, Climate change, impacts and vulnerability in Europe 2016- EEA, Extreme weather and climate in Europe- EEA, 2015). The exposure analysis can be split in two parts: exposure to the current climate and exposure to the future climate.

The 'Detailed Analysis', or Phase 2 of the assessment process, provides a structured method for analysing climate hazards and their impacts, to provide information for decision-making. This process works by assessing the likelihoods and severities of the impacts associated with the hazards identified in the vulnerability assessment (or initial screening of relevant hazards) and assessing the significance of the risk for the success of the Project. Compared to the vulnerability analysis, the risk assessment more readily facilitates the identification of longer cause-effect chains linking climate hazards to how the Project performs across several dimensions (technical, environmental, social/inclusion/accessibility and financial, etc.) and looks at interactions between factors. Hence, a risk assessment may identify issues that are not picked up by the vulnerability assessment. Likelihood analysis of the risk assessment looks at how likely the identified climate hazards are predicted to occur within a given timescale, e.g. the lifetime of the project. Impact assessment of the risk assessment looks at the consequences if the climate hazard identified occurs. This should be assessed on a scale of impact per hazard. This is also referred to as severity or magnitude. Having assessed the likelihood and the impact of each hazard, the significance level of each potential risk can be estimated by combining the two factors. If the risk assessment concludes that there are significant climate risks to the project, the risks will be managed and reduced to an acceptable level. For each significant risk identified, targeted adaptation measures will be assessed.

4.2 Floods

The total number of watercourses that will be crossed by the proposed Project alignment are given in

Paraćin-Stalać		
	Chainage	Watercourse
1	155+908	River Crnica
2	158+844	Bačijski stream
3	159+814	Stream Burdeljski
4	160+349	Slatinski stream
5	163+861	Planski stream
6	169+425	River Jovanovačka
7	172+051	Kočanski stream
8	173+709	Stream Akalavica

.

Table 4-1. Total number of railroad and watercourse crossings

Đunis-Trupale		
	Chainage	Watercourse
1	193+426	Simin Stream
2	196+848	Srezovačka river
3	201+255	Radevačka river
4	205+958	Suvi stream
5	208+820	Suhotnički stream
6	217+642	River Turija
7	219+097	Dašnička river
8	220+315	Drenovački stream
9	223+054	Južna Morava

Paraćin-Stalać		
	Chainage	Watercourse
1	155+908	River Crnica
2	158+844	Bačijski stream
3	159+814	Stream Burdeljski
4	160+349	Slatinski stream
5	163+861	Planski stream
6	169+425	River Jovanovačka
7	172+051	Kočanski stream
8	173+709	Stream Akalavica

Vulnerability and flood risk maps have been produced as a result of several projects (Danube Floodrisk Project, IPA 2014-2020 Flood recovery Serbia IPA 2014-2020 Flood recovery Serbia, SoFPAS in Serbia (Study of Flood Prone Areas in Serbia – Phase 1)). The results of modelling for Q1000[3] show the flooding areas along the Project route. Results of the Flood hazard and risk mapping Component 2 of Serbia National Disaster Risk Management Plan are vulnerability and flood risk maps from 2020. Results of modelling for Q1000 along the Project route are shown in the Table 4-2.

Table 4-2. Modelled flood hazard along the railway route

Location	Chainage [km]	Flood zone length [m]	Flood zone depth [m]	Flood zone risk level
Ćićevac	172+500 - 173+340	840	<0.5, 0.5-1.5	Low
Mezgraja	222+700 – 224+480	1780	<0.5, 0.5-1.5, 1.5-4	Low

The following figures show vulnerability and flood risk maps for the critical sections identified in Table 4-2. The Project route is represented with a red line.

[3] *Q1000 means the flood flow having a recurrence interval of 1000 years or a 0.1% chance of occurring or being exceeded in any given year.*

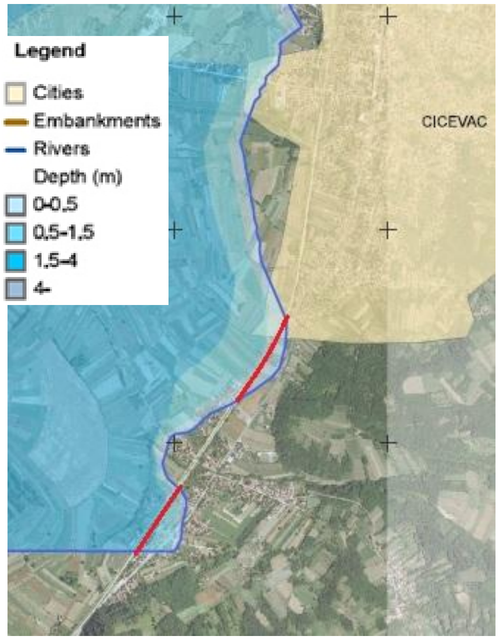


Figure 4-2. Flood hazard map for Ćićevac

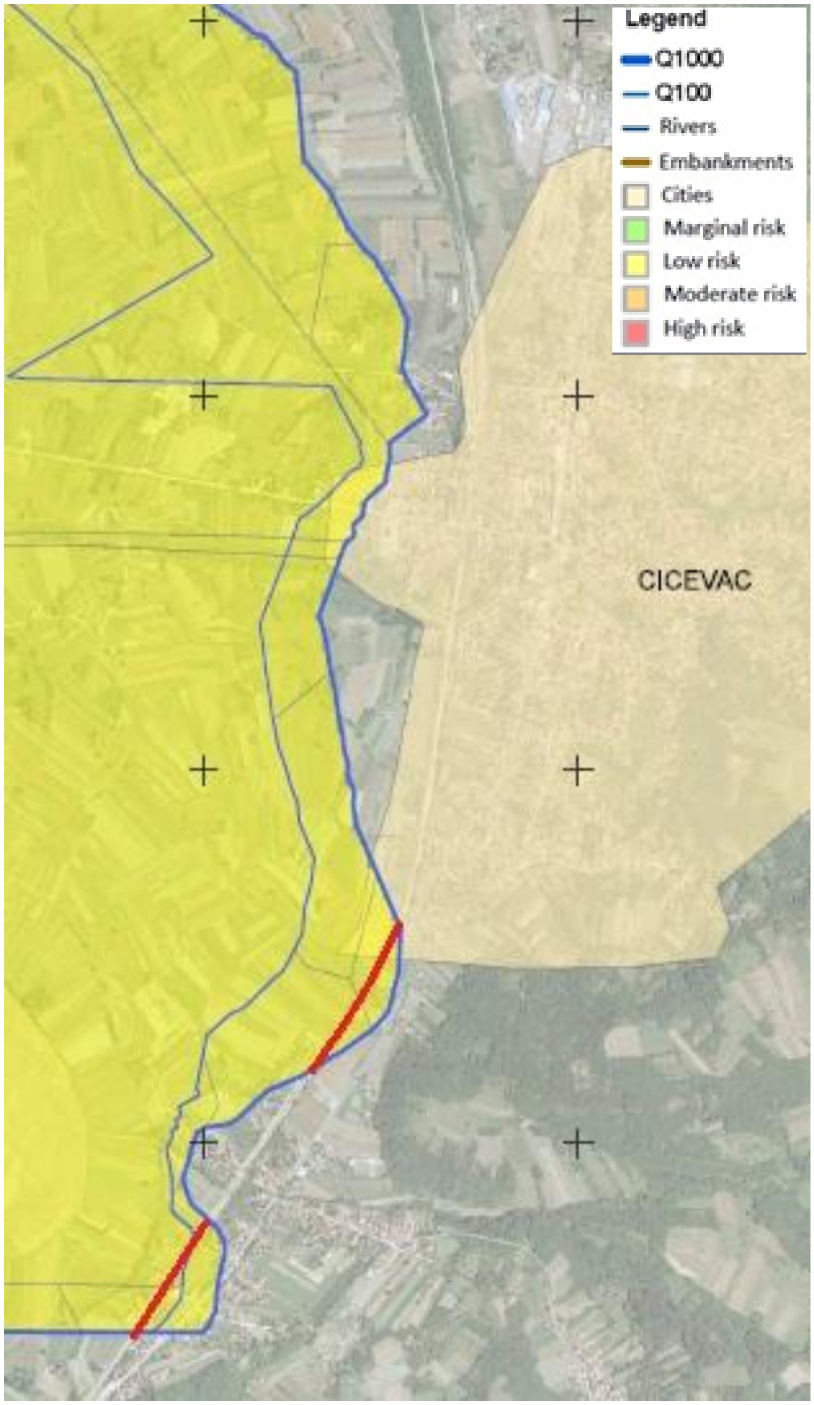


Figure 4-3. Flood risk map for Ćićevac

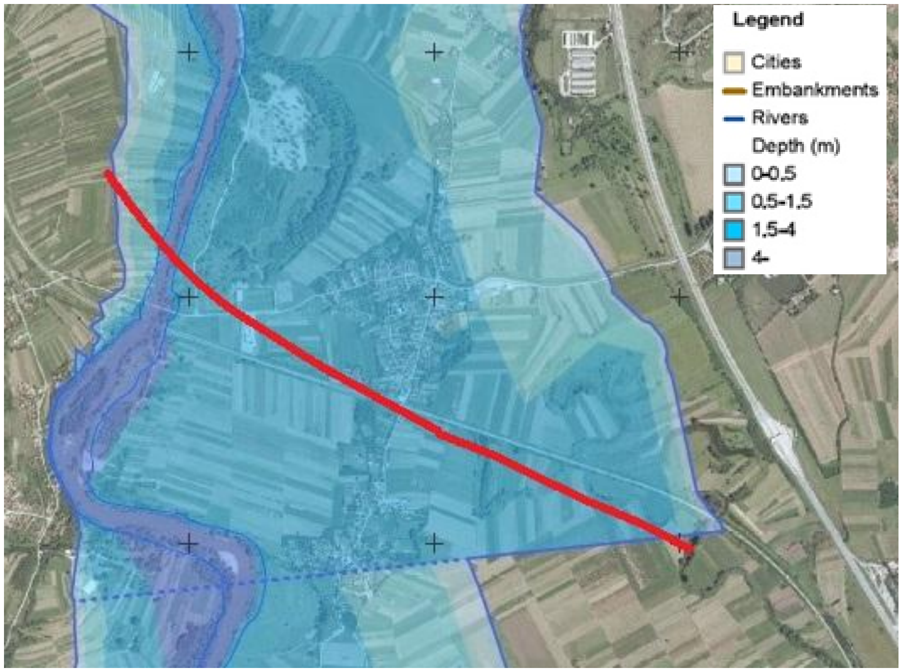


Figure 4-4. Flood hazard map for Mezgraja

Figure 4-5. Flood risk map for Mezgraja

Pluvial floods were not officially recorded (i.e. heavy rainfall-related flooding that is independent of an overflowing body of water).

4.3 Wildfires

The Fire Weather Index (FWI) is a meteorologically based index (European Forest Fire Information System EFFIS classification) used worldwide to estimate wildfire danger. It consists of different components that account for the effects of fuel moisture and wind on fire behaviour and spread. The higher the FWI is, the more favourable the meteorological conditions to trigger a wildfire.

The pan-European Wildfire Risk Assessment (WRA) aims is to describe the development of a pan-European wildfire risk based on the definition of risk adopted by the United Nations International Strategy for Disaster Reduction (UNISDR, 2009). Defining a proper probability of wildfire occurrence/propagation would imply detailed information on local socio-economic, political, and behavioural aspects variable with space and time (as the vast majority of wildfires in Europe is due to human causes) for which no harmonised nor accurate information is available, nor reliable scientific knowledge is developed yet for them to be predictable. As a consequence, the harmonised WRA is based on a semi-quantitative approach where wildfire hazard is modelled as a simpler fuzzy possibility relying on robust (yet semi-quantitative) rank-based analysis. The harmonised WRA will support the inter-comparison of methods and needs among countries and be complementary to existing national WRA. Additionally, it can serve as a first approach to assess wildfire risk in those countries that have not yet performed a national WRA.

The European Forest Fire Information System (EFFIS) has been established by the European Commission in collaboration with the national fire administrations to support the services in charge of the protection of forests against fires in the EU and neighbour countries, and also to provide the EC services and the European Parliament with harmonized information on forest fires in Europe. [4] Wildfire risk maps have been generated as an index to summarize the combined effect of wildfire danger and vulnerability (people, ecosystems and goods exposed in vulnerable areas). The format of the risk maps allows risk classes low, medium and high risk to be identified, with a simple score ranging from 0 % to 100 %, as the percentage of the cell under that specific class. High risk may be expected where high wildfire danger affects the most critical areas for people, and secondarily for the other ecological and socioeconomic aspects. High and intermediate aggregated wildfire risk for the Project alignement is presented in Figure 4-6 and Figure 4-7. Figure 4-8 shows the number of days with high-to-extreme fire danger by weather where the Fire Weather Index is 30 or higher (values of FWI between 21.3 and 38 are chategorized as high). The Project route alignment is indicated with a black line.

[4] https://forest-fire.emergency.copernicus.eu

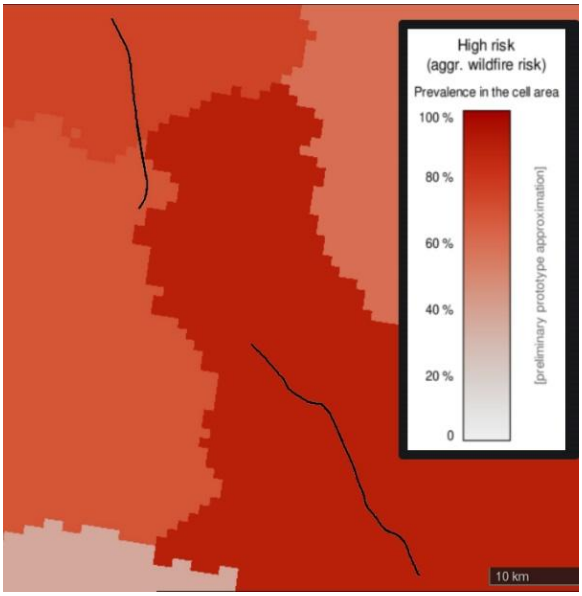


Figure 4-6. High aggregated wildfire risk (prevalence of the higher-risk class in the spatial cell (percentage), modelling wildfires and considering any other typology of vegetation fires only for the potential risk to become a wildfire).

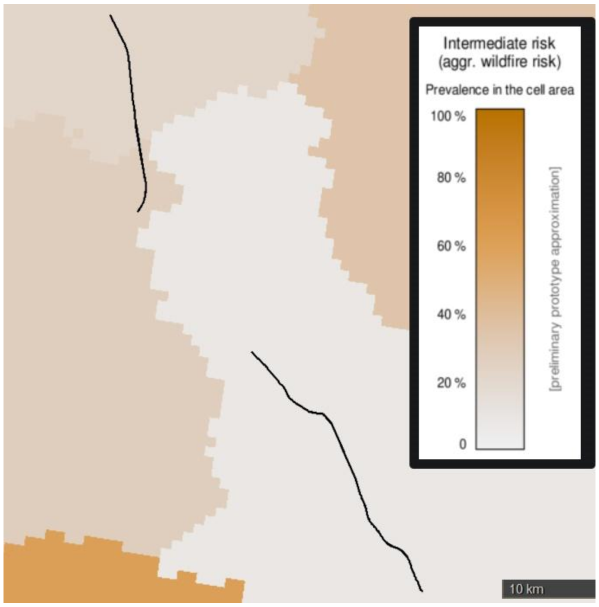


Figure 4-7. Intermediate aggregated wildfire risk (prevalence of the intermediate-risk class in the spatial cell (percentage), modelling wildfires and considering any other typology of vegetation fires only for the potential risk to become a wildfire), railway route marked by the black lines

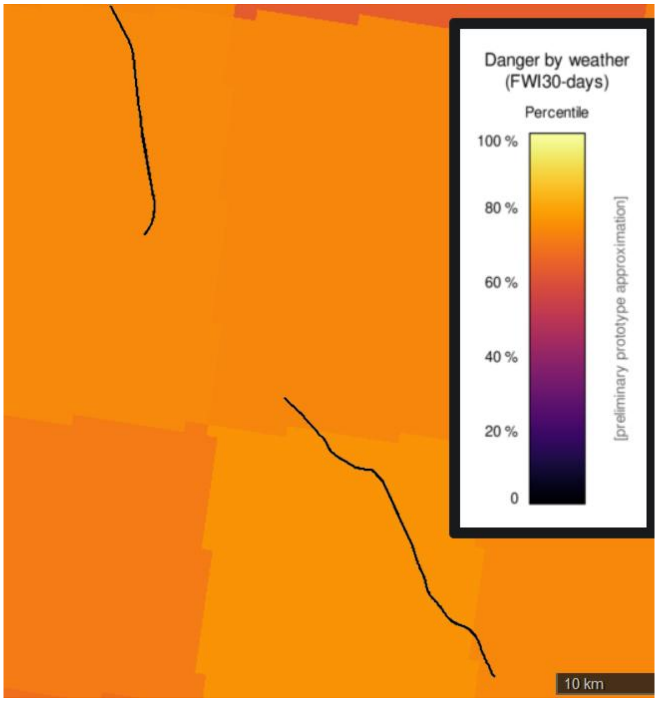


Figure 4-8. Wildfires – danger by weather (number of days with high-to-extreme fire danger by weather (FWI >= 30) (Van Wagner, 1987) – uncertainty aggregation: median value), railway route marked by the black lines

A supplementary source of information for wildfires is: ThinkHazard (https://thinkhazard.org). According to this source, results for Nišavski region indicate a high hazard level for wildfires.

Projections of the Ellenberg quotient, which is a climate index defined as a ratio of the hottest month's temperature and the average annual precipitation sum, are shown in Figure 4-9. The quotient indirectly expresses the relationship between climate and vegetation. The obtained values suggest that wildfires represent a climate hazard in the vicinity of the Project route (within 500m of both sides of the rail track). Values of hydro-thermal coefficient of Selyaninov, used in monitoring of agricultural drought conditions indicate a slow shift towards dryer conditions. Nevertheless, it can be seen from the 2018 Corine satellite imagery with 100m resolution (Figure 4-9), which identifies land cover in the Project area, that the railway route mainly passes through agricultural areas, urban areas and small patches with higher levels of vegetation.

There have been no historic major wildfires in the areas adjacent to the Project alignment.

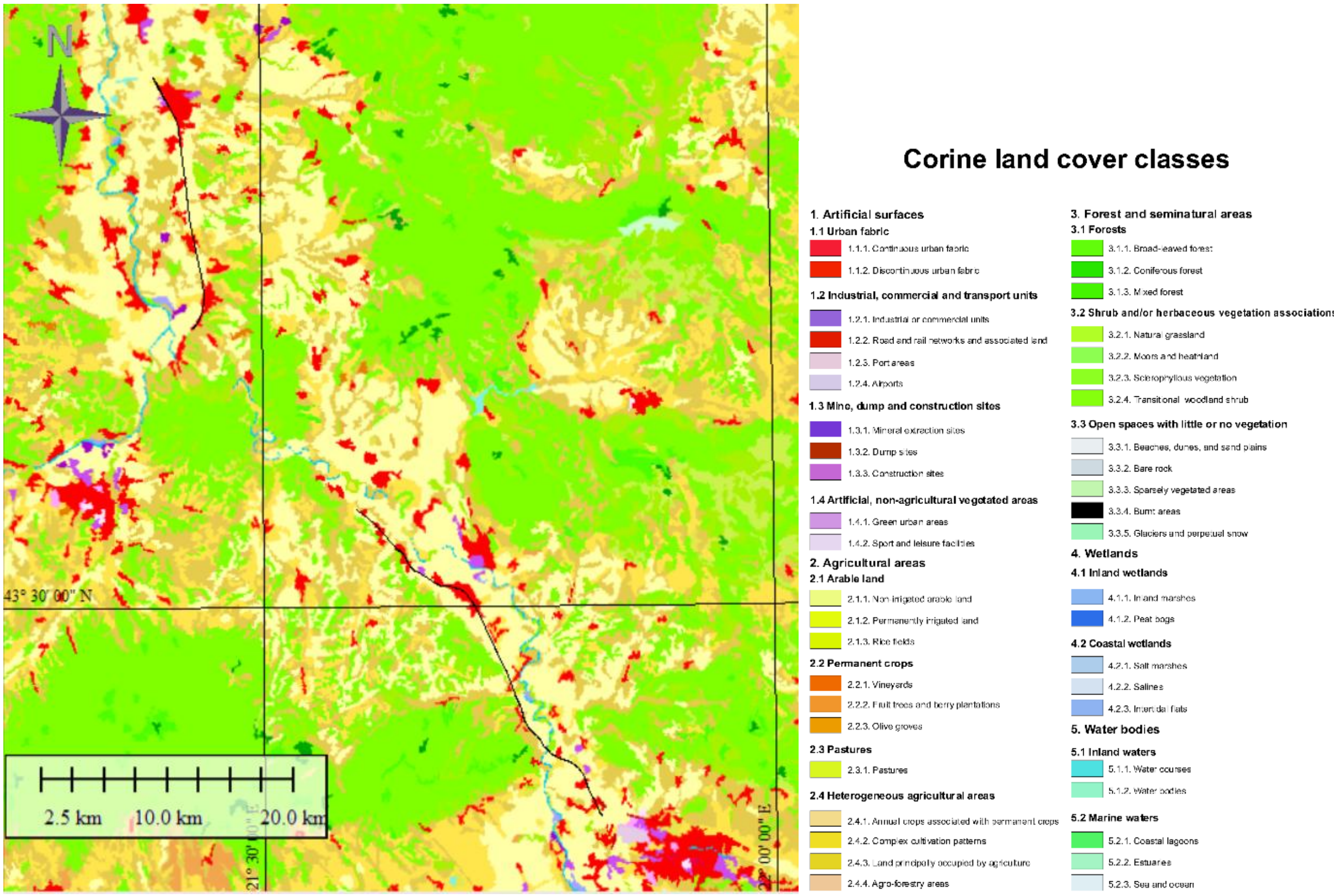


Figure 4-9. LANDSAT 2018 maps with 100m resolution (railway route marked black)

4.4 Landslides

The information from elevation maps is typically used as an initial indicator of where landslides can occur. It is evident from the elevation map (Figure 4-10) that the northern part of the Project route (Paraćin-Stalać) goes through the Velika Morava valley and the southern part (Đunis-Trupale) goes through the Južna Morava valley, where the land is flatter.

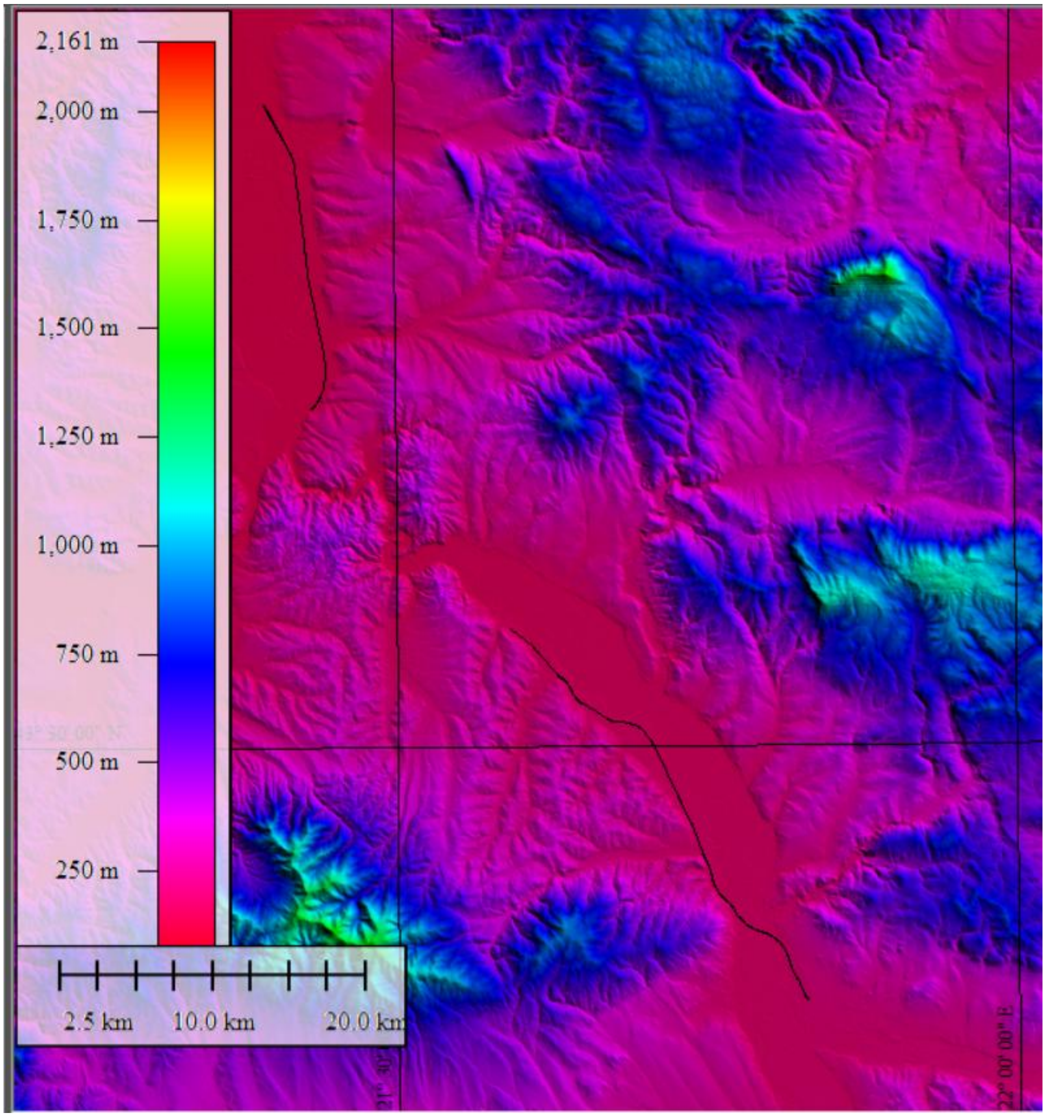


Figure 4-10. Elevation map (SRTM, 1-arc-second resolution) of the railway route (marked black)

The European landslide susceptibility ELSUS V2 map shows the landslide susceptibility zonation for individual climate-physiographic zones across Europe at a spatial resolution of 200 × 200 m.

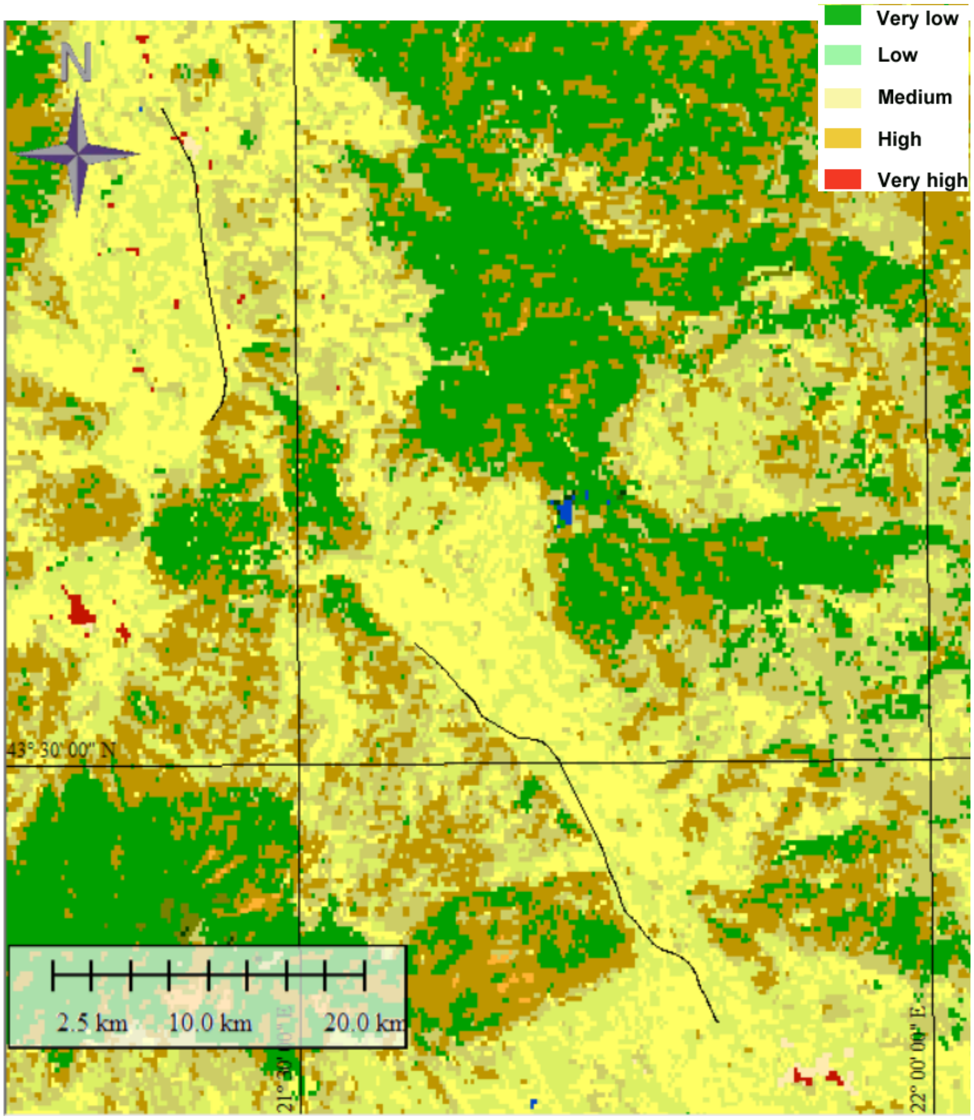


Figure 4-11. ELSUS V2 landslide susceptibility map for the project area

As seen from Figure 4-11, ELSUS foresees a medium landslide risk along the Project route (shown as a black line). However, it is considered that this qualitative assessment, as based on the elevation map (Figure 4-10), is overstated. Even the Đunis-Trupale section of the Project between 218+250 km and 219+000 km has an elevation gradient that is generally insufficient for landslide occurrence. This section is also completely under vegetation, which provides soil stability and reduces the likelihood of landslides occurring.

5. ASSESSMENT OF POTENTIAL IMPACTS

5.1 Choice of climate-related hazards

Available technical guidance gives extensive lists of relevant documents to help identify the relevant climate hazards for the assessment (EEA Report ‘Climate change, impacts and vulnerability in Europe 2016, EEA Report ‘Climate change adaptation and disaster risk reduction in Europe…). For example, the EEA Report ‘State of the European Environment’ lists the following climate- related hazards and indices:

- average temperature (annual near-surface);
- heat extremes;
- total precipitation;
- heavy precipitation and inland floods;
- droughts; and
- global and European sea level.

The Taxonomy Delegated Regulation in Appendix A, Generic criteria for DNSH („do no significant harm“) to climate change adaptation gives the most thorough classification of climate-related hazards ( ).

Not all listed climate related hazards are relevant for the Project. Windrelated events that are not characteristic or predicted for Serbia (cyclone, hurricane, typhoon and tornado), sea-, permafrost- and glaciar-related are excluded. Changes in hydrological regimes are also not of importance for the Project because of their general downward trend. Changing temperatures and temperature variability are, in the case of this Project, already covered by heat stress. Subsidence is excluded because the Project route is located in the Velika Morava valley, with no significant changes in the moisture content of the soil. The Velika Morava valley is also the reason why Changing wind patterns are not relevant. In relation to this Project, Soil erosion can be considered as a subclass of Soil degradation. All projections show that there will be no significant changes in precipitation types.

Some climate related hazards are additionaly separated because of the recorded and anticipated conditions along the Project route i.e. heavy precipitation by rain and hail, fluvial and pluvial floods and rockslides are separated from landslides.

Table 5-1. Classification of climate-related hazards – the Taxonomy Delegated Regulation

	Temperature-related	Wind-related	Water-related	Solid mass-related
Chronic	Changing temperature (air, freshwater, marine water)	Changing wind patterns	Changing precipitation patterns and types (rain, hail, snow/ice)	Coastal erosion
	Heat stress		Precipitation or hydrological variability	Soil degradation
	Temperature variability		Ocean acidification	Soil erosion
	Permafrost thawing		Saline intrusion	Solifluction
			Sea level rise	
			Water stress	
Acute	Heat wave	Cyclone, hurricane, typhoon	Drought	Avalanche
	Cold wave/frost	Storm (including blizzards, dust and sandstorms)	Heavy precipitation (rain, hail, snow/ice)	Landslide
	Wildfire	Tornado	Flood (coastal, fluvial, pluvial, ground water)	Subsidence
			Glacial lake outburs	

Instead of ’storms’, the narrower term ’extreme winds’ is used. The specifications for each relevant climate-related event are given in the Table below.

Table 5-2. Specification of relevant climate-related events

Climate-related event	Relevant climate indices covered with climate projections	Event threshold
Heat stress	Average daily temperature, maximum daily temperature, number of days with the Temperature higher than 35°C, tropical days index	>2°C average summer temperature [5]
Heat wave	Heat wave index, length of heat waves, consecutive dry days index	>3 events
Storm (extreme wind)	Extreme wind speeds at the 50-year return interval	25 m/s
Heavy rain	Daily precipitation, number of days with rainfall above 30mm, maximum 5-day precipitation	70mm- maximum daily sum
Fluvial flood – high regime	Daily precipitation, number of days with rainfall above 30mm, maximum 5-day precipitation, consecutive rainy days index	Water level at the foot of sleepers, water flow
Pluvial flood	Daily precipitation, number of days with rainfall above 30mm, maximum 5-day precipitation, consecutive rainy days index	Water level at the foot of sleepers, water flow
Cold wave/frost	Minimum daily temperature	>10 days with daily temperature below 0°C

[5] *National Program of adaptation to changes in climate conditions with Action plan 2023-2030, 2023*

Climate-related event	Relevant climate indices covered with climate projections	Event threshold
Wildfire	Maximum daily temperature, number of days with the Temperature higher than 35°C, tropical days index, heat wave index, length of heat waves, consecutive dry days index	Fire in the rail profile
Soil erosion	Soil erosion index, daily precipitation, number of days with rainfall above 30mm, maximum 5-day precipitation	>5 tonne/ha/year [6]
Solifluction	Average, maximum and minimum daily temperature, daily precipitation, number of days with rainfall above 30mm, maximum 5-day precipitation, consecutive rainy days index	Not quantifiable rail traffic blocked by the soil
Landslide	Daily precipitation, number of days with rainfall above 30mm, maximum 5-day precipitation, consecutive rainy days index	Not quantifiable rail traffic blocked by the soil
Rockfall	SPEI, number of days with rainfall above 30mm, maximum 5-day precipitation	Not quantifiable rail traffic blocked by the rocks
Water stress	Average daily temperature, maximum daily temperature, number of days with the Temperature higher than 35°C, tropical days index, heat wave index, length of heat waves, consecutive dry days index	60% reduction in annual total run-off
Drought	Average daily temperature, maximum daily temperature, number of days with the Temperature higher than 35°C, tropical days index, heat wave index, length of heat waves, consecutive dry days index, forest aridity index, SPEI	SPEI below −1.0

The following assessment has been performed for the construction and the operations phases of the Project. Predicted impacts and mitigation measures for the construction phase are included in the Framework Environmental and Social Management Plan (ESMP) for Corridor X (Belgrade-Niš) (included as Section 5.5 to this Chapter). These measures are re-assessed from the perspective of actual construction activities that are expected to occur within a relatively short timeframe (so the impact of climate change as quantified through climate projections shouldn't hold large uncertainty). The ESMP for the Project will include the requirement for the construction Contractor to develop and implement a construction phase Emergency Preparedness and Response Plan.

5.2 Sensitivity, exposure and vulnerability analysis

The approach that the Technical Guidance (outlined in Section 3) takes differs from standard ESIA methodology whereby the final output of the assessment is the determination of impact significance. The Guidance recognizes that for some projects climate resilience is not a relevant issue and therefore prescribes that the assessment process should end at the Stage 1 (vulnerability stemming from sensitivity and exposure analysis). Only if the results of this stage are deemed relevant is Phase 2 (risk assessment which encompasses impacts and likelihood) initiated. Therefore, the output of the ESIA methodology is to determine impact significance, whilst the output of the CRVA is an impact risk assessment.

[6] https://ec.europa.eu/eurostat/statistics-explained/index.php?title=File:Map1_Soil_erosion_by_water_on_agricultural_areas_and_natural_grassland_2016_NUTS3.png

The vulnerability assessment aims to identify potential significant hazards and related risks, and it forms the basis for the decision to continue to the risk assessment phase. Typically, it unveils the most relevant hazards for the risk assessment (these can be considered as the vulnerabilities ranked as 'high' and possibly 'medium', depending on the scale).

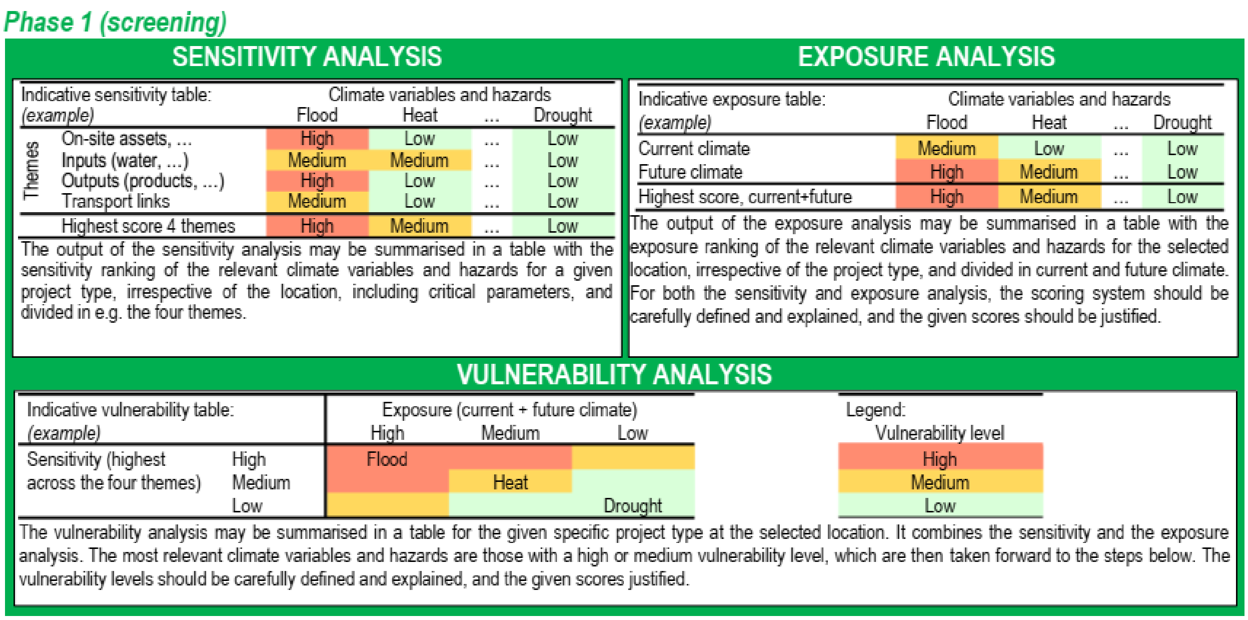


Figure 5-1. Overview of the phase 1 – screening- an example

5.2.1.1 Sensitivity

The aim of the sensitivity analysis is to identify which climate hazards are relevant to the specific type of project, **irrespective of its location**.

The sensitivity analysis should cover the project in a comprehensive manner, looking at the various components of the project and how it operates within the wider network or system. Themes used for this purpose are components of the railway, goods and services.

In addition, the project design may critically depend on specific (engineering or other) parameters. It may be important to include such **critical design parameters** in the climate sensitivity analysis. In case of the relevant railway subsection, such parameters were not identified.

A score of 'high', 'medium' or 'low' sensitivity is given for each theme and climate hazard:

- High sensitivity: the climate hazard may have a significant impact on assets and processes, inputs, outputs and transport links;
- Medium sensitivity: the climate hazard may have a slight impact on assets and processes, inputs, outputs and transport links;
- Low sensitivity: the climate hazard has no (or an insignificant) impact.

Table 5-3: Sensitivity analysis – construction phase

	Climate variables and hazards													
	Chronic				Acute									
Project components	Heat stress	Water stress	Soil erosion	Solifluction	Heat wave	Extreme wind	Heavy precipitation-rain	Fluvial flood	Pluvial flood	Cold wave / frost	Wildfire	Landslide	Rockfall	Drought
Construction activities on site	Medium	Low	Low	Low	Medium	Medium	Medium	Low	Low	Low	Low	Low	Low	Low
Transport to the site (components and materials) and workers	Low	Low	Low	Low	Low	Medium	Low	Medium	Medium	Low	Low	Low	Low	Low
OHS of the workers	Medium	Low	Low	Low	Medium	Medium	Low	Low	Low	Low	Low	Low	Low	Low
Highest score	Medium	Low	Low	Low	Medium	Medium	Medium	Medium	Medium	Low	Low	Low	Low	Low
Critical design parameters	Not identified													

Table 5-4: Sensitivity analysis – operational phase

	Climate variables and hazards													
	Chronic				Acute									
Project components	Heat stress	Water stress	Soil erosion	Solifluction	Heat wave	Extreme wind	Heavy precipitation-rain	Fluvial flood	Pluvial flood	Cold wave / frost	Wildfire	Landslide	Rockfall	Drought
Rail tracks	High	Low	Low	Low	High	Low	Low	Low	Low	Low	Low	Low	Low	Low
Sleepers	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low
Ballast	Low	Low	Low	Low	Low	Low	Low	High	Medium	Low	Low	Low	Low	Low
Subgrade	Low	Low	Low	Low	Low	Low	Low	Medium	Medium	Low	Low	Low	Low	Low
Overhead lines	Medium	Low	Low	Low	Medium	High	Low	Low	Low	Low	Low	Low	Low	Low
Train	Low	Low	Low	Low	Low	Medium	Low	Medium	Medium	Low	Low	Low	Low	Low
Transport service	Low	Low	Low	Low	Low	Medium	Low	High	Medium	Low	Medium	Medium	Medium	Low
Transport links	Low	Low	Low	Low	Low	Medium	Low	Medium	Medium	Low	Low	Low	Low	Low
Highest score	**High**	**Low**	**Low**	**Low**	**High**	**High**	**Low**	**High**	**Medium**	**Low**	**Medium**	**Medium**	**Medium**	**Low**
Critical design parameters	Not identified													

"Transport service" refers to transport of people and goods along the rail and "transport links" refers to position and relevance of the railway section in question to the wider transport network. Rail transport is especially vulnerable to service disruptions, because there are few alternative routes. A single incident may therefore affect many trains, and disruptions may take a long time to clear.

5.2.1.2 Exposure

'Exposure' is the probability that a particular hazard will happen. The aim of the exposure analysis is to identify which hazards are relevant, **irrespective of the project type**, by focusing on the location of the Project**.**

The exposure analysis can be split in two parts: exposure to the current climate and exposure to the future climate. Available historic and current data for the project location (or project alternative locations) should be used to assess current and past climate exposure. Climate model projections can be used to understand how the level of exposure may change in the future. Particular attention should be given to changes in the frequency and intensity of extreme weather events. For the construction phase, deviation from the original methodology has been made considering that, due to the construction schedule, future climate is not relevant, i.e. only current is considered.

Table 5-5: Exposure analysis – construction phase

	Climate variables and hazards													
	Chronic				Acute									
Climate	Heat stress	Water stress	Soil erosion	Solifluction	Heat wave	Extreme wind	Heavy precipitation-rain	Fluvial flood	Pluvial flood	Cold wave/ frost	Wildfire	Landslide	Rockfall	Drought
Current	Medium	Low	Low	Low	Medium	Medium	Low	Low	Low	Low	Low	Low	Low	Low
Highest score	Medium	Low	Low	Low	Medium	Medium	Low	Low	Low	Low	Low	Low	Low	Low

Table 5-6: Exposure analysis – operational phase

	Climate variables and hazards													
	Chronic				Acute									
Climate	Heat stress	Water stress	Soil erosion	Solifluction	Heat wave	Extreme wind	Heavy precipitation-rain	Fluvial flood	Pluvial flood	Cold wave/ frost	Wildfire	Landslide	Rockfall	Drought
Current	Medium	Low	Low	Low	Medium	Medium	Low	Low	Low	Low	Low	Low	Low	Low
Future	High	Low	Low	Low	High	High	Low	Medium	Low	Low	Low	Low	Low	Low
Highest score	High	Low	Low	Low	High	High	Low	Medium	Low	Low	Low	Low	Low	Low

5.2.1.3 Vulnerability

The vulnerability assessment aims to identify potential significant climate hazards and the related risk to Project components (outlined in Table 5-7), and it forms the basis for the decision to continue to the risk assessment phase. Typically, it unveils the most relevant hazards for the further risk assessment (these can be considered as the vulnerabilities ranked as ‘high’ and possibly ‘medium’, depending on the scale).

The qualitative assessment made during the sensitivity and exposure analysis stems from the presented route-specific climate projections, initial screening of the most common climate hazards in the Project area, and the informed forecast stemming from a combination of observed traffic interruptions and future climate. Extreme heat events are already experienced and are to forecast to become more frequent and intense in the future. ‘Extreme winds’ has been allocated a high vulnerability level mostly due to the existence of supercell storms, which are a new reality in the whole region, while fluvial floods should be addressed more thoroughly, especially because of the Jošanička River. Since the whole route passes through the Velika Morava valley (with high soil moisture level, low height gradient, and no extreme temperature differences), water stress, soil erosion, solifluction, and drought are considered to be of minor importance. The number of cold and frosty days is also declining. The same low height gradient and good vegetation coverage also significantly lowers the probability of landslides occurring and, based on the known geology of the Project area geology, also rockfalls. The Project route mostly passes through agricultural and semi-urban areas, so, with the proper maintenance, wildfire vulnerability is also considered to be low.

Table 5-7: Vulnerability analysis

		Exposure (current + future climate)		
		High	Medium	Low
Sensitivity-construction phase	High			
	Medium		Heat stress, Heat wave, Extreme wind	Heavy precipitation- rain, Fluvial flood, Pluvial flood
	Low			Water stress, Soil erosion, Solifluction, Cold wave/ frost, Drought, Landslide, Rockfall, Wildfire
Sensitivity-operational phase	High	Heat stress, Heat wave, Extreme wind	Fluvial flood	
	Medium			Pluvial flood, Landslide, Rockfall, Wildfire
	Low			Heavy precipitation- rain, Water stress, Soil erosion, Solifluction, Cold wave/ frost, Drought

High	Vulnerability level
Medium	
Low	

In line with the Guideline recommendations not to proceed to the phase 2 of CRVA if the results of the phase 1 indicate low vulnerability, having in mind construction schedule (within next couple of years, so the current climate stays relevant) and understanding that medium-level vulnerability results are stemming from workers wellbeing in regard to extreme heat-related events, detailed analysis is going to be performed only for operational phase.

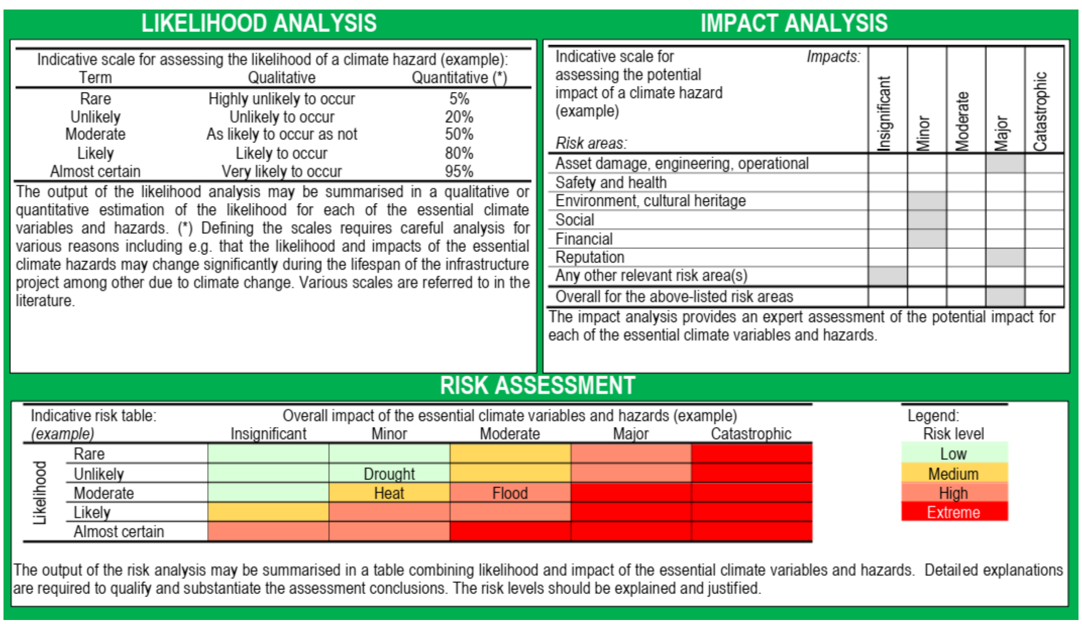
5.3 Phase 2 – Detailed analysis

5.3.1 Impacts, likelihood, and climate risks

The Phase 2 climate risk assessment provides a structured method for analysing climate hazards and their impacts (see Table 5-9) to help provide information for decision making.

This process works by assessing the likelihood and magnitude of the impacts associated with the relevant hazards identified in the vulnerability assessment (or initial screening of relevant hazards) on the receptors identified in Table 5-4**Error! Reference source not found.** and assessing the significance of the risk to the receptors.

Figure 5-2 provides an overview of the likelihood analysis, impact analysis, and risk assessment, which form the basis for identifying, appraising, selecting and implementing adaptation measures.



LIKELIHOOD ANALYSIS

Indicative scale for assessing the likelihood of a climate hazard (example):

Term	Qualitative	Quantitative (*)
Rare	Highly unlikely to occur	5%
Unlikely	Unlikely to occur	20%
Moderate	As likely to occur as not	50%
Likely	Likely to occur	80%
Almost certain	Very likely to occur	95%

The output of the likelihood analysis may be summarised in a qualitative or quantitative estimation of the likelihood for each of the essential climate variables and hazards. (*) Defining the scales requires careful analysis for various reasons including e.g. that the likelihood and impacts of the essential climate hazards may change significantly during the lifespan of the infrastructure project among other due to climate change. Various scales are referred to in the literature.

IMPACT ANALYSIS

Indicative scale for assessing the potential impact of a climate hazard (example) — *Risk areas:* / *Impacts:*	Insignificant	Minor	Moderate	Major	Catastrophic
Asset damage, engineering, operational					
Safety and health					
Environment, cultural heritage					
Social					
Financial					
Reputation					
Any other relevant risk area(s)					
Overall for the above-listed risk areas					

The impact analysis provides an expert assessment of the potential impact for each of the essential climate variables and hazards.

RISK ASSESSMENT

Indicative risk table: *(example)* — Overall impact of the essential climate variables and hazards (example)

Likelihood	Insignificant	Minor	Moderate	Major	Catastrophic
Rare					
Unlikely		Drought			
Moderate		Heat	Flood		
Likely					
Almost certain					

Legend: Risk level
Low
Medium
High
Extreme

The output of the risk analysis may be summarised in a table combining likelihood and impact of the essential climate variables and hazards. Detailed explanations are required to qualify and substantiate the assessment conclusions. The risk levels should be explained and justified.

Figure 5-2. Overview of the climate risk assessment in phase 2 – an example

Compared to the vulnerability analysis, the risk assessment more readily facilitates the identification of longer cause-effect chains linking climate hazards to risks across several dimensions (technical, environmental, social/inclusion/accessibility and financial, etc.) and looks at interactions between factors. Hence, a risk assessment may identify issues that are not picked up by the vulnerability assessment.

5.3.1.1 Likelihood

This part of the risk assessment looks at how likely the identified climate hazards are to occur within a given timescale, e.g. the lifetime of the Project. In the case of a railway that has a lifetime of up to 100 years, the reference period is the end of the century. This information is important because of the selection of the right time horizon within different climate scenarios presented earlier. This approach diverges from defining the spatiotemporal impact as per the ESIA methodology, as the temporal component is divided between exposure analysis (current and future climate) and the likelihood in which adequate climate scenario (based on the relevant climate projection) is chosen.

The following likelihood analysis is based on a combination of historical data (already recorded occurrences of relevant climate hazards in the Project area) and Project-specific climate projections, and. follows the same logic as the vulnerability assessment. The likelihood of extreme winds is mostly based on the statistics regarding the occurrence of supercell storms, whilst fluvial floods are conservatively considered “as likely to occur as not”, because of the possible occurrence of higher flows than Q1000 (2014).

Table 5-8. Likelihood analysis

	Climate variables and hazards			
Likelihood	Heat stress	Heat wave	Fluvial flood	Extreme wind
	Almost certain	Almost certain	Moderate	Almost certain

Term	Qualitative	Quantitative
Rare	Highly unlikely to occur	5%
Unlikely	Unlikely to occur	20%
Moderate	As likely to occur as not	50%
Likely	Likely to occur	80%
Almost certain	Very likely to occur	95%

5.3.1.2 Impact

This part of the risk assessment looks at the consequences if the climate hazard identified occurs (i.e. the impact). This should be assessed on a scale of impact per hazard. This is also referred to as magnitude.

The consequences generally relate to physical assets and operations, health and safety, environmental impacts, social impacts, impact on accessibility for persons with disabilities, financial implications, and reputational risk. The assessment may need to cover the adaptive capacity of the system in which the project operates. It may also be relevant to consider how fundamental this infrastructure is to the wider network or system (i.e. criticality) and whether it may lead to additional wider impacts and cascading effects.

For the identified range of climate related hazards, it can be expected that the likelihood and impacts will change during the lifespan of the project, as global warming and climate change unfolds. The projected changes in likelihood and impacts should be integrated in the risk assessment. For this purpose, it is useful to divide the Project lifespan into a sequence of shorter periods. As such, the Project lifespan has been divided into two periods: 2030-2060 and 2060-2100. Snow-related events are excluded from the assessment due to their low vulnerability and likelihood impact.

Table 5-9. Magnitude of consequence across various risk areas

	Magnitude of consequence				
Risk areas/ receptors	**1 Insignificant**	**2 Minor**	**3 Moderate**	**4 Major**	**5 Catastrophe**
Asset damage / Engineering / Operational	Impact can be absorbed through normal activity	An adverse event that can be absorbed by taking business continuity actions	A serious event that requires additional emergency business continuity actions	A critical event that requires extraordinary / emergency business continuity actions	Disaster with the potential to lead to shut down or collapse or loss of the asset / network
Safety and Health of rail workers and passengers	First aid case	Minor injury, medical treatment	Serious injury or lost work	Major or multiple injuries, permanent injury or disability	Single or multiple fatalities
Environment (all environmental mediums)	No impact on baseline environment. Localised in the source area. No recovery required	Localised within site boundaries. Recovery measurable within one month of impact	Moderate harm with possible wider effect. Recovery in one year	Significant harm with local effect. Recovery longer than one year. Failure to comply with environmental	Significant harm with widespread effect. Recovery longer than one year. Limited

	Magnitude of consequence				
Risk areas/ receptors	1 Insignificant	2 Minor	3 Moderate	4 Major	5 Catastrophe
				regulations / consent	prospect of full recovery
Social	No negative social impact	Localised[7], temporary social impacts	Localised, long term social impacts	Failure to protect poor or vulnerable groups. National, long term social impacts	Loss of social licence to operate. Community protests
Financial (damage of single extreme event/ lost revenue) [EUR][8]	500	1000	10,000	50,000	200,000
Reputation	Localised, temporary impact on public opinion	Localised, short-term impact on public opinion	Regional-level, long-term impact on public opinion with adverse local media coverage	National, short term impact on public opinion; negative national media coverage	National, long term impact with potential to affect the stability of the government
Cultural Heritage and cultural premises	Insignificant impact	Short term impact. Possible recovery or repair.	Serious damage with wider impact to tourism industry	Significant damage with national and international impact	Permanent loss with resulting impact on society

Impacts assessed in Table 5-10 to Table 5-13 are based on the nation-wide and the Project-specific climate projections with expert insights on the Project-based surroundings (especially for the non-tangible receptors). For all hazards assessed in phase 2, it is assumed that the public will gain an increased awareness in the future regarding climate-related events. Therefore, social and reputational impacts will be stronger, even if the future magnitude of hazards remains the same. Financial burdens will also rise as the climate crisis further unfolds. Environmental strains will increase gradually, allowing nature to partially adapt to the changed external conditions (mostly heat events). The magnitue of consequences on cultural heritage assets is generally assessed in terms of potential material damage and from the wider tourist industry perspective, of which the later has a larger impact. In this regard, this section is not applicable to the Project.

[7] *municipal level*

[8] *Assessmenet based on the historical material damage to assets from Table 3-7.*

Table 5-10. Impact analysis – heat stress

		Impacts									
		Heat stress 2030- 2060					Heat stress 2060- 2100				
		Insignificant	Minor	Moderate	Major	Catastrophic	Insignificant	Minor	Moderate	Major	Catastrophic
Risk areas	Asset damage										
	Safety/health										
	Environment										
	Social										
	Financial										
	Reputation										
	Cultural heritage										
	Overall										

Table 5-11. Impact analysis – heat wave

		Impacts									
		Heat wave 2030- 2060					Heat wave 2060- 2100				
		Insignificant	Minor	Moderate	Major	Catastrophic	Insignificant	Minor	Moderate	Major	Catastrophic
Risk areas	Asset damage										
	Safety/health										
	Environment										
	Social										
	Financial										
	Reputation										
	Cultural heritage										
	Overall										

Table 5-12. Impact analysis – extreme wind

		Impacts									
		Extreme wind 2030- 2060					Extreme wind 2060- 2100				
		Insignificant	Minor	Moderate	Major	Catastrophic	Insignificant	Minor	Moderate	Major	Catastrophic
Risk areas	Asset damage										
	Safety/health										
	Environment										
	Social										
	Financial										
	Reputation										
	Cultural heritage										
	Overall										

Table 5-13. Impact analysis – fluvial flood

		Impacts									
		Fluvial flood 2030- 2060					Fluvial flood 2060- 2100				
		Insignificant	Minor	Moderate	Major	Catastrophic	Insignificant	Minor	Moderate	Major	Catastrophic
Risk areas	Asset damage										
	Safety/health										
	Environment										
	Social										
	Financial										
	Reputation										
	Cultural heritage										
	Overall										

5.3.1.3 Risks

Having assessed the likelihood and the impact of each climate related hazard, the significance of each potential risk can be assessed by combining the two factors. The risks are plotted on a risk matrix to identify the most significant potential risks, where adaptation/mitigation measures need to be implemented.

Table 5-14. Risk assessment

		Overall impact of the essential climate variables and hazards									
		2030- 2060					2060- 2100				
		Insignificant	Minor	Moderate	Major	Catastrophic	Insignificant	Minor	Moderate	Major	Catastrophic
Likelihood	Rare										
	Unlikely										
	Moderate		Fluvial flood						Fluvial flood		
	Likely										
	Almost certain	Extreme wind	Heat stress, Heat wave					Extreme wind	Heat stress, Heat wave		

Risk level	Low	Medium	High	Extreme

The risk assessment has shown that heat-related events will have high to extreme risk levels in both time periods. Extreme wind will continue to pose a high threat in the future, whilst the torrential nature of watercourses, if not addressed, could represent a problem in the future.

5.4 Current processes used for mitigation of climate risks beyond ‘Railway infrastructure of Serbia’

The SRI’s scope of engagement with climate risks is limited to reactive maintenance and documenting traffic disruption occurrences.

Flows in the Velika Morava and Južna Morava Rivers are not regulated along the railway route. All of the municipalities in the valleys of these two rivers that were affected by the 2014 floods, have since implemented flood protection measures to some degree, even if only through regular riverbed clearing (financed by Srbijavode).

In 2023 the municipality of Ćićevac successfully implemented one of the most important infrastructure projects for addressing flood risk, involving the rehabilitation and regulation of the Jovanovačka riverbed. Remedial measures taken have included the construction and strengthening of embankments along the river, securing the banks in places of damage and widening the watercourse, to reduce the risk of future flooding.

The International Commission for the Protection of the Danube River produced the document “Sub-Basin Level Flood Action Plan – Velika Morava River Basin and Right Danube – Tributaries between the Sava River Mouth and RS-BG Border” in 2009. This includes high-level structural and non-structural flood-protection measures

The draft Spatial plan of the Republic of Serbia from 2021 to 2035, foresees the construction of several hydroelectric power plants (HPPs) on Velika Morava and Južna Morava Rivers. With proper management of these HPPs, their impact on flood risk is expected to be beneficial.

5.5 Measures incorporated into the Conceptual Design to reduce climate risk

Surface water drainage will be facilitated by the construction of a drainage system that follows the longitudinal and transverse slopes of the railway. The system will incorporate 5 types of drainage channels made of MB20 concrete. Railway track drainage in the cut is facilitated by the transverse slope of the subgrade (i.e. the base layer below the aggregate) being at 4%, which allows water to drain under gravity into either longitudinal drains between the tracks, or concrete channels along the edges of the subgrade. Longitudinal drains between the tracks will be made of semi-perforated PVC pipes with a diameter of 150 mm with a longitudinal drop. Culverts with openings of up to 5m will also be incorporated into the design of the overall drainage system. As such, the designed infrastructure should significantly lower the risks of flooding and landslides.

The complete replacement of all elements of the track superstructure is planned. OCLs, noise barriers and GSM-R masts are designed in accordance with valid regulations in Serbia, including the relevant Eurocodes and national Annexes. Maximum wind speeds in the Project area are known to be around 17 m/s (Figure 3-4). Usually, the applicable rule of thumb is that the ratio between mean wind speed and wind gust speed is in the range between 1.3 and 1.8. Considering the terrain topography (Figure 4-10), low roughness (Figure 4-9 used as a proxy) and the channelling effect of the Velika Morava valley, a coefficient of 1.8 is considered to be adequate. Therefore, wind gusts of approximately 30 m/s are assessed as realistic. All above-ground structural elements will be capable of resisting incident wind loads of approximately 30 m/s. Also, since the statistics (both global and the Project-specific – Table 3-7) show that objects falling on the railway infrastructure due to wind (and not wind itself) are the usual cause of wind-related traffic interruptions, the Conceptual Design envisages regular vegetation maintenance in the railway surroundings. Records of historic damage, and the assessment of the future wind-related damage to the rail components does not justify additional measures beyond that.

The stress-free temperature (SFT) used in the current design is based on historic values and it is 25.5±3°C.

As described in 3/1 Railway drainage project, the storm sewer branch from the access road to the Ćićevac station (~km 171+350) with water treatment in the separator flows into the UP8-d absorption field. The drainage system also flows into the same absorption field before the new culvert at km 171+250.00, with passage under the designed access road to the Ćićevac station. Regulation of Jovanovačka River km 169+425.07, foressen in 3/2 Watercourse regulation project, will serve double purpose- it will lower risk of flooding of Jovanovačka River and also flooding risk downstream, at the identified location km 172+500 to 173+340 (Table 4-2).

Bridges have been designed to ensure that they do not impede the flow of watercourses under flood conditions, in accordance with climate change predictions. This has necessitated raising the bridge superstructure to the required height and providing the necessary bridge spans to accommodate flood flows. In addition, temperature effects on bridge structures have been analysed in accordance with Eurocodes and valid national annexes. The same applies to the effects of wind on structures. Maximum wind speeds and maximum/minimum temperatures were determined on the basis of national annexes that are mandatory for application in the Republic of Serbia.

In Mezgraja, where flood modelling has identified a flood- vulnerable section of the Project (but with low risk), an adequate number of culverts with the appropriate cross sections have been included in the Project design. The drainage systems for the whole section (including Mezgraja), according to the existing design and as it is confirmed with the designers, are sufficient for a Q1000 flood flow.

5.6 Measures defined in Framework ESMP CORRIDOR X Belgrade-Niš

Table 5-15 outlines the mitigation measures relevant to climate related impacts that have been included in the Framework ESMP developed for the Corridor X Project following the Corridor Level Environmental and Social Assessment for the Belgrade-Niš High Speed Railway Corridor from July 2022.

Table 5-15. Climate-related measures already defined in Framework ESMP Corridor X Belgrade-Niš

E&S aspect/ impact	Proposed mitigation measure	Responsibility		Target/ indicator
		Preparation/ implementation/ approval	Monitoring	
Construction Water and Soil Management Plan	The Contractors will be responsible for development and implementation of a Construction Water and Soil Management Plan. The Plan will include at least the following measures: ▪ Suitable construction site drainage system will be provided including cut-off valves, ditches or drains and sustainable drainage systems, or equivalent, with suitably sized treatment facilities; ▪ Appropriate specifically designed areas for the temporary stockpiling of construction materials will be identified including “no-go” areas or specific sensitive locations (ecology receptors, sloping areas or areas that are susceptible to erosion, river flood plains); “no-go” areas boundaries will be physically demarcated. ▪ Any damage caused to ground and surface water infrastructure such as supply systems, irrigation systems, flood defences and drainage ditches must be rectified by the Contractors; ▪ The positioning of stockpiles near to watercourses will be avoided, they will be a minimum of 30m from any watercourse, and they will be located outside areas at fluvial flood risk;	- Preparation and implementation– Contractors - Approval – PIU / Supervision Engineer	- Records on spillage and monitoring performed - Contractors and Supervision Engineer to prepare monthly reports for the PIU on the status of Plan performance	- Plan developed by the Contractors and approved by the PIU/Supervision Engineer and Lenders prior to construction, and implemented by the Contractors

E&S aspect/ impact	Proposed mitigation measure	Responsibility		Target/ indicator
		Preparation/ implementation/ approval	Monitoring	
	▪ Earthworks and works in/around watercourses will be avoided during high flow events and during heavy rainfall to reduce the risk of fine sediment release, erosion and increased flood risk; ▪ The Contractors will implement measures to minimise the risk of erosion by building temporary drainage canals and embankments; ▪ Removal of obstacles and coarse material that could slow down the watercourse due to accumulation and increase the risk of floods;			
Construction Emergency Preparedness and Response Plan	The Contractors will develop a Construction Emergency Preparedness and Response Plan prior to construction works to eliminate hazards and reduce potential negative impacts. The Plan: ▪ Sets out key Serbian and EU policies, laws and standards related to emergency response to reduce negative impacts on society or the environment; ▪ Defines roles and responsibilities; ▪ Identifies and classifies potential emergencies in the construction phase, including spill management, erosion management and flood management; ▪ Lists the activities, measures and equipment needed to respond to emergencies; ▪ Defines the implementation of trainings for emergency preparedness; ▪ Defines media ways of communication in emergency situations; ▪ Defines the procedure of mitigation and recovery after emergency situations; ▪ Defines the maintenance and control of this plan. ▪ The Contractors shall review the Plan after any emergency situation or training exercise to provide opportunity for its continual improvements.	- Preparation and implementation– Contractors - Approval – PIU / Supervision Engineer	- Records of emergencies that occurred on the construction site> Contractors and Supervision Engineer to prepare monthly reports for the PIU on the status of Plan performance	- Plan developed by the Contractors and approved by the PIU prior to construction and implemented during construction - Number of emergencies, the success and timeliness of response

E&S aspect/ impact	Proposed mitigation measure	Responsibility		Target/ indicator
		Preparation/ implementation/ approval	Monitoring	
River Crossing Plan	The Contractors will develop a River Crossing Plan to include environmental requirements and control measures during the construction works near the waterways, including the in-water works, as well as other requirements that will be set in the Water Conditions issued by the Ministry of Agriculture, Forestry and Water Management-Water Directorate: ▪ Predict bridge pillars and support structures that will create the least resistance to water runoff, and which will be hydraulically shaped and parallel to the streams of the river flow; ▪ In case of deep erosion in the zone of riverbanks, envisage technical solutions that will provide support structures and pillars to stabilise the river flow upstream and downstream of the bridge and along the riverbed; ▪ Watercourse will be clear of obstruction and debris to reduce blockage risk; ▪ Restore any affected banks by re-establishing native riparian vegetation. ▪ River Crossing Plan should cover both accidental and intended impacts due to water crossings and define roles and responsibilities.	- Preparation and implementation– Contractors - Approval – PIU / Supervision Engineer	- Contractors and Supervision Engineer to prepare monthly reports for the PIU on the status of Plan performance	- Plan developed by the Contractors and approved by the PIU prior to construction and implemented during construction by the Contractors> Number of accidents caused by river crossings
Construction Compound Selection and Management Plan	The Contractors will be responsible for negotiating agreements with landowners, to temporarily use land for construction compounds and construction access in accordance with the future RAPs to be developed for each subsection. Construction compounds will be selected in consultation with affected communities. Construction compounds should be located away from sensitive receptors to the extent possible to minimise any adverse impacts as a result of construction activities. Suitable drainage from construction compounds/construction workers accommodation must be provided including cut-off valves, ditches or drains and sustainable drainage system, or equivalent, with suitable sized treatment facilities such as settlement or detention basins. Upon completion, areas used as construction compounds will be returned to their original use and state.	- Preparation and implementation– Contractors - Approval – PIU / Supervision Engineer	- The Contractors and Supervision Engineer to prepare monthly reports on the construction sites and construction compounds organisation for the PIU, based on conducted weekly visual inspections	- Construction Compound Selection and Management Plan developed and approved by the PIU / Supervision Engineer and Lenders, and implemented by the Contractors
Construction Planting	The Contractors will develop a Construction Planting Management Plan to cover landscaping actions and restore the construction site to its original condition. The Plan will include at least the following measures:	- Preparation and implementation– Contractors	- Contractors and Supervision Engineer to prepare	- Plan developed by the Contractors and

E&S aspect/ impact	Proposed mitigation measure	Responsibility		Target/ indicator
		Preparation/ implementation/ approval	Monitoring	
Management Plan	▪ Planting activities will be implemented during, or as soon after construction in order to keep the construction site clean after the competition of the construction works; ▪ It is possible to enrich the landscape by partially replacing the vegetation cover through railway verges, these narrow stripes of planted species can provide shelter for many species, minimize noise and vibration pollution naturally, along with many other beneficial ecosystem services. At the same time, the verges act like barriers for invasive species and allergen spreading. ▪ The Plan will outline the tasks to establish and maintain the trees, grass and vegetation in the Project area, especially for returning to the original condition after the completion of construction works. Species type, density and number of plants for shrub and tree planting, as well as seed mixes, quantity and sowing rates for seed mixes (such as grass or wildflower) will be defined for each subsection according to specific species present in the area; ▪ Vegetation around the crossing entrances will be linked to natural vegetation by low shrubs or herbaceous vegetation; the crossing entrances will be covered by natural soils, where appropriate and concrete will be avoided; ▪ Replacement tree planting/ woodland planting will be carried out within disturbed areas noted as being subject to loss. This replacement planting will be located as close to the area of loss as practicable; ▪ Planting measures will be designed to provide enhancement to local landscape character; ▪ Planting measures will also be designed to provide connectivity within the wider landscape where possible; ▪ Planting should make use of species of local/ regional provenance; ▪ Measures to mitigate landscape character effects should also be included;	- Approval – PIU / Supervision Engineer	monthly reports for the PIU on the status of Plan performance	approved by the PIU prior to construction and implemented during construction by the Contractors

E&S aspect/ impact	Proposed mitigation measure	Responsibility		Target/ indicator
		Preparation/ implementation/ approval	Monitoring	
	▪ Compensatory planting for ecological habitats lost to ensure net gain of sensitive habitats will need to be approved as part of the overall planting plan approval process; ▪ Landscape plans, including proposed habitat creation areas and species lists will be agreed with the Ecological Clerk of Works (Contractors), Environmental Expert (Supervision Engineer), and Environmental/Biodiversity Specialist (PIU).			

Measures defined in Construction Planting Management Plan, scaled-up in order to go beyond levels needed for just returning the landscape to the previous form (significant part of railway deviations is planned in agricultural fields/ meadows so various shrubs and/or afforestation by multiple-level planting is suggested), present concrete measures for the operational phase that can significantly impact the effects of all identified relevant climate risks.

In light of the obtained results of the climate screening (OHS is the main source of the climate vulnerability), the measures proposed in Framework ESMP Corridor X Belgrade-Niš are deemed appropriate. It should be noted that detailed OHS mitigation measures are included in the OHS chapter of this ESIA Report (Chapter 18).

5.7 Potentially vulnerable subsections

Based on the data and conclusions from the previous sections, and the considered climate scenarios, a qualitative assessment of potentially vulnerable sections of the Project from a climate perspective is presented in this Section.

Rail bulging has not been detected on the existing railway to date but given the historical trend of extreme temperatures and heat waves (especially during the past couple of years) and climate projections, elevated risks to the whole Project alignment are predicted in the future.

The current risk of fluvial floods is medium. Most of the streams crossing the railway route are of torrential character, so the amount of precipitation and unobstructed movement of water (i.e. no debris in the stream bed) are the two main variables affecting the flow rates. The Jovanovačka river is an exception (see Figure 3-26). At chainage 168+800 – 169+400, the Project could be affected by fluvial floods, but, since the river Jovanovačka itself was regulated in 2023, this risk is mostly mitigated (referring to modelled flood risk in Section 4.2 for Ćićevac and the regulation of the Jovanovačka riverbed described in Section 5.4). As for the flood-vulnerable flood section in Mezgraja (see Section 4.2), the flood risk is low and the number and the capacity of designed culverts is considered to be adequate.

Where the railway crosses the Turija river at 217+642 km, there could be an increased risk of fluvial flooding due to a large, sloped area focused on small riverbed as shown in Figure 5-3). During flood events in 2018, several villages along the River Turija were flooded (including Bankovac – as shown in Figure 5-3), but rail traffic was not jeopardized. Due to the River Turija meandering, especially at higher slopes, overflowing occurs well before the railway crossing point, lowering overall flooding height at that location. Vegetation surrounding the riverbed also greatly mitigates flood effects.

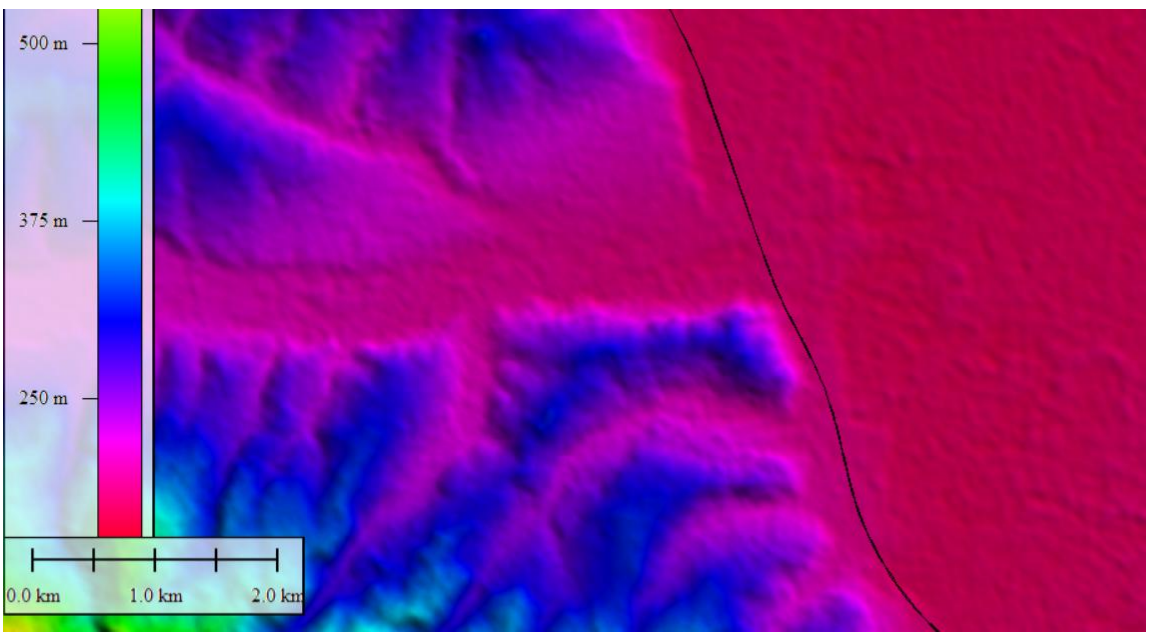


Figure 5-3. Part of the river Turija micro watershed near Bankovac

Historical records list 3 events in the last 20 years along the Project route where extreme winds have caused problems for railway traffic, usually by causing damage to the OCL components.

5.8 Adaptation measures

Based on the identified climate risks and potentially vulnerable locations, the following adaptation measures have been proposed. These do not include climate related mitigation measures for the construction phase that are included in Framework ESMP for Corridor X. Measures that are already incorporated into the design are also omitted.

The results of the climate vulnerability and risk assessment have been transposed into the first column of Table 5-16, where Project designers additionally provided details of the high-level adaptation measures already proposed at locations at risk. Following an iterative process of review to ensure that the identified risks would be adequately addressed (as far as practicable), the envisaged adaptation measures that will be incorporated into the design documentation are listed in column 2 of Table 5-16. Additionally, measures related to vegetation, which are beneficial for adaptation to all relevant climate related risks, will be defined in Construction Planting Management Plan.

The cost of the planned adaptation measures has been included in the Project cost estimates.

Table 5-16. Selection and analysis of the proposed structural adaptation measures

Locations at risk/ proposed measure	Designer's note - envisaged measure	Status	Risks addressed	Residual risk level	Additional actions required
Problems with rail bulging have already been recorded and are to be expected along the whole subsection. Since the design envisages continuously welded rails, following measures are proposed: ▪ use adequate ballast profile (as a height difference between rail shoulder and the bed); plan regular maintenance to keep it clean and compact; ▪ plan adequate positioning of the adjustment switches that take into account future rail temperature profiles corresponding to predicted extreme heat events; ▪ stress free temperature (SFT) used in the current design is based on the historic values and it is 22.5±3°C. Since this temperature range is rather wide and it does not consider future temperature changes that will, base on the current climate projections for mitigation scenario (RCP4.5) see the maximum and minimum daily temperature changes of 0.5°C (mid-century) to 2°C (end of century) increase (represented in Figure 3-10 and Figure 3-11**Error! Reference source not found.**) (not accounting for actual short-term recorded values that are higher even at this point- increase of 2.9°C for 2024. compared to 1951-1980. baseline climatology), it is recommended to re-assess used free stress temperature and conservatively increase it by 1°C. Additionally, start a procedure to determine correct value of SFT in a different time horizons and under various climate scenarios;	All proposed measures are already part of the existing design. It is our opinion that higher value of the defined SFT range (25.5°C) will successfully mitigate impacts on rail of predicted temperature rise.	Under implementation Level of commitment: Main design Responsible: SRI Due date: Q2 2026.	Heat stress, heat wave	Low	/

Locations at risk/ proposed measure	Designer's note - envisaged measure	Status	Risks addressed	Residual risk level	Additional actions required
▪ design rails in tension (rail stress) considering new stress free temperature; ▪ use elastic track fastening; ▪ use devices for prevention of lateral track displacement;					
Extreme winds have been recorded along the whole subsection (usually damaging OCL components). ▪ design railway above-ground structural elements capable of withstanding wind loads of 30 m/s, ▪ vegetation maintenance along the rail tracks; ▪ as for the SFT, consider re-assessing values from the design codes for wind loads. The wind characteristics don't change that fast or drastically as the temperatures and their spatial and temporal coverage is much smaller, but this point must be considered.	All above-ground structural elements such as overpasses, noise protection walls and columns for GSMR are designed in accordance with the valid regulations in Serbia, i.e. Eurocodes and valid national annexes. Those national annexes set wind speeds for the territory of the Republic of Serbia. Those speeds in the Project area are around 17 m/s, with wind gusts up to 30 m/s. The safety coefficients for this type of load are 1.5. This implies that the mentioned structures are capable of resisting incident wind loads of approximately 30 m/s.	Under implementation Level of commitment: Main design Responsible: SRI Due date: Q2 2026.	Extreme wind	Medium	/

Railway Safety Directive (Directive 2004/49/EC) doesn't deal specifically with any of the climate hazards but sets general safety obligations for railway infrastructure managers and railway undertakings. The Operational Emergency Preparedness and Response Plan will cover risk assessment and hazard management, as well as the establishment of emergency preparedness procedures. The Operational Emergency Preparedness and Response Plan should also include the risks associated with climate disasters and measures/actions to address them. The content of this plan is covered in detail in the Major Accidents and Disasters Chapter of this ESIA Report (Chapter 17).

5.9 Residual risk levels

The initial climate risk assessment summarised in Table 5-14, has shown that the occurrence of extreme acute and chronic heat events, fluvial floods and extreme winds will have a high risk level during both time horizons considered, with heat events having an extreme risk level in the end-of-century horizon. The final step of this risk assessment procecess is to assess the residual risks following the implementation of the outlined adaptation measures.

Table 5-17. Residual risk assessment

		Overall impact of the essential climate variables and hazards									
		2030- 2060					2060- 2100				
		Insignificant	Minor	Moderate	Major	Catastrophic	Insignificant	Minor	Moderate	Major	Catastrophic
Likelihood	Rare										
	Unlikely		Heat stress, Heat wave, Fluvial flood					Heat stress, Heat wave, Fluvial flood			
	Moderate										
	Likely	Extreme wind					Extreme wind				
	Almost certain										

Risk level	Low	Medium	High	Extreme

The difference between Table 5-14 and Table 5-17 is in the treatment of likelihood and magnitude of consequences. In Table 5-14, likelihood is the probability that the identified climate hazards will occur within a given timescale. In Table 5-17, likelihood represents the probability that relevant climate hazards will have adverse effects on railway infrastructure or services given the implemetation of adaptation measures.

Envisaged engineering solutions should be accompanied by regular maintenance of riverbeds and riversides, which is the responsibility of PC “Srbijavode”, so inter-institutional cooperation will be needed.

Thunderstrikes, not considered separately here, but representing a part of a “heavy rainfall” and/ or “extreme wind” hazards have also histroically caused rail traffic problems. Given that lightning protection is being incorporated in the Project design, it should be only mentioned that the number of thunderstorms is anticipated to rise globally due to the climate change.

The design solutions and regular vegetation maintenance in the vicinity of the railway profile should significantlly decrease the impact of extreme winds but, given that the whole Project corridor is prone to this hazard, the expected future increase in the frequency of such events and the problem of flying debris from outside of the railway corridor, the residual risk could not be assessed as below ’Medium’.

5.10 Watershed-wide implications of the relevant climate hazards

The above risk assessment has identified extreme acute and chronic heat events, extreme winds and fluvial floods as the major climate related hazards of relevance to the Project. Only heat events have the potential to have a greater scope and to influence wider ecosystems, populations and geographic areas in general. Extreme winds, no matter their frequency and intensity, both of which will increase, are singular events with sometimes significant, but easily quantifiable effects. The same goes for fluvial flooding. Heat events, both acute and chronic, span a much larger area (country, region) and much longer periods (months, seasons) so adaptation measures are much more difficult to realize. Aside from extreme winds (namely supercell storms), the proposed adaptation measures for the railway have little influence beyond the rail corridor. Only the occasional parcel of agricultural land below the railway could benefit or be threatened (e.g. by unintentional flooding) by proposed water management measures.

6. ASSUMPTIONS AND LIMITATIONS

Assessment limitations are related to the methodology used and data availability.

Some of the inherent uncertainties in climate projects are:

- Measurement errors resulting from imperfect observational instruments and/or data processing (e.g. algorithms for estimating surface temperature based on satellite data);
- Aggregation errors resulting from incomplete temporal and/or spatial data coverage;
- Natural variability resulting from unpredictable natural processes within the climate system (internal climate variability; e.g. atmospheric variability), influencing the climate system and/or within climate-sensitive environmental and social systems (e.g. ecosystem dynamics);
- Model limitations (of climate and climate impact models- Digital Climate Atlas) resulting from the limited resolution of models (e.g. hampering the explicit resolution of cloud physics), an incomplete understanding of individual Earth system components or their interactions and feedbacks (e.g. climate–carbon cycle feedbacks), and/or an incomplete understanding of the environmental or social system under consideration (e.g. demographic development in flood risk zones);
- Future development of non-climatic (socio-economic, demographic, technological and environmental) factors determines how a given change in climate affects the environment and society;
- Future changes in societal preferences and political priorities determine the importance attached to a given climate impact (e.g. a local or regional loss of biodiversity).

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ЗА ТЕБЕ

RAILWAY LINE BELGRADE–NIŠ, SECTION III
Paraćin to Trupale (Niš)
Environmental and Social Impact Assessment
12. Noise and Vibration

EU PPF
PROJECT PREPARATION FACILITY

DOCUMENT CONTROL SHEET

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LIST OF ABBREVIATIONS AND ACRONYMS

ISO	International Organization for Standardization
EN	European Standard
SRPS	The Serbian Institute of Standardization (ISS) uses the designation for standards and related documents applicable within Serbia
DIN	German Institute for Standardization
BS	British Standard
AS	Australian Standard
dB	Decibel
Lw	Sound Power Level
Lp	Sound Pressure Level
PPV	Peak Particle Velocity
VdB	Vibration velocity levels in decibels
KBF_{max}	Maximum weighted vibration strength
KBF_{Tr}	Mean vibration strength
Hz	Herz
EMU	Electric Multiple Unit

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1 INTRODUCTION

This chapter presents the findings of the assessment of potential noise and vibration impacts associated with the construction and operational phases of the Project. It identifies specific project activities that may generate noise and vibration affecting the surrounding environment and communities and evaluates the potentially significant impacts on sensitive receptors. The assessment considers both human receptors and physical assets such as buildings and infrastructure.

To manage these potential impacts, appropriate mitigation measures are proposed with the aim of preventing, reducing, or controlling adverse effects. This chapter also outlines the criteria used to define the Magnitude of impact and Sensitivity of receptors in the context of noise and vibration. Additionally, it lists the data sources and references that informed the assessment process.

1.1 Legislative and Policy Framework

1.1.1 EU Requirements

The Environmental Noise Directive (2002/49/EC) and its amendments published on 29/07/2021 provide a comprehensive framework for the assessment and management of environmental noise. This Directive establishes a common approach to avoid, prevent, or reduce the harmful effects of exposure to environmental noise, requiring i) Strategic noise mapping for large agglomerations, major roads, railways, and airports; ii) Development of action plans based on noise mapping results; iii) Public access to information on environmental noise and its effects.

The Environmental Impact Assessment Directive (2011/92/EU, amended by 2014/52/EU) ensures that potential environmental impacts, including noise and vibration, are identified and assessed prior to project approval, requiring the consideration of noise and vibration impacts as part of ESIA for infrastructure and industrial projects.

The Occupational Noise Directive (2003/10/EC), and its amendments published on 26/07/2019, protects workers from risks related to exposure to noise during work. While focused on workplace safety, it is relevant during the construction phase of projects.

The Union Guidelines for the Development of the Trans-European Transport Network (TEN-T) (Regulation (EU) 2024/1679) establishes updated guidelines for the development of the Trans-European Transport Network (TEN-T), aiming to create a reliable, seamless, and high-quality transport network that ensures sustainable connectivity across Europe without physical interruptions, bottlenecks, or missing links. While the regulation primarily focuses on infrastructure development and connectivity, it implicitly supports environmental considerations by promoting sustainable transport modes, such as rail and inland waterways. It sets priorities for railway infrastructure development, with a focus, amongst others, on the mitigation of the impacts of noise and vibration caused by rail transport, in particular through measures for rolling stock and for infrastructure, including noise protection barriers. It also sets noise performance requirements for transport infrastructure and promotes environmentally sustainable transport networks. This Regulation encourages noise abatement measures, especially for rail and road transport projects.

Regulation (EU) No 1304/2014 on Technical Specifications for Interoperability (TSI), and its changes published on 28/09/2023, relating to the subsystem 'rolling stock – noise' applies to the railway projects and sets noise emission limits for a new and upgraded rolling stock to reduce operational noise.

ISO 1996-1:2016 Standard 'Acoustics – Description, measurement and assessment of environmental noise' provides methods for assessing noise levels, including long-term exposure metrics such as L_{den} and L_{night} used in the Environmental Noise Directive.

The European Commission's Noise Guidelines for Projects under the Cohesion Fund and ERDF Offers guidance on noise and vibration management for EU-funded infrastructure projects, and it includes the best practices for noise monitoring, public consultation, and mitigation planning.

The Good Practice Guide on Noise Exposure and Potential Health Effects, issued by European Environment Agency in 2019, provides scientific and policy context for understanding noise-related health effects and supports Environmental Noise Directive implementation.

1.1.2 EBRD Requirements

The European Bank for Reconstruction and Development (EBRD) outlines under the Environmental and Social Policy (2019) noise and vibration considerations primarily in Performance Requirement 3 (PR3): Resource Efficiency and Pollution Prevention and Control.

PR3 underscores the EBRD's commitment to minimizing environmental and social risks associated with noise and vibration, promoting sustainable development practices across its financed projects. It focuses on minimizing adverse environmental impacts through the control of pollutants, including noise and vibration. It requires clients to apply good international practice to minimize emissions of noise and vibration from both construction and operations In the context of noise emission from railways, this includes recommendations from the World Health Organisation (WHO), specifically the Environmental Noise Guidelines for European Region (2018) (refer to Section 2.2.2) In accordance with good international practice all technically and financially feasible, and cost-effective mitigation measures, will be identified and considered as part of the project design, to minimize noise impacts, to align with WHO guidance. This will also include consideration of other impacts of such measures including visual impacts.

1.1.3 EIB Requirements

The European Investment Bank's (EIB's) Environmental and Social Policy (2022), and its Environmental and Social Standards (ESS) (2022), emphasizes the importance of sound environmental management to mitigate pollution, including noise and vibration. The policy acknowledges that reducing noise at its source is crucial for protecting human health and well-being.

The ESS 3 (Pollution Prevention and Abatement) focuses on minimizing pollution, including noise and vibration, through the application of best available techniques and practices, and it encourages the adoption of measures to prevent, reduce, or control emissions that may cause adverse impacts on human health and the environment. The ESS 4 (Biodiversity and Ecosystems) recognizes that noise and vibration can affect wildlife and natural habitats and requires assessments to consider potential impacts on biodiversity and implement measures to mitigate such effects. The ESS 10 (Stakeholder engagement) emphasizes the importance of engaging with stakeholders, including communities potentially affected by noise and vibration, throughout the project lifecycle, and at the same time mandates transparent communication and the establishment of grievance mechanisms to address concerns.

1.1.4 National Legislative Framework

Environmental regulations concerning noise and noise protection in Serbia, have been harmonized with the EU Environmental Noise Directive, and include the following documents:

- Law on Environmental Protection ("Official Gazette of the RS", No. 135/2004, 36/2009, 36/2009 – other law, 72/2009, 43/2011 - decision of the constitutional court, 14/2016, 76/2018, 95/2018 – other law, 94/2024 – other law), which establishes an integrated system for environmental protection, including provisions for pollution control, environmental impact assessments, and public participation. This Law provides the overarching legal basis for environmental noise and vibration regulation, ensuring the right to a healthy environment.
- Law on Environmental Impact Assessment ("Official Gazette of the RS", No. 94/24) requires that potential environmental impacts, including noise and vibration, be assessed before the commencement of projects. It ensures that mitigation measures are identified and implemented to minimize adverse effects on human health and the environment. Based on this Law, projects subject to environmental Impact Assessment (EIA) must now explicitly assess potential noise and vibration impacts during both construction and operational phases. It mandates the development of strategic noise maps and action plans for major urban areas, roads, railways, and airports. Also, it requires the disclosure of noise and vibration assessments and facilitating stakeholder engagement. This law establishes requirements for continuous monitoring of noise and vibration levels and the implementation of mitigation measures to protect human health and the environment.
- Law on Environmental Noise Protection ("Official Gazette of the RS", No. 96/21), which partially transposes Environmental Noise Directive. It i) requires the development of strategic noise maps and action plans for major urban areas, roads, railways, and airports, ii) defines responsibilities of national and local authorities in noise management, and iii) establishes procedures for noise measurement, monitoring, and public information dissemination.
- Regulation on noise indicators, limit values, noise indicators assessment methods, annoyance and harmful effects of environmental noise ("Official Gazette of the RS", No 75/10) specifies permissible noise levels across various environmental zones, such as residential, commercial, and industrial areas. Also, it serves as a critical tool for assessing compliance and implementing noise control measures.

- Rulebook on the methodology for determining acoustic zones ("Official Gazette of the RS", No 72/10)
- Rulebook on the methods of noise measurement, content and scope of the noise measurement reports ("Official Gazette of the RS", No 139/22)
- Rulebook on the conditions to be fulfilled by a professional organization for noise measurement, and documentation to be submitted with the application for acquiring the authorization for noise measurement ("Official Gazette of the RS", No 139/22)
- Rulebook on the content and methods for developing the strategic noise map and action plan, the procedures for their preparation and presentation to the public, as well as their forms ("Official Gazette of the RS", No 90/23).
- Serbia is a signatory to the International Labour Organization's Working Environment (Air Pollution, Noise and Vibration) Convention, 1977 (No. 148), which underscores its commitment to controlling occupational noise and vibration hazards.

The legislation sets out the scope and responsibilities related to environmental noise protection, including the implementation of protective measures and conditions for mitigating environmental noise; procedures for noise monitoring and measurement; public access to information; and other provisions relevant to the protection of the environment and human health.

2 BASELINE CONDITIONS

2.1 Area of Influence

At the ESIA level, the distance from the Project for noise and vibration impact assessment (and associated mapping) is determined based on receptor sensitivity and project characteristics, including terrain and ground conditions, traffic data and speed, proximity to homes, hospitals, schools, cultural monuments, etc. The area of influence (AoI) for noise impacts during both the construction and operation phases is defined as a corridor encompassing 200-700 meters on either side of the Proposed Railway Route, while for vibration it is 50 meters on either side of the railway, which it is expected will capture all potential vibration impacts. A corridor of 200 meters on either side of the railway as the AoI for noise impacts is based on good international practice and experience on another railway projects in the region. However, this is extended up to 700 meters on either side of the Project route in areas that may be potentially affected considering the existing terrain, i.e. mainly in densely inhabited areas and towns.

The identification of noise sensitive receptors was carried out based on available geodetic and topographic plans as well as publicly available data (Google Maps, Bing Maps, OpenStreetMap). Official data on the locations and purposes of each specific objects in the subject railway corridor must be obtained for the development of the Design for Construction Permit.

2.2 Baseline

The following figure presents the location of the railway alignment within densely populated areas within the Paraćin-Stalać and Đunis-Trupale sub-sections. A more detailed disposition and location of objects identified and its density can be seen in the Chapters 7.2, 7.3, 7.4 and 7.5, which presents also the noise maps without measures.

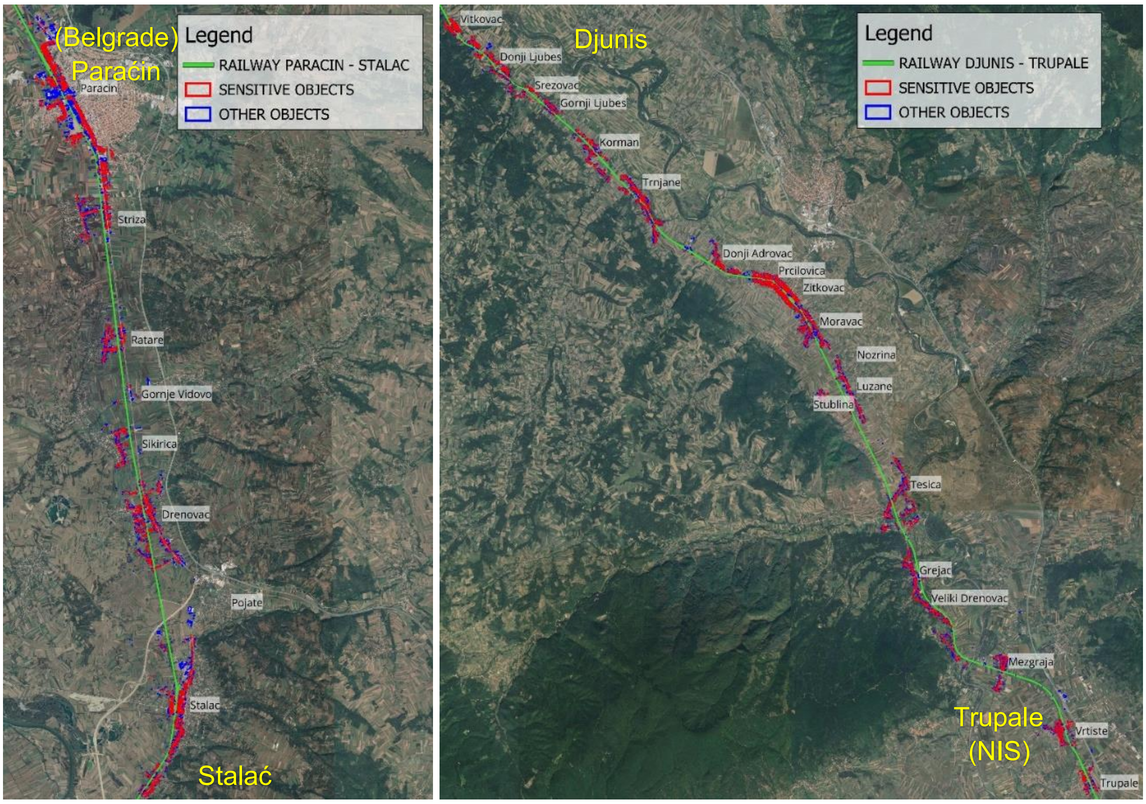

Figure 2-1. Location of sensitive and other objects along the railway within the Paraćin-Stalać (left) and Đunis-Trupale (right) sub-sections

The assessment incorporates settlements or parts of settlements within the municipalities of Paraćin, Ćićevac, Aleksinac and Niš. A total of 7,507 buildings of various functions were identified along the Paraćin–Stalać sub-section, and 11,345 buildings along the Đunis–Trupale sub-section. Of these, 3,449 and 4,848 buildings, respectively, were classified as noise-sensitive receptors, the vast majority of which (over 99.5%) are used for residential purposes, while the remainder serve other functions.

2.2.1 Noise Limit Values in Serbia

The determination of noise indicators[1] based on measurements is conducted in accordance with the SRPS ISO 1996-1 and SRPS ISO 1996-2 standards.

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[1] The term 'noise indicators' is specific to the Common Noise Assessment Methods in Europe (Cnossos-EU) methodology, which defines indicators as e.g. L_{den}, L_{night} etc.

Permissible noise levels for both outdoor and indoor environments are defined based on the intended use of the area and the time of the day. These limits are established to legally prevent adverse effects of noise exposure on the population. During the preparation of spatial and design documentation, the potential impact of noise must be assessed, and appropriate mitigation measures must be integrated into the planning process.

The limit values for environmental noise indicators in outdoor areas are stipulated in the *Regulation on noise indicators, limit values, noise indicators assessment methods, annoyance, and harmful effects of environmental noise ("Official Gazette of the RS", No 75/10)* and are presented in Table 2-1, while the corresponding indoor noise limits are provided in Table 2-2.

Table 2-1. Limit values for environmental noise indicators in outdoor areas

Zone	Use of the area	Noise level in dB(A)	
		Day and evening	Night
1.	For areas designated for rest and recreation, healthcare (including hospitals and recovery facilities), cultural and historical sites, large public parks	50	40
2.	Touristic areas, camps, and school zones	50	45
3.	Residential areas	55	45
4.	Mixed-use business-residential zones, commercial-residential areas, and designated children's play areas	60	50
5.	City centre areas, zones for trades, commercial activities, administrative activities with integrated residential function, as well as areas adjacent to motorways, primary roads and urban road networks	65	55
6.	Industrial, warehousing, and service zones, as well as transport terminals not intended for residential use	At the boundaries of such areas, noise levels must not exceed the limit values prescribed for the adjacent, more sensitive zones	

Relevant Serbian limit values are presented in Table 2-1. In all areas where acoustic zoning has not been conducted, Zone 5 from the Table 2-1 must be applied. The only acoustic zoning along the railway line Belgrade(Resnik)-Nis(Trupale) have been developed for the City of Nis. Within acoustic zoning for City of Nis, area of the Trupale station and neighbourhood, which is part of the current project alignment, is classified as a Residential zone which belongs to the Zone 3 as per Table 2-1.

Table 2-2. Limit values for environmental noise indicators in an indoor environment

Zone	Use of premises	Noise level in dB(A)	
		Day and evening	Night
1.	Common areas (bedroom and living room) in residential building with closed windows	35	30
2.	In public and other buildings, with closed windows:		
2.1.	Healthcare institutions and private practice, as outlined below:		
	a) wards	35	30
	b) surgeries	40	40
	c) surgery theatres without medical devices and equipment	35	35
2.2.	Rooms in buildings designated for children and students, bedrooms in nursing homes, and facilities for retired individuals	35	30
2.3.	Rooms designated for educational and development activities (classrooms, theatres, laboratories, etc.), cinemas, and reading rooms in libraries	40	40
2.4	Theatres and concert halls	30	30
2.5	Hotel rooms	35	30

Noise indicators are used to assess the level of environmental noise, evaluate its impacts, predict noise exposure, create strategic noise maps, and plan appropriate noise mitigation measures. The values of environmental noise indicators are determined either by measurement or calculation.

As per the regulation related to noise indicators ion Serbia, the 24-hour daily period is defined in the time sequences as presented in the Table 2-3.

Table 2-3. The 24-hour daily periods

No.	Period	From	To
1	Day	06:00	18:00
2	Evening	18:00	22:00
3	Night	22:00	06:00

2.2.2 World Health Organisation Noise Guidelines

The World Health Organisation (WHO) Environmental Noise Guidelines for European Region (2018) recommend that average noise exposure from railway traffic (L_{den}) is below 54 dB, and night-time exposure (L_{night}) is below 44 dB.

2.2.3 Vibration Indicator Limit Values in Serbia

As the national legislation of the Republic of Serbia does not prescribe permissible values for vibration and ground borne noise, this study takes into account the German standard DIN 4150-2 (Structural Vibration – Human Exposure to Vibration in Buildings) and 4150-3 (Vibrations in buildings – Part 3: Effects on structures), as well as the Swiss standard BEKS 1999 – Assessment of vibration and structure-born noise from railway traffic (Swiss Directive of the Federal Office for the Environment). The DIN standards are widely applied in international practice and are considered relatively conservative with respect to permissible vibration levels when compared to other standards.

The German standard DIN 4150-2 provides guidance for the assessment of vibration within the frequency range of 1 to 80 Hz, which is particularly relevant for human sensitivities. It defines maximum permissible vibration levels aimed at preventing annoyance to individuals within buildings. Reference values for the evaluation of vibration in residential and similar buildings are shown in Table 2-4, whilst human perception thresholds for vibration are outlined in Table 2-5.

Table 2-4. Reference values for the assessment of vibration in residential and similar buildings in accordance with DIN 4150-2

Use	Day (6:00-22:00)			Night (22:00-6:00)		
	A_u	A_o	A_r	A_u	A_o	A_r
Industrial area	0.4	6	0.2	0.3	0.6	0.15
Predominantly commercial area	0.3	6	0.15	0.2	0.4	0.1
Mixed commercial and residential area	0.2	5	0.1	0.15	0.3	0.07
Mainly residential area	0.15	3	0.07	0.1	0.2	0.05
Special areas, such as hospitals and health resorts	0.1	3	0.05	0.1	0.15	0.05

A_u, A_o, and A_r are reference values defined by the DIN 4150-2 standard. These values are used as guidelines for assessing the impact of vibrations on human perception and structures. The limit A_o represents the threshold above which annoyance is considered to occur for any vibration event. Conversely, the value A_u marks the threshold below which no annoyance is expected. When vibration levels fall between A_u and A_o, the frequency of occurrence becomes relevant, and the additional threshold A_r is applied to assess the cumulative effect.

The vibration assessment is based on indicators KB_{Fmax} (maximum value derived from a running r.m.s. quantity with time constant Fast) and KB_{FTr} (time-weighted mean quantity depending on traffic). The assessment procedure has two basic steps:

- Step 1: if $KB_{Fmax} \leq A_u$ the condition is satisfied.
- Step 2: when $KB_{Fmax} \leq A_0$ the condition is satisfied only if $KB_{FTr} \leq A_r$.

Table 2-5. Human perception of vibration according to DIN 4150-2[2]

Weighted maximum vibration velocity (KB values)	Perception
0.1	Threshold of perception, just noticeable
0.2	Weakly noticeable
0.4	Awakening threshold, Noticeable
0.8	Awakening threshold, clearly noticeable
1.6	Strongly noticeable
6.3	Very strongly noticeable

The German standard DIN 4150-3 addresses the effects of vibration on structures and establishes limits values for short-term (transient) vibration and long-term vibration. Short-term vibration is defined as vibration that occurs infrequently, does not lead to structural fatigue, and does not induce resonance in the structure under assessment (e.g. blasting and impact piling). Long-term vibration refers to all other vibration not classified as short-term, such as generated by vibro-compaction. The guideline values for both short-term and long-term vibrations, in terms of their potential impact on building structures, are presented in Table 2-6 in accordance with DIN 4150-3 standard.

Table 2-6. Guideline values of short-term and long-term vibration for the assessment of impact on building structures in accordance with DIN 4150-3 [PPV mm/s]

No.	Type of structure	Short-term vibration				Long-term vibration
		PPV at the foundation at horizontal and vertical plane			PPV at horizontal plane of highest floor	PPV at horizontal plane of highest floor
		1 Hz – 10 Hz	10 Hz – 50 Hz	50 Hz – 100 Hz	all frequencies	all frequencies
1.	Building used for commercial purposes, industrial buildings and buildings of similar design	20	20 to 40	40 to 50	40	10
2.	Dwellings and buildings of similar design and/or occupancy	5	5 to 15	15 to 20	15	5
3.	Structures that, because of their sensitivity to vibration, do not	3	3 to 8	8 to 10	8	2.5

[2] Review of existing standards, regulations and guidelines, as well as laboratory and field studies concerning human exposure to vibration, RIVAS Deliverable 1.4 (2011)

Table 2-6. Guideline values of short-term and long-term vibration for the assessment of impact on building structures in accordance with DIN 4150-3 [PPV mm/s]

No.	Type of structure	Short-term vibration				Long-term vibration
		PPV at the foundation at horizontal and vertical plane			PPV at horizontal plane of highest floor	PPV at horizontal plane of highest floor
		1 Hz – 10 Hz	10 Hz – 50 Hz	50 Hz – 100 Hz	all frequencies	all frequencies
	correspond to those listed in lines 1 and 2 and are of great intrinsic value					

The issue of reradiated ground borne noise[3] is especially pronounced indoors, because mid and high frequency noise from outside is reduced by the insulating effect of the building, while outdoors, it may be completely or partially masked by higher-frequency noise (e.g. traffic).

The Swiss standard BEKS-1999 provides an assessment framework for evaluating ground borne noise from railway traffic, taking into account the level of urbanization and the time period. It defines two basic criteria for ground borne noise: i) for newly constructed railway lines and another ii) for upgraded or modernized railway lines. The permissible levels of low frequency noise, classified by zone type, time period, and railway category are presented in Table 2-7.

Table 2-7. Guidance values for ground borne indoor noise on accordance with BEKS (1999)

Built-up area	Newly constructed railway line		Modernized railway line*	
	Day (6^{00}-22^{00})	Night (22^{00}-6^{00})	Day (6^{00}-22^{00})	Night (22^{00}-6^{00})
	L_{eq} (16h)	L_{eq} (1h)	L_{eq} (16h)	L_{eq} (1h)
	[dB(A)]	[dB(A)]	[dB(A)]	[dB(A)]
Residential areas, public interest areas of public interest (schools, hospitals)	35	25	40	30
Mixed-use areas, town centres, agriculture areas, and residential areas already exposed to noise	40	30	45	35

* Alteration or refurbishment of existing tracks, change in operating condition

The analysis of the observed corridor determined that in the current state, the source of vibration can be railway traffic. Also in the existing state, the source of vibration can be road traffic (from the existing roads in the corridor).

2.2.4 Acoustic Zoning and Noise Mapping

[3] Ground-borne noise refers to noise that is transmitted through the ground, typically as a result of vibrations caused by construction activities, transportation systems (such as railways or subways), or industrial operations. This type of noise is primarily perceived indoors when the ground vibrations induce sound waves that resonate through the building structure.

In accordance with the Law on Environmental Noise Protection ("Official Gazette of RS", No. 96/21), the development of strategic maps is mandatory, among other criteria, for major railway lines with an average annual traffic flow exceeding 30,000 trains. The existing railway line Beograd–Niš does not meet the traffic volume requirement, and therefore, there has been requirement to develop strategic noise maps. It is expected as per the traffic demand forecast developed for the purpose of this assignment that the number of trains will achieve this level before not later than fifteen years from the commencement of operation under the new scheme.

Municipalities are required to implement measures to protect the population from environmental noise. To achieve this, they must determine acoustic zones within settlements and establish the corresponding noise indicator limit values for these zones, in accordance with the law governing environmental noise protection in Serbia. Acoustic zones are defined based on the existing development status, land use, and planned land use. An acoustic zone refers to an area where uniform noise indicator limit values are prescribed.

Relevant Serbian limit values are indicated in Table 2-1 of chapter 2.2.1. In all areas where acoustic zoning has not been conducted, Zone 5 from the Table 2-1 must be applied. As explained in chapter 2.2.1, the only acoustic zoning has been developed for the City of Nis along the railway line which is the scope of this assignment. Consequently, according to the Serbian legislation, Zone 5 has to be applied to the entire railway line which is scope of this assignment except the Trupale station neighbourhood which belongs to the Zone 3 (Residential area) as per Table 2-1.

The reference values required by the EBRD requirements, which are defined in detail in the WHO Guidelines, will be applied in noise modelling for this study as they are more stringent than the national requirements. This application of WHO noise thresholds for the implementation of this Project was also confirmed by the Serbian Railways Infrastructure on 07 March 2025. Consequently, L_{den} (indicator for the day-evening-night period) noise limit levels of 54 dB, and L_{night} noise limit levels for the night-time period (22:00–06:00) of 44 dB are used for the noise modelling in this assessment.

Since the WHO defines threshold values for two time periods (a 24-hour average and a night period), while the CNOSSOS-EU methodology distinguishes three periods (day: 06:00–18:00, evening: 18:00–22:00, night: 22:00–06:00), the WHO recommended Lden value of 54 dB is used to derive corresponding values for the day and evening periods. Based on this redistribution, noise levels of 54 dB for the daytime (Lday) and 49 dB for the evening (Levening) are applied, while the WHO Lnight value of 44 dB is directly applied to the night period.

2.2.5 Noise Measurements

In order to assess the impact of noise from the existing railway traffic, a noise monitoring plan was conducted, and on-site measurements were carried out. The objective of the noise monitoring plan is to assess the current noise impact caused by the operation of railway traffic on section Paraćin–Stalać and Djunis–Trupale.

The noise measurements were conducted in accordance with the Rulebook on the methods of noise measurement, content and scope of the noise measurement reports ("Official Gazette of the RS", No 139/22) and the Regulation on noise indicators, limit values, noise indicators assessment methods, annoyance and harmful effects of environmental noise ("Official Gazette of the RS", No 75/10).

Noise levels were measured at 17 locations continuously for 24 hours. The coordinates of noise measurement locations are provided in Table 2-8, while their respective positions can be found in Figure 2-2. Limit values for environmental noise indicators in outdoor areas by acoustic zones are shown in Table 2-1. Photographs from the field during noise measurements are shown in Figure 2-3.

Table 2-8. List of the measurement points and GPS coordinates

Measurement point	N	E	Acoustic zone
N1 - Paraćin	43.866471	21.398509	5
N2 - Striza	43.832477	21.415905	5
N3 - Ratare	43.800448	21.421458	5
N4 - Sikirica	43.781551	21.423048	5
N5 - Drenovac	43.765056	21.427935	5
N6 - Cicevac	43.719926	21.438386	5
N7 - Vitkovac	43.591623	21.551507	5
N8 - Donji Ljubes	43.578805	21.572162	5
N9 - Srezovac	43.572260	21.581845	5
N10 - Gornji Ljubes	43.565640	21.593559	5
N11 - Korman	43.553949	21.611382	5
N12 - Trnjane	43.538741	21.630803	5
N13 - Donji Adrovac	43.515811	21.667404	5
N14 - Zitkova	43.508729	21.692274	5
N15 - Moravac	43.498073	21.703103	5
N16 - Vrtiste	43.376770	21.807594	5
N17 - Trupale	43.356991	21.818712	5

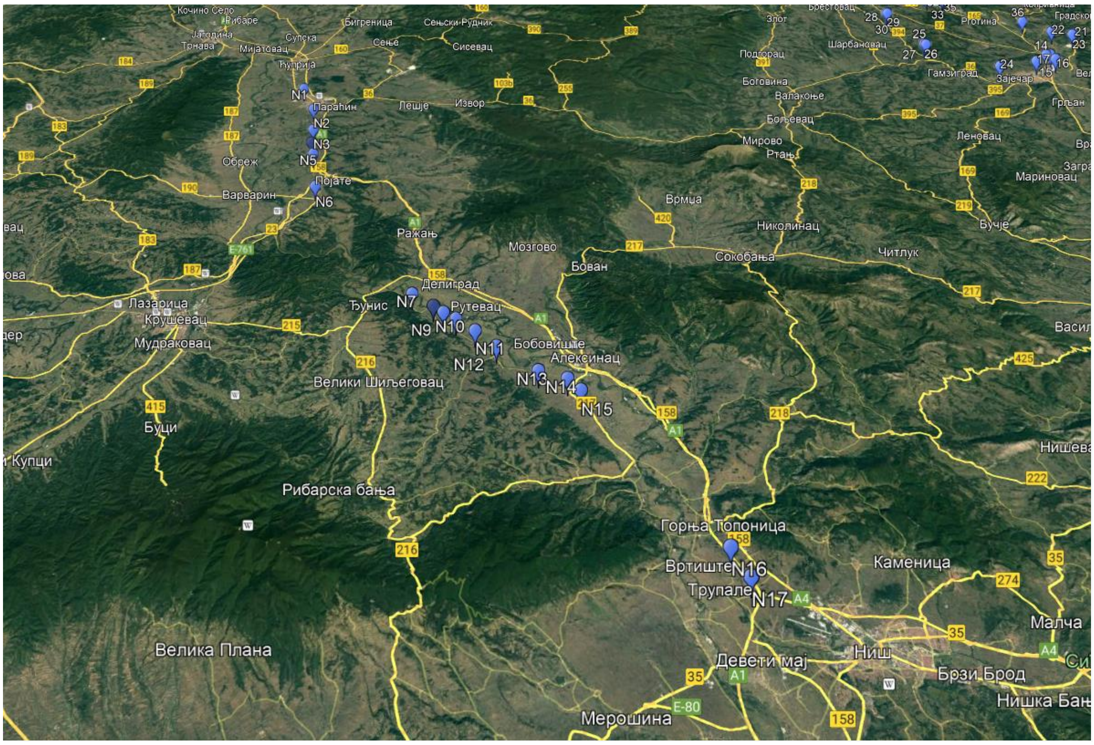

Figure 2-2. Location of the measurement points

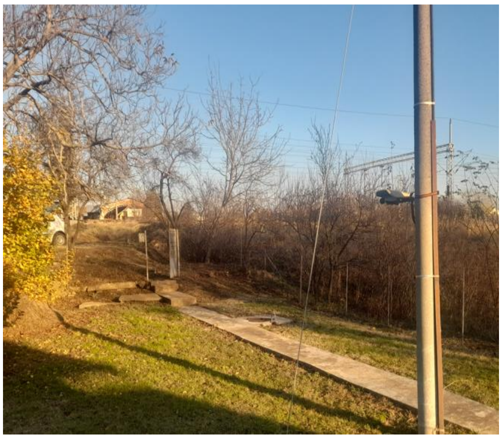

Figure 2-3. Photographs from the field during noise measurements

Weather conditions during the measurements were favourable, with a wind speed of 3.2 m/s and no precipitation. All measurements were conducted in an open space near noise-sensitive areas. The microphone was placed at a height of 1.5 meters above the ground and positioned three meters away from an acoustically reflective surface. Measurements were carried out during regular traffic. At all locations, the dominant source of noise was railway traffic. This methodology allowed for the collection of relevant data on noise levels in real-world conditions, particularly considering the impact of railway traffic on the environment.

The noise rating levels (L_{Req}) derived from the conducted measurements for all measurement points are displayed in the table below. For further details, please refer to the Noise Testing Report (Report No. 53102359, Anahem, 2024).

Table 2-9. Results at the measurement points – Rating level LAeq [dB]

Measurement point	Reference time interval		
	Day 06^{00}-18^{00}	Evening 18^{00}-22^{00}	Night 22^{00}-06^{00}
N1 - Paraćin	51.3	48.3	44.6
N2 - Striža	56.1	54.1	47.4
N3 - Ratare	54.5	54.5	47.0
N4 - Sikirica	49.6	49.9	45.9
N5 - Drenovac	58.1	57.3	51.6
N6 - Ćićevac	56.6	52.2	55.8
N7 - Vitkovac	59.9	60.6	52.8
N8 - Donji Ljubeš	49.0	49.5	47.1
N9 - Srezovac	52.3	47.8	47.9
N10 - Gornji Ljubeš	57.1	61.9	57.9
N11 - Korman	58.6	58.5	57.6
N12 - Trnjane	51.3	47.2	47.2
N13 - Donji Adrovac	57.8	58.1	54.8
N14 - Žitkova	59.5	54.9	56.1
N15 - Moravac	60.0	57.2	53.8
N16 - Vrtište	55.7	55.9	51.1
N17 - Trupale	53.8	52.6	48.0

Residual noise level is the background noise in an area when there are no specific noise sources, like those from railway construction or operation, active. Assessing these noise levels is important to understand the usual conditions before starting construction or railway operations and to evaluate how these activities affect the surrounding environment.

According to the Law on Railways (Official Gazette of RS, No. 41/18 and 62/23, Article 71), in the zone of 8 m from the axis of the end track (6 m in the urban zone) on both sides, it is prohibited to build any structures except for those that serve some railway functions. All buildings within this zone have been excluded from the analysis since any buildings within this zone will be subject to physical resettlement as described in the Resettlement Policy Framework (RPF).

3 ASSESSMENT OF POTENTIAL IMPACTS

Railway construction and modernization activities can cause temporary but potentially significant noise and vibration impacts, especially near sensitive areas such as homes, schools, and hospitals. Construction noise may disturb daily activities, cause annoyance, and affect rest and sleep, while vibration from heavy machinery or groundworks can lead to discomfort and concerns about possible building damage. The severity of these impacts depends on the type of work, distance to receptors, ground conditions, and duration of exposure. To address these risks, noise and vibration assessments should be conducted in line with national and EU standards. Recommended mitigation measures include limiting works to daytime hours, using low-noise equipment, installing temporary barriers, and informing the public in advance. With proper planning and mitigation, construction-related impacts can be reduced to acceptable levels.

Noise from railway operations can significantly affect people, particularly those living or working near the railway line. The most common impacts include annoyance and reduced quality of life in residential areas, as well as sleep disturbance during night-time operations, which may lead to long-term health effects. Prolonged exposure to elevated noise levels is associated with increased risks of cardiovascular and metabolic conditions. Children are especially vulnerable, with studies showing negative effects on concentration and learning outcomes in schools located near railway lines. Social and economic consequences, such as decreased property values and increased healthcare costs, are also relevant. These effects highlight the importance of early noise assessment, alignment with national and international standards, and the implementation of effective mitigation measures, such as noise barriers, optimized train schedules, and proper track maintenance. With adequate planning and monitoring, noise impacts can be reduced to acceptable levels, ensuring the protection of public health and well-being.

Vibration from railway operations can have noticeable effects on people, particularly those residing or working in close proximity to the railway line. While less commonly perceived than noise, vibration can cause annoyance, discomfort, and in some cases, concern about potential structural damage to buildings, even when such damage is unlikely. Continuous or repeated exposure to vibration may lead to stress, reduced concentration, and disruption of daily activities, particularly during night-time or in sensitive environments such as hospitals, schools, and residential buildings. Although health effects from vibration are less well-documented than those from noise, the disturbance it causes can negatively impact quality of life. The level of impact depends on several factors, including train type, speed, track condition, soil characteristics, and building sensitivity. Effective assessment using predictive modelling, aligned with relevant standards, is essential to determine potential exceedances and the need for mitigation. Common measures include track improvements, vibration-isolating elements, and maintaining appropriate distance from sensitive receptors. With proper planning and mitigation, vibration impacts on people can be minimized to acceptable levels.

3.1 Impact Assessment Methodology

The standard methodology for assessing the impacts of the operation and construction phase of the Project on noise and vibration is outlined in Chapter 5 of this ESIA. Any deviations from this methodology are outlined in the following Sections of this Chapter.

3.1.1 Noise modelling methodology during railway operation

During the operational phase of the railway, noise impact assessment focuses on the long-term exposure of nearby sensitive receptors, such as residential areas, schools, and healthcare facilities, to increased noise levels resulting from train movements. The assessment has been carried out using predictive modelling based on traffic volumes, train types, speeds, and operational schedules. Predicted noise levels are compared with Project-specific noise limits and relevant thresholds. For this Project, the WHO noise thresholds will be applied. The goal is to identify where there will be exceedances of threshold noise levels, enabling the formulation of appropriate mitigation measures where necessary to ensure compliance and protect public health and quality of life. The methodology for assessing noise impacts is based on the noise modelling of the railway operations under the new scheme i.e. after construction of the railway line.

The calculation of noise generated by rail traffic was done using the "CNOSSOS-EU – Common Noise Assessment Methods," which is compliant with Environmental Noise Directive and the technical standards for the implementation of the Environmental Noise Directive. The CNOSSOS-EU (Common Noise Assessment Methods) method was developed in accordance with article 6.2 of the Environmental Noise Directive and it is used for calculation of noise generated by road traffic, railway traffic and industrial plants and facilities.

The Ministry of Environmental Protection officially confirmed, on 7 March 2024, that the CNOSSOS-EU methodology is acceptable for use in the development of this study, which forms part of the project for the reconstruction and modernisation of the railway corridor between Belgrade and Niš. Accordingly, this methodology has been applied in the noise modelling for this Project (Section 3).

The following list outlines features that could be sensitive to noise and therefore which were considered in defining the components considered in this study:

- The presence of settlements and populations potentially exposed to noise and vibration generated by the railway.
- The presence of sensitive receptors—such as schools, hospitals, retirement homes, and similar facilities—within areas exposed to noise and vibration.
- In the biodiversity-sensitive areas, no significant noise or vibration impacts on flora and fauna are expected. For further details, please refer to Chapter 14 – Biodiversity.

Noise modelling was conducted to predict noise levels that would potentially occur during the operation phases of the Project. The noise indicators were calculated and have been presented in the form of noise maps (see annexes, 7.7, 7.8, 7.9, and 7.10) using the CadnaA (Computer Aided Noise Abatement) software package developed by DataKustik.

A summary of the noise impact assessment steps conducted using CadnaA for the Project are as follows:

- Definition of Assessment Scope
    - The spatial extent of the study area, relevant to the railway sub-sections Paraćin-Stalać and Đunis-Trupale was determined, as presented in Chapter 2.1 of this Chapter.
- Data Collection and Input Preparation
    - Key input data were gathered, including:
        - Digital terrain models (DTM)
        - Railway alignment, including track geometry, elevation and railway/ track characteristics
        - Locations of sensitive receptors
        - Train traffic data (volume, speed, types of trains, schedules)
        - Train characteristics.
- Selection of Noise Prediction Methodology
    - The CNOSSOS-EU methodology, approved by the Ministry of Environmental Protection, was implemented within CadnaA to ensure consistency with EU noise assessment standards.
- Noise modelling in CadnaA
    - A detailed noise model was developed in CadnaA, a specialised software tool for environmental noise prediction, in accordance with the CNOSSOS-EU methodology. The modelling process involved the integration of all relevant spatial and technical data, including digital elevation models, ground absorption types, building geometries, and the proposed railway infrastructure. In accordance with the CNOSSOS-EU methodology.
    - The 3D model of the railway substructure is formed based on the railway Preliminary design, as well as from the SRTM (Shuttle Radar Topography Mission) global dataset for wider calculation area. The technical characteristics of the railway line and the railway transport data were taken from the railway Preliminary design. Geodetic survey data are available, but only for a narrow corridor along the railway alignment. These data have been used in combination with the digital terrain model provided in the alignment design documentation, ensuring accurate terrain representation in the immediate vicinity of the railway. For the broader area beyond the alignment corridor, SRTM elevation data have been used to model the wider topography. In the context of Serbia, the vertical accuracy of SRTM data is typically up

to ±10 meters, which is generally acceptable for preliminary design/ESIA noise modelling, though less precise than local geodetic surveys.

- Train operations were modelled using input parameters such as rolling stock type (passenger, freight), train speeds, frequency of movements (day, evening, night periods), and rail track characteristics (e.g. rail roughness, curvature, gradients). The total number of trains per train type, speed, time periods, and train lengths are presented in chapter 7.1. Noise modelling was developed for 15-year and 30-year traffic demand forecasts (i.e. in 2045 and 2060) to understand the difference, and whether it will be technically feasible (e.g., sufficient space, engineering structures calculated accordingly, etc.) to install noise barriers in the future when/if the traffic demand growth requires it. The data on the projected scope of railway traffic for the modelling and analysis of noise, vibration, and ground borne noise were derived from the Feasibility Study and Functional and Operation Design (Traffic Technology Preliminary Design) of the Project.
- The ground absorption coefficient of G = 1 was chosen for the acoustic assessment based on site specific conditions along the Paraćin–Trupale railway corridor. The route predominantly crosses open agricultural land and vegetation zones, where the ground consists of soft soil and gravel track. Furthermore, this approach aligns with CNOSSOS-EU recommendations for acoustically soft terrains and provides a realistic representation of noise propagation for the existing railway configuration, which involves only minor route modifications. The decision to apply G = 1 is supported by the physical characteristics of the area there is minimal hard, paved, or urbanized soil, especially outside railway stations and by the track's gravel base. In addition to this, as per the Guide for strategic noise mapping in Serbia (2019, the only official guide for this subject issued by the Ministry of Environmental Protection of the Republic of Sebria, and funded by the EC), for railway corridors buffer zone is designated as absorbing (G=1), to represent ballast area.
- This modelling provided a spatially detailed representation of noise distribution, enabling identification of exceedances, impact zones, and the need for mitigation.

- Identification of Noise-Sensitive Receptors
  - Receptors within the AoI were identified and classified according to sensitivity to sensitive (residential, schools, hospitals, etc.) and other objects.
- Comparison with Noise Limit Values
  - Predicted noise levels were compared against WHO threshold values to assess compliance and determine the magnitude of impacts. The WHO threshold sets limits for average noise exposure at 54 dB Lden, and for nighttime (22:00-06:00) noise at 44 dB. Based on this redistribution, noise levels of 54 dB for the daytime (Lday) and 49 dB for the evening (Levening) are applied, while the WHO Lnight value of 44 dB is directly applied to the night period.

- Proposed Mitigation Measures
  - Where predicted noise levels exceeded WHO thresholds, a range of mitigation measures was considered to reduce impacts to acceptable levels. The calculated noise levels during the night-time period, in the absence of noise barriers (so-called without project scenario), are graphically presented as noise contour maps in graphical documentation within annexes, 7.2, 7.3, 7.4, and 7.5. The night-time period was selected as the reference for further analysis, as exceedances of the relevant noise thresholds were observed at all affected properties during this period. The mitigation strategy was developed based on the source–path–receiver concept and included relevant measures.
  - Mitigation measures included:
    - Noise barriers installed along sections of the railway where significant noise propagation to sensitive receptors was predicted. Noise barrier characteristics were optimised through iterative modelling in CadnaA.
    - Track-based measures, such as rail dampers or rail fasteners, to reduce noise emissions at the source.
    - Passive noise protection measures were considered where above two mitigation measures were technically or economically unfeasible, or where residual impacts remained after implementation of the noise barriers and mitigation measures at source. These included facade insulation improvements for affected buildings, such as installation of high-performance windows, doors, and external wall insulation to reduce indoor noise levels but also system that ensures fresh air supply while the windows and doors remain closed.
- Other
  - Land-use planning recommendations, such as avoiding future development of noise-sensitive facilities in high-impact zones, is also suggested as part of long-term mitigation strategy.

All proposed measures were re-modelled within CadnaA to quantify their effectiveness in reducing noise levels at key receptor locations, and the outcomes were used to inform final recommendations in this assessment. The result of this modelling is presented in Section 4.2 of this Chapter, which outlines proposed mitigation measures during the operation phase.

Noise calculations shall be defined in the frequency range from 63 Hz to 8 kHz. Frequency band results shall be provided at the corresponding frequency interval. Calculations are performed in octave bands for railway traffic, except for the railway noise source sound power, which uses third octave bands. For railway traffic, based on these octave band results, the A-weighted long term average sound pressure level for the day (day is defined as a reference time period between 6.00 h and 18.00 h), evening (evening is defined as a reference time period between 18.00 h and 22.00 h) and night period and night is defined as a reference time period between (22.00 h and 6.00 h), as defined in Annex I and referred to in Art. 5 of Directive 2002/49/EC, is computed by summation over all frequencies:

$$L_{Aeq,T} = 10 * \lg \sum_{i=1} 10^{(L_{eq,Ti}+A_i)/10}$$

where:

$L_{eg,T}$ - equivalent continuous sound pressure level,

A_i - denotes the A-weighting correction according to IEC 61672-1,

i - frequency band index, and

T - is the time period corresponding to day, evening or night.

The model for railway traffic noise, describes the noise sound power emission of a specific combination of vehicle type and track type which fulfils a series of requirements described in the vehicle and track classification, in terms of a set of sound power per each vehicle ($L_{W,0}$). The noise emission of a traffic flow on each track shall be represented by a set of two source lines characterized by its directional sound power per meter per frequency band. This corresponds to the sum of the sound emissions due to the individual vehicles passing by in the traffic flow and, in the specific case of stationary vehicles, taking into account the time spent by the vehicles in the railway section under consideration.

If a steady flow of Q vehicles per hour is assumed, with an average speed v, on average at each moment in time there will be an equivalent number of Q/v vehicles per unit length of the railway section. The noise emission of the vehicle flow in terms of directional sound power per meter $L_{W',eq,line}$ (expressed in dB/m) is integrated by:

$$L_{w',eq,line,i(\psi,\varphi)} = L_{W,0,dir,i(\psi,\varphi)} + 10 * \lg \left(\frac{Q}{1000v}\right)$$

where:

Q - is the average number of vehicles per hour on the j-th track section for vehicle type t, average train speed s and running condition c,

v - is their speed on the j-th track section for vehicle type t and average train speed s, and

$L_{W,0,dir}$ - is the directional sound power level of the specific noise (rolling, impact, squeal, braking, traction, aerodynamic, other effects) of a single vehicle in the directions ψ, φ defined with respect to the vehicle's direction of movement.

In order to determine the equivalent sound pressure levels at the place of receiver point (noise immission), noise attenuation during outdoor propagation is calculated based on the sound power of noise sources (noise emission). As sound propagates outdoors, it is attenuated or modified by geometrical spreading, atmospheric absorption, interaction by reflection or absorption by the ground or ground cover and refraction and/or diffraction by a non-uniform atmosphere and by obstacles.

The CNOSSOS-EU method predicts the equivalent continuous sound pressure level at a receiver point corresponding to two particular types of atmospheric conditions: downward-refraction propagation conditions (positive vertical gradient of effective sound celerity) from the source to the receiver and relevant atmospheric conditions (null vertical gradient of effective sound celerity) over the entire area of propagation. The method of calculation does not provide results in upward-refraction propagation conditions (negative vertical gradient of effective sound speed) but these conditions are approximated by homogeneous conditions.

To calculate the attenuation due to atmospheric absorption in the case of transport infrastructure, the temperature and humidity conditions are calculated according to ISO 9613-1:1996.

The method provides results per octave band, from 63 Hz to 8 000 Hz. The calculations are made for each of the centre frequencies.

To reflect realistic annual average conditions in the noise propagation model, favourable meteorological conditions were applied in CadnaA. Specifically, the following proportions were adopted: 50% during the day (06:00–18:00), 70% during the evening and first part of the night (18:00–00:00), and 100% during late night (00:00–06:00).This approach appropriately accounts for the gradual stabilization of the atmosphere after sundown and the associated formation of temperature inversions and reduced wind speeds, which collectively enhance downward propagation of railway noise toward nearby receptors. The Paracin-Tupale railway predominantly crosses rural and agricultural land, where human activity drops significantly at night, further contributing to these conditions. The adopted proportions therefore reflect a more accurate, site-specific scenario and enable a reliable basis for assessing potential noise impacts in the context of the railway's operational conditions and surrounding environment.

3.1.2 Vibration and ground-borne noise modelling methodology during the railway operations

Vibration and ground-borne noise levels due to the railway traffic were calculated using VIBRA-1 (Ziegler Consultants and Swiss Rail) software package. Vibrations were calculated based on the individual trains passing, while the total impact was equal to a sum of standardized procedures in DIN 4150-2. Vibration and ground-borne noise are calculated using a regression model. The model parameters have been determined by statistical evaluation of a large number of measurements. Even though VIBRA is a semi-empirical model, the results obtained using it can be used for vibration and ground-borne impact assessment at the EIA/ESIA level, as it pertains to a new railway track that will be constructed and maintained according to European standards, with railway vehicles that are maintained in good working condition. The calculated values are a best estimation according to available data and are considered to be sufficient for the ESIA and/or EIA level impact assessment.

Vibrations created by passing trains are propagated through the soil to the building foundation. From there they travel through the walls up to the floors and ceilings in the entire building. On its path from the track to the building foundation the vibration is attenuated in the soil due to geometric and material damping. While passing from the soil to the building foundation the vibrations are considerably attenuated due to the so called “coupling effect”. The vibrations reach the higher floors through the walls without much modification. In the floors the vibrations are generally amplified by a large amount due to resonance phenomena.

A simple method to calculate the vibration transmission from track to building includes the most important influencing parameters such as: train type, train velocity, track type, switches, distance between track and building, type of building and type of floor. The attenuation can be expressed by:

$$v_j = v_{0,j} * \left(\frac{G}{G_0}\right)^h * F_t * F_s * F_b * \left(\frac{r_0}{r}\right)^m * F_a * F_d$$

where:

v_j - RMS-value (over train passage time) of the vibration velocity in the middle of the floor for train type j,

$v_{0,j}$ - reference value of vibration for train type j. This value corresponds to the characteristic vibration in a distance r_0 (reference distance) from the track centreline,

G - average train velocity,

G_0 - reference train velocity,

h - exponent for scaling train velocity,

F_t - factor for track type (open section, tunnel, dam, cut, etc.),

F_s - track factor for switches and other track irregularities,

F_b - factor for soil type under the track,

r_0 - reference distance (usually 8 m),

r - distance between building and track centre line.

m - exponent for geometric and material damping in the soil.

F_a - coupling factor between building and soil, and

F_d - factor for vibration amplification in floor.

The calculation of ground-borne sound is conducted in an analogous fashion as the calculation of vibration.

The ground-borne sound is calculated from the "frequency limited"[4] vibration of the floor and the transfer factor between vibration and structure borne sound:

$$p = v * F_{ks}$$

where:

p - RMS value of the radiated sound in Pa, and

F_{ks} - transfer factor for ground-borne sound (VIBRA-1 uses predefined coefficient values ranging from 0.60 to 0.85 depending on the type of floor in the building. Higher values correspond to concrete floor constructions, while lower values correspond to wooden floor constructions. For calculation purposes, a coefficient value of 0.85 was used as it better corresponds to modern buildings construction types.).

Based on the results for the individual trains the total impact is calculated by summation. In this calculation the summation procedure specified in the various national codes for vibration and ground-borne noise are used.
Summation equation for vibrations due to railway traffic according to DIN 4150-2 is:

$$KB_{FTr} = \sqrt{\frac{1}{N}\sum_{i=1}^{k} K_i^2 * f_i}$$

where:

N - is the number of non-overlapping 30-second cycles in the evaluation period,

K_i - characteristic vibration for each train category *i*,

f_i - number of trains per hour *fi* for each train category *i*.

Summation equation for ground-borne sound (noise) due to railway traffic according to BEKS 1999 is:

$$L_{Aeq,16h} = 10 * log\left[\frac{\sum_{i=1}^{k} 10^{K_i/10} * f_i * t_i}{T}\right]$$

[4] The frequency range for ground-borne noise is generally taken as 16 Hz – 250 Hz (see ISO 14837). Based on that 40 Hz can hardly be perceived by the human ear and frequencies above 125 Hz do not occur in buildings with train induced vibrations ground-borne noise is calculated in this frequency range (as stated in the VIBRA-1 manual).

where:

K_i - characteristic vibration for each train category i,

t_i - effective passage time i for each train category i,

T - time period, and

f_i - number of trains *fi* per *T* time period for each train category *i*.

The projected daily number of trains within the Paraćin-Stalać and Đunis-Trupale sub-sections are shown in Annex 7.1.3. Traffic demand projections for the year 2060 (presenting 30-year operation period, considered as conservative) have been utilized to model and predict vibration levels and ground-borne noise. The train categories and operational characteristics applied in this assessment are consistent with those used in the noise modelling analysis.

The calculated values are the best estimate according to available data and are considered sufficient for the ESIA level impact assessment.

The Paraćin-Stalać and Đunis-Trupale sub-sections have been further divided into smaller sections according to the parameters that determine the extent of vibration and ground-borne noise (railway line characteristics, train speed and train traffic mix), as stated:

- Section: Ćuprija-Paraćin
- Station: Paraćin
- Section: Paraćin-Sikirica/Ratare
- Station: Sikirica/Ratare
- Section: Sikirica/Ratare - Ćićevac
- Station: Ćićevac
- Section: Ćićevac - Stalać
- Section: Đunis – Kormani
- Tunnel: Đunis
- Station: Kormani
- Section: Kormani - Adrovac
- Station: Adrovac
- Section: Adrovac - Aleksinac
- Station: Aleksinac
- Section: Aleksinac - Luzane
- Station: Luzane
- Section: Luzane - Tesica
- Station: Tesica
- Section: Tesica - Trupale

- Station: Trupale
- Section: Trupale – end of section

3.1.3 Impact assessment methodology

Impact assessment methodology for measuring the impact of railway reconstruction and operations on noise, vibration and ground-borne noise levels involves a comprehensive approach to evaluating potential environmental and social implications. The methodology encompasses the identification and characterization of negative and positive impacts, including cumulative effects, throughout various project stages such as construction and operation.

The methodology for assessing noise impacts is based on magnitude, spatio-temporal scale, environmental sensitivity, and impact likelihood, with these elements defined at the level of the Study.

The magnitude of noise impact is based on the predicted noise level. People usually don't notice changes in noise levels of 0 to 3 dB. However, an increase of 10 dB is perceived as doubling the noise. The criteria for evaluating noise impact are defined according to the noise limits set by the project. The criteria for the magnitude of noise impact during railway construction and operation are shown in Table 3-1.

Table 3-1. Criteria for evaluating the magnitude of noise impact

Magnitude	Equivalent nose level [dB]	
	Day and Evening	Night
Very low (negligible)	< 50	< 40
Low	50 - 54	40 - 44
Medium	54 - 60	44 - 50
High	60 - 70	50 - 60
Very high	> 70	> 60

The magnitude of vibration impact is based on a predicted vibration level expressed as peak particle velocity (PPV) in millimetres per second (mm/s). Criteria for evaluation of the magnitude of vibration impact are based on the provisions of DIN 4150-2 and DIN 4150-3. The lower limit for vibration level that may cause cosmetic damage to residential buildings is 5 mm/s. The criteria for the magnitude of vibration impact during railway construction and operation are shown in Table 3-2.

Table 3-2. Criteria for evaluating the magnitude of vibration impact

Magnitude	Equivalent nose level [PPV mm/s]	
	Day and Evening	Night
Very low (negligible)	< 0.1	< 0.1
Low	0.1 – 0.8	0.1 – 0.4

Medium	0.8 – 1.6	0.4 – 0.8
High	1.6 – 5.0	0.8 - 5.0
Very high	> 5.0	> 5.0

3.2 Construction Phase Impacts

Railway construction activities can cause temporary but potentially significant noise, vibration and ground-borne impacts. An increase in noise, vibration, and ground-borne noise may negatively affect the health and well-being of people living near the construction site, causing stress, sleep disturbance, and reduced quality of life.

3.2.1 Noise

The noise levels during the railway construction primarily depend on the organization of works at the site, the number and type of construction machines used at the site, and their position and distance from residential and other sensitive buildings in the impact zone. At this stage of the Project, information on the organization of the construction site, the technology of works and information on which tools, equipment and machinery will be used are not available. All calculation and analyses given here are based on default values from referenced standards and literature, while the exact values can be determined after the method and technology of construction works decided upon.

The study sets noise threshold levels for construction works at 65 dB for the daytime (06:00–18:00) and evening (18:00–22:00) periods, and 55 dB for the nighttime (22:00–06:00), in accordance with the Law on Environmental Noise Protection (“Official Gazette of the RS”, No. 96/21) and the Regulation on Noise Indicators, Limit Values, Methods for Assessing Noise Indicators, Annoyance, and Harmful Effects of Environmental Noise (“Official Gazette of the RS”, No. 75/10). The limit values for environmental noise indicators in outdoor areas prescribed for Acoustic Zone 5 have been adopted as the relevant reference values.

Typical noise levels from tools, equipment and machinery that may occur during railway construction are given on the basis of standards BS5228 (Code of practice for noise and vibration control on construction and open sites – Part 1: Noise) and AS2436 (Guide to noise and vibration control on construction, demolition and maintenance sites), are shown in the table below.

Table 3-3. Estimated sound power levels of construction tools, equipment or machinery

Construction tools, equipment or machinery	Estimated sound power levels Lw [dB]
Bulldozer	114
Grader	105
Hydraulic excavator 20 t	107
Excavator 20 t	108
Dump track	109
Roller 18 t	101

Construction tools, equipment or machinery	Estimated sound power levels Lw [dB]
Backhoe	96
Water cart	109
Mobile cranes	99
Auger Piling Rig	110
Impact Piling Rig	133
Track Works Sleeper	114
Track Layer Plant	114
Ballast Regulator	114
Rail Welding Machine (Generator)	107
Ballast Tamper	115

The levels of construction noise depend on a large number of factors, such as: intensity of construction activities; location of construction activities; type of tools, equipment and equipment used; existing local noise sources; terrain topography and weather conditions.

It is assumed that no tools, equipment or machine will run at full power all the time, when the noise levels they emit are the highest. Periods with full power engagement should be relatively short, and "average" power values will be used most of the time during construction works, when the sound power levels produced are lower than those listed in Table 3-3. Also, not all types of tools, equipment and machines will be present and engaged on the construction site at the same time.

For the purposes of analysing the impact of tools, equipment and machines during construction works on environmental noise levels, an assessment of sound propagation was performed at their maximum engagement in conditions of even distribution. The acoustic calculations did not take into account the obstacles to sound propagation, and in real conditions noise levels can be expected to be lower than estimated. The estimated sound pressure levels of tools, equipment and machines at distances of 50, 100, 250, 500, 1000, 2000 and 3000 meters are shown in Table 3-4.

Table 3-4. The estimated sound pressure levels of tools, equipment and machines for different distances [dB]

Construction tools, equipment or machinery	Distance [m]						
	50	100	250	500	1000	2000	3000
Bulldozer	72	66	58	52	46	40	36
Grader	63	57	49	43	37	31	27
Hydraulic excavator 20 t	65	59	51	45	39	33	29
Excavator 20 t	66	60	52	46	40	34	30
Dump track	67	61	53	47	41	35	31
Roller 18 t	59	53	45	39	33	27	23
Backhoe	54	48	40	34	28	22	18
Water cart	67	61	53	47	41	35	31

Construction tools, equipment or machinery	Distance [m]						
	50	100	250	500	1000	2000	3000
Mobile cranes	57	51	43	37	31	25	21
Auger Piling Rig	68	62	54	48	42	36	32
Impact Piling Rig	91	85	77	71	65	59	55
Track Works Sleeper/Track Layer Plant	72	66	58	52	46	40	36
Ballast Regulator	72	66	58	52	46	40	36
Rail Welding Machine (Generator)	65	59	51	45	39	33	29
Ballast Tamper	73	67	59	53	47	41	37

Source: Transit Noise and Vibration Impact Assessment, Federal Transit Administration, May 2006

The calculated sound pressure levels shown in Table 3-4, which meet the requirements of the study standard for construction works during the day and evening periods are coloured green.

NATM is a standard method for building tunnels, which uses the geological stress from natural ground around a tunnelling site to build a tunnel safely. As a part of NATM technology blasting may be required for excavations of tunnels section. When an explosive is detonated, an air-blast overpressure occurs.

Using the following equation, the air-blast overpressure resulting from an explosion can be estimated:

$$P = K_a * \left(\frac{R}{Q^{\frac{1}{3}}}\right)^a \text{ [kPa]}$$

Where:

P – the pressure [kPa]

R – the distance from charge [m]

Q – the charge mass [kg]

K_a – the site constant. The AS2187.2 recommends for confined blasthole charges values to be commonly in the range of 10 to 100. A value of 55 has been adopted for this assessment.

a – site exponent. The AS2187.2 recommends for confined blasthole charges a good estimate of a = -1.45.

The estimated values of the air-blast overpressure in function of distance and charge mass are shown in Table 3-5.

Table 3-5. Estimated values of the explosion air-blast overpressure in function of distance and charge mass [Pa]

Charge mass [kg]	Distance [m]						
	50	100	250	500	1,000	2,000	3,000
0.5	135.3	49.5	13.1	4.8	1.8	0.6	0.4
1	189.2	69.2	18.3	6.7	2.5	0.9	0.5
2	264.5	96.8	25.6	9.4	3.4	1.3	0.7

Table 3-5. Estimated values of the explosion air-blast overpressure in function of distance and charge mass [Pa]

Charge mass [kg]	Distance [m]						
	50	100	250	500	1,000	2,000	3,000
5	411.8	150.7	39.9	14.6	5.3	2.0	1.1
10	575.7	210.7	55.8	20.4	7.5	2.7	1.5
15	700.3	256.3	67.9	24.8	9.1	3.3	1.8
50	1253.2	458.7	121.5	44.5	16.3	6.0	3.3
100	1752.0	641.3	169.8	62.2	22.8	8.3	4.6

The air-blast overpressure propagation can be increased with unfavourable meteorological conditions and decreased with topographic shielding.

The sound pressure levels of explosions air-blast overpressure from Table 3-5, expressed in decibels (reference value of sound pressure is 2*10-5 Pa) are shown in Table 3-6.

Table 3-6. Estimated values of the explosion air-blast sound pressure levels in function of distance and charge mass [dB]

Charge mass [kg]	Distance [m]						
	50	100	250	500	1,000	2,000	3,000
0.5	137	128	116	108	99	90	85
1	140	131	119	111	102	93	88
2	142	134	122	113	105	96	91
5	146	138	126	117	109	100	95
10	149	140	129	120	111	103	98
15	151	142	131	122	113	104	99
50	156	147	136	127	118	109	104
100	159	150	139	130	121	112	107

The Bureau of Mines Report of Investigations 8485 (1980), "Structure Response and Damage Produced by Air blast From Surface Mining" generally recommends a maximum safe overpressure of 134 dB for air blast recorded at residential structures[5]. The estimated sound pressure levels shown in Table 3-6, which meet the requirements of 134 dB are coloured green.

[5] Nicholson R.F, Determination of blast vibrations using peak particle velocity at Bengal Quarry, in St Ann, Jamaica. Master's thesis. Lulea University of Technology, 2005.

During the construction works, it is expected that noise levels will exceed the adopted standard threshold values during the daytime and evening periods within distances up to 100 meters from the construction site. An exception occurs during impact piling operations, where exceeding the threshold values may be expected at distances up to 500 meters.

A summary of the risks that may arise during the construction works from the aspect of noise is presented in the Table 3-7. The work is scheduled to be carried out during the day and evening reference period, which is between 6:00 to 22:00 hours. The noise criterion for potential annoyance to people during construction works is defined in the Study, stipulating that the allowable noise level must not exceed 65 dB during the daytime period. The noise criterion for possible building damage is not applicable.

Table 3-7. Possible risks during construction work

Types of construction work		Possible people annoyance
Noise	Impact piling	up to 500 m
	All other works (except impact piling)	up to 100 m

For all residential and other sensitive buildings which are in zones up to 100 m from construction site (distance depends on the type of construction work and the tools, equipment and machines used), it is necessary to plan temporary mitigation measures to reduce the negative impact of construction noise. Impact piling works should be avoided in zones where residential buildings are located at a distance less than 500 meters. As an alternative option, low or non-vibratory piling methods can be employed to minimize potential disturbances. However, if impact piling must be used, safe distances for executing works can be managed through pre-works tests, such as a preliminary piling series, which assess noise levels based on specific equipment and technology, along with establishing monitoring. Furthermore, the construction of the railway is transient in nature, so that the negative impacts of the noise will be reduced as the construction of the railway tracks progresses along the route away from sensitive receivers.

During the construction works (excluding impact piling), special attention from the perspective of noise protection must be paid in the following zones, as specified in the table below. The zones shown are for informational purposes only and are not limited in number or location. Before the start of the works, the contractor must accurately determine them.

Table 3-8. Indicative zones where negative noise impact is expected during construction works

Zone	Railway line chainage		Position in relation to railway line
	Start	End	
Section Paraćin - Stalać			
1	153+800	153+900	Left
2	154+300	154+650	Right
3	154+500	155+800	Left
4	155+200	155+700	Right

Zone	Railway line chainage		Position in relation to railway line
	Start	End	
5	155+900	156+050	Left
6	155+900	156+000	Right
7	156+100	156+150	Right
8	156+650	157+100	Left
9	156+850	157+050	Right
10	157+200	157+450	Left
11	157+650	157+700	Left
12	157+850	158+050	Left
13	158+400	158+500	Left
14	158+750	159+500	Left
15	158+800	158+900	Right
16	158+950	159+000	Right
17	161+900	162+600	Left
18	162+150	162+250	Right
19	162+450	162+600	Right
20	163+500	163+600	Left
21	164+500	164+750	Right
22	164+650	164+700	Left
23	164+900	165+000	Right
24	165+700	166+850	Left
25	166+050	168+300	Right
26	167+150	167+250	Left
27	168+100	168+200	Left
28	170+000	170+050	Left
29	170+200	170+300	Right
30	171+200	171+250	Right
31	171+300	172+300	Left
32	171+350	171+950	Right
33	172+450	173+100	Left
34	173+250	173+700	Right
35	173+450	174+150	Left
36	173+850	174+150	Right
Section Djunis - Trupale			
37	193+650	194+250	Left
38	193+750	194+300	Right
39	194+400	194+600	Right
40	194+700	195+200	Left
41	195+150	195+400	Right
42	195+400	196+600	Left
43	195+850	196+150	Right
44	196+300	196+750	Right
45	196+950	197+000	Right
46	197+150	197+400	Right

Zone	Railway line chainage		Position in relation to railway line
	Start	End	
47	197+200	197+550	Left
48	197+700	197+750	Right
49	197+750	197+800	Left
50	197+900	198+650	Left
51	198+200	198+650	Right
52	198+950	199+050	Left
53	199+500	200+850	Left
54	199+550	199+600	Right
55	199+750	188+850	Right
56	200+100	200+700	Right
57	2001+700	201+900	Left
58	202+050	203+850	Right
59	202+200	203+800	Left
60	204+000	204+100	Right
61	204+850	205+450	Right
62	206+100	207+350	Left
63	207+550	210+700	Left
64	207+650	210+800	Right
65	211+000	211+250	Left
66	212+400	212+450	Left
67	213+250	213+300	Left
68	213+650	213+750	Right
69	216+700	216+750	Right
70	216+900	217+200	Right
71	216+950	217+200	Left
72	217+850	218+000	Right
73	218+700	218+900	Right
74	219+600	219+700	Right
75	219+800	219+950	Left
76	221+200	221+900	Right
77	223+800	224+450	Left
78	224+200	224+250	Right
79	226+800	227+450	Right
80	227+100	227+450	Left
81	227+700	228+000	Left
82	227+750	227+950	Right
83	228+750	229+450	Right
84	228+900	229+600	Left

The assessment of the significance for impact related to increase in noise levels during construction phase is given in the Table 3-9.

Table 3-9. Assessment of noise impact significance during construction phase

Location	Magnitude	Spatio-temporal scale	Sensitivity	Likelihood	Overall significance
Zones defined in Table 3-8	High (3)	Short term (less than 5 years) and very localized (1)	Mostly dwellings (2)	The impact considered will happen with certainty (4)	HIGH (10)

The construction noise has local character (only in vicinity of construction site), limited duration (only during the execution of works) and with no residuals (will end after construction activities).

3.2.2 Vibration and ground-borne noise

The vibration and ground-borne noise levels during the railway construction primarily depend on the organization of works at the site, the number and type of the used construction machines and their position and distance from residential and other sensitive buildings in the impact zone. In this project phase, accurate organization and technology of works at the site were not available, as well as which tools, equipment and machinery will be used. All calculation and analyses are based on assumptions (default values from standards and literature will be used), while the actual values will be determined only when the Contractor of the works will be known, and the technique and technology of construction works adopted.

The following construction equipment will probably be needed to carry out the civil work: bulldozers, graders, excavators, scrapers, dampers, rollers, backhoes, cranes and piles. While for the track works, following will probably be needed: sleeper layer, track layer, ballast wagons, rail welding machine, tamper, excavators and backhoes.

Typical vibration levels for some of the construction tools, equipment and machinery are shown in Table 3-10. While the Table 3-10 provides one level for each piece of equipment, it should be noted that reported ground vibration levels from construction activities can vary considerably. The data from Table 3-10 provide a reasonable estimate for a wide range of soil conditions.

Table 3-10. Typical vibration levels of construction tools, equipment and machinery

Tool, equipment or machinery		Estimated vibration level @7.6 m [PPV mm/s]
Pile drive (impact)	Upper range	38.6
	Typical	16.4
Pile drive (sonic)	Upper range	18.6
	Typical	4.3
Vibratory roller		5.3
Hoe ram		2.3
Large bulldozer		2.3

Table 3-10. Typical vibration levels of construction tools, equipment and machinery

Tool, equipment or machinery	Estimated vibration level @7.6 m [PPV mm/s]
Caisson drilling	2.3
Loaded trucks	1.9
Jackhammer	0.9
Small bulldozer	0.1

Source: Transit Noise and Vibration Impact Assessment, Federal Transit Administration, May 2006

The energy of tools, equipment and machines during the execution of works is transferred to the ground and transmitted in the form of vibrations. The transmission rate of vibrations depends on the geological characteristics of the soil, frequency, object construction and other factors, and, as a function of distance it decreases. Without data from a specific location, it is not possible to accurately calculate the rate of vibration reduction. A simplified method based on the following regression equation can be used for estimation purposes[6]:

$$PPV = PPV_{ref} * \left(\frac{D_{ref}}{D}\right)^{n} \text{[mm/s]}$$

where:

PPV - the peak particle velocity adjusted per distance,

PPV_{ref} - the vibration level at a reference distance,

n - - the propagation coefficient based on soil class. The literature review shows that the value of this coefficient varies within the range of 0.8 to 1.7, depending on the quality of the soil. For calculation purposes, a coefficient value of 1.0 has been adopted, which corresponds to various soils (generally firm). Site-specific geotechnical investigations and laboratory testing are required to determine accurate coefficient value for a particular soil type at a given site.

D - the distance from construction activity to the receptor.

In order to determine the impact of some tools, equipment and machines, which will be engaged in the construction of the Paraćin–Trupale railway section, a calculation was performed using a regression equation. Threshold distances were determined at which vibration levels defined in Table 2-5 (human perception of vibration) and Table 2-6 (impact on building structures) are reached. The calculation results are shown in Table 3-11.

[6] Transit Noise and Vibration Impact Assessment Guide, The United States (US) Federal Transit Administration’s

Table 3-11. Estimated threshold distances for characteristic vibration levels [m]

Tool, equipment or machinery	Estimated vibration level @7.6 m	Characteristic vibration levels for human perception and impact of building structures [PPV mm/s]										
	[PPV mm/s]	0.1	0.2	0.4	0.8	1.6	2.5	3.0	5.0	6.3	10.0	20.0
Pile drive (impact)	16.4	1246	623	312	156	78	50	42	25	20	12	6
Pile drive (sonic)	4.3	327	163	82	41	20	13	11	7	5	3	2
Vibratory roller	5.3	403	201	101	50	25	16	13	8	6	4	2
Hoe ram	2.3	175	87	44	22	11	7	6	3	3	2	≤ 1
Large bulldozer	2.3	175	87	44	22	11	7	6	3	3	2	≤ 1
Caisson drilling	2.3	175	87	44	22	11	7	6	3	3	2	≤ 1
Loaded trucks	1.9	144	72	36	18	9	6	5	3	2	≤ 1	≤ 1
Jackhammer	0.9	68	34	17	9	4	3	2	≤ 1	≤ 1	≤ 1	≤ 1
Small bulldozer	0.1	8	4	2	≤ 1	≤ 1	≤ 1	≤ 1	≤ 1	≤ 1	≤ 1	≤ 1

The calculated threshold distances in Table 3-11 indicate that the impact of vibrations on buildings will exceed the permissible values for dwellings and buildings of similar design and/or occupancy (as specified in Table 2-6 with a limit of 5 mm/s) at distances up to 25 meters in the case of impact piling, and up to 8 meters when using other tools, equipment, and machines.

When taking into consideration human sensitivity to vibrations, the threshold distances become significantly larger. Referring to the DIN 4150-2 standard (Table 2-5), vibrations at the perception threshold of 0.1 mm/s are detectable at distances of up to 1246 meters during impact piling operations and up to 403 meters when using other equipment. Sleep disturbances, which can arise at a vibration level of 0.8 mm/s (awakening threshold), may occur at distances up to 156 meters and 50 meters, respectively.

During railway construction, ground-borne noise levels can vary depending on several factors such as the specific construction activities, location, time of day, and the distance from the noise source. It is important to note that actual ground-borne noise levels can differ significantly based on these factors and the specific conditions of the construction site.

The calculation of ground-borne noise levels during construction works for tools, equipment, or machinery, as indicated in Table 3-10, is performed using a simplified method[7]:

$$L_{GBN} = L_v + C_{dist} + C_{dmp} + C_{bld} + C_{pile} + C_{floor} + C_{noise} + C_{weight} \text{ [dB]}$$

where:

[7] Environmental Impact Assessment - Integration for Siu Ho Wan and Silver Mine Bay Water Treatment Works - APPENDIX 4.4 Detailed Calculation of Ground-borne Noise - Minimum Distance required for Compliance with Evening and Nighttime Criteria (Agreement No. CE 57/2005(EP), 2010)

L_{GBN} - estimated ground-borne noise level [dB];

C_{dist} - distance attenuation $C_{dist} = -20 * \log\left(\frac{R}{R_o}\right)$ [dB]. R_o - reference distance (7.6 m);

C_{dmp} - soil damping loss. No soil damping was applied (worst case scenario);

C_{bld} - coupling loss into building foundation. Correction of 0 dB is assumed (worst case scenario);

Cpile - coupling loss from bed rock to pile (0 dB for house without pile support);

C_{floor} - coupling loss per floor (0 dB for units located at ground floor);

C_{noise} - conversion factors from floor vibration to noise levels. It depends on the dimensions of the room and the reverberation time (-26 dB for typical room);

C_{weight} - conversion from vibration level (VdB) to A-weighted noise level (dB). For low frequency (<30 Hz) value is -50 dB, for mid frequency (30 to 60 Hz) value is -35 dB and for high frequency (60 to 100 Hz) value is -20 dB. A value of 20 dB has been adopted for the calculation (worst case scenario).

The calculated ground-borne noise values are presented in the Table 3-12.

Table 3-12. Indicative ground-borne noise levels L_{GBN} [dB]

Tool, equipment or machinery	Approximate Lv[8] @7.6 m [VdB]	Distance [m]					
		10	20	30	40	50	60
Pile drive (impact)	104	56	52	50	46	42	40
Pile drive (sonic)	93	44	41	38	35	30	29
Vibratory roller	94	46	42	40	36	32	30
Hoe ram	87	39	35	33	29	25	23
Large bulldozer	87	39	35	33	29	25	23
Caisson drilling	87	39	35	33	29	25	23
Loaded trucks	85	37	34	31	28	23	21
Jackhammer	79	31	27	25	21	17	15
Small bulldozer	60	11	8	5	2	≤ 1	≤ 1

The Indicative ground-borne noise levels for construction works in Table 3-12 which meet the preferred requirements of the standard BEKS (which can be adopted for the low frequency noise assessment during construction works) for day period (Table 2-7) are shaded green.

[8] RMS velocity in decibels (VdB) re 1 10^{-6} inch/second with crest factor of 4, Transit Noise and Vibration Impact Assessment, Federal Transit Administration, May 2006

It is assumed that all tunnels will be built using the NATM (New Austrian Tunnelling Method). The only possible exception will be entrances and/or exits of some tunnels, which will be built by the cut-and-cover method (for which the same or similar machines will be used as for civil works).

The estimated maximum vibration levels that can occur during mechanical excavation of a tunnel (cut-and-cover) is shown in Table 3-13.

Table 3-13. Indicative maximum ground vibration levels for mechanical tunnel excavation methods [mm/s PPV][9]

Vibration source	Distance					
	5 m	10 m	20 m	30 m	40 m	50 m
Heavy roadheading	1.10	0.43	0.17	0.09	0.06	0.05
Heavy rockbreaking	4.50	1.30	0.40	0.20	0.14	0.10

The indicative maximum ground vibration levels for mechanical tunnel excavation methods shown in Table 3-13 will not cause damage to the structures. It is estimated that population annoyance may be expected during heavy rockbreaking at distances of up to 5 meters.

The estimated low frequency noise levels that can occur during mechanical excavation of a tunnel (cut-and-cover) are shown in Table 3-14.

Table 3-14. Indicative low frequency noise levels for mechanical tunnel excavation methods [dB(A)][10]

Low frequency noise source	Distance					
	5 m	10 m	20 m	30 m	40 m	50 m
Heavy roadheading	57	48	39	34	30	27
Heavy rockbreaking	67	58	50	45	40	37
Drilling (small percussive rig)	58	49	40	36	31	29

The indicative low frequency noise levels for mechanical tunnel excavation methods shown in Table 3-14 which meet the preferred requirements of the BEKS standard (which is adopted for the low frequency noise assessment during construction works) for day period (Table 2-7) are coloured green.

[9] Bus and Train (BaT) Tunnel, Environmental Impact Statement, Construction Noise and Vibration, Report Number 620, 2014
[10] Bus and Train (BaT) Tunnel, Environmental Impact Statement, Construction Noise and Vibration, Report Number 620, 2014

A summary of the risks that may arise during the construction works from the aspect of vibrations and ground-borne noise is presented in the Table 3-15. The work is scheduled to be carried out during the day and evening reference period, which is between 6:00 to 22:00 hours. Two sets of criteria for assessing the impact of construction works on the environment from the aspects of vibration and ground-borne noise have been adopted.

- The vibration criterion for possible building damage has been set in accordance with identified sensitive objects and DIN 4150-3 standard requirements (Table 2-6), so the allowable level of vibrations must not exceed 5 mm/s.
- The vibration criterion for possible people annoyance has been set in accordance with human perception to vibration according to DIN 4150-2 (Table 2-5), at 1.6 mm/s.
- The ground-borne noise criterion for possible building damage is not applicable.
- The ground-borne noise criterion for potential human annoyance has been set based on human sensitivity to ground-borne noise, in accordance with BEKS 1999 (Table 2-7, Modernized Railway Line). The allowable ground-borne noise levels must not exceed 40 dB during the daytime period and 35 dB during the nighttime period.

Table 3-15. Possible risks during construction work

Types of construction work		Possible damages to buildings	Possible people annoyance
Vibration	Impact piling	up to 25 m	up to 78 m
	All other works (except impact piling)	up to 8 m	up to 25 m
Ground-borne noise	Impact piling	not applicable	up to 60 m
	All other works (except impact piling)	not applicable	up to 30 m

For all residential and other sensitive buildings which are in zones up to 30 m from construction site (distance depends on the type of construction work and the tools, equipment and machines used), it is necessary to plan temporary mitigation measures to reduce the negative impact of vibration and/or ground-borne noise. Impact piling works should be avoided if possible, and in any case, they are not allowed in zones where residential buildings are located at a distance less than 78 meters. As an alternative option, low or non-vibratory piling methods can be employed to minimize potential disturbances.

However, if impact piling must be used, safe distances for executing works can be managed through pre-works tests, such as a preliminary piling series, which assess vibration levels based on specific equipment, technology and ground conditions, along with establishing monitoring. Furthermore, the construction of the railway is transient in nature, so that the negative impacts of the vibration and ground-borne noise will be reduced as the construction of the railway tracks progresses along the route away from sensitive receivers.

During the construction works (excluding impact piling), special attention from the perspective of vibration protection must be paid in the following zones, as specified in the table below. The zones shown are for informational purposes only and are not limited in number or location. Before the start of the works, the contractor must accurately determine them.

Table 3-16. Indicative zones where negative vibration and ground-borne noise impact is expected during construction works

Zone	Railway line chainage		Position in relation to railway line
	Start	End	
Section Paraćin - Stalać			
1	154+300	154+350	Right
2	154+500	155+800	Left
3	155+200	155+700	Right
4	155+900	156+000	Left
5	155+900	156+000	Right
6	156+650	157+100	Left
7	156+850	157+050	Right
8	157+200	157+450	Left
9	157+850	158+050	Left
10	158+400	158+500	Left
11	158+750	159+500	Left
12	158+800	158+900	Right
13	161+900	162+400	Left
14	162+150	162+200	Right
15	162+450	162+600	Right
16	163+500	163+600	Left
17	164+550	164+750	Right
18	164+900	164+950	Right
19	165+900	166+850	Left
20	166+050	166+150	Right
21	166+300	166+400	Right
22	166+500	168+300	Right
23	167+150	167+250	Left
24	168+100	168+200	Left
25	170+000	170+050	Left
26	170+200	170+250	Right
27	171+150	171+250	Right
28	171+350	172+300	Left
29	171+450	171+950	Right
30	172+450	173+100	Left
31	173+250	174+150	Right
32	173+450	174+150	Left
Section Djunis - Trupale			
33	193+650	194+250	Left
34	193+850	194+300	Right
35	194+400	194+550	Right
36	194+700	195+200	Left
37	195+150	195+400	Right
38	195+400	196+600	Left
39	195+850	195+150	Right

Zone	Railway line chainage		Position in relation to railway line
	Start	End	
40	195+350	196+750	Right
41	196+950	197+000	Right
42	197+150	197+400	Right
43	197+200	198+650	Left
44	197+700	197+750	Right
45	198+200	198+650	Right
46	199+500	200+750	Left
47	199+550	199+600	Right
48	199+750	199+850	Right
49	200+100	200+700	Right
50	201+750	201+900	Left
21	202+100	202+400	Right
52	202+200	203+800	Left
53	202+650	203+850	Right
54	204+000	204+100	Right
55	204+850	205+450	Right
56	205+050	205+450	Right
57	206+250	207+350	Left
58	207+600	211+250	Left
59	207+650	210+800	Right
60	212+400	212+450	Left
61	213+250	213+300	Left
62	213+650	213+750	Right
63	216+900	217+150	Right
64	216+950	217+200	Left
65	217+950	218+000	Right
66	218+700	218+850	Right
67	219+600	219+700	Right
68	219+800	219+950	Left
69	221+200	221+750	Right
70	223+800	224+250	Left
71	224+200	224+250	Right
72	226+800	227+450	Right
73	227+100	227+450	Left
74	227+700	228+000	Left
75	227+750	227+950	Right
76	228+750	229+450	Right
77	228+900	229+450	Left

The assessment of the significance for impact related to increase in vibration levels during construction phase is given in the Table 3-17.

Table 3-17. Assessment of vibration impact significance during construction phase

Location	Magnitude	Spatio-temporal scale	Sensitivity	Likelihood	Overall significance
Zones defined in Table 3-16	High (3)	Short term (less than 5 years) and very localized (1)	Mostly dwellings (2)	The impact considered will happen with certainty (4)	HIGH (10)

The construction vibration and ground-borne noise has local character (only in vicinity of construction site), limited duration (only during the execution of works) and with no residuals (will end after construction activities).

3.3 Operations Phase Impacts

Railway operations can cause continuous and potentially significant noise, vibration, and ground-borne impacts. Increased exposure to these disturbances may negatively affect the health and well-being of people living near the construction site, causing stress, sleep disturbance, and reduced quality of life.

3.3.1 Noise

The calculated noise levels in the night periods without use of noise barriers are graphically presented (noise map) in graphical documentation within Annexes 7.2, 7.3, 7.4, and 7.5. The night period was taken as a reference for further analysis. This was because excessive values were observed during the night period on all properties, and there were no properties where excessive values occurred only during the day or evening.

All sensitive objects where the study threshold noise levels were exceeded are marked with a grey pattern, (outlined in red for schools, hospitals and similar objects, and dark red for residential objects) in Annexes 7.2, 7.3, 7.4, and 7.5. For all objects where the study threshold noise levels were exceeded, it is necessary to plan measures to reduce the negative impact of noise on the environment.

Based on the acoustic calculations and analysis carried out, 12 zones have been identified along the Paraćin–Stalać section, in both time phases (the years 2045 and 2060), where adverse environmental impacts due to railway noise are expected. In the identified zones, in the year 2045, residents of 2,871 properties will be exposed to noise levels exceeding the project's allowable limits, while in 2060, this number is expected to increase to 3,068. This represents an increase of 197 properties along the Paraćin–Stalać section over the period from 2045 to 2060. Further details regarding the subject zones, including their positions (starting and ending stations) are provided in the in Table 3-18 for the year 2045 and year 2060.

Table 3-18. Zones with expected negative impact of railway noise, Paraćin-Stalać sub-section

Zone No.	Railway line chainage		Position in relation to railway line	Number of affected objects - 15-year scenario	Number of affected objects - 30-year scenario
	start point [km]	end point [km]			
1	153+600.00	157+250.00	Right	346	378
2	153+380.00	159+500.00	Left	791	862
3	158+450.00	159+850.00	Right	109	114
4	161+650.00	162+900.00	Right	131	141
5	161+850.00	162+600.00	Left	58	59
6	163+400.00	163+850.00	Left	9	9
7	163+800.00	165+550.00	Right	138	142
8	164+650.00	168+200.00	Left	295	305
9	165+950.00	168+300.00	Right	252	260
10	169+950.00	172+100.00	Right	134	146
11	169+950.00	174+170.00	Left	559	603
12	173+200.00	174+170.00	Right	49	49

Based on the acoustic calculations and analysis carried out, 25 zones have been identified along the Đunis-Trupale section, in both time phases (the years 2045 and 2060), where adverse environmental impacts due to railway noise are expected. In the identified zones, in the year 2045, residents of 4,530 properties will be exposed to noise levels exceeding the project's allowable limits, while in 2060, this number is expected to increase to 4,644. This represents an increase of 114 properties along the Đunis-Trupale section over the period from 2045 to 2060. Further details regarding the subject zones, including their positions (starting and ending stations) are provided in the in Table 3-19 for the year 2045 and year 2060.

Table 3-19. Zones with expected negative impact of railway noise, Đunis-Trupale sub-section

Zone No.	Railway line chainage		Position in relation to railway line	Number of affected objects - 15-year scenario	Number of affected objects - 30-year scenario
	start point [km]	end point [km]			
1	192+900.00	194+700.00	Right	110	111
2	193+600.00	194+300.00	Left	134	144
3	194+600.00	196+650.00	Left	283	285
4	194+900.00	197+800.00	Right	178	179
5	197+150.00	199+000.00	Left	147	147
6	198+150.00	198+700.00	Right	16	16
7	199+450.00	201+050.00	Left	135	135
8	199+500.00	201+650.00	Right	183	188
9	201+350.00	204+000.00	Left	310	319
10	201+950.00	204+300.00	Right	197	199
11	205+000.00	205+550.00	Right	6	6

Zone No.	Railway line chainage		Position in relation to railway line	Number of affected objects - 15-year scenario	Number of affected objects - 30-year scenario
	start point [km]	end point [km]			
12	205+650.00	211+400.00	Left	711	738
13	207+600.00	211+100.00	Right	613	632
14	211+600.00	214+400.00	Left	187	187
15	212+400.00	213+100.00	Right	26	26
16	213+600.00	213+700.00	Right	7	7
17	215+550.00	218+250.00	Left	206	212
18	216+700.00	218+300.00	Right	106	109
19	218+650.00	223+300.00	Right	439	443
20	219+550.00	220+100.00	Left	13	13
21	223+400.00	224+450.00	Left	126	129
22	224+000.00	224+450.00	Right	51	53
23	226+850.00	227+950.00	Right	196	209
24	226+950.00	227+950.00	Left	42	42
25	228+700.00	229+642.00	Right+Left	108	115

The assessment of the significance for impact related to increase in noise levels during operational phase is given in the Table 3-20.

Table 3-20. Assessment of noise impact significance during operational phase

Location	Magnitude	Spatio-temporal scale	Sensitivity	Likelihood	Overall significance
Zones defined in Table 3-18 and Table 3-19	High (3)	Long term / Permanent (more than 20 years) and very localized (3)	Mostly dwellings (2)	The impact considered will happen with certainty (4)	HIGH (12)

The railway operations noise has local impact (only in vicinity of railway line), short-term (transient) character (only during the train passage), and with no or small residuals (after the application of protective measures).

3.3.2 Vibration and ground-borne noise

The results of the vibration and ground-borne noise calculation, based on the defined methodology, are presented in the Annex 7.6 Vibration modelling without protection measures – 30-year scenario, in Table **7-19** to

Table 7-39. The total number of vibration impacts on buildings is significantly lower than those caused by noise. Therefore, no options analysis is required for vibration, unlike the noise assessment where a comparison between 15-year and 30-year traffic scenarios was conducted.

The Paraćin-Stalać and Đunis-Trupale sub-sections have been divided into sections according to the parameters that determine the extent of vibration and ground-borne noise (railway line characteristics, train speed and train traffic mix), as stated:

- Section: Ćuprija-Paraćin (Table 7-19),
- Station: Paraćin (Table 7-20),
- Section: Paraćin-Sikirica/Ratare (Table 7-21),
- Station: Sikirica/Ratare (Table 7-22),
- Section: Sikirica/Ratare – Ćićevac (Table 7-23),
- Station: Ćićevac (Table 7-24),
- Section: Ćićevac – Stalać (Table 7-25),
- Section: Đunis – Kormani (Table 7-26),
- Tunnel: Đunis (
-
- Table 7-27),
- Station: Kormani (Table 7-28),
- Section: Kormani – Adrovac (Table 7-29),
- Station: Adrovac (Table 7-30),
- Section: Adrovac – Aleksinac (Table 7-31),
- Station: Aleksinac (Table 7-32),
- Section: Aleksinac – Luzane (Table 7-33),
- Station: Luzane (Table 7-34),
- Section: Luzane - Tesica (Table 7-35),
- Station: Tesica (Table 7-36),
- Section: Tesica - Trupale (Table 7-37),
- Station: Trupale (Table 7-38),
- Section: Trupale – end of section (
-
- Table 7-39).

The calculated vibration levels during railway operation are compared with the reference values defined in the DIN 4150-2 for mainly residential areas, as listed in Table 2-4. The calculated ground-borne noise level during railway operation is compared with the reference values defined in the BEKS 1999, as listed in Table 2-7 for residential areas and newly constructed railway line.

The zones where vibration levels do not comply with the assessment procedure specified in DIN 4150-2 for primarily residential areas (Table 2-4) and the zones where ground-borne noise levels do not meet the criteria for the newly constructed railway line and residential areas (Table 2-7) according to BEKS 1999 are all up to 20 meters of the railway line. These zones are presented in the annexed tables in Section 7.6.

Presented values show the impact of vibration from the railway line in the at the following locations, as presented in the two tables below and on the vibration maps in chapters 7.11 and 7.12. For objects marked with green cells in Table 3-21 and Table 3-22 relevant vibration mitigation measures should be proposed.

Table 3-21. Number of affected sensitive objects, station and objects for sectioning along the open railway section and switch areas on Paraćin-Stalać, within and outside regulation line

Area	Object No.	Number of affected objects							
		up to 5 m		between 5 and 10 m		between 10 and 15 m		between 15 and 20 m	
		within regulation line	outside regulation line	within regulation line	outside regulation line	within regulation line	outside regulation line	within regulation line	outside regulation line
Section Ćuprija-Paraćin	-	-	-	-	-	Not applicable			
Station Paraćin	1	-	-	-	-	-	-	-	155+370
	2**	-	-	-	-	155+390	-	-	-
	3	-	-	-	-	-	155+450	-	-
	4	-	-	-	-	-	155+470	-	-
	5	-	-	-	-	-	155+490	-	-
	6	-	-	-	-	-	-	-	155+530
Section Paraćin - Sikirica/Ratare	7**	-	-	156+860	-	Not applicable			
	8**	157+410	-	-	-				
Station Sikirica/Ratare	9**	-	-	-	-	163+550	-	-	-
Section Sikirica/Ratare - Ćićevac	10*	-	-	164+950	-	Not applicable			
	11**	166+670	-	-	-				
	12**	-	-	166+990	-				
Station Ćićevac	13**	171+810	-	-	-	-	-	-	-
	14	-	-	-	-	-	-	-	172+080
Section Ćićevac - Stalać	-	-	-	-	-	-	-	-	-

* Objects such as station or object for sectioning
** Objects within regulation line that will be demolished

Table 3-22 Number of affected sensitive objects, station and objects for sectioning along the open railway section and switch areas on Djunis-Trupale, within and outside regulation line

Area	Object No.	Number of affected objects							
		up to 5 m		between 5 and 10 m		between 10 and 15 m		between 15 and 20 m	
		within regulation line	outside regulation line	within regulation line	outside regulation line	within regulation line	outside regulation line	within regulation line	outside regulation line
Section Đunis - Korman	15**	-	-	194+030	-	Not applicable			
	16**	194+160	-	-	-				
	17**	194+730	-	-	-				
	18**	195+890	-	-	-				
	19**	195+910	-	-	-				
	20**	-	-	195+910	-				
	21**	-	-	195+940	-				
	22**	-	-	196+480	-				
	23**	197+170	-	-	-				
	24**	197+210	-	-	-				
	25**	197+260	-	-	-				
Station Korman	26	-	-	-	-	-	-	-	200+450
	27	-	-	-	-	-	-	-	200+520
	28**	-	-	201+160	-	-	-	-	-
Section Korman - Adrovac	29**	202+880	-	-	-	Not applicable			
	30**	-	-	202+930	-				
	31**	202+960	-	-	-				
	32**	202+970	-	-	-				
	33**	202+980	-	-	-				
	34**	202+990	-	-	-				
	35**	203+020	-	-	-				
	36**	-	-	203+650	-				
	37	-	-	-	203+770				
Station Adrovac	38**	-	-	204+880	-	-	-	-	-
Section Adrovac - Aleksinac	-	-	-	-	-	Not applicable			
Station Aleksinac	39**	-	-	-	-	-	-	208+750	-
	40**	-	-	-	-	208+770	-	-	-
	41**	-	-	-	-	208+780	-	-	-
	42**	208+800	-	-	-	-	-	-	-
	43**	208+820	-	-	-	-	-	-	-
	44**	-	-	208+860	-	-	-	-	-

Area	Object No.	Number of affected objects							
		up to 5 m		between 5 and 10 m		between 10 and 15 m		between 15 and 20 m	
		within regulation line	outside regulation line	within regulation line	outside regulation line	within regulation line	outside regulation line	within regulation line	outside regulation line
	45*	-	-	-	-	-	-	208+920	-
	46**	-	-	-	-	-	-	209+860	
Section Aleksinac - Lužane	47**	-	-	211+220	-	Not applicable			
Station Lužane	-	-	-	-	-	-	-	-	-
Section Lužane - Tešica	-	-	-	-	-	Not applicable			
Station Tešica	-	-	-	-	-	-	-	-	-
Section Tešica - Trupale	48**	223+860	-	-	-	Not applicable			
	49**	-	-	224+230	-				
	50**	227+140	-	-	-				
	51**	-	-	227+230	-				
	52**	227+240	-	-	-				
	53**	227+290	-	-	-				
	54**	-	-	227+320	-				
	55**	227+420	-		-				
Station Trupale	56**	-	-	227+800	-	-	-	-	-
	57**	227+840	-	-	-	-	-	-	-
	58**	-	-	227+840	-	-	-	-	-
	59**	227+870	-	-	-	-	-	-	-
	60	-	-	-	-	-	-	-	227+870
	61**	227+890	-	-	-	-	-	-	-
	62**	227+910	-	-	-	-	-	-	-
	63**	-	-	-	-	227+910	-	-	-
	64**	227+920	-	-	-	-	-	-	-
	65**	227+930	-	-	-	-	-	-	-
	66**	-	-	227+950	-	-	-	-	-
	67**	-	-	-	-	-	-	229+170	-
	68**	-	-	-	-	-	-	229+210	-
	69**	-	-	-	-	229+410	-	-	-

* Objects such as station or object for sectioning
** Objects within regulation line that will be demolished

A total of 69 buildings have been identified along Paraćin-Trupale railway section as potentially affected by vibration and ground-borne noise, out of which 35 are located in the station areas and 34 are located on the open sections between stations. In total, 57 objects are planned to be demolished, 25 objects in stations and 32 objects on open sections. Out of remaining 12 objects, 2 objects are station related while the 10 objects are classified as vibration sensitive receptors that must be protected.

The vibration energy on the bridge is partially radiated in the air as noise (which is included in the noise assessment), and partially transferred from the bridge foundation points to the soil. Vibration levels on nearby objects depend on the ratio of energy used for noise emission, vibration energy absorbed by the bridge structure, as well as the distances between objects and the bridge foundation points. For the objects in the bridge zone, this represents a worst-case scenario when all vibration energy is transferred to the soil along the railway line axis. In real situations, it can be expected that vibration levels at objects in the bridge zone will be lower than the calculated values.

The assessment of the significance for impact related to increase in vibration levels during operational phase is given in the Table 3-23.

Table 3-23. Assessment of vibration impact significance during operational phase

Location	Magnitude	Spatio-temporal scale	Sensitivity	Likelihood	Overall significance
Zones defined in Table 3-21 and **Error! Reference source not found.**	High (3)	Long term / Permanent (more than 20 years) and very localized (3)	Mostly dwellings (2)	The impact considered will happen with certainty (4)	HIGH (12)

The railway operations vibration and ground-borne noise have local impact (only in vicinity of railway line), short-term (transient) character (only during the train passage), and with no or small residuals (after the application of protective measures).

Perceptible vibration is usually accompanied by noise. The cumulative effects of vibration and noise on people is a relatively unexplored area. Research has shown that in areas with high levels of vibration in order for annoyance to be equal as when there is no vibration, noise exposure should be lower. However, the calculated vibration levels inducted by a railway traffic are relatively small and, in that sense, the cumulative noise and vibration effects are negligible.

3.4 Summary of impacts

The significance of noise, vibration, and ground-borne noise impacts has been assessed based on the magnitude of the impact, its spatial and temporal scale, the sensitivity of affected receptors, and the likelihood of occurrence. A summary of the overall significance of these impacts before the implementation of mitigation measures is presented in Table 3-24.

Table 3-24: Summary of Significance of Construction and Operations Phase Noise, Vibration and Ground-borne Noise Impacts

Project Phase	Impact	Positive/Negative	Overall significance before mitigation measures are implemented
Construction	*Noise*	Negative	HIGH (10)
	Vibration and ground-borne noise	Negative	HIGH (10)
Operation	*Noise*	Negative	HIGH (12)
	Vibration and ground-borne noise	Negative	HIGH (12)

4 MITIGATION MEASURES

4.1 Construction Phase

4.1.1 Noise

The Contractor shall develop a Construction Noise Management Plan, which will include the following measures to mitigate the negative impacts of railway construction on noise:

- Construction working hours will be limited to day and evening period (based on Serbian regulations, this period is from 6.00 to 22.00 (the period can be adjusted, but it must be within these limits);
- A description of the standards and other regulations governing noise protection that must be fulfilled during work execution;
- The maximum allowed levels of noise shall be done based on the purpose of the structure, land use and time period, in accordance with the Serbian legislation. The reference values are provided in the Table 2-1.
- A description of the contractor's environment management system;
- A matrix of responsibility in plan implementation;
- A plan and program for the execution of works (definition of working hours, identification and description of noise generating activities, works that shall be executed out of working hours, etc.);
- Training sessions for the engaged staff will be prepared and conducted with the aim of raising awareness about environmental protection, potential problems, solutions, and good practices to prevent problems from occurring;
- A description and manner of internal and external communication of staff at the site with respect to the noise management;
- The way in which the (local) public shall be included and/or informed during the work execution;
- Local residents will be informed of the planned works and the potential periods of disruption;
- Reference to their external complaint/grievance mechanism;
- Assessment of impacts of civil works on noise levels;
- Definition and planning temporary measures to reduce the negative impact of noise in case it is determined that the construction works will affect the population;
- Definition of noise monitoring procedure during construction work (definition of number and location of the measuring points, measuring methods, measurement procedure in case of complaints, etc.);
- All construction equipment will comply with the requirements of EU Directive 2000/14/EC (must have CE marking);
- Definition of maximum allowable noise levels for machinery, equipment and tools that shall be used at the site;
- All construction equipment and vehicles will be maintained in good working order;
- The noisy construction equipment must be fitted with noise muffling devices that will reduce sound levels;
- Reversing alarms that do not have a tonal component (i.e. broadband) will be used, if applicable;
- The noisy construction equipment will be located as far as possible from sensitive receptors;
- External construction access road should avoid passing near residential and other sensitive buildings, where is possible;

- Restriction of the maximum speed on the internal and external construction access roads;
- Maintaining the access roads and/or construction site in good condition to minimize noise generation;
- Transport and construction management will be used to avoid the cumulative effects of noise along construction roads and/or construction site;
- Avoid simultaneous use of equipment that generate a lot of noise;
- The work that makes a lot of noise near sensitive receptors will be organized in such a way that the exposure time is as short as practicable (schedule and resource planning).
- In case where noisy works need to be performed at night (only in exceptional cases) or during a longer period than one day in the vicinity of the sensitive objects, a temporary noise barrier shall be used around the working area;
- Including a hierarchy of mitigation measures, encompassing design considerations (such as avoiding high noise processes), source-based mitigation, as well as on-site (e.g. hoardings) and off-site mitigation.

The Construction Noise Management Plan must be approved by the investor and/or other relevant organizations, and the contractor shall organize works at the site in accordance with the plan.

Before and during the Construction works, the Contractor should carry site inspection to ascertain information on the condition of the Site and the surrounding area, with regards to the construction works and their impact on the environment and the local population, with special regards to sensitive objects. The contractor must determine whether there are other noise sources in the vicinity of the construction site, and if they exist, their levels must be determined by measurements conducted by accredited organizations. A publicly available database with pre-construction noise collected data needs to be established.

The noise monitoring system must be established within the construction site vicinity, at locations of the most sensitive objects, in order to evaluate the impacts and determine if they exceed the allowable values. Additionally, the system should be used to quantify the impacts by comparing them with the pre-construction conditions. The monitoring system must be in accordance with the dynamics and locations of the construction works along the future railway route.

If complaints arise from local residents despite the presence of an established construction noise monitoring system during the execution of work, additional measurements must be conducted and further mitigation measures may be necessary.

4.1.2 Vibration and ground-borne noise

The Contractor shall develop a Construction Vibration Management Plan, which will include the following measures to mitigate the negative impacts of railway construction on vibration:

- Construction working hours will be limited to day and evening period (based on Serbian regulations, this period is from 6.00 to 22.00 (the period can be adjusted, but it must be within these limits);

- A description of the standards and other regulations governing vibration and ground-borne noise protection that must be fulfilled during work execution;
- The maximum allowed levels of vibration and ground-borne noise shall be done based on the purpose of the structure, land use and time period, in accordance with the standards DIN 4150-2, DIN 4150-3, and BEKS 1999. The reference values are provided in the Table 2-4, Table 2-6 and Table 2-7;
- A description of the contractor's environment management system;
- A matrix of responsibility in plan implementation;
- A plan and program for the execution of works (definition of working hours, identification and description of vibration and ground-borne noise generating activities, works that shall be executed out of working hours, etc.);
- a vibration risk assessment for the construction works, identifying all potential sensitive receptors and defining and implementing a hierarchy of mitigation measures, encompassing design considerations (such as avoiding high vibration processes), source-based mitigation, as well as on-site and off-site mitigation.
- The requirement to:
  - Undertake a detailed pre-condition survey of all sensitive buildings by a qualified, independent surveyor to visually identify all existing signs of exterior or interior damage, cracks (including size, type and direction) and settlement before the construction takes place. The assessment should include a written record and photographs of the existing situation.
  - During construction, condition surveys will be undertaken at least bi-monthly, and following the construction activities that generate a high level of vibration at specific location.
  - If required, crack gauges will be installed to enhance monitoring and construction methodologies will be refined to reduce vibration levels.
  - Condition surveys will be undertaken post construction, to identify any damage that needs to be repaired by the Contractor, in consultation with the affected people. The Contractor will be responsible for the repair of such damage.
- Training sessions for the engaged staff will be prepared and conducted with the aim of raising awareness about environmental protection, potential problems, solutions, and good practices to prevent problems from occurring;
- A description and manner of internal and external communication of staff at the site with respect to the vibration and ground-borne noise management;
- The way in which the (local) public shall be included and/or informed during the work execution;
- Local residents will be informed of the planned works and the potential periods of disruption;
- Reference to their external complaint/grievance mechanism;
- Assessment of impacts of civil works on vibration and ground-borne noise levels;
- Definition and planning temporary measures to reduce the negative impact of vibration and ground-borne noise in case it is determined that the construction works will affect the population;
- Definition of vibration monitoring procedure during construction work (definition of number and location of the measuring points, measuring methods, measurement procedure in case of complaints, etc.);
- All construction equipment will comply with the requirements of EU Directive 2000/14/EC (must have CE marking);
- Definition of maximum allowable vibration levels for machinery, equipment and tools that shall be used at the site;
- All construction equipment and vehicles will be maintained in good working order;

- The construction equipment that generates a lot of vibration will be located as far as possible from sensitive receptors;
- External construction access road should avoid passing near residential and other sensitive buildings, where is possible;
- Restriction of the maximum speed on the internal and external construction access roads;
- Maintaining the access roads and/or construction site in good condition to minimize vibration generation;
- Transport and construction management will be used to avoid the cumulative effects of vibration along construction roads and/or construction site;
- Avoid simultaneous use of equipment that generate a lot of vibration;
- The work that makes a lot of vibration near sensitive receptors will be organized in such a way that the exposure time is as short as practicable (schedule and resource planning);
- Whenever feasible, utilize piling equipment with low or non-vibratory methods (such as rotary or bored) rather than impact piling.
- During planning and/or work execution, avoid vibratory compaction and using static force compaction wherever possible (e.g., reduce use of smooth-wheeled or sheepsfoot rollers and similar equipment);
- Selection of demolition methods not involving vibration impact, where is possible.

Before and during the Construction works, the Contractor should carry site inspection to ascertain information on the condition of the Site and the surrounding area, with regards to the construction works and their impact on the environment and the local population, with special regards to sensitive objects. The contractor must determine whether there are other sources of vibrations in the vicinity of the construction site, and if they exist, their levels must be determined by measurements conducted by accredited organizations. A publicly available database with pre-construction vibration and ground-borne noise collected data needs to be established.

The vibration and ground-borne monitoring system must be established within the construction site vicinity, at locations of the most sensitive objects, in order to evaluate the impacts and determine if they exceed the allowable values. Additionally, the system should be used to quantify the impacts by comparing them with the pre-construction conditions. The monitoring system must be in accordance with the dynamics and locations of the construction works along the future railway route.

If complaints arise from local residents despite the presence of an established construction vibration and ground-borne noise monitoring system during the execution of work, additional measurements must be conducted, and further mitigation measures may be necessary.

4.2 Operations Phase

4.2.1 Noise

Noise protection measures are planned for buildings used for residential purposes and for noise-sensitive receptors such as kindergartens, primary and secondary schools, universities, healthcare centres, hospitals and cultural and historical sites. In the planning and implementation of these measures, the operational hours of noise-sensitive facilities are duly considered. In addition to existing structures, future land use plans and potential urban development are also be considered during the calculation and optimisation of noise protection strategies.

Noise protection measures are typically divided into two main categories:

- At source

  This type of noise protection targets noise mitigation at its point of origin. Source-level noise control can be achieved through several measures, including:

  - the use of quieter equipment or machinery
  - regular maintenance to prevent the development of excessive noise
  - reduction of operational speeds
  - modification of timetable during the night, and
  - application of rail dampers and fasteners, among others.

  Quieter equipment or machinery contributes to reducing noise emissions from a railway line primarily during the operational phase, therefore, newer trains that will be used in the future are expected to be designed with noise reduction in mind; considering improved aerodynamics to reduce wind noise, noise insulated bogies and undercarriages, quieter braking systems, electric motors with lower noise outputs, etc.

  However, consistent and comprehensive maintenance of the railway infrastructure and associated equipment will be essential to prevent noise emissions resulting from track degradation.

  While design-phase interventions often focus on infrastructure, as considered in this study, implementing quieter equipment and machinery during the operations phase is essential to ensure long-term and effective noise control throughout the lifecycle of the Project. Consequently, noise protection measures incorporated during the design phase represent only an initial step and a necessary precondition for reducing noise emissions at the source. However, their effectiveness must be reinforced by sound operational practices and continued commitment from both the Railway Infrastructure Manager and Railway Undertakings. Such an integrated approach supports

  adaptation to evolving technologies and compliance with increasingly stringent environmental and regulatory requirements, ultimately contributing to improved living conditions in areas adjacent to the railway corridor.

- Between the source and the receiver

This type of noise protection measure reduce noise by interrupting the propagation of the sound waves, and this way it clearly emphasizes their intervention role. These measures may include:

- the construction of noise barriers positioned between the railway infrastructure and exposed areas.

- At the receiver

Noise protection at the receiver level refers to mitigation measures aimed at reducing the impact of noise after it has been emitted, particularly in areas where sensitive receptors are located, such as residential buildings, educational institutions, or cultural and historical sites, may be affected. These measures may include:

- the soundproofing of buildings through enhanced insulation and the installation of joinery with improved sound insulation and façade with enhanced acoustic performance,
- spatial planning interventions, including the relocation or reclassification of noise-sensitive land uses.

Receiver-oriented measures play a complementary role to source-level noise controls and are particularly important in built-up or acoustically sensitive environments, where exposure to railway noise cannot be fully mitigated at source.

As part of this study, both the soundproofing of buildings and the installation of noise barriers have been proposed, as outlined below. Furthermore, spatial planning interventions are recommended for local authorities in the development and periodic update or new municipal spatial plans.

Noise modelling summary

The following table presents a summary of the results of noise modelling undertaken for both a 15-year rail traffic demand forecast (i.e. in 2045) and a 30-year traffic demand forecast (i.e. in 2060). More details per sub-section are presented in subsequent tables below.

Table 4-1 Noise modelling summary, Paraćin-Stalać and Đunis-Trupale railway sub-sections, 2045 and 2060

Railway section	Noise barrier length [m]		Noise barrier area [m^2]		Number of objects with passive measures	
	Traffic		Traffic		Traffic	
	15-year	30-year	15-year	30-year	15-year	30-year
Paraćin -Stalać	26,348	27,032	89,752	103,515	114	160
Đunis-Trupale	52,064	52,064	236,164	256,670	105	147

When comparing the 30-year traffic scenario (forecast for 2060) to the 15-year traffic scenario (baseline year 2045), notable increases in the scope of noise protection measures were observed. For the Paraćin–Stalać railway sub-section, the total length of noise protection barriers increased by 3%, the surface area of barriers increased by 15%, and the number of buildings requiring passive noise protection measures (soundproofing of buildings) rose by 40%. In the Djunis–Trupale railway sub-section, the total barrier length is the same, barrier surface area by 9%, and the number of passively protected buildings rose significantly by 40%. These increases reflect the projected rise in railway traffic intensity and the corresponding need for enhanced noise mitigation.

Rail dampers and fasteners are proposed in the same locations where the noise barriers are recommended.

As a conclusion with regards to the noise barriers, it is recommended that the Preliminary Design implementation should be based on the 30-year traffic forecast, while installing noise barrier panels appropriate for the 15-year traffic level and the rest for the 30-year traffic (e.g. foundation, profiles, etc.). This approach provides an efficient balance between present requirements and future demands. It ensures cost-effective implementation while maintaining flexibility to upgrade the noise barrier panels in the future, in line with the traffic growth and noise levels actually observed during the line operation.

Noise protection measures 'at source' – rail dampers and rail fasteners

Noise reduction at source has been addressed directly within the modelling process. The input data incorporated technical specifications of new rolling stock, including EMU Stadler KISS and EMU FLIRT units, as well as freight wagons. Furthermore, the design integrates modern railway substructure elements such as i) Elastic rail fasteners, ii) Rail dampers, and iii) Continuous welded rails (CWR) on concrete sleepers. These components contribute to reducing noise and vibration transmission from the track to the surrounding environment.

Rail dampers and rail fasteners are proposed to be implemented along all the locations where either passive noise protection measures (soundproofing of buildings) or noise protection barriers are implemented.

Rail dampers (also called track dampers) are proposed to be installed directly on the track, either on the rails or on the ties (sleepers). They work by absorbing and dissipating the energy that is generated when the wheels pass over the rails, thereby reducing the vibration and noise caused by the wheel-rail interaction. This measure must be incorporated into the Preliminary design and elaborated in detail in the next phase of the design process – the Design for Construction Permit.

Rail fasteners are proposed to securely attach the rails to the track infrastructure, ensuring stable and proper alignment of the track. They are proposed to reduce vibrations and improve track integrity, indirectly contributing to noise reduction by reducing the movement and friction that leads to noise.

Expected noise reduction from using rail dampers is typically 3–7 dB(A), most commonly around 3 dB(A), while resilient rail fasteners can contribute to noise reduction in the range of 3–5 dB(A). It is recommended, as justified by the noise modelling in this study, to install both rail dampers and rail fasteners along the same chainages where noise barriers are proposed to be installed, as presented below in Table 4-2 and

Table 4-3 for Paraćin-Stalać sub-section and in Table 4-4 and *Objects that could be replaced with passive measures based on the cost-effectiveness assessment undertaken under Step 2, which requires confirmation/modelling at the next level of design, i.e. within the design for construction permit, and after the development of the detailed cost estimate for the noise barriers and passive measures applied at the sensitively affected buildings.

** Based on Step 4, and the assessments done within the ESIA's chapter Landscape and Visual Impact Assessment, these noise barriers should be transparent, and therefore up to 46 sensitive buildings need to be protected more in addition to presented in Table 4-8.

Table 4-5 for Đunis-Trupale sub-section. From an engineering standpoint, there is no conflict in installing these elements concurrently at the same location, as rail fasteners and dampers are track-integrated, and noise barriers are placed beside the track on separate foundations. Space constraints (e.g. in urban environments) may affect barrier placement, but not the installation of dampers or fasteners. In some cases, acoustic modelling may recommend that rail dampers or fasteners extend slightly beyond the start or end points of noise barriers (by a few tens of meters but the detailed analyses in the next design phases will determine the required extent), to minimize edge effects, where sound might escape around the beginning or end of a barrier, and it needs to be elaborated in detail during the next design phase – Design for Construction Permit.

Noise protection measures 'between the source and the receiver'– noise barriers

Noise barriers are considered to be the primary mitigation measure for addressing exceedances of regulatory noise threshold levels. To maximise their effectiveness, barriers must be positioned as close to the noise source as technically feasible. In the case of railway infrastructure, the minimum offset is calculated from the track axis and varies based on train speeds:

- 3.30 metres for operational speeds up to 160 km/h
- 4.00 metres for operational speeds exceeding 160 km/h

The expected noise attenuation achieved by noise barriers ranges from 5 to 15 dB, depending on several factors, including: i) barrier height, ii) distance between the barrier and the protected building, and iii) elevation difference between the barrier and the receptor.

It is important to note that barrier efficiency decreases with increasing building height, making it more challenging to protect upper floors effectively.

The consultant has undertaken the following cost-effectiveness analysis:

- Step 1: Cost-effectiveness assessment of the protection of affected building: soundproofing vs noise barriers.
- Step 2: Cost-effectiveness assessment undertaken for set of buildings identified as sensitive to soundproofing price.

- Step 3: Cost-effectiveness assessment of selected locations with the highest length and area covered by the noise barriers per protected buildings.
- Step 4: Visual impact & Cost-effectiveness assessment: Assessment of the cost effectiveness of applying fully transparent noise barriers at the selected locations with visual impact.

Detailed specifications for each noise barrier, including start and end points, heights, lengths, and surface areas, are provided in Table 4-2 and

Table 4-3 for Paraćin-Stalać subsection and in Table 4-4 and *Objects that could be replaced with passive measures based on the cost-effectiveness assessment undertaken under Step 2, which requires confirmation/modelling at the next level of design, i.e. within the design for construction permit, and after the development of the detailed cost estimate for the noise barriers and passive measures applied at the sensitively affected buildings.

** Based on Step 4, and the assessments done within the ESIA's chapter Landscape and Visual Impact Assessment, these noise barriers should be transparent, and therefore up to 46 sensitive buildings need to be protected more in addition to presented in Table 4-8.

Table 4-5 for Đunis-Trupale subsection.

Table 4-2. List of recommended noise barriers, Paraćin-Stalać sub-section, 2045 traffic

Barrier No.	Settlement/ Municipality	Railway line chainage		Position in relation to railway line	Height	Length	Area	No. of Protected Objects
		start point	end point					
		[km]	[km]		[m]	[m]	[m²]	
1	Paraćin	153+628.00	154+248.00	Left	3.5-4	620	2,278	22
2	Paraćin	154+546.00	154+958.00	Left	6	412	2,472	161
3	Paraćin	155+250.00	155+530.00	Right	5.5	280	1,540	82
4	Paraćin	155+158.00	155+358.00	Left	5.5	200	1,100	80
5	Paraćin/Striža	155+401.00	159+670.00	Left	2-6	4,272	14,996	528
6	Paraćin	155+566.00	157+482.00	Right	1-5.5	1,916	5,896	262
7	Striža	158+255.00	159+967.00	Right	1-3	1,712	3,074	109
8	Ratare	161+525.00	163+045.00	Right	1.5-4	1,520	3,970	131
9	Ratare	161+764.00	162+780.00	Left	2-3	1,016	2,884	58
10*	Sikirica	163+621.00	164+061.00	Right	4.5	440	1,980	7
11	Sikirica/Drenovac	164+230.00	165+590.00	Right	2-4.5	1,360	3,608	131
12	Drenovac/Pojate	165+459.00	168+347.00	Left	1.5-4.5	2,888	8,870	294
13	Drenovac/Pojate	165+971.00	168+355.00	Right	2.5-4.5	2,384	9,658	252
14	Ćićevac	169+816.00	170+500.00	Right	2-4	684	1,894	17
15	Ćićevac	169+772.00	171+356.00	Left	1-4.5	1,584	4,904	91
16	Ćićevac	171+018.00	171+366.00	Right	5.5	348	1,914	23
17	Ćićevac	171+279.00	174+175.00	Left	2.5-7	2,896	12,318	468
18	Ćićevac /Lučina	171+468.00	172+292.00	Right	1.5-4.5	824	2,562	94
19	Lučina	173+178.00	174+170.00	Right	2-4.5	992	3,834	49
Total						26,348	89,752	2,859

*Objects that could be replaced with passive measures based on the cost-effectiveness assessment undertaken under Step 2, which requires confirmation/modelling at the next level of design, i.e. within the design for construction permit, and after the development of the detailed cost estimate for the noise barriers and passive measures applied at the sensitively affected buildings..

Table 4-3: List of recommended noise barriers, Paraćin-Stalać sub-section, 2060 traffic

Barrier No.	Settlement/ Municipality	Railway line chainage start point [km]	Railway line chainage end point [km]	Position in relation to railway line	Height [m]	Length [m]	Area [m²]	No. of Protected Objects
1	Paraćin	153+628.00	154+248.00	Left	4-6	620	2,912	22
2	Paraćin	154+546.00	154+958.00	Left	6.5	412	2,678	185
3	Paraćin	155+250.00	155+530.00	Right	6.5	280	1,820	96
4	Paraćin	155+158.00	155+358.00	Left	6	200	1,200	88
5	Paraćin /Striža	155+401.00	159+670.00	Left	2.5-6.5	4,272	17,296	569
6	Paraćin	155+566.00	157+482.00	Right	1.5-6.5	1,916	7,004	280
7	Striža	158+255.00	159+967.00	Right	1.5-3.5	1,712	3,401	114
8	Ratare	161+525.00	163+045.00	Right	2-5	1,520	4,530	141
9	Ratare	161+540.00	162+780.00	Left	2-3.5	1,240	3,686	59
10*	Sikirica	163+621.00	164+061.00	Right	5.5	440	2,420	8
11	Sikirica/Drenovac/Pojate	164+151.00	168+355.00	Right	1.5-5.5	4,204	15,592	395
12	Drenovac/Pojate	165+459.00	168+347.00	Left	1.5-5.5	2,888	10,252	305
13	Ćićevac	169+816.00	170+500.00	Right	2.5-4	684	1,990	17
14	Ćićevac	169+772.00	171+356.00	Left	2-4.5	1,584	5,236	101
15	Ćićevac	171+018.00	171+366.00	Right	6.5	348	2,262	23
16	Ćićevac	171+279.00	174+175.00	Left	2.5-7.5	2,896	13,442	508
17	Ćićevac /Lučina	171+468.00	172+292.00	Right	2-5	824	3,172	108
18	Lučina	173+178.00	174+170.00	Right	3-5.5	992	4,622	49
Total						27,032	103,515	3,056

*Objects that could be replaced with passive measures based on the cost-effectiveness assessment undertaken under Step 2, which requires confirmation/modelling at the next level of design, i.e. within the design for construction permit, and after the development of the detailed cost estimate for the noise barriers and passive measures applied at the sensitively affected buildings.

Table 4-4: List of recommended noise barriers, Đunis-Trupale sub-section, 2045 traffic

Barrier No.	Settlement/ Municipality	Railway line chainage start point [km]	Railway line chainage end point [km]	Position in relation to railway line	Height [m]	Length [m]	Area [m²]	No. of Protected Objects
1**	Vitkovac	193+501.00	194+713.00	Right	3.5-7	1,212	6,302	110
2**	Vitkovac/Donji Ljubes	193+417.00	196+721.00	Left	2-7	3,304	14,074	417
3	Donji Ljubes/Srezovac/ Gornji Ljubes	195+080.00	198+724.00	Right	2-7	3,644	16,696	194
4	Srezovac/Gornji Ljubes/ Korman	197+044.00	200+708.00	Left	3-7.5	3,664	14,488	262
5**	Korman/Trnjane	199+431.00	204+427.00	Right	2-7.5	4,996	26,122	380
6	Korman	200+817.00	201+181.00	Left	3.5-5	364	1,586	20
7**	Korman/Trnjane	201+440.00	204+284.00	Left	3-7.5	2,844	14,496	310
8*	Tranjane/Donji Adrovac	204+880.00	205+460.00	Right	6.5	580	3,770	6
9**	Donji Adrova/Pricilovica/ Zitkovac	205+422.00	208+922.00	Left	4-7	3,500	18,720	446
10**	Pricilovica/Zitkovac/ Moravac	207+589.00	211+297.00	Right	3.5-7.5	3,708	22,206	613
11	Zitkovac	208+935.00	209+091.00	Left	6	156	936	57
12**	Zitkovac/Moravac/Nozrina/ Luzane	209+350.00	213+738.00	Left	2.5-6.5	4,388	19,510	358
13	Nozrina/Luzane	212+091.00	213+215.00	Right	1-3	1,124	2,252	26
14*	Luzane	213+451.00	213+831.00	Right	5	380	1,900	7
15	Luzane	213+813.00	214+485.00	Left	3.5-5	672	2,772	37
16	Tesica	215+401.00	216+857.00	Left	1.5-3.5	1,456	3,288	68
17	Tesica	216+517.00	217+129.00	Right	3-6.5	612	3,698	39
18	Tesica/Grejac	216+935.00	218+519.00	Left	3-7.5	1,584	6,988	138
19	Tesica/Grejac	217+397.00	218+405.00	Right	3-7.5	1,008	5,150	67
20	Grejac/Veliki Drenovac/ Supovac/Mezgraja	218+539.00	223+553.00	Right	2-5.5	5,016	16,860	439
21*	Grejac	219+424.00	220+220.00	Left	2,5-4	796	2,456	13
22	Supovac/Mezgraja	223+077.00	224+413.00	Left	2-4.5	1,336	4,412	126
23	Mezgraja/Vrtiste	223+891.00	224+607.00	Right	4	716	2,864	51
24	Vrtiste/Tupale	226+603.00	228+063.00	Right	1.5-7.5	1,460	5,838	196
25-1	Vrtiste/Tupale	226+742.00	228+022.00	Left	3-6.5	1,280	5.736	40
25-2	Vrtiste/Tupale	228+456.00	228+860.00	Left	3.5-5.5	404	1.846	11
26	Trupale	228+438.00	229+638.00	Right	4-7.5	1,200	6,358	74
27	Trupale	228+956.00	229+036.00	Left	6	80	480	7
28	Trupale	229+062.00	229+642.00	Left	5.5-7.5	580	3,820	18
Total						52,064	236,164	4,530

*Objects that could be replaced with passive measures based on the cost-effectiveness assessment undertaken under Step 2, which requires confirmation/modelling at the next level of design, i.e. within the design for construction permit, and after the development of the detailed cost estimate for the noise barriers and passive measures applied at the sensitively affected buildings.

** Based on Step 4, and the assessments done within the ESIA's chapter Landscape and Visual Impact Assessment, these noise barriers should be transparent, and therefore up to 46 sensitive buildings need to be protected more in addition to presented in Table 4-8.

Table 4-5: List of recommended noise barriers, Đunis-Trupale sub-section, 2060 traffic

		start point	end point					
		[km]	[km]		[m]	[m]	[m^2]	
1**	Vitkovac	193+501.00	194+713.00	Right	3.5-7	1,212	6,692	110
2**	Vitkovac/Donji Ljubes	193+417.00	196+721.00	Left	3-7	3,304	15,226	429
3	Donji Ljubes/Srezovac/ Gornji Ljubes	195+080.00	198+724.00	Right	2.5-7	3,644	17,956	195
4	Srezovac/Gornji Ljubes/ Korman	197+044.00	200+708.00	Left	3-7.5	3,664	15,786	262
5**	Korman/Trnjane	199+431.00	204+427.00	Right	3-7.5	4,996	27,730	387
6	Korman	200+817.00	201+181.00	Left	4.5-5	364	1,742	20
7**	Korman/Trnjane	201+440.00	204+284.00	Left	3.5-7.5	2,844	15,442	319
8*	Tranjane/Donji Adrovac	204+880.00	205+460.00	Right	7	580	4,060	6
9**	Donji Adrova/Pricilovica/ Zitkovac	205+422.00	208+922.00	Left	5-7.5	3,500	20,496	460
10**	Pricilovica/Zitkovac/ Moravac	207+589.00	211+297.00	Right	4.5-7.5	3,708	24,168	632
11	Zitkovac	208+935.00	209+091.00	Left	6	156	936	66
12**	Zitkovac/Moravac/Nozrina/ Luzane	209+350.00	213+738.00	Left	3-7	4,388	21,684	363
13	Nozrina/Luzane	212+091.00	213+215.00	Right	2-3	1,124	2,812	26
14*	Luzane	213+451.00	213+831.00	Right	5	380	1,900	7
15	Luzane	213+813.00	214+485.00	Left	4-5	672	2,968	37
16	Tesica	215+401.00	216+857.00	Left	2-5	1,456	4,016	73
17	Tesica	216+517.00	217+129.00	Right	4-7	612	4,044	39
18	Tesica/Grejac	216+935.00	218+519.00	Left	3-7.5	1,584	7,196	139
19	Tesica/Grejac	217+397.00	218+405.00	Right	4-7.5	1,008	5,370	70
20	Grejac/Veliki Drenovac/ Supovac/Mezgraja	218+539.00	223+553.00	Right	2-6	5,016	17,744	443
21*	Grejac	219+424.00	220+220.00	Left	3-4	796	2,864	13
22	Supovac/Mezgraja	223+077.00	224+413.00	Left	2.5-5	1,336	5,080	129
23	Mezgraja/Vrtiste	223+891.00	224+607.00	Right	4.5	716	3,222	53
24	Vrtiste/Tupale	226+603.00	228+063.00	Right	2.5-7	1,460	6,790	209
25-1	Vrtiste/Tupale	226+742.00	228+022.00	Left	4-7	1,280	6,666	40
25-2	Vrtiste/Tupale	228+458.00	228+860.00	Left	4.5-6	404	2,142	11
26	Trupale	228+438.00	229+638.00	Right	5-7.5	1,200	7,558	76
27	Trupale	228+956.00	229+036.00	Left	6	80	480	7

28	Trupale	229+062.00	229+642.00	Left	3-7	580	3,900	23
Total						52,064	256,670	4,644

*Objects that could be replaced with passive measures based on the cost-effectiveness assessment undertaken under Step 2, which requires confirmation/modelling at the next level of design, i.e. within the design for construction permit, and after the development of the detailed cost estimate for the noise barriers and passive measures applied at the sensitively affected buildings.

** Based on Step 4, and the assessments done within the ESIA's chapter Landscape and Visual Impact Assessment, these noise barriers should be transparent, and therefore 46 sensitive buildings need to be protected more in addition to presented in Table 4-9.

The layouts and spatial distribution of the proposed noise barriers are presented in graphical documentation in annexes, 7.7 and 7.8 for Paraćin-Stalać subsection, and in 7.9 and 7.10 for Đunis-Trupale subsection. These figures illustrate the required dimensions, both length and height, necessary to achieve compliance with applicable noise standards (i.e. WHO noise thresholds) by effectively mitigating railway traffic noise. The layouts represent a preliminary draft, and the precise locations and heights of each barrier, identified by chainage, will be further detailed within the Preliminary Design documentation.

However, final specifications, including barrier materials and any required adjustments to their dimensions, shall be defined during the Design for Construction Permit phase. As part of the Design for Construction Permit, the noise model must be updated by the Contractor to account for the updated design, including any changes from the preliminary design. Additionally, this will include an update to the noise co-efficient to account for site-specifiic socil conditions, with special attention given to urban areas, where the coefficient may be slightly lower than 1.0 due to the presence of numerous paved surfaces. In addition, a detailed cost-effectiveness assessment of the proposed noise protection measures must be conducted. This assessment should be based on the detailed design costs for building soundproofing, noise barrier installation, and the specifications of noise protection equipment at the source. Based on the results, noise modelling should be performed to optimize the proposed measures within the Environmental and Social Impact Assessment (ESIA). Where feasible, transparent barriers (e.g., 1 meter in height) should be integrated at the appropriate height of the absorptive noise barriers, including an additional protection for sensitive buildings affected by the inclusion of transparent panels at the appropriate height of the absorptive noise barriers, which must be modelled in detail within the Design for Construction Permit. This approach aims to reduce the visual impact along the railway line for both passengers and local residents, while also requiring additional protection for sensitive buildings affected by the inclusion of transparent panels.

It is also recommended that, during the next design phase (Design for Construction Permit), a detailed assessment be carried out in coordination with the rail infrastructure manager and railway undertakings. This should include a review of their long-term plans (up to 2045 and 2060) for future rolling stock, provided such information is readily available. This will allow for the appropriate adjustment of brake system specifications, if necessary.

This process will necessitate continued coordination and consultation with relevant design teams until the moment of submission and then approval of the Preliminary Design by the State Revision Committee, including those responsible for stations, culverts, retaining walls, track alignment, structures, catenary systems, telecommunications, and geotechnical assessments. This will ensure integration and resolve any potential technical conflicts. Upon resolution of all such conflicts, the finalised noise barrier layout will be established.

The heights of the noise barriers from the tables above shall be measured relative to the head of the rail. Additionally, all noise barriers must be constructed using absorption materials.

The extensive implementation of noise barriers is justified by the high frequency of scheduled train operations, their operational speeds, and the necessity to comply with World Health Organization (WHO) noise threshold guidelines, particularly given the presence of numerous residential areas situated along the alignment.

The WHO standards however represent guidance and further refinement if and where needed can be undertaken as described above.

The design of noise barriers shall comply with provisions of the National and European legislation, as well as corresponding standards:

- COMMISSION REGULATION (EU) No. 1304/2014 on the technical specification for interoperability relating to the subsystem “rolling stock — noise” and its consolidated version from 28/09/2023;
- SRPS EN 16272-1, Railway applications - Track - Noise barriers and related devices acting on airborne sound propagation - Test method for determining the acoustic performance - Part 1: Intrinsic characteristics - Sound absorption in the laboratory under diffuse sound field conditions;
- SRPS EN 16272-2, Railway applications - Track - Noise barriers and related devices acting on airborne sound propagation - Test method for determining the acoustic performance - Part 2: Intrinsic characteristics - Airborne sound insulation in the laboratory under diffuse sound field conditions;
- SRPS EN 16272-3-1, Railway applications - Track - Noise barriers and related devices acting on airborne sound propagation - Test method for determining the acoustic performance - Part 3-1: Normalized railway noise spectrum and single number ratings for diffuse field applications;
- SRPS EN 16272-3-2, Railway applications - Track - Noise barriers and related devices acting on airborne sound propagation - Test method for determining the acoustic performance - Part 3-2: Normalized railway noise spectrum and single number ratings for direct field applications;
- SRPS EN 16727-1, Railway applications - Track - Noise barriers and related devices acting on airborne sound propagation - Non-acoustic performance - Part 1: Mechanical performance under static loadings - Calculation and test method;
- SRPS EN 16727-2-1, Railway applications - Track - Noise barriers and related devices acting on airborne sound propagation - Non-acoustic performance - Part 2-1: Mechanical performance under dynamic loadings due to passing trains - Resistance to fatigue;
- SRPS EN 16727-2-2, Railway applications - Track - Noise barriers and related devices acting on airborne sound propagation - Non-acoustic performance - Part 2-2: Mechanical performance under dynamic loadings caused by passing trains - Calculation method;
- SRPS EN 16727-3, Railway applications - Track - Noise barriers and related devices acting on airborne sound propagation - Non-acoustic performance - Part 3: General safety and environmental requirements;

- SRPS EN 16951-1, Railway applications - Track - Noise barriers and related devices acting on airborne sound propagation - Procedures for assessing long term performance - Part 1: Acoustic characteristics;
- SRPS EN 16951-2, Railway applications - Track - Noise barriers and related devices acting on airborne sound propagation - Procedures for assessing long term performance - Part 2: Non-acoustic characteristics.

Additional guidelines recommended below will also be followed:

- DB Netz AG Guideline 804: Railway bridges (and other civil engineering structures);
- ZT-LSW 06: Additional technical contractual requirements for noise barriers;
- RVE 04.01.01 Noise barriers – calculation and design;
- Eurocode 1: Actions on structures;
- Eurocode 3: Design of steel structures;
- Eurocode 9: Design of aluminium structures.

The acoustic panels that will be used for noise barriers shall have sound absorption of minimum 12 dB (class A4 in accordance with SRPS EN 16272-1) and soundproofing of minimum 25 dB (class B3 in accordance with SRPS EN 16272-2).

All elements of noise barriers shall be grounded. The efficiency of the grounding system for the chosen type of noise barriers shall be verified by professional accredited institution. The lightning charge current test shall be carried out to reach the effective value of 40 kA and pulse duration of 100 ms minimum. All acoustic panels shall have Integrated earthing system.

In the zones of traction substations, noise barriers with doors should be provided to allow communication with the tracks. Extra attention should be given during the installation of noise barriers in the switch zone to ensure their proper operation.

The acoustic panels shall have service life of minimum 20 years without major changes in their acoustic and non-acoustic performances.

The acoustic panels and/or complete noise barriers must be suitable for installation alongside railway lines with a maximum permitted speed of up to 200 km/h.

Noise barriers will be designed and located with consideration of the visual impacts as specified in the Landscape and Visual Impact Assessment Chapter.

For noise barriers longer than 600 meters, it is necessary to provide emergency exits and adequate access paths at intervals of 300 meters. All emergency exits should be clearly marked with appropriate pictograms. If doors are used for emergency exits, they must be equipped with anti-panic locks that open only from the railway line side. The doors should be integrated into the noise barrier and the entire system should be soundproofed, ensuring that the doors remain closed for the proper functioning of the noise barrier.

Noise protection measures 'at the receiver' – passive protection measures

Soundproofing at the receiver, i.e., passive noise protection measures applied to buildings, is considered a mitigation strategy for addressing exceedances of regulatory noise thresholds, either as a complement to noise barriers or as a standalone solution. According to Table 2-2 limit values inside residential buildings that should be achieved for day and evening period are 35 dB(A) and for night period 30 dB(A).

As presented in Table 4-1 there are in total 114 buildings with applied passive measures for Paraćin-Stalać in 2045, and 160 objects in 2060, while for Djunis-Trupale section 105 and 147 respectively.

Detailed locations for each recommended passive measures are provided in the Table 4-6 and Table 4-7 for section Paraćin-Stalać and in the Table 4-8 and Table 4-9 for section Djunis-Trupale.

Table 4-6 List of recommended passive protection measures at buildings, Paraćin-Stalać sub-section, 2045 traffic

No. of building	Chainage	Position in relation to railway line	No. of building	Chainage	Position in relation to railway line	No. of building	Chainage	Position in relation to railway line
1	153+710	R	39	155+100	L	77	155+490	R
2	154+310	R	40	155+100	L	78	155+520	R
3	154+340	L	41	155+100	L	79	155+520	R
4	154+360	L	42	155+120	L	80	155+530	R
5	154+470	L	43	155+120	L	81	155+540	R
6	154+500	L	44	155+130	L	82	155+540	R
7	154+470	L	45	155+130	L	83	155+560	R
8	154+470	L	46	155+140	L	84	155+560	R
9	154+470	L	47	155+140	L	85	155+570	R
10	154+470	L	48	155+150	L	86	155+560	R
11	154+490	L	49	155+150	L	87	155+570	R
12	154+500	L	50	155+160	L	88	155+950	R
13	154+510	L	51	155+160	L	89	163+460	L
14	154+520	L	52	155+160	L	90	163+480	L
15	154+520	L	53	155+180	L	91	163+490	L
16	154+510	L	54	155+190	L	92	163+540	L
17	154+530	L	55	155+210	L	93	163+530	L
18	154+550	L	56	155+120	R	94	163+520	L
19	154+540	L	57	155+150	R	95	163+540	L
20	154+550	L	58	155+160	R	96	163+730	L
21	154+890	L	59	155+170	R	97	163+820	L
22	154+930	L	60	155+170	R	98	163+680	L
23	154+960	L	61	155+180	R	99	170+470	L
24	154+980	L	62	155+270	R	100	170+560	L
25	155+000	L	63	155+270	R	101	171+320	L
26	155+000	L	64	155+280	R	102	171+330	L
27	155+010	L	65	155+330	L	103	171+380	L
28	155+030	L	66	155+350	L	104	171+410	L
29	155+010	L	67	155+370	L	105	171+450	L
30	155+030	L	68	155+390	L	106	171+460	L
31	155+040	L	69	155+420	L	107	171+380	R
32	155+050	L	70	155+420	L	108	171+410	R
33	155+050	L	71	155+440	L	109	171+460	R
34	155+060	L	72	155+370	R	110	171+490	R
35	155+060	L	73	155+380	R	111	171+490	R
36	155+060	L	74	155+390	R	112	171+500	R
37	155+090	L	75	155+450	R	113	171+510	R
38	155+070	L	76	155+480	R	114	171+670	L

Table 4-7 List of recommended passive protection measures at buildings, Paraćin-Stalać sub-section, 2060 traffic

No	Chainage	Position in relation to railway line	No	Chainage	Position in relation to railway line	No	Chainage	Position in relation to railway line	No	Chainage	Position in relation to railway line
1	153+710	R	43	155+000	L	85	155+440	L	127	163+460	L
2	154+200	L	44	155+010	L	86	155+440	L	128	163+480	L
3	154+340	L	45	155+020	L	87	155+080	R	129	163+490	L
4	154+360	L	46	155+010	L	88	155+180	R	130	163+540	L
5	154+360	L	47	155+020	L	89	155+230	R	131	163+530	L
6	154+470	L	48	155+030	L	90	155+260	R	132	163+730	L
7	154+470	L	49	155+060	L	91	155+270	R	133	163+820	L
8	154+470	L	50	155+060	L	92	155+120	R	134	163+680	L
9	154+490	L	51	155+050	L	93	155+150	R	135	170+470	L
10	154+520	L	52	155+060	L	94	155+170	R	136	170+560	L
11	154+510	L	53	155+070	L	95	155+180	R	137	171+380	R
12	154+520	L	54	155+070	L	96	155+190	R	138	171+400	R
13	154+570	L	55	155+080	L	97	155+290	R	139	171+410	R
14	154+470	L	56	155+070	L	98	155+300	R	140	171+460	R
15	154+470	L	57	155+100	L	99	155+310	R	141	171+490	R
16	154+470	L	58	155+100	L	100	155+320	R	142	171+490	R
17	154+490	L	59	155+100	L	101	155+320	R	143	171+500	R
18	154+500	L	60	155+130	L	102	155+310	R	144	171+510	R
19	154+510	L	61	155+150	L	103	155+260	R	145	171+320	L
20	154+510	L	62	155+120	L	104	155+300	R	146	171+330	L
21	154+540	L	63	155+130	L	105	155+270	R	147	171+330	L
22	154+550	L	64	155+130	L	106	155+280	R	148	171+380	L
23	154+580	L	65	155+150	L	107	155+300	R	149	171+380	L
24	154+530	L	66	155+140	L	108	155+360	R	150	171+400	L
25	154+540	L	67	155+160	L	109	155+370	R	151	171+410	L
26	154+550	L	68	155+160	L	110	155+390	R	152	171+430	L
27	154+550	L	69	155+170	L	111	155+450	R	153	171+450	L
28	154+550	L	70	155+170	L	112	155+480	R	154	171+480	L
29	154+520	L	71	155+180	L	113	155+490	R	155	171+500	L
30	154+520	L	72	155+190	L	114	155+510	R	156	171+510	L
31	154+310	R	73	155+180	L	115	155+520	R	157	171+630	L
32	154+800	L	74	155+220	L	116	155+530	R	158	171+680	L
33	154+890	L	75	155+220	L	117	155+540	R	159	171+760	L
34	154+890	L	76	155+210	L	118	155+550	R	160	154+470	L
35	154+880	L	77	155+220	L	119	155+560	R			
36	154+890	L	78	155+320	L	120	155+560	R			
37	154+910	L	79	155+330	L	121	155+570	R			
38	154+930	L	80	155+340	L	122	155+560	R			
39	154+960	L	81	155+360	L	123	155+570	R			
40	154+980	L	82	155+390	L	124	155+950	R			
41	154+980	L	83	155+420	L	125	163+520	L			
42	155+000	L	84	155+420	L	126	163+530	L			

Table 4-8 List of recommended passive protection measures at buildings, Đunis-Trupale sub-section, 2045 traffic

No. of building	Chainage	Position in relation to railway line	No. of building	Chainage	Position in relation to railway line	No. of building	Chainage	Position in relation to railway line
1	199+890	L	36	209+240	L	71	217+150	R
2	200+460	L	37	209+270	L	72	217+150	R
3	200+520	L	38	209+310	L	73	217+160	R
4	200+670	L	39	209+330	L	74	217+170	R
5	200+670	L	40	209+380	L	75	217+200	R
6	200+670	L	41	209+200	L	76	217+220	R
7	200+690	L	42	209+230	L	77	217+200	R
8	200+690	L	43	209+240	L	78	217+220	R
9	200+690	L	44	209+260	L	79	217+260	R
10	200+720	L	45	209+270	L	80	217+230	R
11	200+740	L	46	209+300	L	81	217+240	R
12	200+740	L	47	209+300	L	82	217+310	R
13	200+740	L	48	209+310	L	83	217+270	R
14	200+800	L	49	209+330	L	84	217+310	R
15	200+850	L	50	209+350	L	85	217+360	R
16	200+850	L	51	209+370	L	86	217+390	R
17	200+860	L	52	209+260	R	87	217+400	R
18	200+860	L	53	209+280	R	88	217+410	R
19	200+870	L	54	213+750	L	89	217+410	R
20	200+870	L	55	213+780	L	90	217+470	R
21	202+560	L	56	213+800	L	91	217+450	R
22	202+600	L	57	216+900	L	92	217+470	R
23	202+580	L	58	216+900	L	93	227+310	L
24	202+550	L	59	216+920	L	94	227+440	L
25	205+430	R	60	216+930	L	95	228+840	L
26	208+850	L	61	216+940	L	96	228+860	L
27	208+860	L	62	216+970	L	97	228+930	L
28	208+920	L	63	217+000	L	98	228+930	L
29	208+920	L	64	217+070	R	99	228+970	L
30	208+930	L	65	217+100	R	100	229+010	L
31	208+960	L	66	217+100	R	101	229+020	L
32	208+980	L	67	217+100	R	102	229+070	L
33	209+130	L	68	217+100	R	103	229+080	L
34	209+210	L	69	217+120	R	104	228+970	R
35	209+230	L	70	217+140	R	105	209+240	L

Table 4-9 List of recommended passive protection measures at buildings, Đunis-Trupale sub-section, 2060 traffic

No	Chainage	Position in relation to railway line	No	Chainage	Position in relation to railway line	No	Chainage	Position in relation to railway line	No	Chainage	Position in relation to railway line
1	193+890	R	43	208+980	L	85	216+900	L	127	217+480	R
2	194+060	L	44	208+990	L	86	216+900	L	128	217+480	R
3	195+380	R	45	209+060	L	87	216+920	L	129	217+470	R
4	196+980	R	46	209+070	L	88	216+930	L	130	217+470	R
5	199+890	L	47	209+130	L	89	216+940	L	131	217+450	R
6	200+460	L	48	209+200	L	90	216+970	L	132	217+410	R
7	200+520	L	49	209+210	L	91	217+000	L	133	217+400	R
8	200+650	R	50	209+210	L	92	217+060	L	134	226+860	R
9	200+670	L	51	209+230	L	93	217+060	L	135	226+870	R
10	200+670	L	52	209+240	L	94	217+100	R	136	227+310	L
11	200+670	L	53	209+240	L	95	217+100	R	137	227+440	L
12	200+690	L	54	209+230	L	96	217+100	R	138	228+840	L
13	200+690	L	55	209+240	L	97	217+060	R	139	228+860	L
14	200+690	L	56	209+260	L	98	217+100	R	140	228+930	L
15	200+720	L	57	209+270	L	99	217+100	R	141	228+930	L
16	200+740	L	58	209+300	L	100	217+120	R	142	228+970	R
17	200+740	L	59	209+300	L	101	217+140	R	143	228+970	L
18	200+740	L	60	209+270	L	102	217+150	R	144	229+010	L
19	200+800	L	61	209+310	L	103	217+150	R	145	229+020	L
20	200+850	L	62	209+310	L	104	217+160	R	146	229+070	L
21	200+850	L	63	209+330	L	105	217+140	R	147	229+080	L
22	200+860	L	64	209+330	L	106	217+160	R			
23	200+860	L	65	209+350	L	107	217+170	R			
24	200+870	L	66	209+350	L	108	217+200	R			
25	200+870	L	67	209+370	L	109	217+200	R			
26	200+890	L	68	209+380	L	110	217+200	R			
27	202+550	L	69	209+260	R	111	217+220	R			
28	202+580	L	70	209+280	R	112	217+220	R			
29	202+600	L	71	213+620	L	113	217+270	R			
30	202+920	L	72	213+720	L	114	217+310	R			
31	203+780	R	73	213+750	L	115	217+250	R			
32	205+430	R	74	213+760	L	116	217+260	R			
33	207+570	L	75	213+770	L	117	217+280	R			
34	208+850	L	76	213+790	L	118	217+280	R			
35	208+860	L	77	213+800	L	119	217+290	R			
36	208+870	L	78	213+820	L	120	217+350	R			
37	208+910	L	79	213+850	L	121	217+360	R			
38	208+920	L	80	213+850	L	122	217+390	R			
39	208+920	L	81	213+920	L	123	217+400	R			
40	208+930	L	82	213+940	L	124	217+410	R			
41	208+960	L	83	216+870	L	125	217+410	R			
42	208+970	L	84	216+890	L	126	217+470	R			

The total number of objects identified for demolition in the Resettlement Framework Policy is a subject to refinement. Noise maps presented in appendices of this report illustrate all structures identified by the consultant using detailed topographic maps, the official cadastre of Serbia (GeoSrbija), orthophotomaps developed for project purposes, and Googlemaps. The design team was consulted to review the identified objects based on these inputs, focusing specifically on those located within the regulation line. As a conclusion, it is important to note that the number of objects marked for demolition, as well as those remaining, may differ from the initial figures presented in the Resettlement Framework Policy. This variance may result from further design development and the influence of the land acquisition process. Therefore, it is recommended that the number of affected objects by noise and vibration be reviewed and updated during subsequent design phases, particularly during the development of the Design for Construction Permit phase, and once the full extent of land acquisition is confirmed. Update report with this conclusion. This conclusion also applies to the vibration impact.

The final mitigations for operational railways noise including at source mitigations; the location and specification of noise barriers and mitigations at receptors (e.g. insultation at properties) will be developed during the Design for Construction Permit/Detailed Design and will be based on the results of consultations with affected communities and further design development and optimization to ensure a balance between techno-economic feasibility of noise protection measures, potential noise benefits and visual impacts is reached, considering the necessarily noise limits which need to be achieved (limits in Serbian legislation must be met; in accordance with good international practice all technically and financially feasible, and cost-effective measures, will be identified and considered as part of the project design, to minimize noise impacts, to align with WHO guidance).

The newly built noise barriers shall be visually inspected to prove that they are free of any defect or damage. Acoustic control of noise barriers shall be carried out before the railway line becomes operational. An adequate number of measurements will be carried out to demonstrate the effectiveness of the new noise barriers based on the obtained results. Moreover, all noise barriers shall be subjected to measurements to obtain values for sound diffraction and reflection, and isolation of airborne sound fully in compliance with ISO 10847, SRPS EN 16272-4, SRPS EN 16272-5, SRPS EN 16272-6 and SRPS CEN/TS 16272-7 standards.

The condition of tracks and rolling stock has the biggest impact on railway noise emission and therefore the regular maintenance is planned as one of the most important noise suppression measures. The planned noise barriers will fulfil their main function only if the tracks and rolling stock are in good condition and undergo regular maintenance.

The SRI should develop an Operational Noise Management Plan to prevent negative operations noise impacts along the railway alignment. The SRI should implement a complaint/grievance mechanism during the operations phase to receive, investigate and respond to complaints including those related to noise. Depending on the results of such investigations, additional mitigation measures may be taken.

4.2.2 Vibration and ground-borne noise

Various mitigation measures can be applied to suppress and/or reduce the negative effects of vibration and ground-borne noise. The mitigation measures can be applied in all three parts of the railway system: i) on the vehicle, ii) on the track and iii) on the transmission path (that is generally soil). Based on the outputs of the conducted vibration modelling for the Project, the proposed mitigation measures are all on the track.

Mitigation measures on the track

An important factor for the magnitude of ground-borne effects is the overall track stiffness. Indeed, if too low, there is an increase in the deformation of the soil and ballast, whilst conversely, when the stiffness is too high, a corrugation is more easily generated. Additionally, if the stiffness has radical fluctuations over the track section, then track deterioration and vibration levels are increased. Track imperfections and degradation (not only due to track stiffness) are crucial to the track vibrations.

Therefore, the correct selection of these elements (rail, fastening, sleepers, ballast) plays a central role in diminishing the formation and propagation of vibration. Increasing the flexibility of the superstructure components raises their ability to dampen (dissipate) vibration generated at the wheel-rail interface.

When rail dampers and rail fasteners are implemented as part of proposed noise mitigation measures in Chapter 4.2.1, they can also effectively contribute to reducing vibration levels and ground-borne noise, as these components are specifically designed to absorb dynamic forces at the wheel–rail interface, limit structural resonance, and impede the transmission of vibratory energy into the track and surrounding ground. All track systems shall include vibration and noise mitigation components where required, in compliance with EU TSI and EN standards. Rail fasteners shall have dynamic stiffness optimized for vibration isolation, tested per EN 13146-9. Where modelling indicates excess noise, certified rail dampers meeting CEN/TS 14531-6 shall be used to achieve at least 3–5 dB(A) noise reduction. During subsequent design stages, i.e. within the Design for construction permit, once specific types and configurations of dampers and fasteners are selected, detailed noise and vibration modelling shall be carried out to verify their effectiveness under project-specific conditions. These measures ensure compliance with relevant EU Directives, including EBRD and EIB requirements.

Rail dampers are prefabricated passive elements in steel material, which are fixed to both sides of the rail web serve to reduce the vibration of the rails. Rail dampers are usually installed between every sleeper in problematic areas of the track.

Use of these measures will reduce vibration and ground-born noise on affected sensitive buildings as shown in **Error! Reference source not found.**.

Table 4-10: List of zones with vibration mitigation measures

Vibration impact zone No.	Chainage	Type of measures recommended
Paraćin-Stalać		

1	km 155+320 – km 155+580	Rail Dampers and Rail Fasteners
2	km 172+030 – km 172+130	Rail Dampers and Rail Fasteners
Djunis-Trupale		
3	km 200+400 – km 200+570	Rail Dampers and Rail Fasteners
4	km 20+720 – km 203+820	Rail Dampers and Rail Fasteners
5	km 227+820 – km 227+920	Rail Dampers and Rail Fasteners

On the transmission path, barriers can be used with materials or without materials (e.g., open trench and/or filled trench), which are able to attenuate propagation of vibration waves. In urban areas it can be realized as underground barriers near the rail track. It is also possible to mitigate the ground vibration intervening in the geotechnical of the soil proprieties (stiffening to improve the soil absorption capacity) under the track, around the track, or between the source and the receiver.

Once the new rails are installed, preventive grinding shall be performed to remove initial roughness on the rail surface, as well as any layer with non-uniform carbon content and irregularities caused by superimposed tolerances during track laying (including adjustments of both direction and reference level).

In the course of railway operation, the running surface of a rail should be flat and smooth. Maintenance plans shall include regular rail grinding. All calculations have been done assuming that the running surface of a rail is flat and smooth. Regular profile and surface inspections are mandatory. For this purpose, it is possible to use specialized rail inspection vehicles, equipped with systems that automatically determine optimal grinding angles, passes, patterns, and rail grinder speeds to ensure the proper rail profile is achieved, can be utilized.

During the preparation of design for modernization of the existing tracks and construction of new tracks, the reduction of breaks in the running surface of a rail (rail joints, switches and crossings) should be considered. Rails shall be welded to form continuous welded rails (CWR). In addition, it is necessary to increase the elasticity of permanent way using the elastic fastening system.

The SRI should develop an Operational Vibration Management Plan to prevent negative vibration and groundborne noise impacts along the railway alignment. The SRI should implement a complaint/grievance mechanism during the operations phase to receive, investigate and respond to complaints including those related to noise and vibration. Depending on the results of such investigations, additional mitigation measures may be taken.

4.3 Monitoring

The SRI will develop an Operational Noise and Vibration Management Plan in order to prevent negative impacts along the railway alignment. The Plan will include the following measures:

- Noise monitoring shall be conducted in the zones of residential and other sensitive buildings located in the immediate vicinity of the railway, and shall be adjusted according to the sections specified in Table 3-18 and Table 3-19 (excluding area of the railway infrastructure belt). In selecting the measuring points, the following shall be included in the monitoring: structures that were not considered affected during calculations, structures protected with noise barriers and structures protected by applying passive protection measures. Measuring points representative for the analysed area shall be selected, but in case of justified complaints of local population, the number of measuring points can be increased. Measurements of noise level shall be performed in compliance with stipulations stated in SRPS ISO 1996-1 and SRPS ISO 1996-2 standards. Noise monitoring at each measurement location should be conducted for at least 15 days, twice per year. Parameters of environmental noise levels that are to be monitored are as follows: Equivalent noise level $L_{Aeq,T}$ [dB], Referent noise level $L_{Raeq,T}$ [dB] and Residual noise level [dB].

- Initial Technical Inspection. Upon completion of the installation of noise barriers, the acoustic parameters following the set of standards outlined in the study (sound insulation, reflection, and diffraction) of each barrier must be verified as part of the technical inspection at an appropriate number of points per linear kilometre. The requirements for in-situ acoustic parameters and the necessary number of measurement points per kilometre must be defined in the next phase of the design process. If the acoustic parameters fail to meet the requirements, the contractor is obligated to rectify the identified irregularities at their own expense. The noise barriers characteristics shall be controlled at least once in five years. Control shall be performed in accordance with: ISO 10847, SRPS EN 16272-4, SRPS EN 16272-5, SRPS EN 16272-6 and SRPS CEN/TS 16272-7. In case the noise barriers are formed of materials having lower environmental resistance (possible changes acoustic properties due to environmental exposure), checks shall be performed after one year, then once in a three-year period and finally once in five years after installation.

- Visual control of noise barriers shall be carried out at least once a calendar year. Control may be performed on a selected sample but the sample always has to be different. If the control shows particularly bad spots, they shall be controlled on an annual basis, regardless of the selected sample. In any case, during inspection of protective structures, the manufacturer’s requirements and recommendations shall be strictly observed. More rigorous criteria will be required during inspection.

- The vibration and ground-borne noise monitoring plan should be performed at residential buildings closest to the railway line and adjusted based on the sections as specified in Table 3-21 and Table 3-22 (excluding area of the railway infrastructure belt). The vibration levels should be monitored at the most affected façade and/or room (closest to the railway vibration source). The vibration measurements can be done following the principles outlined in ISO 14837-1. Vibration monitoring at each measurement location should be conducted for at least 15 days, twice per year. Monitoring will be synchronized with track control measurements.

5 RESIDUAL IMPACTS ASSESSMENT

Table 5-1 presents an assessment of the residual significance of impacts on noise, vibration and ground-borne noise, during both the construction and operational phases of the Project, following implementation of the mitigation measures defined in Chapter 4.

Table 5-1. Significance of Impacts on Noise, Vibration and Ground-borne Noise After Mitigation

Phase	Impact	Negative or Positive	Overall significance before mitigation	Summary of mitigation	Assessment of impact after mitigation	Overall significance after mitigation
Construction	Increase in noise levels during construction works	Negative	(10) HIGH	Construction Noise Management Plan including restrictions on working hours; maximum noise levels at residential receptors; temporary mitigation measures including on-site and off-site measures; noise monitoring; sensitive work scheduling; complaints mechanism	Magnitude is low as noise will be substantially decreased by mitigation measures (1); the impact is short term (less than 5 years) and expected to be very localized (1); sensitive human receptors are present near some sections of the railway (2); the increase is considered to happen with low likelihood after the mitigation measures (1)	*M(1) + ST(1) + S(2) + L(1) = 5 LOW*
	Increase in vibration levels during construction	Negative	(10) HIGH	Construction Noise Management Plan including restrictions on working hours; maximum vibration levels at residential receptors; vibration risk assessment, pre- and post-condition surveys of sensitive buildings; access road selection; temporary mitigation measures including on-site and off-site measures; vibration monitoring; sensitive work scheduling; complaints mechanism	Magnitude is low as vibration and ground-borne noise will be substantially decreased by mitigation measures (1); the impact is short term (less than 5 years) and expected to be very localized (1); sensitive human receptors are present near some sections of the railway (2); the increase is considered to happen with low likelihood after the mitigation measures (1)	M(1) + ST(1) + S(3) + L(1) = 5 LOW
Operations	Increase in noise levels during operations due to train movements	Negative	(12) HIGH	Operational Noise Management Plan; Railway vehicles meeting defined specifications - TSI requirements for noise;	Magnitude is low as noise will be substantially decreased by mitigation measures (1); the impact is long term (more than 20 years) and expected	M(1) + ST(3) + S(2) + L(1) = 7 LOW

Phase	Impact	Negative or Positive	Overall significance before mitigation	Summary of mitigation	Assessment of impact after mitigation	Overall significance after mitigation
				detailed design and installation of noise barriers after further consultation and feasibility analysis; property sound insultation; noise monitoring program; complaints mechanism	to be very localized (1); sensitive human receptors are present near some sections of the railway (2); the increase is considered to happen with very low likelihood after the mitigation measures (1)	
	Increase in vibration and ground-borne noise levels during operations due to train movements	Negative	(12) HIGH	Operational Vibration Management Plan; Rolling stock meeting defined specifications - TSI requirements; detailed design to include under ballast mats and other measures as required; maintenance programme including preventative grinding; noise monitoring program; complaints mechanism	Magnitude is low as vibration and ground-borne noise will be substantially decreased by mitigation measures (1); the impact is long term (more than 20 years) and expected to be very localized (3); sensitive human receptors are present near some sections of the railway (2); the increase is considered to happen with very low likelihood after the mitigation measures (1)	M(1) + ST(3) + S(2) + L(1) = 7 LOW

6 REFERENCES

- Review of existing standards, regulations and guidelines, as well as laboratory and field studies concerning human exposure to vibration, RIVAS Deliverable 1.4 (2011).
- Nicholson R.F, Determination of blast vibrations using peak particle velocity at Bengal Quarry, in St Ann, Jamaica. Master's thesis, Lulea University of Technology (2005).
- Transit Noise and Vibration Impact Assessment Guide, The United States (US) Federal Transit Administration's (2018).
- Environmental Impact Assessment - Integration for Siu Ho Wan and Silver Mine Bay Water Treatment Works - APPENDIX 4.4 Detailed Calculation of Ground-borne Noise - Minimum Distance required for Compliance with Evening and Nighttime Criteria (Agreement No. CE 57/2005(EP), 2010).
- Bus and Train (BaT) Tunnel, Environmental Impact Statement, Construction Noise and Vibration, Report Number 620, 2014.
- DIN 4150-2:1999-06, Vibrations in buildings – Part 2: Effects on persons in buildings, Deutsches Institut für Normung (DIN), Berlin, Germany.
- DIN 4150-3:2016-12, Vibrations in buildings - Part 3: Effects on structures, Deutsches Institut für Normung (DIN), Berlin, Germany.
- WEISUNG für die Beurteilung von Erschütterungen und Körperschall bei Schienenverkehrsanlagen (BEKS), Bundesamt für Umwelt, Wald und Landschaft (BUWAL) (1999).

7 ANNEX 1

7.1 Railway operations parameters used for noise and vibration modelling

The data on the projected scope of railway traffic for the modelling and analysis of noise, vibration, and ground borne noise were derived from the Feasibility Study and Functional and Operation Design (Traffic Technology Preliminary Design) of the Project.

7.1.1 Railway infrastructure specifications

The following railway infrastructure and rolling stock specifications were applied as inputs for the noise impact assessment:

- Track structure:
  - Monoblock soft-pad concrete sleepers with continuous welded rail (0 joints per 100 m).
  - Track ballast composed of crushed stone, providing stable and consistent track conditions.
  - The characteristics of the bridges have been fully considered in the noise modelling. A review of the bridge designs shows that crushed stone barriers, concrete protection of the waterproofing on the roadway slab, and the installation of an elastomeric mat for noise and vibration reduction are planned. These measures aim to prevent additional increase in noise levels in the bridge areas.

7.1.2 Rolling stock specifications

Passenger trains are divided into five train categories: local, regional, high-speed, EuroCity and EuroNight. These categories differ in terms of maximum speeds and the numbers and locations of scheduled stops. Both international and domestic passenger and freight trains are expected to operate on the Project railway line.

- Passenger train categories and characteristics:
  - High-speed trains: Stadler Kiss sets, maximum speed 200 km/h, length ~100 m, equipped with disk brakes.
  - International trains (EuroCity and EuroNight): Stadler Kiss sets, maximum speed 200 km/h, length 150–160 m, equipped with disk brakes.
  - Regional trains: Stadler Flirt sets, maximum speed 160 km/h, length ~78 m, equipped with disk brakes.
  - Local trains: Class 412–416 (RVZ Riga), maximum speed 120 km/h, length 102–108 m, equipped with eu-min brakes.
- Freight trains:
  - Locomotive-hauled by Bombardier 189 (similar to Siemens Vectron), maximum speed 120 km/h, maximum length ~650 m. Freight trains are equipped with iron cast brakes.

These parameters reflect the expected operational conditions and rolling stock characteristics and were used to model noise emissions along the Paraćin–Trupale railway corridor.

The maximum permitted speeds within each sub-section of the Project are presented in the tables below.

Table 7-1. The maximum permitted speeds on the Paraćin–Stalać railway line

No	Chainage		Speed limit	Settlement/Municipality
	start point from	end point to	[km/h]	
1	153+380	156+059	120	Paraćin
2	156+059	156+516	160	Paraćin
3	156+516	174+170	200	Paraćin/Striza/Ratare/Sikirica/ Drenovac/Pojate/Ćićevac/Lucina

Table 7-2. The maximum permitted speeds on the Đunis–Trupale railway line

No	Railway line chainage		Speed limit	Settlment
	start point [km]	end point [km]	[km/h]	
1	191+937.96	194+875.97	160	Đunis/Vitkovac
2	194+875.97	201+973.08	200	Vitkovac/Donji Ljubes/Srezovac/Gornji Ljubes/Korman/Trnjane
3	201+973.08	208+068.07	160	Trnjane/Donji Adrovac/Pricilovica
4	208+068.07	211+651.20	120	Pricilovica/Zitkovac/Moravac
5	211+651.20	229+642.12	200	Moravac/Nozrina/Luzane/Tesica/Grejac/Veliki Drenovac/Supovac/Mezgraja/Vrtiste/Trupale
6	229+642.12	-	80	Trupale

7.1.3 Train Frequency and Operational Schedule

The total number of passenger and freight trains has been derived from the timetable developed under this assignment for both 2045 and 2060. Detailed information on the number of trains per time period (day, evening, night) is presented in the tables below.

The maximum projected number of trains per day in 2045 is 124 on the Aleksinac–Trupale section, while in 2060 it is expected to reach 174 on the Paraćin–Stalać section.

Table 7-3. Daily number of trains, section Ćuprija–Paraćin, 2045

Train type	Train category	Day 06:00-18:00	Evening 18:00-22:00	Night 22:00-06:00	Total number of trains
Passenger	Local	15	8	5	28

Train type	Train category	Day 06:00-18:00	Evening 18:00-22:00	Night 22:00-06:00	Total number of trains
	Regio	12	4	4	20
	High-Speed	16	8	2	26
	EuroCity	6	-	-	6
	EuroNight	-	-	2	2
Freight	-	15	5	20	40
Total		64	25	33	122

Table 7-4. Daily number of trains, section Ćuprija–Paraćin, 2060

Train type	Train category	Day 06:00-18:00	Evening 18:00-22:00	Night 22:00-06:00	Total number of trains
Passenger	Local	21	10	7	38
	Regio	16	7	5	28
	High-Speed	22	8	4	34
	EuroCity	8	-	-	8
	EuroNight	-	-	4	4
Freight	-	23	8	31	62
Total		90	33	51	174

Table 7-5. Daily number of trains, section Paraćin–Sikirica/Ratare, 2045

Train type	Train category	Day 06:00-18:00	Evening 18:00-22:00	Night 22:00-06:00	Total number of trains
Passenger	Local	15	8	5	28
	Regio	12	4	4	20
	High-Speed	16	7	3	26
	EuroCity	6	-	-	6
	EuroNight	-	-	2	2
Freight	-	15	5	20	40
Total		64	24	34	122

Table 7-6. Daily number of trains, section Paraćin–Sikirica/Ratare, 2060

Train type	Train category	Day	Evening	Night	Total number of trains
		06:00-18:00	18:00-22:00	22:00-06:00	
Passenger	Local	21	10	7	38
	Regio	16	7	5	28
	High-Speed	21	8	5	34
	EuroCity	8	-	-	8
	EuroNight	-	-	4	4
Freight	-	23	8	31	62
Total		89	33	52	174

Table 7-7. Daily number of trains, section Sikirica/Ratare–Ćićevac, 2045

Train type	Train category	Day	Evening	Night	Total number of trains
		06:00-18:00	18:00-22:00	22:00-06:00	
Passenger	Local	15	8	5	28
	Regio	12	4	4	20
	High-Speed	16	7	3	26
	EuroCity	6	-	-	6
	EuroNight	-	-	2	2
Freight	-	15	5	20	40
Total		64	24	34	122

Table 7-8. Daily number of trains, section Sikirica/Ratare–Ćićevac, 2060

Train type	Train category	Day	Evening	Night	Total number of trains
		06:00-18:00	18:00-22:00	22:00-06:00	
Passenger	Local	21	10	7	38
	Regio	16	8	4	28
	High-Speed	21	8	5	34
	EuroCity	8	-	-	8
	EuroNight	-	-	4	4
Freight	-	23	8	31	62
Total		89	34	51	174

Table 7-9. Daily number of trains, section Ćićevac–Stalać, 2045

Train type	Train category	Day 06:00-18:00	Evening 18:00-22:00	Night 22:00-06:00	Total number of trains
Passenger	Local	15	8	5	28
	Regio	13	3	4	20
	High-Speed	16	7	3	26
	EuroCity	6	-	-	6
	EuroNight	-	-	2	2
Freight	-	15	5	20	40
Total		65	23	34	122

Table 7-10. Daily number of trains, section Ćićevac–Stalać, 2060

Train type	Train category	Day 06:00-18:00	Evening 18:00-22:00	Night 22:00-06:00	Total number of trains
Passenger	Local	21	10	7	38
	Regio	17	7	4	28
	High-Speed	21	8	5	34
	EuroCity	8	-	-	8
	EuroNight	-	-	4	4
Freight	-	23	8	31	62
Total		90	33	51	174

Table 7-11. Daily number of trains, section Stalać–Đunis, 2045

Train type	Train category	Day 06:00-18:00	Evening 18:00-22:00	Night 22:00-06:00	Total number of trains
Passenger	Local	8	4	2	14
	Regio	6	2	2	10
	High-Speed	16	7	3	26
	EuroCity	6	-	-	6
	EuroNight	-	-	2	2
Freight	-	18	5	23	46
Total		54	18	32	104

Table 7-12. Daily number of trains, section Stalać–Đunis, 2060

Train type	Train category	Day 06:00-18:00	Evening 18:00-22:00	Night 22:00-06:00	Total number of trains
Passenger	Local	10	6	2	18
	Regio	8	4	2	14
	High-Speed	21	8	5	34
	EuroCity	8	-	-	8
	EuroNight	-	-	4	4
Freight	-	24	9	33	66
Total		71	27	46	144

Table 7-13. Daily number of trains, section Đunis–Aleksinac, 2045

Train type	Train category	Day 06:00-18:00	Evening 18:00-22:00	Night 22:00-06:00	Total number of trains
Passenger	Local	8	4	2	14
	Regio	6	2	2	10
	High-Speed	16	7	3	26
	EuroCity	6	-	-	6
	EuroNight	-	-	2	2
Freight	-	18	5	23	46
Total		54	18	32	104

Table 7-14. Daily number of trains, section Đunis–Aleksinac, 2060

Train type	Train category	Day 06:00-18:00	Evening 18:00-22:00	Night 22:00-06:00	Total number of trains
Passenger	Local	10	6	2	18
	Regio	8	4	2	14
	High-Speed	21	8	5	34
	EuroCity	8	-	-	8
	EuroNight	-	-	4	4
Freight	-	23	10	33	66
Total		70	28	46	144

Table 7-15. Daily number of trains, section Aleksinac–Trupale, 2045

Train type	Train category	Day	Evening	Night	Total number of trains
		06:00-18:00	18:00-22:00	22:00-06:00	
Passenger	Local	24	8	2	34
	Regio	6	2	2	10
	High-Speed	16	7	3	26
	EuroCity	6	-	-	6
	EuroNight	-	-	2	2
Freight	-	18	5	23	46
Total		70	22	32	124

Table 7-16. Daily number of trains, section Aleksinac–Trupale, 2060

Train type	Train category	Day	Evening	Night	Total number of trains
		06:00-18:00	18:00-22:00	22:00-06:00	
Passenger	Local	24	8	2	34
	Regio	8	4	2	14
	High-Speed	21	8	5	34
	EuroCity	8	-	-	8
	EuroNight	-	-	4	4
Freight	-	23	10	33	66
Total		84	30	46	160

Table 7-17. Daily number of trains, section Trupale–Niš North, 2045

Train type	Train category	Day	Evening	Night	Total number of trains
		06:00-18:00	18:00-22:00	22:00-06:00	
Passenger	Local	24	8	2	34
	Regio	6	2	2	10
	High-Speed	16	7	3	26
	EuroCity	6	-	-	6
	EuroNight	-	-	2	2
Freight	-	18	5	23	46
Total		53	17	9	79

Table 7-18. Daily number of trains, section Trupale–Niš North, 2060

Train type	Train category	Day 06:00-18:00	Evening 18:00-22:00	Night 22:00-06:00	Total number of trains
Passenger	Local	24	8	2	34
	Regio	8	4	2	14
	High-Speed	21	8	5	34
	EuroCity	8	-	-	8
	EuroNight	-	-	4	4
Freight	-	23	10	33	66
Total		62	20	13	95

7.2 Noise maps without protection measures – 15-year scenario, Paraćin-Stalać

7.3 Noise maps without protection measures – 30-year scenario, Paraćin-Stalać

7.4 Noise maps without protection measures – 15-year scenario, Đunis-Trupale

7.5 Noise maps without protection measures – 30-year scenario, Đunis-Trupale

7.6 Vibration modelling without protection measures – 30-year scenario

The given values refer to both the left and right side of the line unless otherwise indicated. The assessed values of vibration and ground-borne noise that exceed the reference values/limits, set out in DIN 4150-2 for mainly residential areas (Table 2-4 above) and BEKS 1999 for residential areas and newly constructed railway line (Table 2-7 above), are shaded. The KB values shown in the tables are compared to mm/s, even though the KB value is officially dimensionless[11].

Table 7-19. Calculated values of vibration and ground borne noise on the open section Ćuprija – Paraćin

Distance from the axle of the nearest track	Day		Night		Ground-borne noise	
	KB_{Fmax}	KB_{FTr}	KB_{Fmax}	KB_{FTr}	Day Leq (16h)	Night Leq (1h)
m					[dB(A)]	[dB(A)]
5	0.62	0.06	0.62	0.06	21.62	25.76
10	0.29	0.03	0.29	0.03	15.63	19.78
15	0.19	0.02	0.19	0.02	12.11	16.26
20	0.14	0.01	0.14	0.02	9.57	13.72
25	0.16	0.02	0.16	0.02	10.23	14.37
30	0.09	0.01	0.09	0.01	5.94	10.09
35	0.07	0.01	0.07	0.01	4.55	8.70
40	0.06	0.01	0.06	0.01	3.33	7.48
45	0.06	0.01	0.06	0.01	2.25	6.40
50	0.05	0.01	0.05	0.01	1.29	5.44

Table 7-20. Calculated values of vibration and ground borne noise at the switch area of station Paraćin

Distance from the axle of the nearest track	Day		Night		Ground-borne noise	
	KB_{Fmax}	KB_{FTr}	KB_{Fmax}	KB_{FTr}	Day Leq (16h)	Night Leq (1h)
m					[dB(A)]	[dB(A)]
5	1.24	0.11	1.24	0.12	27.54	31.70
10	0.55	0.05	0.55	0.06	21.01	25.17
15	0.33	0.03	0.33	0.04	16.92	21.08
20	0.23	0.02	0.23	0.03	13.80	17.96
25	0.16	0.02	0.16	0.02	11.18	15.34
30	0.13	0.01	0.13	0.01	8.87	13.03
35	0.12	0.01	0.12	0.01	8.02	12.18
40	0.08	0.01	0.08	0.01	4.75	8.91
45	0.06	0.01	0.06	0.01	2.81	6.97
50	0.05	0.01	0.05	0.01	1.28	5.44

Table 7-21. Calculated values of vibration and ground borne noise on the open section Paraćin-Sikirica/Ratare

[11] Railway induced vibration, State of the art report, November 2017, UIC

Distance from the axle of the nearest track	Day		Night		Ground-borne noise	
	KB_{Fmax}	KB_{FTr}	KB_{Fmax}	KB_{FTr}	Day Leq (16h)	Night Leq (1h)
m					[dB(A)]	[dB(A)]
5	0.62	0.06	0.62	0.06	22.55	26.35
10	0.29	0.03	0.29	0.03	16.57	20.37
15	0.19	0.02	0.19	0.02	13.04	16.84
20	0.14	0.02	0.14	0.02	10.50	14.31
25	0.11	0.01	0.11	0.01	8.51	12.32
30	0.09	0.01	0.09	0.01	6.87	10.68
35	0.07	0.01	0.07	0.01	5.48	9.28
40	0.06	0.01	0.06	0.01	4.26	8.07
45	0.06	0.01	0.06	0.01	3.19	6.99
50	0.05	0.01	0.05	0.01	2.22	6.02

Table 7-22. Calculated values of vibration and ground borne noise at the switch area of station Sikirica/Ratare

Distance from the axle of the nearest track	Day		Night		Ground-borne noise	
	KB_{Fmax}	KB_{FTr}	KB_{Fmax}	KB_{FTr}	Day Leq (16h)	Night Leq (1h)
m					[dB(A)]	[dB(A)]
5	1.24	0.12	1.24	0.13	28.51	32.29
10	0.55	0.06	0.55	0.06	21.98	25.75
15	0.33	0.04	0.33	0.04	17.89	21.67
20	0.23	0.03	0.23	0.03	14.76	18.54
25	0.16	0.02	0.16	0.02	12.15	15.93
30	0.13	0.01	0.13	0.01	9.84	13.62
35	0.10	0.01	0.10	0.01	7.72	11.50
40	0.08	0.01	0.08	0.01	5.72	9.50
45	0.06	0.01	0.06	0.01	3.78	7.56
50	0.05	0.01	0.05	0.01	2.24	6.02

Table 7-23. Calculated values of vibration and ground borne noise on the open section Sikirica/Ratare-Ćićevac

Distance from the axle of the nearest track	Day		Night		Ground-borne noise	
	KB_{Fmax}	KB_{FTr}	KB_{Fmax}	KB_{FTr}	Day Leq (16h)	Night Leq (1h)
m					[dB(A)]	[dB(A)]
5	0.62	0.06	0.62	0.06	22.57	26.35
10	0.29	0.03	0.29	0.03	16.59	20.37
15	0.19	0.02	0.19	0.02	13.06	16.84
20	0.14	0.02	0.14	0.02	10.53	14.31
25	0.11	0.01	0.11	0.01	8.54	12.32
30	0.09	0.01	0.09	0.01	6.90	10.68
35	0.07	0.01	0.07	0.01	5.50	9.28
40	0.06	0.01	0.06	0.01	4.29	8.07
45	0.06	0.01	0.06	0.01	3.21	6.99
50	0.05	0.01	0.05	0.01	2.24	6.02

Table 7-24. Calculated values of vibration and ground borne noise at the switch area of station Ćićevac

Distance from the axle of the nearest track	Day		Night		Ground-borne noise	
	KB_{Fmax}	KB_{FTr}	KB_{Fmax}	KB_{FTr}	Day Leq (16h)	Night Leq (1h)
m					[dB(A)]	[dB(A)]
5	1.24	0.12	1.24	0.13	28.51	32.29
10	0.55	0.06	0.55	0.06	21.98	25.75
15	0.33	0.04	0.33	0.04	17.89	21.67
20	0.23	0.03	0.23	0.03	14.76	18.54
25	0.16	0.02	0.16	0.02	12.15	15.93
30	0.13	0.01	0.13	0.01	9.84	13.62
35	0.10	0.01	0.10	0.01	7.72	11.50
40	0.08	0.01	0.08	0.01	5.72	9.50
45	0.06	0.01	0.06	0.01	3.78	7.56
50	0.05	0.01	0.05	0.01	2.24	6.02

Table 7-25. Calculated values of vibration and ground borne noise on the open section Ćićevac-Stalać

Distance from the axle of the nearest track	Day		Night		Ground-borne noise	
	KB_{Fmax}	KB_{FTr}	KB_{Fmax}	KB_{FTr}	Day Leq (16h)	Night Leq (1h)
m					[dB(A)]	[dB(A)]
5	0.62	0.06	0.62	0.06	22.57	26.35
10	0.29	0.03	0.29	0.03	16.59	20.37
15	0.19	0.02	0.19	0.02	13.06	16.84
20	0.14	0.02	0.14	0.02	10.53	14.31
25	0.11	0.01	0.11	0.01	8.54	12.32
30	0.09	0.01	0.09	0.01	6.90	10.68
35	0.07	0.01	0.07	0.01	5.50	9.28
40	0.06	0.01	0.06	0.01	4.29	8.07
45	0.06	0.01	0.06	0.01	3.21	6.99
50	0.05	0.01	0.05	0.01	2.24	6.02

Table 7-26. Calculated values of vibration and ground borne noise on the open section Đunis-Kormani

Distance from the axle of the nearest track	Day		Night		Ground-borne noise	
	KB_{Fmax}	KB_{FTr}	KB_{Fmax}	KB_{FTr}	Day Leq (16h)	Night Leq (1h)
m					[dB(A)]	[dB(A)]
5	0.62	0.06	0.62	0.06	21.75	26.36
10	0.29	0.03	0.29	0.03	15.77	20.38
15	0.19	0.02	0.19	0.02	12.24	16.85
20	0.14	0.01	0.14	0.02	9.70	14.31
25	0.11	0.01	0.11	0.01	7.71	12.32
30	0.09	0.01	0.09	0.01	6.07	10.69
35	0.07	0.01	0.07	0.01	4.68	9.29
40	0.06	0.01	0.06	0.01	3.46	8.07
45	0.06	0.01	0.06	0.01	2.39	7.00
50	0.05	0.01	0.05	0.01	1.42	6.03

Table 7-27. Calculated values of vibration and ground borne noise along the Đunis tunnel section

Distance from the axle of the nearest track	Day		Night		Ground-borne noise	
	KB_{Fmax}	KB_{FTr}	KB_{Fmax}	KB_{FTr}	Day Leq (16h)	Night Leq (1h)
m					[dB(A)]	[dB(A)]
5	0.78	0.07	0.78	0.08	23.27	28.06
10	0.36	0.03	0.36	0.04	17.29	22.08
15	0.23	0.02	0.23	0.03	13.76	18.55
20	0.17	0.02	0.17	0.02	11.22	16.02
25	0.13	0.01	0.13	0.02	9.23	14.03
30	0.11	0.01	0.11	0.01	7.60	12.39
35	0.09	0.01	0.09	0.01	6.20	10.99
40	0.07	0.01	0.07	0.01	4.01	8.80
45	0.07	0.01	0.07	0.01	3.91	8.70
50	0.06	0.01	0.06	0.01	2.94	7.73

Table 7-28. Calculated values of vibration and ground borne noise at the switch area of station Kormani

Distance from the axle of the nearest track	Day		Night		Ground-borne noise	
	KB_{Fmax}	KB_{FTr}	KB_{Fmax}	KB_{FTr}	Day Leq (16h)	Night Leq (1h)
m					[dB(A)]	[dB(A)]
5	1.24	0.11	1.24	0.12	27.68	32.29
10	0.55	0.05	0.55	0.06	21.15	25.76
15	0.33	0.03	0.33	0.04	17.06	21.67
20	0.23	0.02	0.23	0.03	13.94	18.55
25	0.16	0.02	0.16	0.02	11.32	15.93
30	0.13	0.01	0.13	0.01	9.02	13.63
35	0.10	0.01	0.10	0.01	6.90	11.51
40	0.08	0.01	0.08	0.01	4.89	9.50
45	0.06	0.01	0.06	0.01	2.95	7.56
50	0.05	0.01	0.05	0.01	1.42	6.03

Table 7-29. Calculated values of vibration and ground borne noise on the open section Kormani-Adrovac

Distance from the axle of the nearest track	Day		Night		Ground-borne noise	
	KB_{Fmax}	KB_{FTr}	KB_{Fmax}	KB_{FTr}	Day Leq (16h)	Night Leq (1h)
m					[dB(A)]	[dB(A)]
5	0.62	0.06	0.62	0.06	21.75	26.36
10	0.29	0.03	0.29	0.03	15.77	20.38
15	0.19	0.02	0.19	0.02	12.24	16.85
20	0.14	0.01	0.14	0.02	9.70	14.31
25	0.11	0.01	0.11	0.01	7.71	12.32
30	0.09	0.01	0.09	0.01	6.07	10.69
35	0.07	0.01	0.07	0.01	4.68	9.29
40	0.06	0.01	0.06	0.01	3.46	8.07
45	0.06	0.01	0.06	0.01	2.39	7.00
50	0.05	0.01	0.05	0.01	1.42	6.03

Table 7-30. Calculated values of vibration and ground borne noise at the switch area of station Adrovac

Distance from the axle of the nearest track	Day		Night		Ground-borne noise	
	KB_{Fmax}	KB_{FTr}	KB_{Fmax}	KB_{FTr}	Day Leq (16h)	Night Leq (1h)
m					[dB(A)]	[dB(A)]
5	1.24	0.11	1.24	0.12	27.27	32.06
10	0.55	0.05	0.55	0.06	20.73	25.53
15	0.33	0.03	0.33	0.04	16.64	21.44
20	0.23	0.02	0.23	0.03	13.52	18.32
25	0.16	0.01	0.16	0.02	9.74	14.54
30	0.13	0.01	0.13	0.01	8.60	13.39
35	0.10	0.01	0.10	0.01	6.48	11.27
40	0.08	0.01	0.08	0.01	4.48	9.27
45	0.06	0.01	0.06	0.01	2.54	7.33
50	0.05	0.01	0.05	0.01	1.00	5.80

Table 7-31. Calculated values of vibration and ground borne noise on the open section Adrovac-Aleksinac

Distance from the axle of the nearest track	Day		Night		Ground-borne noise	
	KB_{Fmax}	KB_{FTr}	KB_{Fmax}	KB_{FTr}	Day Leq (16h)	Night Leq (1h)
m					[dB(A)]	[dB(A)]
5	0.62	0.05	0.62	0.06	21.33	26.12
10	0.29	0.03	0.29	0.03	15.35	20.14
15	0.19	0.02	0.19	0.02	11.82	16.62
20	0.14	0.01	0.14	0.02	9.29	14.08
25	0.11	0.01	0.11	0.01	7.30	12.09
30	0.09	0.01	0.09	0.01	5.66	10.45
35	0.07	0.01	0.07	0.01	4.26	9.06
40	0.06	0.01	0.06	0.01	3.05	7.84
45	0.06	0.01	0.06	0.01	1.97	6.76
50	0.05	0.01	0.05	0.01	1.00	5.80

Table 7-32. Calculated values of vibration and ground borne noise at the switch area of station Aleksinac

Distance from the axle of the nearest track	Day		Night		Ground-borne noise	
	KB_{Fmax}	KB_{FTr}	KB_{Fmax}	KB_{FTr}	Day Leq (16h)	Night Leq (1h)
m					[dB(A)]	[dB(A)]
5	1.24	0.11	1.24	0.12	27.52	31.71
10	0.55	0.05	0.55	0.06	20.99	25.18
15	0.33	0.03	0.33	0.04	16.90	21.09
20	0.23	0.02	0.23	0.02	13.77	17.96
25	0.16	0.02	0.16	0.02	11.16	15.35
30	0.13	0.01	0.13	0.01	8.85	13.04
35	0.10	0.01	0.10	0.01	6.73	10.92
40	0.08	0.01	0.08	0.01	4.73	8.92
45	0.06	0.01	0.06	0.01	2.79	6.98
50	0.05	0.01	0.05	0.01	1.25	5.44

Table 7-33. Calculated values of vibration and ground borne noise on the open section Aleksinac-Luzane

Distance from the axle of the nearest track	Day		Night		Ground-borne noise	
	KB_{Fmax}	KB_{FTr}	KB_{Fmax}	KB_{FTr}	Day Leq (16h)	Night Leq (1h)
m					[dB(A)]	[dB(A)]
5	0.62	0.06	0.62	0.06	22.40	26.36
10	0.29	0.03	0.29	0.03	15.73	19.69
15	0.19	0.02	0.19	0.02	12.23	16.18
20	0.14	0.02	0.14	0.02	10.36	14.31
25	0.11	0.01	0.11	0.01	8.37	12.32
30	0.09	0.01	0.09	0.01	6.73	10.69
35	0.07	0.01	0.07	0.01	5.33	9.29
40	0.06	0.01	0.06	0.01	4.12	8.07
45	0.06	0.01	0.06	0.01	3.04	7.00
50	0.05	0.01	0.05	0.01	2.07	6.03

Table 7-34. Calculated values of vibration and ground borne noise at the switch area of station Luzane

Distance from the axle of the nearest track	Day		Night		Ground-borne noise	
	KB_{Fmax}	KB_{FTr}	KB_{Fmax}	KB_{FTr}	Day Leq (16h)	Night Leq (1h)
m					[dB(A)]	[dB(A)]
5	1.24	0.12	1.24	0.12	28.34	32.29
10	0.55	0.06	0.55	0.06	21.81	25.76
15	0.33	0.04	0.33	0.04	17.72	21.67
20	0.23	0.03	0.23	0.03	14.59	18.55
25	0.16	0.02	0.16	0.02	11.98	15.93
30	0.13	0.01	0.13	0.01	9.67	13.63
35	0.10	0.01	0.10	0.01	7.55	11.51
40	0.08	0.01	0.08	0.01	5.55	9.50
45	0.06	0.01	0.06	0.01	3.61	7.56
50	0.05	0.01	0.05	0.01	2.07	6.03

Table 7-35. Calculated values of vibration and ground borne noise on the open section Luzane-Tesica

Distance from the axle of the nearest track	Day		Night		Ground-borne noise	
	KB_{Fmax}	KB_{FTr}	KB_{Fmax}	KB_{FTr}	Day Leq (16h)	Night Leq (1h)
m					[dB(A)]	[dB(A)]
5	0.62	0.06	0.62	0.06	22.40	26.36
10	0.29	0.03	0.29	0.03	15.73	19.69
15	0.19	0.02	0.19	0.02	12.23	16.18
20	0.14	0.02	0.14	0.02	10.36	14.31
25	0.11	0.01	0.11	0.01	8.37	12.32
30	0.09	0.01	0.09	0.01	6.73	10.69
35	0.07	0.01	0.07	0.01	5.33	9.29
40	0.06	0.01	0.06	0.01	4.12	8.07
45	0.06	0.01	0.06	0.01	3.04	7.00
50	0.05	0.01	0.05	0.01	2.07	6.03

Table 7-36. Calculated values of vibration and ground borne noise at the switch area of station Tesica

Distance from the axle of the nearest track	Day		Night		Ground-borne noise	
	KB_{Fmax}	KB_{FTr}	KB_{Fmax}	KB_{FTr}	Day Leq (16h)	Night Leq (1h)
m					[dB(A)]	[dB(A)]
5	1.24	0.12	1.24	0.12	28.34	32.29
10	0.55	0.06	0.55	0.06	21.81	25.76
15	0.33	0.04	0.33	0.04	17.72	21.67
20	0.23	0.03	0.23	0.03	14.59	18.55
25	0.16	0.02	0.16	0.02	11.98	15.93
30	0.13	0.01	0.13	0.01	9.67	13.63
35	0.10	0.01	0.10	0.01	7.55	11.51
40	0.08	0.01	0.08	0.01	5.55	9.50
45	0.06	0.01	0.06	0.01	3.61	7.56
50	0.05	0.01	0.05	0.01	2.07	6.03

Table 7-37. Calculated values of vibration and ground borne noise on the open section Tesica-Trupale

Distance from the axle of the nearest track	Day		Night		Ground-borne noise	
	KB_{Fmax}	KB_{FTr}	KB_{Fmax}	KB_{FTr}	Day Leq (16h)	Night Leq (1h)
m					[dB(A)]	[dB(A)]
5	0.62	0.06	0.62	0.06	22.40	26.36
10	0.29	0.03	0.29	0.03	15.73	19.69
15	0.19	0.02	0.19	0.02	12.23	16.18
20	0.14	0.02	0.14	0.02	10.36	14.31
25	0.11	0.01	0.11	0.01	8.37	12.32
30	0.09	0.01	0.09	0.01	6.73	10.69
35	0.07	0.01	0.07	0.01	5.33	9.29
40	0.06	0.01	0.06	0.01	4.12	8.07
45	0.06	0.01	0.06	0.01	3.04	7.00
50	0.05	0.01	0.05	0.01	2.07	6.03

Table 7-38. Calculated values of vibration and ground borne noise at the switch area of station Trupale

Distance from the axle of the nearest track	Day		Night		Ground-borne noise	
	KB_{Fmax}	KB_{FTr}	KB_{Fmax}	KB_{FTr}	Day Leq (16h)	Night Leq (1h)
m					[dB(A)]	[dB(A)]
5	1.24	0.09	0.96	0.05	25.95	27.36
10	0.55	0.04	0.42	0.02	19.42	20.83
15	0.33	0.03	0.25	0.01	15.33	16.74
20	0.23	0.02	0.17	0.01	12.21	13.61
25	0.16	0.01	0.13	0.01	9.59	11.00
30	0.13	0.01	0.10	0.01	7.28	8.69
35	0.10	0.01	0.08	0.00	5.16	6.57
40	0.08	0.01	0.06	0.00	3.16	4.57
45	0.06	0.01	0.05	0.00	1.22	2.63
50	0.05	0.00	0.04	0.00	-0.31	1.09

Table 7-39. Calculated values of vibration and ground borne noise on the open section Trupale – end of section

Distance from the axle of the nearest track	Day		Night		Ground-borne noise	
	KB_{Fmax}	KB_{FTr}	KB_{Fmax}	KB_{FTr}	Day Leq (16h)	Night Leq (1h)
m					[dB(A)]	[dB(A)]
5	0.62	0.06	0.62	0.06	22.40	26.36
10	0.29	0.03	0.29	0.03	15.73	19.69
15	0.19	0.02	0.19	0.02	12.23	16.18
20	0.14	0.02	0.14	0.02	10.36	14.31
25	0.11	0.01	0.11	0.01	8.37	12.32
30	0.09	0.01	0.09	0.01	6.73	10.69
35	0.07	0.01	0.07	0.01	5.33	9.29
40	0.06	0.01	0.06	0.01	4.12	8.07
45	0.06	0.01	0.06	0.01	3.04	7.00
50	0.05	0.01	0.05	0.01	2.07	6.03

7.7 Noise maps with protection measures – 15-year scenario, Paraćin-Stalać

7.8 Noise maps with protection measures – 30-year scenario, Paraćin-Stalać

7.9 Noise maps with protection measures – 15-year scenario, Đunis-Trupale

7.10 Noise maps with protection measures – 30-year scenario, Đunis-Trupale

7.11 Vibration maps – vibration impact zones, Paraćin-Stalać

7.12 Vibration maps – vibration impact zones, Đunis-Trupale

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ЗА ТЕБЕ

RAILWAY LINE BELGRADE–NIŠ, SECTION III
Paraćin to Trupale (Niš)
Environmental and Social Impact Assessment
12. Noise and Vibration
Annex 2 – Noise modelling assessment – additional tests and sensitivities

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LIST OF ABBREVIATIONS AND ACRONYMS

ISO	International Organization for Standardization
EN	European Standard
SRPS	The Serbian Institute of Standardization (ISS) uses the designation for standards and related documents applicable within Serbia
DIN	German Institute for Standardization
BS	British Standard
AS	Australian Standard
dB	Decibel
Lw	Sound Power Level
Lp	Sound Pressure Level
PPV	Peak Particle Velocity
VdB	Vibration velocity levels in decibels
KBF_{max}	Maximum weighted vibration strength
KBF_{Tr}	Mean vibration strength
Hz	Herz
EMU	Electric Multiple Unit

Contents

1 ANNEX 2 - NOISE MODELLING ASSESSMENT – VARIOUS TESTS AND SENSITIVITIES

1.1 Assessment of mitigation measures' effectiveness

The consultant has undertaken the following cost-effectiveness analysis:

- Step 1: Cost-effectiveness assessment of the protection of affected sensitive building: soundproofing vs noise barriers

  It has been undertaken cost-effectiveness assessment for all locations based on the assumed average prices per soundproofing of building of 150m2, (EUR 48,000 in 2025 prices, including windows, outer façade, inner isolation, floor isolation and fresh air system) and the average price of noise protections barriers per similar regional experiences per meter (EUR 840 per m in 2025 prices). Considered prices has incorporated also financial contingency having in mind that the construction of the noise protection measures will happen in several years from now. As a result, Table 4-1 Noise modelling summary, Paraćin-Stalać and Đunis-Trupale railway sub-sections, 2045 and 2060 of the ESIA's Chapter 12 Noise and Vibrations has been generated, presenting the total potential number of noise protection barriers and buildings to be protected with passive measures.

- Step 2: Cost-effectiveness assessment undertaken for the set of buildings identified as sensitive to soundproofing price for the sensitive building protection

  For all these locations more detailed assessment of the area per protected buildings have been analysed, which were close to 100m2 for the selected noise barriers and consequently with lower cost. Consequently, it has come out that 1 noise barrier (no.10) for Paracin-Stalać section could be replaced with passive measures, and 3 noise barriers (no.8, no.14 and no.21 from the table above) for Djunis-Trupale, as marked with '*' in the **Error! Reference source not found.**, **Error! Reference source not found.**, **Error! Reference source not found.** and **Error! Reference source not found.** above. This analysis was developed based on the rough estimation of the costs of passive measures and noise barriers considering similar market prices, it is strongly recommended that this analysis is updated within the Design for construction permit, when all design prices are known - which should be also recommendation of the Preliminary Design. In addition to this, results of consultations with affected communities must be considered too. In addition to this, results of consultations with affected communities must be considered too. Therefore, as a conclusion, there are potentially 34 objects that could have applied passive measures instead of 4 noise barriers.

- Step 3: Cost-effectiveness assessment of selected locations sensitive to the highest length and area covered by the noise barriers per protected sensitive buildings

  The second set of additional cost-effectiveness tests were applied to the zones where there are noise barriers with the highest length per protected buildings and the highest area of noise barriers per protected buildings.

In all analysed cases (noise barrier no. 1, no. 13 and no. 15 along the Paracin-Stalać Section and noise barriers no. 25 and no. 28 along the Djunis-Trupale Sections) it has been concluded that if the noise barrier height is lowered for approximately 2 m, or if the noise barriers are shortened, it is still cost-effective to have the noise barriers implemented and not to be replaced with additional soundproofing. As a conclusion of this assessment, noise barrier no.25 was split into 2 noise barriers, as presented in the **Error! Reference source not found.** and **Error! Reference source not found.** above.

- Step 4: Visual impact & Cost-effectiveness assessment: Assessment of the cost effectiveness of applying fully transparent noise barriers at the selected locations with visual impact

  The selected 4 locations as per Landscape and Visual Impact chapter are as follows:

  - Vitkovac (VP5): km 194+110,
  - Trnjane (VP6): km 202+968,
  - Zitkovac (VP7): km 208+740, and
  - Moravac (VP8): km 210+355.

  Based on additional modelling tests, for a 100-meter segment before and after the identified chainages for these four locations, it can be concluded that the transparent noise barriers, when combined with passive measures, could be implemented to mitigate visual impacts. While this solution is less cost-effective compared to the original design using absorption noise barriers, it supports improved visual integration.

  As a result, passive measures should be applied to the following number of buildings:

  - VP5 (Vitkovac): 12 buildings
  - VP6 (Trnjane): 21 buildings
  - VP7 (Žitkovac): 11 buildings
  - VP8 (Moravac): 2 buildings

  If there are no further comments or objections from the local communities, the visual impacts at these locations can be considered resolved in line with this proposal and incorporated into the next design stage.

  In addition to this, implementation of the transparent noise panels has been tested on the railway section Đunis – Trupale, covering the segment from km 194+150 to km 195+850. By using combined noise barriers, consisting of an absorptive barrier with a 1-meter-high transparent element, an additional 60 sensitive buildings require noise protection. Also, it is necessary to undertake assessment and modelling by using combined noise barriers, consisting of an absorptive barrier with at least of a 1-meter-high transparent element allowing passengers from the train to enjoy the environment where necessary and an additional protection for sensitive buildings affected by the inclusion of transparent panels.

1.2 Assessment of ground absorption coefficient

Based on the request from the Technical Assistance team, additional tests were conducted regarding the ground absorption factor. If the ground absorption coefficient of 0,7 is applied for the entire section Paraćin-Stalać, an additional 76/110 objects (2045/2060) would require protection, representing 2,5/3,6% (2045/2060) of the total number of sensitive objects to be protected. The average noise level difference compared to the modelled values with the ground absorption coefficient 1,0 is approximately 0,90/0.96dB for night period (2045/2060), with maximum values reaching up to 2,3/2.4dB (2045/2060). If a ground absorption coefficient of 0.8 is used instead, the results show additional are 38/79 sensitive buildings needing protection, corresponding to 1.3%/2,6% of the total, and the average noise level difference is 0,6/0.63dB with maximum values reaching up to 1,6/1.6dB. These findings could impact future building protection measures, potentially requiring higher noise barriers or passive protection measures applied on more sensitive buildings.

1.3 Assessment of the impact of various noise protection measures

The specific tests were conducted at the request of the Technical Assistance team to assess the impact of the proposed measures independently, as well as to evaluate the effects of noise reduction achieved by increasing the height of the noise barriers.

The analyses were conducted on the railway section Đunis – Trupale, covering the segment from km 194+150 to km 195+850, where the project also includes the installation of noise barriers with heights of 5, 6, and 7 meters. These are covering approximately 300 receptors. The conclusions are as follows:

- Applying only rail dampers and rail fasteners results in average noise reductions of 6.3 dB, with maximum reductions reaching up to 6.9 dB. Based on the available data, the combined noise reduction effectiveness achieved through the simultaneous application of rail dampers and rail fasteners is approximately equivalent to the sum of their individual contributions. It is important to highlight that, during the noise modelling phase, conservative values for the effectiveness of both rail dampers and fasteners were employed, rather than their maximum reported efficiencies, which is also in line with Technical Assistance recommendation.
- Combining rail dampers, rail fasteners, and noise protection barriers achieves, on average, 5.6 dB greater noise reduction compared to using noise barriers alone.
- Applying rail dampers and fasteners can achieve noise reductions equivalent to increasing the noise barrier height by approximately 2 to 2.5 meters, depending on the site-specific conditions.
- Increasing the noise barrier height by 0.5 meters provides an average noise reduction of 1.3 dB (up to 4.4 dB), while a 1-meter increase yields an average of 2.3 dB (up to 6.8 dB).
- Increasing the barrier height by 1 m (either 5 to 6 or 6 to 7 or 7 to 8) provides an average noise reduction of 2.3 dB, with maximum values reaching up to 6.8 dB.

1.4 Assessment of the application of composite brake blocks

The analyses were conducted on the railway section Đunis – Trupale, covering the segment from km 194+150 to km 195+850.

By applying composite brake blocks for freight wagons, on average 9-10dB savings could be achieved, which is in total 67 less sensitive buildings affected by noise.

Current composition of the rolling stock is mainly with the cast iron brake blocks, therefore if future distribution until 2060 is known the noise modelling could be done in more details.

1.5 Assessment of the application of dampers and fasteners with very high effectiveness

Testing of the Paraćin–Stalać section under the 30-year scenario demonstrated that applying dampers and fasteners with maximum efficiency at locations where noise barriers of 6 meters or higher are planned would reduce the number of buildings requiring passive noise protection measures from approximately 5 % to 2.5% out of the total number of affected buildings. This analysis was conducted specifically in the zones of walls 1, 2, 3, 5, 6, 15, and 16, which include segments with barrier heights of 6 meters or more.

Furthermore, combining the use of highly efficient dampers and fasteners with adjusted (reduced) barrier heights, reduction in the height of barriers that are 6 meters or higher by 2 meters, would lead to a reduction in passive noise protection measures from approximately 5 % to 3.5% out of the total number of affected buildings.

The reduced need for passive measures in this scenario is mainly due to the use of more effective noise-reducing solutions at source near the Paraćin and Ćićevac stations where noise barriers could not be implemented.

For the Djunis–Trupale section, analysis under the 30-year scenario showed that the application of dampers and fasteners with maximum efficiency in the zones of walls 1, 2, 3, 4, 5, 7, 8, 9, 10, 11, 12, 17, 18, 19, 20, 24, 25-1, 25-2, 26, 27, and 28, where certain segments reach heights of 6 meters or more would result in reduction of the number of buildings requiring passive noise protection measures from approximately 3% to 1.5% out of the total number of affected buildings.

In an alternative scenario where dampers and fasteners with maximum efficiency are used in combination with a reduction in the height of barriers that are 6 meters or higher by 2 meters, the number of buildings requiring passive protection would increase from approximately 3% to 3.5% out of the total number of affected buildings. This indicates that although high-performance track-based mitigation measures offer substantial benefits, reducing the height of taller barriers may compromise overall noise protection effectiveness, especially in areas near sensitive receptors.

Consequently, if the most effective dampers and fasteners are planned to be implemented, further modelling is needed to optimize the noise barrier height at these locations.

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LIST OF ABBREVIATIONS AND ACRONYMS

GIS	Geographic Information System
ESIA	Environmental and Social Impact Assessment
EIA	Environmental Impact Assessment
GIS	Geographic Information System
GLVIA	Guidelines for Landscape and Visual Impact Assessment
IBA	Important Bird Areas
LCU	Landscape Character Unit
LCA	Landscape Character Area
LEP	Local Environmental Plan
LI	Landscape Institute
LVIA	Landscape and Visual Impact Assessment
pSPA	potential Special Protection Area
REF	Review of Environmental Factors
ROW	Right-of-Way
ESMP	Environmental and Social Management Plan
SEA	Strategic Environmental Impact Assessment
SCI	Sites of Community Importance
VP	Viewpoint
ZTV	Zone of Theoretical Visibility

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13. LANDSCAPE AND VISUAL IMPACT ASSESSMENT

13.1. Introduction

The Landscape and Visual Impact Assessment (LVIA), reports the findings on the potential effects of proposed Project related to the landscape and visual amenity.

The purpose of this LVIA is following:

- Identify Visual Changes: Assess the visual alterations from new infrastructure, such as tracks, stations, and signalling systems, on the existing landscape.
- Assess Visual Impact on Communities: Evaluate how these changes will affect the aesthetics of residential areas, public spaces, and landmarks, considering views from key locations to determine potential visual intrusion or disruption.
- Evaluate Scenic and Cultural Value: Examine impacts on scenic and cultural landscapes, including historically significant areas, and propose mitigation strategies.
- Assess impacts on landscape as a resource on its own rights.
- Assess impacts on specific views and on the general visual amenity experienced by people.
- Present Mitigation Measures: Recommend measures to reduce negative visual impacts through design modifications, landscaping, screening, or other strategies to integrate new infrastructure with the existing environment.
- Inform Decision-Making: Provide essential information for decision-makers to incorporate visual impact considerations into the planning and design process, ensuring balanced and informed decisions.
- Enhance Public Acceptance: Improve public acceptance by addressing visual concerns and providing transparent information on visual impacts, engaging with communities, and incorporating their feedback.
- Ensure Compliance with Regulations: compliance with relevant environmental and planning regulations, supporting the project's environmental impact and social assessment (ESIA) by addressing required visual aspects.

This chapter should be read in conjunction with the following chapters:

- Chapter 1 Introduction
- Chapter 2 Project Description
- Chapter 3 Legal Framework
- Chapter 5 Approach to ESIA
- Chapter 12 Noise and Vibration
- Chapter 15 Cultural Heritage
- Chapter 20 Cumulative impacts

The baseline data and other analyses were informed by the following resources:

- Preliminary Design for the reconstruction and construction of the Belgrade Center-Junction 'G'-Rakovica-Mladenovac-Lapovo-Nis-Presevo-State Border (Tabanovce), railway line - section Belgrade Center-Junction 'G'-Rakovica-Mladenovac-Lapovo-Nis, prepared by SUEZ Consulting (SAFEGE) in consortium with EGIS, EPEM, and KPMG,
- Aerial imagery,
- Desk-based review of existing publicly available information,

- Desk-based review of the documentation delivered by the Client,
- Desk-based review of current national policies and spatial documentation,
- Desk-based review of current national policies and spatial documentation,
- Site visits and site photography.

The Belgrade to Nis Railway Corridor Rehabilitation has been divided into three sections for the purpose of detailed development:

- Section 1: Belgrade (Resnik) to Velika Plana,
- Section 2: Velika Plana to Paracin,
- Section 3: Paracin to Trupale (Nis)

This LVIA focuses on Section 3, which spans from Paracin to Trupale (Nis), excluding the already advanced section from Stalac to Djunis. Section 3 is divided into two subsection: Paracin-Stalac and Djunis-Trupale subsection.

The **Paracin-Stalac subsection** (km 153+380 to km 174+170.79) is 20.8 km long and passes through 8 settlements. The alignment largely follows the existing route, with minor adjustments for high-speed train compatibility. Key infrastructure updates include the reconstruction of Paracin and Cicevac stations and the upgrade of Sikirica-Ratare stop to a station. Several bridges will be demolished and replaced with new concrete steel span structures.

The **Djunis-Trupale subsection** (km 191+937.96 to km 229+642) spans 37.7 km, passing through 19 settlements. Key changes include the construction of new bridges and viaducts, such as the new Juzna Morava river bridge at km 223+054.78 and two new viaducts at km 220+544.70 and km 223+205.49, as well as the new 580-meter-long Djunis tunnel.

13.2. Study Area

The study area has been delineated using the Zones of Theoretical Visibility (ZTV) model, as outlined in Chapter 13.3.3. This model calculates the areas from which project components, such as protective fencing, passing trains, overpasses, and related infrastructure may theoretically be visible, assuming ideal viewing conditions. Based on this analysis, a 5 km radius was established as the baseline for the Study area. The choice of a 5 km ZTV is consistent with recognized LVIA methodologies and reflects standard practice for infrastructure projects involving elements of moderate height (up to 20 m). This distance is generally sufficient to capture the full extent of potential visual influence, including long-range views from elevated or sensitive locations. The analysis results indicated that visibility naturally diminishes around the 5 km mark due to the Earth's curvature and line-of-sight limitations. While visibility over 5 km is technically possible under exceptional conditions, such occurrences are rare and typically of limited perceptual impact. It is important to note that the ZTV was generated using a digital elevation model (DEM) and assumes a clear line of sight, without accounting for intervening vegetation, buildings, or atmospheric conditions, which in reality would reduce visibility. Therefore, the 5 km radius represents a standard approach, likely overestimating actual visibility, to ensure that all potential visual and landscape effects are appropriately considered in the assessment.

. To comprehensively assess all potential visual and landscape impacts, including those on the surrounding environment, the Study area has been defined to cover this 5 km radius, as shown in Figure 13- 1.

The analysed study area is defined as 5 km on both sides of the proposed alignment.

Figure 13- 1: Study Area

13.3. Baseline Conditions

13.3.1. Project Components Relevant to Visual and Landscape Assessment

This chapter provides a brief description of the main components of the Project that are expected to have the potential to affect the landscape and visual amenity. All additional technical details are available in Chapter 1-3 of this ESIA.

The railway line components are as follows:

Superstructure: The railway superstructure will be completely replaced, including rails, sleepers, fastenings, ballast, and protective layers. Superelevation in curves is based on design speed. Guard rails with elastic fastenings will be installed on bridges and nearby sections for derailment protection. Tracks will use 60E1 rails for main lines and 49E1 for secondary tracks, mounted on concrete sleepers in category I ballast (min. 30 cm thick). The track gauge is 1435 mm, with welds made using the aluminothermic method in 120 m sections. Bridge tracks will be built in closed ballast beds within reinforced concrete tubs.

Substructure: Embankments will have slopes of 1:1.5 for lower heights, 1:2 for higher ones, and 1:2.25 for those over 3 m. They will be built from existing materials in 30 cm compacted layers, following all regulatory requirements. A 20 cm topsoil layer will be removed before substructure construction.

Structure: tunnels, bridges, underpasses, overpasses, culverts, drainage channels and retaining walls:

- Bridges: All bridges along the Project route will be newly constructed, with no refurbishment of existing structures. Most new bridges will replace existing ones at the same or slightly shifted locations and will be built in two phases to ensure uninterrupted traffic on one track during construction. New bridges replacing existing ones include those over the Crnica River (km 155+908.80), Planski stream (km 163+861.90), Jovanovacka River (km 169+425.70), Kocanski stream (km 172+051.85), Akalavica stream (km 173+709.21), Simin stream (km 193+426.23, alignment shifted 2.2 m left), Srezovacka River (km 193+426.23, shifted ≈30 m left), Radevacka River (km 201+255.67, shifted 0.8 m right), Suvi stream (km 205+958.44, stream relocated ≈22 m south and track shifted ≈3.2 m right), Turija River (km 217+642.36, shifted ≈17 m left), and Dasnicka River (km 219+097.12, shifted ≈19 m right). Additionally, three entirely new structures will be built on a realigned route without affecting existing traffic: a viaduct at km 220+544.70, a bridge over the Južna Morava River at km 223+054.78, and another viaduct at km 223+205.49.
- Level crossings, overpasses and underpasses: All 48 existing road level crossings, many of which are currently uncontrolled, will be abolished and replaced with 30 new deleveled crossings (overpasses and underpasses), not necessarily in the same locations. These were selected based on traffic analysis, road category, and site-specific constraints. Stakeholder feedback was collected through municipal meetings and public consultations. Three pedestrian and bicycle underpasses will be built in Paracin (km 155+495), Cicevac (km 173+678), and Mezgraja (km 224+180), each equipped with elevators and stairs, designed for full accessibility and safety. The underpasses will feature video surveillance and enhanced lighting.
- Tunnel: The Djunis tunnel will be newly constructed and will be 580 m in length. The tracks will be 4.0m distance apart, and the axis will be curved with a radius of 3002 m, to enable a design speed of up to 160 km/h. The entrance portal is at km 192+274, and the exit portal is at km 192+854.

Other components: stations, signalling and telecommunication, fencing:

- Stations: The Project will include modernization of 7 existing stations, reconfiguration of 1 stop into a new station, and retaining 2 key existing stations. Paracin remains an intermediate and branch station. Sikirica-Ratare is a newly designed station replacing the existing stop, serving local trains. CiCevac, Korman, Adrovac, and Aleksinac remain intermediate stations with upgraded platforms and extensive track capacities for passenger and freight traffic. The new Tesica station will consolidate the existing Grejac station and Tesica halt, featuring two 220 m platforms for local passenger and freight services. Trupale station remains a border station at the Nis junction, managing local passenger services and wagonload shipments, with two 400 m island platforms and multiple through, overtaking, receiving, and handling tracks. All stations are designed for efficient train traffic management, passenger comfort, and operational flexibility.
- Signalling: The Project will use conventional electronic signal safety devices, including visual signals, speed control, and a centralized automatic block system that can automatically stop trains up to 160 km/h in emergencies. It will support ETCS Level 2 for interoperability and enable train speeds up to 200 km/h on both tracks. All stations will be equipped with electronic signalling and interlocking (CBI) systems for double-track operation, with centralized switch point control and automatic train routing. These systems will connect to CTC centres, ETCS, and centralized monitoring. Power comes primarily from the public grid, with the overhead contact line and batteries as backups, ensuring uninterrupted operation for several hours. Key features include LED signal lights, electric switch point

machines adapted for concrete sleepers, axle counters for track occupation detection, polyethylene-insulated or optical cables, heated switch points powered by the catenary, and upgraded signalling rooms.

- Telecommunication: The Project's telecommunication system will ensure reliable traffic and modern passenger info through fibre optic cables, upgraded digital dispatch phones, GSM-R wireless communication, and advanced transmission networks. Stations will have IP-based VoIP phones, passenger info displays, video surveillance, and safety systems including access control, fire detection, and SOS. The system supports ETCS L2 and meets high reliability and interoperability standards.
- Fencing: The railway line, designed for speeds up to 200 km/h, will be fenced with a 1.8 m high highway-style fence on both sides, 1 m from the embankment toe, to prevent unauthorized access by people and animals and reduce accidents and vandalism. A 5 m service road zone will be reserved outside the fence. The fence will use 3 mm galvanized steel wire with 50 mm square mesh and galvanized steel posts set in concrete.

13.3.2. Establishing the Landscape Baseline

In order to establish the landscape baseline in line with the Guidelines of Landscape and Visual Impact Assessment[1] the following aspects were analysed:

- landscape designations and features,
- landform,
- land cover,
- settlement types,
- protected landscape areas,
- cultural heritage.

Addressing other features such as landscape and scenic quality, rarity, representativeness, recreational value and perceptual aspects helped to draw informed conclusions about the landscape character.

Landscape Designation and Features

The key characteristics that define the broader Project area landscape character are:

- The Velika Morava River and its tributaries form a defining natural element of the landscape, with meandering courses that shape the valley floor and contribute to the area's ecological diversity and scenic quality.
- The topography transitions from the flat plains of the Pannonian Basin to the rolling hills of the Sumadija region, creating a visually dynamic setting with alternating lowlands and elevated terrain.
- Undulating terrain dominates the railway corridor in Paracin area, with gentle elevation changes ranging from 110m to 129m above sea level, influencing both views and settlement patterns.
- The visual landscape is seasonally dynamic, displaying vibrant autumn colours and lush spring and summer greenery, which enhance the area's aesthetic value throughout the year.

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1 https://www.landscapeinstitute.org/technical/glvia3-panel/

- Panoramic and expansive views are available from higher elevations, offering broad vistas across the Morava River valley and reinforcing the visual depth of the region.
- A pronounced sense of open sky is experienced across much of the project corridor, largely due to the expansive flat plains that dominate the landscape. This openness contributes significantly to the visual character of the area, enhancing the perception of wide, uninterrupted horizons and reinforcing the landscape's identity as spacious and exposed.
- Deciduous forest patches occur in localized areas, providing contrast to the surrounding cultivated landscape and supporting local biodiversity.
- Extensive agricultural land cover characterises the region, primarily consisting of arable fields planted with crops such as wheat, corn, and sunflowers, with orchards and vineyards on the hilly slopes.
- Land use and vegetation patterns are heavily influenced by human activity, including agriculture, railway infrastructure, and watercourse training, leading to a largely anthropogenically altered landscape.

Figure 13- 2 and Figure 13- 3 illustrate typical scenes along the Project corridor, featuring expansive plains, arable land, the river valley, and occasional contrasts in the form of low hills and gentle elevations.

Figure 13- 2: Juzna Morava river

Figure 13- 3: Semi urban zones with arable land

Landform

The landform along the Project alignment from Paracin to Nis presents a diverse range of variations, which significantly shape the landscape character and influence land use and infrastructure development. The northern section, near Paracin, is predominantly characterised by flat to gently undulating terrain, with elevations ranging from 26 to 380 meters. This relatively leveled landscape, composed of expansive, fertile plains, is highly conducive to agricultural activities.

As the railway progresses southward, the topography undergoes a notable transformation, becoming progressively more rugged and complex. This shift is particularly evident near the confluence of the Turija River with the Juzna Morava River, and further south towards Nis, where the terrain is characterised by steep slopes, rolling hills, and pronounced valleys. Elevations rise dramatically, reaching up to approximately 886 meters, adding a striking vertical dimension to the landscape. The increasingly varied relief in this southern region introduces more pronounced physical barriers and changes in land use potential.

A key feature of the southern landscape is the Juzna Morava River valley, which forms a significant ecological and agricultural corridor, with fertile plains lying in stark contrast to the adjacent hilly and mountainous zones. The distinct topographical variations across this area influence local climate patterns, which in turn affect the distribution of vegetation and the suitability for different types of agriculture. Figure 13- 4 and Figure 13- 5 present elevation maps for Section 3, illustrating that the Paracin-Stalac subsection is predominantly flat, whereas the Djunis-Trupale subsection is characterized by more undulating, hilly terrain.

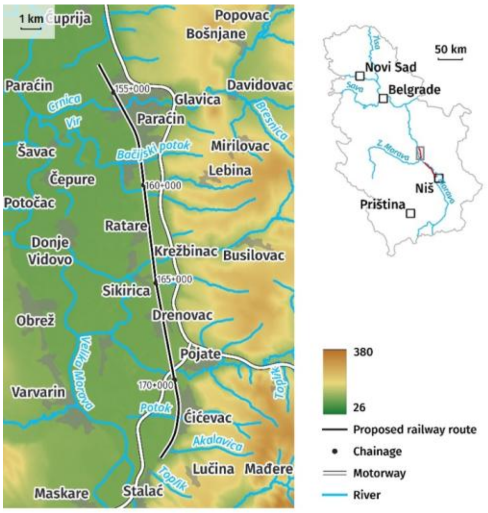

Figure 13- 4: Elevation map for the Paracin-Stalac subsection

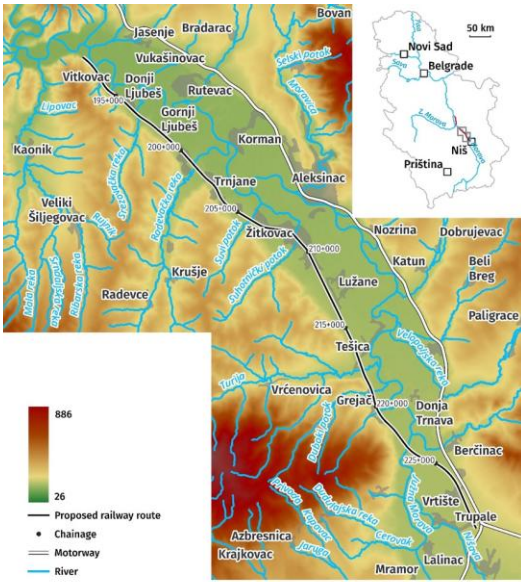

Figure 13- 5: Elevation map for the Djunis-Trupale subsection

Land Cover

The region between Paracin and Nis presents a diverse range of habitats shaped by its topographical and environmental characteristics. Agricultural lands are predominant, with crops such as corn, barley, and sunflower being primarily cultivated. These agricultural areas are interspersed with natural and semi-natural vegetation strips, as depicted in Figure 13- 6 and Figure 13- 7, as well as small patches of degraded forests.

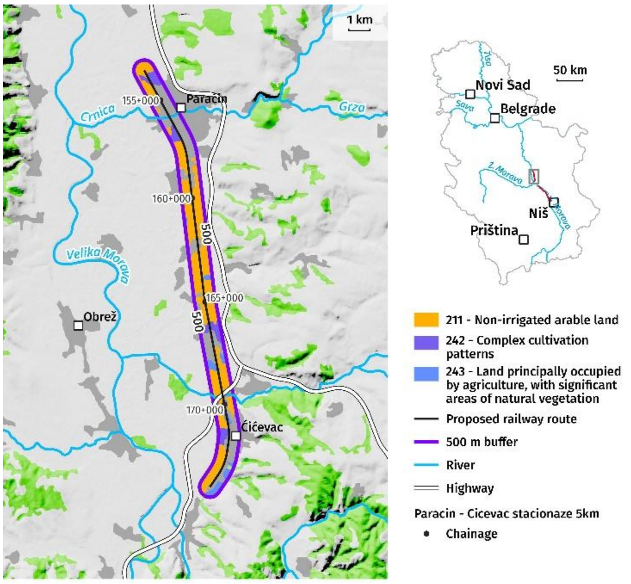

Figure 13- 6: Paracin-Stalac land use

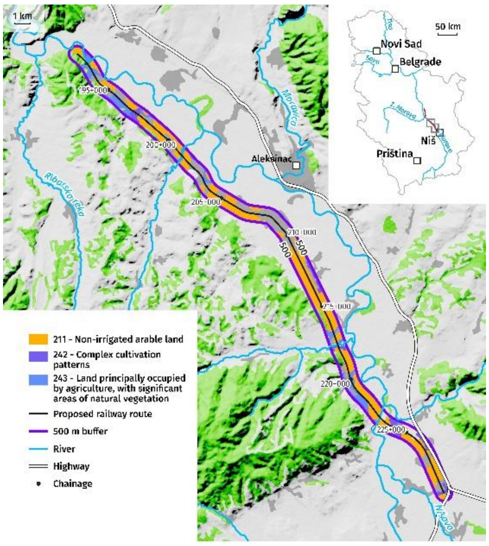

Figure 13- 7: Djunis-Trupale land use

The alluvial plains near the Juzna Morava River are particularly notable for supporting riparian vegetation, with fragmented forests of white willow and poplar. In the hinterlands of these plains, oak species such as Hungarian oak and Turkey oak are prevalent, as outlined in the Chapter 14 (Biodiversity) of this ESIA. Along the watercourses and railway corridors, seasonal wet grasslands and ruderal vegetation are common, reflecting human influences such as land reclamation and urbanization. The landscape is further characterized by anthropogenic habitats, including suburban areas, industrial zones, and additional railway corridors. This dynamic interplay of natural and altered environments creates a complex mosaic of ecological zones, where both natural processes and human activity shape biodiversity and land cover across the Study area.

Figure 13- 8: Alluvial plains near the Juzna Morava river

Settlements Type

The Project passes directly through several urban and semi urban settlements, as follows:

- Urban: Paracin, Cicevac, Aleksinac,
- Semi-urban (including the settlements Striza, Sikirica, Drenovac, Djunis, Donji Ljubes, Trnjani, Tesica, Grejac and Supovac along the Project route), usually surrounded by agricultural areas, meadows, and patches of bush and higher vegetation.

Figure 13- 9: Paracin - urban settlement type

Figure 13- 10: Semi-urban settlement type

Settlements within the Project area through which the railway passes are closely linked to its presence, as the railway has often defined their origin, structure, and development. In many cases, the railway has served as a central axis of growth, shaping these communities into characteristic railway settlements that remain functionally and spatially dependent on the rail infrastructure.

In larger urban centres, development has typically occurred on one side of the railway, resulting in the railway alignment now forming part of the urban periphery and often acting as a boundary or interface between different parts of the urban fabric. In contrast, in smaller, semi-urban settlements, the railway frequently runs through the settlement core. These areas are often organized around the station and include a small square, shops, a post office, and other communal amenities in close proximity.

In both urban and semi-urban contexts, the railway forms an integral part of the community's collective identity and is embedded in the everyday life of residents. In urban areas, the railway can act as a physical and psychological barrier, creating borders between neighbourhoods and influencing patterns of movement and connectivity. This can lead to challenges such as reduced pedestrian permeability and the segmentation of urban fabric, affecting social cohesion and accessibility. Conversely, in smaller towns and semi-urban contexts, the railway frequently shapes the townscape by defining linear development patterns and becoming a landmark around which community life revolves. The presence of railway buildings, platforms, and associated infrastructure contributes to the character and visual identity of these settlements.

Protected Landscape Areas

The Project corridor directly intersects the internationally recognised Important Bird Area (IBA) Dobric-Nisava, located at the southernmost section of the planned railway route, as shown in Figure 13- 11. In addition, another

IBA, Gornje Pomoravlje is situated within the Study Area, although the railway alignment does not cross into this protected site. These IBAs are part of Serbia's ecological network and are important for the conservation of breeding bird species. Gornje Pomoravlje supports species such as the Common Tern and Common Kingfisher, while Dobric-Nisava provides habitat for the Grey Partridge and Black-headed Bunting.

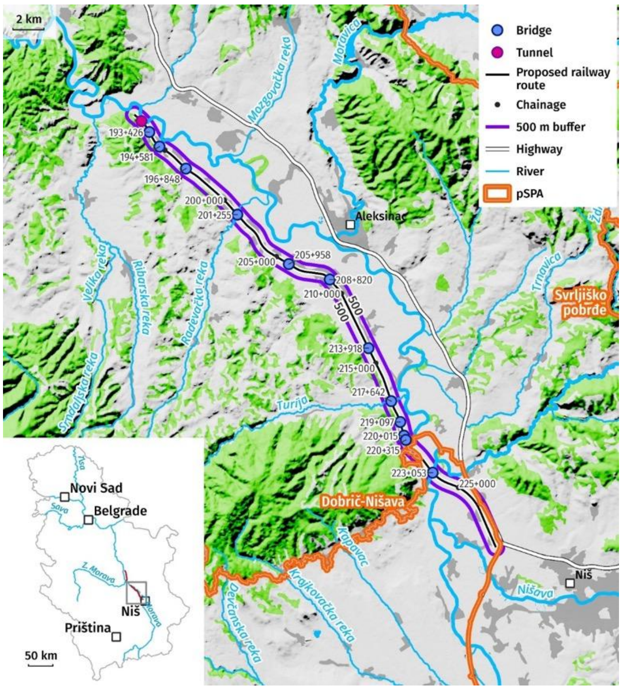

Figure 13- 11: Protected areas Dobric-Nisava and Svrljisko pobrdje

In addition, **several protected areas and sites of high biodiversity value are located in a Study area but are not directly intersected by the alignment**. These include:

- Proposed Special Protection Areas (pSPAs):
- Gornje Pomoravlje
- Dobric-Nisava
- Svrljisko Pobrdje

Potential Sites of Community Importance (pSCIs):

- Velika Morava
- Juzna Velika Morava
- Poslonske Planine
- Obla Glava
- Juzna Morava
- Nis
- Lalinacka Slatina

Landscape of Exceptional Value:

- Mojsinjske planine and Stalacka klisura Juzne Morave
- Gornje Pomoravlje

These areas are recognised for their ecological and landscape value, including diverse habitat types such as wetlands, riparian zones, xerophilous forests, and significant native vegetation like Turkey oak and Moesian beech forests. They also provide habitat for species of national and international conservation concern, such as the European Otter, Southern Festoon butterfly, and Common Noctule bat.

A number of natural monuments are also located within the wider Study area, including:

- Rajkovicev hrast,
- Hrast luznjak u Donjoj Trnavi,
- Wetland ecosystem: Lalinacka Slatina, shown in figure Figure 13- 12, known for its rich biodiversity.

Figure 13- 12: Lalinacka Slatina

Based on current state of the landscape, as well as the fact that the railway alignment already exists and that the new route follows the same or a slightly modified corridor, the Project is not expected to result in significant direct or indirect impacts on the identified protected areas. This is primarily due to their location along less ecologically sensitive zones or at a sufficient distance from the alignment. The Appropriate Assessment of this ESIA concluded that the majority of the Project route follows less ecologically sensitive zones or maintains a sufficient distance from them, with the exception of the pSPA Dobric-Nisava. Accordingly, the part of the Project that passes through the Dobric-Nisava pSPA, specifically in the section around the Juzna Morava River at the end of the Djunis-Trupale subsection, has been defined as a separate sub-receptor in Chapter 13.4.4 to appropriately address potential impacts. Given that a new bridge over the Južna Morava is planned in this section, the abutments of the proposed bridge must be designed to retain habitats along the waterways and allow for the continued movement of species, as specified in the ESMP of this ESIA.

This chapter focuses solely on the visual and physical characteristics of the landscape, including those of the designated protected natural areas. Further details regarding their ecological value, functionality, and management are provided in the Chapter 14 (Biodiversity) of this ESIA.

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Cultural Heritage

According to data from the Institute for the Protection of Cultural Monuments of Serbia[2], there are no officially protected immovable cultural properties located directly along the Project corridor within the Paracin-Stalac and Djunis-Trupale subsections. However, within the broader Study area, several cultural monuments of high value have been identified, including cultural monuments of great importance, archaeological sites, and historically significant structures.

The most notable cultural-historical assets in the Study area include:

- Archaeological Site Motel Slatina near Paracin - identified as an important archaeological locality.
- Medieval Fortress of Stalac - designated as a cultural monument of great importance.
- Monastery of Saint Roman near Djunis - classified as a cultural monument of great importance.
- Trenches from the first Serbian uprising in the village of Deligrad - also, classified as a cultural monument of great importance.

In addition to these, several other immovable cultural properties are present within the Study Area. Notably, five cultural monuments are located within the historical center of the town of Paracin, the nearest of which is approximately 500 meters from the railway alignment. These include preserved examples of residential and commercial architecture, as well as the Memorial to the Fallen Warriors in the First World War and Supovac Tower. Furthermore, within the municipality of Aleksinac, there are 11 registered cultural monuments located approximately 4 km northeast of the Project route, near the settlement of Zitkovac. These include a town villa, historical civic houses, educational and judicial buildings, and the local Homeland Museum, as outlined in Chapter 15 (Cultural heritage) of this ESIA. While these assets are not directly within the Project footprint, their proximity requires appropriate consideration during project planning and implementation, particularly in relation to vibration, noise, and visual impacts.

As outlined in the Chapter 15 (Cultural Heritage) of this ESIA according to the location conditions issued for the Spatial Plan for the special purpose of the railway corridor, **there are no archaeological sites or zones within the Cultural Heritage AoI** (500m either side of the railway line). Figure 13- 13 and Figure 13- 14 below show the cultural heritage sites along the Project route.

2 https://a3.geosrbija.rs/kulturna_dobra

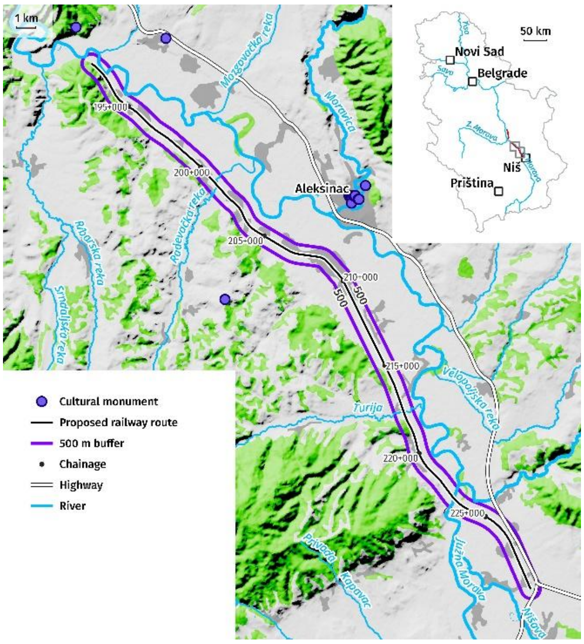

Figure 13- 13: Cultural heritage sites, Paracin-Stalac subsection

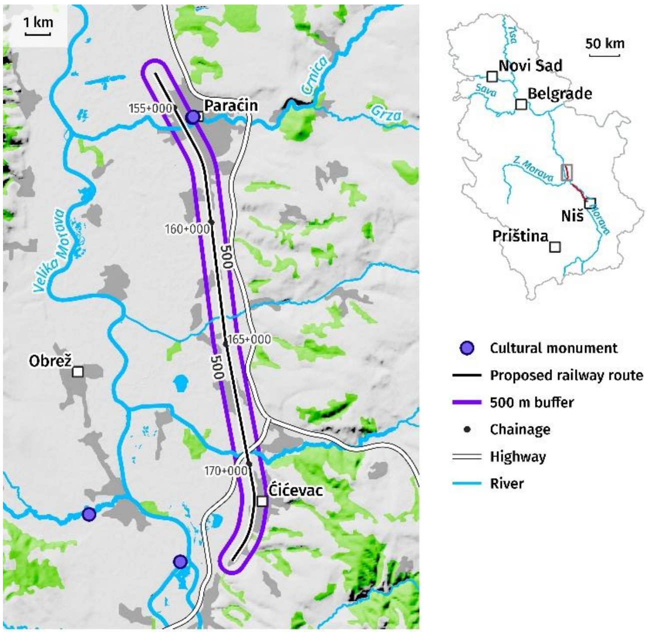

Figure 13- 14: Cultural heritage sites, Djunis-Trupale subsection

Overview of Landscape Receptors

While the landscape functions as an integrated whole, with its elements inherently interconnected in landscape perception, certain areas exhibit distinct characteristics and, consequently, specific sensitivities to the potential impacts of the Project. Although Serbia does not have official Landscape Character Assessments, these areas - Landscape Character Areas (LCA) have been delineated based on observable and consistent features. To avoid generalization and provide a more detailed analysis, the potential impacts of the Project on these specific landscape areas have been assessed. While precise data regarding the size of each zone is unavailable due to challenges in formally defining boundaries between these landscape units, it is evident that some areas are larger than others. These areas are therefore listed below in order of their relative size within the Study area:

- **The Agricultural Plains of Pomoravlje Region**: This landscape character area is characterised by a patchwork of intensively cultivated fields, often forming a mosaic of wheat, maize, sunflower, and vegetable plots, as shown in Figure 13- 15. Fields are typically rectilinear and bounded by narrow access roads or windbreak vegetation, such as lines of poplar or willow. Linear village settlements often occur at the transition between farmland and transport corridors, with low-rise residential clusters, small-scale farm infrastructure, and occasional religious or community buildings acting as landmarks. The edges of settlements gradually blend into the agricultural matrix, marked by utility gardens, fruit trees, and informal paths. This LCA type reflects a transitional rural landscape, where human habitation and productive land use are tightly integrated, and views across the open plains are occasionally interrupted by the rise of river terraces or embankments.
- **Semi Urban Zone with Agricultural Lands**: This LCA covers Cicevac and Djunis region and is defined by fertile, enclosed valleys shaped by meandering rivers and seasonal streams, creating naturally irrigated pockets of agricultural land, as shown in Figure 13- 16. These valley floors are typically cultivated with grains, vegetables, and orchards, taking advantage of the alluvial soils and moisture retention. Settlements are compact and located near water sources, often following the alignment of valley roads. Houses are modest, with traditional, red-tiled roofs, surrounded by utility

gardens, sheds, and small pastures. The intimacy of the valleys contrasts with the openness of larger agricultural plains, giving this character area a more enclosed and tranquil feel, often with limited long-range views due to surrounding topography.

- **Juzna Morava River Valley**: This LCA encompasses the broad, flat alluvial plain immediately adjacent to the Juzna Morava River, where soil fertility and water availability are highest, as shown in Figure 13- 17Figure 13- 16. The landscape is predominantly used for intensive agriculture, with large, geometric fields of corn, wheat, and sunflower. Linear irrigation channels, small dikes, and access tracks form a visible part of the landscape structure. The riverbanks are fringed with dense riparian vegetation, including white willow, poplar, and reed beds, which provide both ecological value and a scenic natural buffer along the watercourse. Occasional floodplain meadows and unmanaged wet grasslands appear in lower-lying zones, especially near tributary inlets or oxbow remnants, enhancing the mosaic-like character of this sub-zone. Settlements are limited in this area due to flood risk, with buildings generally sited on slightly elevated ground or at the foot of the nearby hills.
- **Urban Zones**: This landscape character area features more developed landscape, featuring a mix of residential, commercial, and industrial land uses, such as Paracin, Cicevac and Aleksinac, as shown inFigure 13- 18. Key elements include urban infrastructure such as roads, buildings, and industrial facilities, along with public spaces like parks and cultural landmarks. The area has a higher population density and more diverse land use than the other LCAs in the Study area.
- **Protected Natural Areas**: This LCA encompass protected and ecologically significant areas located along Project's Study Area. It includes various nationally and internationally recognised designations, such as Important Bird Areas (IBA), Proposed Special Protection Areas (pSPAs), Potential Sites of Community Importance (pSCIs), and Landscapes of Exceptional Value. The railway corridor directly intersects the Dobric-Sisava IBA, situated in the southernmost part of the Djunis-Trupale subsection. Several additional ecologically important areas are in proximity to the Project corridor, including the Gornje Pomoravlje and Dobric-Nis pSPAs, as well as multiple pSCIs such as Velika Morava, Juzna Velika Morava, Poslonske Planine, Obla Glava, JuZna Morava, Nis, and Lalinacka Slatina shown in Figure 13- 19. Physically, these landscapes are diverse, and defined by gently undulating terrain, low riverbanks, alluvial plains, and the occasional steep gorge, such as that found in Stalacka klisura. The terrain combines flat agricultural valleys with forested slopes and narrow river corridors, contributing to their ecological richness and visual complexity.
- **Cultural Heritage Features**: While no officially protected immovable cultural properties are located directly along the railway corridor itself, the Study area contains a number of heritage sites, contributing to the cultural value and identity of the landscape. Among the most notable heritage elements are the archaeological site Motel Slatina near Paracin, the medieval Stalac Fortress shown in Figure 13- 20, and the Monastery of Saint Roman near Djunis, all designated as cultural monuments of great importance. In addition, the Deligrad trenches, associated with the First Serbian Uprising, further underscore the region’s historical depth. Physically, this zone is characterised by urban edges, historic town centres, rural settlements, and archaeological landscapes that are spatially embedded within lowland plains and gentle hill slopes. These elements, though not visually dominant from the railway alignment, contribute to the cultural layering of the landscape.

Figure 13- 15: Agricultural Plains of Pomoravlje Region

Figure 13- 16: Semi Urban Zone with Agricultural Lands

Figure 13- 17: Juzna Morava River Valley

Figure 13- 18: Urban Zones, Paracin

Figure 13- 19: Protected Natural Areas

Figure 13- 20: Cultural Heritage Features, Stalac Fortress

13.3.3. Establishing the Visual Baseline

Mapping Visibility

To understand the visual connection with the surrounding area and identify potential visual receptors, a Zone of Theoretical Visibility (ZTV) model was created. This approach was chosen due to the scale of the Project and its placement within complex topography.

The Zone of Theoretical Visibility is a computer-generated model created using QGIS 3.40.0. The model was created based on a Digital Elevation Model (DEM) with a 30 m interval resolution. While this provides a broad understanding of visibility, the model is subject to limitations related to resolution, terrain generalization, and the exclusion of vegetation and built structures, which are not included due to software constraints. The model included key project elements such as the railway, rolling stock, and associated infrastructure, including overpasses, viaducts, bridges, and electrical facilities (PS, PSN, EVP), which in many cases exceed the height of railway vehicles and may contribute to increased visual exposure. As several of these structures are being introduced into the landscape for the first time, their inclusion in the visibility assessment is considered essential. Target points were generally placed at 30 m intervals along the proposed railway and fence line to ensure consistent coverage. However, in areas identified as topographically complex or visually sensitive, such as steep slopes or zones near cultural heritage sites (e.g., the historical center of Paracin), additional, denser point sets were introduced to more accurately capture visibility and receptor interactions. Overpasses and larger structures were represented by 3–5 points each, depending on their length and visual prominence.. For the proposed stations, electrical facilities (PS - sectioning facility, PSN - sectioning facility with neutral section and EVP - Electric traction substation facility),, sets of multipoint were defined. Overpasses, bridges and viaducts were represented by 3-5 points each, depending on their length.

The **height of the target points** was set based on the data from the Preliminary Design, as follows:

- Railway – 5,6 meters (Including one meter for the average embankment and four meters for the height of the railway vehicle)
- Fence - 1.8 meters
- Overpass - 15 meters (Although most of the overpasses are significantly lower, this number was used because it represents the highest point of the several overpasses)
- Bridges and viaducts - 9 meters (While this is the highest bridge, this value was considered to simplify the calculation)
- Stations, PS and PSN Buildings - 9 meters (Nine meters was used for the calculation, as one station building has this height. Although the other buildings are lower, mostly single-story, this value was chosen to simplify the calculation and represent a worst-case scenario)
- **GSM-R Sytem base stations** – 20 meters (total of 9 base stations with a maximum height of 20 m, which include Network switching subsystem - NSS, Base switching subsystem - BSS, Operation support subsystem - OSS and Mobile station - MS)
- Noise barriers – 7 meters (A height of seven meters was used for calculation purposes, although in most locations the actual height of the noise barriers is lower. Heights ranging from five to seven meters are foreseen only in densely populated areas and small settlements organized directly along the railway line)
- Tunnel portals – 7 meters (Two tunnel portals are planned as part of the tunnel on the Djunis-Trupale subsection. Their height is 7 meters, and their total length is 9 meters.)

The observer's sightline was set to 1.7 m. Tunnel pipe (one tunnel at Djunis-Trupale subsection) was excluded from the analysis as they will not be visible, and their construction is not expected to have any impact on the surrounding environment. The tunnel portals were included in the analysis, as explained above. Due to software limitations, underpasses were excluded from the analysis. As they will not be visible except from close proximity, their visual impact will be assessed through receptor-based perception analysis, which will be addressed in detail in Chapter 13.4.5.

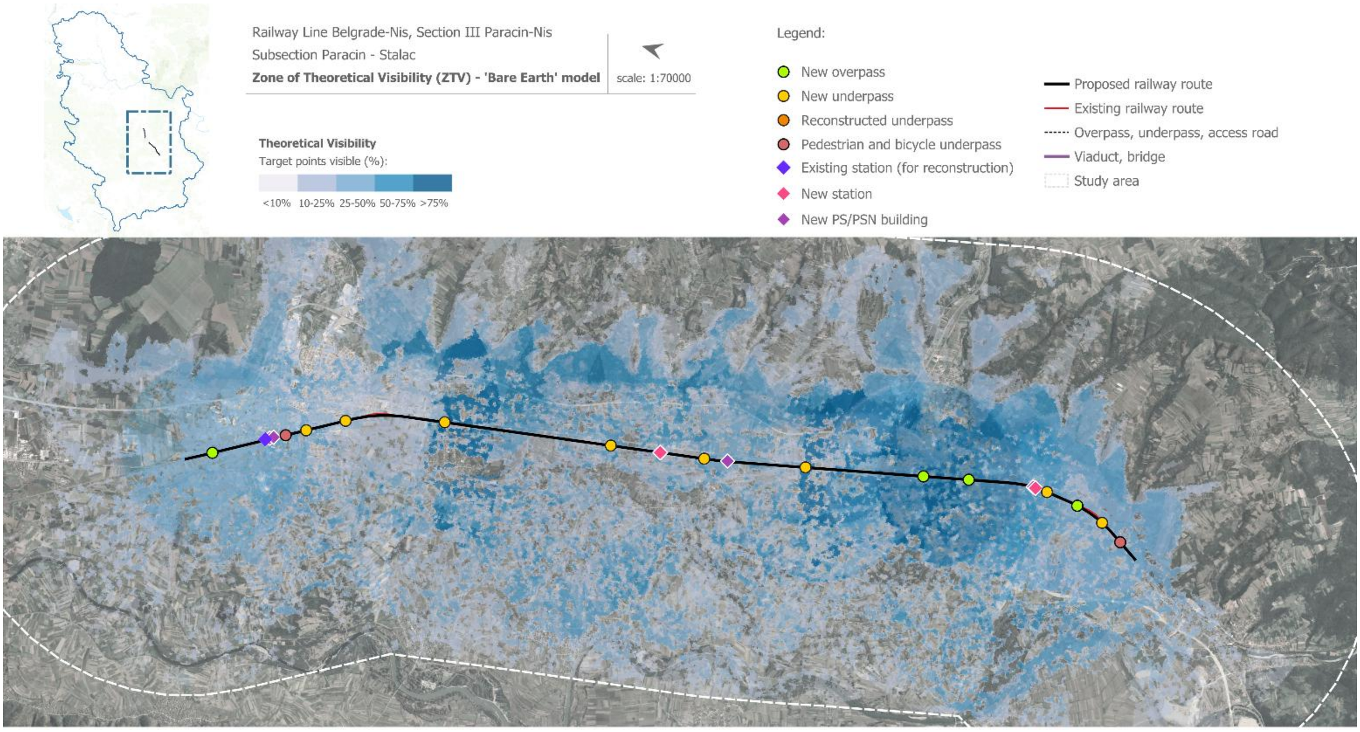

Figure 13- 21: ZTV Bare Earth model for Paracin-Stalac subsection

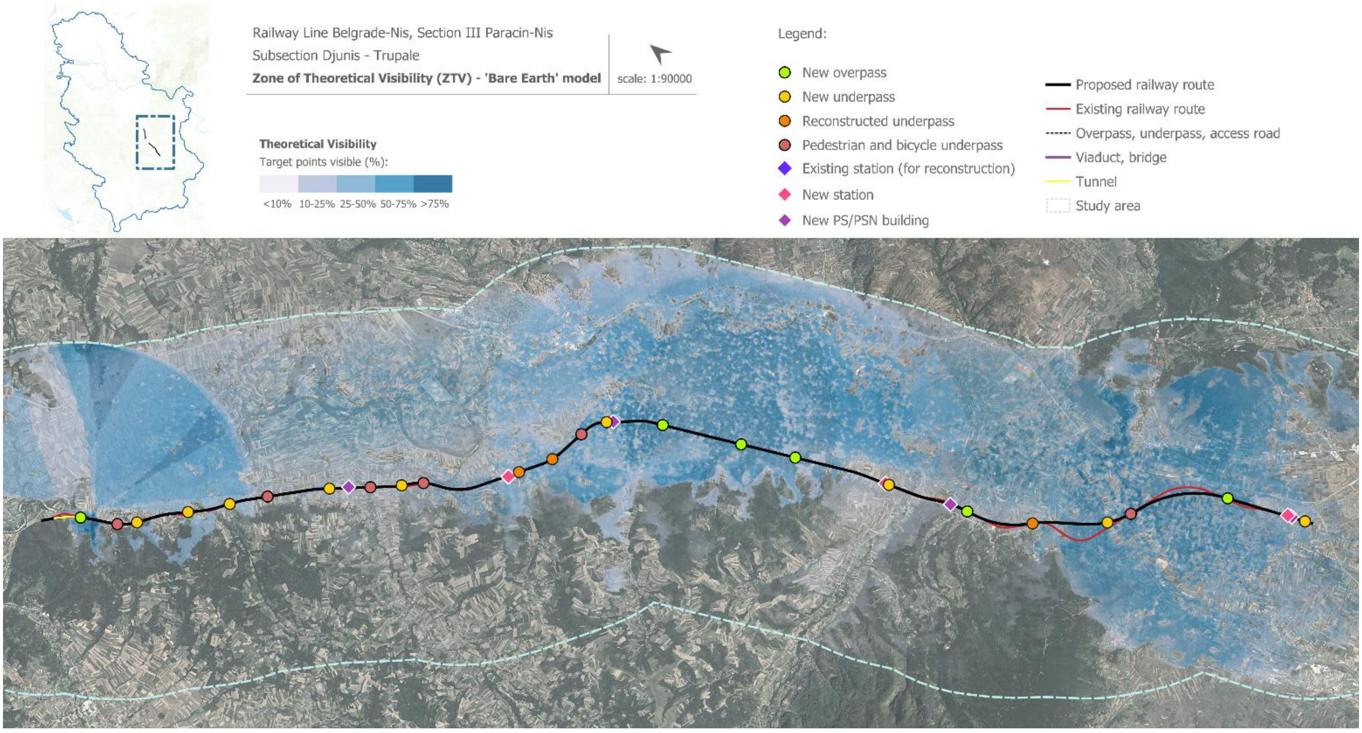

Figure 13- 22: ZTV Bare Earth model for Djunis-Trupale subsection

The resulting gradual model presents the zone of theoretical visibility - locations that have visual connections with the alignment. 'Bare-earth' model, shown in Figure 13- 21 and Figure 13- 22 Figure 13- 21 Figure 13- 22 represents a 'worst-case scenario', based solely on topography and not taking vegetation or artificial obstacles (such as buildings, fences, or barriers) into account. The darker the colour, the higher the percentage of target points that will be theoretically visible from the surrounding location. The analysis has indicated that certain points along the Project alignment may be theoretically visible from distances of up to 5 kilometers. While this level of visibility is technically possible, it is considered less likely in practice due to the presence of intervening elements such as vegetation, built structures, and other landscape features. Nevertheless, this distance has been adopted as the basis for delineating the Study area, in order to ensure that all potential visual receptors are accurately identified and assessed.

In the Paracin-Stalac subsection, the relatively flat terrain allows for moderate visibility extending along both sides of the railway. Visibility generally reaches up to approximately three kilometers toward the northeast, while in the southwest direction, it extends up to a maximum of around five kilometers.

Along the Djunis-Trupale subsection, visibility is limited to the northeastern side of the alignment, while the opposite side gently slopes, meaning the railway will not be visible from these areas, except in the southern part of the subsection. Here, on the southwest side, there is an elevation from which the alignment will again be visible. The ZTV 'Bare Earth' model for both sections has shown that certain infrastructure elements, particularly the overpasses, will be significantly more visible compared to other project elements, due to their size and height.

It is important to note that just because visibility in an area is low (e.g., less than 25% of the total study points visible), it does not necessarily imply that the visual impact will be low. The visible target points might represent features, such as a bridge or an overpass, which could be more visually intrusive than a railway tracks.

The ZTV was initially defined with a radius of up to 5 km, based on the assumption that this distance generally encompasses any significant visual impacts of the railway. This is under the premise of ideal conditions, including clear visibility, flat terrain, the Earth's curvature, and the absence of visual obstructions. However, in real-world conditions, the presence of vegetation, structures, and other potential obstructions must be considered. Therefore, prior to identifying visual receptors, it is essential to account for these factors in the analysis.

To illustrate this, an additional ZTV map has been developed showing the woodland cover in the Study area (based on the EU Corine Land Cover 2018), as shown in Figure 13- 23 and Figure 13- 24. The woodland screening map highlights areas of vegetation where the Project is likely to be obscured and thus not visible. It serves as a complementary layer to the Bare Earth model, which only accounts for terrain elevation and does not include vegetation. It is also important to note that most of the woodland cover at the location is deciduous, and the project's visibility will change with the seasons. This means that the Project may be more visible from woodland areas during the winter.

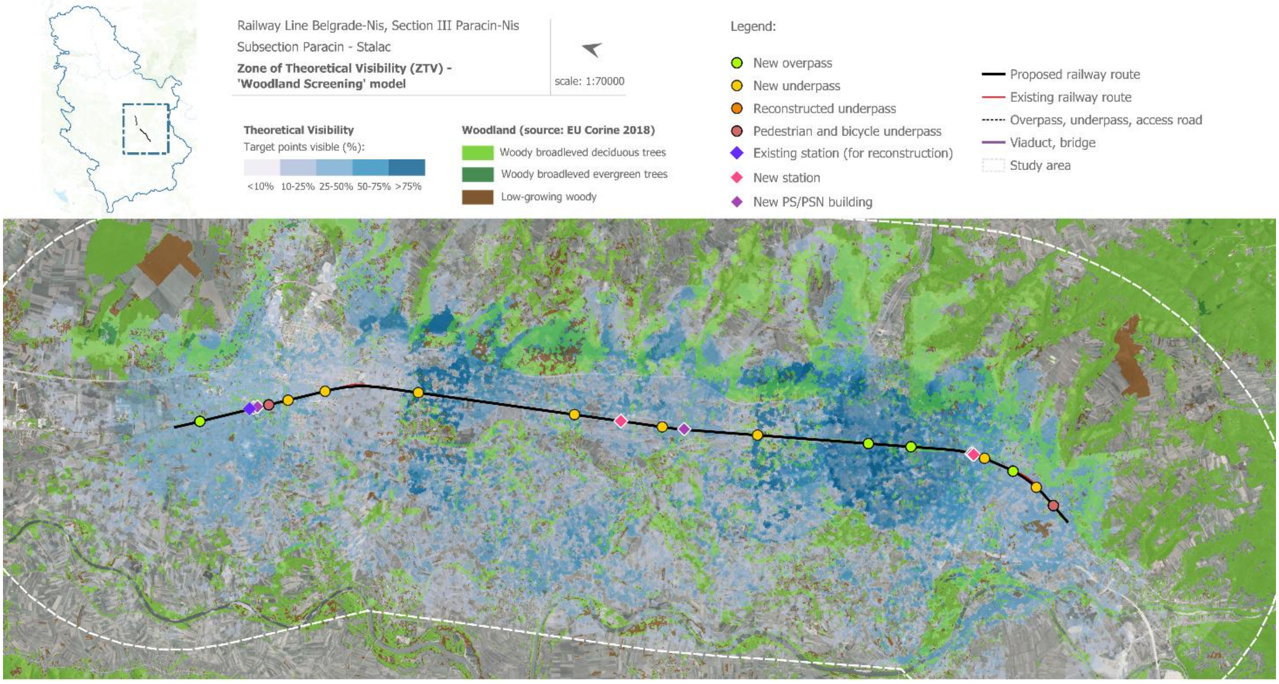

Figure 13- 23: ZTV Woodland Screening model for Paracin-Stalac subsection

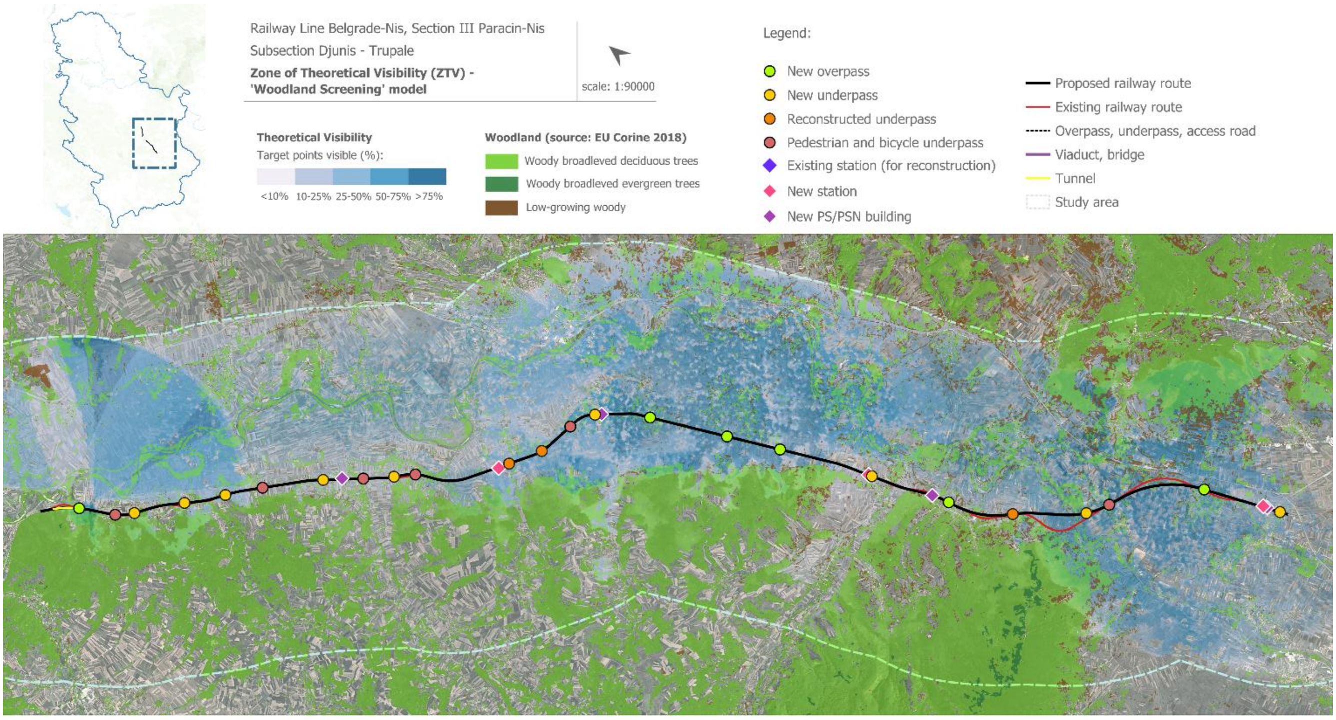

Figure 13- 24: ZTV Woodland Screening model for Djunis-Trupale subsection

According to the GLVIA3 methodology applied, where the ZTV has been defined as 5 kilometres, the following distance bands represent the potential extent of visual influence on receptors, as shown below in the Table 13- 1:

Table 13- 1: Viewpoint distance and impact table

Distance	Impact
0–100 m	Immediate surroundings, construction impacts, dominance
100–500 m	Intermediate effects, integration in context
500 m-2 km	Wider landscape, cumulative context, transitions
2-5 km	Distant receptors, scenic/heritage views, skyline impacts

In line with this, the receptors, as well as the potential impacts of the Project on their visual experience will be analysed in the following chapters.

Overview of Visual Receptors

Visual receptors are individuals within the area who will be affected by changes in views and visual amenity. This section outlines the primary groups of visual receptors identified along the Project route. Given the scale and complexity of the alignment, and to facilitate a clearer understanding of the receptor types and their spatial relationship to the proposed development, the receptors are further detailed and contextualized through accompanying maps presented in the Chapter Sensitivity of Visual Receptors.

The groups of visual receptors within the study area include:

- Residents: The Study area includes several settlements, namely Paracin, Cicevac, Aleksinac, Striza, Sikirica, Drenovac, Djunis, Donji Ljubes, Trnjani, Tesica, Grejac, and Supovac. Depending on their location, residents will experience varying degrees and types of views toward the Project. Most residential buildings are not oriented towards the railway line, but rather face small local roads, which serve as the primary access routes within the settlements. Those living near the railway alignment and associated infrastructure, are expected to be the most affected by visual changes. Residents located further from the alignment may also have intermittent views of the Project from their homes, depending on their specific micro-location. Except for Paracin and Cicevac, where a limited number of low-rise apartment buildings (typically 4-5 storeys) are present, most residential structures within the study area are low-rise, single-family homes, generally consisting of a ground floor and one upper floor. These are typically surrounded by private plots of varying size, often with mature vegetation. As a result, even properties located near the alignment may not have direct views of the Project due to existing natural screening. In several smaller settlements, such as Drenovac, Korman, and Trnjani, the railway line passes directly through the center of the village,**and influences the spatial relationship between the settlement.**. Residents in these areas are long accustomed to living and moving near the railway. This is particularly evident in smaller, predominantly residential communities where houses are located immediately adjacent to the railway alignment, with little to no presence of industrial zones, unlike in larger urban settlements.
- Workers in the urban and industrial zones: Within urban areas, the Project route predominantly passes through peripheral industrial zones. Workers employed in these facilities may have direct or distant views of the Project, depending on their proximity.
- Workers in agricultural areas: Given that a significant portion of the railway alignment passes through large expanses of arable land, agricultural workers are identified as one of the relevant receptor groups. Cultivated fields are present along most of the Project route, particularly between smaller settlements located adjacent to the railway. An exception is the area around Vitkovac, where a coniferous forest dominates the landscape on one side of the railway. Agricultural work often involves prolonged periods outdoors. Given that a significant portion of the Project route traverses arable land, it is expected that workers operating in the fields will have unobstructed, close-range views of the Project.
- Tourists: Although there is no precise data available on the number of tourists visiting local attractions, those referenced in Chapter Cultural Heritage include several cultural monuments of great national significance, forming an integral part of Serbia's cultural heritage and warranting careful consideration. These sites are not in close proximity to the Project, as outlined in Chapter 15 (Cultural Heritage). Potential visual interaction with the Project corridor is expected to be limited, primarily occurring during the approach to these sites, rather than from within the sites themselves, where views are often screened by surrounding vegetation or built structures.
- Travellers passing state and local roads: Several roadways run parallel to, or in proximity with, the railway alignment between Paracin and Trupale. These include state roads No. 158 and No. 217 between Zitkovac and Tesica, as well as local roads Djunis-Zitkovac and Tesica-Trupale routes. These roads follow the broad valley of the Morava River, and in certain sections, they align almost directly with the railway corridor. The travellers are usually residents commuting for work, schoolchildren, and other local users. The number of transient or long-distance travellers is relatively low, given the proximity of the Belgrade-Nis highway, which serves as the primary transit route and runs near the railway alignment within the Study area.

13.4. Assessment of Impacts

13.4.1. Methodology

The Environmental Impact Assessment (EIA) procedure in the Republic of Serbia is governed by the Law on Environmental Impact Assessment, which aligns with the European EIA Directive[3]. Although a robust EIA framework exists, Serbia currently lacks formal guidance specific to Landscape and Visual Impact Assessment (LVIA). As a result, all assessments related to landscape and visual impacts are prepared in accordance with the principles of the following guidelines, recognised as industry best practices in the UK and aligned with EU requirements:

- Guidelines for Landscape and Visual Impact Assessment (GLVIA) Third Edition (2013[4]),
- Technical guidance note (TGN): Assessing Landscape Value Outside National Designations[5],
- Guideline for landscape character and visual impact assessment, Environmental impact assessment practice notes EIA-N04 (2020)[6],
- Environmental impact assessment practice note EIA-N04 - Guideline for landscape character and visual impact assessment, (2020) Version 2.2 - Centre for Urban Design, Transport for New South Wales,
- Photography and Photomontages in Landscape and Visual Assessment Landscape Institute, (2011), Landscape Institute Advice Note 01/11;
- Visual Representation of Development Proposals (2019) - Landscape Institute Technical Guidance Note 06/19;
- An Approach to Landscape Character Assessment (2014) - Natural England;
- An Approach to Landscape Sensitivity Assessment - To Inform Spatial Planning and Land Management (2019) - Natural England;
- Reviewing Landscape Visual Impact Assessments (LVIAs and Landscape and Visual appraisals (LVAs) Technical Guidance Note 1/20 Landscape Institute.

The LVIA distinguishes between landscape effects (changes to the landscape as a resource) and visual effects (changes in views and visual amenity), assessing both short-term construction and long-term operational impacts. Within this assessment, two different but inseparable aspects of landscape and visual amenity have been analysed:

- Landscape: crucial component of the distinctiveness and uniqueness of any local area taking its character from different elements such as landform, land use, land pattern, vegetation, open spaces and cultural heritage sites, settlements type and all the effects and changes those settlements make and have made during the years.
- Visual amenity: considered view to the Project site and from the Project site. Views and how people perceive space is a crucial component of the landscape itself.

The methodology involves an iterative combination of desk study and field survey, using satellite imagery, project documentation, and terrain studies. The following stages have been performed while conducting the assessment of both landscape and visual impacts:

- Assessment of the existing situation,
- Review of the relevant guidance and spatial planning policy,
- Review of all the Project documentation relevant to the assessment,
- Assessment of local landscape character,

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3 (85/337/EEC, 97/11/EC, 2003/35/EC, COM 2009/378, codified by Directive 2011/92/EU, and amended by Directive 2014/52/EU)

4 https://www.landscapeinstitute.org/technical/glvia3-panel/

5 https://www.landscapeinstitute.org/publication/tgn-02-21-assessing-landscape-value-outside-national-designations/

6 https://www.transport.nsw.gov.au/system/files/media/documents/2023/guideline-landscape-character-and-visual-impact.pdf

- Identification of potential landscape and visual receptors,
- Site visit to confirm the potential visual receptors assumptions,
- Assessing the receptors in terms of their sensitivity and susceptibility to change,
- Identification of potential impacts associated with the Project, during both construction and operational phase,
- Assessing overall effect on all receptors,
- Identification of mitigation measures where needed.

The initial stage of the landscape and visual assessment involved identifying both landscape receptors (elements of the landscape likely to be affected by the Project) and visual receptors (people who will be exposed to views of the Project) and assessing their sensitivity. The sensitivity of these receptors was determined by evaluating their susceptibility to change and the inherent value associated with each view or landscape area, as detailed in the Table 13- 2 below:

Table 13- 2: Receptors sensitivity

Sensitivity	Receptors	Context, Value, Quality	Susceptibility to Change
High	Visual Amenity: Many viewers including static viewpoints such as residential property and major tourist attractions.	Residential areas; high quality public open space; visitors/users of recreational, historical or cultural sites where landscape is a significant factor in its enjoyment (such as long-distance trails, protected areas, UNESCO world heritage sites) Examples of receptors: residents, tourists, visitors to scenic viewpoints, users of protected recreational areas). High susceptibility to change.	**High**
	Landscape: recognised at national and international levels and other good quality, often designated landscape.	Strong and good quality landscape with many features worthy of conservation, high value and often designated landscape of high importance. Areas with strong integrity and high susceptibility to visual change.	
Medium	Visual Amenity: Several viewers, longer transient views such as from public open space and recreational areas.	Retail areas, offices, formal sports facilities where landscape is secondary to enjoyment of the sport; outdoor workspaces; user of scenic roads; railways or waterways; users of touristic routes; schools and other institutional buildings and their outdoor areas. Moderate susceptibility to change.	**Moderate**
	Landscape: Pleasant but unremarkable landscapes.	A reasonably attractive landscape with a mix of attractive features and intrusive elements. Pleasant but unremarkable. Moderate importance. Some ability to absorb change due to mixed character or existing alterations.	
Low	Visual amenity: Several viewers, longer transient views such as from public open space and recreational areas.	Viewers with short-term or incidental views where visual amenity is not central to the activity (e.g. workers in industrial areas, shoppers in commercial zones, indoor workers in medium quality landscape; passengers in public transport on main arterial routes; users of recreational facilities)Low susceptibility to change.	**Low**

	Landscape: Landscapes of poor quality and low importance.	Poor quality landscape of low importance, with detracting features and intrusive features but with occasional attractive features and elements, with greater capacity to absorb further change.	
Negligible	Visual amenity: very few viewers; fast transient views such as from vehicles along roads.	Industrial area, land awaiting development; indoor workers in poor quality landscape; users of large main roads. May be upgraded if context involves sensitive settings (e.g. national parks or heritage sites).	**Negligible**
	Landscape: degraded or disturbed landscapes.	A degraded or disturbed landscape, typically awaiting development. Many unattractive and intrusive elements, litter and dirt. Poor quality landscape of very low importance, only used when supported by contextual justification.	

As part of the assessment, the **value of the potentially affected landscape** should be defined. However, since there is no specific guidance on LVIA in Serbia and no LCA are being performed and published, the following factors were considered to identify the value of a landscape[7]:

- Landform: natural or anthropogenic land features that define the terrain,
- Landcover: surface components of land that are physically present and visible, usually referred to as vegetation,
- Settlements: places where people established a community and whose features shape the landscape,
- Landscape quality (condition): A measure of the physical state of the landscape, including the intactness of the landscape and the condition of individual elements,
- Scenic quality: The term used to describe landscapes that appeal primarily to the visual sense,
- Rarity: The presence of rare elements or features in the landscape,
- Representativeness: Whether the landscape contains a particular character and/or features or elements which are considered particularly important examples,
- Conservation interests: The presence of features of wildlife, earth science or archaeological or historical and cultural interest can add to the value of the landscape as well as having value,
- Recreation value: Evidence that the landscape is valued for recreational activity where experience of the landscape is important,
- Perceptual aspects: A landscape may be valued for its perceptual qualities, notably wildness and/or tranquillity.

According to the GLVIA, the value of the potentially affected landscape is defined on a verbal descriptive scale. Therefore, this assessment adopts the standard categories: exceptional, good, pleasant but ordinary, poor, and damaged, as described in Chapter 13.4.4. These categories provide a qualitative measure of the intrinsic importance and quality of the landscape, reflecting factors such as scenic quality, cultural significance, rarity, recreational value and others. To ensure a consistent and transparent evaluation process, these value categories are integrated with the sensitivity scoring framework. Landscape sensitivity considers both the value of the landscape and its susceptibility to change from the proposed project. Thus, a landscape classified as ‘exceptional’ or ‘good’ typically corresponds to a higher sensitivity score, while ‘poor’ or ‘damaged’ landscapes generally exhibit lower sensitivity. This combined sensitivity score is then used alongside the magnitude of change anticipated from the project within the impact assessment matrix. The matrix systematically evaluates the significance of potential impacts by correlating

7 The list of factors is complementary to Guidance on Landscape and Visual Impact Assessment, Third edition

landscape sensitivity with the magnitude of visual or physical change. Consequently, the initial landscape value categories serve as a foundational input that influences overall impact conclusions, ensuring that higher-value and more sensitive landscapes receive appropriate consideration.

After assessing the sensitivity of landscape and visual receptors, the next step included evaluating the magnitude of effect to properly identify the interactions between these receptors and various components of the development at different stages. The following criteria were used to assess this magnitude:

- Size or scale of the effect,
- Affected geographical area,
- Duration of the effect,
- Reversibility of the effect,
- Type of the effect (is it direct or indirect).

Both judgement on sensitivity of the receptor and judgement on magnitude of change generated overall impact evaluation. The following impact evaluation matrix was used, shown in Table 13- 3 below.

Table 13- 3: Impact evaluation matrix

		Magnitude of change			
		Adverse			
		Major	Moderate	Minor	Negligible
Receptors Sensitivity	High	Major	Major	Moderate	Negligible
	Medium	Major	Moderate	Minor	Negligible
	Low	Moderate	Minor	Negligible	Negligible
	Negligible	Minor	Negligible	Negligible	Negligible

For the selected viewpoints, where groups of highly sensitive receptors are located and where a high magnitude of change is anticipated, photomontages have been prepared to illustrate the expected visual impact. These are presented in the chapter Overview of Viewpoints and Views.

The photomontages were developed using a combination of QGIS 3.40.0, SketchUpPro 2025, and Adobe Photoshop 2025. Following the identification of key viewpoints, site photographs were taken in the field and then georeferenced, with the viewing direction and angle of view determined accordingly.

As the Preliminary design does not provide detailed specifications for certain project components, such as fences, noise barriers, and similar features, generalised modelling was carried out in SketchUp. This was based on descriptions available in the preliminary design documentation, including dimensions such as height and length. Since material specifications have not yet been finalised, typical materials were assumed and illustrated based on international examples of modern railway infrastructure. The resulting visualisations serve as an initial tool for understanding the likely visual effects of the Project. However, it is important to note that a detailed 3D model and specifications for all elements should be developed at the Main Design stage. At that point, this LVIA study should be updated accordingly to reflect the final design details.

13.4.2. Assumptions and Limitations

The following **assumptions** and exclusions were made while preparing this chapter:

- The maximum height of the rolling stock will be 5,6 meters, which is used for calculating the zone of theoretical visibility.
- It is assumed that planting for visual screening will reach a height of over 6 meters by the 10th year of operation, with monitoring and replanting undertaken to ensure successful growth
- Stockpiled mounds of material will have a maximum height of 2 meters, as specified in Environmental and Social Management Plan (ESMP).
- The Zone of Visual Influence has been prepared based on available GIS Data at the time of production.
- It is assumed that there will be no visual impact on the environment where Project is located within the tunnel.
- Properties within the Project's footprint will be subject to physical resettlement, ensuring affected individuals and communities are adequately compensated.
- Assumptions have been made regarding the nature of the view (e.g., short or long distance, enclosed or open) and the associated receptors (e.g., residents and workers) based on the information gathered to date from the desk study and site visits. Where the nature of the view is transient, such as from a vehicle, the orientation of the viewer has been specified (e.g., when looking in a westerly direction).
- The assessment assumes that the screening benefit provided by existing and proposed vegetation is reduced during the winter months due to the absence of foliage on broadleaved trees. However, broadleaved vegetation has been proposed in mitigation measures, despite its reduced winter screening capability, because it consists of native species that reflect the character of the existing landscape.
- The assessment presents a worst-case scenario, particularly concerning viewpoints and visual impact. Many residents will not have a view similar to those from designated viewpoints due to factors such as the orientation of objects, their position within the settlement, other objects in the foreground, and local vegetation.
- The noise mitigation measures are planned for all residential and other sensitive areas that will be exposed to noise levels exceeding the limits established by Serbian legislation and Project standards.[8] However, specific designs for noise barriers have not yet been defined. Their final design will be crucial in determining the extent of potential visual impacts, particularly in settlements located near the railway. Among the mitigation measures outlined in the chapter 0, it is specified that residents should be consulted in the process of selecting the noise barrier design.

The following **limitations** influenced development of this chapter:

- Site visits conducted during specific seasons may not fully capture the variability in landscape visibility and character, especially in forested and agricultural areas where seasonal changes can significantly affect visual impact.
- Limitations in GIS and 3D modelling software could impact the accuracy of visualizations, particularly for simulating viewpoints in urban and rural areas.
- No landscape groups (LCAs) have been defined at the national level in Serbia or for the wider project. The landscape character has been assessed using aerial photography, satellite imagery, field survey photographs, and publicly available data, based on the criteria mentioned in Chapter 13.3.2.

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8 As explained in ESIA Chapter 1-3

- Cultural heritage assets are assessed primarily as points of interest and for visitor experience, rather than through a comprehensive cultural heritage impact assessment (this is covered in Chapter 15 of this ESIA, Cultural Heritage).
- While recommended, the effectiveness of mitigation measures in eliminating visual impacts may be limited, especially in locations exposed to significant intrusive elements such as high and large overpasses.
- Representative viewpoint locations have been identified solely from publicly available places (such as local community squares and roads). According to GLVIA standards, representative viewpoints are selected from the most sensitive publicly accessible locations. This approach ensures that the assessment reflects the experience of the wider public and key receptors. While it is acknowledged that impacts within private properties (such as a private yard) may be somewhat more pronounced, for the purpose of group assessment and field verification, the viewpoint is taken from the nearest publicly accessible point to the most sensitive receptors, typically a road or public space adjacent to the private area in question.
- Changes in land use, vegetation, or construction activities along the Project area between the conducted study and project implementation could alter the baseline landscape and visual conditions.

13.4.3. Overview of Potential Impacts

Contextual parameters shaping visual and landscape perception

In order to form a well-founded assessment of the Project impacts, it is important to highlight several key considerations, which will be referenced throughout following chapters:

- The railway line is already an established feature and forms part of the broader contextual landscape of each settlement along the route. Since the first train passed along this track in 1884, the railway has become an integral part of the region's identity, forming an essential element of the *genius loci*, the distinctive character and spirit of the place, and serving as one of the keys identifying features of this area. Residents are accustomed to its presence as a visual element within the landscape, as well as through associated experiences. The fact that the project primarily involves reconstruction, rather than entirely new development, suggests that potential visual impacts may be perceived as less intrusive due to the pre-existing alignment. It is difficult to consider the train itself as a significant source of visual impact, given that its presence is momentary and transient. Its influence is more strongly perceived through the experience of sound and vibration, rather than through any lasting visual effect. While receptors will inevitably observe the train as it passes, this occurrence is brief and episodic, representing a short-term event within the landscape rather than a permanent visual element.
- The newly planned stations and technical buildings along the alignment have been designed to integrate with the existing environment in terms of scale and materials. These are predominantly small, rectangular, single-storey buildings clad in brick. While receptors in close proximity to these structures will experience some degree of visual impact, the modest scale of the buildings suggests that the impact will be limited. Moreover, the analysis did not identify a consistent or distinctive architectural character within the surrounding settlements. Instead, these areas are composed of a variety of architectural styles, largely developed in an unplanned and organic manner.
- Changes to the landscape will also result from the introduction of supporting infrastructure, with overpasses and noise barriers being the most prominent elements. These structures, previously absent in the area, are now being introduced with substantial dimensions dictated by technical regulations. As such, they may appear incongruous and visually intrusive, particularly within rural settings where their scale and form contrast sharply with the existing landscape character.
- All bridges planned for reconstruction at the locations of existing structures are expected to have a reduced visual impact compared to the current ones. The existing bridges are predominantly constructed with large steel trusses, which are highly visible in the landscape. In contrast, the newly designed structures will utilize concrete support systems, resulting in a lower overall profile. As a result, only the safety railing will be visible above ground level, thereby significantly minimizing their visual prominence within the surrounding environment. In the Figure 13- 25

below, the current appearance of the bridge is shown, featuring tall steel trusses, while the newly designed bridge, shown in Figure 13- 26 will have only railings or noise barriers above ground level, without a tall structural framework.

Figure 13- 25: Current bridge over Morava river

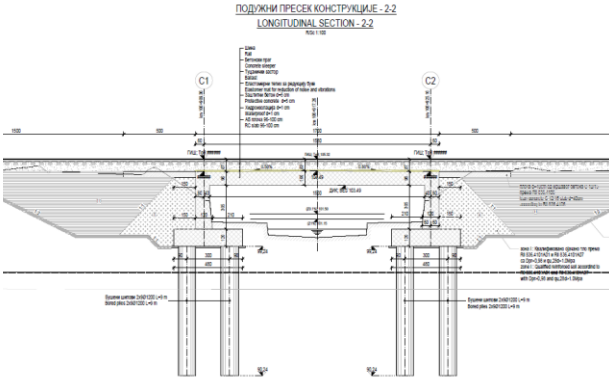

Figure 13- 26: Planned bridge over Morava river

Impacts during construction phase

The railway impact on landscape and visual amenity occurs during the construction phase, as well as during operational phase, which will be addresses separately. As the landscape is considered as an integrated whole, the various impacts become inherently interconnected, collectively shaping the way it is perceived. These impacts influence both landscape and visual receptors, albeit to differing extents. To accurately determine the interaction between the Project and its surroundings, the following potential impacts during construction phase, on both visual and landscape receptors have been identified:

- **Clearance of vegetation and disruption of arable fields**: This will occur across all landscape character areas, though to a limited extent overall. The most notable impacts will occur in rural areas where the railway deviates from the existing alignment to accommodate new construction. In these locations, the permanent loss of both natural vegetation and cultivated land will contribute to a visible alteration of the landscape, potentially resulting in visual degradation, particularly in areas characterised by open rural settings and small agricultural settlements.
- **Permanent alteration of landscape character within the railway corridor**: Visual and landscape transformations are expected only in sections where the railway alignment deviates from the existing corridor. In areas such as between Veliki Drenovac and Vrtiste at subsection Djunis-Trupale, where such deviations occur through rural, mostly flat terrain with scattered settlements, the introduction of new rail infrastructure will have a more noticeable impact. However, compared to the overall scope of the reconstruction works, these deviation sections represent a smaller portion of the alignment.
- **Permanent landform modifications from cuts and embankments**: Although the terrain is relatively flat, much of the Project will involve the construction of embankments. While these embankments will generally not be visible from populated areas, except to the nearest receptors, in sections where the railway alignment deviates, particularly between approx. km 219 and km 229, the formation of embankments and cuttings will locally alter the predominantly agricultural landscape, which is otherwise characterized by open arable fields and farmland.

- **Expropriation and removal of existing structures**: Properties located within the revised railway alignment will be subject to expropriation. Demolition of buildings and other infrastructure may result in both visual and physical changes to the landscape character.
- **Temporary land use changes for construction compounds and machinery**: The establishment of construction compounds, use of heavy machinery, and associated infrastructure (e.g., signage, fencing, lighting) will temporarily dominate the visual environment, particularly near sensitive receptors like residential areas.
- **Light pollution:** Night-time construction works may introduce light pollution, especially in rural or otherwise dark-sky areas, such as Vrtiste, Moravac, Zitkovac and Vitkovac along the Djunis-Trupale subsection, and Drenovac and Striza along the Paracin-Stalac subsection. This could impact nearby residents and sensitive visual receptors by disrupting the natural nightscape and the area's tranquil character.
- **Dust pollution**: Construction dust may cause temporary discomfort for residents especially near settlements Vrtiste, Moravac, Zitkovac and Vitkovac along the Djunis-Trupale subsection, and Drenovac and Striza along the Paracin-Stalac subsection.
- **Traffic Disruption**: Increased construction traffic and temporary road closures, particularly near key crossings or the sole access points in settlements, may cause significant inconvenience for residents and temporarily alter the visual and functional character of the area, as shown in Figure 13- 47

Impacts during operational phase

Following potential impacts during operational phase, on both visual and landscape receptors have been identified:

- **Permanent structures in the landscape, overpasses and noise barriers**: The overpasses represent the most visually prominent elements of the Project due to their scale and structural form. They will be visible from multiple settlements and a variety of viewing positions along the corridor. Their visual impact will be particularly pronounced in flat, open landscapes dominated by agricultural land, where the absence of built structures and natural vertical elements accentuates the sense of openness, making the overpasses more conspicuous, such as for example in Figure 13- 48. There are total of 11 overpasses planned: overpass at km 169+159.51, km 170+132.23, km 172+515.95 along the Paracin-Stalac subsection, and km 193+051.67, km 210+360.94, km 212+668.35, km 214+249.68, km 219+404.75 and km 227+126.66 along the Djunis-Trupale subsection. On the Paraćin-Stalac section, a total of 26,348 meters of noise barriers is planned for the 15-year projection scenario, and 27,032 meters for the 30-year scenario. For both timeframes, a total length of 52,700 meters is planned on the Djunis-Trupale section, as outlined in the Draft Chapter 12 - Noise and Vibration.
- **Increased Traffic**: The movement of trains, particularly if visible from the village, can disrupt the area's tranquillity by introducing dynamic visual elements. This effect is likely to be more pronounced in rural areas; however, most agricultural fields are actively cultivated unless they fall within settlement boundaries, meaning the landscape cannot be considered entirely untouched or pristine.
- **Lighting and Signage**: Railway signage and lights can introduce light pollution at night, affecting the visual environment and potentially reducing the settlement’s dark sky quality.

Loss of Visual Connections: The railway construction will result in a physical division within certain settlements, limiting sightlines between different parts of the community and altering the spatial relationship between built-up areas and the surrounding landscape. This effect will be particularly evident in settlements that historically developed around the railway itself, such as Paracin, Stalac and Zitkovac, where the alignment runs through the center and influences the spatial arrangement and connectivity of different parts of the settlement, such as for example in Figure 13- 46.

13.4.4. Landscape Impact Assessment

Sensitivity of Landscape Receptors

According to the *Guidelines for Landscape and Visual Impact Assessment (GLVIA 3rd edition)*, landscape value refers to the relative importance ascribed to a particular landscape by society, based on its distinctive qualities and attributes. Establishing landscape value is a critical first step in determining a landscape's sensitivity to change.

Within the railway corridor, one regionally recognised natural heritage feature is identified, the Dobric-Nisava IBA, as detailed in Chapter 13.3.2. Aside from this designation, the landscape along the railway corridor does not include other formally protected or uniquely valued features.

The general condition of the landscape is good, although localised degradation is visible in areas affected by industrial facilities and associated infrastructure. The predominant landscape character consists of extensive agricultural plains and small rural settlements located along the railway, reflecting a long-standing human influence on the area. These elements are characteristic of eastern Serbia, defined by wide river valleys, dispersed settlements, low rolling hills, and open arable fields.

Despite its coherence and functionality, the landscape does not exhibit notable landmark features or rare visual elements that would confer a distinctive sense of place or elevate its aesthetic or cultural value. All visible landscape elements, such as agricultural fields, scattered settlements, and low vegetation, are representative of the broader regional character and do not include distinctive natural or cultural features that would elevate the landscape value. This conclusion is based on both field observations and reference to national and regional landscape typologies.

Given these observations, the landscape may be described as **visually pleasant but generally ordinary**.

In addition to the general value of the landscape, assessing the sensitivity of the landscape areas as a receptor is crucial for evaluating the potential effects of the Project, as discussed in Chapter 13.4.1. The analysis has revealed that the area consists of several interconnected yet distinct zones, each with varying levels of sensitivity. Their sensitivity was assessed based on Table 13- 2, and is shown in the Table 13- 4 below.

Table 13- 4: Sensitivity of landscape receptors

LANDSCAPE RECEPTORS	DESCRIPTION	RECEPTOR SENSITIVITY
Urban zones	Given the long-standing interaction between human activity and the environment, and the dominance of built features such as residential, commercial, and industrial infrastructure, this landscape character area is considered having **low sensitivity**. The high level of development and diverse land use patterns have already significantly shaped the landscape, reducing its vulnerability to further visual or functional transformation.	**Low**
The agricultural plains of Pomoravlje region	This landscape character area has **low sensitivity** to change due to its extensively developed and managed nature. The area consists primarily of intensively cultivated fields and settlements, with few natural features remaining. Human activity dominates the landscape, with agricultural use, linear infrastructure, and low-rise residential clusters forming a consistent and well-established pattern.	**Low**
Semi urban zone with agricultural lands	The landscape within this LCA is predominantly managed, with traditional agricultural practices and modest residential development closely aligned with water sources and valley roads. While the terrain feels more enclosed than open plains, the visual and ecological structure is stable and long altered by human use. Given the long-standing human presence and the functional, utilitarian land use, the area is assessed as having **low sensitivity** to change.	**Low**
Juzna Morava river valley	Despite the structured farmland and visible irrigation infrastructure in this LCA, the river corridor remains ecologically valuable, with dense riparian vegetation,	**Medium**

	willows, poplars, and reeds providing natural habitat. Pockets of unmanaged wet grasslands and floodplain meadows add to its ecological diversity. Given the presence of a largely intact river ecosystem and its relative distance from the Project corridor, this area is assessed as having **medium sensitivity** to change.	
Protected natural areas	This LCA includes several ecologically significant areas within the Study Area, such as the Dobric-Nisava IBA, which is directly intersected by the railway and considered of **high sensitivity**. Other protected sites, including pSPAs (Gornje Pomoravlje, Dobric-Nis), pSCIs (e.g., Velika Morava, Juzna Morava), and Landscapes of Exceptional Value, are located nearby but not directly affected, and thus have **medium sensitivity**. The physical landscape features a mix of river valleys, forested slopes, and alluvial plains, contributing to high biodiversity and visual diversity.	Dobric-Nisava IBA - **High** Other areas - **Medium**
Cultural heritage features	While no officially protected immovable cultural properties are located directly along the railway corridor itself, the Study Area contains several important heritage sites, such as the archaeological site Motel Slatina near Paracin, the medieval Stalac Fortress, the Monastery of Saint Roman near Djunis, and the Deligrad trenches from the First Serbian Uprising. These sites contribute significantly to the cultural identity of the region. However, due to their distance from the railway corridor, these cultural monuments are considered to have **medium sensitivity**, as they are not in immediate proximity to the Project.	**Medium**

Analysis of Potential Impacts

Impacts during construction phase

Table 13- 5 below summarizes the impacts on landscape receptors during the construction phase.

Table 13- 5: Summary of potential landscape impacts and effects during construction phase

LANDSCAPE RECEPTORS	IMPACT ANALYSIS	RECEPTOR SENSITIVITY	MAGNITUDE OF CHANGE	SIGNIFICANCE OF EFFECT
Urban zones	The high level of development and diverse land use patterns have already significantly shaped the landscape, reducing its vulnerability to further visual or functional transformation. During the construction phase, there may be temporary disruptions to the landscape, primarily due to the need for earthworks, excavation, and the installation of new infrastructure such as pedestrian overpasses, bridges, and railway stations. These activities could result in localized changes to the terrain and vegetation, especially in areas where additional structures are being introduced or where ground levelling is required. The movement of heavy construction machinery and equipment could lead to noise, dust, and temporary access restrictions for local communities. While these impacts may cause short-term alterations to the visual and functional characteristics of the area, they are expected to be limited to the immediate construction zones and will largely be reversed once the works are completed.	**Low**	Moderate	**Minor Adverse**
The agricultural plains of Pomoravlje region	Dominated by intensively cultivated fields, scattered settlements, and linear infrastructure, this LCA presents a stable and predictable pattern with few remaining natural features. Agricultural land use and low-rise residential clusters are widespread, forming a visually cohesive yet utilitarian setting. Construction works will lead to temporary alterations in the land use, with construction zones disrupting agricultural activities and requiring the realignment of existing access roads or farm pathways. The presence of heavy machinery and construction equipment will result in localized disturbances, including noise, dust, and temporary restrictions to movement for residents and agricultural workers. There is also a potential for temporary fragmentation of larger agricultural plots due to the construction of new infrastructure, which may disrupt the flow of farming activities and alter the spatial organization of the landscape. However, these impacts will be short-term and localized, and once the project is completed, the landscape is expected to return to its more established and predictable patterns, with only minor long-term changes.	**Low**	Moderate	**Minor Adverse**
Semi urban zone with agricultural lands	Although the terrain offers a more enclosed feel due to surrounding hills and vegetation, the landscape structure is stable and reflects a well-established pattern of mixes residential and agricultural land use. Its sensitivity to change is considered low, as the functional characteristics are already defined by the infrastructure. During the construction phase, earthworks will be needed for the installation of embankments, reconfiguration of the railway alignment, and the construction of new fencing and infrastructure. This will lead to temporary disruption of agricultural land and settlement access, as construction zones may block or reroute roads and paths. The presence of heavy machinery and construction traffic will create noise and vibration, potentially affecting both the residential and agricultural activities nearby.	**Low**	Moderate	**Minor Adverse**
Juzna Morava river valley	Despite its ecological significance, the area is situated at a considerable distance from the Project corridor, resulting in a medium sensitivity to change. Elsewhere along the Djunis-Trupale subsection, the railway generally runs parallel to the river with sufficient offset to minimize direct impacts. Given the distance of the majority of the	**Medium**	Minor	**Minor Adverse**

	river course from the Project, no significant disturbances are expected during the construction phase. Sections of the river that are in close proximity to the Project have been addressed below as a sub-receptor.			
Juzna Morava sub-receptors (Djunis tunnel section and Bridge Construction Zone)	Within the Djunis-Trupale subsection, near Vitkovac at approx. km +193, the current railway alignment runs directly adjacent to the river. The proposed Project includes a tunnel at this location, which will significantly reduce direct interaction with the river corridor. Also, the planned new bridge over the Velika Morava near Supovac at approx. km +229 will replace an existing structure, resulting in a slight shift in its position. Construction of the new bridge may have more significant temporary impacts on the river ecosystem, particularly during earthworks and the installation of the new structure. Construction activities such as dredging, piling, and changes to riverbed profiles could disrupt the natural habitat and water flow in the immediate vicinity. Sedimentation and noise from construction machinery may also temporarily affect aquatic life.	**High**	Major	**Major Adverse**
Protected natural areas	This landscape character area encompasses several ecologically significant sites within the Study Area, including the Dobric-Nisava Important Bird Area (IBA), which is directly intersected by the railway route and is therefore considered of high sensitivity. In contrast, other protected areas are in the vicinity but are not directly traversed by the Project. In the southernmost section of the Djunis-Trupale subsection (from km +221 to km +229.600), where the route intersects the Dobric-Nisava IBA, the most significant impacts are expected during the construction phase, particularly due to the major alignment deviation in this part of Section 3. Anticipated construction impacts include vegetation clearance, soil erosion, sedimentation, potential disturbance to bird nesting areas, and increased noise and vibration, all of which could affect sensitive species and habitats, such as sedentary and nocturnally active organisms, as outlined in Chapter 15 on Biodiversity.	Dobric-Nisava IBA - **High** Other areas - **Medium**	Major to Moderate	Dobric-Nisava IBA - **Major Adverse** Other areas - **Moderate Adverse**
Cultural heritage features	Cultural heritage sites contribute significantly to the cultural identity of the region. Due to their distance from the railway corridor, these cultural monuments are considered to have medium sensitivity. Given this distance, no significant impacts are anticipated during the construction phase. The heritage sites are far enough from the railway alignment that construction activities, such as earthworks, excavation, or noise from machinery, are unlikely to directly affect these areas. Furthermore, any indirect impacts related to vibrations or dust would be minimal, given the spatial separation between the Project route and these protected cultural assets.	**Medium**	Minor to Negligible	**Minor Adverse to Negligible**

Impacts during operational phase

Table 13- 6 below summarizes the impacts on landscape receptors during the operational phase.

Table 13- 6: Summary of potential landscape impacts and effects during operational phase

LANDSCAPE RECEPTORS	IMPACT ANALYSIS	RECEPTOR SENSITIVITY	MAGNITUDE OF CHANGE	SIGNIFICANCE OF EFFECT
Urban zones	The high level of development and diverse land use patterns have already significantly shaped the landscape, reducing its vulnerability to further visual or functional transformation. As such, the magnitude of change introduced by the railway reconstruction is expected to be minor. Since the railway is an existing feature within this landscape and the project largely involves upgrades within the current alignment, any alterations will integrate into the existing urban fabric with minimal disruption. Impacts on landscape are likely to be limited and localized, primarily associated with the introduction of new fencing, minor structural works, or station upgrades, none of which are expected to significantly alter the area's visual character or identity. The installation of railway fencing may contribute to a urban fragmentation, an effect that is however already present due to the physical division created by the existing railway.	**Low**	Moderate	**Minor Adverse**

The agricultural plains of Pomoravlje region	Dominated by intensively cultivated fields, scattered settlements, and linear infrastructure, this LCA presents a stable and predictable pattern with few remaining natural features. Agricultural land use and low-rise residential clusters are widespread, forming a visually cohesive yet utilitarian setting. However, the railway reconstruction will introduce new linear and structural elements that may alter the functional landscape patterns, such as the reconfiguration of access routes, changes in land division, and potential fragmentation of agricultural plots. While these modifications align with the existing anthropogenic character, they represent a moderate magnitude of change in landscape structure and land use dynamics.	**Low**	Moderate	**Minor Adverse**
Semi urban zone with agricultural lands	Although the terrain offers a more enclosed feel due to surrounding hills and vegetation, the landscape structure is stable and reflects a well-established pattern of mixes residential and agricultural land use. Its sensitivity to change is considered low, as the functional characteristics are already defined by the infrastructure. However, the railway reconstruction will introduce physical alterations to land patterns, such as new embankments, fencing, or minor realignments, that may influence drainage flows, land access, and spatial continuity. These interventions will bring a moderate magnitude of change to the landscape, primarily through the modification of its functional and spatial organisation rather than its inherent character.	**Low**	Moderate	**Minor Adverse**
Juzna Morava river valley	Despite its ecological significance, the area is situated at a considerable distance from the Project corridor, resulting in a medium sensitivity to change. Elsewhere along the Djunis-Trupale subsection, the railway generally runs parallel to the river with sufficient offset to minimize direct impacts.	**Low**	Minor	**Minor Adverse**
Juzna Morava sub-receptors (Djunis tunnel section and Bridge Construction Zone	Within the Djunis-Trupale subsection, near Vitkovac at approx. km +193, the current railway alignment runs directly adjacent to the river. The proposed Project includes a tunnel at this location, which will significantly reduce direct interaction with the river corridor during the operational phase. Also, the planned new bridge over the Velika Morava near Supovac at approx. km +229 will replace an existing structure, resulting in a slight shift in its position. While this may introduce localized changes, the overall impact on the river ecosystem is expected to be minimal during the operational phase, as the area is already influenced by the presence of the existing bridge.	**High**	Minor	Djunis Tunnel Construction area **- Minor Adverse** Bridge Construction area **- Moderate adverse**
Protected natural areas	This landscape character area encompasses several ecologically significant sites within the Study Area, including the Dobric-Nisava Important Bird Area (IBA), which is directly intersected by the railway route and is therefore considered of high sensitivity. In contrast, other protected areas are located in the vicinity but are not directly traversed by the Project. In the southernmost section of the Djunis-Trupale subsection (from km +221 to km +229.600), where the route intersects the Dobric-Nisava IBA, Project may lead to long-term changes to the landscape. These changes may include altered habitat connectivity, potential disturbance from increased railway operations, and the ongoing presence of the railway infrastructure in an ecologically sensitive area. However, as the landscape is already influenced by human activity, these impacts are likely to be moderate, with long-term alterations to local biodiversity and habitat dynamics expected but not necessarily severe.	Dobric-Nisava IBA - **High** Other areas - **Medium**	Major to Moderate	Dobric-Nisava IBA - **Major Adverse** Other areas - **Moderate Adverse**
Cultural heritage features	Cultural heritage sites contribute significantly to the cultural identity of the region. Due to their distance from the railway corridor, these cultural monuments are considered to have medium sensitivity. In the operational phase, no significant long-term impacts are expected, as the heritage sites are sufficiently distant from the railway alignment. The ongoing railway operations, including noise and vibration, are unlikely to directly affect these cultural assets. Furthermore, the presence of the railway infrastructure, although noticeable in the broader landscape, is not expected to alter the historical character or integrity of the cultural heritage sites over time, given the spatial separation and established context.	**Medium**	Minor to Negligible	**Minor Adverse to Negligible**

13.4.5. Visual Impact Assessment

Sensitivity of Visual Receptors

Visual Receptors defined in Chapter 13.3.3 are assessed based on their sensitivity. The initial section of this chapter provides a review of the receptor groups identified, along with an assessment of their overall sensitivity, based on the methodological framework outlined in the chapter 13.4.1. The subsequent section presents a detailed spatial analysis of the most sensitive receptors, taking into account both their proximity to the Project and the nature of the planned interventions. This analysis is supported by appropriately referenced maps, offering clear visual context for the assessment.

- Residents: Residents across all settlements along the Project corridor will have static views of the railway infrastructure. Depending on their specific micro-location, these views may be unobstructed or partially screened by existing structures or vegetation. Given the predominantly flat terrain, direct views of the Project will typically be limited to the first row of buildings oriented toward the railway. Structures located behind these frontline properties, although physically close, will generally have only intermittent or dynamic views of the railway, depending on visibility gaps. As the railway already exists, the majority of residents will primarily perceive the addition of the new fence as a static visual element, while the passing train will only occasionally appear within their view. The most notable realignment occurs between km +224 and km +227, near the settlement of Supovac, where the railway will be shifted approximately 450 meters northward. As a result, the railway will appear smaller and more distant when viewed from the settlement, thereby reducing its visual prominence. Another deviation will occur between the settlements of Grejac and Veliki Drenovac, where the alignment will be shifted approximately 90 meters to the northeast and a viaduct will be constructed. Due to the presence of a wooded area between the existing railway and the planned viaduct location, it is expected that most residents will not have a direct line of sight toward this section. Residents living near the planned overpasses, particularly in the settlements of Cicevac, Moravac, Nozrina, Grejac, and Vrtiste will have direct views of these structures. Given their scale, the overpasses will become prominent visual features within the landscape. *Consequently, the sensitivity of residents in these areas is high, while residents in other parts of the corridor are assessed as having medium sensitivity due to their location and limited visual exposure.*
- Workers in urban and industrial areas: Within urban areas, the project route predominantly passes through peripheral industrial zones. Workers employed in these facilities may have direct or distant views of the Project, depending on their proximity. However, due to the nature of their work, *these receptors are considered to have medium to low sensitivity.*
- Workers in agricultural areas: Agricultural work often involves prolonged periods outdoors. Given that a significant portion of the Project route traverses arable land, it is expected that workers operating in the fields will have unobstructed, close-range views of the Project. Certain elements, such as overpasses, are likely to be more visually intrusive than features like fencing but will nonetheless be visible. While these workers are considered exposed due to their presence in open areas, *their sensitivity is assessed as medium*, considering the functional nature of their activities and the limited focus on surrounding visual conditions during the course of their work.
- Tourists: Tourists visiting the locations identified in Chapter 13.3.2 may experience limited visual interaction with the Project corridor, primarily during their approach to the tourist sites, rather than from within the sites themselves. For instance, visitors to the Tower of Todor, a medieval fortress and cultural monument of great importance near Stalac, will not have a direct view of the Project, as the site is located approximately four kilometers from the southernmost section of the Paracin-Cicevac alignment. Similarly, visitors to the archaeological site Motel Slatina, situated near the outer edge of the Study Area in the Glavica settlement, will not have visibility of the Project due to distance and terrain configuration. The Monastery of Saint Roman, located near Dunis and classified as a cultural monument of great importance, lies

approximately 600 meters east of the Project corridor. Although visitors to the monastery will not have views of the railway from within the monastery complex itself, owing to the surrounding dense forest, they may experience partial visibility of the Project during their approach, particularly the newly planned overpass at km 193+051.67. For other cultural monuments located in Paracin and Aleksinac, all of which are situated within the historical urban cores, views of the Project are not anticipated. These monuments are generally surrounded by existing buildings and greenery, which serve as natural visual buffers. Visitors engaging in recreational hiking at a few locations across the relatively flat terrain may have intermittent, long-distance views of the linear railway corridor. However, given the presence of the existing railway infrastructure, such views are unlikely to result in significant visual disturbance. For example, hikers on the elevated terrain northwest of Supovac may obtain distant views of the planned railway deviation toward the northeast. Nonetheless, due to the dense woodland cover of the area, the sensitivity of this receptor group is assessed as low. Finally, it is noted that a considerable number of tourists in the region are transit passengers traveling between Belgrade and Nis, many of whom use the railway network. *Overall, based on their locations and nature of exposure, the overall sensitivity of the tourist receptor group is assessed as medium to low.*

- Travellers passing state and local roads: Several roadways run parallel to, or in proximity with, the railway alignment between Paracin and Trupale. These include state roads No. 158 and No. 217 between Zitkovac and Tesica, as well as local roads Djunis-Zitkovac and Tesica-Trupale routes. These roads follow the broad valley of the Morava River, and in certain sections, they align almost directly with the railway corridor. As such, the railway will be intermittently visible to road users, particularly along segments where roads run parallel and near the Project alignment. Visual attention may occasionally be drawn to specific infrastructural elements such as newly constructed overpasses, especially where these are located near the road network. However, considering that the railway already exists in this area, and acknowledging that drivers are generally focused on the act of driving rather than on the surrounding landscape, *the overall visual sensitivity of this receptor group is assessed as low.*

In the subsequent section of this chapter, ZTV maps, shown at a larger scale in Chapter 13.3.3, are here further divided into several parts in order to illustrate the relationship between the receptors and the changes brought about by the Project. Their exposure, as well as the nature and type of views they may have toward the Project, will also be addressed.

Subsection Paracin-Stalac

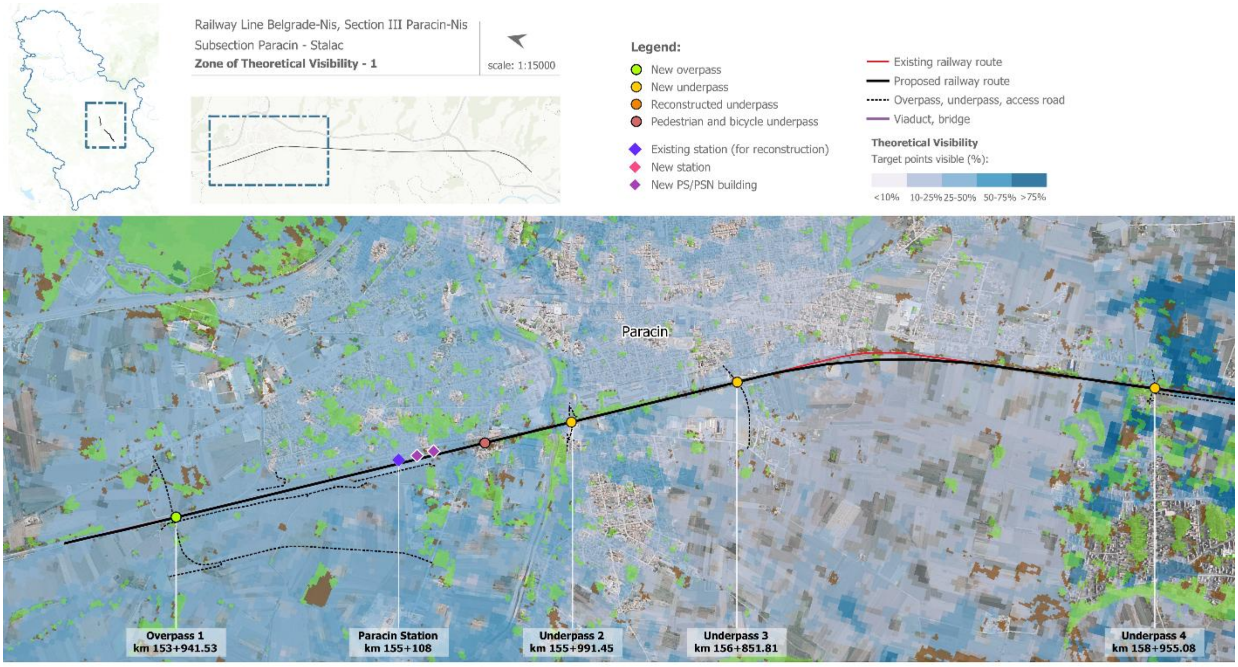

Figure 13- 27: Paracin-Stalac subsection, Overview of visual receptors - 1

Workers in the industrial zone located outside the center of Paracin, as well as agricultural workers positioned on the opposite side of the railway, will experience intermittent views of Overpass 1 at approx. km 153+941.53. The overpass will be visible in the lower section of their visual field. Due to the presence of existing vegetation, particularly along road 158, the visibility of the overpass will be partially obstructed, with views being sporadic or fleeting.

The existing stations and two new technical structures planned at approx. km 155+108 will be visible only to a few residential buildings in proximity. Due to the presence of the road in between, these structures will not dominate the view of the surrounding environment, nor will they be visible beyond the first row of buildings to other receptors. Underpass 2 and 3 at km 155+991.45 and km 156+851.81 will be visible only to a few residential buildings in close proximity to these structures. They will appear in the lower portion of their view and are unlikely to be visible from the interiors of these buildings. Additionally, they will not obstruct the view of the surrounding environment nor block natural light. In the segment between km 156+851.81 and km 158+955.08, the railway and trains will be visible from a distance, but their presence is not expected to cause substantial changes to the overall visual perception of the surrounding environment. Underpass 4 at km 158+955.08 will be visible only from a limited number of nearby residential properties due to its proximity. Positioned below ground level, it will occupy the lower portion of the viewers' sightlines, without significantly altering the overall visual context of the surroundings.

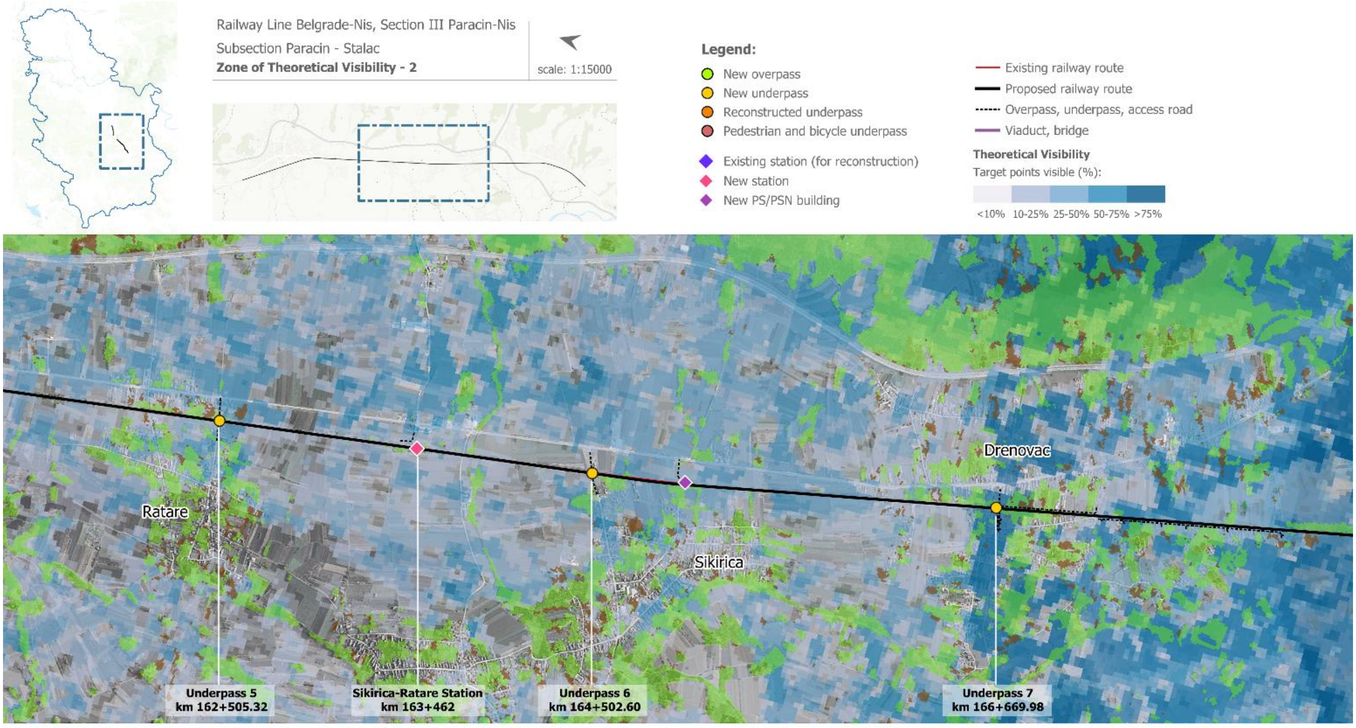

Figure 13- 28: Paracin-Stalac subsection, Overview of visual receptors - 2

In the central part of the Paracin-Cicevac subsection, there are relatively few sensitive receptors in close proximity to the Project. Workers in the fields surrounding the railway and residents at a distance will primarily see the new fence and the train in the distance. However, the railway will not dominate their visual experience, except when in immediate proximity. Only two settlements, Ratare and Drenovac, are directly crossed by the railway. In these areas, in addition to the fence and railway, underpasses will be present through the center of the settlements. These will only be visible to the immediate surroundings of the railway and will occupy the lower portion of the sightlines. The remaining visual experience will remain largely unchanged, with the fence occasionally visible. The new Sikirica-Ratare station will be constructed at approx. km 163+462, but there are no sensitive receptors nearby. It will be visible to workers in the fields at a distance. The station building is a single-story structure with a relatively small volume. Residents of Sikirica will see the new technical building in the distance, which will be of small dimensions. Additionally, they will be able to observe the access roads and underpass as they approach the Project site.

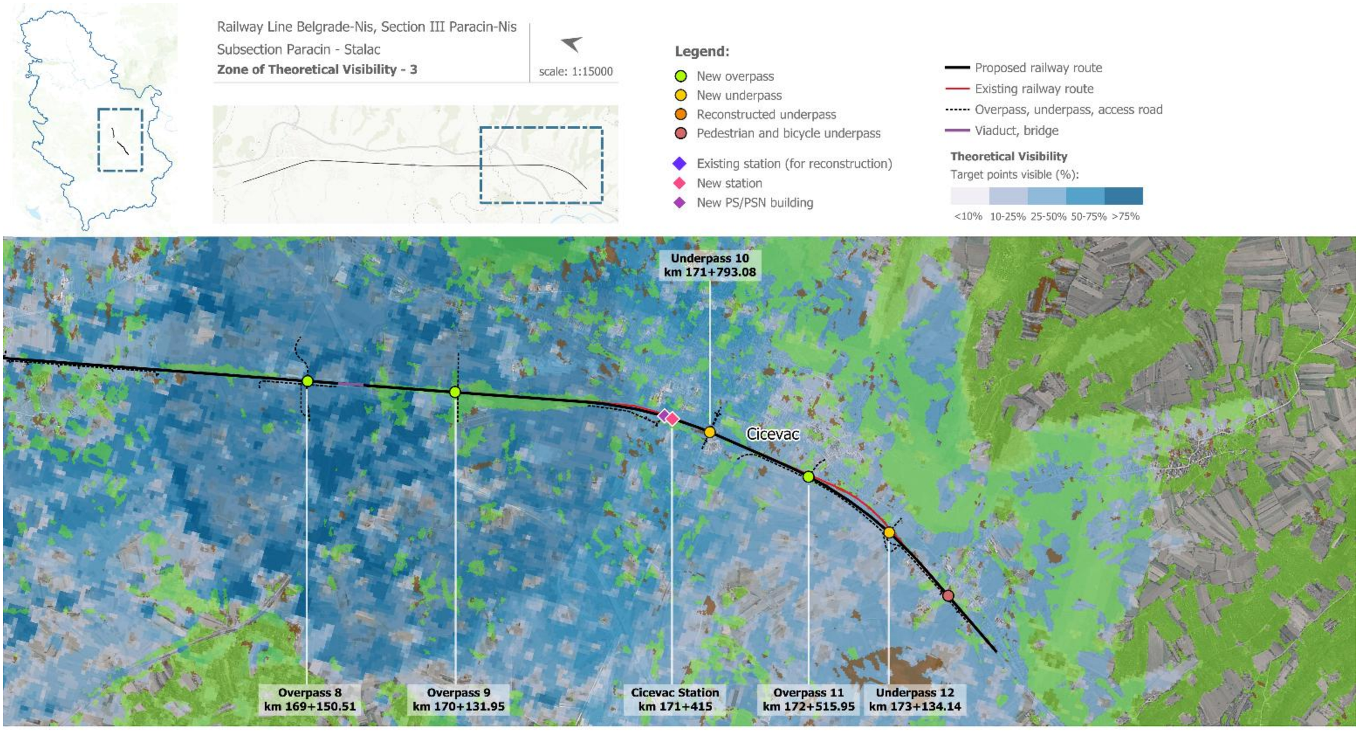

Figure 13- 29: Paracin-Stalac subsection, Overview of visual receptors - 3

The ZTV model of the final part of the Paracin-Cicevac subsection indicates that two overpasses at km 169+150.51 and km 170+131.95 will be visible and will dominate the surrounding flat terrain. However, receptor analysis shows that there are no particularly sensitive receptors in these areas, as the surrounding land is predominantly agricultural. For workers in these fields, the overpasses will appear as new structures and will be visible from a distance. As they approach the project site, these structures will dominate the area. The southernmost part of the route, where it ends in Paracin, shows that the most prominent object will be overpass located at km 172+515.95. The closest sensitive receptors, residents, are situated approximately 80-100 meters away and will be able to see both the access roads and the 14-meters-high overpass itself. The houses are oriented towards local road 2b, meaning most residents will likely see the overpass from their side rooms or from the backyards. The remaining residents will view the overpass from a distance, while local vegetation present in the southeastern part will block much of the view toward this area.

Subsection Djunis-Trupale

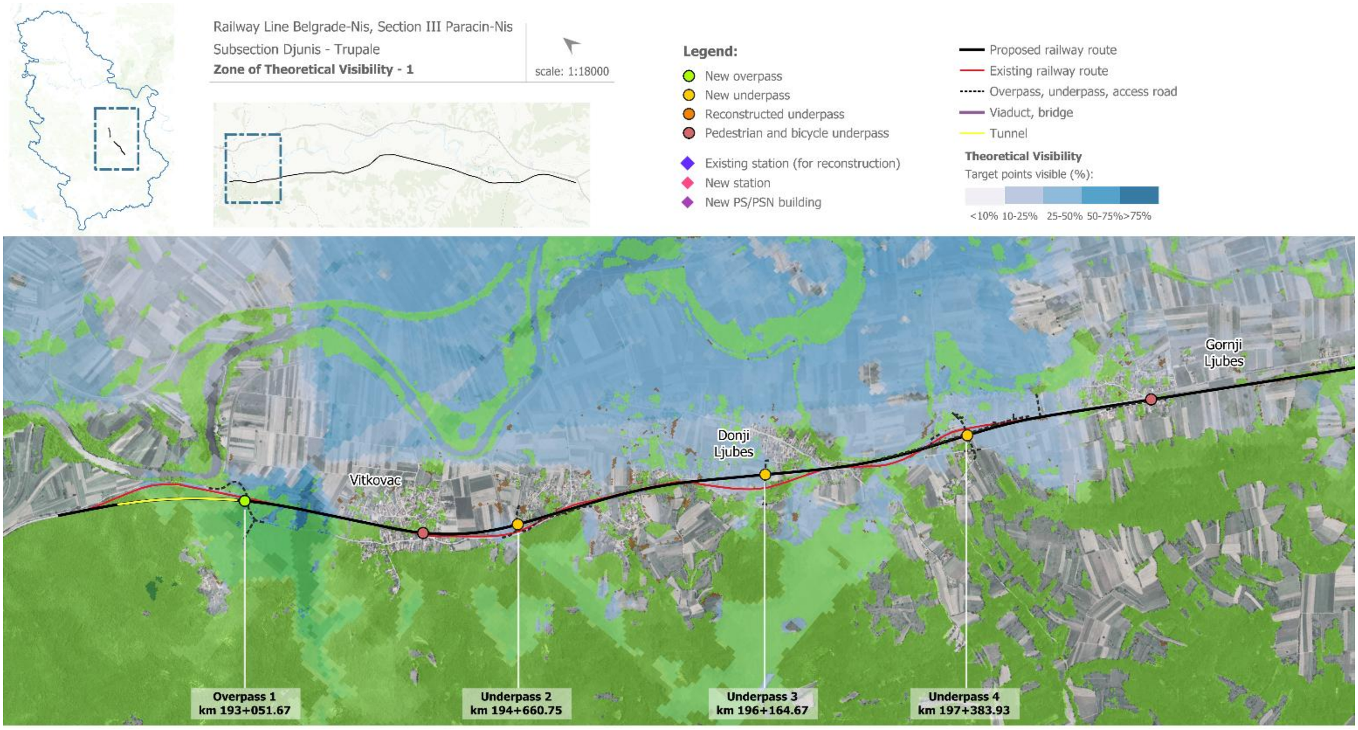

Figure 13- 30: Djunis-Trupale subsection, Overview of visual receptors - 1

Within the initial section of the Djunis-Trupale alignment, receptors situated to the northeast of the railway corridor are expected to experience varying degrees of visibility of the Project components from different locations, depending on local topography and vegetation. In contrast, receptors located to the southwest are visually shielded by existing forest cover, which will act as a natural visual barrier, significantly reducing or entirely obstructing direct views toward the railway. Tourists approaching the Monastery of Saint Roman, a designated cultural monument of high importance located near Djunis, may have intermittent views of the railway and the proposed overpass at km 193+051.67 during access to the site. However, due to the dense forestation surrounding the monastery itself, no visual exposure to the Project is anticipated from within the grounds of the monument. In Vitkovac, residential receptors will have direct visibility of the reconstructed railway fence and intermittent views of passing trains. A new pedestrian and bicycle crossing is proposed at the location of the existing level crossing. This structure will be visible primarily from residences in the immediate vicinity and will occupy only a minor portion of their visual frame, without disrupting broader visual access to the surrounding environment. Settlements including Donji Ljubes, Srezovac, and Gornji Ljubes are positioned in close proximity to the existing railway corridor, resulting in continued visibility of the railway infrastructure. In Srezovac and Donji Ljubes in particular, the closest residential receptors will have partial views of the newly proposed underpasses at km 196+164.67 and km 197+383.93. These underpasses, being low-lying structures, will enter the lower margins of the field of view and are not expected to introduce significant visual intrusion. Views toward the wider rural landscape, characterised by open fields and gently undulating terrain, will remain largely intact and unaffected.

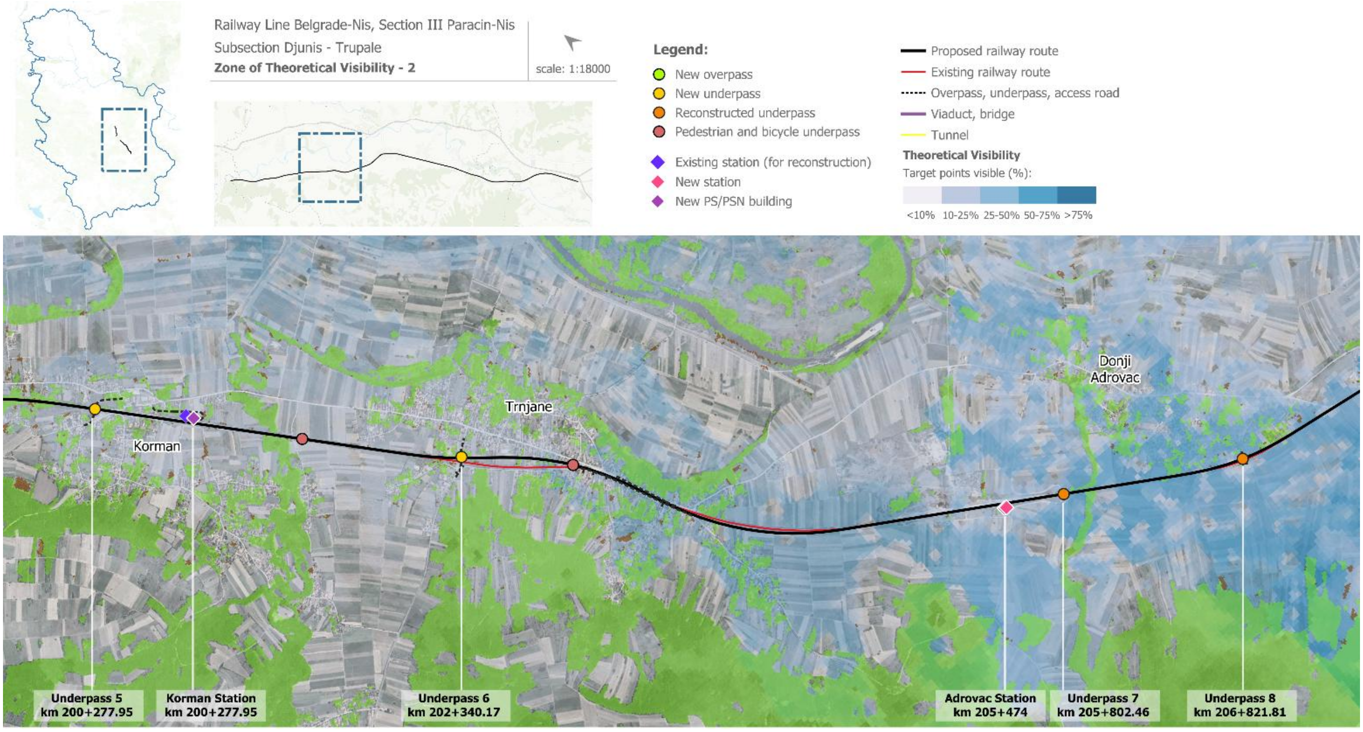

Figure 13- 31: Djunis-Trupale subsection, Overview of visual receptors - 2

In the settlement of Korman, residential receptors will be exposed to views of the newly proposed underpass at approximately km 200+277.95. While the Project will be visible from residential gardens, majority of dwellings are oriented toward local access roads. Additionally, the presence of mature vegetation along the railway alignment is expected to provide partial visual screening. Surrounding arable lands located between Korman and Trnjane will afford long-distance views toward the Project. However, given the relative distance and open nature of the terrain, the visual impact is anticipated to be minimal, with the railway forming only a small and intermittent component within an otherwise expansive agricultural landscape. In Trnjane, residents in close proximity to the proposed infrastructure will have partial visibility of the new underpass at km 202+340.17. Although the underpass is situated at a slightly lower elevation, the short distance from surrounding properties will allow for clear views of both the underpass structure and the railway fence. A new pedestrian underpass is also planned within this settlement. Given its modest scale and integration within the existing alignment, it is not expected to obstruct existing views. Between Trnjane and Adrovac, the landscape is characterized by broad agricultural plains with a strong sense of openness, where the sky forms a dominant visual element. The absence of significant vegetation or built structures allows for unimpeded panoramic views. Within this visual context, the railway corridor may be perceptible at intervals but will not dominate or significantly alter the character of the open landscape. The receptors located nearest to the proposed underpass at km 206+821.81 will experience partial views of the infrastructure. These views, however, are mitigated by the presence of an intervening belt of vegetation and a local road, which together provide a degree of visual separation from the Project components.

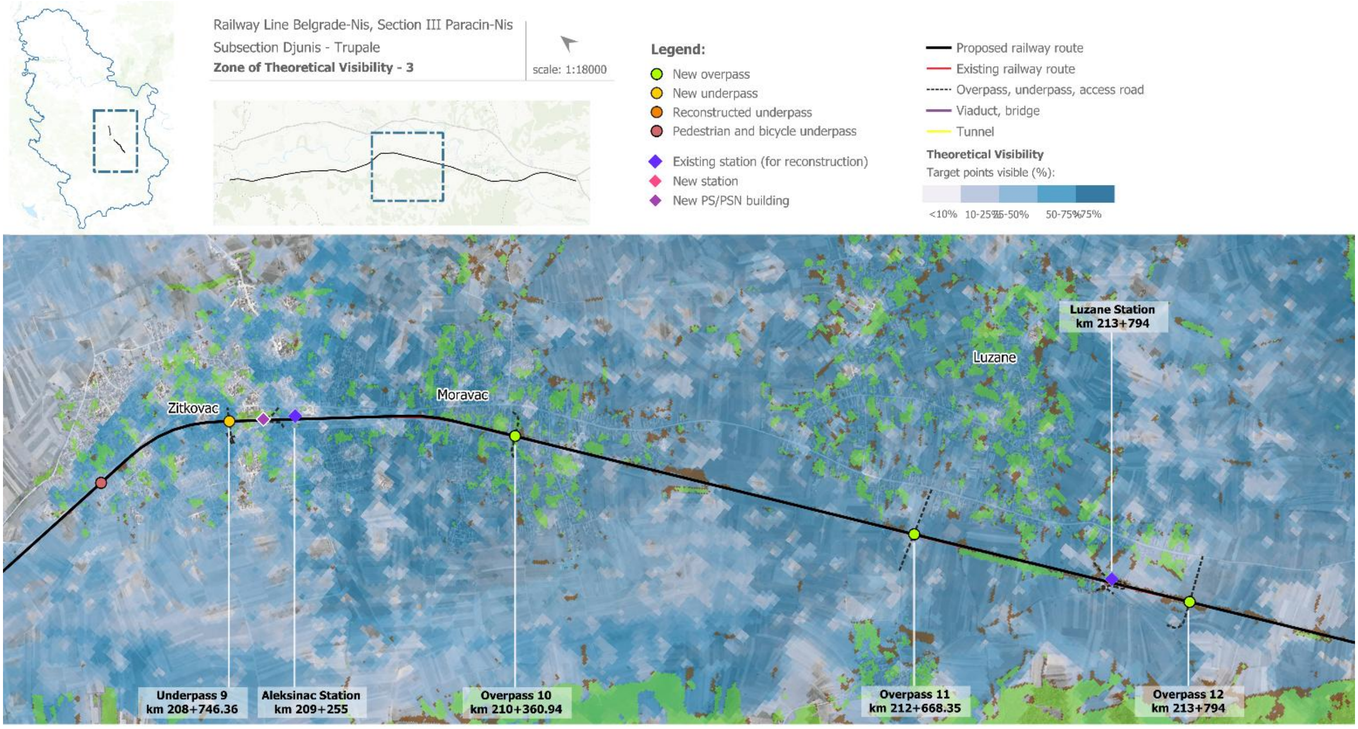

Figure 13- 32: Djunis-Trupale subsection, Overview of visual receptors - 3

In the central part of the Djunis-Trupale subsection, the railway will pass directly through the settlement of Zitkovac, making it visible along its length. The fence, passing trains and newly planned underpass at km 208+746.36 will be visible to nearby houses but will remain in the lower part of the view. As the railway already exists, residents are accustomed to its presence, though the new fence may affect the closest receptors, particularly around the village center, where a square, park, and several cafés are located. In Moravac, a new overpass at km 210+360.94 is planned. While most properties include vegetation that will screen some views, the overpass will remain visible due to its size and may obstruct certain sightlines. Between km 210+360.94 and km 212+668.35, there are no sensitive receptors in the immediate vicinity. Agricultural workers will see the Project in the distance, occupying only a small portion of their view. The underpass at km 212+668.35 will be built in an agricultural area, with a few residential properties located approximately 250 m away. These homes, oriented toward state road 217, will see the Project from their backyards. The same applies to the overpass at km 213+794.

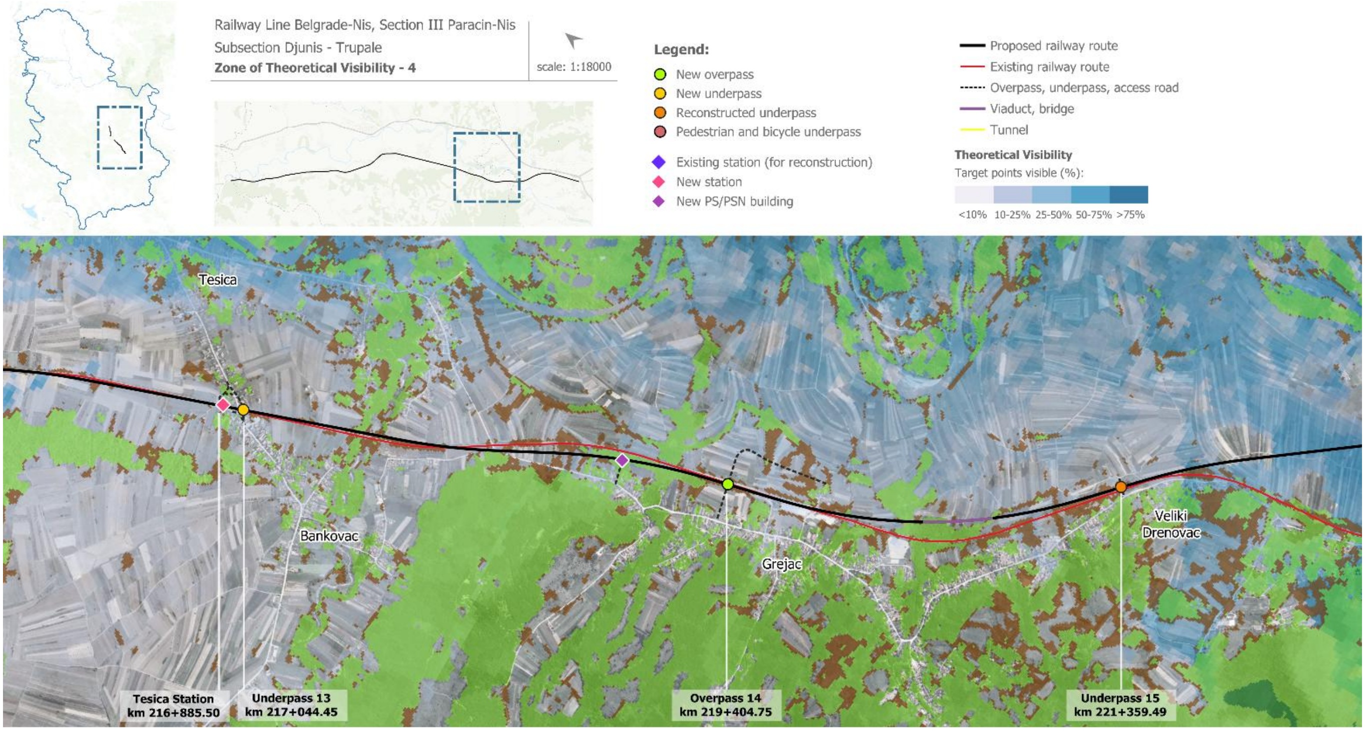

Figure 13- 33: Djunis-Trupale subsection, Overview of visual receptors - 4

In the settlement of Tesica, the construction of a new station at km 216+885.50 and an underpass at km 217+044.45 is planned. The immediate surroundings include only a limited number of potentially sensitive receptors, with the majority of nearby structures comprising agricultural buildings, such as barns and ancillary facilities. The station, due to its modest scale, is expected to blend into the existing rural character of the area. The most visually prominent element will be the railway fence, which may locally interrupt views toward the alignment. In the vicinity of the existing station in Grejac, a new overpass is proposed at km 219+404.75. A small number of receptors estimated based on desktop analysis of aerial images and field visits, at fewer than ten will be directly exposed to views of this structure, when looking in the northeastern direction. For other surrounding properties, visibility will be limited or intermittent, largely due to intervening vegetation. Furthermore, a viaduct is proposed along the section of the route undergoing realignment. However, due to the presence of light woodland in the area, it is anticipated that the structure will remain partially or entirely screened from view.

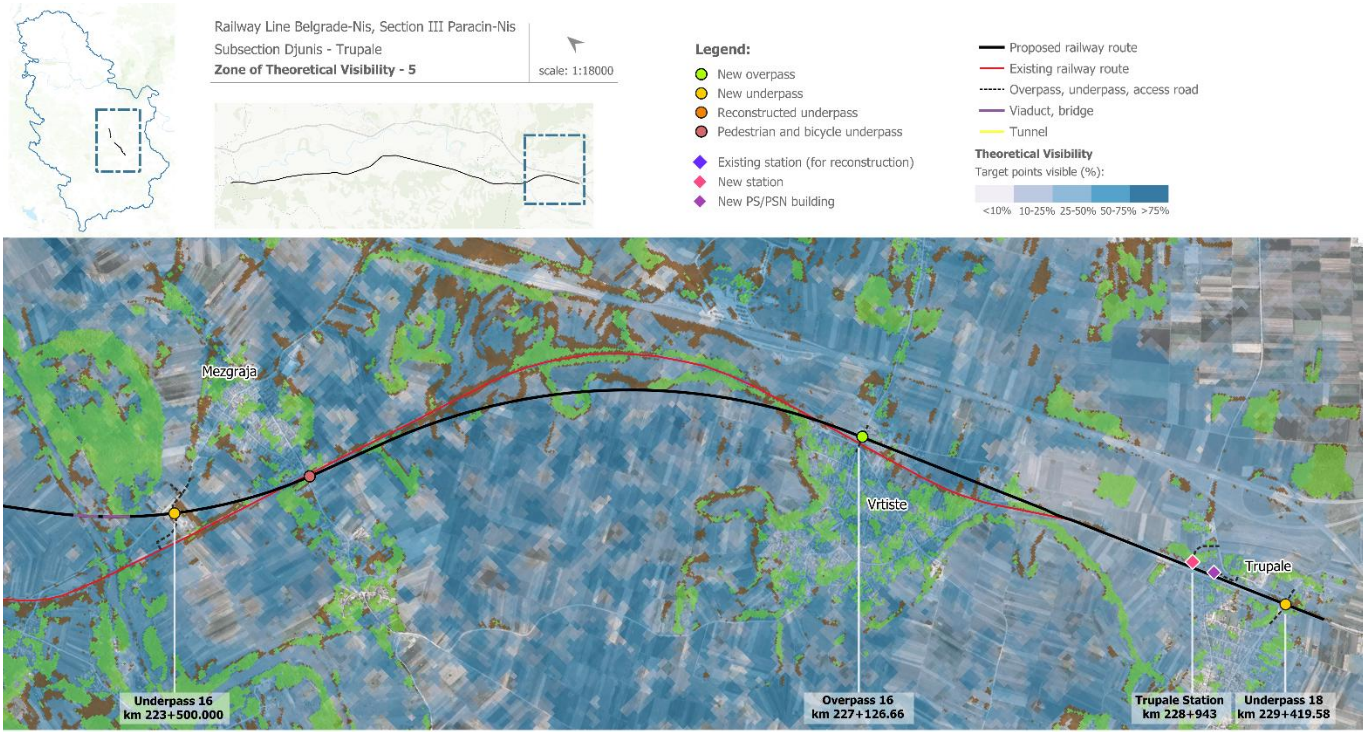

Figure 13- 34: Djunis-Trupale subsection, Overview of visual receptors - 5

Tourists and hikers visiting Supovacka Kula and the southwestern hills will have distant views of the new Morava River bridge and railway deviation. Due to the distance, these elements will appear as low-profile linear structures and will not significantly alter the expansive and open landscape character. In the southern parts of Veliki Drenovac, the deviation may be partially visible; however, the presence of substantial vegetation will limit views to occasional glimpses. Residents of Mezgraja will see the new railway in the distance, while the underpass at approximately km 223+500.00 will only be visible during direct use. In Vrtiste, residents will be exposed to views of the new overpass at km 227+126.66, which will visually dominate the local setting. However, given the proximity of the existing highway (approximately 300 meters away), local residents are accustomed to infrastructure in the area. Most residential properties are also surrounded by dense vegetation, which will help mitigate visual impacts. In Trupale, the nearest receptors are approximately 80 meters from the Project. They will be exposed to views of the new railway fence, which will occupy the lower portion of their visual field without significantly obstructing broader views of the surroundings.

Overview of Viewpoints and Views

Based on the detailed receptor analysis in the previous chapter, the following maps show the selected viewpoints from areas where significant impacts are expected, considering the magnitude of change, sensitivity, and the number of visual receptors.

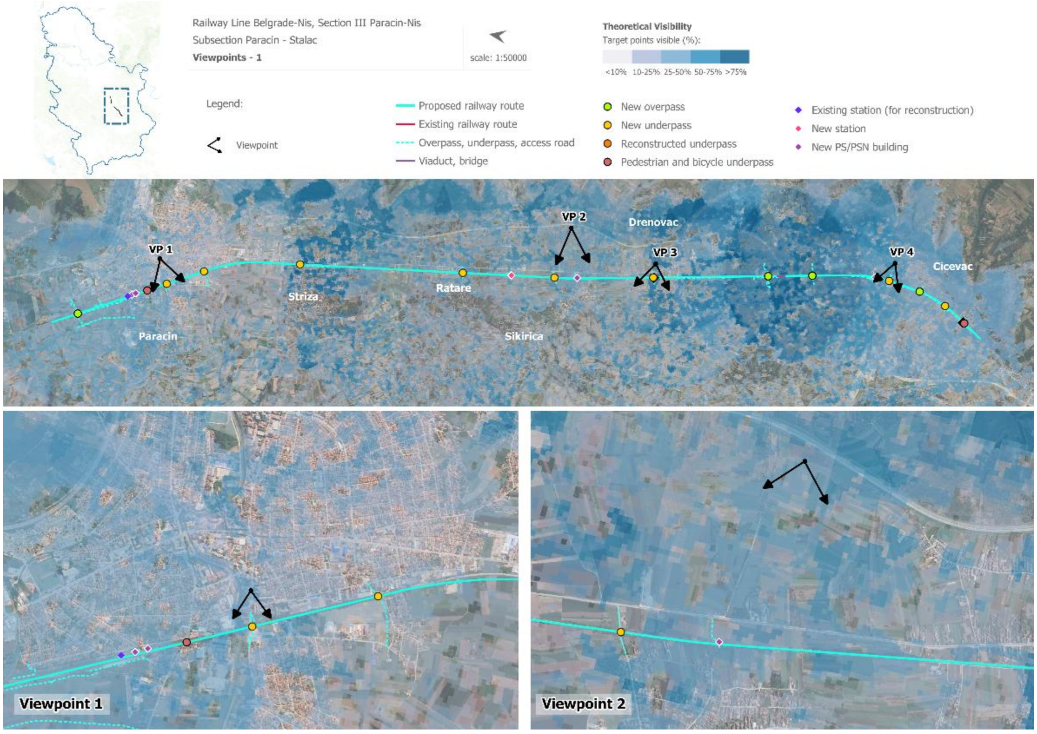

Figure 13- 35: Paracin-Stalac subsection, viewpoints - 1

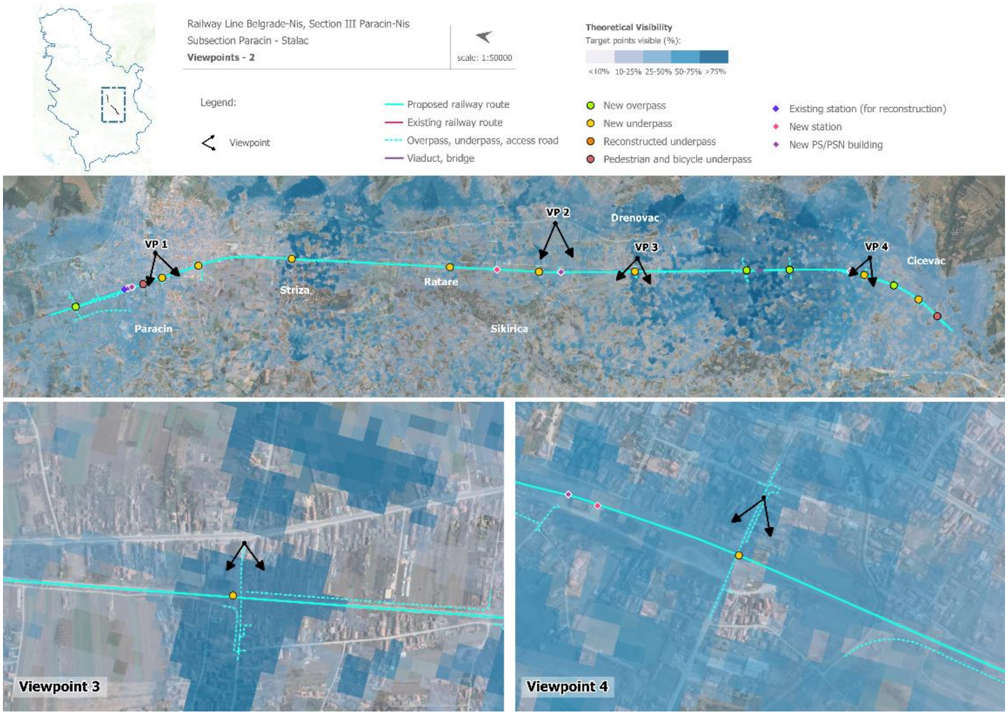

Figure 13- 36: Paracin-Stalac subsection, viewpoints - 2

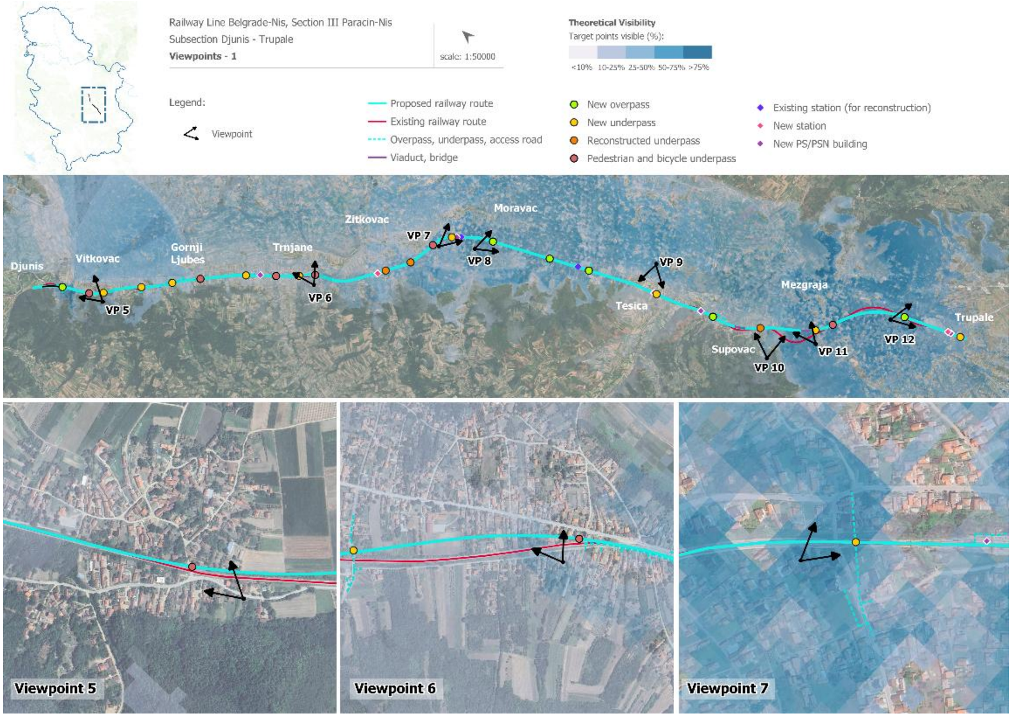

Figure 13- 37: Djunis-Trupale subsection, viewpoints - 1

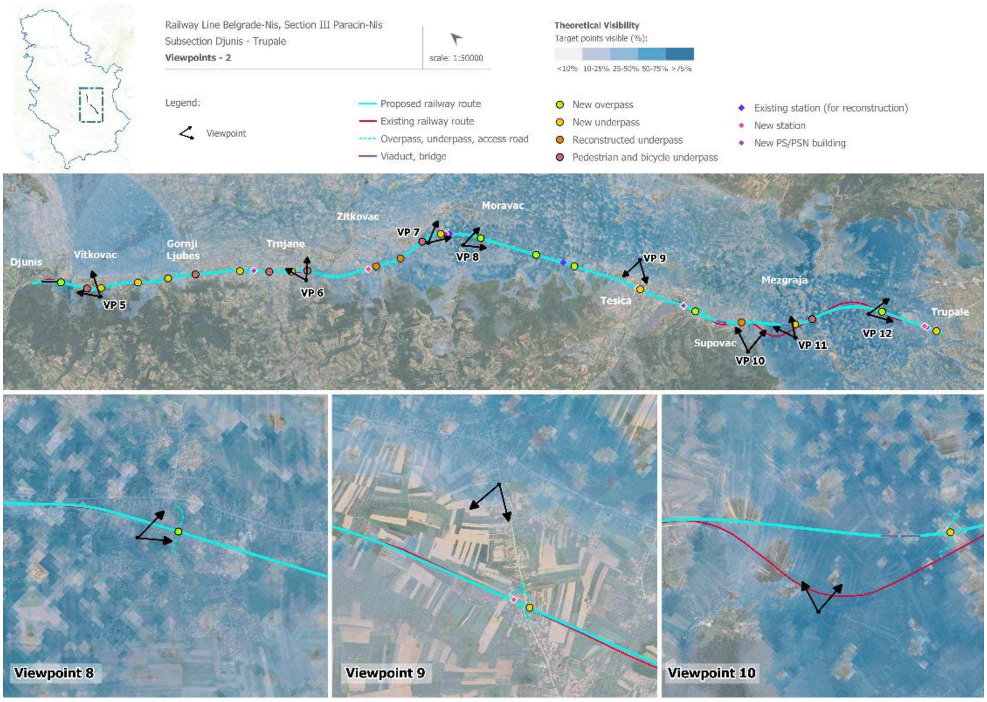

Figure 13- 38: Djunis-Trupale subsection, viewpoints – 2

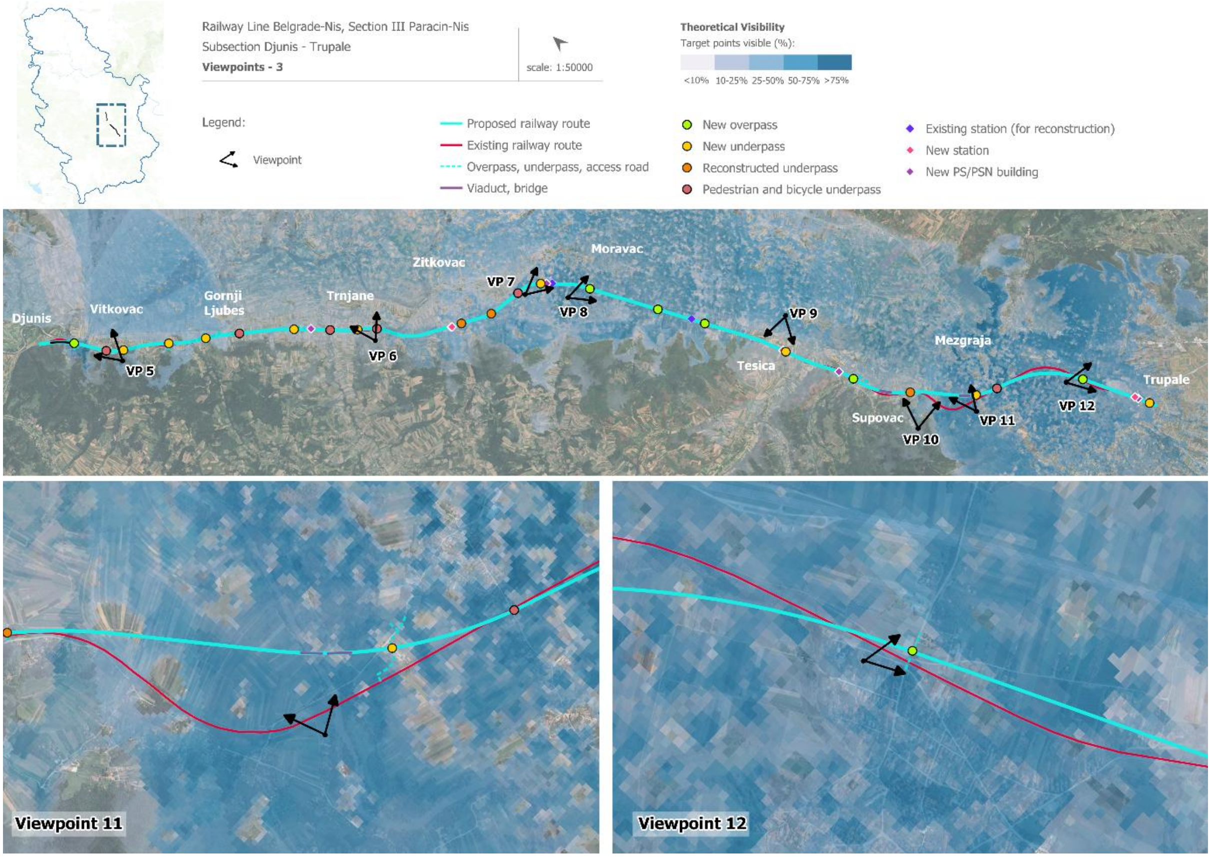

Figure 13- 39: Djunis-Trupale subsection, viewpoints – 3

The Table 13- 7 below provides an overview of the selected viewpoints and the relevant views. Field surveys, conducted on multiple occasions, confirmed that all long-range views are rare and generally have limited influence and a low magnitude of change compared to receptors located closer to the Project. Furthermore, due to the high level of public interest and involvement, as described in the chapter Alternatives of this ESIA, the following viewpoints were selected to properly assess the Project's impact, particularly in locations where previous complaints were recorded from sensitive receptors, namely residents living in areas directly adjacent to the Project corridor.

Table 13- 7: Viewpoints overview

VP ID	Viewpoint Name / Description	LCA of the Viewpoint	Latitude (°)	Longitude (°)	Camera Height (m)	Direction of View	Distance to the Project (m)	Receptor Type
VP 1	Paracin center	Urban zones	43.6941	21.3302	1,85	SW	150	Walkers
VP 2	Sikirica	Agricultural plains of Pomoravlje	43.6169	21.3561	1,85	SW	250	Workers in the field
VP 3	Drenovac	Semi urban zone with agricultural lands	43.6037	21.3487	1,85	W	80	Residents, walkers
VP 4	Cicevac	Urban zones	43.5580	21.3593	1,85	w	100	Residents, walkers
VP 5	Vitkovac	Juzna Morava River Walley	43.4472	21.4457	1,85	NE	20	Residents

VP ID	Viewpoint Name / Description	LCA of the Viewpoint	Latitude (°)	Longitude (°)	Camera Height (m)	Direction of View	Distance to the Project (m)	Receptor Type
VP 6	Trnjane	Semi urban zone with agricultural lands	43.3932	21.5158	1,85	NE	40	Residents
VP 7	Zitkovac	Semi urban zone with agricultural lands	43.3682	21.5641	1,85	SW	50	Residents
VP 8	Moravac	Semi urban zone with agricultural lands	43.3564	21.5752	1,85	SE	40	Residents
VP 9	Tesica	Agricultural plains of Pomoravlje	43.2941	21.6164	1,85	SW	300	Walkers, travellers
VP 10	Supovac	Juzna Morava River Walley	43.2563	21.6332	1,85	NE	560	Residents
VP 11	Supovac tower	Cultural Heritage Features	43.2531	21.6380	1,85	NE	370	Tourists
VP 12	Vrtiste	Semi urban zone with agricultural lands	43.2327	21.6710	1,85	E	50	Residents

The analysis presented in the chapter Sensitivity of Visual Receptors also identified four locations with the highest concentration of sensitive receptors:

- Vitkovac (VP5): km 194+110,
- Trnjane (VP6): km 202+968,
- Zitkovac (VP7): km 208+740
- Moravac (VP8): km 210+355

For these locations, the use of transparent noise barriers has been proposed, as outlined in the Chapter 13.5. Although these barriers may not provide the same level of noise attenuation as solid ones, they allow for the preservation of visual continuity, particularly important in these areas, where the Project passes directly through or near the center of settlements.

Accordingly, Viewpoints 5, 6, 7 and 8 below include an illustration of such transparent barriers. The image is indicative in nature; should transparent barriers be selected in consultation with the local population, their specification needs to be developed within a detailed design. Based on the detailed design, this study should then be updated with the precise visual representation of the final noise barrier solution.

Viewpoint 1

The Figure 13- 42: Viewpoint Figure 13- 40shows the current condition in the city of Paracin, and the planned bridge at km 155+985, which is in the same location as existing bridge. The viewpoint is located in LCA Urban Zones.

Section III
Subsection Paracin-Stalac
Viewpoint 1

Longitude: 21.3302° E
Latitude: 43.6941° N

Date: 05/11/2024
Time: 13:26:00

Camera: Canon EOS R6m2 35mm
Height of Observer: 185 cm

Figure 13- 40: Viewpoint 1

Viewpoint 2

The Figure 13- 41 shows a view in Sikirica, showing rural surroundings, agricultural fields and Project in mid-range view. The workers and passengers will be able to see new fence proposed by the Project, besides railway tracks and occasionally passing trains. The viewpoint 2 is located in LCA Agricultural plains of Pomoravlje.

Figure 13- 41: Viewpoint 2

Viewpoint 3

The Figure 13- 42: Viewpoint shows the current condition in the settlement of Drenovac, and the planned underpass at km 166+669.98, which will appear in the lower part of the view toward the railway. In addition to the underpass, the nearest residents will be able to see the protective fence and passing trains. The viewpoint 3 is located in LCA Semi urban zone with agricultural lands.

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Figure 13- 42: Viewpoint 3

Viewpoint 4

Figure 13- 43Figure 13- 1 illustrates both the existing and proposed conditions, highlighting the underpass located at km 171+793.08. While the underpass is expected to blend with the surrounding infrastructure and have minimal

visual impact, the newly installed protective fence may be perceived by nearby residents and pedestrians as a visual disturbance, particularly due to its linear and repetitive form. Viewpoint 4 is located in LCA Urban zones.

Figure 13- 43: Viewpoint 4

Viewpoint 5

Figure 13- 44 illustrates the current state in Vitkovac, with the existing station in the background, which will be demolished. It also presents the planned condition of the area, featuring a transparent and opaque noise barrier. The viewpoint is in LCA Juzna Morava River valley.

Section III
Subsection Djunis-Trupale
Viewpoint 5

Longitude: 21.4457° E
Latitude: 43.4472° N

Date: 26/04/2025
Time: 14:57:00

Camera: Canon EOS R6m2 35mm
Height of Observer: 185 cm

Figure 13- 44: Viewpoint 5

Viewpoint 6

The top image at Figure 13- 45 below shows the current condition at the Trnjani location, while the bottom images illustrate the planned state, with both transparent and opaque noise barriers options. Several buildings in the area between km 202 and km 203 will be demolished, and the space will be replaced by a widened and slightly offset railway alignment. The viewpoint 6 is located in LCA Semi urban zone with agricultural lands.

Figure 13- 45: Viewpoint 6

Viewpoint 7

Figure 13- 46 shows the current situation and planned Project components, in Zitkovac, where residents will be exposed to views of the noise barriers and passing trains. The photo also shows the option with transparent noise barrier, as defined in chapter 13.5.1. At the location of the existing level crossing, a new underpass will be constructed at km 208+746.38, and several buildings in the area will be demolished. The viewpoint 7 is located in LCA Semi urban zone with agricultural lands.

Section III
Subsection Djunis-Trupale
Viewpoint 7

Longitude: 21.5641° E
Latitude: 43.3682° N

Date: 26/04/2025
Time: 14:24:00

Camera: Canon EOS R6m2 35mm
Height of Observer: 185 cm

Figure 13- 46: Viewpoint 7

Viewpoint 8

Figure 13- 47 below illustrates the location of Moravac, where residents will be exposed not only to views of the railway infrastructure, but also to the noise barriers and the new overpass at km 210+360.94, which may appear

visually dominant in relation to the surrounding environment. There are two options presented in the photo, transparent and opaque noise barrier. The viewpoint 8 is located in LCA Semi urban zone with agricultural lands.

Section III
Subsection Djunis-Trupale
Viewpoint 8

Longitude: 21.5752° E
Latitude: 43.3564° N

Date: 26/04/2025
Time: 14:12:00

Camera: Canon EOS R6m2 35mm
Height of Observer: 185 cm

Figure 13- 47: Viewpoint 8

Viewpoint 9

The Figure 13- 48 below shows the current state in the settlement of Tesica, with the planned state underneath. Travellers or workers in the field will see a railway steel fence in mid-range view. The viewpoint 9 is located in LCA Agricultural plains of Pomoravlje.

Section III
Subsection Djunis-Trupale
Viewpoint 9

Longitude: 21.6164° E
Latitude: 43.2941° N

Date: 06/11/2024
Time: 14:55:00

Camera: Canon EOS R6m2 35mm
Height of Observer: 185 cm

Figure 13- 48: Viewpoint 9

Viewpoint 10

As shown in Figure 13- 49 below, residents in Supovac settlement will see the Project in long-distance, compared to the current state, as this is where the Project route is realigned towards the north. The viewpoint is located in LCA Juzna Morava river valley.

Section III
Subsection Djunis-Trupale
Viewpoint 10

Longitude: 21.6332° E
Latitude: 43.2563° N

Date: 06/11/2024
Time: 15:20:00

Camera: Canon EOS R6m2 35mm
Height of Observer: 185 cm

Figure 13- 49: Viewpoint 10

Viewpoint 11

Although there is no exact data on the number of visitors to the Supovac Tower, the number is approximated as relatively low. Instead of the current train route, which passes close by, the Project foresees a route change. As a result, the railway will now be visible from a distance, given that it has been relocated and shifted northward, as shown in Figure 13- 50. The Supovac tower is located in LCA Cultural heritage features.

Section III
Subsection Djunis-Trupale
Viewpoint 11

Longitude: 21.6380° E
Latitude: 43.2531° N

Date: 06/11/2024
Time: 14:55:00

Camera: Canon EOS R6m2 35mm
Height of Observer: 185 cm

Figure 13- 50: Viewpoint 11

Viewpoint 12

The Figure 13- 51 below shows the current state in the settlement of Vrtiste, with the planned state underneath. In addition to the slightly shifted railway infrastructure, a new structure will be introduced into the landscape, an overpass located at km 227+126.66. Besides this, the residents will mostly see the noise barrier. The viewpoint 12 is located in LCA Semi urban zone with agricultural lands.

Section III
Subsection Djunis-Trupale
Viewpoint 12

Longitude: 21.6710° E
Latitude: 43.2327° N

Date: 12/05/2025
Time: 09:35

Camera: Canon EOS R6m2 35mm
Height of Observer: 185 cm

Figure 13- 51: Viewpoint 12

Analysis of potential impacts

Impacts during construction phase

Table 13- 8 below summarises the visual impacts and effects during **construction** phase.

Table 13- 8: Summary of potential visual impacts and effects during construction phase

VISUAL RECEPTORS AND LOCATION	IMPACT ANALYSIS	RECEPTOR SENSITIVITY	MAGNITUDE OF CHANGE	SIGNIFICANCE OF EFFECT
Viewpoint 1 – residents, passengers	Residents and passers-by will be able to see construction machinery and the construction site during the building of the new bridge, which will take place at the location of the existing one. This may temporarily reduce the visual quality of views towards the southwest. However, this effect will be short-term.	Residents - **High** Passengers - **Medium**	Moderate	**Major to Moderate Adverse**
Viewpoint 2 - workers	Workers operating in the fields near the Sikirica settlement may observe construction activities, machinery, and the workers' camp in the mid-range distance. However, these are not expected to have a significant impact on them, given the nature of their activities.	Low	Moderate	**Minor Adverse**
Viewpoint 3 - Residents, workers and passengers	The closest residential receptors in Drenovac will have direct views of heavy machinery, scaffolding, soil stockpiles from underpass excavation, and the demolition of existing structures during the construction phase. The most notable visual impacts are expected during the demolition phase. Given the modest scale of surrounding residential buildings, the machinery is likely to appear visually dominant, although the broader view will remain largely unaffected. Residents closest to the site will also experience nighttime lighting, as well as dust and disturbance to vegetation and ground surfaces. Transient receptors in the central square, an area with hospitality and commercial facilities, will also perceive the construction works, albeit from a greater distance.	Residents - **High** Passengers, workers - **Low**	Moderate	**Major to Moderate Adverse**
Viewpoint 4 - Residents, workers	Closest residents in Cicevac, who are mostly located around the railway, will experience urban fragmentation due to the presence of construction fences, heavy machinery, and material stockpiles during works on the railway infrastructure and the underpass at km 171+793.08. As the railway in this area is slightly offset from the residential zones, the machinery and construction activities will appear in the middle-range view and are not expected to dominate views toward the surrounding landscape.	Closest residents - **High** Others - **Low**	Moderate	**Moderate to Minor Adverse**
Viewpoint 5 - Residents, workers	Residents of Vitkovac, a small hamlet located along the railway at the start of the Djunis-Trupale subsection, will be directly exposed to construction activities, including views of heavy machinery, scaffolding, and the installation of protective fencing. The hamlet has a single level crossing, which is planned to be closed during both the construction and operational phases, disrupting established movement patterns for residents who regularly use this connection. While this change will impact local accessibility and daily routines, the presence of existing vegetation in the area is expected to offer partial visual screening, helping to somewhat reduce the perceived visual impact.	Closest residents - **Medium** Others - **Low**	Moderate	**Moderate to Minor Adverse**
Viewpoint 6 - Residents, workers	Residents in Trnjani will witness the demolition of a block of small residential structures at approx. km 202+700, which will be replaced by new infrastructure. The visual impact will be most pronounced during the construction phase. Given the modest scale of surrounding residential buildings, the machinery is likely to appear visually dominant, although the broader view will remain largely	Closest residents - **High** Others - **Medium**	Major	**Major Adverse**

VISUAL RECEPTORS AND LOCATION	IMPACT ANALYSIS	RECEPTOR SENSITIVITY	MAGNITUDE OF CHANGE	SIGNIFICANCE OF EFFECT
	unaffected. Residents closest to the site will also experience nighttime lighting, as well as dust and disturbance to vegetation and ground surfaces.			
Viewpoint 7 - Residents, workers	New access roads and an underpass will be constructed in place of existing residential structures in Zitkovac, resulting in a significant visual impact during the construction phase. Receptors will have direct views of heavy machinery, scaffolding, soil stockpiles from underpass excavation, and the demolition of existing structures during the construction phase. The most notable visual impacts are expected during the demolition phase. While this change will impact local accessibility and daily routines, the presence of existing vegetation in the area is expected to offer partial visual screening, helping to somewhat reduce the perceived visual impact.	Closest residents - **High** Others - **Low**	Moderate	**Major to Moderate Adverse**
Viewpoint 8 - Residents, workers	During the construction phase, residents of Moravac will be exposed to noticeable visual changes in the landscape due to the construction of the overpass at km 210+360.94, along with associated access roads, railway fencing, and the railway infrastructure itself. The overpass structure will be visible from both sides of the railway and due to its height and location in a relatively open area, it will dominate the surrounding landscape. The temporary presence of construction machinery, scaffolding, and material storage will further degrade the visual quality of the area. The most pronounced visual impact is expected to be experienced by receptors in closest proximity to the alignment, while in the wider area, existing vegetation and built structures may offer partial visual screening.	Closest residents - **High** Others - **Low**	Major	**Major Adverse**
Viewpoint 9 – Workers and travellers	Workers in the fields and travellers on existing local roads will be exposed to visual changes in the landscape due to the presence of construction machinery, scaffolding, and material storage, near Tesica settlement. However, considering their overall nature of activity, they are considered not sensitive to these temporary changes.	Low	Moderate	**Minor Adverse**
Viewpoint 10 - Residents	In this part of the Project, near the Supovac settlement, the alignment is being shifted further north, away from the settlement. Residents may experience increased lighting during nighttime construction works, but overall, with the railway moving further away, the impacts will be reduced.	Medium	Minor	**Minor Adverse**
Viewpoint 11 - Tourists	There are not many tourists, as this is not a frequently visited cultural heritage feature. It is poorly maintained and relatively inaccessible. Visitors will be able to see the construction site and activities in the distance, but the impact will be minor due to the considerable distance, as the Project is moving away from this location.	Medium	Minor	**Minor Adverse**
Viewpoint 12 - Residents, workers, people engaged at sports activities	During the construction phase in Vrtiste, significant visual disruption is expected for residents living near and for individuals using the nearby stadium. The introduction of heavy machinery, scaffolding, construction materials, and temporary fencing will alter the visual character of the area. The construction of the overpass at km 227+126.66, due to its scale and elevated position, will be particularly prominent within the flat surrounding terrain. While some vegetation exists in the area, it will not be sufficient to screen these temporary elements, resulting in a noticeable reduction in visual quality for nearby receptors. Noise, dust, and increased activity levels may also contribute to a general perception of disturbance during this period.	**Medium**	Moderate	**Moderate Adverse**

Impacts during operational phase

Table 13- 9 below summarises the visual impacts and effects during **operational** phase:

Table 13- 9: Summary of potential visual impacts and effects during operational phase

VISUAL RECEPTORS AND LOCATION	IMPACT ANALYSIS	RECEPTOR SENSITIVITY	MAGNITUDE OF CHANGE	SIGNIFICANCE OF EFFECT
Viewpoint 1 – residents, passengers	In the operational phase, there will be no significant visual impact for residents and passers-by, as the new bridge will replace the existing one in the same location. The views towards the southwest will remain unchanged once construction is completed, as shown in Figure 13- 40.	Residents - **High** Passengers - **Medium**	Minor	**Moderate to Minor Adverse**
Viewpoint 2 - workers	The views and daily activities of people working in Sikirica area will remain unaffected, apart from a partially visible transparent white fence that will appear in the lower part of their field of view, as shown in Figure 13- 41.	Low	Minor	**Negligible**
Viewpoint 3 - Residents, workers and passengers	The closest residential receptors in Drenovac will have direct views of the new railway fence, noise barrier, passing trains, underpass, and access roads located centrally within the settlement, as shown in Figure 13- 42. The most notable visual impacts are expected from the fence. The fence will occupy a significant portion of the view but only for few nearby residents. Given the modest scale surrounding residential buildings, the fence is likely to appear visually dominant for them, although wider view will remain unaffected. The underpass will also be visible in the lower part of the view, contributing to the overall impact. Transient receptors in the central square an area with hospitality and commercial facilities, will also perceive the new infrastructure while passing beneath the railway, for shorter durations.	Residents - **Medium** Passengers, workers - **Low**	Moderate to Minor	**Moderate to Minor Adverse**
Viewpoint 4 - Residents, workers	Residents in Cicevac, since mostly located around the railway, will see the railway fence, noise barrier, passing trains and closest ones will see the new underpass at km 171+793.08, as shown in Figure 13- 43. Since the railway in this area is slightly moved from the residential zones, the infrastructure will appear in the middle range view and will not dominate their views to the surrounding areas.	Closest residents - **Medium** Others - **Low**	Minor	**Minor Adverse to Negligible**
Viewpoint 5 - Residents, workers	Residents in Vitkovac, a small hamlet located along the railway at the start of the Djunis-Trupale subsection, will have views of the new railway fence, noise barriers and passing trains, as shown in Figure 13- 44. The bicycle and pedestrian underpass will only be visible from close proximity and will not significantly affect broader views. A slight deviation of the railway alignment occurs in this location, bringing the fence and tracks closer to properties on the eastern side of the settlement. This proximity increases the visual prominence of the infrastructure for those receptors. However, the presence of existing vegetation will provide some degree of visual screening, partially mitigating the overall impact.	Closest residents - **High** Others - **Low**	Minor	**Minor Adverse**
Viewpoint 6 - Residents, workers	Residents in Trnjani will witness the demolition of a block of small residential structures, which will be replaced by new infrastructure,as shown in Figure 13- 45. Once the Project is completed, their views will primarily consist of the railway fence, noise barriers and passing trains, while the upper portions of their visual field will remain unaffected. The pedestrian and bicycle underpass will be visible only to the closest residents.	Closest residents - **High** Others - **Medium**	Moderate	**Major to Moderate Adverse**

VISUAL RECEPTORS AND LOCATION	IMPACT ANALYSIS	RECEPTOR SENSITIVITY	MAGNITUDE OF CHANGE	SIGNIFICANCE OF EFFECT
Viewpoint 7 - Residents, workers	During the operational phase, newly constructed access roads and an underpass at km 208+746.36 will replace several existing residential structures in Zitkovac, resulting in a noticeable transformation of the local urban fabric. Residents living in close proximity to the railway will have direct views of the railway fence, noise barriers and frequent passing trains, which may alter the visual character and reduce the aesthetic quality of their immediate surroundings, as shown in Figure 13- 46. The underpass itself will be prominently visible to nearby households and pedestrians, introducing a new infrastructure element into what was previously a residential zone.	Closest residents - **High** Others - **Low**	Moderate	**Moderate Adverse**
Viewpoint 8 - Residents, workers	In the operational phase, residents of Moravac will have sustained views of the newly constructed overpass at km 210+360.94, along with accompanying access roads, the railway fence, noise barriers and passing trains, as shown in Figure 13- 47. Given its elevated structure and location within a relatively open landscape, the overpass will remain a dominant visual feature, clearly visible from both sides of the railway. Its scale and form will contrast with the surrounding low-rise residential and agricultural context, potentially altering the overall perception of the local landscape. For residents in close proximity, the infrastructure may introduce a lasting sense of visual intrusion, particularly in areas where no substantial vegetation or built features provide screening.	Closest residents - **High** Others - **Low**	Moderate	**Major to Minor Adverse**
Viewpoint 9 – Workers and travellers	In the operational phase, workers in the fields and travellers on existing local roads near the Tesica settlement will not be exposed to any significant visual changes. The only visible element may be a transparent fence in the lower part of the view, which is not expected to affect their activities or visual experience, as shown in Figure 13- 48.	Low	Minor	**Negligible**
Viewpoint 10 - Residents	In the operational phase, there will be no significant visual impact on residents near the Supovac settlement, as the railway alignment has been shifted further north, away from the settlement. The increased distance will reduce visibility of the Project, and no prominent features will be introduced into the view, as shown in Figure 13- 49.	Medium	Negligible	**Negligible**
Viewpoint 11 - Tourists	In the operational phase, there will be no visual impact on visitors, as this cultural heritage feature is rarely visited, poorly maintained, and relatively inaccessible. With the Project moved further away, no visible elements are expected to affect the views from this location, as shown in Figure 13- 51.	Medium	Negligible	**Negligible**
Viewpoint 12 - Residents, workers, people engaged at sports activities	During the operational phase, residents and users of the local football stadium in Vrtiste will experience continuous and close-range views of the newly introduced railway infrastructure, including the protective fence,noise barriers frequent passing trains, and the overpass located at km 227+126.66, as shown in Figure 13- 51. Due to the flat topography of the area, the height and scale of the overpass will make it a visually dominant structure within the local landscape. Although some vegetation is present, it will offer only limited screening and will not significantly reduce the overpass's visibility.	Closest residents - **High** Others - **Medium**	Moderate	**Major to Moderate Adverse**

13.5. Mitigation Measures

To further minimise visual impact at specific areas of concern or on a site-specific basis during the project implementation stage, tailored mitigation strategies may be applied. Developing customised approaches for these areas will help address the unique characteristics and sensitivities of each receptor effectively.

13.5.1. Construction phase

To reduce adverse effects identified on landscape character, following mitigation measures during construction phase are proposed

Landscape Character

To reduce adverse effects identified on landscape character, following mitigation measures are proposed:

- **Erosion control**: Apply measures such as silt fences, straw bales, and erosion control blankets to minimise soil erosion and preserve landscape integrity and form.
- **Construction site management**: Contain construction materials and waste within designated areas to avoid spreading debris across the landscape. Use temporary visual barriers, like screens or fencing, designed to be visually unobtrusive, especially near cultural assets and protected areas.
- **Noise and Dust Control**: Use dust suppression methods (water spraying, coverings) to prevent dust from degrading visual quality and vegetation health. Schedule noisy activities during daylight hours and use quieter machinery to reduce disturbance.

Visual Amenity

To reduce adverse effects identified on visual amenity, following mitigation measures during construction phase are proposed:

- **Limiting the stockpiling**: Restrict stockpile heights to a maximum of two meters during the construction phase to mitigate visual impacts, as outlined also in Chpater 7 (Soil) of this ESIA.
- **Screening fences in densely populated areas:** In locations where the railway passes through densely populated or visually sensitive urban areas, install visually appropriate fencing or screening structures designed to reduce the visual prominence of the construction works.

13.5.1. Operational phase

Landscape Character

To reduce adverse effects identified on landscape character, following mitigation measures during operational phase are proposed:

- **Restoration of construction areas**: Upon completion of construction, areas used as construction compounds will be returned to their original use and state.
- **Native planting strategy**: In settlements such as Drenovac, Cicevac, Vitkovac, Gornji Ljubes, Trnjane, Zitkovac, Moravac, Vrtiste and Trupale, where space is available on both sides of the railway line, or where the new alignment is slightly offset from the existing settlement, plant dense native vegetation. While evergreen species may provide more effective year-round visual screening, the use of indigenous species will better support integration with the surrounding landscape and local ecological context. Implement native tree planting and vegetation screens, focusing

on fast-growing species for immediate cover and slower species for long-term sustainability, especially in areas noted as being subject to significant loss and near sensitive areas like cultural heritage and residential sites. Locations are provided in the Table 13- 10 below:

Table 13- 10: Mitigation planting locations

Settlement	Location
Drenovac	km 166+600 – km 166+900
Cicevac	km 171+800 – km 172+600 (left side only, as seen from Belgrade-Nis direction)
Vitkovac	km 194+00 – km 194+100
Gornji Ljubes	km 198+200 – km 198+400
Trnjane	km 202+300 – km 203+00
Zitkovac	km 208+200 – km 208+700
Moravac	km 210+100 – km 210+500
Vrtiste	km 227+00 – km 227+200

Visual Amenity

To reduce adverse effects identified on visual amenity, following mitigation measures during operational phase are proposed:

- **Establish natural-looking vegetation**: Rehabilitate embankments and cuttings with native plant species to ensure they blend seamlessly with the surrounding landscape.
- **Architectural integration**: Incorporate architectural elements that harmonise with the surroundings, where feasible, such as new station and technical buildings, overpasses, or cuts and embankments. These elements often include white facades combined with traditional materials such as red brick or tiled roofs for electrical building facilities, which are common in the region.
- **Design and colour of infrastructure**: Use muted, natural colours for railway infrastructure to blend with the landscape and incorporate artistic or architectural treatments on structures like noise barriers and bridges.
- **Overpasses treatment**: Integrate landscaping and climbing plants on the overpass to blend with the surroundings. Match materials and colours with local structures.
- **Noise barriers**: In settlements where the railway passes through the centre and through densely built-up urban fabric (Vitkovac, Trnjane, Zitkovac and Moravac) with no available space for tree planting, and where noise barriers are planned, it is necessary to consult the local population regarding the design of the barriers. If residents express a preference for maintaining visual connectivity with the rest of the settlement, transparent (glass) barriers may be a more favourable option, despite offering lower levels of acoustic insulation. Proposals for these 4 locations where transparent noise barriers are included are shown in the Figure 13- 44, Figure 13- 45, Figure 13- 46 and Figure 13- 47
- As stated in the Noise & Vibrations chapter, the introduction of combined noise barriers (including a 1-meter transparent section) was tested along the section from km 194+150 to km 195+850. If this proposal is adopted during the Design Stage, the LVIA will be updated to reflect these modifications.

13.6. Residual Impacts Assessment

It is evident that the proposed mitigation measures will contribute to a partial reduction of impacts on the landscape character and visual receptors. Nevertheless, some residual effects will remain, which cannot be fully addressed through mitigation. These residual impacts are detailed in the following chapters.

13.6.1. Residual impacts during construction phase

The Table 13- 11 below summarises the residual impacts and effects during **construction** phase.

Table 13- 11: Summary of potential residual impacts and effects during construction phase

	RECEPTOR SENSITIVITY	MAGNITUDE OF CHANGE	SIGNIFICANCE OF EFFECT	Comments on Mitigation Measures	Residual Impact
LANDSCAPE RECEPTORS					
Urban zones	**Low**	Moderate	**Minor Adverse**	Although the area's high level of development and mixed land use has already shaped its character, construction activities such as earthworks, excavation, and infrastructure installation may cause temporary, localized disruptions. These include terrain changes, vegetation clearance, noise, dust, and restricted access. However, due to the area's low sensitivity to further change and the use of mitigation measures like dust control, access management, and efficient phasing, these impacts are expected to be minor and limited to the construction period.	**Minor Adverse**
The agricultural plains of Pomoravlje region	**Low**	Moderate	**Minor Adverse**	Construction activities may temporarily disrupt agricultural use, require realignment of access roads, and introduce localized disturbances such as noise, dust, and movement restrictions. Some fragmentation of farmland may occur, affecting the flow of agricultural activities. However, these impacts will be short-term and confined to construction zones, with the landscape expected to largely return to its established patterns post-construction, aside from minor long-term changes.	**Negligible**
Semi urban zone with agricultural lands	**Low**	Moderate	**Minor Adverse**	Construction activities, including earthworks, embankment installation, and railway reconfiguration, may temporarily disrupt agricultural land and access routes. Noise, vibration, and construction traffic may also affect nearby residents and farms, but these impacts are expected to be short-term and localized. Mitigation measures such as scheduling works to avoid peak farming periods, providing temporary access routes, using low-vibration machinery where feasible, and implementing noise and dust control strategies will help minimize disruption during the construction phase.	**Minor Adverse**
Juzna Morava river valley	**Medium**	Major to Moderate	**Major to Moderate Adverse**	Mitigation measures will help reduce the impacts, and the distance of the river from the Project indicates that, after mitigation, the impacts will not be significant.	**Minor Adverse**
Juzna Morava sub-receptors (Djunis tunnel section and Bridge Construction Zone	**High**	Major	**Major Adverse**	Although the new bridge over the Velika Morava near Supovac (approx. km +229) and construction of tunnel Djunis may cause temporary disruption during construction, mitigation measures, such as timing works to avoid sensitive periods, controlling sedimentation, and monitoring water quality, will to a certain	**Moderate Adverse**

	RECEPTOR SENSITIVITY	MAGNITUDE OF CHANGE	SIGNIFICANCE OF EFFECT	Comments on Mitigation Measures	Residual Impact
				extent reduce ecological impacts. As a result, any remaining effects on the river ecosystem are expected to be moderate, partly localized, and short-term.	
Protected natural areas	Dobric-Nisava IBA - **High** Other areas - **Medium**	Major to Moderate	Dobric-Nisava IBA - **Major Adverse** Other areas - **Moderate Adverse**	In the southernmost section of the Djunis-Trupale subsection (km +221 to km +229.600), where the route intersects the Dobric-Nisava IBA, Project construction may temporarily affect sensitive habitats through vegetation clearance, soil erosion, sedimentation, and increased noise and vibration. Mitigation measures such as minimizing the construction footprint, installing sediment control barriers, using low-noise machinery, and preserving vegetation buffers where possible will significantly reduce these impacts. As a result, any remaining effects are expected to be minor, localized, and limited to the construction phase.	**Moderate to Minor Adverse**
Cultural heritage features	**Medium**	Minor to Negligible	**Minor Adverse to Negligible**	Cultural heritage sites in the region hold significant cultural value but are located at a sufficient distance from the railway corridor, resulting in medium sensitivity. Due to this separation, no significant construction impacts are expected. Indirect effects such as vibrations, dust, or noise from machinery are likely to be minimal and unlikely to affect the integrity of these sites, ensuring their preservation throughout the Project.	**Negligible**
VISUAL RECEPTORS					
Viewpoint 1 – residents, passengers	Residents – **High** Passengers - **Medium**	Moderate	**Major to Moderate Adverse**	After mitigation, visual impacts from heavy machinery, scaffolding, and soil stockpiles in Paracin center during construction will be reduced but may still be noticeable to nearby residents, especially during demolition. Nighttime lighting, dust, and minor disturbance to vegetation are expected to be limited by using screening, dust control measures, and controlled lighting.	**Moderate Adverse**
Viewpoint 2 - workers	Low	Moderate	**Minor Adverse**	Effects after mitigation will be minor and will not change the overall setting in Sikirica settlement.	**Negligible**
Viewpoint 3 - Residents, workers and passengers	Residents - **High** Passengers, workers - **Low**	Moderate	**Major to Moderate Adverse**	After mitigation, visual impacts from heavy machinery, scaffolding, and soil stockpiles in Drenovac during construction will be reduced but may still be noticeable to nearby residents, especially during demolition. Nighttime lighting, dust, and minor disturbance to vegetation are expected to be limited through the use of screening, dust control measures, and controlled lighting.	**Moderate Adverse**
Viewpoint 4 - Residents, workers	Closest residents - **High**	Moderate	**Moderate to Minor Adverse**	After mitigation, residents in Cicevac near the railway may still experience some urban fragmentation from construction fences, machinery, and material stockpiles during works at km 171+793.08. However, with measures such as careful site	**Minor Adverse**

	RECEPTOR SENSITIVITY	MAGNITUDE OF CHANGE	SIGNIFICANCE OF EFFECT	Comments on Mitigation Measures	Residual Impact
	Others - **Low**			organization, visual screening, and limiting the footprint of stockpiles, these impacts are expected to be minor and confined to the immediate construction area.	
Viewpoint 5 - Residents, workers	Closest residents - **High** Others - **Low**	Moderate	**Moderate to Minor Adverse**	After mitigation, residents of Vitkovac will still have views of heavy machinery, scaffolding, and fencing during construction, but existing vegetation will help soften and partially screen these visual impacts. Measures like strategic placement of temporary barriers and minimizing lighting glare will further reduce disturbance to visual amenity. While construction activity will temporarily affect the hamlet's visual character, these impacts are expected to be short-term and localized, with the visual amenity largely restored after completion.	**Moderate to Minor Adverse**
Viewpoint 6 - Residents, workers	Closest residents - **High** Others - **Medium**	Major	**Major Adverse**	After mitigation, the large-scale demolition of residential structures near km 202+700 in Trnjani will remain a prominent visible for nearby residents during construction. However, the use of screening barriers, careful scheduling, and dust control measures will help reduce its overall visual impact. Although machinery and demolition activities will dominate close-range views temporarily, these effects are expected to be limited in duration.	**Moderate Adverse**
Viewpoint 7 - Residents, workers	Closest residents - **High** Others - **Low**	Moderate	**Major to Moderate Adverse**	After mitigation, construction of new access roads and an underpass in Zitkovac will still be clearly visible to nearby receptors due to heavy machinery, scaffolding, and soil stockpiles. However, existing vegetation and temporary screening measures will help reduce the overall visual impact. While these activities will temporarily change the local visual environment, the effects are expected to be moderate and limited to the construction period.	**Moderate to Minor Adverse**
Viewpoint 8 - Residents, workers	Closest residents - **High** Others - **Low**	Major	**Major Adverse**	After mitigation, the construction of the overpass at km 210+360.94 in Moravac will remain a prominent visual feature due to its height and open location. However, measures such as installing visual screening, organizing material storage to minimize clutter, and controlling lighting will help reduce the impact on nearby residents. While heavy machinery and scaffolding will still be visible, these efforts will lessen the overall visual disturbance, keeping impacts localized and temporary throughout the construction phase.	**Moderate Adverse**
Viewpoint 9 – Workers and travellers	**Low**	Moderate	**Minor Adverse**	The impacts on the visual experience of the surroundings will be negligible after mitigation measures are implemented.	**Negligible**

	RECEPTOR SENSITIVITY	MAGNITUDE OF CHANGE	SIGNIFICANCE OF EFFECT	Comments on Mitigation Measures	Residual Impact
Viewpoint 10 - Residents	**Medium**	Minor	**Minor Adverse**	The impacts on the visual experience of the surroundings will be negligible after mitigation measures are implemented.	**Negligible**
Viewpoint 11 - Tourists	**Medium**	Minor	**Minor Adverse**	The impacts on the visual experience of the surroundings will be negligible after mitigation measures are implemented.	**Negligible**
Viewpoint 12 - Residents, workers, people engaged at sports activities	Closest residents - **High** Others **- Medium**	Moderate	**Moderate Adverse**	After mitigation, construction of the overpass at km 227+126.66 in Vrtiste will remain highly visible due to its scale and elevated position in the flat terrain. Although existing vegetation offers limited screening, measures such as temporary visual barriers, careful site organization, and dust and noise control will help reduce the overall visual disruption.	**Moderate Adverse**

13.6.1. Residual impacts during operational phase

The Table 13- 12 below summarises the residual impacts and effects during **operational** phase:

Table 13- 12: Summary of potential residual impacts and effects during operational phase

	RECEPTOR SENSITIVITY	MAGNITUDE OF CHANGE	SIGNIFICANCE OF EFFECT	Comments on Mitigation Measures	Residual Impact
LANDSCAPE RECEPTORS					
Urban zones	**Low**	Moderate	**Minor Adverse**	After mitigation measures are implemented, the impacts on the landscape from the railway reconstruction are expected to remain minor. Given the area’s high level of development and diverse land use, changes will largely integrate into the existing urban fabric with minimal disruption. New fencing, minor structural works, and station upgrades will be localized and unlikely to significantly alter the visual character or identity of the area. While the installation of additional railway fencing may slightly contribute to urban fragmentation, this effect will be minimal and consistent with the division already created by the existing railway.	**Minor Adverse**

	RECEPTOR SENSITIVITY	MAGNITUDE OF CHANGE	SIGNIFICANCE OF EFFECT	Comments on Mitigation Measures	Residual Impact
The agricultural plains of Pomoravlje region	**Low**	Moderate	**Minor Adverse**	After mitigation measures are applied, the impacts of the railway reconstruction on this predominantly agricultural landscape are expected to be minor and and well-integrated into the existing anthropogenic character. Changes such as reconfigured access routes, adjusted land divisions, and some fragmentation of agricultural plots will be localized and managed to minimize disruption. While these alterations will modify landscape structure and land use dynamics, they will maintain the overall stable and utilitarian pattern of the area without causing significant long-term visual or functional changes.	**Minor Adverse**
Semi urban zone with agricultural lands	**Low**	Moderate	**Minor Adverse**	After mitigation, the railway reconstruction's physical changes, such as new embankments, fencing, and minor realignments, will have a minor and controlled impact on land patterns. While some effects on drainage, access, and spatial continuity may occur, the overall landscape character and stable mix of residential and agricultural uses will be preserved.	**Minor Adverse**
Juzna Morava river valley	**Low**	Minor	**Minor Adverse**	After mitigation, the Project's impacts on the Juzna Morava river valley is expected to be minimal considering the overall distance from the Project.	**Minor Adverse**
Juzna Morava sub-receptors (Djunis tunnel and Bridge construction zone)	**High**	Minor	**Moderate Adverse**	After mitigation, the Project's impacts on the ecologically significant river corridor near Vitkovac and along the Djunis-Trupale subsection are expected to be minimal. The tunnel near km +193 will greatly reduce direct river interaction, while the new bridge over the Velika Morava near Supovac will cause only localized changes due to its slight shift.	Djunis Tunnel Construction area **- Minor Adverse** Bridge Construction area **– Moderate adverse**
Protected natural areas	Dobric-Nisava IBA - **High** Other areas - **Medium**	Major to Moderate	Dobric-Nisava IBA - **Major Adverse** Other areas - **Moderate Adverse**	After mitigation, the Project's long-term impacts on the Dobric-Nisava IBA and other natural areas are expected to be minor. While habitat connectivity and local biodiversity may experience some changes due to the ongoing presence and operation of the railway, the area's existing human influence will help limit the severity of these effects. Overall, landscape and ecological alterations are anticipated but are unlikely to cause severe or irreversible damage.	**Minor Adverse**
Cultural heritage features	**Medium**	Minor to Negligible	**Minor Adverse to Negligible**	After mitigation, no significant long-term impacts on nearby cultural heritage sites are expected during railway operations. The sufficient distance and spatial separation from the railway corridor will minimize effects such as noise, vibration, or visual intrusion, ensuring the historical character and integrity of these sites remain preserved within their established context.	**Negligible**

	RECEPTOR SENSITIVITY	MAGNITUDE OF CHANGE	SIGNIFICANCE OF EFFECT	Comments on Mitigation Measures	Residual Impact
VISUAL RECEPTORS					
Viewpoint 1 – residents, passengers	Residents - **High** Passengers - **Medium**	Minor	**Moderate to Minor Adverse**	There will be limited scope for mitigation measures due to the nature of the Project being a bridge; therefore, a minor adverse impact is expected to remain.	**Minor Adverse**
Viewpoint 2 - workers	Low	Minor	**Negligible**	The views and daily activities of people working in the Sikirica area will remain unaffected, apart from a partially visible transparent white fence that will appear in the lower part of their field of view. After mitigation measures, the impact will be negligible.	**Negligible**
Viewpoint 3 - Residents, workers and passengers	Residents - **Medium** Passengers, workers - **Low**	Moderate to Minor	**Moderate to Minor Adverse**	After mitigation, visual impacts in Drenovac will be reduced but some effects will remain. The new railway fence and underpass will still be visible to nearby residents, with the fence appearing visually dominant for a limited number of receptors. However, natural-looking vegetation, architectural treatments, and the use of muted colors will help the infrastructure blend better into the surroundings.	**Minor Adverse**
Viewpoint 4 - Residents, workers	Closest residents - **Medium** Others - **Low**	Minor	**Minor Adverse to Negligible**	After mitigation, residents in Cicevac will continue to see the railway fence, noise barriers, passing trains, and the new underpass, though these elements will appear at a middle-range distance and will not dominate their views. The use of natural vegetation, muted colors, and architectural treatments will help the infrastructure blend with the surroundings. Residents need to be consulted on noise barrier designs to ensure a balance between visual openness and acoustic performance, minimizing any sense of visual intrusion.	**Minor Adverse to Negligible**
Viewpoint 5 - Residents, workers	Closest residents - **High** Others - **Low**	Minor	**Minor Adverse**	After mitigation, residents of Vitkovac will still see the new railway fence, noise barriers and passing trains, with the underpass visible mainly from nearby locations and having minimal impact on broader views. The slight realignment bringing the railway closer to some properties will increase the infrastructure's visual prominence for those residents. However, existing vegetation and planned landscaping will provide partial visual screening, helping to soften the overall impact and maintain the settlement's visual character.	**Minor Adverse**
Viewpoint 6 - Residents, workers	Closest residents - **High** Others - **Medium**	Moderate	**Major to Moderate Adverse**	After mitigation, residents in Trnjani will continue to see the railway fence, noise barriers and passing trains as the main visual elements. The visual effects will be more pronounced	**Moderate Adverse**

	RECEPTOR SENSITIVITY	MAGNITUDE OF CHANGE	SIGNIFICANCE OF EFFECT	Comments on Mitigation Measures	Residual Impact
				here due to the complete demolition and replacement of the existing housing by the railway infrastructure.	
Viewpoint 7 - Residents, workers	Closest residents - **Medium** Others - **Low**	Moderate	**Moderate to Minor Adverse**	After mitigation, residents in Zitkovac will continue to experience visual changes due to the new access roads, underpass, railway fence, and passing trains, which will alter the local urban character. However, natural-looking vegetation and architectural integration measures will help soften the visual impact, blending infrastructure with the surroundings. Use of muted colors and landscaping treatments on the underpass and overpasses will further reduce visual intrusion.	**Minor Adverse**
Viewpoint 8 - Residents, workers	Closest residents - **High** Others - **Low**	Moderate	**Major to Minor Adverse**	After mitigation, residents of Moravac will still have clear views of the elevated overpass, access roads, railway fence, and passing trains, as the structure remains a prominent feature in the open landscape. Despite architectural treatments and the use of muted colors to help the infrastructure blend with its surroundings, the overpass's scale and height will continue to contrast with the low-rise residential and agricultural context, creating a lasting visual presence. Natural vegetation planting and climbing plants on the overpass will provide some screening over time, but in areas without substantial existing cover, the sense of visual intrusion may persist.	**Moderate to Minor Adverse**
Viewpoint 9 – Workers and travellers	Low	Minor	**Negligible**	Since the impact is negligible, there will be no need for mitigation measures.	**Negligible**
Viewpoint 10 - Residents	Medium	Negligible	**Negligible**	Since the impact is negligible, there will be no need for mitigation measures.	**Negligible**
Viewpoint 11 - Tourists	Medium	Negligible	**Negligible**	Since the impact is negligible, there will be no need for mitigation measures.	**Negligible**
Viewpoint 12 - Residents, workers, people engaged at sports activities	Closest residents - **High** Others - **Medium**	Moderate	**Major to Moderate Adverse**	After mitigation, residents and stadium users in Vrtiste will continue to experience close-range views of the railway infrastructure, including the protective fence, passing trains, and the prominent overpass. The overpass's height and scale will remain visually dominant within the flat landscape, with limited existing vegetation providing only partial screening. Architectural treatments, muted colors, and planting of native vegetation around the structure will help soften its visual impact over time, but the overpass will still be a noticeable feature. Engaging local residents in the design of noise barriers will help balance visual and community preferences, ensuring the	**Moderate to Minor Adverse**

	RECEPTOR SENSITIVITY	MAGNITUDE OF CHANGE	SIGNIFICANCE OF EFFECT	Comments on Mitigation Measures	Residual Impact
				infrastructure integrates as harmoniously as possible into the surroundings.	

13.7. Monitoring

To ensure that the mitigation measures are effective and successfully reduce the Project's impacts, the following monitoring mechanisms are proposed:

- Develop a monitoring schedule (biannual or seasonal site visits)
- Conduct site inspections to ensure ongoing maintenance (watering, replacement of failed plantings).
- Inspect integration of landscaping and climbing plants
- Monitor survival and health of vegetation over time

13.8. Conclusion

The reconstruction of the railway along this Section Paracin-Nis will result in noticeable alterations to the landscape and visual environment due to the introduction of new infrastructure elements such as upgraded tracks, fencing, overpasses, noise barriers, and related facilities. These changes will impact a diverse range of receptors, including rural settlements, agricultural areas, urban zones, and culturally sensitive sites. Visual sensitivity varies across the corridor, with heightened sensitivity near residential areas, schools, and heritage sites, and lower sensitivity in industrial or heavily modified landscapes.

Mitigation measures, such as planting native vegetation, erosion control, architectural integration, and thoughtfully designed noise barriers, will substantially reduce the scale and duration of visual impacts during both construction and operational phases. Crucially, involving local communities in the design of noise barriers will help address their concerns and preferences, enhancing social acceptance and reducing feelings of visual and physical separation. While some visual impacts may remain, especially in densely developed or ecologically sensitive zones, these residual effects will be minimized through careful planning.

In conclusion, the proactive application of these mitigation strategies will preserve the distinctive visual character of the corridor’s rural and urban areas, balancing infrastructure development with landscape integrity. Ongoing monitoring and adaptive management will ensure that emerging visual and landscape issues are addressed promptly throughout the railway’s lifecycle.

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Environmental and Social Impact Assessment, BIODIVERSITY

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LIST OF ABBREVIATIONS AND ACRONYMS

CH	Critical Habitats
EAAA	Ecologically appropriate area of analysis
EBRD	The European Bank for Reconstruction and Development
ECoW	Ecological Clerk of Works
EIB	The European Investment Bank
ESIA	Environmental and Social Impact Assessment
ESS	Environmental and Social Standards
EU	European Union
EUNIS	the European Nature Information System
HD	Habitats Directive
IUCN	the International Union for the Conservation of Nature
NNL/NG	Nonet loss/ Net gain
PAoI	Project Area of Influence
PBF	Priority Biodiversity Features
PR	Performance Requirement
pSCI	Proposed Site of Community Importance
pSPA	Proposed Special Protection Area
RoW	Right of Way

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14. ENVIRONMENTAL BASELINE

14.1. Biodiversity and ecological resources

14.1.1. Defining study area

For the purpose of understanding the existing biodiversity and habitats, as well as protected (or planned to be protected) areas, within the area that may be affected by the project, a study area needs to be defined. This has been informed by ESIAs for projects of similar nature and complexity, as well as potential impacts of linear traffic infrastructure (roads, railways) on biodiversity and protected area features – their magnitude and impact zones (during construction and operation phase, and as well decommissioning phase), together with possible cumulative impact zones.

In the process of defining the study area it was considered that the project primarily involves the reconstruction and modernization of the existing railway, with only a small number of segments of the railway being re-aligned and requiring the establishment of a new corridor.

Based on previous experience and practice, the Area of Influence (AoI) for linear infrastructure of this capacityis a 1.000 m wide corridor along the Project route (500 m from each side of the railway route). This area is referred to as ***Project Area of Influenc***e (PAoI) further in the text. The entirety of the PAoI was covered by biodiversity surveys conducted over all four seasons. This area is more valid and relevant when considering impacts to mobile fauna species. For flora and habitats, a **working corridor** of 30 m + 30 m has been considered in the context of temporary impact and **railway corridor** during operation (15 m + 15 m) for permanent impact.

To assess impact of the Project on biodiversity, the project components (route alignment, stations, crossings, access roads, bridges and tunnel) which have been defined by the Preliminary design were taken into consideration (Figure 14-1 and Figure 14-2). Detailed description of all components is presented in Chapter 2.3 Preliminary design.

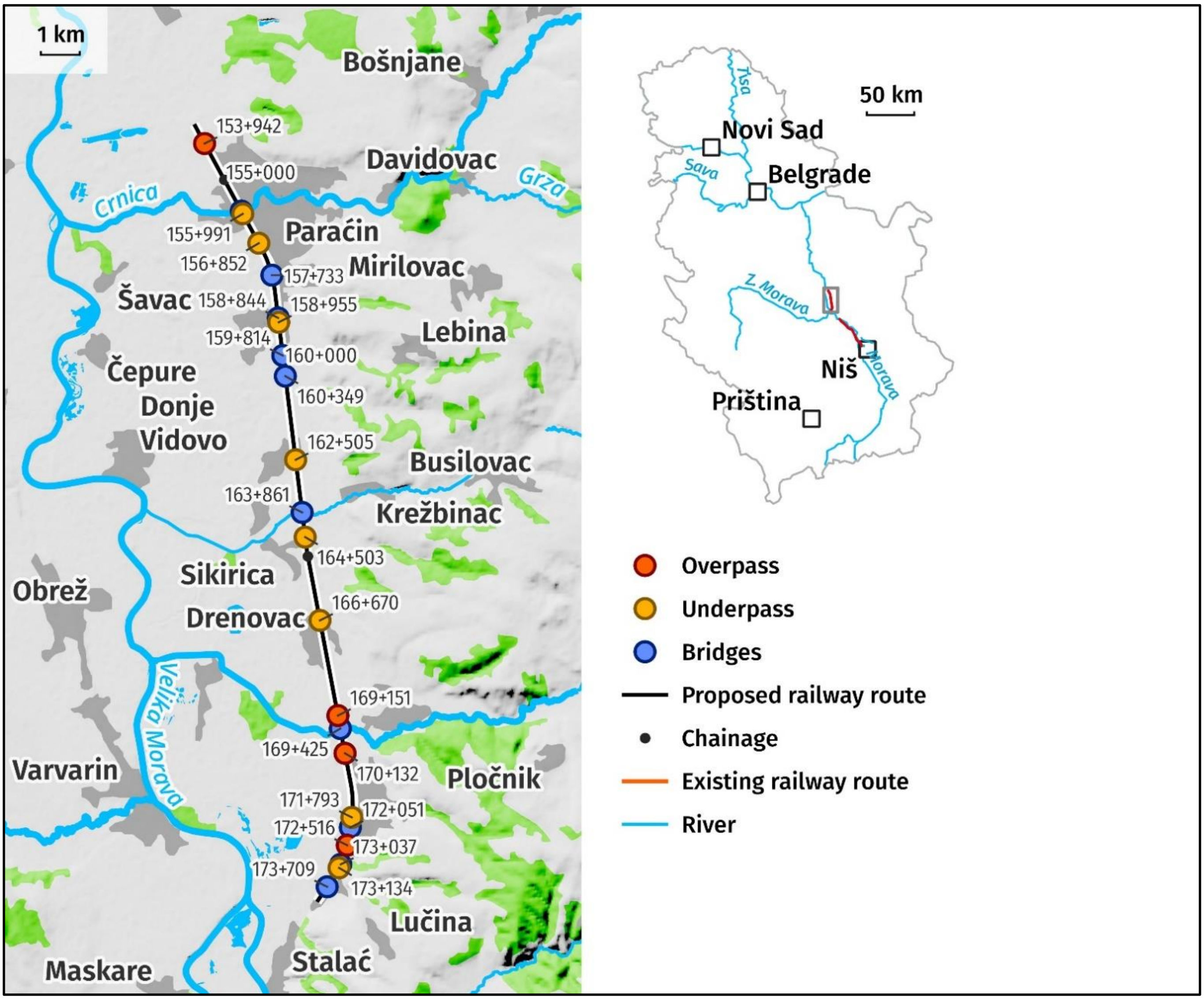

Figure 14-1. Project components within Paraćin–Stalać subsection

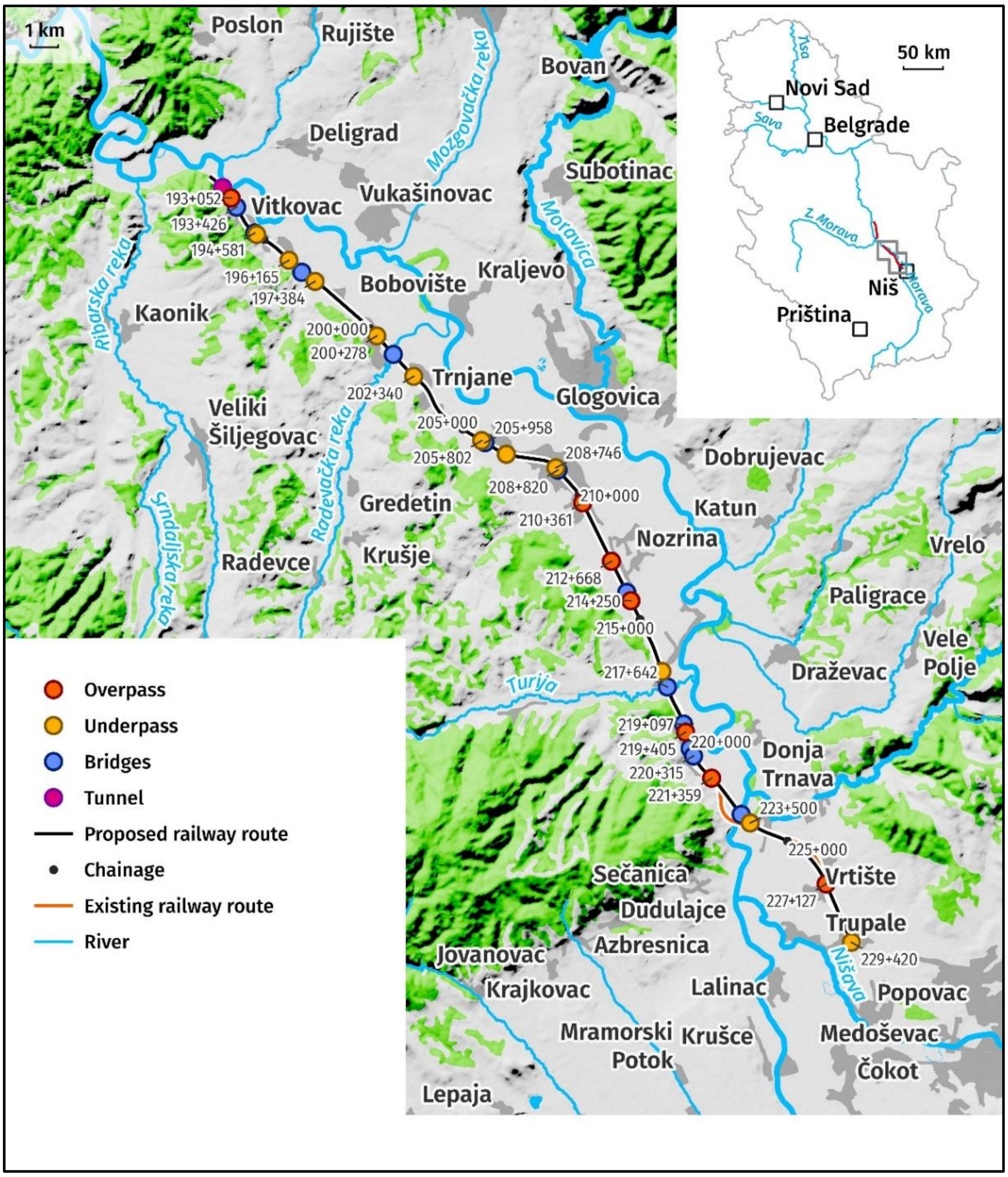

Figure 14-2. Project components within Đunis–Trupale subsection

As outlined in Chapter 2.3, some existing Project stations and stops will be decommissioned, existing stations and stops will be retained, some stations are to be reconstructed and modernised and some stops are to be reconfigured as stations. A total of 11 stations and stops will be decommissioned, seven stations will be retained, and two stations will be newly constructed.

It is planned that all 21 of the existing road level crossings will be abolished and replaced with 30 new deleveled crossings. A total of 12 will be newly built within sub-section Paraćin-Stalać, and 18 crossings will be newly built within sub-section Đunis-Trupale. Detailed description of all crossings is presented within Chapter 2.3.

All bridges within the Project route will be newly constructed following demolition of the existing bridges. Twelve bridges and two viaduts will be constructed within booth sub-sections. Five bridges will be newly built within Paraćin–Stalać Sub-Section (Bridge over the Crnica river at km 155+908.80, Bridge over the Planski stream at km 163+861.90, Bridge over the Jovanovačka river at km 169+425.70, Bridge over the Kočanski stream at km 172+051.85, Bridge over the Akalavica stream at km 173+709.21). Within Đunis-Trupale sub-section seven bridges and two viaducts (Bridge over the Simin stream at km 193+426.23, Bridge over the Srezovačka river at km 196+848.21, Bridge over the Radevačka river at km 201+255.67, Bridge over the Suvi stream at km 205+958.44, Bridge over the Turija river at km 217+642.36, Bridge over the Dašnička river at km 219+097.12, Viaduct at km 220+544.70, Viaduct at km 220+544.70 and Bridge over the South Morava River at km 223+054.78) will be built. The piers of the Bridge over the South Morava River (at km 223+054.78) will be built in the water.

There are 42 existing culverts within the Project area. A number of them will be adapted as part of the Project to jointly function as wildlife crossings. For now, the construction of 35 culverts is planned along the corridor. However, during the further development of the technical documentation, the construction of two additional culverts (chainages: cca 225+170 km and 225+525 km) will be planned. One tunnel will be constructed within sub-section Đunis-Trupale. The Đunis tunnel will be newly constructed. The entrance portal is at km 192+274, and the exit portal is at km 192+854.

Additionally, Ecologically Appropriate Areas of Analysis (EAAAs) were defined for each recognised/identified and confirmed critical habitat (CH) and/or priority biodiversity feature (PBF), based on previous experience, documentation relating to similar projects, the Project area characteristics, and potential impacts identified. EAAAs taken into account are 5 km around the railway. The 'wider project area' (up to 5 km) out of PAoI is analysed for protected areas, based on data received from the Institute for Nature Conservation. Only for fish grounds due to nature of water bodies, area of up to 15 km is considered.

For detailed habitats mapping the corridor of 1,000 m has been identified and analysed. Within the working corridor direct impacts of construction have been assessed, while the railway corridor considers operational impacts.

For areas planned to be protected at national level (i.e. proposed NATURA 2000 sites), the EAAA for the entire area that is planned to be protected was considered. This precautionary approach seeks to account for mobile and migratory species that could move across the railway alignment, or which may be associated with a protected area but use other habitats in the wider area and which, therefore, could be directly or indirectly impacted by Project activities (e.g. bird species). Within the Annex of this ESIA study, an Appropriate Assessment will be prepared.

14.1.2. Scoping

The scoping was performed in early stages of the Pproject. In the first phase, focus was given to collecting all national documents regarding the Project area and screening which international documents and strategies could be relevant for this Project. Access to all identified documents (if not publicly available) were requested from national institutions in charge of nature and environmental protection and other relevant institutions. Available data about the species and ecosystems that are priority for conservation on national, regional and global level (endangered and restricted species, rare and vulnerable habitats etc.) were also collected.

An extensive desktop literature review was performed. Priority was given to the most recent literature regarding species distribution and present habitats. Desktop analysis provided information about distance from, size and species of protected areas in different categories, that are crossed or are within 15 km of the railway.

The scoping methodology was prepared in accordance with EBRD Performance Requirement 6 – Biodiversity Conservation and Sustainable Management of Living Natural Resources (PR 6) and EIB Environmental and Social Standard S44 (ESS4), as well as applicable EU directives and national regulation. The biodiversity features that have been identified for inclusion in this assessment include:

- Ecosystems that are a priority for conservation (habitats listed in the Annex 1 of the EU Habitats Directive , Key Biodiversity Areas (KBAs), ecosystems evaluated using the International Union for the Conservation of Nature (IUCN) Red List of Threatened Ecosystems method with a status of Vulnerable, Endangered, or Critically Endangered, and ecosystems recognised by the scientific community as being associated with key evolutionary processes,
- Species and their habitats that are a priority for conservation (species listed by the EU Habitats Directive and Birds Directive, Bern Convention, species listed at a national level using the IUCN Red List methodology, species with restricted ranges, migratory and congregatory species that utilise the area),
- Protected areas (areas with existing or planned legal conservation protection).

The ESIA Scoping Report for railway section Paraćin-Trupale (Niš), was published on official website of SRI (June 2024).

Based on the collected data, further steps in the ESIA development were identified. As one of the gaps was the absence of official habitat map of Serbia, habitat mapping was performed as a part of the ESIA. Habitat mapping included a comparative study of available vector and raster data such as CORINE land cover (CLC) 2018, EUNIS habitat types, Digital Map of European Ecological Regions, geological map, digital orthophoto imagery, topographic and digital terrain maps. Also, a detail study of existing literature data about the habitats in Serbia was performed. These baseline data have later been confirmed and complimented with results of field surveys.

During the desktop analysis, the following documents and databases have been consulted: "ENOVA Corridor Report"[1], Scoping Report[2], literature sources, data available from online databases (e.g. Integrated Biodiversity Assessment Tool (IBAT), International Union for Conservation of Nature (IUCN) Red List, Birdlife Data Zone), satellite imagery and maps concerning the PAoI and surrounding ecosystems, migration and movement corridors, endemic/restricted-range species, invasive species, IUCN and nationally threatened (red-listed) species; species and their habitats that are a priority for conservation.

To grasp the locations of planned protected areas and to detect areas of great biodiversity value, a detail prospection of areas designated for protection was performed. In other words, rule of precautionary approach was applied.

The areas that are planned to be protected that have been identified as relevant for this Project are: potential NATURA 2000 sites Južna Velika Morava, Južna Morava, Niš, Lalinačka Slatina, Obla glava and Poslonske planine (all pSCIs); and pSPAs Dobrić-Nišava and Gornje Pomoravlje. Additionally, nationally protected areas belonging to the category 'Natural monument' located near the railway route (at a distance from the railway of between 2.12 and 5.01 km), have been assessed, namely: Novoselski brest zapis, Dud zapis u Medoševcu, Rajkovićev hrast, Hrast lužnjak u Donjoj Trnavi i Lalinačka slatina.

Special emphasis was given to the planned protected or protected areas that are located within the railway corridor itself. A detailed desktop study was undertaken to determine the key values of these areas and identify potential conflicts and future drivers of spatial and temporal changes.

Based on the ESIA Scoping report findings, identified priority biodiversity features and critical habitats were carefully surveyed, with special emphasis given to the current status of habitat quality and the presence (and spread) of invasive species etc.

Before the field surveys, stakeholder consultations were undertaken in January 2022, to gather information and data from relevant experts, institutions and civil society organizations and to obtain their opinions on potential impacts of the Project on biodiversity and ecosystems. A list of relevant stakeholders that were consulted is provided below:

- Natural History Museum in Belgrade (Prirodnjački muzej u Beogradu) – data owner regarding flora, vegetation and fauna, participant in consultations

  Njegoševa 51

  11000 Beograd

[1] *CORRIDOR ENVIRONMENTAL & SOCIAL ASSESSMENT REPORT Corridor Level Environmental and Social Assessment for the Belgrade-Nis High Speed Railway Corridor, Serbia, July 2022*

[2] *SCOPING REPORT Reconstruction and modernization of the railway line Belgrade – Niš up to speed of 200 km/h. Preparation for Feasibility Study, ESIA and Preliminary Design, May 2022*

nhmbeo@nhmbeo.rs

- Public Enterprise „Srbijašume" (JP „Srbijašume") – data owner about state forests

  Department for forestry and environment protection (Sektor za šumarstvo i zaštitu životne sredine)

  Bul. Mihajla Pupina 113

  11000 Beograd

  sumarstvo@srbijasume.rs

- Public Enterprise „Zelenilo-Beograd" (JKP „Zelenilo-Beograd") - participant in consultations

  Mali Kalemegdan 8

  11000 Beograd

  info@zelenilo.rs

- Institute for Nature Conservation of Serbia (Zavod za zaštitu prirode Srbije) – data provider, request for their opinion on project design is part of legal procedure for EIA, participant in consultations

  Dr. Ivana Ribara 91

  11070 Novi Beograd

  beograd@zzps.rs

- Faculty of Science and Mathematics - University of Niš, Department for Biology and Ecology (Prirodno-matematički fakultet – Univerzitet u Nišu, Biologija i ekologija) - data owner regarding flora and fauna, participant in consultations

  Višegradska 33

  18106 Niš

  pmfinfo@pmf.ni.ac.rs

- Faculty of Science and Mathematics- University of Kragujevac, Department of Biology and Ecology (Prirodno-matematički fakultet – Univerzitet u Nišu, Institut za biologiju i ekologiju) - data owner regarding flora and fauna, participant in consultations

  Radoja Domanovića 12

  34000 Kragujevac

  upravnik-ibe@pmf.kg.ac.rs

- Serbian Hunting Association (Lovački savez Srbije) - data owner regarding fauna, participant in consultations

  Obilićev venac 41

  18105 Niš

  lunis@mts.rs

A summary of the issues discussed and conclusions from the stakeholder consultation process for the entire Corridor Project (Belgrade–Niš) is outlined below:

- Regarding impacts on biodiversity, all experts agree it is advantageous that most of the proposed route variants overlap with the existing railway (also referred to Right of Way, RoW). In addition, all protected areas are already located near populated areas. The (re)construction of the railway will not have an additional negative impact on any protected area, in terms of value for the protection, especially since the proposed route variants do not violate the territory of the protected area.
- Considering barrier effects, the piers of the bridges in water bodies will not have such an effect, however the Belgrade-Niš railway itself represents a barrier to the movement of animals along its entire length. If the railway is fenced, it will certainly have a barrier effect along its entire length, which should be regulated through mitigation measures, e.g. proposal for the construction of "green bridges".
- Experts agree that any confusion regarding the impact of railway reconstruction on protected areas, sensitive areas, critical habitats, protected and strictly protected species, will be resolved by gathering nature protection conditions according to the Law on Nature Protection (Articles 8 and 9 of the Law), which the investor is obliged to request from competent institutions (Institute for Nature Conservation of Serbia). They also emphasise that the complete list of all parts of the ecological network that are located nearby, or on the railway route, will be issued within the conditions for nature protection, after the investor addresses this institution.
- Experts explained that recently, on the website of the Daphne institution (which has implemented a project to define potential NATURA2000 sites in Serbia for the past three years), an interactive map of potential NATURA 2000 habitats (proposed Sites of Community Importance (pSCIs) and Proposed Special Protection Areas (pSPAs) are available. The complete results of the project will be submitted to the Ministry of Environmental Protection of the Republic of Serbia, during the next period, so we should communicate with the Ministry about the availability and use of the database for this project.
- Experts agreed on the cumulative effects listed. In addition, they noticed the cumulative effects can be manifested after the reconstruction, i.e. construction of the railway and the period of exploitation, through possible intensification of urbanization and other human activities in the narrower and wider area around the route, which may result in additional habitat fragmentation, landscape change, pollution, increased noise level and further amplification of the barrier effect. Ultimately, these effects may, directly or indirectly, affect the population status of flora and fauna in the zones of influence.
- There are sites of special interest along the railway, such as snake hibernacles, or habitats within the IBA area where protected bird species nest / winter / feed, so these sites should be given special attention at later stages, detected them, determine on the map the areas where they are located and propose the necessary protection measures through the project, if necessary.
- There are fish species of importance for protection in watercourses. It is therefore necessary to consult the Law on Protection and Sustainable Use of Fish Stock, in order to avoid intensive works and disturbance, and to reduce the intensity of works, during spawning of fish species.

14.1.3. Conducting fieldwork

After the extensive desktop study, field surveys along the proposed Project route were performed. A team of ecologists and flora and fauna experts conducted surveys of the terrestrial and aquatic environments to determine the existing habitat types and identify habitats, fauna and flora species present. The focus of field work was to confirm and/or identify the presence of priority biodiversity features and critical habitats. Priority was given to indicator plant species and specific groups of animals (birds and other larger vertebrates). The focus was on the detection of drivers of changes in the environment and potential receptors.

Targeted biodiversity field surveys of the PAoI have also been performed over the period of one year, covering all vegetative seasons (winter only for birds and mammals, and spring, summer, and autumn for all flora and fauna groups, including habitats). Groups that were included in the surveys are flora, invertebrates, fish, amphibians, reptiles, birds and mammals. However, it should be noted that the assessment of impacts on bats was based on available literature and data rather than field surveys. This approach was chosen based on the known existing data resources. These included the first comprehensive study about bat fauna in Serbia and Montenegro (i.e. former Federal Republic of Yugoslavia)[3], which considered the diversity and distribution of bats and detected the centres of biodiversity. It was concluded that the Velika Morava River and Južna Morava River valleys (the last one mentioned is a part of the PAoI), belong to the "zones of low diversity", among few others in Serbia. Later comprehensive studies and publications [4]; [5]) supplemented with much more data confirmed previous conclusions about the Velika Morava River and Južna Morava River valleys as a "zone of low diversity" for bats. Data on the presence of bat species were and remained scarce and existing records are mostly related to urban environments. The main reason for this situation is attributed to almost absolute dominance of highly modified, man-made agroecosystems and the consequent absence of suitable roosting places and shelters for bats.

As Serbia does not have a map of habitats, special attention was given to the identification of habitat types along the Project route. Ecosystems that are a priority for conservation (habitats listed by the EU Habitats Directive Annex I), Bern Convention (Resolution 4), Key Biodiversity Areas, Red List of Threatened Ecosystems (IUCN) and ecosystems recognised by the scientific community as being associated with key evolutionary processes are defined based on the results of the field surveys. Also, species and their habitats that are a priority for conservation, including species listed by the EU Habitats Directive and Birds Directive, Bern Convention, IUCN Red List, Bonn Convention, CITES and Law on Nature Protection of the Republic of Serbia are determined during the field research, and results are presented in the form of Lists of flora and fauna.

The main aim of the field survey was to collect data on flora and fauna species of interest for protection, as well as data on important habitat types to evaluate the possible impacts of the construction and operation of railway on biodiversity.

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[3] *Savić, I., Paunović, M., Milenković, M. & Stamenković, S. (1995). Biodiversity of mammals (Mammalia) of Yugoslavia, with an overview of species of international importance. In: Biodiversity of Yugoslavia with an overview of species of international importance (Eds. V. Stevanović, Vasić, V.), 517-554. Faculty of Biology and Ecolibri, Belgrade. (in Serbian)*

[4] *Paunović, M. (2016). Distribution, ecology and centers of biodiversity of bats (Mammalia, Chiroptera) in Serbia. PhD Dissertation. Faculty of Biology, University of Belgrade. 479 pp. (in Serbian).*

[5] *Paunović, M., Karapandža, B., Budinski, Ivana & Stamenković, S. (2020). Bats (Mammalia, Chiroptera) of Serbia. Serbian Academy of Science and Art. Special issues, Book DCXCIII. Belgrade. 601 pp. (in Serbian)*

The scope of all foreseen activities within biodiversity surveys included research on natural habitats, flora and fauna species; mapping of natural habitats within the PAoI and species and habitats within the Project area that are a priority for conservation, to confirm their presence and abundance.

A detailed methodology for one-year field surveys has been developed as part of ESIA Scoping Report.

The outcomes of the field surveys are as follows:

- For habitats - Identification, mapping, and description of the natural, semi-natural, and artificial habitats along the corridor. The classification of the present habitat types follows EUNIS version 2012 (amended 2019), and the digitalization has been performed using QGIS.
- For species - Recording species, with a focus on species of conservation concern (globally/nationally threatened species, endemic/restricted range species, migratory/congregatory species, and bird flyways, Annex II/Annex IV species protected under the EU Habitats Directive, invasive species, and nationally protected species).
- Flora surveys have been performed visually, including collecting plants to determine the most important ones, and by taking photos.
- The habitat/flora survey was focused on natural and semi-natural habitats, with less attention given to modified/anthropogenic habitats such as agricultural fields.
- The fauna surveys covered macro zoobenthos, insects, reptiles, amphibians, fishes, birds, and terrestrial mammals. Data collection methods used during the field surveys included direct observations, listening, collection of specimens (only if it was necessary), collection of increments, and taking photos.

The results of desktop study and field surveys are included in the following Sections.

14.1.4. Biodiversity characteristics of the project area

The Project is wholly located within the ‘Continental’ bio-geographical region, as shown in Figure 14-3.

The Continental region surrounds the Pannonian region as well as the Carpathian Mountains (which belong to the Alpine region) and contains some of the continent’s most productive ecosystems. In Serbia, as in other countries such as Slovenia, Croatia and Bosnia-Herzegovina, the transitions from one region to another occur over short distances. The Continental region is the transition zone on the north-south axis between the woodland-dominated coniferous Boreal region and the open Steppic region. Agricultural land covers more than half the area n this region. Additionally, there is a significant proportion of grasslands, mostly seminatural. Forests are much less prominent than in the Boreal region. Large bog and mire areas have been drained and cultivated. The infrastructure is dense, especially in the western region. With growing economic activity in the east, urbanisation and infrastructure are expected to increase significantly. The change in land use is leading to the increased fragmentation of habitats and the creation of barriers, which isolate species populations (Source: European Environmental Agency).

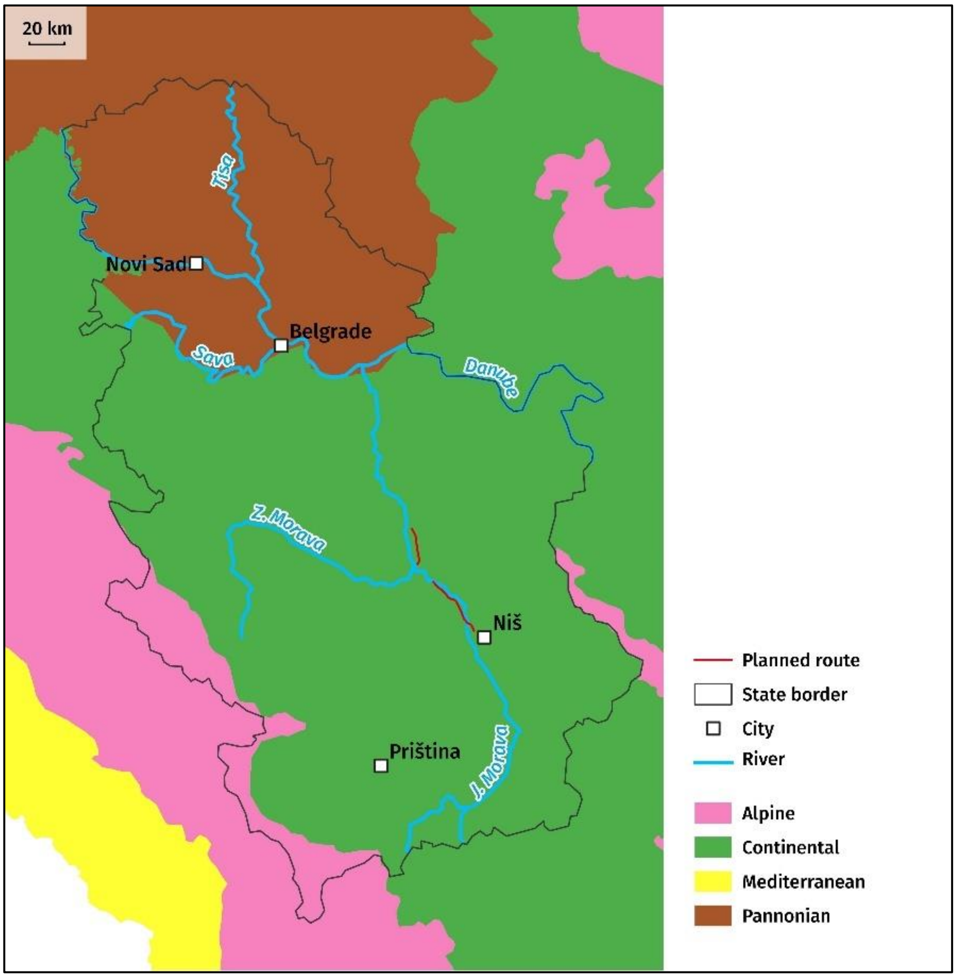

Figure 14-3. Map of biogeographical regions in Serbia[6]

Habitat types and flora along the railway route

All three field survey reports (covering the spring, summer and autumn seasons) including the detailed methodology and findings are provided as a stand-alone document" as a part of the ESIA package.

Field surveys of habitats and flora within the PAoI along the planned Project route were conducted during the spring (6 and 17 May 2023), summer (11-21 July 2023) and autumn (5-12 October 2023) seasons.

[6] *European Environmental Agency*

As anthropogenic habitats cover most of the Project area, the preliminary habitat survey points chosen were fragments of semi-natural and natural habitats. During the field investigation, some survey points were added or modified to cover as wide an area as possible where natural habitats are located. The habitat surveys were undertaken by walking and driving along selected routes and stopping near areas noted to support the habitats selected for review. At sample points, notes were taken on the vegetation type assemblage and habitat representativeness. Notes on visible degradation were also recorded to determine habitat condition. At all points, a GPS coordinate, as well as, photographs were taken. Ultimately, a total of 21 habitat survey points were covered along the Project alignment, listed in

Table 14-1. The following lists have been used as references for habitat types: EUNIS classification, EU Habitat Directive Annex I, Bern Convention Res. No. 4. The study area for analysis of habitat types was widened depending on their distribution and connectivity in the landscape. Namely, PAoI was expanded to include uninterrupted areas of occurrence of certain priority habitats or habitats of conservation concern for habitats).

Flora surveys of the project area included the defined PAoI. The flora surveys were undertaken by walking and driving at selected points along the corridor. They were performed visually, including collecting plants to determine the most important ones, and by taking photos. Species were generally identified in the field and, where required, literature and publications were used to enhance species identification. At all points, a GPS coordinate was taken. The selected flora survey points are presented in Table 14-2. Plant identification was based on Flora Europaea[7,8], Flora of Serbia[9,10,11,12]. Nomenclature is presented mainly according to Euro+Med Plantbase[13]. Conservation statuses were aligned with the following reference lists: the IUCN Red List of Threatened Species (IUCN 2016), Bern Convention (Council of Europe 1979), Annex II, IV and V of Habitat Directive (Council Directive 92/43/EEC), Appendix II of CITES Convention (CITES 2011) and Law on Nature protection of the Republic of Serbia (Official Gazette, No. 36/2009, 88/2010, 91/2010 - corr., 14/2016, 95/2018, 71/2021).

[7] *Tutin TG, Heywood VH, Burges NA, Moore DM, Valentine DH, Walters SM, Webb DA, editors. 1968-1980. Flora Europaea 2-5. Cambridge: Cambridge University Press;*

[8] *Tutin TG, Burges NA, Chater AO, Edmondson JR, Heywood VH, Moore DM, Valentine DH, Walters SM, Webb DA, editors. 1993. Flora Europaea 1. 2nd edition. Cambridge: Cambridge University Press*

[9] *Josifović M, editor. 1972-1977. Flora Srbije III-IX [Flora of Serbia III-IX]. Beograd: Srpska akademija nauka i umetnosti Serbian.*

[10] *Sarić M, editor. 1986. Flora Srbije X [Flora of Serbia X]. Beograd: Srpska akademija nauka i umetnosti. Serbian.*

[11] *Stevanović V. 1992. Floristička podela teritorije Srbije sa pregledom viših horiona i odgovarajućih flornih elemenata [Floristic division of the territory of Serbia with higher chorion survey and appropriate floral elements]. In: Sarić M, editor. Flora Srbije 1 [Flora of Serbia 1]. 2nd ed. Beograd: Srpska akademija nauka i umetnosti. p. 49–65. Serbian.*

[12] *Stevanović V, editor. 2012. Flora Srbije 2 [Flora of Serbia 2]. 2nd ed. Beograd: Srpska akademija nauka i umetnosti. Serbian*

[13] *http://ww2.bgbm.org/EuroPlusMed/query.asp*

Table 14-1. Coordinates of habitat survey points

No.	E	N	Location	City	Comment
1.	43.366282	21.811914	Near Vrtište settlement	Niš	Wet meadow and forest
2.	43.376001	21.814132	Suburban area of Vrtište settlement	Niš	Arable land, ruderal communities and forest
3.	43.37982	21.80619	Near Mezgraja village	Niš	Wet habitats and arable land
4.	43.38156	21.80636	Near Mezgraja village	Niš	Forests
5.	43.3825	21.8039	Near Mezgraja village	Niš	Forests and arable land
6.	43.38483	21.80066	Near Mezgraja village	Niš	Wet meadow
7.	43.39044	21.7873	Suburban area – Mezgraja village	Niš	Forests and arable land
8.	43.39139	21.78479	Suburban area – Mezgraja village	Niš	Arable land
9.	43.39168	21.78105	Suburban area – Mezgraja village	Niš	Forest
10.	43.395279	21.772234	Bank of Južna Morava River	Niš	Forests and arable land
11.	43.40632	21.76152	Suburban area – Veliki Drenovac		Anthropogenic habitats
12.	43.427822	21.751280	Near Veliki Drenovac village	Niš	Forests and arable land
13.	43.56186	21.59074	Gornji Ljubeš village	Aleksinac	Forests
14.	43.58538	21.5591	Donji Ljubeš village	Aleksinac	Forests
15.	43.58771	21.55463	Donji Ljubeš village	Aleksinac	Forests and anthropogenic village
16.	43.59228	21.55945	Bank of Južna Morava River near Vitkovac	Stalać	Forests
17.	43.602689	21.543882	Bank of Južna Morava River near Đunis	Stalać	Arable land and forests
18.	43.604451	21.535313	Forest near Đunis	Stalać	Forest
19.	43.697868	21.428732	Forest near Lučina settlement	Ćićevac	Forest and anthropogenic habitats
20.	43.732037	21.433479	Suburban area of Ćićevac	Ćićevac	Anthropogenic habitats
21.	43.789931	21.426087	Industry area near Ratare village	Paraćin	Anthropogenic habitats

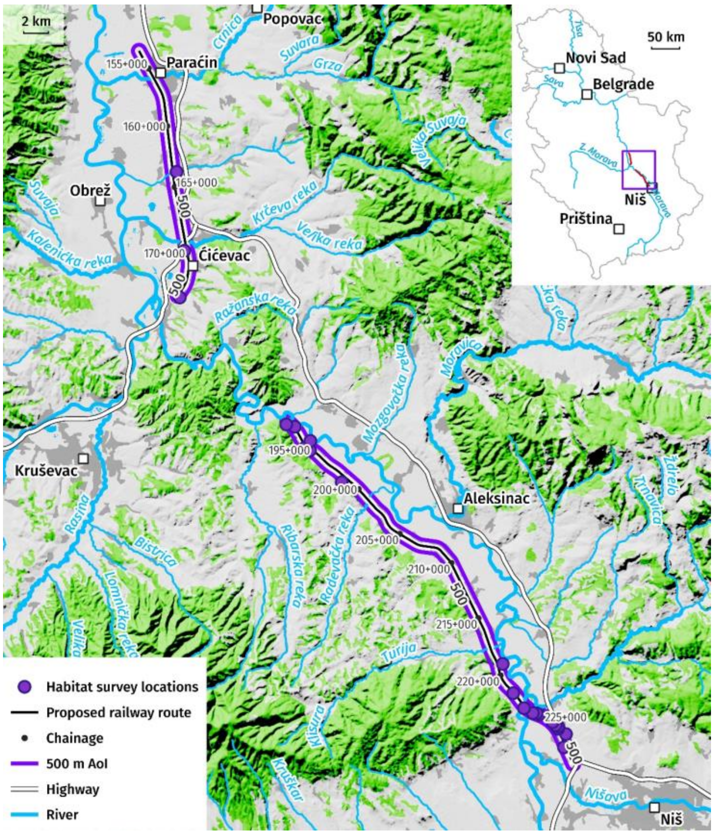

Figure 14-4. The map of habitat survey points

Table 14-2. Coordinates of flora survey points

No.	E	N	Location	City	Comment
1.	43.366282	21.811914	Near Vrtište settlement	Niš	Wet meadow and forest
2.	43.376001	21.814132	Suburban area of Vrtište settlement	Niš	Arable land, ruderal communities and forest
3.	43.3794444	21.820555	Vrtište	Niš	Forests
4.	43.38561	21.80151	Near Mezgraja village	Niš	*Robinia pseudoacacia* plantation
5.	43.39789	21.77348	Near Mezgraja village	Niš	Ponds and forest
6.	43.39508	21.77125	Near Mezgraja village	Niš	Arable land, grasses and forest
7.	43.39432	21.77022	Near Mezgraja village	Niš	Arable land, grasses and forest
8.	43.57023	21.58971	Donji Ljubeš village	Aleksinac	Forests and anthropogenic habitats
9.	43.57063	21.57717	Donji Ljubeš village	Aleksinac	Forests
10.	43.579	21.57653	Donji Ljubeš village	Aleksinac	Arable land
11.	43.604451	21.535313	Forest near Đunis	Stalać	Forest
12.	43.697868	21.428732	Forest near Lučina settlement	Ćićevac	Forest and anthropogenic habitats
13.	43.732037	21.433479	Suburban area of Ćićevac	Ćićevac	Anthropogenic habitats
14.	43.789931	21.426087	Industry area near Ratare village	Paraćin	Anthropogenic habitats

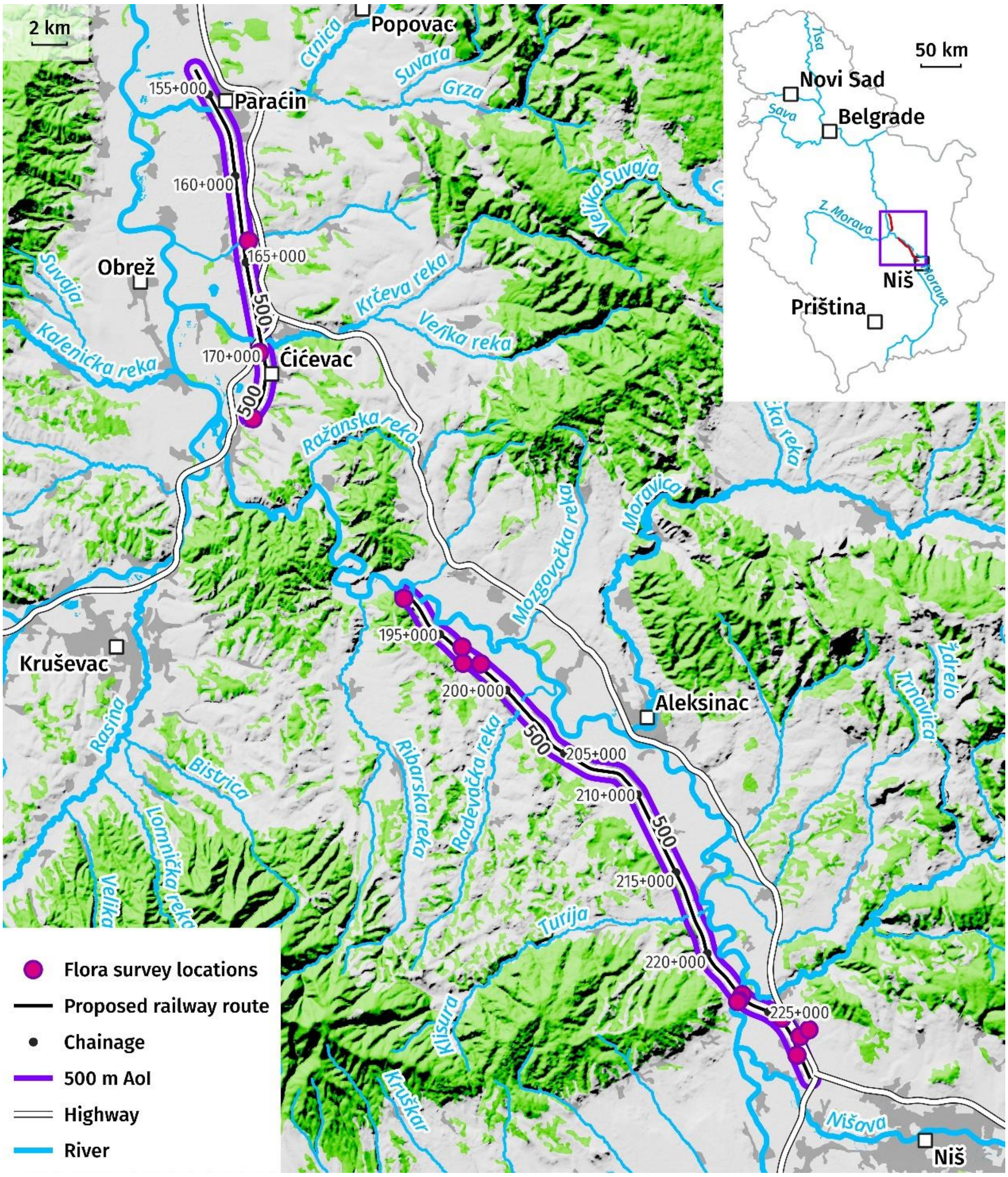

Figure 14-5. The map of flora survey points

Natural habitats recorded along the Project alignment are forests, shrublands, grasslands, and water habitats. Urbanization (settlements and road construction), land reclamation, the regulation of watercourses, expansion of arable land, and the use of herbicides and other pollutants have resulted in the degradation of natural vegetation within the PAoI. Anthropogenic habitats recorded include agricultural land, grasslands, and urban areas.

The forests represent 'Potential Natural Vegetation', not only within the PAoI, but also in the wider, surrounding area. Due to strong anthropogenic pressures over the last several decades (including clearance of forests for arable farming purposes and urban expansion), forests have been degraded and fragmented. Today, fragments of forests are sporadically present within the PAoI, which demonstrate altered floristic composition from native forests. The list of recorded habitat types is provided in Table 14-3 below, while details on the habitats and their characteristics within the PAoI are given in the rest of the chapter.

Table 14-3. EUNIS habitat types identified within the railway corridor 500m + 500m

EUNIS		EUNIS habitat descriptions	EU Habitats Directive		
Code*	Name of habitat		code	Name of habitat	Habitats recorded within the working corridor (30 m + 30 m)
C1.33	Rooted submerged vegetation of eutrophic waterbodies	Formations of water bodies constituted by submerged, rooted, perennial phanerogams with often emerging flower spikes, in particular entirely immersed pondweeds of genus *Potamogeton*. Alliances *Potamion lucentis* and *Potamion pusilli*. Other frequent species are *Myriophyllum spicatum*, *Myriophyllum verticillatum*, *Najas marina* and *Najas minor*.	3150	Natural eutrophic lakes with *Magnopotamion* or *Hydrocharition* -type vegetation	√
C2.3	Permanent non-tidal, smooth-flowing watercourses	Permanent water courses with non-turbulent water and their associated animal and microscopic algal pelagic and benthic communities. Slow-flowing rivers, streams, brooks, rivulets and rills; also fast-flowing rivers with laminar flow. The bed is typically composed of sand or mud. Features of the riverbed, uncovered by low water or permanently emerging, such as sand or mud islands and bars are treated as the littoral zone (C3). Includes mid and low-altitude streams as defined by the Water Framework Directive.	3260	Water courses of plain to montane levels with the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation	-
C3.2	Water-fringing reedbeds and tall helophytes other than canes	Water-fringing stands of tall vegetation by lakes (including brackish lakes), rivers and brooks, usually species-poor and often dominated by one species. Includes stands of *Carex* spp.,*Cladium mariscus*, *Equisetum fluviatile*, *Glyceria maxima*, *Hippuris vulgaris*, *Phragmites australis*, *Sagittaria sagittifolia*, *Schoenoplectus* spp., *Sparganium* spp. And *Typha* spp. Excludes terrestrialised reed and sedge beds which are not at the water's edge (D5.1, D5.2).	-	-	√
E2.6	Agriculturally-improved, re-seeded and heavily	Land occupied by heavily fertilised or reseeded permanent grasslands, sometimes treated by selective herbicides, with very	-	-	√

EUNIS		EUNIS habitat descriptions	EU Habitats Directive		
Code*	Name of habitat		code	Name of habitat	Habitats recorded within the working corridor (30 m + 30 m)
	fertilised grassland, including sports fields and grass lawns	impoverished flora and fauna, used for grazing, soil protection and stabilization, landscaping or recreation.			
E3	Wet or seasonally wet grasslands	Unimproved or lightly improved wet meadows and tall herb communities of the boreal, nemoral, warm-temperate humid, steppic and mediterranean zones.	-	-	√
E5.1	Anthropogenic herb stands	Stands of herbs developing on abandoned urban or agricultural land, on land that has been reclaimed, on transport networks, or on land used for waste disposal.	-	-	-
F9.35	Riparian stands of invasive shrubs	Riparian stands of invasive shrubs, for example *Amorpha fruticosa*, recorded from Romania and Croatia, and *Reynoutria japonica* (= *Fallopia japonica*) (Japanese Knotweed), which invades watercourses and roadsides.	-	-	√
FA.3	Species-rich hedgerows of native species	Hedgerows composed mainly of native species, with on average at least five native woody species per 25 m length, excluding undershrubs such as *Rubus fruticosus* or climbers such as *Clematis vitalba* or *Hedera helix*. In western Europe, many such hedges are thought to be medieval in origin.	-	-	√
G1	Broadleaved deciduous woodland	Woodland, forest and plantations dominated by summer-green non-coniferous trees that lose their leaves in winter. Includes woodland with mixed evergreen and deciduous broadleaved trees, provided that the deciduous cover exceeds that of evergreens. Excludes mixed forests (G4) where the proportion of conifers exceeds 25%.	-	-	√
G1.11	Riverine *Salix* woodland	Salix spp. scrub or arborescent formations, lining flowing water and submitted to periodic flooding, developed on recently	*91E0	Alluvial forests with *Alnus glutinosa* and *Fraxinus*	√

EUNIS		EUNIS habitat descriptions	EU Habitats Directive		
Code*	Name of habitat		code	Name of habitat	Habitats recorded within the working corridor (30 m + 30 m)
		deposited alluvion. Willow brushes are particularly characteristic of rivers originating in major mountain ranges. Shrubby willow formations also constitute an element of lowland and hill riverine successions in all major biomes, often making the belt closest to the water course. Taller arborescent willow formations often constitute the next belt landwards in riverine successions of lowland western nemoral, eastern nemoral and warm-temperate humid forest regions, and a large part of the less diverse riverine systems of the steppic, mediterranean and cold desert zones. Vegetation of alliance *Salicion albae*, species *Salix alba, Salix fragilis, Populus alba, Populus nigra, Populus canescens, Lycopus europaeus, Lysimachia vulgaris, Phalaroides arundinacea* and *Urtica dioica*. May be affected by the invasive alien species *Solidago canadensis, Aster novi-belgii, Aster novi-anglii, Impatiens glandulifera*.		*excelsior* (*Alno-Padion, Alnion incanae, Salicion albae*)	
G1.223	Southeast European Fraxinus - Quercus - Alnus forests	Mixed riverine forests of Ponto-Pannonic and sub-Mediterranean regions of southeastern Europe, usually dominated by *Quercus robur* and/or *Fraxinus angustifolia*, with varying admixtures of *Ulmus minor, Ulmus laevis, Carpinus betulus, Acer campestre, Alnus glutinosa, Fraxinus excelsior, Salix alba, Populus alba*.	91F0	Riparian mixed forests of *Quercus robur, Ulmus laevis and Ulmus minor, Fraxinus excelsior* or *Fraxinus angustifolia*, along the great rivers (*Ulmenion minoris*)	√
G1.76	Balkano-Anatolian thermophilous *Quercus* forests	Xerophile or xero-mesophile forests of *Quercus frainetto, Quercus cerris*, of *Quercus petraea* and related deciduous oaks, locally of *Quercus pedunculiflora* or *Quercus virgiliana*, of the sub-continental central and eastern Balkan peninsula, of the	91M0	Pannonian-Balkanic turkey oak – sessile oak forests	√

EUNIS		EUNIS habitat descriptions	EU Habitats Directive		
Code*	Name of habitat		code	Name of habitat	Habitats recorded within the working corridor (30 m + 30 m)
		supra-Mediterranean level of continental Greece, except the extreme south, and of supra-Mediterranean Anatolia. In most of their range they constitute the lowest altitudinal tier of forest vegetation; in Greece and adjacent areas, however, they occur above the forests of the Ostryo-Carpinion. In western Carpathians they have the northern boundary of occurrence and here are represented by the alliance Quercion confertae cerris with species *Lathyrus niger, Melica picta, Serratula tinctoria, Veronica officinalis.*			
G1.C3	*Robinia* plantations	Plantations and spontaneous formations of Robinia pseudacacia. Vegetation of alliances *Chelidonio-Robinion* and *Balloto nigrae-Robinion*.	-	-	√
G5	Lines of trees, small anthropogenic woodlands, recently felled woodland, early-stage woodland and coppice	Stands of trees greater than 5 m in height or with the potential to achieve this height, either in more or less continuous narrow strips or in small (less than about 0.5 ha) plantations or small (less than about 0.5 ha) intensively-managed woods. Woodland and coppice that is temporarily in a successional or non-woodland stage, but which can be expected to develop into woodland in the future. Excludes parkland (E7.1, E7.2).	-	-	√
I1.1	Intensive unmixed crops	Cereal and other crops grown on large, unbroken surfaces in open field landscapes.	-	-	√
I1.5	Bare tilled, fallow or recently abandoned arable land	Fields abandoned or left to rest, and other interstitial spaces on disturbed ground. Set-aside or abandoned arable land with forbs planted for purposes of soil protection, stabilization, fertilisation or reclamation. Abandoned fields are colonised by numerous	-	-	-

EUNIS		EUNIS habitat descriptions	EU Habitats Directive		
Code*	Name of habitat		code	Name of habitat	Habitats recorded within the working corridor (30 m + 30 m)
		pioneering, introduced or nitrophilous plants. They sometimes provide habitats that can be used by animals of open spaces.			
J1.1	Residential buildings of city and town centres	Buildings in urban areas where buildings, roads and other impermeable surfaces occupy at least 80% of the land, and with continuous or nearly continuous buildings, which may be houses, flats or buildings occupied for only part of the day.	-	-	√
J1.2	Residential buildings of villages and urban peripheries	Residential buildings in suburbs and villages where buildings and other impermeable surfaces occupy between 30% and 80% of the land area.	-	-	√
J1.4	Rural industrial and commercial sites still in active use	Buildings in sites with current industrial or commercial use. Includes office blocks, factories, industrial units, large (greater than 1 ha) greenhouse complexes, large animal-rearing batteries and large farm units.	-	-	√
J1.6	Urban and suburban construction and demolition sites	Non-rural sites in which buildings are being constructed or demolished; this land, when in use, would have been or will be classified as J1.1, J1.2, J1.3 or J1.4.	-	-	√
J4.2	Road networks	Road surfaces and car parks, together with the immediate highly-disturbed environment adjacent to roads, which may consist of roadside banks or verges.	-	-	√
J4.3	Rail networks	Railway tracks, and the immediate highly-disturbed environment adjacent to railways, which may consist of banks or verges.			√
J4.7	Constructed parts of cemeteries	Hard-surfaced areas within cemeteries.	-	-	-
X07	Intensively-farmed crops interspersed with strips of	'Intensively-grown crops interspersed with strips of natural and/or semi-natural vegetation. The semi-natural vegetation, which may consist of ruderal and pioneer species colonising	-	-	√

EUNIS		EUNIS habitat descriptions	EU Habitats Directive		
Code*	Name of habitat		code	Name of habitat	Habitats recorded within the working corridor (30 m + 30 m)
	natural and/or semi-natural vegetation	uncultivated land, may be allowed to develop on broad headlands at arable field margins.			
X25	Domestic gardens of villages and urban peripheries	Domestic gardens, usually small in area, usually < 0.5 ha, often with very mixed species-rich flora and fauna (crops, lawns, shrubs, flowerbeds etc., frequently interspersed with paths and small buildings) in close proximity to human dwellings, agricultural land, natural or semi-natural habitats. The component habitat types comprise combinations of several level 1 units.	-	-	√

** Habitats in blue correspond to Habitats listed as well in Resolution 4 of the Bern convention*[14]

[14] *European Environment Agency (https://eunis.eea.europa.eu/habitats.jsp and https://www.eea.europa.eu/data-and-maps/data/eunis-habitat-classification)*

<u>*Reference to EUNIS Habitats: C1.33 - Rooted submerged vegetation of eutrophic waterbodies*</u>
Reference to EU HD Annex I: 3150 Natural eutrophic lakes with *Magnopotamion* or *Hydrocharition*-type vegetation
Reference to Bern Convention: Resolution 4 habitat type (used for designation of Emerald sites)

This habitat type is recorded at several locations along the Project alignment: near Mezgraja settlement (around chainage 223+000 km), Vrtište village (between chainages 225+000 km and 226+000 km, cca 228+000 km). Some of the dominant species within these habitats are: *Potamogeton nodosus* (Pondweed), *Myriophyllum spicatum* (Spiked Water-milfoil), *Lemna minor* (Common duckweed) as illustrated in Figure 14-6. Typically this habitat type is surrounded by tall helophytes, such as *Typha angustifolia* (Lesser Bulrush), *T. latifolia* (Broadleaf cattail), *Phragmites communis* (Common red) or hygrophilous plant spescies such as: *Salix alba*, *Populus* sp.

Figure 14-6. Surface standing waters in the near of Mezgraja settlement

<u>*Reference to EUNIS Habitats: C2.3 Permanent non-tidal, smooth-flowing watercourse*</u>
Reference to EU HD Annex I: 3260 Water courses of plain to montane levels with the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation
Reference to Bern Convention: none

During the field surveys this habitat type was not recorded. Furthermore, this habitat type is not included in the database of the Instutute for nature conservation of Serbia. However, this habitat could potentially be found in the riparian zone of the Južna Morava River. Therefore, this habitat type has been included in the priority biodiversity features and critical habitat assessment.

<u>*Reference to EUNIS Habitats: C3.2 - Water-fringing reedbeds and tall helophytes other than canes*</u>
Reference to EU HD Annex I: none
Reference to Bern Convention: Resolution 4 habitat type (used for designation of Emerald sites)

Low floristic diversity is the main characteristic of the abovementioned habitats. *Typha angustifolia* (Lesser Bulrush), *T. latifolia* (Broadleaf cattail) are the dominant species within this type of habitat. In addition to *Typha* spp., the following species were recorded during the Project field surveys: *Phragmites communis* (Common red), *Schoenoplectus lacustris* (Common club-rush), *Carex acutiformis* (Lesser Pond-Sedge), *Carex hirta* (Hairy sedge), *C. vulpina* (True Fox Sedge), *Mentha aquatica* (Water mint), *Mentha pulegium* (Pennyroyal), *Ranunculus sceleratus* (Celery-leaved buttercup), *Veronica anagallis-aquatica* (Véronique Faux Mouron), *Lycopus europaeus* (Gypsywort), *Epilobium parviflorum* (Hoary Willowherb). This habitat type was recorded near Mezgraja settlement (cca 223+00 km, cca 225+000 km, between 225+000 km and 226+000 km, cca 227+000 km and cca 228+000 km), as illustated in Figure 14-7 and Figure 14-8.

Figure 14-7. Water-fringing reedbeds and tall helophytes other than canes in the near of Mezgraja settlements in spring season

Figure 14-8. Water-fringing reedbeds and tall helophytes other than canes in the near of Mezgraja settlements in summer season

Reference to EUNIS Habitats: E2.6 - Agriculturally-improved, re-seeded and heavily fertilised grassland, including sports fields and grass lawns
Reference to EU HD Annex I: none
Reference to Bern Convention: none

These habitat types are spread in the form of small fragments along the Project alignment. Different types of grasses and legumes are dominant in these communities, as illustrated in Figure 14-9**Error! Reference source not found.**. Agrostis alba (black bent), *Alopecurus pratensis* (Meadow foxtail), *Bromus* spp., *Cichorium intybus* (Common chicory), *Cynosurus cristatus* (Crested dog's-tail), *Galium palustre* (Marsh-bedstraw), *Lolium perenne* (Perennial ryegrass), *Lotus corniculatus* (Bird's-foot trefoil), *Medicago arabica* (Spotted medick), *Plantago lanceolata* (Ribwort plantain), *Poa pratensis, Ranunculus repens* (Creeping buttercup), *Ranunculus sardous* (Hairy buttercup), *Leontodon taraxacum* (Common dandelion), *Trifolium spp*. are some of species recorded within this habitat type. This habitat type was recorded at the following chainages: 194+200 km, 194+500 km, between 195+200 km and 196+300 km, cca 198+000 km, between 199+800 km and 200+200 km, cca 223+000 km.

Figure 14-9. Agriculturally improved, re-seeded and heavily fertilised grassland, including sports fields and grass lawns

Reference to EUNIS Habitats: E3 Wet or seasonally wet grasslands
Reference to EU HD Annex I: none
Reference to Bern Convention: none

Autochthonous grasses *Alopecurus pratensis* (Meadow foxtail), *Agrostis alba* (Redtop), *Hordeum secalinum* (Meadow barley), *Poa trivialis* (Rough bluegrass) are dominant species. Also, clover species Trifolium fragiferum (Strawberry clover) and Trifolium resupinatum (Persian clover). These habitats are characterised by great diversity of plant species. They are also strongly influenced by groundwater levels. Besides these different autochthonous plant species are recorded such as: *Bromus racemosus* (Bald brome), *Galium debile* (Marsh Bedstraw), Rumex crispus (Curly dock), *Ranunculus sardous* (Hairy buttercup), *Leontodon taraxacum* (Dandelion), *Eleocharis palustris* (Common spike-rush), *Festuca pratensis* (Meadow fescue), *Poa pratensis* (Kentucky bluegrass), *Potentilla reptans* (Creeping cinquefoil), *Trifolium repens* (White clover) etc. Within the Project AoI, these habitats are surrounded by agricultural land and many invasive or allochthonous weed species from the edge entered into stands such as *Robinia pseudoacacia* (Black locust), *Erigeron annus* (Daisy fleabane), *E. canadensis* (Horseweed), Ambrosia artemisiifolia, (Common ragweed). Within the PAoI, these habitats were recorded around chainages 223+000, cca 225+000 km, between 225+000 km and 226+000 km and cca 228+000 km, as illustrated in Figure 14-10.

Figure 14-10. E3 Wet or seasonally wet grasslands

Reference to EUNIS Habitats: E5.1 Anthropogenic herb stands
Reference to EU HD Annex I: none
Reference to Bern Convention: none

Ruderal and weedy plant species are dominant within these habitat types and such vegetation is widely present throughout the Project AoI. Most of the grasslands are of anthropogenic origin. They occupy small areas since most of the agricultural land is permanently arable, as shown in Figure 14-11. Some of the species are: *Cynodon dactylon* (Scutch grass), *Lolium perenne* (Perennial ryegrass), *Bromus spp.* (Bromes), *Hordeum vulgare* (Hordeum vulgare), *Sambucus ebulus* (Danewort), *Artemisia vulgaris* (Mugwort), *Cichorium intybus* (Chicory), *Cirsium arvense* (Canada thistle), *Dipsacus laciniatus* (Cutleaf teasel), *Chenopodium album* (White goosefoot), *Arctium lappa* (Greater burdock), *etc*. Also, these habitats are suitable for the establishment of invasive plants, such as

Erigeron annus, *Datura stramonium* (Jimsonweed), *Ambrosia artemisifolia* (Annual ragweed), *Syphiotrichum lanceolatum* (Panicled aster), *Sorghum halepense* (Johnson grass) etc. It is found at cca 197+000 km.

Figure 14-11. Anthropogenic herb stand

Reference to EUNIS Habitats: F9.35 Riparian stands of invasive shrubs
Reference to EU HD Annex I: none
Reference to Bern Convention: none

These habitats are located along watercourses and roadsides. Stands of shrubs *Amorpha fruticosa* (false indigo) and *Robinia pseudoacacia* (Black locust) were recorded within the PAoI, as shown in Figure 14-12. These habitats are typically found in areas with a high groundwater table. They were present around chainages: 192+500, 193+000 between 226+000 and 227+000 km).

Figure 14-12. Riparian stands of invasive shrubs

Reference to EUNIS Habitats: FA.3 Species-rich hedgerows of native species
Reference to EU HD Annex I: none

Reference to CoE BC Res. No. 4 1996: none

Within the PAoI, different shrubs form hedgerows along the railway alignment. Autochthonous plants are dominant in the floristic composition of the hedgerow, such as *Prunus spinosa* (blackthorn), *Rosa canina* (dog rose), *Cornus sanguine* (common dogwood), *Acer campestre* (field maple), *Crataegus monogyna* (common hawthorn), *Acer tataricum* (Tatar maple), *Corylus avellana* (Common hazel). However, this habitat type is also inhabited by invasive species *Robinia pseudoaccacia* (black locust), *Acer negundo* (boxelder maple) and *Ailanthus altissima* (Tree of heaven). It is found along the tracks of the whole railway corridor, illustrated in Figure 14-13.

Figure 14-13. Species-rich hedgerows of native species

Reference to EUNIS Habitats: G.1 Broadleaved deciduous woodland.
Reference to EU HD Annex I: none
Reference to Bern Convention: none

Broadleaved deciduous woodland are present in small, fragmented areas within the PAoI as shown in Figure 14-14**Error! Reference source not found.Error! Reference source not found.**. Within these habitats, different autochthonous plant species are recorded, such as *Quercus robur* (Europaean oak), *Carpinus betulus* (common hornbeam), *Crataegus monogyna* (common hawthorn), *Fraxinus angustifolia* (narrow-leafed ash), *Acer campestre* (field maple), *Evonymus europaeus* (European spindle), *Prunus spinosa* (blackthorn), *Rosa canina* (dog rose), *Cornus sanguine* (common dogwood), *Crataegus monogyna* (common hawthorn), *Ulmus minor* subsp. *minor* (field elm), *Clematis vitalba* (Old man's beard).At the edges of these habitats ruderal and invasive plants can be found, including *Amorpha fruticosa* (indigo bush), *Robinia pseudoaccacia* (black locust), *Ailanthus altissima* (Tree of heaven), and particularly, *Acer negundo* (Boxelder maple) are invasive species that are present along the edges of the Broadleaved deciduous woodland. Some of ruderal plants that are present along the edges of these habitats are: *Sambucus ebulus* (Danewort), *Daucus carota* (Wild carrot), *Dactylis glomerata* (Cat grass), *Dipsacus laciniatus* (Cut-leaved teasel), *Urtica dioica* (Common nettle), *Rubus sp.* (Brambles), *Cichorium intybus* (Common chicory), *Chelidonium majus* (Greater celandine), and others. This habitat type was recorded along the corridor at following chainages: cca 192+200 km, cca 196+000 km, cca 198+000 km, cca 199+000 km and from 199+300 km to 200+000 km.

Figure 14-14. Broadleaved deciduous woodland

Reference to EUNIS Habitats: G1.11 - Riverine Salix woodland

Reference to EU HD Annex I: *91E0 Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-Padion, Alnion incanae, Salicion albae*)

Reference to Bern Convention: Resolution 4 habitat type (used for designation of Emerald sites)

Within the PAoI, preserved Riverine *Salix* woodland is found along the banks of Južna Morava River, as shown in Figure 14-15 and in the lower parts of the alluvial plain, where groundwater levels are high. However, today willow and poplar forests are almost completely disturbed and represented only by small groups or more precisely by strips of *Salix alba* (White willow), *Populus alba* (White poplar), *Populus nigra* (Black poplar). In addition to the aforementioned species, *Populus tremula* (European aspen), *Acer campestre* (field maple), *Fraxinus angustifolia* (Narrow-leaved ash), *Evonymus europaeus* (European spindle), *Cornus sanguine* (common dogwood), *Crataegus monogyna* (common hawthorn), *Ulmus minor* (field elm), *Clematis vitalba* (Old man's beard), *Ranunculus repens* (Creeping buttercup), *Galium aparine* (Cleavers), *Rubus sp.* are recorded within these habitats. Also, ruderal plants are common, such as *Dactylis glomerata* (Cat grass), *Urtica dioica* (Common nettle), *Chelidonium majus* (Greater celandine), *Anisantha sterilis* (Barren brome), *Leontodon taraxacum* (Common dandelion), *Geranium robertianum* (Herb robert), *Sambucus ebulus* (danewort) and others. At the edges of the habitat some invasive plants are present: *Amorpha fruticosa* (indigo bush), *Robinia pseudoaccacia* (black locust), *Acer negundo* (Boxelder maple), *Reynouria japonica* (Japanese knotweed) etc.. These habitats are recorded within the PAoI at the following chainages: between 192+000 km and 193+000 km, cca 193+000 km, cca 197+000 km, cca 197+000 km, cca 200+000 km, cca 223+000 km, cca 225+000 km, between 225+000 km and 226+000 km, cca 226+000 km, cca 227+000 km and cca 228+000.

Figure 14-15. Riverine *Salix* woodland along the Južna Morava River

<u>*Reference to EUNIS Habitats: G1.223 - Southeast European Fraxinus - Quercus - Alnus forests*</u>
Reference to EU HD Annex I: Annex I habitat type (code 91F0)
Reference to Bern Convention: Included in a Resolution 4 habitat type at a higher level (G1.22)

This habitat type is characterised by a great diversity of woody species, such as *Ulmus laevis* (European white elm), *Ulmus minor* subsp. *minor* (Field Elm), *Pyrus communis* subsp. *pyraster* (Wild pear), *Acer campestre* (Field maple), *Populus alba* (White Poplar), *Crataegus monogyna* (Hawthorn), *Crataegus rhipidophylla* (English hawthorn), *Euonymus europaeus* (Spindle), *Cornus sanguinea* (Common dogwood), *Prunus spinosa* (Blackthorn). These habitats were recorded at several locations in the PAoI, and illustrated in Figure 14-16**Error! Reference source not found.** (cca 217+500 km, cca 219+000 km, between 219+000 km and 220+000 km, cca 228+000 km).

Figure 14-16. Southeast European *Fraxinus - Quercus - Alnus* forests

Reference to EUNIS Habitats: G1.76 - Pannonian-Balkanic turkey oak-sessile oak forests
Reference to EU HD Annex I: Annex I habitat type (code 91M0)
Reference to CoE BC Res. No. 4 1996: Included in a Resolution 4 habitat type at a higher level (G1.7)

As already mentioned, potential natural vegetation within the PAoI are xerophilous forests of *Quercus frainetto* (Hungarian oak) and *Quercus cerris* (Turkey oak). However, these forests are to a large degree degraded and fragmented along the corridor, as illustrated in Figure 14-17**Error! Reference source not found.**. *Quercus frainetto* (Hungarian oak) and *Quercus cerris* (Turkey oak) are the dominant species. *Fraxinus ornus* (Manna ash), *Carpinus orientalis* (Oriental hornbeam), *Crataegus monogyna* (Hawthorn), *Cotinus coggygria* (Smoke-bush), *Cornus sanguine* (common dogwood), *Acer campestre* (field maple), *Crataegus monogyna* (common hawthorn), *Acer tataricum* (Tatar maple), *Corylus avellana* (Common hazel), *Frangula alnus* (Glossy Buckthorn) are some of the species present in the tree and shrub layers. *Veronica officinalis* (Heath speedwell), *Brachypodium silvaticum* (False-brome), *Dioscorea communis* (Black bryony), *Teucrium chamaedrys* (Wall germander), *Polygonatum multiflorum* (Solomon's seal) are some of the species recorded in the layer of herbaceous plants. Within the PAoI these habitats are recorded at the following chainages: between 191+500 km and 195+200 km, between 196+500 km and 197+300 km, between 198+100 km and 199+500 km, between 202+200 km and 203+200 km, between 204+800 km and 205+100 km, between 218+000 km and 219+200 km and cca 205+000 km.

Figure 14-17. Pannonian-Balkanic turkey oak-sessile oak forests above Gornji Ljubeš village

Reference to EUNIS Habitats: G1.C3 - Robinia plantations
Reference to EU HD Annex I: none
Reference to Bern Convention: none

Species *Robinia pseudoacacia* (Black locust) has been planted by humans and is shown in Figure 14-18**Error! Reference source not found.**. As this species is invasive and fast-growing, it spreads spontaneously. It was found around 194+000 km,cca 223+000 km.

Figure 14-18. *Robinia* plantations

Reference to EUNIS Habitats: G5 - Lines of trees, small anthropogenic woodlands, recently felled woodland, early-stage woodland and coppice
Reference to EU HD Annex I: none
Reference to Bern Convention: none

Fragments of this habitat type were found in the PAoI (from 174+000 km to 175+000 km, cca 173+500 km, 201+300 km to 204+000 km, from 215+000 to 217+000, cca 220+500 km). This habitat is composed of native decidous trees.

Reference to EUNIS Habitats: I1.1 Intensive unmixed crops
Reference to EU HD Annex I: none
Reference to Bern Convention: none

Arable land is the dominant habitat along the entire Project corridor, as illustrated in Figure 14-19**Error! Reference source not found.Error! Reference source not found.**. The agroecosystems along the corridor are represented by individual parcels of different types of agricultural crops. The dominant agricultural crops are corn and sunflower. Species including *Lolium perenne* (Perennial ryegrass), *Daucus carota* (Wild carrot), *Urtica dioica* (Common nettle), *Artemisia vulgaris* (Mugwort), *Chenopodium album* (White goosefoot), *Consolida regalis* (Forking larkspur), *Cichorium intybus* (Chicory), *Cirsium arvense* (Cree ping thistle), *Persicaria lapathifolia* (Pale smartweed), *Portulaca oleracea* (Common purslane) are present along the edges of arable land. In the summer, invasive plants were recorded within these habitats, such as: *Ambrosia artemisifolia* (Common ragweed), *Xanthium strumarium* (Rough cocklebur), *Sorghum halepense* (Johnson grass), *Datura stramonium* (Thorn apple) and *Echinochloa crus-galli* (Barnyard Grass), *Amaranthus retroflexus* (Red-root amaranth). This habitat is found in many locations within the PAoI (from 153+000 to 155+800 km, cca 157+500 km, from 157+000 to 162+200 km, from 162+500 to 166+200 km, cca 167+000 km, from 167+600 to 175+000 km, from 192+800 to 195+300 km, from 202+300 to

205+500 km, from 206+300 to 208+000 km, from 209+500 to 210+200 km, from 210+800 to 213+700 km, from 221+250 to 223+000 km, from 223+500 to 230+000 km).

Figure 14-19. Corn field surrounded by ruderal and invasive plants

Reference to EUNIS Habitats: I1.5 Bare tilled, fallow or recently abandoned arable land
Reference to EU HD Annex I: none
Reference to CoE BC Res. No. 4 1996: none

Annual and perennial weed communities are developed on land where there were arable fields several years ago. When the arable fields were abandoned, the succession process began and it is still ongoing. Nitrophilous annual and perennial plants inhabit this land, as shown in Figure 14-20. The areas surrounding this habitat type are colonised mainly by nitrophilous herbaceous ruderal plant species. Some of them are *Artemisia vulgaris* (Mugwort), *Cirsium arvense* (Creeping thistle), *Rumex crispus* (Curly dock), *Agrostemma* githago (Corncockle), *Consolida regalis* (Forking larkspur), *Rumex obtusifolius* (Bitter dock), *Anchusa officinalis* (Common bugloss), *Viola arvensis* (Field pansy), *Fumaria officinalis* (Common fumitory), *Lathyrus tuberosus* (Tuberous pea), *Leopoldia comosa* (Tassel hyacinth), *Dactylis glomerata* (Cock's-foot), *Vicia sativa* (Common vetch), *Trfolium pratense* (Red clover), *Trifolium repens* (White clover). Also, invasive plants *Ambrosia artemisifolia* (Common ragweed), *Erigeron canadensis* (Horseweed) and *Erigeron annus* (Daisy fleabane) are present within this habitat (around chainages km 197+000, cca 204+000 km, cca 205+000 km).

Figure 14-20. Bare tilled, fallow or recently abandoned arable land

Urban and suburban areas along the railway corridor are very densely populated. The presence of isolated houses is also common. The urban and suburban habitats along the railway corridor are:

Reference to EUNIS Habitats: J1.1 - Residential buildings of city and town centres;
Reference to EUNIS Habitats: J1.2 Residential buildings of villages and urban peripheries;
Reference to EUNIS Habitats: J1.4 Urban and suburban industrial and commercial sites still in active use
*Reference to EUNIS Habitats: J1.6 Urban and suburban construction and demolition site*s
Reference to EU HD Annex I: none
Reference to CoE BC Res. No. 4 1996: none

The primary characteristic of these habitat types is the presence of numerous allochthonous plants, essentially decorative trees and shrubs. Also, most plant species are strictly adapted to urban environmental conditions. Common ruderal plant species are also dominant within all urbanised areas, such as *Daucus carota* (Wild carrot), *Urtica dioica* (Common nettle), *Artemisia vulgaris* (Mugwort), *Chenopodium album* (White goosefoot), *Cichorium intybus* (Chicory), *Cirsium arvense* (Creeping thistle), *Atriplex hastata* (Spear-leaved orache), *Amaranthus sp.* (Amaranth), *Parietaria officinalis* (Eastern pellitory-of-the-wall), *Conium maculatum* (Wild hemlock), *Daucus carota* (Wild carrot), *Dipsacus laciniatus* (Cutleaf teasel), *Arctium lappa* (Greater burdock), *Setaria glauca* (Yellow foxtail), *Sambucus ebulus* (Danewort), *Bidens tripartite* (Three-lobe beggarticks), *Senecio vulgaris* (Common groundsel), *Dactilys glomerata* (Cat grass) etc. The urban and suburban environment is very suitable for the colonisation and spread of invasive plants as the habitats are fragmented, climate conditions are specific, and soil is nitrophilous. Some of them are: *Ailanthus altissima* (Tree of heaven), *Acer negundo* (Boxelder maple), *Amorpha fruticose* (Indigo bush), *Phytolacca americana* (American pokeweed), *Robinia pseudoacacia* (Black locust), *Erigeron annus* (Annual fleabane), *Erigeron canadensis* (Horseweed), *Echinocystis lobata* (Wild cucumber), *Symphiotrichum* spp. (Aster), *Sorghum halepense* (Johnson grass), *Xantium strumarium* (Rough cocklebur).

These habitat types are found at the following localities:

- J1.1 - Residential buildings of city and town centres (from 154+400 km to 157+500 km)
- J1.2 Residential buildings of villages and urban peripheries (from 157+500 to 159+800 km, from 161+800 to 162+800 km, from 164+400 km to 168+100 km, from 170+200 km to 173+200 km, from 173+900 to 175+000 km, from 193+600 km to 197+000 km, from 198+000 to 199+500 km, from 201+700 km to 204+000 km, from 206+000 to 211+350 km, from 211+6000 km to 214+200, cca 217+000 km, from 218+7000 km to 222+000 km, from 228+7000 km to 229+700 km)
- J1.4 Urban and suburban industrial and commercial sites still in active use (from 153+700 km to 154+400 km, cca 155+200 km, cca 157+000 km, cca 163+400 km, cca 165+000km, cca 167+500 km, from 168+200 km to 171+200 km).
- J1.6 Urban and suburban construction and demolition sites (cca 205+000 km)

Figure 14-21. Residential buildings of villages and urban peripheries

<u>Reference to EUNIS Habitats: J4.2 - Road networks</u>
<u>Reference to EUNIS Habitats: J4.3 - Rail networks</u>
Reference to EU HD Annex I: none
Reference to Bern Convention: none

These two habitat types refer to the railway tracks (Figure 14-22**Error! Reference source not found.**) and roads (Figure 14-23), which are colonised mainly by nitrophilous herbaceous ruderal plant species such as *Setaria glauca* (green bristlegrass), *Chenopodium album* L. (White goosefoot), *Fumaria officinalis* (Common fumitory), *Conium maculatum* L. (Hemlock), *Artemisia vulgaris* L. (common mugwort), *Rubus sp.*, *Cichorium intybus* (common chicory), *Senecio vulgaris* (groundsel), *Dactilys glomerata* (cock's-foot), *Hordeum murinum* (hare barley), *Convolvulus arvensis* (field bindweed), *Chelidonium majus* (Greater celandine), etc.

Figure 14-22. Road networks

Figure 14-23. Rail networks

Reference to EUNIS Habitats: J4.7 - Constructed parts of cemeteries
Reference to EU HD Annex I: none
Reference to Bern Convention: none

As with all previous mentioned anthropogenic habitats, this habitat is colonised mainly by nitrophilous herbaceous ruderal plant species such as *Setaria glauca* (green bristlegrass), *Chenopodium album* L. (White goosefoot), *Fumaria officinalis* (Common fumitory), *Conium maculatum* L. (Hemlock), *Artemisia vulgaris* L. (common mugwort), *Rubus sp.*, *Cichorium intybus* (common chicory), *Senecio vulgaris* (groundsel), *Dactilys glomerata* (cock's-foot), *Hordeum murinum* (hare barley), *Convolvulus arvensis* (field bindweed), *Chelidonium majus* (Greater celandine), etc. Within the PAoI the habitat is located at cca 204+800 km.

Reference to EUNIS Habitats: X07 - Intensively-farmed crops interspersed with strips of natural and/or semi-natural vegetation
Reference to EU HD Annex I: none
Reference to Bern Convention: none

This habitat type occupies large areas in some parts of the PAoI (from 153+800 to 155+200 km, from 164+900 to 165+600 km, from 172+750 to 173+200 km, from 173+700 to 174+300 km, from 191+500 to 122+700 km, cca 193+500 km, from 194+000 to196+000km, from 197+200 to198+000km, from 198+600 to 200+300km, from 202+200 to 203+100km, from 203+500 to 204+200km, from 205+200 to 206+300km, from 210+300 to 211+150km, from 213+000 to 217+600km, from 217+750 to 224+000km, from 224+500 to 226+100km, from 229+200 to 230+000km). This habitat type comprises intensively grown crops interspersed with strips of natural and/or semi-natural vegetation. It is formed on the sites of natural forest, grass and shrub vegetation that were widespread in the past but destroyed by humans. *Prunus spinosa* (blackthorn), *Cornus sanguinea* (common dogwood), and *Acer campestre* (field maple) are shrub species make the floristic composition of the habitat. Also, some ruderal species are recorded within this habitat, such as *Lamium purpureum* (Red deadnettle), *Silene latifolia* (White campion), *Erodium cicutarium* (Common stork's-bill), *Euphorbia platyphyllos* (Broad-leaved spurge), etc. (Figure 14-24**Error! Reference source not found.Error! Reference source not found.**).

Figure 14-24. Intensively-farmed crops interspersed with strips of natural and/or semi-natural vegetation

Reference to EUNIS Habitats: X25 - Domestic gardens of villages and urban peripheries
Reference to EU HD Annex I: none
Reference to Bern Convention: none

Within these habitats, different flora species (mainly decorative plants and crops) are present. As they are situated near human dwellings, agricultural land, natural or semi-natural habitats, ruderal species are also found (around chainages 159+000 km, cca 167+000 km, cca 168+500 km, 217+300 km, 217+600).

Figure 14-25. Domestic gardens of villages and urban peripheries

Habitat map of the project area

Detailed habitat mapping included comparative study of available vector and raster data such as CORINE landcover, EUNIS habitat types, Digital Map of European Ecological Regions, digital orthophoto imagery, topographic maps and digital terrain maps. Identified habitats were then further analysed and confirmed during field work. Special focus was given on identifying specific drivers of change along the railway route that could shape the specific features of habitats. Based on these combined data, detailed habitat map within the railway route corridor was made using the Quantum GIS software. The categorization of the habitats was provided in accordance with the EUNIS habitat classification. Official descriptions within these EUNIS categories were included.

Habitat maps of the PAoI (divided by segments for the sake of representativeness) are provided below as Figure 14-26 – to Figure 14-40.

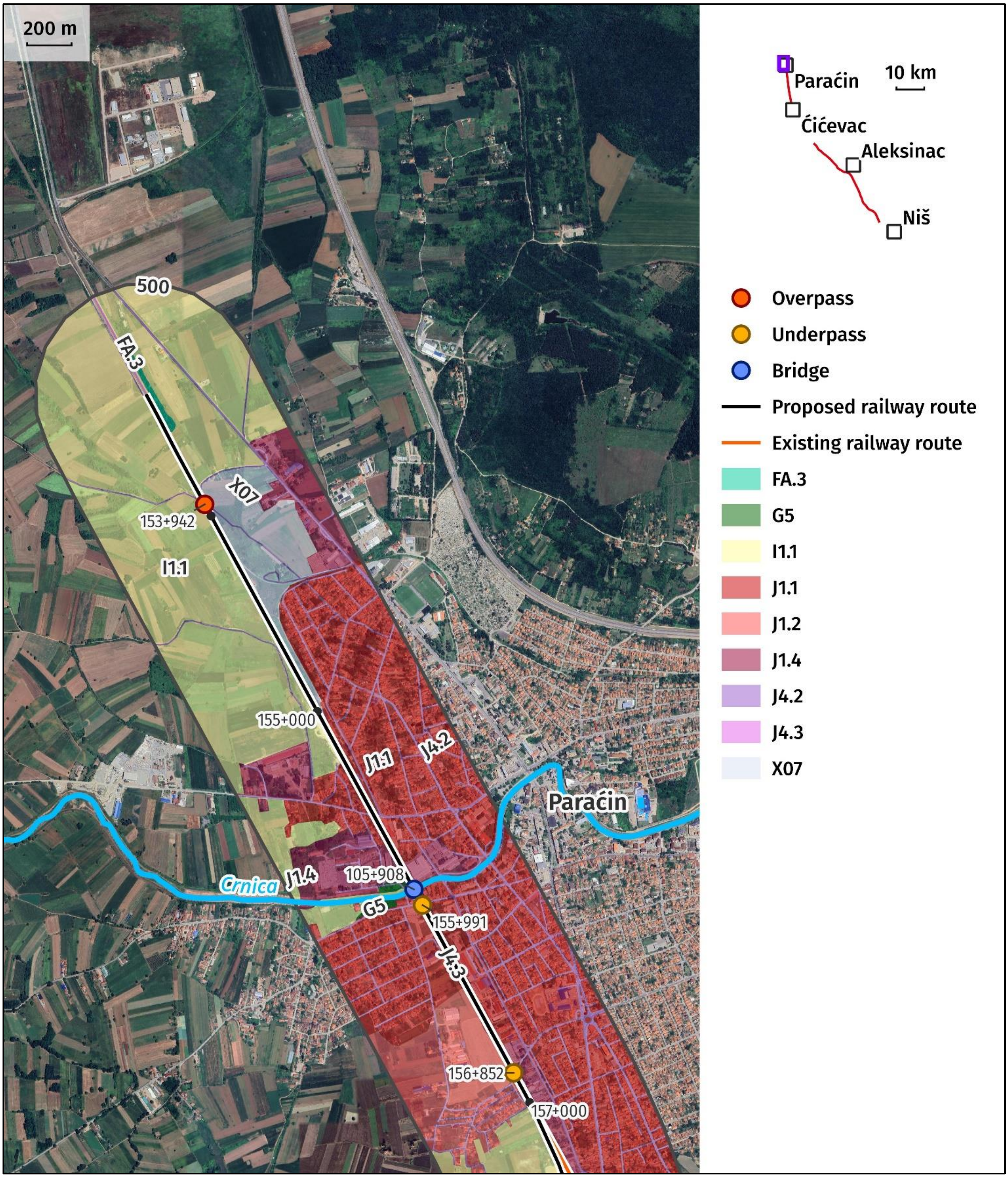

Figure 14-26. Habitat map within 500m + 500m AoI – segment 1 (Paraćin-Stalać subsection)

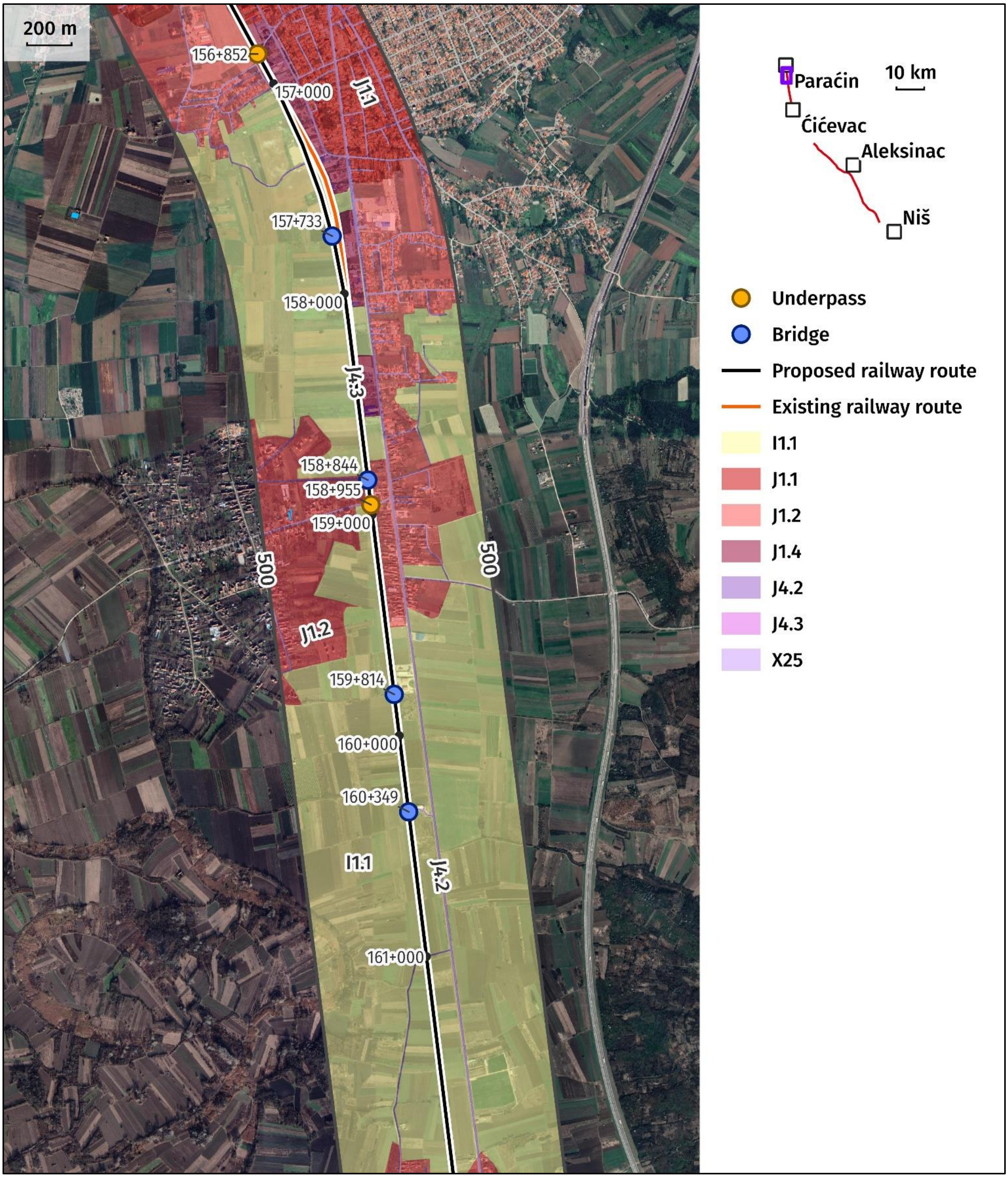

Figure 14-27. Habitat map within 500m + 500m AoI – segment 2 (Paraćin-Stalać subsection)

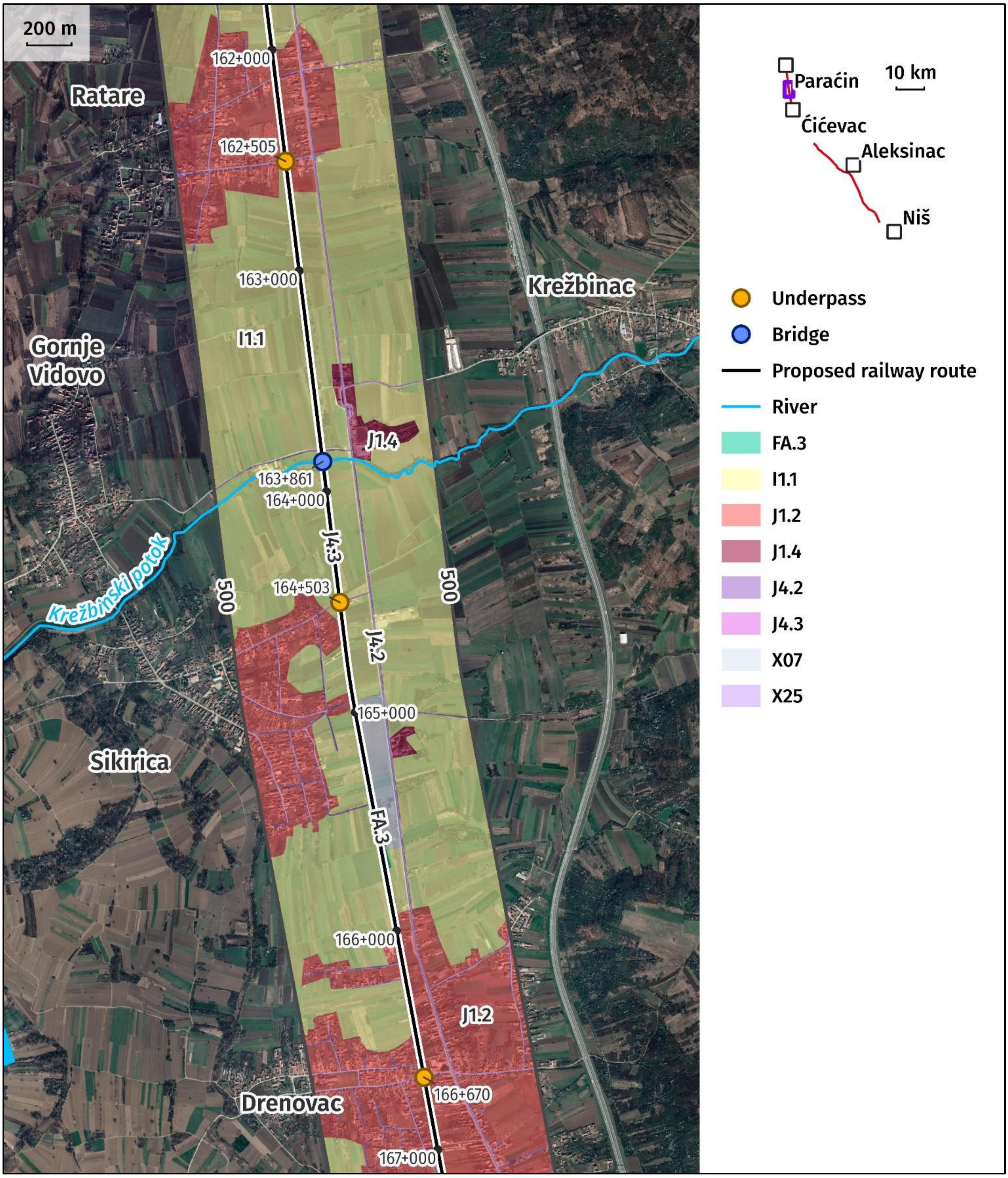

Figure 14-28. Habitat map within 500m + 500m AoI – segment 3 (Paraćin-Stalać subsection)

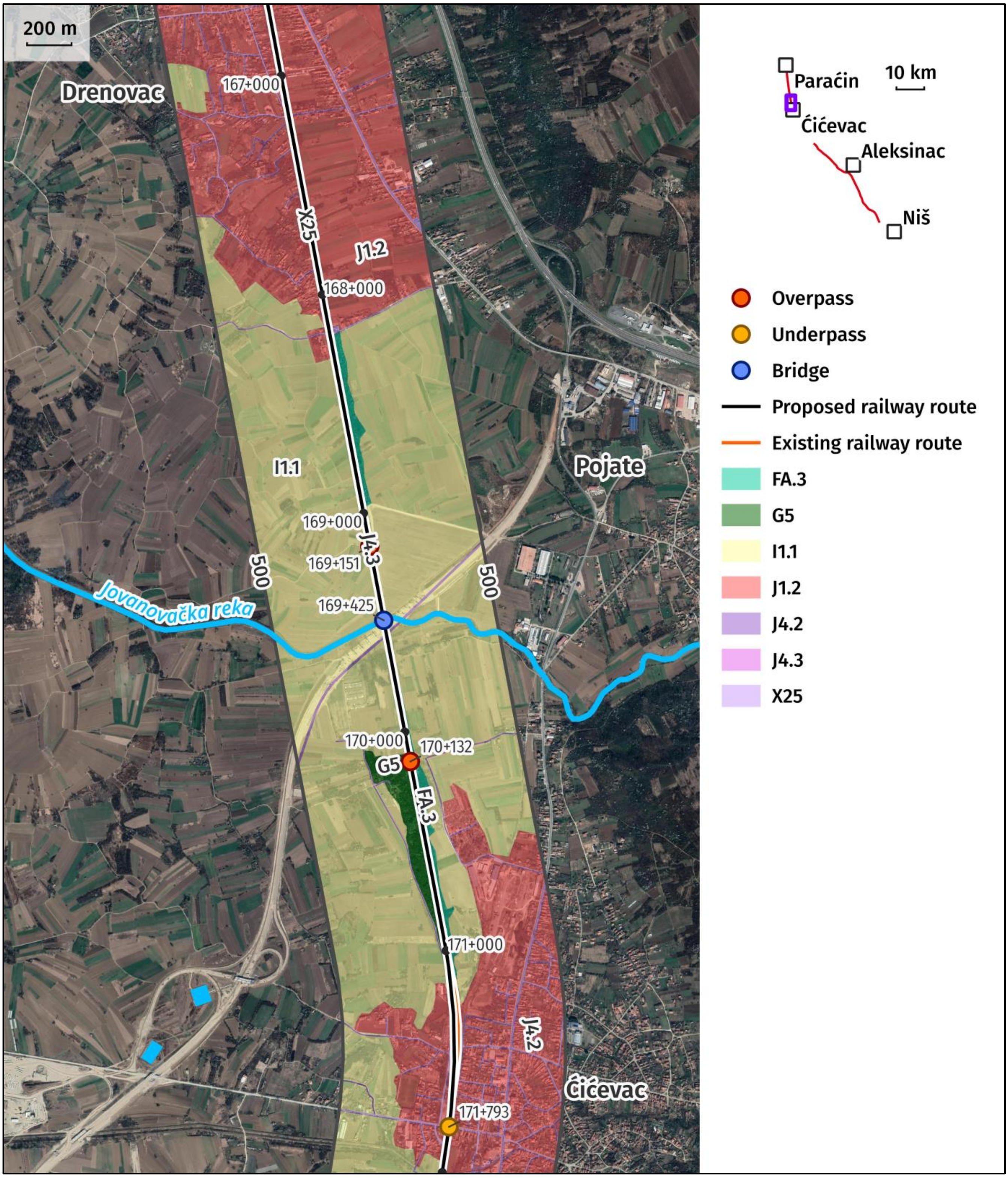

Figure 14-29. Habitat map within 500m + 500m AoI – segment 4 (Paraćin-Stalać subsection)

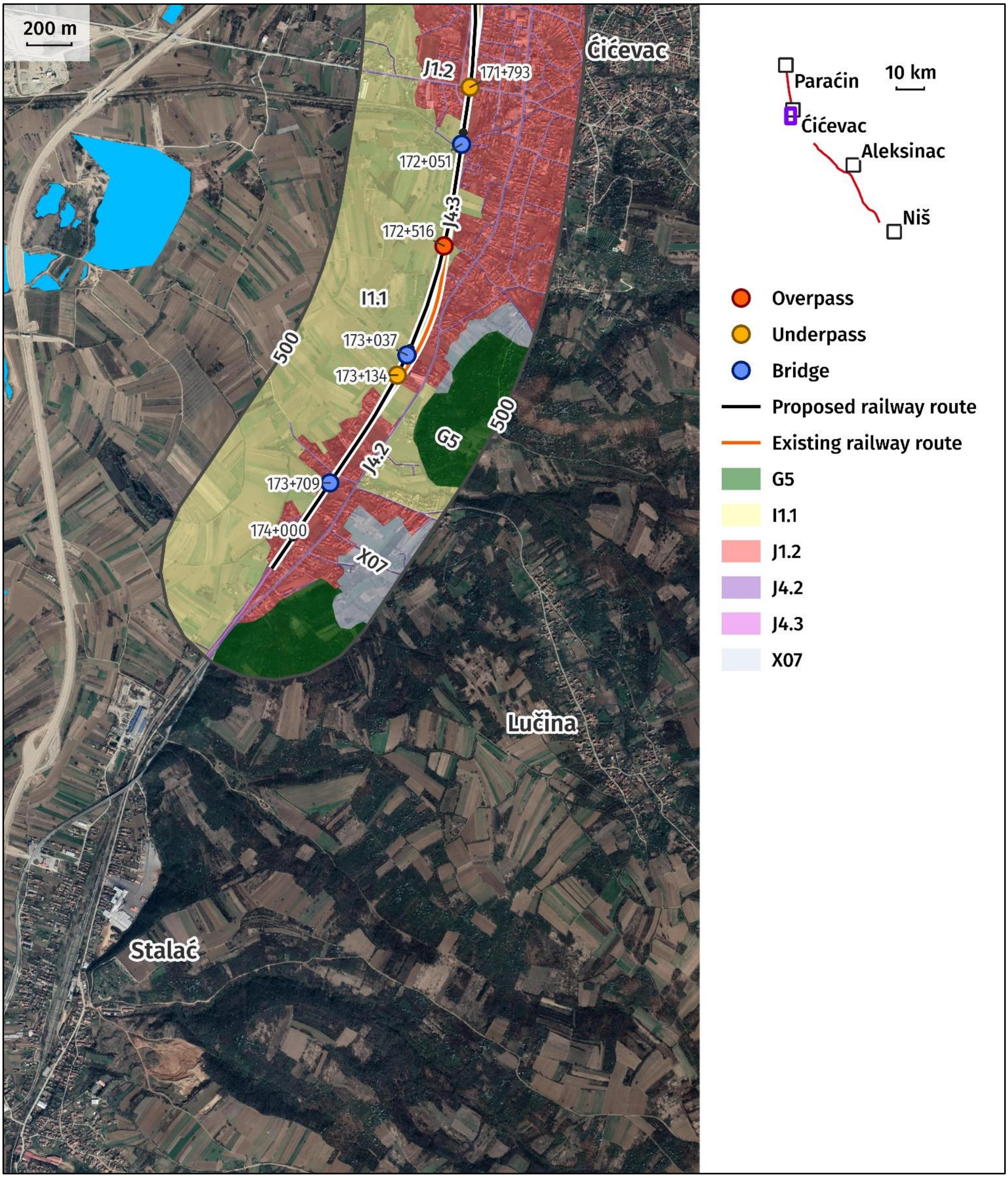

Figure 14-30. Habitat map within 500m + 500m AoI – segment 5 (Paraćin-Stalać subsection)

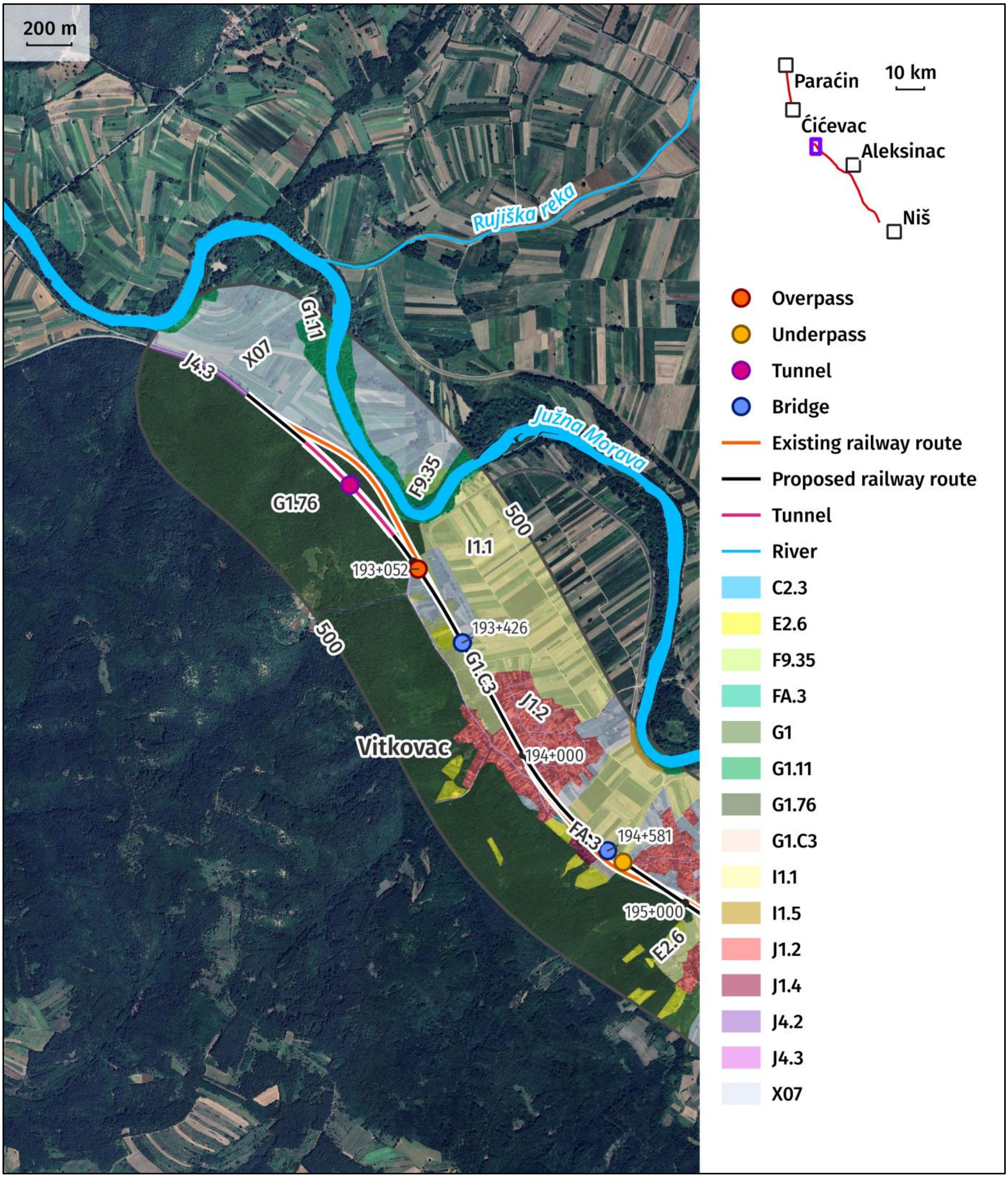

Figure 14-31. Habitat map within 500m + 500m AoI – segment 6 (Đunis-Trupale subsection)

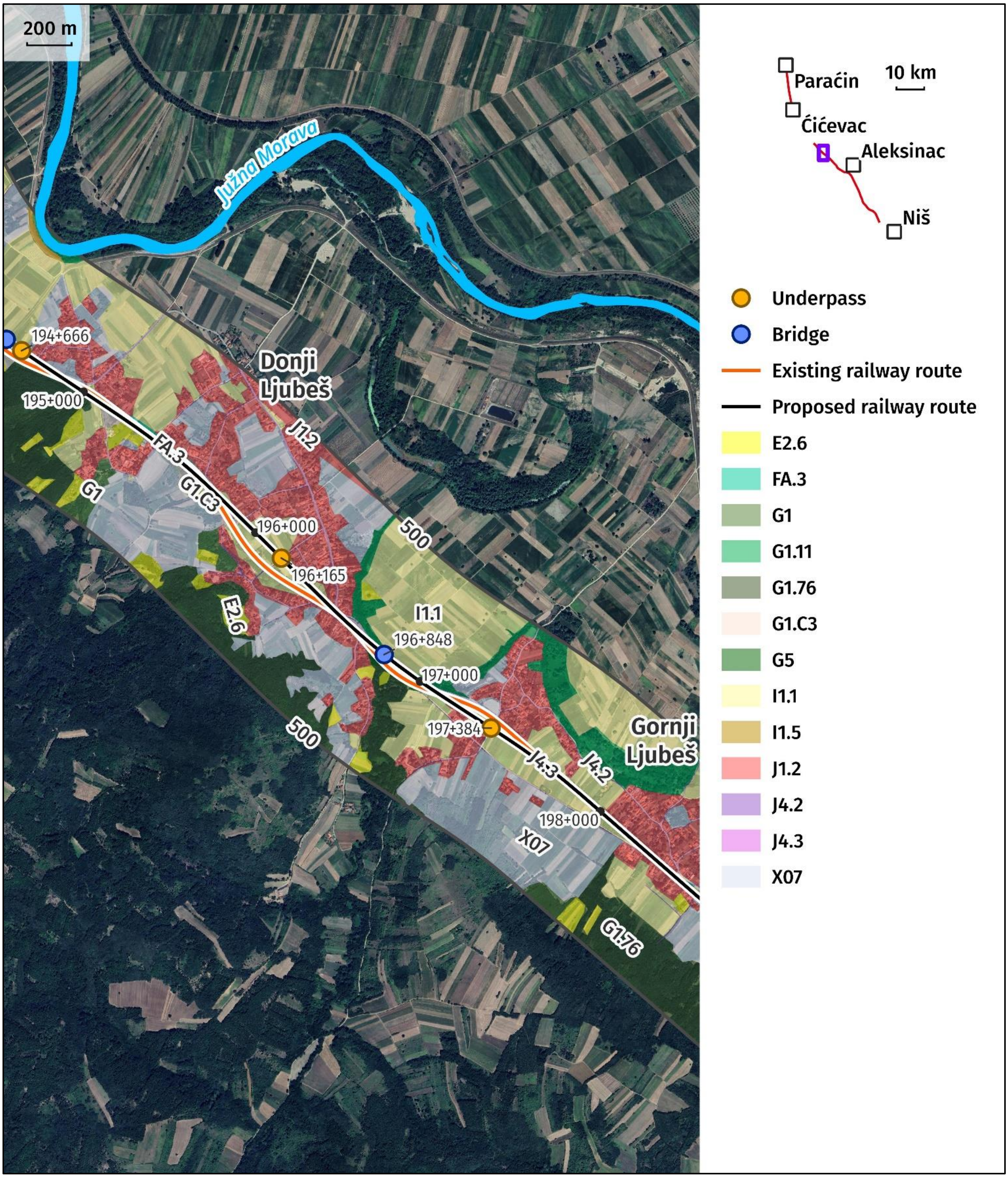

Figure 14-32. Habitat map within 500m + 500m AoI – segment 7 (Đunis-Trupale subsection)

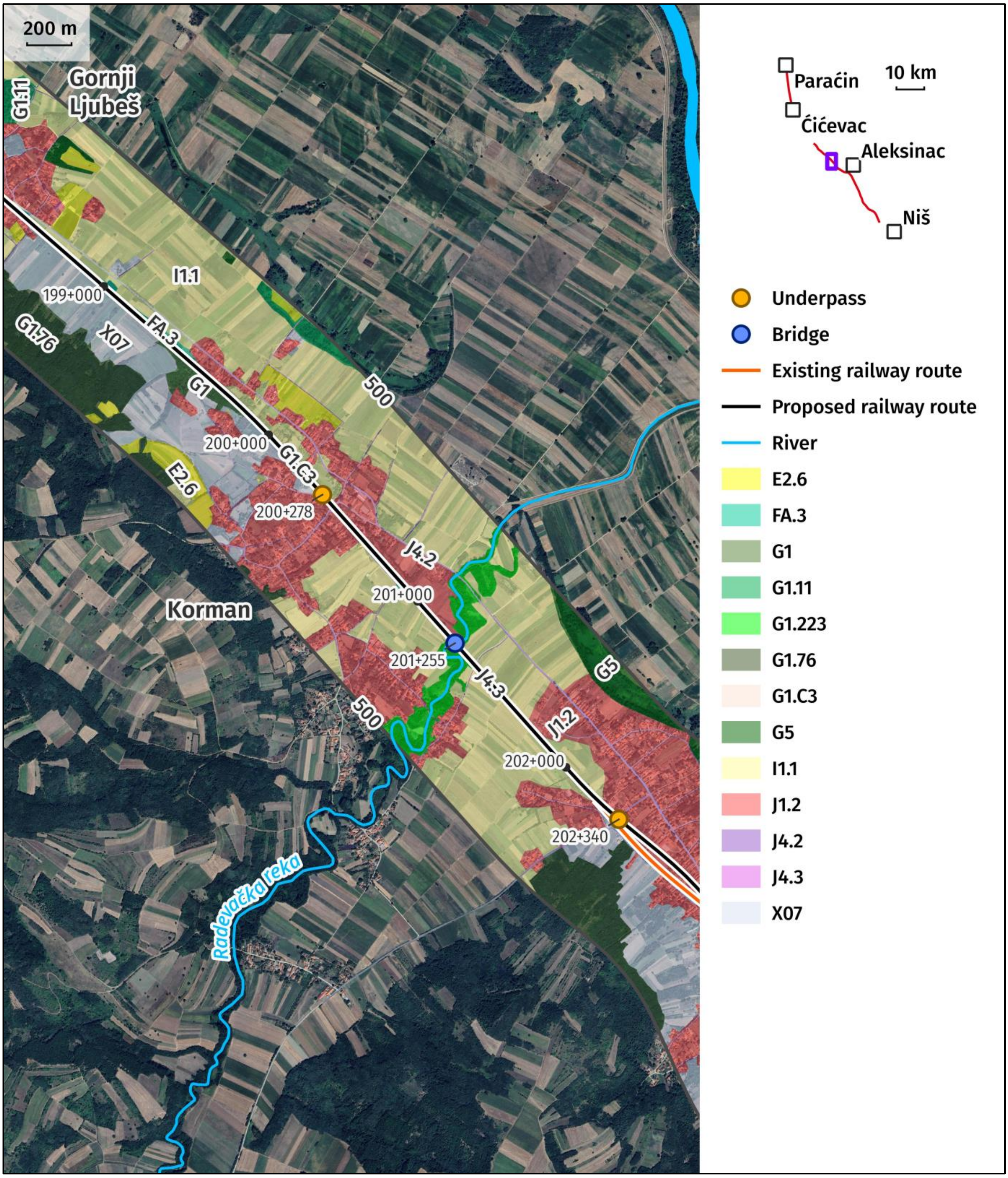

Figure 14-33. Habitat map within 500m + 500m AoI – segment 8 (Đunis-Trupale subsection)

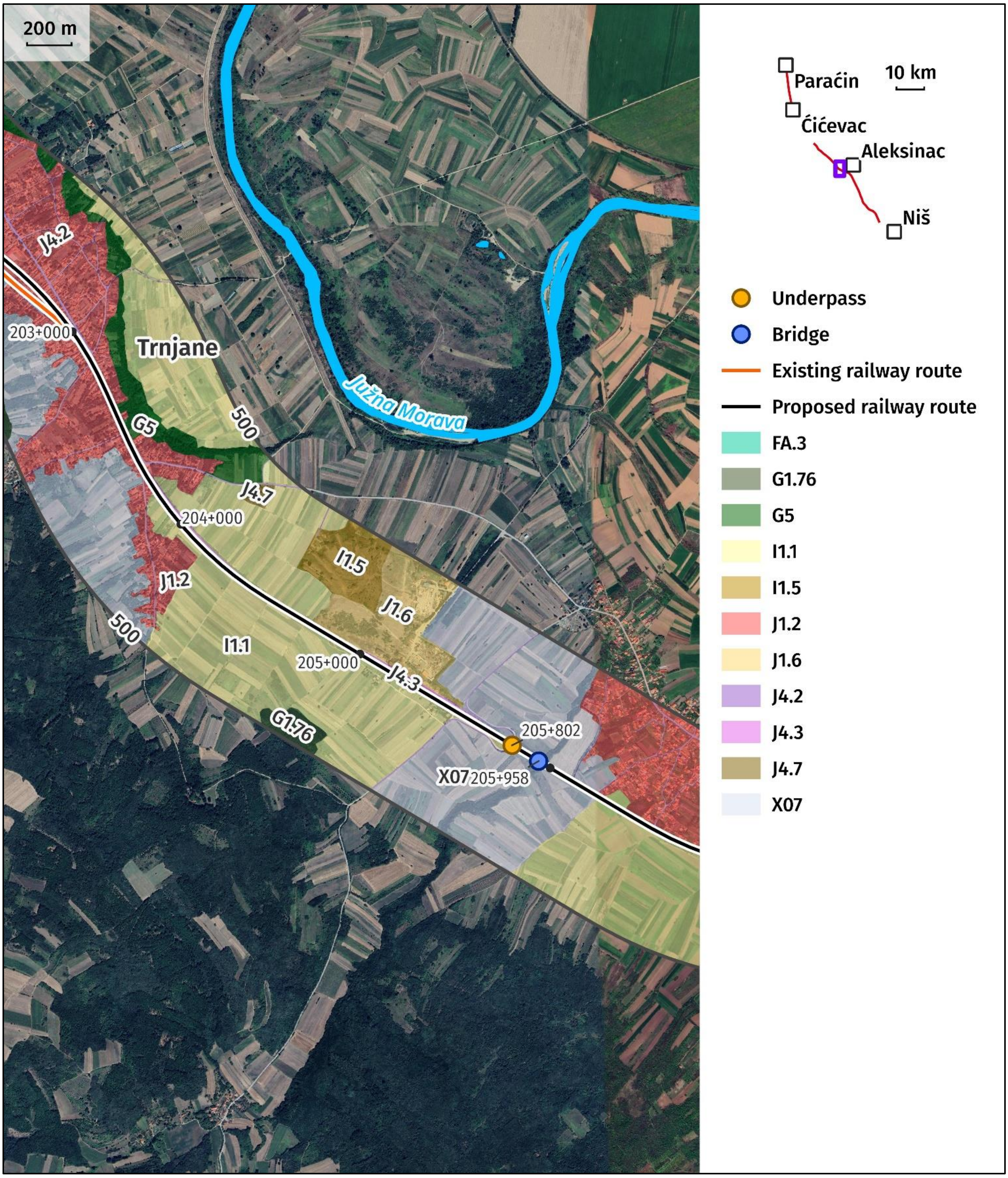

Figure 14-34. Habitat map within 500m + 500m AoI – segment 9 (Đunis-Trupale subsection)

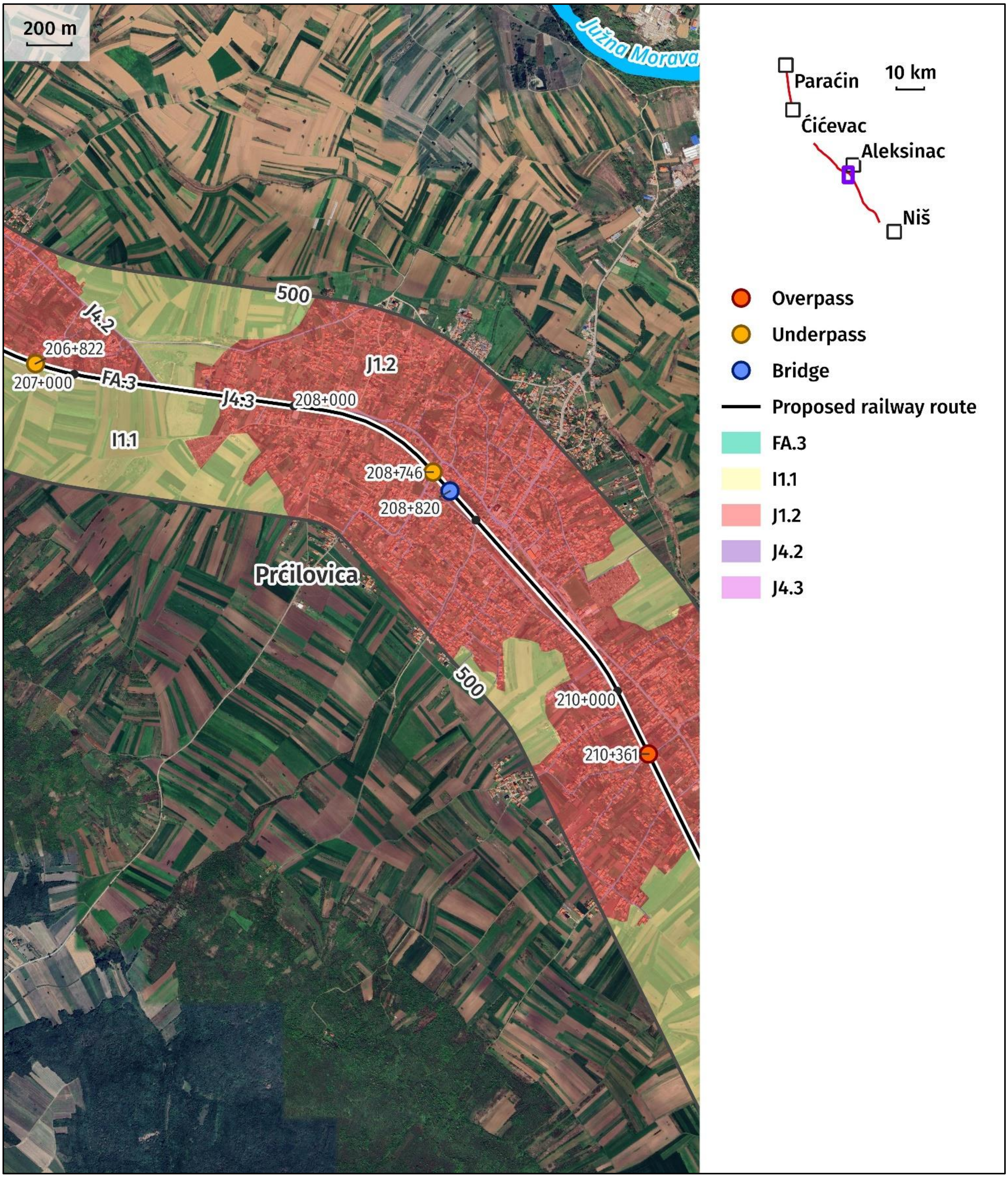

Figure 14-35. Habitat map within 500m + 500m AoI – segment 10 (Đunis-Trupale subsection)

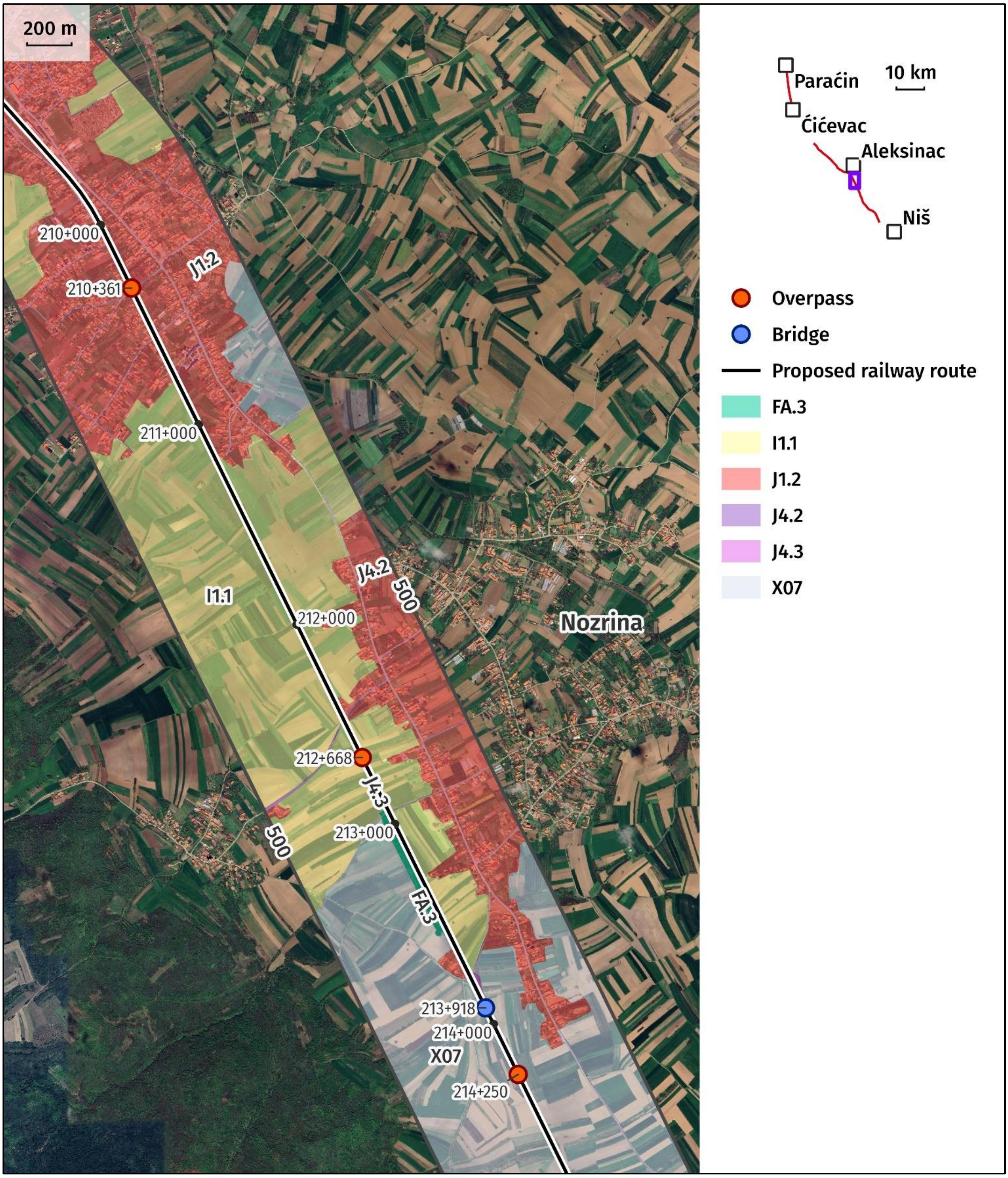

Figure 14-36. Habitat map within 500m + 500m AoI – segment 11 (Đunis-Trupale subsection)

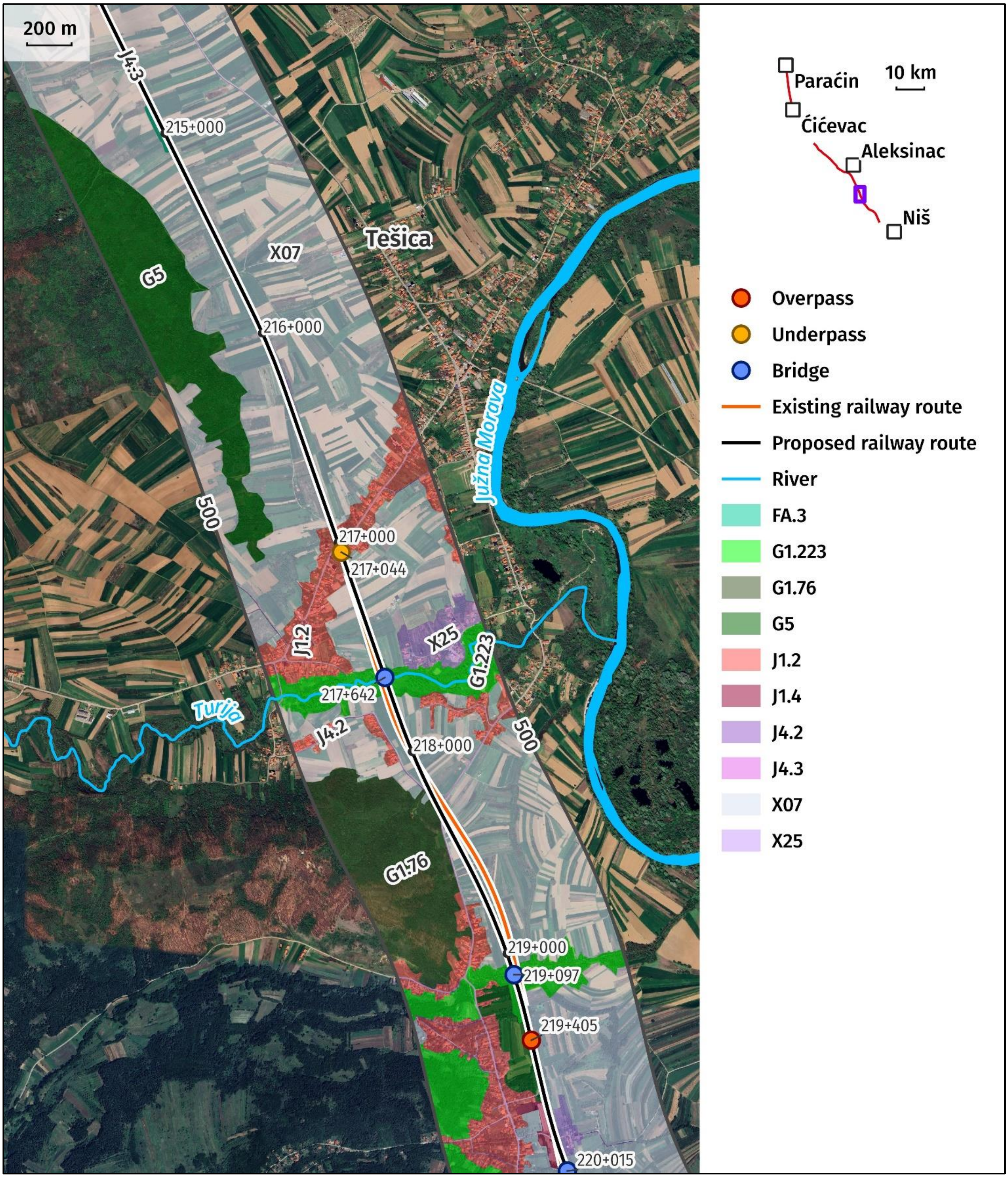

Figure 14-37. Habitat map within 500m + 500m AoI – segment 12 (Đunis-Trupale subsection)

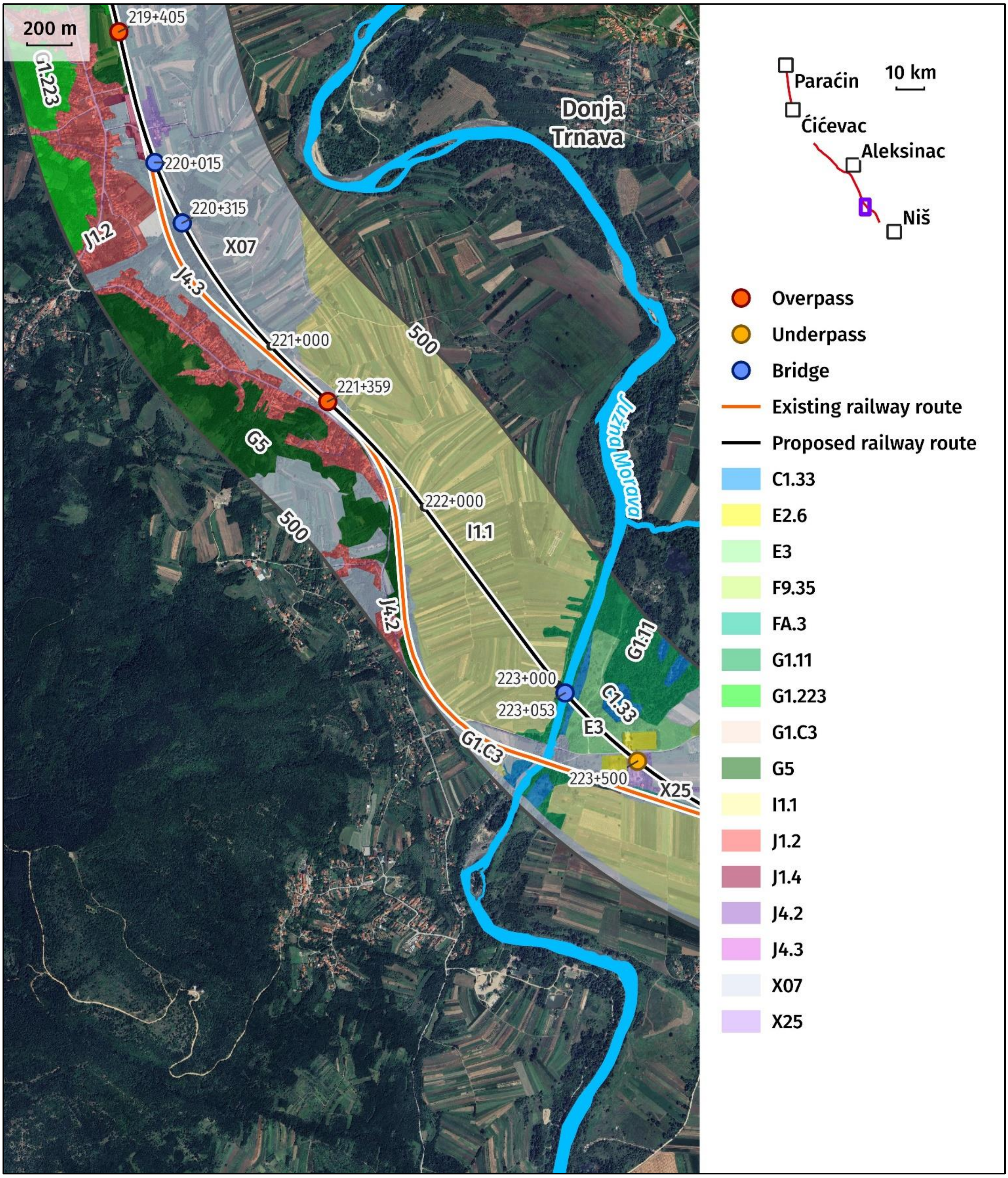

Figure 14-38. Habitat map within 500m + 500m AoI – segment 13 (Đunis-Trupale subsection)

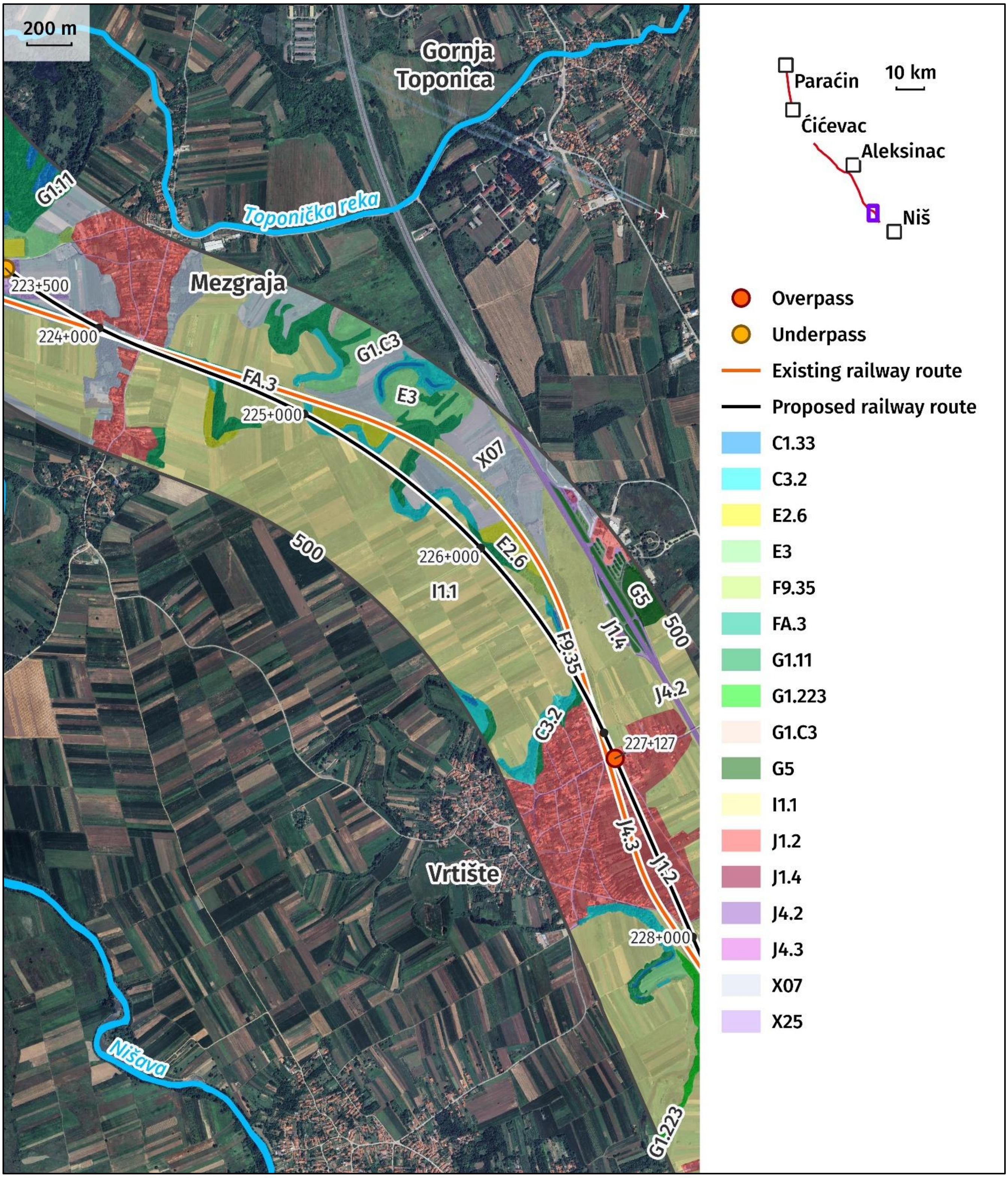

Figure 14-39. Habitat map within 500m + 500m AoI – segment 14 (Đunis-Trupale subsection)

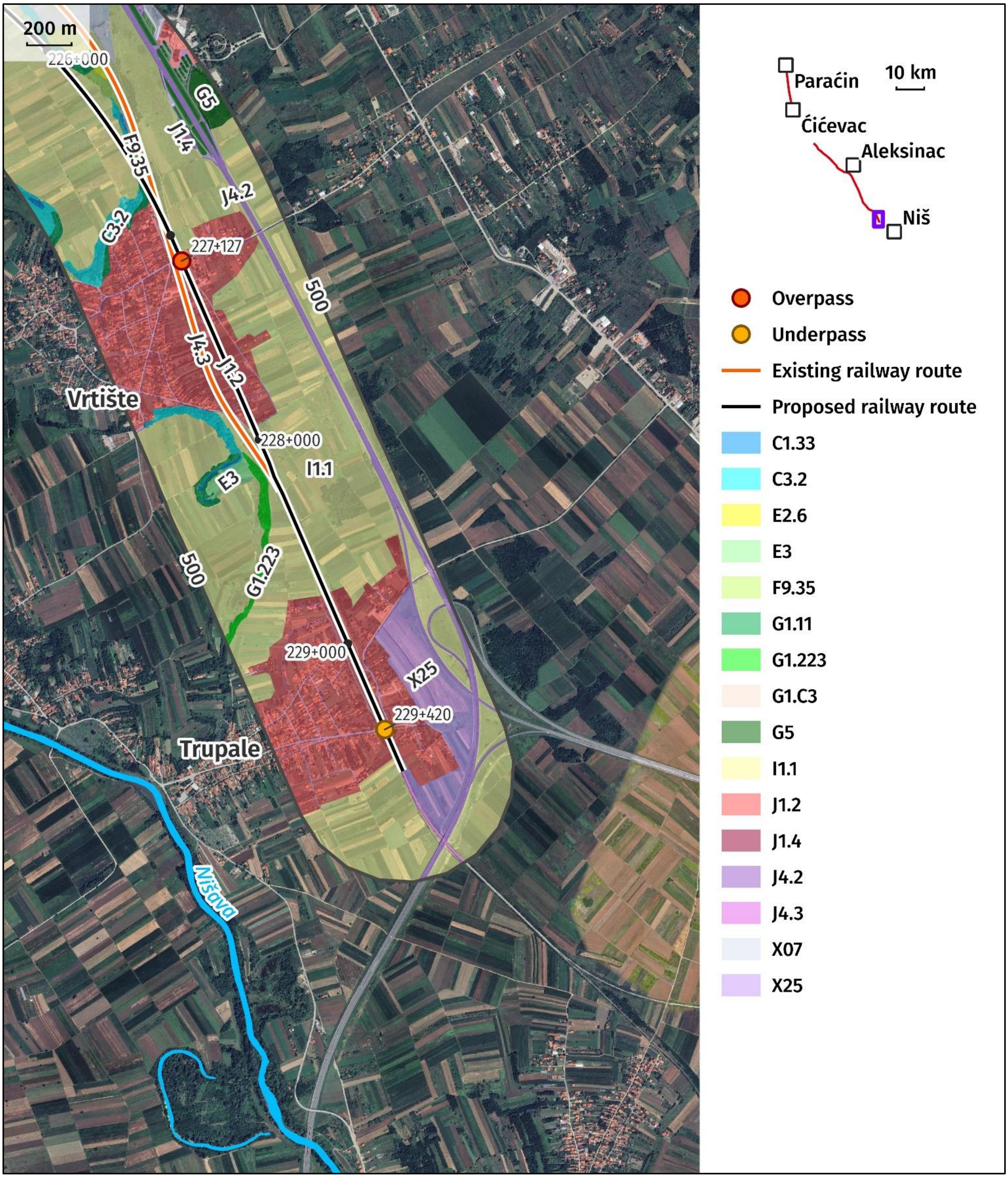

Figure 14-40. Habitat map within 500m + 500m AoI – segment 15 (Đunis-Trupale subsection)

Flora

In total, 278 flora species were recorded within the PAoI, based on “ENOVA Corridor Report”, Data of Institute of nature protection of Serbia and conducted field surveys. As expected within the investigated area, which is under strong anthropogenic pressures, ruderal species are numerous. Endemic and relict plants are not found. In terms of species of international importance, 97 plant species are listed under the IUCN Red List as Least Concern (LC), five plant species have been evaluated as Data Deficient (DD) and one species has been evaluated as Near Threatened (NT). None of these species belong to the group of ‘rare, endangered or vulnerable’ species, and they are widespread and common in Serbia. However, some of them are protected by national law, namely: *Achillea millefolium* (Yarrow), *Arctium lappa* (greater burdock), *Cornus mas* (Cornelian cherry), *Crataegus monogyna* (common hawthorn), *Fragaria vesca* (Wild strawberry), *Hypericum perforatum* (ST John's- wort), *Geranium robertianum* (Herb-Robert), *Leucojum vernum* (Spring Snowflake), *Potamogeton nodosus* (Pondweed), *Quercus robur* (European oak), *Rosa canina* (dog rose), *Syringa vulgaris* (Common lilac), *Teucrium chamaedrys* (Wall germander) and *Tilia tomentosa* (Silver Lime), which are protected in terms of trading and commercial use according to the Rulebook on declaration and protection of protected and strictly protected species of plants, animals, and fungi (Official Gazette of RS, No 5/10). The full list of plant species recorded within the PAoI is presented in Annex 1 to this Chapter.

Invasive plant species within the project area

Invasive alien plant species represent one of the most significant factors causing biodiversity loss. They spread easily and quickly in new habitats, suppressing native species and leading to changes in the structure and function of ecosystems. Invasive species affect the richness and diversity of native communities. Furthermore, the introduction of allochthonous animal pests, depletion of water resources, changes in soil physio-chemical characteristics, negative impacts on human health and economic damage are some of the consequences of the colonization and spread of invasive plants. The most common ways to introduce invasive plant species are intentional or unintentional human intervention, the spread of seeds by wind or by some animals, and vegetative spreading.

The introduction of invasive plants is particularly common in habitats that are under strong anthropogenic stress (i.e. where the species' natural composition and environmental conditions are significantly disturbed). These include urbanised areas, industrial and agricultural areas, construction sites, over-exploited forest areas, forest edges, roadside areas, affected inland waters, modified soils etc.

Within the project area of influence 19 invasive plants were recorded (Table 14-4). Most of these form dense and numerous populations. The number of invasive species ranges from one to five per locality. *Robinia pseudoacacia* forms stable populations along the edge of almost all native forest habitats. In addition, the species *Acer negundo* often occurs along the edges of forests. Species *Erigeron canadensis, Erigeron annus, Xanthium strumarium, Sorghum halepense* and *Amaranthus retroflexus* were recorded along the roads. *Datura stramonium* was mainly recorded along agricultural areas. *Amorpha fruticose* is a dominant species on wet habitats, most often along watercourses, where it forms monodominant populations. *Ailanthus altissima, Oenothera biennis* and *Phytolacca americana* were recorded near suburban and urban settlelements. *Ambrosia artemiisifolia* was frequently recorded at abandoned arable or urban land. *Symphyiotrichum* spp. have been frequently recorded on anthropogenic herb stands.

All listed species are spreading very quickly and pose a threat to biodiversity. Some of them are shown in Figures below (from Figure 14-41 to Figure 14-46). Construction works are expected to further accelerate their expansion.

Table 14-4. Invasive plants recorded within the PAoI

Latin name	Common name
1. Acer negundo	Boxelder maple
2. Ailanthus altissima	Tree of heaven
3. Amaranthus retroflexus	Red-root amaranth
4. Ambrosia artemiisifolia	Common ragweed
5. Amorpha fruticosa	Indigo bush
6. Asclepias syriaca	Common milkweed
7. Datura stramonium	Thorn apple
8. Echinocystis lobata	Wild Cucumber
9. Echinochloa crus-galli	Barnyard Grass
10. Erigeron annus	Daisy fleabane
11. Erigeron canadensis	Horseweed
12. Lycium barbarum	Chinese wolfberry
13. Oenothera biennis	Common evening- primrose
14. Phytolacca americana	Pokeweed
15. Reynoutria japonica	Japanese knotweed
16. Robinia pseudoacacia	Black locust
17. Sorghum halepense	Johnson grass
18. Symphyiotrichum spp.	Asters
19. Xanthium strumarium	Rough cocklebur

Figure 14-41. *Sorghum* halepense

Figure 14-42. *Phytolacca* americana

:

Figure 14-43. *Reynoutria japonica*

Figure 14-44. *Amorpha fruticosafruticose*

Figure 14-45. *Echinocystis lobata*

Figure 14-46. ***Ailanthus altissima***

Fauna along the railway route

Entomofauna

Field surveys were conducted during the spring (between 6 and 17 of May 2023), summer (11-21 of July 2023) and autumn (5-12 October 2023). During fieldwork insects were observed, photographed, caught, and released after identification. The survey focused on covering different habitats, mostly open spaces, pastures, and forested areas. Transects were done along the road, natural, semi-natural, and artificial habitats. The insect survey covered the presence of several insect groups, namely butterflies, beetles, orthopterans, and dragonflies. Surveys aimed to cover areas representing more preserved fragments of natural and semi-natural habitats and locations where it was expected that species of importance for protection would be recorded. No endemic or rare species of insects were registered during the field survey.

The survey locations were determined by reviewing satellite imagery of the habitats in Google Earth software. In total, 15 localities along the entire section Paraćin-Trupale railway route were visited during field surveys (Table 14-5 and Figure 14-47).

Table 14-5. Locations surveyed during the field visits for entomofauna

No.	E	N	Location	City	Comment
1.	43.7891	21.4220	Gornje Vidovo	Paraćin	A hedge along the railway line
2.	43.88298	21.38093	Drenovac	Paraćin	Bushes, meadows and agriculture area
3.	43.884135	21.384939	Sikirica	Paraćin	Agriculture area
4.	43.6482	21.4659	Braljina Rasinska	Ćićevac	A hedge along the railway line
5.	43.6473	21.4527	Braljina Rasinska_2	Ćićevac	A hedge along the railway line
6.	43.6166	21.4840	Trubarevo	Ćićevac	A hedge along the railway line
7.	43.6083	21.4878	Trubarevo_2	Ćićevac	A hedge along the railway line
8.	43.5990	21.5452	Vitkovac	Aleksinac	The village, mosaic of agriculture areas, small individual gardens and orchards
9.	43.5738	21.5816	Srezovac	Aleksinac	The village, mosaic of agriculture areas, small individual gardens and orchards
10.	43.565717	21.589073	Donji Ljubes	Aleksinac	Quercetum forest above the houses, under the influence zone of railway construction
11.	43.5196	21.6584	Donji Adrovac	Aleksinac	Meadow
12.	43.4390	21.7379	Bankovac/Tešica	Aleksinac	Turija River
13.	43.3970	21.7743	Mezgraja	Niš	In the vicinity of the bridge. *Populus* and *Salix* individual trees
14.	43.3802	21.8060	Vrtiste	Niš	Junk yards alongside the railway near Vrtiste
15.	43.3673	21.8121	Vrtiste_2	Niš	Bushes, individual trees of *Populus*. The railway passes through the settlement. Agriculture areas around.

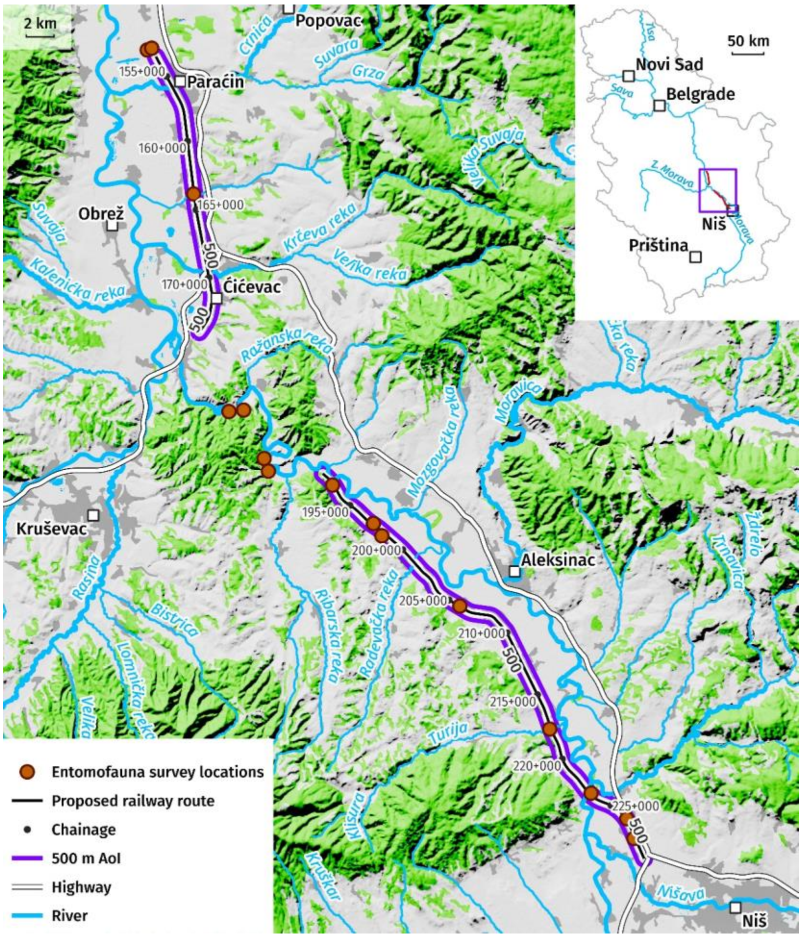

Figure 14-47. The map of entomofauna survey points

Annex 1 provides a list of fauna species in the PAoI with their national and international conservation status, including a complete list of observed insects from the field survey (Insects table). This includes relevant information gathered through literature, as well as the conservation status of insect species. The list also includes data that are available through Alciphron—Database of Insects of Serbia *https://alciphron.habiprot.org.rs/*[15], data from the Red Data Book of Fauna of Serbia IV Orthoptera[16], Red Book of Butterflies[17]and data on strictly protected and protected species provided by the Institute for Nature Protection of the Republic of Serbia.

Some vulnerable, endangered, or threatened species in Niš and the surrounding area that were noted through abovementioned literature were not registered during present field research. For example, the following species

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[15] *Miljević, M. & Popović, M. (2014) Alciphron—Database of insects of Serbia: Lepidoptera, Papilionoidea. HabiProt, Belgrade. Available from: http://alciphron.habiprot.org.rs (accessed 6 December 2017)*

[16] *Pavićević, D., Karaman, I., Horvatović, M. (2018) Crvena knjiga faune Srbije IV pravokrilci / Red Data Book of Fauna of Serbia IV Orthoptera. Zavod za zaštitu prirode Srbije*

[17] *Jaksic, P. (2003) Crvena knjiga dnevnih leptira Srbije: Lepidoptera: Hesperioidea i Papilionoidea / Red Book of Butterflies of Serbia: Lepidoptera: Hesperioidea i Papilionoidea. Zavod za zaštitu prirode Srbije.*

have been recorded, associated with grazing habitats: *Bradyporus (Callimenus) macrogaster longicollis* (RE-Regionally extinct), *Onconotus servillei* (CR-Critically endangered), *Bradyporus (Bradyporus) dasypus* (EN-Endangered), *Gampsocleis glabra* (VU-Vulnerable), *Arcyptera (Pararcyptera) microptera* (VU-Vulnerable), *Vichetia oblongicollis* (NT-Near Threatened).

Nowadays those steppe habitats are faced with fragmentation and conversion into agricultural land, the intensive use of pesticides and insecticides, deliberately set fires to create arable land, very limited restoration of pastures, afforestation, extensive grazing, and urbanization. Steppe and grass communities were historically the predominant habitat type in the Project area, especially around the City of Niš. To the north of Niš, towards the Paraćin municipality, these habitats have largely been replaced by, now dominant, agricultural land. Our assumption is that due to habitat destruction, the abovementioned vulnerable, endangered, or threatened species have become rare in this area, or even extinct.

Figure 14-48. Aleksinac, Donji Ljubeš

Figure 14-49. ***Lucanus cervus***

Figure 14-50. ***Nymphalis vaualbum***

The following species are noted as important for protection (

Table 14-6):

- *Nymphalis vaualbum* is a species that requires special conservation and is listed in Annex II and Annex IV of the EU Habitats Directive (92/43/EEC), Annex II and Resolution 6 of the Berne Convention on the conservation of European wildlife and natural habitats (1979), and declared as one of the qualifying species for many Natura 2000 sites. The species is Least Concern (LC) in Europe, while in Serbia it is endangered (EN).
- *Lycaena dispar* is a strictly protected species in Serbia. It is listed in Annexes II and IV to the Habitats Directive and Resolution 6 of the Berne Convention. Globally the species is Near Threatened (NT), in Europe it is LC, and in Serbia, it is LC.
- *Phengaris arion* is on Annex IV to the Habitats Directive, and on Annex II of Berne Convention. It is considered a Near Threatened species at the global and Europe level (NT), but on the territory of Serbia it is Least concern (LC).
- *Euphydryas aurinia* is listed in Annex II of the habitats Directive and Annex II and Resolution 6 of the Berne Convention. Globally status is Least concern (LC).
- *Zerynthia polyxena* is present along the route and is listed in Annex IV to the Habitats Directive and Annex II of the Berne Convention. Globally and in Serbia, this species is Least concern (LC).
- *Parnassius mnemosyne* is listed in Annex IV of the Habitats Directive and Annex II of the Berne Convention. Its status Least concern (LC) at the global and national level in Serbia.
- *Lucanus cervus,* species is listed in Annex II of the Habitats Directive, Annex III and Resolution 6 of the Berne Convention. Despite being common in Serbia, it will require targeted protection measures due to being of European importance. Globally it has status Least concern (LC), however its status in Europe is NT.
- *Morimus asper* is on Annex II of the Habitats Directive and within Resolution 6 of the Berne Convention. It is globally considered an vulnerable species (VU), but its endangered status is not known at the European and national level in Serbia.
- *Cerambyx cerdo* is listed in Annex II and IV of the Habitats Directive, Annex II and Resolution 6 of the Berne Convention. Globally this species is vulnerable (VU).

The insect species of ‘conservation concern’ that were recorded within the PAoI (

Table 14-6) were selected based on their inclusion in Annex II and IV of the Habitats Directive, Annex II and Resolution 6 of the Bern Convention and/or their conservation status according to IUCN.

Table 14-6. List of insect species of conservation concern within the Project AoI

Species	Conservation status	Description
Nymphalis vaualbum (Compton tortoiseshell)	Annex II and IV of the Habitats Directive, Annex II and Resolution 6 of the Berne Convention, LC in Europe, in Serbia is endangered (EN)	Strictly protected species in Serbia. The species is declared endangered in both the Red Data Book of Serbian Butterflies (Jakšić 2003)[18] and the Red Data Book of European Butterflies (van Swaay & Warren 2003)[19], due to an estimated decrease of the population size of 50–80%. It inhabits deciduous and coniferous forest in a wide range throughout the Northern Hemisphere. It also occurs in forest edges, forest paths, glades and mixed forests. *Nymphalis vaualbum* was recorded on several occasions in Serbia. These findings are important as this species reach western limit of the

[18] Jakišić, P. (2003): Red data book of Serbian butterflies (Lepidoptera: Hesperioidea and Papilionoidea). — Zavod za zaštitu prirode Srbije, Belgrade, 198 pp. [bilingual: Serbian/English].

[19] Van Swaay, C. A. M., & Warren, M. S. (2003): Red data book of European butterflies (Rhopalocera). — Nature and Environment no. 99, Strasbourg (Council of Europe Publ.)

Species	Conservation status	Description
		range in Serbia. Most of the historical records of *Nymphalis vaualbum* in Serbia are almost 100 years old (Forster & Wohlfahrt 1955[20], Anđus 2008[21]), with only few sightings from one location in the second half of the twentieth century (Zečević 2002)[22]. EOO on the territory of Serbia is 58,410 km^2. Permanent populations are linked to the hilly and mountainous regions of the country, while migrants can be found outside this area as well. It is estimated that the size of the permanent population within the investigated area is small. This species was recorded only through literature survey
Lycaena dispar (Large copper butterfly)	Annex II and IV of the Habitats Directive, Annex II and Resolution 6 of the Bern Convention, globally it is NT, and in Europe and in Serbia Least Concern (LC)	This is strictly protected species in Serbia. Its status in Serbia and globally is Least concern (LC). It inhabits dry grassland and wet meadows, but may also occur in cropland, urban woodland, and forest. This species is widely distributed. It inhabits temperate areas of Europe and Asia. The Extent of occurrence (EOO) on the territory of Serbia is 94,551 km^2 and small populations are located on the entire territory of the country. Caterpillars develop on different species of sorrel (*Rumex* spp.), sometimes also on *Polygonum bistorta*. Species was recorded through both literature and field surveys.
Phengaris arion (Large blue)	Annex IV of the Habitats Directive and Annex II of Berne Convention. Near-threatened species at the global and Europe level (NT),in the territory of Serbia - Least Concern (LC)	The species is strictly protected in Serbia. In Serbia, it is most often connected with overgrown meadows, in hilly regions, but less often with more open habitats. Caterpillars feed on oregano plants (*Origanum vulgare*), or *Thyme* (*Thymus* spp.). This butterfly inhabits temperate regions of Europe and Asia. EOO on the territory of Serbia is 62,133 km^2. Expert opinion is that the number of populations within the AoI is small. This species was recorded only through literature
Zerynthia polyxena (Southern festoon)	Annex IV of the Habitats Directive and Annex II of the Berne Convention. Globally and in Serbia is Least concern (LC).	The species is strictly protected in Serbia. It inhabits open habitats near rivers and streams, but it can also be found in agricultural areas, as well as within human settlements. It is widespread in Central Europe, on the Balkan Peninsula, and in the western parts of Asia. EOO on the territory of Serbia is 85,887 km^2. It is found throughout Serbia. There are significant populations of this butterfly in the researched area. Species was recorded through both literature and field surveys.
Parnassius mnemosyne (Clouded Apollo)	Annex IV of the Habitats Directive and Annex II of the Berne Convention. Globally and in Serbia is Least concern (LC).	The species is strictly protected in Serbia. It is listed in Annex IV of the Habitats Directive and Annex 2 of the Berne Convention. It is not threatened at the global and national level (LC). It inhabits forest roads, clearings, forest edges, and the belt along the upper forest border in the mountains. Caterpillars feed on *Corydalis spp.* This species is widely distributed and inhabits Europe, western and central Asia. EOO on the territory of Serbia is 73,683 km^2. In Serbia, it is not found in the plains of Vojvodina. It is assumed that the populations of this species are small to moderate in abundance in the investigated area. Species was recorded through both literature and field surveys.

[20] *Forster, W. & T. A. Wohlfahrt 1955. Die Schmetterlinge Mitteleuropas 2: Tagfalter. - Franckh'sche Verlagshandlung Stuttgart. 126 pp. 28 pis*

[21] *Andjus, Lj. 2008. Butterflies (Lepidoptera, Hesperioidea and Papilionoidea) from the collection of the Natural History Museum in Belgrade. Natural History Museum in Belgrade, Belgrade, 40, pp. 1-94.*

[22] *Zečević, M. 2002. Fauna leptira Timočke krajine (Istočna Srbija).Bor: Bakar; Zaječar: Narodni muzej.*

Species	Conservation status	Description
Euphydryas aurinia (Marsh fritillary)	Annex II of the Habitats Directive and Anex II and Resolution 6 of the Bern Convention. Globally status is Least concern (LC)	This species is listed in Annex II of the Habitats Directive and Anex II and Resolution 6 of the Bern Convention. As of 2019 the butterfly's global conservation status is considered of least concern, but it has faced rapid decline and is considered regionally vulnerable or endangered over much of its range. Most preferred habitats are grassland and wetlands, but may also occur in heathland and shrub, woodland and forest. Species was recorded through field surveys.
Morimus asper	Annex II of the Habitats Directive and Resolution 6 of the Bern Convention. Globally vulnerable species (VU).	The species is strictly protected in Serbia. It is on Annex II of the Habitats Directive and within Resolution 6 of the Berne Convention. It is globally considered an vulnerable species (VU), but its status is not known at the European and national level. *Morimus asper* is a silvicolous, xylophagous and saproxylic species, its main habitat being deciduous and mixed forests. The species lives mainly in old-growth forests or well-structured woodlands, with a medium-high density of dead wood. Species was recorded through field surveys.
Cerambyx cerdo (Great capricorn beetle)	Annex II and IV of the Habitats Directive, Annex II and Resolution 6 of the Bern Convention, globally Vulnerable (VU)	This species is strictly protected species in Serbia. Globally is vulnerable species (VU), conservation actions needed. It thrives in dying or aged English oak trees found in sunny patches. Less often, beech, elm or Sessile oaks are used both as depository for eggs and as food for adult individuals. Deadwood and healthy trees are avoided. Species was recorded through both literature and field surveys.
Lucanus cervus (Stag beetle)	Annex II of the Habitats Directive and Annex III and Resolution 6 of the Berne Convention. Globally is Least Concern (LC), however in Europe it is NT	The Stag beetle is strictly protected in Serbia. The threat status in the territory of Europe and Serbia is not known. The Stag beetle inhabits Central and Southern Europe and Asia. Most preferred habitats are urban woodland and forest, but may also occur in grassland, heathland, and shrubs. It can most often be found in old trees or stumps. Species was recorded through field surveys

Macroinvertebrates and Ichthyofauna

Macroinvertebrate and fish surveys were conducted at five localities along the Project route, in April 2024, considering them as target aquatic communities. Sampling surveys were carried out at the localities chosen based on previously conducted surveys and assessments relevant to the Project[23], and given in Table 14-7.

Table 14-7. The list of sampling locations

No.	E	N	Location	City	Comment
Section Paraćin-Trupale					
1.	21.40364444	43.60952500	Near Paracin	Paraćin	Crnica River
2.	21.52910000	43.60958889	Near Cerovo	Aleksinac	Južna Morava River
3.	21.54529444	43.60189722	Near Vitkovac	Aleksinac	Južna Morava River
4.	21.77168889	43.39760556	Near Gornja Toponica	Niš	Južna Morava River
5.	21.83220833	43.32475556	Near Niš	Niš	Nišava river

[23] *CORRIDOR ENVIRONMENTAL & SOCIAL ASSESSMENT REPORT. Corridor Level Environmental and Social Assessment for the Belgrade-Nis High Speed Railway Corridor, Serbia. ENOVA, July 2022*

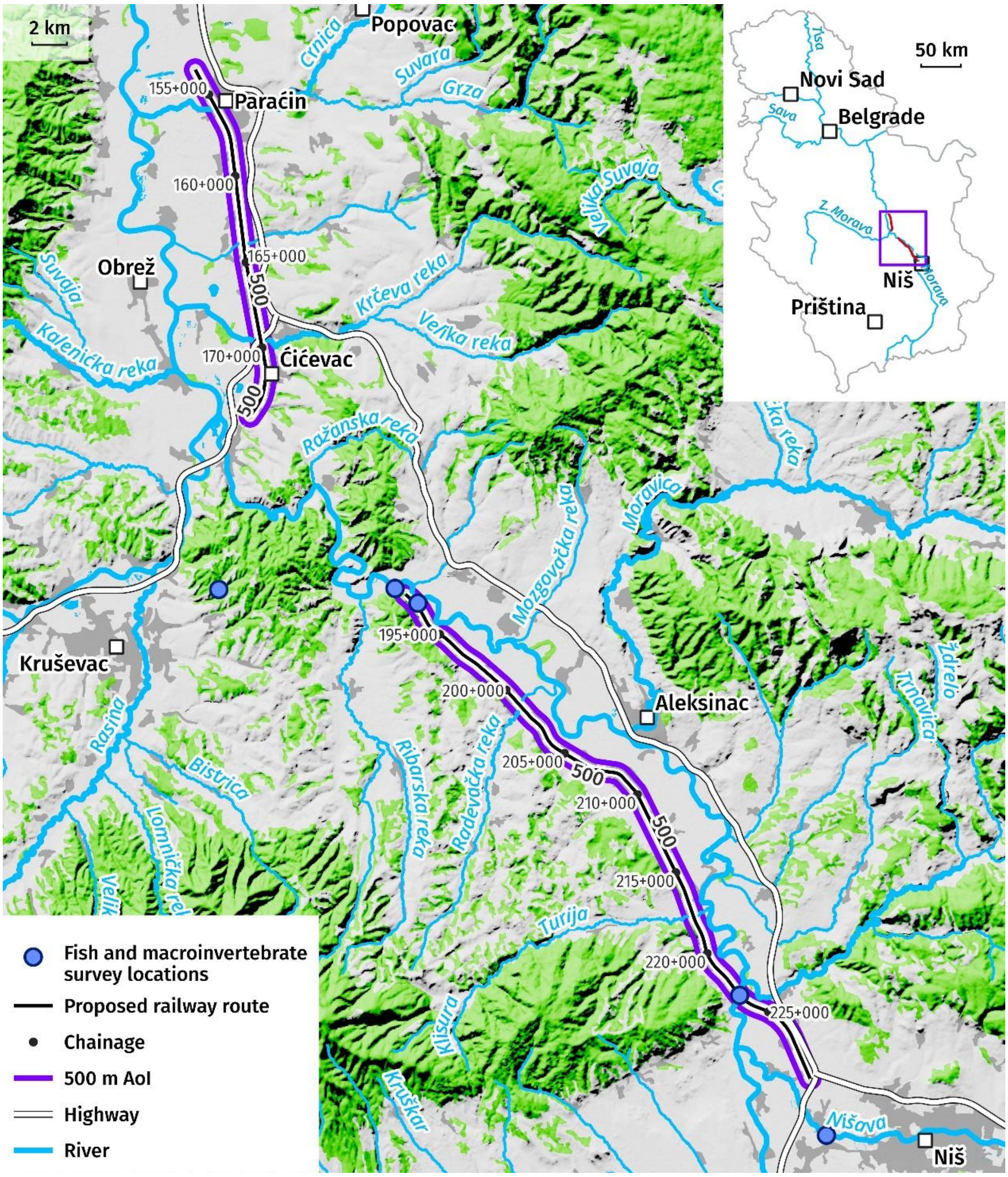


Figure 14-51. The map of macroinvertebrate and ichthyofauna survey points

Water quality was simultaneously measured at each of the five sampling locations. The parameters were selected according to the criteria specified under the Law on Waters ("Official Gazette of RS", No. 30/10, 93/2012, 101/2016, 95/2018 and 95/2018 – other laws), and were measured using the following methods:

- water temperature (t), electro-conductivity (EC), pH concentration, concentrations of oxygen (DO-mg/l), and oxygen saturation (DO%) were determined using the WTW multi 340 I probe device (WTW GmbH, Weilheim);
- water turbidity was measured with a Lovibond PC Checkitdevice
- orthophosphates, nitrates, nitrites, ammonia, and chlorides were determined using the Lovibond MD600

- Biochemical oxygen demand (BOD5) was estimated using the standard methodology recommended by APHA (1999).

Results of the water quality analysis from these specific sampling locations are presented in Surface water chapter: Table 9-9. The values of measured physicochemical parameter.

Figure 14-52. Nišava river (left), Crnica river (right); sampling site

Macroinvertebrate

Macroinvertebrate species of 'conservation concern' that recorded within the PAoI (Table 14-8) were selected based on their inclusion in Annex II and IV of the Habitats Directive, Annex II and Resolution 6 of the Bern Convention, and/or their conservation status according to IUCN.

The species *Theodoxus transversalis* (Striped nerite) was recorded during the field survey in the Južna Morava River near Cerovo and Južna Morava River near Vitkovac, as well as in Nišava River, near Niš. Considering this species is listed in Annex II and Annex IV of the Habitats Directive, as well as in Annex I of Resolution 6 of the Bern Convention, is a globally endangered-EN species and represents one of the triggering species for pSCI Južna Velika Morava, the species will be included in this impact assessment.

Furthermore, the species *Unio crassus* (The thick-shelled river mussel) was recorded in the database of the Institute for Nature Conservation, in Velika Morava River near Varvarin and Južna Morava near Aleksinac,[24]. Therefore, it is possible that this species still exists in this area. Considering that it is listed in Annex II and Annex IV of the Habitats Directive, as well as in Annex I of Resolution 6 of the Bern Convention, is globally endangered-

[24] *Tomovic, J., Zoric, K., Kracun, M., Markovic, V., Vasiljevic, B., Simic. V., Paunovic, M. (2012): Freshwater Mussels of the Velika Morava River. Water Research and Management 2(4): 51-55.*

Zivic, I. (2005): Faunisticka i ekoloska studija makrozoobentosa tekucica sliva Juzne Morave sa posebnim osvrtom na taksonomiju larvi Trichoptera (Insecta).- Bioloski fakultet Univerziteta u Beogradu, Beograd, 1-508.

EN (in EU and Europe vulnerable-VU), and represents one of the triggering species for pSCI Južna Velika Morava, the species will be included in this impact assessment.

Table 14-8. List of macroinvertebrates species of conservation concern within the Project AoI

Species	Conservation status	Description
Unio crassus	Annexes II, IV of the Habitats Directive and Resolution 6 of the Bern Convention IUCN EN	*U. crassus* is a strictly protected species in Serbia according to national legislation. Their populations declined during the 20th century everywhere in Europe due to deteriorating water quality, habitat fragmentation and host fish limitation This species inhabits clean river ecosystems and lakes, with flowing waters and sandy or sandy-gravel bottoms. Present in: Velika Morava (Markovac, Ćuprija), only literature record.
Theodoxus transversalis	Annexes II, IV of the Habitats Directive and Resolution 6 of the Bern Convention IUCN EN	Typically inhabits river bottoms with solid substrates. This species thrives in habitats characterised by relatively high dissolved oxygen levels and slow water flow velocities along the middle and lower Danube and its tributaries. Present in: Južna Morava (Vitkovac, Cerovo), Nišava river. Species was recorded during the field survey.

Ichthyofauna

Fish surveys were conducted during the spring season (April 2024) at five sampling points, chosen based on previous conducted surveys and assessment[25]. The electrofishing method was used. It should be noted that all fish were found in good condition, without noticeable deformities or parasite infections.

Table 14-9 provides a list of fish species of ‘conservation concern’ recorded within the PAoI. These species were selected based on their inclusion in Annex II and IV of the Habitats Directive, Annex II and Resolution 6 of the Bern Convention and/or their conservation status according to IUCN.

Table 14-9. List of fish species of conservation concern within the Project AoI

Species	Conservation status	Description
Cobitis elongata	Annex II of the Habitats Directive and Annex III and Resolution 6 of the Bern Convention IUCN LC, RS LC	Species inhabits moderate to fast-flowing stretches of shallow rivers of Danube drainage, on sandy banks and shores, and sometimes on rock bottom with submerged vegetation. Regulation on measures for the preservation and protection of fish stock has put a permanent ban on fishing this species in 2019. Present in: Južna Morava River. Species was recorded through field research.
Cobitis taenia	Annex II of the Habitats Directive and Annex III and Resolution 6 of the Bern Convention IUCN LC, RS LC	Inhabit slow-flowing rivers, streams, ponds, and lakes with muddy, sandy, or gravelly bottoms, often near vegetation or debris. It is widely distributed across Central and Eastern Europe. Present in: Južna Morava River. Species was recorded through field research.
Cottus gobio	Annex II of the Habitats Directive and Annex III and Resolution 6 of the	Occurs in cold, clear and fast-flowing water of small stream to medium-sized rivers as well as on gravel or rocky shores of cold lakes. It feeds on small bottom invertebrates, mainly insects, and crustaceans. Present in Crnica River. Species was recorded through field research.

[25][25] *CORRIDOR ENVIRONMENTAL & SOCIAL ASSESSMENT REPORT. Corridor Level Environmental and Social Assessment for the Belgrade-Nis High Speed Railway Corridor, Serbia. ENOVA, July 2022*

Species	Conservation status	Description
	Bern Convention IUCN LC, RS LC	
Barbus balcanicus	Annex V and Resolution 6 of the Bern Convention IUCN LC, RS LC	Adults inhabit fast to moderate-flowing premontane and montane streams and small rivers with gravel bottoms. They are most abundantly present in rapids and riffles during the day. Spawn in riffles. Common in the AoI area and present in: Južna Morava River, Nišava River, Crnica River. Migratory species, migration route must not be affected. Species was recorded through field research.
Barbus meridionalis	Annex II, V of the Habitats Directive Annex III and Resolution 6 of the Bern Convention IUCN LC, RS LC	Adults inhabit fast to moderate-flowing premontane and montane streams and small rivers with gravel bottom. Found most abundantly in rapids and riffles during the day. Spawn in riffles. Present in: Južna Morava River. Migratory species. Species was recorded only through literature.
Leuciscus aspius	Annex II and V of the Habitats Directive and Annex III and Resolution 6 of the Bern Convention IUCN LC, RS LC	The species occurs in open water of large and medium-sized lowland rivers and large lakes. It prefers to stay near bridge piers, tributaries, under weirs, in deep currents and overgrown parts of rivers, and quiet bays of river bends. The construction of the railway will not have a permanent impact on the adaptable asp. Present in: Južna Morava River. Species was recorded through field research.
Rhodeus amarus	Annex II of the Habitats Directive and Annex III and Resolution 6 of the Bern Convention IUCN LC, RS LC	Occurs most abundantly in still or slow-flowing water with dense aquatic vegetation and sand-silt bottom as lowland ponds, canals, slow-flowing rivers, backwaters and oxbows, where mussels are present. Present in: Južna Morava River. Species was recorded through field research.
Romanogobio albipinnatus	Annex II of the Habitats Directive and Annex III and Resolution 6 of the Bern Convention IUCN LC, RS LC	Inhabits clean, fast-flowing rivers and streams with gravel or rocky bottoms, preferring moderate to strong currents and clear waters with good oxygenation. It is native to the Danube River basin, found in primarily in the lower and middle reaches of the Danube River and its major tributaries, such as Morava rivers. Present in: Južna Morava River. Species was recorded through field research.
Romanogobio kesslerii	Annex II of the Habitats Directive and Annex III and Resolution 6 of the Bern Convention IUCN LC, RS LC	Inhabits clean, fast-flowing rivers and streams with gravel or rocky substrates, preferring well-oxygenated waters with moderate to strong currents. It is native to the Danube River basin, primarily in the lower and middle reaches of the Danube River and its major tributaries, including Morava Rivers. This species is typically found in shallow areas with clear water and a neutral to slightly alkaline pH. Present in: Južna Morava River. Species was recorded through field research.
Romanogobio uranoscopus	Annex II of the Habitats Directive and Annex III and Resolution 6 of the Bern Convention IUCN LC, RS LC	Prefers clean, fast-flowing rivers and streams with gravel or rocky substrates, thriving in moderately strong currents and well-oxygenated waters. This species inhabits the lower reaches of rivers, typically in shallow areas with clear, slightly alkaline waters. Present in: Južna Morava River. Species was recorded through field research.
Zingel streber	Annex II of the Habitats Directive and Annex III and Resolution 6 of the Bern Convention IUCN LC, RS VU	This species inhabits moderately flowing river sections of the Danube, Prut, Dniester and some of their river branches. It prefers deep water and relatively fast flows. In Serbia, this fish inhabits the Danube River and its main tributaries (Sava River, Tisa River, Drina River, Velika Morava River, Zapadna Morava River, etc). The ordinance on measures for the preservation and protection of fish stock has put a permanent ban on fishing of this species in 2019. Present in: Velika Morava River and Južna Morava River. Species was recorded through field research.
Zingel zingel	Annex II, V of the Habitats Directive and Annex III and Resolution 6 of the	This species is found in moderately flowing river sections of the Danube River, Prut River, Dniester River and some of their tributaries. It prefers deep water and relatively fast flows. In Serbia, this fish inhabits the Danube River and its main tributaries (Sava River, Tisa River, Drina River, Velika Morava River, Zapadna Morava

Species	Conservation status	Description
	Bern Convention IUCN LC, RS VU	River, etc). The ordinance on measures for the preservation and protection of fish stock has put a permanent ban on fishing of this species in 2019. Present in: Južna Morava River. Species was recorded through field research.

Fishing grounds

The Project passes through the territory of the following fishing grounds (from north to south):

Velika Morava 1 – This fishing ground extends over the territories of the following local self-government units: the City of Kragujevac, the City of Jagodina, the Municipality of Rača, the Municipality of Lapovo, the Municipality of Batočina, the Municipality of Knić, the Municipality of Rekovac, the Municipality of Varvarin, the Municipality of Paraćin, and the Municipality of Ćuprija. It is established on the fishing waters of the following river courses: Velika Morava from its source to the mouth of the rivers Rača, Lepenica, Crnica, Lugomir, Belica, Rača, and all other tributaries of the aforementioned rivers and other natural or artificial fishing waters within the boundaries of the fishing area, except for fishing waters within the boundaries of protected areas.

Timok – This fishing ground spans the territories of the following local government units: The city of Zaječar, the Municipality of Boljevac, the Municipality of Ćićevac, the Municipality of Ražanj, the Municipality of Aleksinac, the Municipality of Sokobanja, the Municipality of Svrljig, and the Municipality of Knjaževac. It is established in the fishing waters of the following river watercourses: Beli Timok, Crni Timok, Timok, Južna Morava from the location of Donja Trnava to the confluence, Moravica, and all other tributaries of these rivers, as well as other natural or artificial fishing waters within the boundaries of the fishing area, except for the fishing waters within the boundaries of protected areas.

Južna Morava 2 – This fishing ground spans the territories of the following local government units: the City of Niš, the Municipality of Gadžin Han, the Municipality of Doljevac, the Municipality of Merošina, the Municipality of Žitorađa, the Municipality of Prokuplje, the Municipality of Kuršumlija, the Municipality of Bojnik, the Municipality of Lebane, and the Municipality of Medveđa. It is established in the fishing waters of the following river watercourses: Južna Morava from the confluence of Barbetska River (near the settlement of Zaplanjska Toponica) to the location of Donja Trnava, Jablanica from its source to the administrative boundary between the municipality of Lebane and the municipality of Leskovac, Pusta River, Toplica, Topončka River, Nišava from the boundary of the "Sićevačka Gorge" Nature Park to the confluence, and all other tributaries of these rivers, as well as other natural or artificial fishing waters within the boundaries of the fishing area, except for the fishing waters within the boundaries of protected areas.

Ten fish species of conservation concern may be found in all fishing grounds: *Cobitis elongata* (Balkan loach), *Cobitis taenia* (Spined loach), *Sabanejewia balcanica* (Balkan spined loach), *Cottus gobio* (Bullhead), *Barbus balcanicus* (Danube barbel), *Cyprinus carpio* (Common carp), *Leuciscus aspius* (Asp), *Rhodeus amarus* (European bitterling), *Zingel streber* (Streber), *Zingel zingel* (Common zingel). However, only one species

(*Cyprinus carpio*,) has significant commercial importance. For recreational fishing, the important species are: *Barbus balcanicus*,*Leuciscus aspius* ,, *Zingel streber* ,, *Zingel zingel* ,.

Within the wider Project area for aquatic features (up to 15 km), one additional fishing ground "Rasina" is located on the left side of the Južna Morava River. It extends over the territories of the following local self-government units: the City of Kruševac, the Municipality of Blace, the Municipality of Brus, the Municipality of Aleksandrovac, and the Municipality of Trstenik. The fishing area "Rasina" is established on the fishing waters of the following river courses: the Zapadna Morava from the administrative boundary between the Municipality of Trstenik and the Municipality of Vrnjačka Banja to the confluence with the Velika Morava, the Rašina River, and all other tributaries of these rivers, as well as other natural or artificial fishing waters within the boundaries of the fishing area, except for the fishing waters within the boundaries of protected areas. This fishing ground was assessed in the baseline study but was scoped out because of the distance. The Project is not expected to have any impact to this fishing ground.

Reptiles and amphibians

Surveys of reptiles and amphibians were conducted in the spring (6 – 17 of May 2023), summer (11 – 21 of July 2023) and autumn (5 – 12 October 2023), covering most of the active period for these animals. A total of eight survey localities were selected based on previously conducted surveys and assessments[26], and shown in**Error! Reference source not found.**.

Table 14-10. List of locations surveyed for reptiles and amphibians

No.	E	N	Location	City
1.	21.82714°	43.31062°	Donje Međurovo	Niš
2.	21.81158°	43.35732°	Trupale	Niš
3.	21.81215°	43.36633°	Vrtište 1	Niš
4.	21.80612°	43.37944°	Vrtište 2	Niš
5.	21.77333°	43.39771°	Mezgraja	Niš
6.	21.64855°	43.52711°	Trnjane	Aleksinac
7.	21.58934°	43.56601°	Gornji Ljubeš	Aleksinac
8,	21.57469°	43.57697°	Donji Ljubeš	Aleksinac

[26] *CORRIDOR ENVIRONMENTAL & SOCIAL ASSESSMENT REPORT. Corridor Level Environmental and Social Assessment for the Belgrade-Nis High Speed Railway Corridor, Serbia. ENOVA, July 2022*

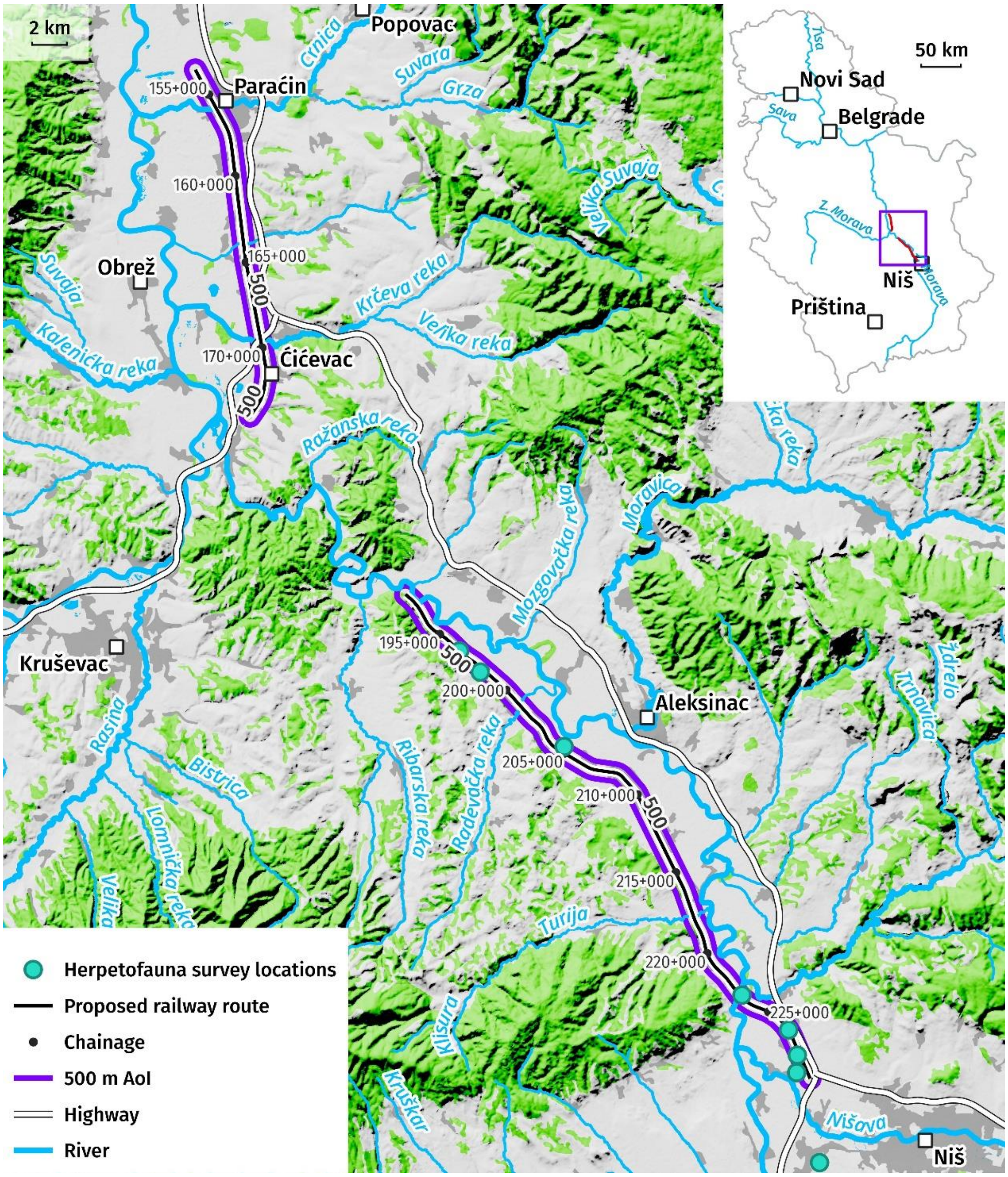


Figure 14-53. The map of reptiles and amphibians survey points

Nine out of eleven recorded species are ‘strictly protected’ or ‘protected’ species in Serbia: (*Bombina variegata, Rana dalmatina, Pelophylax ridibundus*, *Emys orbicularis, Testudo hermanni, Dolichophis caspius, Zamenis longissimus, Natrix tessellata, Natrix natrix*). While *Podarcis muralis* and *Lacerta viridis* are neither protected nor strictly protected in Serbia, they are internationally significant and are on the lists of protected species of the Bern Convention and the Habitats Directive.

The most common amphibian species found was *Pelophylax ridibundus,* which is prevalent in wet habitats, such as lakes, ponds and canals (Donje Međurovo and Vrtište).

The most common reptile species found were *Podarcis muralis* and *Lacerta viridis,* mostly found on rocky ground and bushes around the railway. Also, a large number of reptiles (mostly *Podarcis muralis*) were recorded at garbage dumps near the railway. Several species are mentioned in relevant literature as being present in this area, however, they were not found during the surveys: *Lissotriton vulgaris, Triturus macedonicus, Hyla arborea* and *Coronella austriaca*.

Figure 14-54. *Pelophylax ridibundus*

The greatest diversity of amphibians and reptiles was observed near surface water bodies and habitats (ponds, canals, rivers and flood plains) and in mosaic habitats (forest edges, crossings between forests and meadows, or agricultural areas). There are a significant number of canals and flood plains adjacent to the railway where amphibians were frequently recorded. However, during field surveys, no carcasses of reptiles and amphibians were observed on the railway which could be a result of collision with trains. Expert opinion states that directions of daily or seasonal (spring and autumn) migrations of amphibians and reptiles do not cross the existing railway. Therefore, there is no evidence to suggest the railway presents an obstacle to movement of herpetofauna from terrestrial to aquatic habitats, which would require the construction of crossings for these animals.

The full list of herpetofauna species recorded during the surveys is provided in Annex 1.

The herpetofauna species of 'conservation concern' that were recorded within the PAoI (Table 14-11) were selected based on their inclusion in Annex II and IV of the Habitats Directive, Annex II and Resolution 6 of the Bern Convention and/or their conservation status according to IUCN

According to the Global IUCN Red list, most species of amphibians and reptiles found have the LC status, except *Emys orbicularis* which has the NT status, and *Testudo hermanni* which has the VU status. According to the

Habitats Directive, all of the registered species of amphibians and reptiles are listed under Annex II, IV, or V (Table 14-11). All species listed in Table 14-13 are recorded during the field research.

Figure 14-55. *Rana dalmatina*

Table 14-11. List of herpetofauna of conservation concern

Habitats/species	Conservation status	Description
Bombina variegata	Annex II and IV of the Habitats Directive, Annex II and Resolution 6 of the Bern Convention, IUCN Global/RS LC	In Serbia, this species is strictly protected. It is common in Central Serbia and inhabits only a few locations in Vojvodina. This species lives in bushlands and meadows, floodplains, grasslands etc. It uses various types of water bodies, including lakes, ponds, swamps, rivers, stream pools and springs. Potential disturbance/loss of habitat unlikely to significantly impact the long-term survival of the species. The presence of this species is evidenced at localities Donje Medjurovo and Mezgraja.
Rana dalmatina	Annex IV of the Habitats Directive, Annex II of the Bern Convention, IUCN Global/RS LC	In Serbia, this species is strictly protected. It is the most common and widespread brown frog, which can be found in all altitudinal regions – Pannonian, Peripannonian and Mountain-valley. It inhabits mostly open deciduous forests and damp meadows. It is also found in all habitats with suitable shallow or ephemeral ponds, including steppe fragments, rural habitats, parks and edges of agricultural land. Agile frog inhabits parts of the Western and Central Europe, Apennine and Balkan peninsulas and northern Asia. According to expert opinion and field survey results, the size of the population within the investigated area is rather small. The presence of this species is evidenced at locality Gornji Ljubeš
Testudo hermanni	Annexes II and IV of the Habitats Directive, Annex II and Resolution 6 of the Bern Convention, IUCN Global VU, RS NT	In Serbia, this species is protected and it is common in southern and eastern Serbia. *Testudo hermanni* prefer warm deciduous forests, but due to habitat destruction, they are also found in habitats such as dry, hilly grasslands, meadows, orchards, vineyards or farmland. Possible negative impact of the reconstruction of the railway on habitats will not have significant impact to the long-term survival of the species. But attention should be paid to the species because it is slow and can be run over by train or get stuck in rails or drains next to the railway line.. The presence of this species is evidenced at localities Donje Medjurovo, Vrtište, Mezgraja, Djunis, Ćićevac

Emys orbicularis	Annexes II and IV of the Habitats Directive and Annex II and Resolution 6 of the Bern Convention, IUCN Global NT, RS DD	*E. orbicularis* is strictly protected species in Serbia that occurs in a large area in the territory of the Republic of Serbia. It can be found in almost all types of aquatic biotopes with stagnant and slowly flowing waters. Its populations are particularly numerous in aquatic biotopes with abundant vegetation. For this species, habitat conservation is one of the fundamental and most important direct protection measures. Population of this species in Serbia is stable and possible negative impact of the reconstruction of the railway on habitats will not have significant impact to the long-term survival of the species. The presence of this species is evidenced at locality Vrtište.
Podarcis muralis	Annex IV of the Habitats Directive, Annex II of the Bern Convention, IUCN Global/RS LC	There is no protection status for this species in Serbia. This is a very common and widespread species, well-adjusted to natural and urban habitats in majority of Serbia. The species is also widely spread in Europe and of the least conservation concern. Possible loss of habitat unlikely to significantly impact the long-term survival of the species. The populations are very numerous and widespread along the railway corridor. The presence of this species is evidenced at localities Donje Medjurovo, Vrtište, Mezgraja, Ćuprija, Gornji Ljubeš, Ćićevac, Djunis, Stalać
Lacerta viridis	Annex IV of the Habitats Directive, Annex II of the Bern Convention, IUCN Global/RS LC	In Serbia, this species is without protection regime. It is very common in open, warm habitats dotted with bushes. It is widespread mainly in the southern part of Europe, and most part of Eastern Europe. Possible disturbance and/or loss of habitat unlikely to significantly impact the long-term survival of the species. It is very common along the railway. The presence of this species is evidenced at localities Donje Medjurovo, Vrtište, Mezgraja, Ćuprija, Gornji Ljubeš, Ćićevac, Djunis, Stalać
Natrix tessellata	Annex IV of the Habitats Directive, Annex II of the Bern Convention, IUCN Global/RS LC	This species is strictly protected in Serbia. It is a common and widespread species in Serbia, with occurrences in rivers, coasts, streams, lakes, ponds and the surrounding terrestrial habitat. Potential disturbance/loss of habitat unlikely to significantly impact the long-term survival of the species. It is common in wet habitats along the railway. The presence of this species is evidenced at locality Ćuprija.
Zamenis longissimus	Annexes IV of the Habitats Directive, Annex II of the Bern Convention, IUCN Global/RS LC	This species is strictly protected in Serbia. It prefers forested, warm but not hot, moderately humid but not wet, hilly or rocky habitats with proper insolation and varied, not sparse vegetation. It occures in places such as forest clearings in succession, shrublands at the edges of forests interspersed with meadows, but avoids open plains and agricultural deserts. In Serbia, it is a very common species that can be found on the entire territory. The presence of this species is evidenced at localitiy Donji Ljubeš.
Dolichophis caspius	Annex IV of the Habitats Directive and Annex II of the Bern Convention, IUCN Global LC , RS DD	In Serbia, this species is strictly protected. It is a widely distributed species and inhabits the entire territory of Serbia, except for the western and southwestern parts. It is very common in eastern and southeaster Serbia. *Dolichophis caspius* prefer warm and sunny habitats: open steppes, semi-deserts, open forests, maquis, vineyards stone slopes with vegetation. In Serbia, this species inhabits steppe and forest-steppe regions, thermophilic, mixed oak forests, open groves forest edges and bushes. It is a common species of snake near the railroad, especially in places with a lot of garbage and large waste. The presence of this species is evidenced at localities Korman and Drenovac

Birds

Field surveys of birds were conducted in the winter (7 – 11 February 2023), the spring (6 – 17 May 2023), summer (11 – 21 July 2023) and autumn (5 – 12 October 2023), covering the entire active period of these animals. Surveys were carried out at six localities, chosen based on previously conducted surveys and assessments[27], shown in Table 14-12 and Figure 14-56.

Table 14-12. List of locations surveyed during the field visits for birds

No.	Location name	Coordinates of transect start point	Coordinates of transect start point	Coordinates of transect end point	Coordinates of transect end point	Length of covered railway
		Latitude	Longitude	Latitude	Longitude	meters
1.	Donje Međurovo	43.302607°	21.830407°	43.313515°	21.827143°	1235
2.	Vrtište	43.380464°	21.805035°	43.388255°	21.793964°	1231
3.	Mezgraja	43.396981°	21.773036°	43.416783°	21.750406°	2880
4.	Ćićevac	43.703075°	21.430235°	43.712185°	21.436286°	1112
5.	Pojate	43.739190°	21.433921°	43.750653°	21.431356°	1293
6.	Paraćin	43.874192°	21.391694°	43.883947°	21.384501°	1223

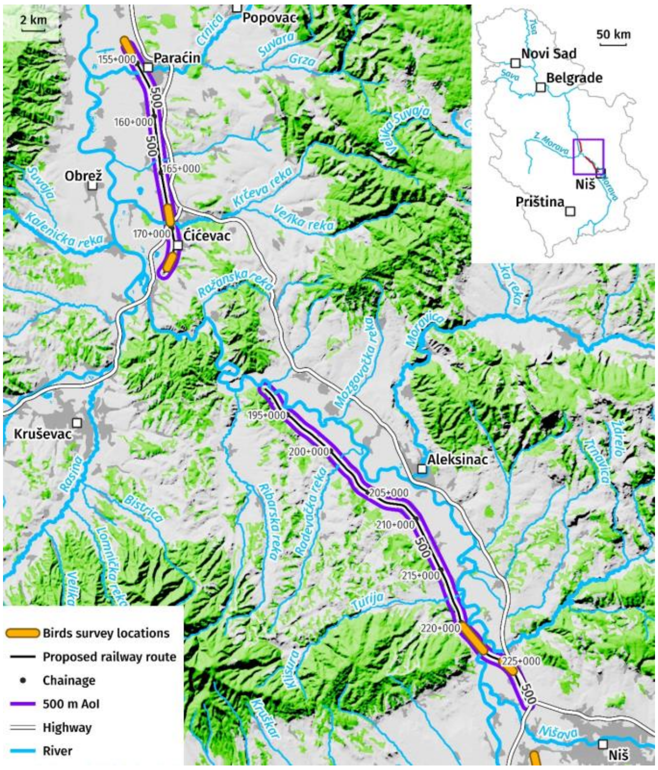


Figure 14-56. The map of bird survey points

[27] *CORRIDOR ENVIRONMENTAL & SOCIAL ASSESSMENT REPORT. Corridor Level Environmental and Social Assessment for the Belgrade-Nis High Speed Railway Corridor, Serbia. ENOVA, July 2022*

A section of the Project route intersects the Important Bird Area (IBA) "Dobrić-Nišava" between the following (Figure 14-57). The approximate length of the railway section that intersects the IBA area is 9,240 m (from km 220+315 to the end of Section 3, start to end: 43.413571°, 21.753489°; 43.351424°, 21.823143°).

IBA "Dobrić-Nišava" is located in central Serbia between the Mali Jastrebac mountain in the north, Vidojevica in the south and the city of Niš in the east. This predominantly agricultural lowland area is interspersed with mountain peaks, villages, rivers, streams, gravel pits and Lake Oblačina. The area has been identified as important nesting site for Grey Partridge (*Perdix perdix*) and Black-headed Bunting (*Emberiza melanocephala*).

In total, 83 bird species were registered during the surveys. Only one (*Columba livia* f. *domestica*) is not protected by national law. A total of 62 of the recorded bird species are strictly protected, and 20 are protected species.

In addition, following the Convention on the Protection of European Wildlife and Natural Habitats (Law on Ratification of the Convention on the Protection of European Wildlife and Natural Habitats (Bern Convention), "Official Gazette – International agreements no. 102/07), 55 of the species recorded are found in Annex II to the Bern Convention, which implies their strict protection, while 19 species are listed in Annex III, which implies the possibility of their controlled use. In total, 32 species are listed in Annexes of the EU Birds Directive; where 16 of them are listed in Annex I.

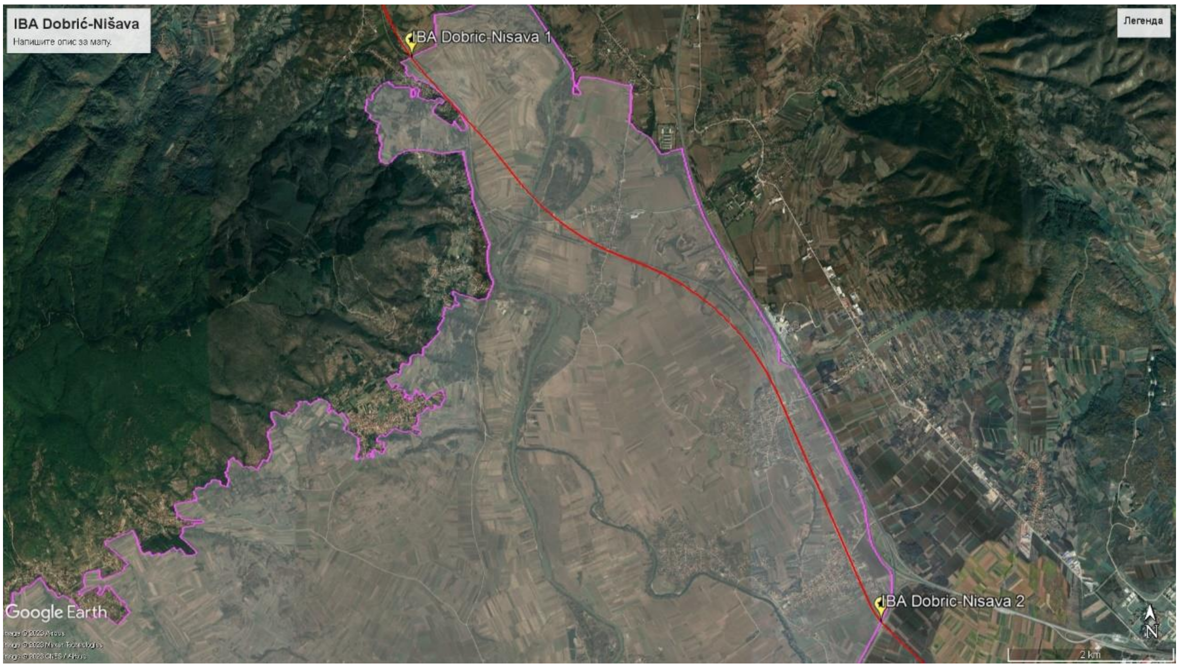


Figure 14-57. IBA "Dobrić-Nišava" railway crossing points

Figure 14-58. Južna Morava River, IBA “Dobrić-Nišava”

Figure 14-59. Vrtište

During the surveys, important habitats for nesting birds were also observed, including *Nycticorax nycticorax, Ciconia ciconia, and Circus aeruginosus*. Records of songbird species from the genera *Acrocephalus* and *Locustella*,characteristic species of wetlands, are noteworthy. A mixture of different types of fauna was registered in mosaic habitats, resulting from significant habitat changes caused by anthropogenic factors. Characteristic species that nest in such mosaic habitats are: *Buteo buteo, Streptopelia turtur, Sylvia atricapilla, Columba palumbus, Cuculus canorus, Picus viridis, and Dendrocopos major*. A total of 62 breeding species were recorded in the PAoI, as listed in **Error! Reference source not found.**Table 14-13**Error! Reference source not found.**.

Table 14-13. Breeding bird species found within the PAoI

Latin name	English name	Locations	IUCN global	Red Book of Serbia	EU Birds Directive	BERN	Rulebook	Suitable Habitat
Falco tinnunculus	Common Kestrel	Donje Međurovo, Vrtište, Between Mezgraja and Ćićevac, Stalać, Pojate	LC	LC, LC		II	SP	Agriculture areas, urban habitats - good conditions
Falco subbuteo	Eurasian Hobby	Mezgraja, Stalać, Ćićevac	LC	LC, LC		II	SP	Agriculture mozaik areas, river valleys - good conditions
Corvus monedula	Eurasian Jackdaw	Donje Međurovo	LC	LC, LC	IIB		P	Agriculture areas, village settlement - good conditions
Carduelis carduelis	European Goldfinch	Donje Međurovo	LC	LC, LC		II	SP	Agriculture mozaik areas - good conditions
Chloris chloris	European Greenfinch	Stalać, Ćićevac	LC	LC, LC		II	SP	Agriculture mozaik areas - good conditions
Streptopelia decaocto	Eurasian Collared-dove	Donje Međurovo, Stalać, Ćićevac, Pojate	LC	LC, LC	IIB	III	P	Agriculture mozaik areas - good conditions
Streptopelia turtur	European Turtle Dove	Mezgraja, Stalać, Pojate	VU	VU, VU	IIB	III	P	Agriculture mozaik areas, river valleys - bad conditions
Buteo buteo	Eurasian Buzzard	Donje Međurovo, Between Donje Međurovo and Vrtište, Vrtište, Between Mezgraja and Stalać, Ćićevac, Pojate, Paraćin	LC	LC, LC		II	SP	Agriculture mozaik areas, forest areas - good and bad conditions
Passer montanus	Eurasian Tree Sparrow	Donje Međurovo, Vrtište, Mezgraja, Ćićevac, Paraćin	LC	LC, LC		III	P	Village settlement - good conditions
Passer domesticus	House Sparrow	Donje Međurovo, Stalać, Ćićevac	LC	LC, LC			P	Village settlement - good conditions

Latin name	English name	Locations	IUCN global	Red Book of Serbia	EU Birds Directive	BERN	Rulebook	Suitable Habitat
Corvus corone	Carrion Crow	Donje Međurovo, Mezgraja, Vrtište, Ćićevac, Pojate, Stalać, Paraćin	LC	LC, LC	IIB		P	Agriculture mozaik areas, village settlement - good conditions
Pica pica	Eurasian Magpie	Donje Međurovo, Vrtište, Stalać, Ćićevac, Pojate	LC	LC, LC	IIB		P	Agriculture mozaik areas, village settlement - good conditions
Corvus corax	Common Raven	Donje Međurovo, Vrtište, Mezgraja, Between Mezgraja and Stalać, Ćićevac	LC	LC, LC		III	P	Agriculture mozaik areas, forest areas, anthropogenic structures (eg power lines) - bad conditions
Sturnus vulgaris	Common Starling	Donje Međurovo, Vrtište, Mezgraja, Stalać, Ćićevac, Pojate, Paraćin	LC	LC, LC	IIB		P	Agriculture mozaik areas, anthropogenic structures - good conditions
Emberiza schoeniclus	Reed Bunting	Vrtište, Mezgraja	LC	LC, LC		II	SP	Fragments of wetlands, river valleys - bad conditions, need to preserve
Columba palumbus	Common Woodpigeon	Donje Međurovo, Vrtište, Mezgraja, Stalać, Pojate	LC	LC, LC	IIA; IIIA		P	river valleys - bad conditions, need to preserve
Picus viridis	Eurasian Green Woodpecker	Vrtište, Mezgraja, Between Mezgraja and Stalać, Ćićevac	LC	LC, LC		II	SP	orchards, river valleys, riparian vegetation - bad conditions, need to preserve
Troglodytes troglodytes	Northern Wren	Vrtište, Mezgraja	LC	LC, LC		II	SP	river valleys, riparian vegetation - bad conditions, need to preserve
Aegithalos caudatus	Long-tailed Tit	Vrtište, Mezgraja	LC	LC, LC		II	SP	hedges, river valleys - bad conditions, need to preserve
Alauda arvensis	Eurasian Skylark	Mezgraja	LC	LC, LC		II	SP	Agriculture mozaik areas - good conditions
Garrulus glandarius	Eurasian Jay	Vrtište, Mezgraja	LC	LC, LC	IIB		P	Agriculture mozaik areas, village settlement - good conditions

Latin name	English name	Locations	IUCN global	Red Book of Serbia	EU Birds Directive	BERN	Rulebook	Suitable Habitat
Cyanistes caeruleus	Eurasian Blue Tit	Vrtište	LC	LC, LC		II	SP	Fragments of wetlands, river valleys - bad conditions, need to preserve
Turdus merula	Eurasian Blackbird	Vrtište, Mezgraja, Stalać, Pojate	LC	LC, LC	IIB	III	SP	Agriculture mozaik areas, hedges - good conditions
Emberiza cirlus	Cirl Bunting	Vrtište, Donje Međurovo	LC	LC, LC		II	SP	Agriculture mozaik areas, village settlement - good conditions
Dendrocopos syriacus	Syrian Woodpecker	Vrtište, Ćićevac	LC	LC, LC	I	II	SP	Orchards, river valleys - bad conditions, need to preserve
Dryocopus martius	Black Woodpecker	Mezgraja	LC	LC, LC	I	II	SP	river valleys - bad conditions, need to preserve
Parus major	Great Tit	Donje Međurovo, Mezgraja, Vrtište, Stalać, Pojate, Ćićevac	LC	LC, LC		II	SP	Fragments of wetlands, river valleys, village settlement - bad conditions for Fragments of wetlands, river valleys, need to preserve
Dendrocopos major	Great Spotted Woodpecker	Mezgraja, Vrtište, Stalać, Pojate	LC	LC, LC		II	SP	Orchards, river valleys - bad conditions, need to preserve
Leiopicus medius	Middle Spotted Woodpecker	Ćićevac	LC	LC, LC	I	II	SP	Orchards, river valleys - bad conditions, need to preserve
Dryobates minor	Lesser Spotted Woodpecker	Stalać	LC	LC, LC		II	SP	Orchards, river valleys - bad conditions, need to preserve
Anas platyrhynchos	Mallard	Mezgraja, Stalać	LC	LC, LC	IIA, IIIA	III	P	river valleys - bad conditions, need to preserve
Accipiter nisus	Eurasian Sparrowhawk	Between Mezgraja and Stalać	LC	LC, LC		II	SP	Agriculture mozaik areas, forest areas, village settlement - good conditions

Latin name	English name	Locations	IUCN global	Red Book of Serbia	EU Birds Directive	BERN	Rulebook	Suitable Habitat
Alcedo atthis	Common Kingfisher	Mezgraja, Between Donje Međurovo and Vrtište, Stalać	LC	LC, LC	I	II	SP	Artificial water bodies - bad conditions, need to improve
Acrocephalus arundinaceus	Great Reed Warbler	Vrtište	LC	LC, LC		II	SP	Wetland and water habitats - bad conditions, need to preserve
Acrocephalus palustris	Marsh Warbler	Vrtište	LC	LC, LC		II	SP	Wetland and water habitats - bad conditions, need to preserve
Acrocephalus scirpaceus	Eurasian Reed Warbler	Vrtište	LC	LC, LC		II	SP	Wetland and water habitats - bad conditions, need to preserve
Cettia cetti	Cetti's Warbler	Vrtište	LC	VU, DD		II	SP	Wetland habitats - bad conditions, need to preserve
Ciconia ciconia	White Stork	Donje Međurovo, Vrtište, Between Mezgraja and Stalać	LC	LC, LC	I	II	SP	Agriculture mozaik areas, settlements - good and bad conditions
Coturnix coturnix	Common Quail	Donje Međurovo	LC	VU, LC		III	P	Agriculture areas - bad conditions
Curruca communis	Common Whitethroat	Donje Međurovo, Vrtište, Between Mezgraja and Stalać, Mezgraja, Stalać, Ćićevac, Pojate, Paraćin	LC	LC, LC		II	SP	Agriculture areas and hedges - good conditions
Phylloscopus collybita	Common Chiffchaff	Vrtište, Ćićevac, Pojate	LC	LC, LC		II	SP	River valleys, Agriculture mozaik areas - good and bad conditions
Emberiza calandra	Corn Bunting	Donje Međurovo, Mezgraja, Between Mezgraja and Stalać, Paraćin	LC	LC, LC		II	SP	Agriculture mozaik areas - good conditions
Emberiza citrinella	Yellowhammer	Donje Međurovo	LC	LC, LC		II	SP	Agriculture mozaik areas near river vally - good and bad conditions

Latin name	English name	Locations	IUCN global	Red Book of Serbia	EU Birds Directive	BERN	Rulebook	Suitable Habitat
Emberiza hortulana	Ortolan Bunting	Mezgraja, Pojate, Paraćin	LC	LC, LC	I	III	SP	
Hirundo rustica	Barn Swallow	Donje Međurovo, Vrtište, Between Donje Međurovo and Vrtište, Mezgraja, Between Mezgraja and Stalać, Stalać, Ćićevac	LC	LC, LC		II	SP	Agriculture mozaik areas, settlements, primary as feeding grounds - good conditions
Locustella luscinioides	Savi's Warbler	Vrtište	LC	LC, LC		II	SP	Wetland habitats - bad conditions, need to preserve
Luscinia megarhynchos	Common Nightingale	Donje Međurovo, Vrtište, Between Mezgraja and Stalać, Mezgraja, Stalać, Ćićevac, Pojate, Paraćin	LC	LC, LC		II	SP	Mozaic agriculture areas and hedges - good conditions
Merops apiaster	European Bee-eater	Donje Međurovo, Between Donje Međurovo and Vrtište, Mezgraja	LC	LC, LC		II	SP	Artificial wetlands, vertical river banks and river alluvium mines - bad conditions, need to preserve
Motacilla flava	Western Yellow Wagtail	Between Mezgraja and Stalać, Stalać, Pojate, Paraćin	LC	LC, LC		II	SP	Mozaic agriculture areas near river valleys - good conditions
Perdix perdix	Grey Partridge	Vrtište, Mezgraja, Donje Međurovo	LC	VU, NA		III	P	Mozaic agriculture areas - bad conditions
Sylvia atricapilla	Eurasian Blackcap	Donje Međurovo, Vrtište, Mezgraja, Between Mezgraja and Stalać, Stalać, Ćićevac, Pojate, Paraćin	LC	LC, LC		II	SP	Agriculture areas and wood fragments - good conditions
Lanius collurio	Red-backed Shrike	Donje Međurovo, Vrtište, Mezgraja, Ćićevac, Between Mezgraja and Ćićevac, Pojate, Stalać, Paraćin	LC	LC, LC	I	II	SP	Agricultural areas, Pastures with bushy vegetation - good condition
Lanius minor	Lesser Grey Shrike	Ćićevac, Pojate	LC	LC, LC	I	II	SP	Agricultural areas, Pastures with bushy vegetation - good condition
Upupa epops	Common Hoopoe	Between Donje Međurovo and Vrtište	LC	LC, LC		II	SP	Agriculture mozaik areas, Orchards, river valleys -

Latin name	English name	Locations	IUCN global	Red Book of Serbia	EU Birds Directive	BERN	Rulebook	Suitable Habitat
								good and bad conditions
Oriolus oriolus	Eurasian Golden Oriole	Donje Međurovo, Vrtište, Between Donje Međurovo and Vrtište, Mezgraja, Paraćin, Stalać, Ćićevac, Pojate	LC	LC, LC		II	SP	Mozaic agriculture areas with fragments of forest - good conditions
Athene noctua	Little Owl	Donje Međurovo, Ćićevac	LC	LC, LC		II	SP	Settlements - good conditions
Charadrius dubius	Little Ringed Plover	Stalać	LC	LC, LC		II	SP	Rivers - bad conditions
Cuculus canorus	Common Cuckoo	Vrtište, Mezgraja, Pojate, Paraćin	LC	LC, LC		III	SP	Mozaic agriculture areas with fragments of forest - good conditions
Erithacus rubecula	European Robin	Pojate	LC	LC, LC		II	SP	Mozaic agriculture areas with fragments of forest - good conditions
Fringilla coelebs	Common Chaffinch	Stalać, Ćićevac	LC	LC, LC		III	SP	Mozaic agriculture areas with fragments of forest - good conditions
Galerida cristata	Crested Lark	Pojate, Paraćin	LC	LC, LC		III	SP	Mozaic agriculture areas - good conditions
Phasianus colchicus	Common Pheasant	Vrtište, Mezgraja, Stalać, Ćićevac, Paraćin	LC	NA, NA	IIA; IIIA	III	P	Mozaic agriculture areas with fragments of forest - good conditions

*Rows highlighted in green indicate habitats in bad conditions

Several localities in the table are entitled as “bad conditions, need to preserve “, meaning that habitats where these species breed are not in good condition and potential disturbance/loss of habitats is likely to impact the long-term survival of the species in PAoI. This includes habitat changes and potential impact due to increased train speeds and presumably higher frequency, as well as fencing. Birds are expected to temporarily vacate the areas where the construction works are taking place, but are likely to return once the disturbance ceases, provided that suitable habitat conditions remain. The railway already exists, and the local populations appear stable, with individuals having adapted to the daily and seasonal rhythms. None of the recorded species are narrowly specialised for particular habitats, nor are the habitats unique to the railway corridor. All species and habitats are widely distributed in Serbia, and the Project is unlikely to cause the local disappearance of any species. A monitoring programme is to be established to evaluate whether the species indeed returned following the cessation of works

The bird species of 'conservation concern' recorded within the PAoI (Table 14-14) were selected based on their inclusion in Annex I of the Birds Directive, Annex II and Resolution 6 of the Bern Convention and/or their conservation status according to IUCN.

Table 14-14. List of bird species of conservation concern

Species	Conservation status	Description
Alcedo atthis	Annex I of the Birds Directive; Annex II and I, Res. 6 of Bern Convention, national LC status in Serbia, and LC according to the IUCN	This is a strictly protected breeding species in Serbia. National population is estimated at 2,700-4,000 pairs. Its nesting places are near water with sand cliffs, especially in areas around Morava River in the PAoI. Artificial water bodies and wetlands where this species is recorded in PAoI are in bad conditions, need to be preserved.
Ardea alba	Annex I of the Birds Directive; national LC status in Serbia, and LC according to the IUCN	This is a strictly protected migratory species in Serbia. National population is estimated at 450-600 pairs. In the PAoI it was recorded in river valleys and agriculture mosaic areas that are in bad conditions, need to be preserved.
Ardea purpurea	Annex I of the Birds Directive; national VU status in Serbia, and LC according to the IUCN	This is a strictly protected breeding species in Serbia. National population is estimated at 645-900 pairs. Purple herons are colonial breeders and build a bulky nest out of dead reeds or sticks close to the water' edge among reeds or in dense vegetation. In the PAoI it was recorded in river valleys and agriculture mosaic areas that are in bad conditions, need to be preserved.
Ciconia ciconia	Annex I of the Birds Directive; national LC status in Serbia, and LC according to the IUCN	This is a strictly protected migratory species in Serbia. National population is estimated at 1,240-1,410 pairs. The species nests in the settlements on electric poles or roofs of houses, or in agriculture mosaic areas, with good and bad conditions. No nests were recorded along the PAoI, individuals in flight were recorded.
Ciconia nigra	Annex I of the Birds Directive; national NT status in Serbia, and LC according to the IUCN	This is a strictly protected migratory species in Serbia. National population is estimated at 135-172 pairs. The species nests in the settlements on electric poles or roofs of houses, or in agricultural mosaic areas, with good and bad conditions. Recorded in migration along the PAoI, individuals in flight were recorded.
Cettia cetti	National VU status in Serbia, and LC according to the IUCN.	This is a strictly protected migratory species in Serbia. This bird is rare in Serbia, with the estimated number of individuals 20-110 pairs. In the PAoI it inhabits wetland habitats which are in bad conditions, need to be preserved.
Emberiza hortulana	Annex I of the Birds Directive; national LC status in Serbia, and LC according to the IUCN.	This is a strictly protected breeding species in Serbia; prefers mosaic open habitats of orchards and agricultural areas with shrubs. National population is estimated at 29,000-47,000 pairs. In the PAoI it is recorded in agricultural mosaic areas, orchards which are in good and bad conditions. Territorial behaviour of males indicates breeding area of species.
Lanius collurio	Annex I of the Birds Directive; national LC status in Serbia, and LC according to the IUCN.	This is a strictly protected breeding species in Serbia. National population is estimated at 87,000-125,000 pairs. It inhabits open habitats (meadows, pastures, etc.) with hedges, shrubs, and bushes, and regularly occurs in mosaic agricultural areas.

Species	Conservation status	Description
		It is a very common and widespread bird in Serbia, also very often recorded in the PAoI, in habitats with scrubs along the railway lines. It nests in numerous different open habitats. Almost all recorded individuals were on their territory with breeding behaviour.
Lanius minor	Annex I of the Birds Directive; national LC status in Serbia, and LC according to the IUCN.	This is a strictly protected breeding species in Serbia. The national population is estimated at 730-1,120 pairs. Various mosaic habitats along the PAoI are suitable for this species, agricultural areas, pastures with bushy vegetation in good condition.
Nycticorax nycticorax	Annex I of the Birds Directive; national LC status in Serbia, and LC according to the IUCN.	This is a strictly protected migratory species in Serbia. The national population is estimated at 2800-3820 pairs. It inhabits fresh-water wetlands. The habitats where they were recorded are suitable, but there were no indications of nesting. The nearest colony is near Velika Plana, in Section 2.
Streptopelia turtur	Annex IIB of the Birds Directive; national VU status in Serbia, and VU according to the IUCN.	This is a protected breeding species in Serbia. National population is estimated at 49,000-68,000 pairs. It inhabits agriculture mosaic habitats with shrubs and trees in the hills and plains, forest edges, floodplains of large rivers, orchards, and degraded forest complexes which are in bad condition, need to be preserved. The turtle dove population is declining for most of the area. It is considered as a nesting bird in the PAoI. Mosaic habitats of dense vegetation along the railway and agricultural areas are excellent nesting places for this species.
Tringa glareola	Annex I of the Birds Directive; national LC status in Serbia, and LC according to the IUCN.	This migratory species is strictly protected in Serbia. This bird is usually found on freshwater during migration and wintering. They forage by probing in shallow water or on wet mud and mainly eat insects and similar small prey. Nests on the ground or uses an abandoned old tree nest of another bird. It breeds in wetland areas across to the PAoI.
Sterna hirundo	Annex I of the Birds Directive; Bern Convention Res. 6, national VU status in Serbia, and LC according to the IUCN.	It is a strictly protected migratory species in Serbia National population is estimated at 216-280 pairs. Common Tern was recorded on Velika Morava River, near Stalać. In the vicinity of its nesting place, where alot of work was done on the construction of a new highway in the past, so nesting of the species has not been proven.
Perdix perdix	National VU status in Serbia, and LC according to the IUCN.	This is a protected breeding species in Serbia. National population is declining, and it is estimated at 20,000-28,000 pairs. Inhabits natural open meadows, grazing land, and agriculture land used to produce grain and row crops. In the PAoI this species is recorded in mosaic agricultural areas,
Milvus migrans	Annex I of the Birds Directive; Bern Convention Res. 6, national EN status in Serbia, and LC according to the IUCN.	This is a strictly protected migratory species. National population is estimated at 34-45 pairs. Frequently forages in urban areas, rubbish dumps, aquatic habitats, and grassland, but usually avoids heavily forested areas. Sometimes solitary but also gathers in large flocks on migration and at good feeding areas. It was found in Vrtiste, in area with significant agricultural mosaics and its behaviour indicated that population was in migration, and that individuals do not nest in these locations.
Dendrocopos syriacus	Annex I of the Birds Directive; Bern Convention Res. 6, national LC status in Serbia, and LC according to the IUCN.	It is a strictly protected, breeding species, widespread in the wider area of Southeast Europe and Asia Minor. in Serbia, the population is slightly growing and is estimated at 28,000-37,000 breeding pairs. It is a resident bird. Inhabits semi-open habitats of plains and hills, old orchards, tree lines, bans, hedges, parks and gardens. It nests in holes

Species	Conservation status	Description
		in tree trunks that it makes itself. It is very numerous and nests all over PAoI.
Dryocopus martius	Annex I of the Birds Directive; Bern Convention Res. 6, national LC status in Serbia, and LC according to the IUCN.	This is a strictly protected, breeding species. National population is estimated at 2,400-3,200 pairs. Lives in mature forests across the northern Palearctic. In the last years, population growth has been observed. It is widespread in PAoI and inhabits many different habitats (orchards, different types of forest, parks...).
Leiopicus medius	Annex I of the Birds Directive; national LC status in Serbia, and LC according to the IUCN.	This is a strictly protected breeding species. Population is estimated at 10,000-15,000 pairs. It nests in all regions of Serbia. In PAoI inhabits orchards in river valleys, that is in bad conditions, need to be preserved.
Circus aeruginosus	Annex I of the Birds Directive; Bern Convention Res. 6, national NT status in Serbia, and LC according to the IUCN.	It is a strictly protected migratory species. National population is estimated at 349-468 pairs. It nests near the water in a thick reed and feeds on a variety of small mammals, eggs, small birds, fish, and reptiles. Inhabits wetlands and water habitats. In PAoI such habitats are in bad conditions, need to be preserved.

Mammals

Field surveys for mammals were conducted during the winter (7 – 11 February 2023), spring (6– 17 May 2023), summer (11 – 21 July 2023) and autumn (5 – 12 October 2023), covering the entire active period of these animals. The six survey localities, chosen based on previously conducted surveys and assessments[28], are listed in Table 14-15.

Table 14-15. Locations of mammal surveys

No.	Location name	Coordinates of transect start point		Coordinates of transect end point		City (municipality)
		Latitude	Longitude	Latitude	Longitude	
1	Vrtište	43°21'31.83"N	21°48'40.58"E	43°22'1.41"N	21°48'44.51"E	Niš
2	Mezgraja – Veliki Drenovac	43°23'42.78"N	21°46'32.42"E	43°24'52.35"N	21°45'3.10"E	Niš - Aleksinac
3	Tešica	43°26'47.37"N	21°44'9.32"E	43°28'14.84"N	21°43'13.12"E	Aleksinac
4	Donji Adrovac-Trnjane	43°31'8.82"N	21°39'29.64"E	43°31'41.82"C	21°38'20.82"И	Aleksinac
5	Vitkovac	43°35'35.02"N	21°33'0.54"E	43°36'20.81"N	21°31'2.88"E	Aleksinac
6	Ratare - Striža	43°48'23.87"N	21°25'11.01"E	43°49'36.69"N	21°24'57.84"E	Paraćin

[28] CORRIDOR ENVIRONMENTAL & SOCIAL ASSESSMENT REPORT. Corridor Level Environmental and Social Assessment for the Belgrade-Nis High Speed Railway Corridor, Serbia. ENOVA, July 2022

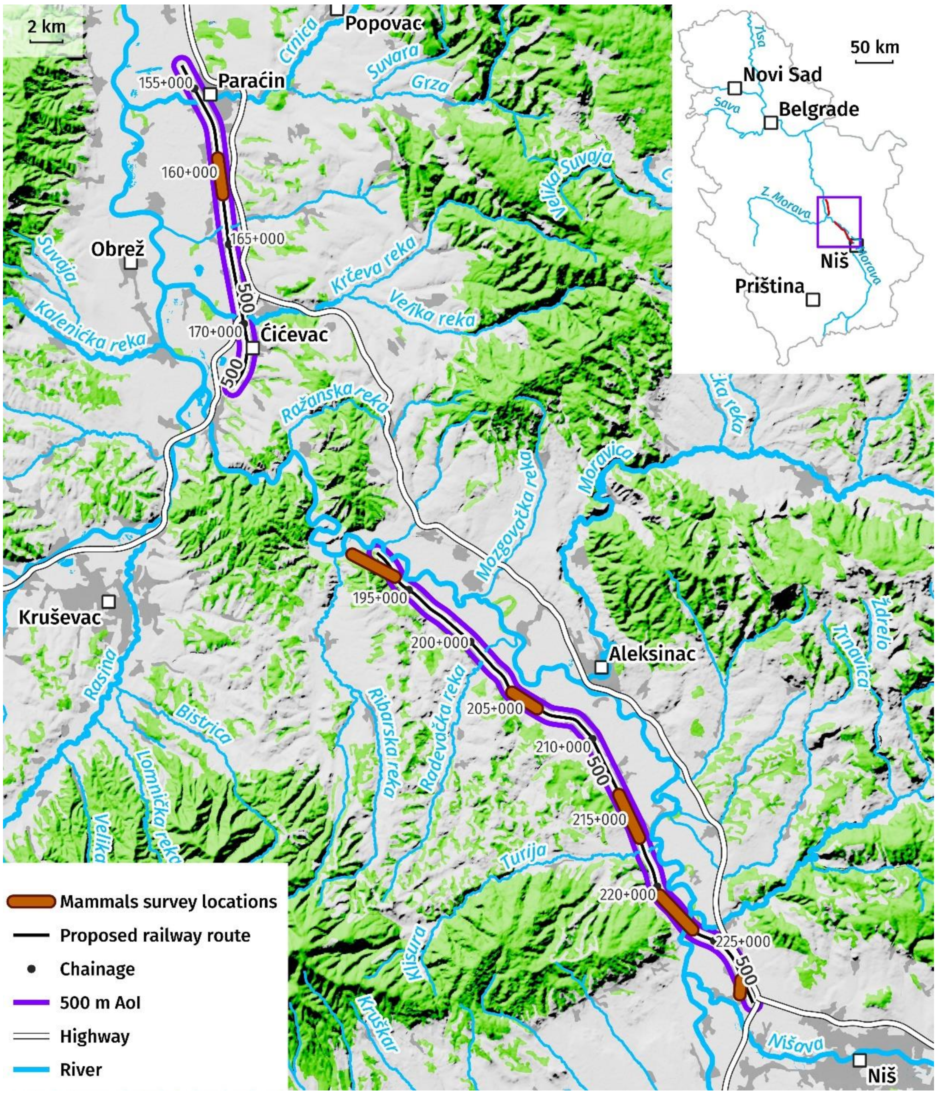


Figure 14-60. The map of mammal survey points

In total, 22 species of mammals were recorded within the PAoI.

Three species of order Insectivores (*Eulipotyphla)* were recorded in the PAoI.The European mole - *Talpa europaea,* prefers forests and forest-like habitats, as well as open habitats. The Pygmy shrew - *Sorex minutus,* and Hedgehog - *Erinaceus roumanicus,* mostly inhabit mosaic fields, forest and bush edges.

Four species of Rodentia were also recorded, and one species from the order Lagomorpha (*Lepus europaeus*). These are species of a wide ecological spectrum that inhabit different types of habitats, from forest, and steppe habitats, to significantly anthropogenically modified habitats. The presence of a Harvest mouse (*Micromys minutus*), recognisable by nests made of grass leaves woven into spherical balls in tall grasses or cereals, was particularly notable, as this species is relatively rare in Serbia (Figure 14-61 and Figure 14-62)

Figure 14-61. Nest of Harvest mouse (*Micromys minutus*)

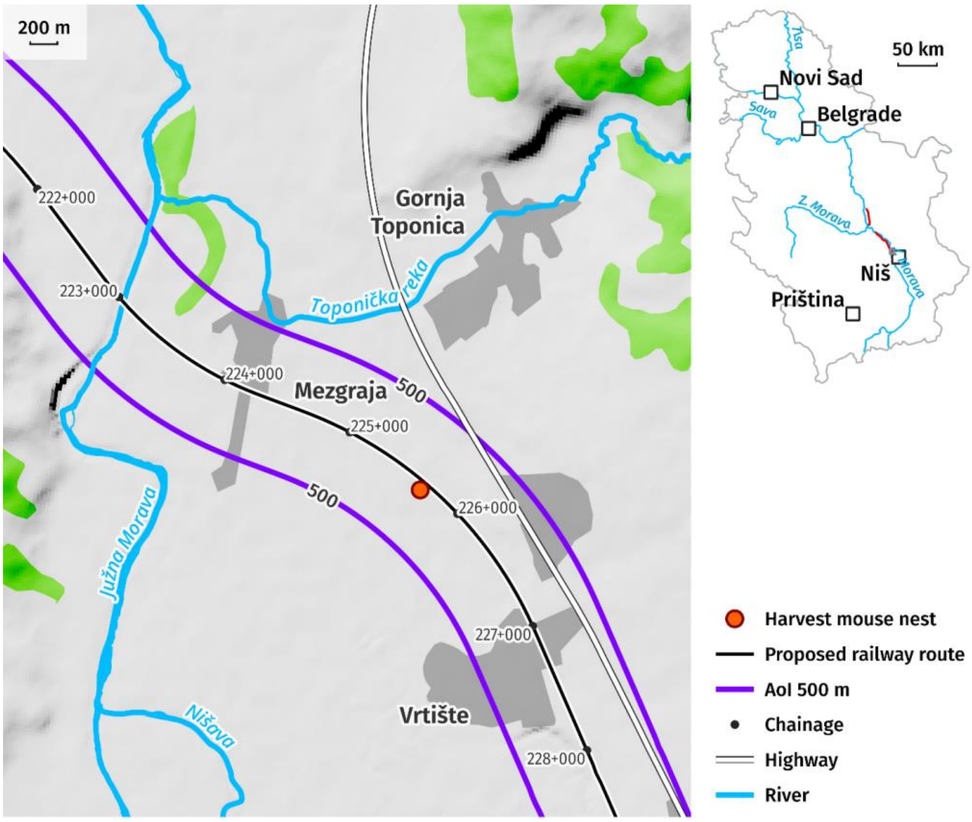


Figure 14-62. Position of nest of Harvest mouse (*Micromys minutus*)

The Harvest Mouse is strictly protected on national level in Serbia. The presence of one steppe species - the Steppe mouse (*Mus spicilegus* syn. *hortulanus*), is also notable (Figure 14-63). Almost the entire known range of this species in Serbia is within the Pannonian and narrow Peripannonian regions, with rare finds in a narrow belt along the Velika Morava and Južna Morava rivers. The species has no particular conservation status in Serbia.

Figure 14-63. Mound of the Steppe mouse *(Mus spicilegus)*

While bats (*Chiroptera*) are very heterogeneous and numerous mammals, not one species was recorded in PAoI during the field survey. Discussion on this is provided under Chapter 14.1.3. Conducting fieldwork.The most recent available data (Paunović, 2016; Paunović *et al.*, 2020) indicates the presence of six species, including within the wider Project area. Most of the bat species inhabit urban and suburban areas.

Data about presence of bat species along the planned railroad are based on newest literature data from the most comprehensive study about bats in Serbia up to now (Paunović et al., 2020). According to the study, within the PAoI, there are scarce records of bat species from urban areas, rather than natural habitats. Records pertain to bat shelters. Valleys of Morava rivers (Great and South) are mostly outside the PAoI.

Four Carnivore species were recorded (*Martes foina, Meles meles, Canis aureus* and *Vulpes vulpes*). Given the general ecological and trophic status of Carnivora, large populations of most of these species have not been recorded along the Project route. However, in recent years, there has been a significant increase in species more adaptable to environmental changes. Such species are the Red fox (*Vulpes vulpes*), the European badger (*Meles meles*), and especially the Golden jackal (*Canis aureus*).

In addition to the four carnivore species recorded through field surveys, based on literature and other sources (Information System of Institute of Nature Conservation of Serbia), other species like the Grey wolf – *Canis lupus* and Marbled polecat – *Vormela peregusna* have been recorded. The presence of the Grey wolf is occasional, while the records of Marbled polecat date from 1995. and 1997.

Figure 14-64. Badger (*Meles meles*) trace in the mud

Figure 14-65. Golden jackal (*Canis aureus*) footprint

Even-toed ungulates (*Artiodactyla*) are represented by species that are characteristic of nearly the entire territory of Serbia (Roe deer-*Capreolus capreolus* and Wild boar-*Sus scrofa*). These species have relatively broad ecological niches in terms of habitat selection and food preferences, which is why they are also present in the wider area of the railway route.

The mammal species of 'conservation concern' that were recorded within the PAoI (Table 14-16) were selected based on their inclusion in Annex II and IV of the Habitats Directive, Annex II and Resolution 6 of the Bern Convention and/or their conservation status according to IUCN.

Table 14-16. List of mammal species of conservation concern

Species	Conservation status	Description
Canis lupus	Annex II and IV of Habitats Directive, Annex II and Resolution 6 of Bern Convention, IUCN Global LC, IUCN Serbia NT	This is a protected species in Serbia (strictly protected species on the territory of Vojvodina Autonomous Province). Grey wolf is on Annex II and IV of the HD with fairly wide areal on the territory of Serbia. Grey wolf is a regular inhabitant of hilly and mountainous forested regions of Serbia. Based on data collected from hunters and literature data, appearance of wolves is occasional and sporadic, mostly in the vicinity of Drenovac village. These specimens most probably originated from the forested area of Mt. Mali Jastrebac
Vormela peregusna	Annex II and IV of the Habitats Directive, Annex II and Resolution 6 of Bern Convention, IUCN Global VU, IUCN Serbia VU	This is strictly protected species in Serbia. Today's species native range in Serbia is not well known and researched enough. The findings so far mainly come from mountain-steppe and forest-steppe areas in Eastern, Southeastern and Southwestern Serbia. Data from the railroad and surrounding corridor originated from the late nineties, with no new data or even indices, so the species will not be discussed in the study.
Lutra lutra	Annex II, IV of the Habitats Directive, Annex II Res. 6 of Bern Convention, IUCN Global NT, IUCN Serbia LC	This is a strictly protected species in Serbia and is fairly widespread on the territory of Serbia. Mainly inhabits the banks of larger and smaller waterflows, canals, ponds and swamps. It could be found along the Južna Morava River, but out of project Area of influence. This species is trigger for pSCI Južna Velika Morava, located within the northernmost part of the railway, but does not overlap with the project AoI. This species will be excluded from the further study, it is not recorded in data base of the Institute for Nature Conservation neither during field survey..
Myotis bechsteinii	Annex II and IV of the Habitats Directive, Annex II and Resolution 6 of Bern Convention, Appendix II of Bonn Convention, IUCN Global NT, IUCN Serbia NT	This is strictly protected species in Serbia. A species inhabits old deciduous forests, with a large percentage of old trees, both in the lowlands and in the highlands. Maternity colonies mostly inhabit cavities, while individual specimens are mostly found in cracks in the tree, caves and artificial ones underground shelters (old fortresses). In Serbia, swarming and hibernation, they have been recorded in natural and artificial underground shelters, such as caves, mines and fortress lagoons. The record from the Section 3 originated from urban area (city of Paraćin). The presence of species is based on literature data.
Myotis mystacinus	Annex IV of the Habitats Directive, Annex II of Bern Convention, Appendix II of Bonn Convention,IUCN Global LC, IUCN Serbia LC	This is strictly protected species in Serbia. This species is present in all habitats with forest elements vegetation, including orchards and other suitable rural habitats. Hunting territories represent the outer and inner edges of broad-leaved deciduous forests along smaller watercourses and others water surface. Summer shelters are probably in tree hollows, winter shelters in trees and caves. Record of species is based on literature data.
Nyctalus noctula	Annex IV of the Habitats Directive, Annex II of Bern	This is strictly protected species in Serbia. This species occurs mostly in hardwood forests though it can now often be spotted in urban areas if enough prey and water is available. For summer roosts *N. noctula* favours

Species	Conservation status	Description
	Convention, Appendix II of Bonn Convention IUCN Global LC IUCN Serbia LC	tree holes (e.g. once woodpeckers make) along the forest edges. In winter, rock crevices in buildings and bridges are often used. The species forages in a wide range of landscapes, although it seems to avoid coniferous forests and prefers riparian forests. The presence of species is based on literature data.
Pipistrellus nathusii	Annex IV of the Habitats Directive, Annex II of Bern Convention, Appendix II of Bonn Convention IUCN Global LC IUCN Serbia LC	This is a strictly protected species in Serbia. The specimen of this forest species are regularly found in forests and woodlands fragments, bushy wet habitats and anthropogenic environment. In the settlements they prefer parks, orchards, tree rows, cemeteries and other areas dominated by trees. In natural habitats, they hunt for prey in the outer and inner forests edges. The primary shelters are tree hollows, but more finds relate to the use of anthropogenic shelters. Presence of species is based on literature data
Plecotus austriacus	Annex IV of the Habitats Directive, Annex II of Bern Convention, Appendix II of Bonn Convention IUCN Global LCIUCN Serbia LC	This is strictly protected species in Serbia and a fairly large European bat. It has distinctive ears, long and with a distinctive fold. This species can be found dwelling in caves, tall tropical flowers, old bird nests, under rocks, or more likely in tunnels and buildings with many crevices, often found in villages where there is an abundance of trees and old buildings. In Serbia usually found in urban areas. It hunts above woodland, often by day, and mostly for moths. It is more likely to forage in anthropogenic habitats, including gardens, parks, orchards, streetlights, and in towns. The presence of species is based on literature data.
Vespertilio murinus	Annex IV of the Habitats Directive, Annex II of Bern Convention, Appendix II of Bonn Convention IUCN Global LCIUCN Serbia LC	This is strictly protected species in Serbia. Shelters are mostly in residential buildings, cracks in the rocks, less often in caves entrances During the winter often found in the settlements, in the summer in gorges, even on high mountains. Mostly, anthropogenic shelters are used in urban areas, where it is usually found which makes Parti-colored bat a highly synanthropic species. Vespertilio murinus is adapted to forage in open space. While females are almost exclusively foraging over large productive water bodies, males seem to show a preference for rivers, as well as other structures such as water bodies, agricultural land and forests. Parti-colored bat has also been observed to forage opportunistically around streetlamps in the vicinity of cities and villages. This is a migratory species. Individuals are reported to migrate seasonally over distances of more than 800 km at the northern edge of the distribution. Yet more typically the species probably undertakes shorter (5–40 km) regional movements between summer and winter roosts. The presence of species is based on literature data.
Miniopterus schreibersii	Annex II, IV of the Habitats Directive IUCN Global VU IUCN Serbia LCAnnex II and Resolution 6 of Bern Convention, Appendix II of Bonn Convention	This is strictly protected species in Serbia. Inhabits mainly karst regions, rivers valleys with caves, hilly grounds and mountains up to 1500 m. Shelters are mostly underground habitats - caves, tunnels of the old fortress; forms colonies. The hunting territories of this species are open and semi-open natural and artificial habitats such as deciduous and mixed forests, orchards and parks, and intense hunting activity was recorded around streetlamps in urban areas. Presence of species is based on literature data

Only one species, the Golden jackal (*Canis aureus*) is listed in Annex V of EU Habitats Directive. However, given the conservation status of this species in Serbia and current population trends, the Golden jackal is not considered a species of conservation concern.

Hunting grounds – Section 3

The Project route passes through the territory of the following four hunting grounds (from the north to south):

- **Crnica** –territory of City of Paraćin–47.278,26 ha;
- **Rasina** –minor part of the territory of City of Kruševac–72.179,69 ha;
- **Krvevac** –part of the municipality of Aleksinac–25.931 ha;
- **Nišava** –territory of City of Niš-59.391,64 ha;

These hunting grounds are managed by local hunting societies, organised at the municipality or city level. In all four hunting grounds the main game species are roe deer (*Capreolus capreolus*), wild boar (*Sus scrofa*), Europaen hare (*Lepus europaeus*), phaesant (*Phasianus colchicus*) and partridge (*Perdix perdix*). Of lesser importance are red fox (*Vulpes vulpes*), golden jackal (*Canis aureus*) and some waterfowl species. The game species are managed under hunting management plans which are updated every 10 years (with adapted annual plans during the 10 years period) and officially approved by the Ministry of Agriculture, Forestry and Water Management. They include, *inter alia*, the assessment of population numbers and density of managed game species, their conservation status, quotas of sustainable yield and measures for protection of species and habitats, according to Law on Natural Protection and Law on Game and Hunting.

According to the Law on Game and Hunting, areas like urban areas and other settlements, airports, highways, railroads, industrial complexes, cemeteries, military facilities. etc. are considered non-managed areas, where there are no conditions for appropriate game management (breeding, protecting and hunting of animals). These areas are excluded from the hunting ground and management process and practice.

Since all four hunting grounds are intersected by both the existing railroad and highway (A1), management practices are adjusted accordingly. Continuous strips of larger or smaller settlements, groups of houses or commercial buildings along the Project route are predominant, and are additionally incorporated into the game management practices. The Project is not expected to have significant implications to the proper management of game.

Invasive aquatic fauna species within the AoI

Three invasive fauna species (two fish and one freshwater snail) were recorded within the PAoI (**Error! Reference source not found.**Table 14-17).

Table 14-17. Invasive fauna species recorded within the AoI (500m + 500m corridor)

Latin name
Carassius gibelio (Bloch, 1782)
Neogobius fluviatilis (Pallas, 1814)
Physa acuta (Draparnaud, 1805)

14.1.5. Protected areas

Protected areas in Serbia

In the Republic of Serbia, protected areas are defined by the Law on Nature Protection (Official Gazette of RS, No. 36/2009, 88/2010, 91/2010 – corrigendum, 14/2016, 95/2018 – state law and 71/2021).

Seven categories of protected areas are recognised: national parks, nature parks, strict nature reserves, special nature reserves, outstanding natural landscapes, monuments of nature, and protected habitats. A total of 473 areas have been protected, which constitutes 8,65% of Serbian territory[29].

These protected areas are important for geological, biological, ecosystem, and/or landscape diversity and values.

Habitats of bird species and other migratory species that are significant according to international regulations can also be designated as protected areas of general interest. The assessment of a protected area is prepared according to the Rulebook on the Criteria for Evaluation and the Procedure of Categorization of Protected Areas (Official Gazette of RS, No. 97/15) and is performed concerning the degree of the expressed main natural features, phenomena, and processes of interest for the protection of the area, as well as to the functions and purposes of the area.

Accordingly, protected areas fall into 3 categories: areas of exceptional (international, national), major (provincial/regional), and local importance.

Emerald Network in Serbia

Serbia ratified the Bern Convention on April 27, 1992. The Emerald Network is part of the Bern Convention and it is made up of Areas of Special Conservation Interest (ASCIs).

Serbia has set up the Emerald Network with the identification of 61 sites based on the lists of strictly protected species of flora (Appendix I) and fauna (Appendix II) and the list of protected species of fauna (Appendix III) that are part of the Bern Convention and require legislative and administrative measures to ensure their conservation. In addition, the use of certain agents and methods of killing, capturing and other forms of exploitation of mammals, birds and freshwater fish is prohibited (Appendix IV).

The total area of the potential Emerald network in Serbia is 1,019,269.31 ha, i.e. 11.54% of the territory of Serbia.

No parts of the Emerald network fall within the PAoI.

[29]Source: zzps.rs (Institute for Nature Conservation of the Republic of Serbia)

Proposed Natura2000 sites in Serbia

Serbia is a potential candidate for EU membership and therefore is aiming to establish Natura2000 sites in preparation for EU accession. Through the Ministry of Environmental Protection and the Institutes for Nature Conservation of Serbia and Vojvodina, Serbia has been working on the identification and designation of the Natura2000 network for several years.

The implemented project “EU for Natura2000 in Serbia”, has provided an initial list of potential Natura2000 sites (SPAs and SCIs) (2019-2021.). This list of sites is based on the Birds and Habitats Directives criteria; agreed with experts responsible for their implementation in the Republic of Serbia.

The boundaries of potential Natura2000 sites are delineated roughly according to the distribution of species and habitat types. Their exact boundaries will be confirmed later according to the cadastral parcels.

Currently, all national and nature parks overlap with the proposed Natura2000 sites; however not all of the remaining protected areas fulfil the criteria for the designation of Natura2000 sites. Several new sites have also been proposed as Natura2000 sites that do not overlap with any recognised protected areas.

One proposed Natura 2000 site is crossed by the existing railway and is within the AoI: pSPA (IBA) Dobrič-Nišava. It is crossed at 220+315 km (Figure 14-66).

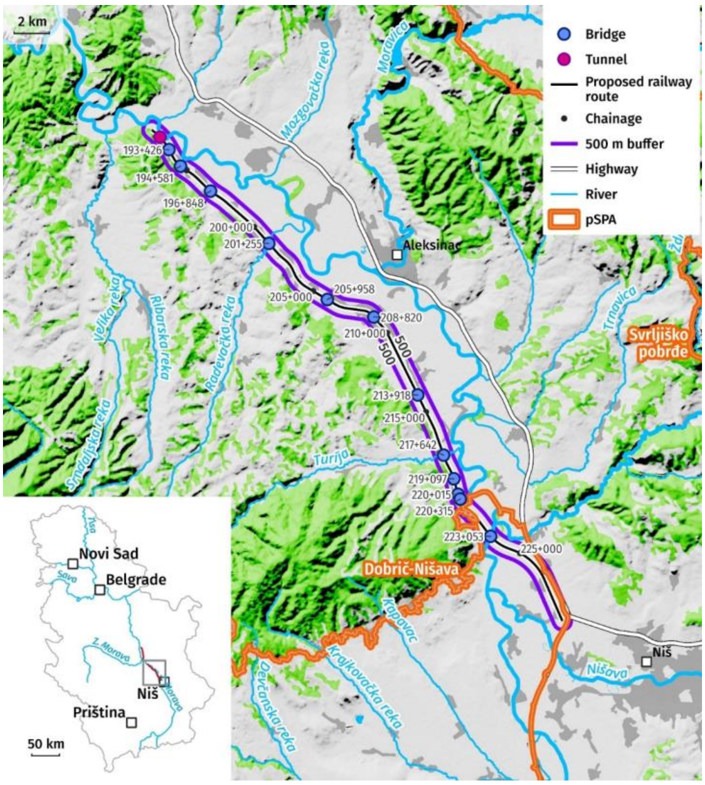


Figure 14-66. pSPA Dobrič-Nišava

However, within a wider area of up to 10 km from the Project, the following Natura2000 sites are present (Table 14-18):

Table 14-18. Natura2000 sites in wider area of Section 3

Name of protected area	Natura2000 category	Distance from the railway corridor (km)	The reason for protection
Dobrić-Nišava	pSPA (IBA)	crossed	internationally important for bird conservation
Gornje Pomoravlje	pSPA (IBA)	1.14	internationally important for bird conservation
Južna Velika Morava	pSCI	0.49	„Top location" for seven animal species
Južna Morava	pSCI	3.65	„Top location" for two animal species
Niš	pSCI	2.63	„Top location" for two animal species
Lalinačka Slatina	pSCI	5.01	„Top location" for one habitat type
Obla glava	pSCI	3.84	„Top location" for one habitat type
Poslonske planine	pSCI	1.39	„Top location" for one habitat type

Proposed Special Protection Areas (pSPA) and Important Bird Areas (IBAs)

Two Proposed Special Protection Areas (pSPA) and Important Bird Areas (IBAs) are located within the PAoI: "Dobrić-Nišava" and "Gornje Pomoravlje" (Figure 14-67 and Figure 14-69).

pSPA Dobrić-Nišava 35389 ha / IBA RS048

This IBA is situated in Central Serbia between Mt. Mali Jastrebac to the north, Mt. Vidojevica to the south and City of Niš to the east (Table 14-20). This mostly agricultural, flat area is interspaced with hills, villages, rivers, creeks, gravel pits and one lake (Oblačinsko jezero). Inside the IBA borders there are more than 40 villages belonging to six municipalities (Niš, Aleksinac, Merošina, Prokuplje, Žitorađa and Doljevac). Most of the existing habitats within the IBA (92%) are artificial and terrestrial, covered with perennial crops, orchards and groves.

The site was identified as internationally important for bird conservation in 2019 because it regularly supports significant populations of the species listed below (Table 14-19).

Table 14-19. Population of IBA trigger species – "Dobrić-Nišava"

Species	Current IUCN Red List Category	Season	Year(s) of estimate	Population estimate	IBA Criteria Triggered
Grey Partridge *Perdix perdix*	LC	Resident	2016-2019.	1,000–1,500 breeding pairs	B1b
Black-headed Bunting *Emberiza melanocephala*	LC	Breeding	2016-2019.	700–1,000 breeding pairs	B2a

pSPA and IBA "Dobrić-Nišava", as part of the ecological network, has been designated based on the presence of 50 Natura2000 bird species, along with 112 other bird species. pSPAs are areas designated according to the criteria given in the EU Birds Directive and are selected to protect one or more rare, threatened, or vulnerable bird species. Similar principles are used in the designation of IBAs

The pSPA/IBA "Dobrić-Nišava" is located on the southernmost part of the Project, from 220+315 km to the end of Section 3 (Figure 14-67 and Figure 14-68).

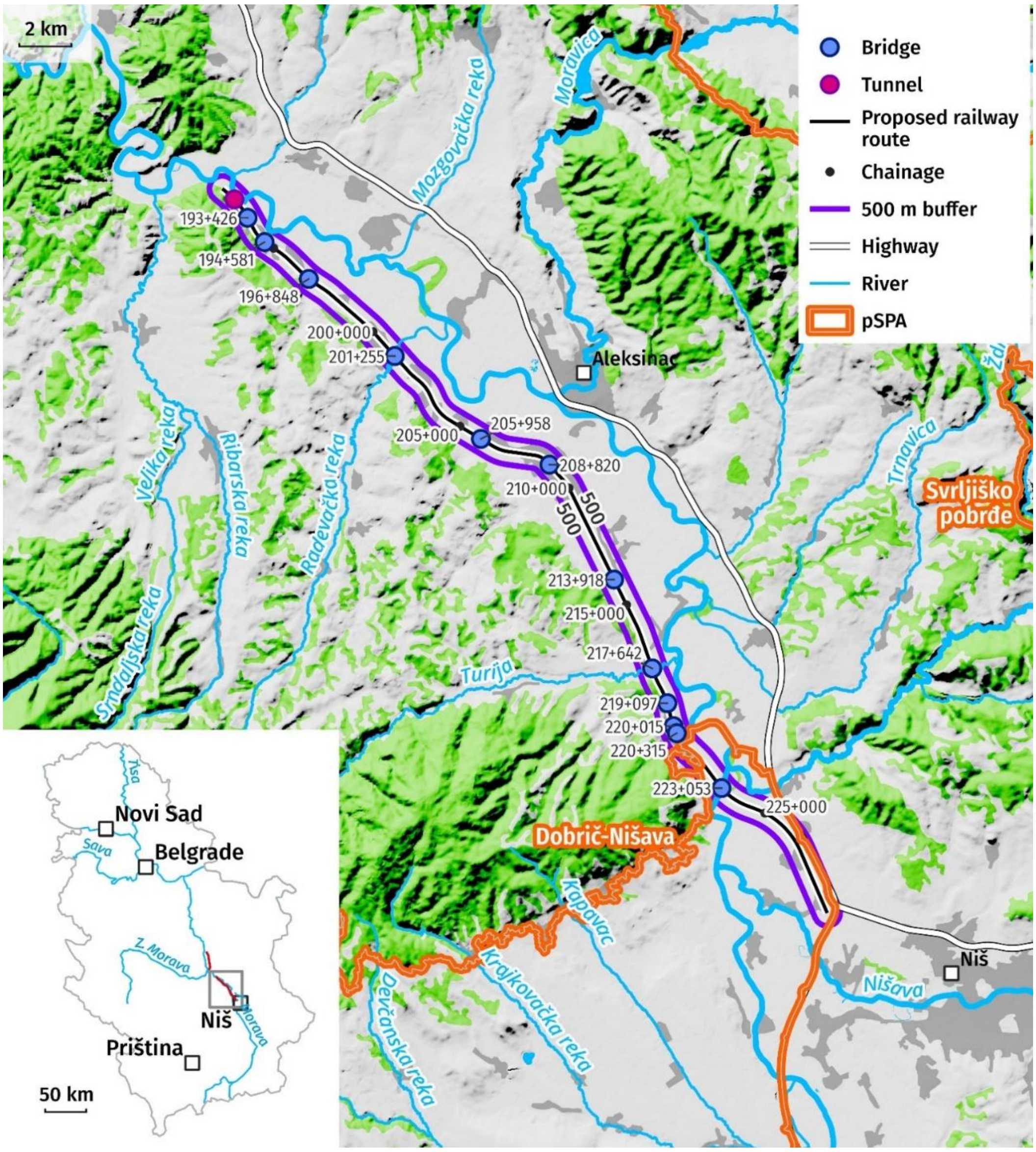


Figure 14-67. pSPA "Dobrić-Nišava" in 500 m AoI

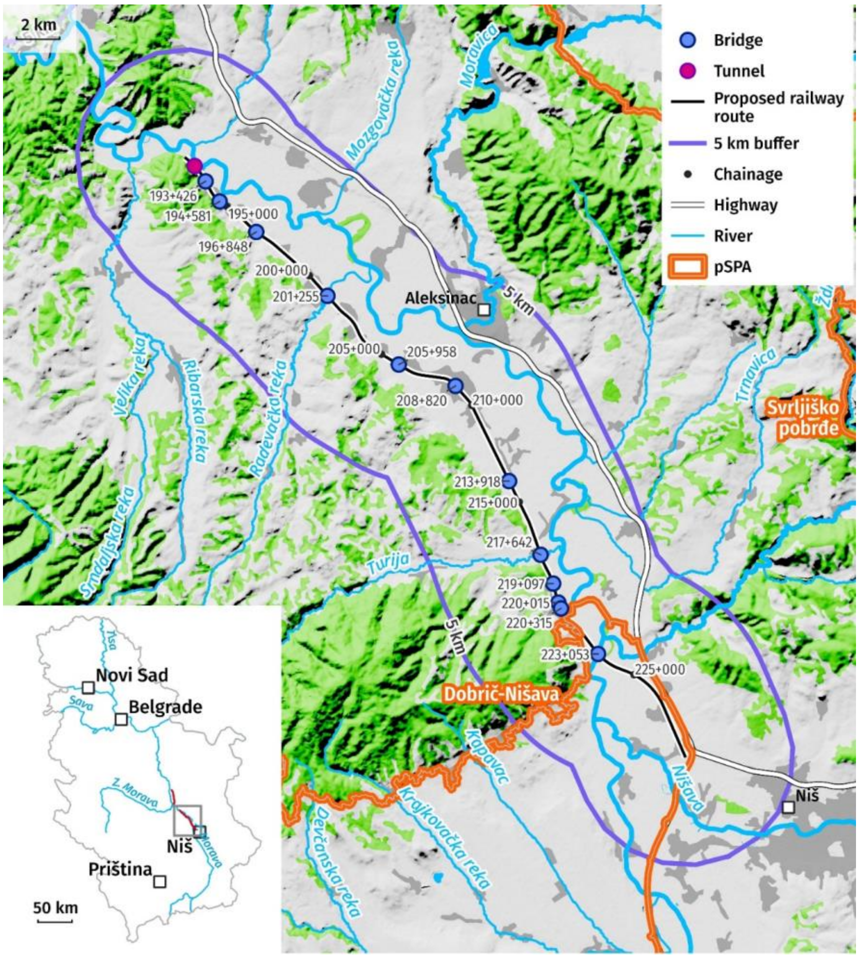


Figure 14-68. pSPA “Dobrić-Nišava” in 5km wider project area

Table 14-20. Occurrence of 50 Natura 2000 Annex Bird Species in pSPA “Dobrić-Nišava” from 2000 till 2021

Taxon Valid Name	Bird Directive	IUCN 2020
Accipiter brevipes	Annex I	LC
Acrocephalus melanopogon	Annex I	LC
Alcedo atthis	Annex I	LC
Anas acuta	Annex IIA, Annex IIIB	LC
Anthus campestris	Annex I	LC
Ardea alba	Annex I	LC
Ardea purpurea	Annex I	LC
Ardeola ralloides	Annex I	LC
Asio flammeus	Annex I	LC
Aythya ferina	Annex IIA, Annex IIIB	VU
Aythya nyroca	Annex I	NT

Taxon Valid Name	Bird Directive	IUCN 2020
Botaurus stellaris	Annex I	LC
Bucephala clangula	Annex IIB	LC
Ciconia ciconia	Annex I	LC
Ciconia nigra	Annex I	LC
Circaetus gallicus	Annex I	LC
Circus aeruginosus	Annex I	LC
Circus cyaneus	Annex I	LC
Circus pygargus	Annex I	LC
Coracias garrulus	Annex I	LC
Coturnix coturnix	Annex IIB	LC
Crex crex	Annex I	LC
Egretta garzetta	Annex I	LC
Emberiza hortulana	Annex I	LC
Falco peregrinus	Annex I	LC
Falco vespertinus	Annex I	NT
Ficedula albicollis	Annex I	LC
Gallinago gallinago	Annex IIA, Annex IIIB	LC
Himantopus himantopus	Annex I	LC
Chlidonias hybrida	Annex I	LC
Ixobrychus minutus	Annex I	LC
Lanius collurio	Annex I	LC
Lanius minor	Annex I	LC
Lullula arborea	Annex I	LC
Mareca penelope	Annex IIA. Annex IIIB	LC
Mareca strepera	Annex IIA	LC
Mergus merganser	Annex IIB	LC
Microcarbo pygmaeus	Annex I	LC
Nycticorax nycticorax	Annex I	LC
Pandion haliaetus	Annex I	LC
Pernis apivorus	Annex I	LC
Rallus aquaticus	Annex IIB	LC
Recurvirostra avosetta	Annex I	LC
Spatula clypeata	Annex IIA, Annex IIIB	LC
Spatula querquedula	Annex IIA	LC
Sterna hirundo	Annex I	LC
Streptopelia turtur	Annex IIB	VU
Sylvia nisoria	Annex I	LC
Turdus pilaris	Annex IIB	LC
Vanellus vanellus	Annex IIB	NT

pSPA Gornje Pomoravlje 5920 ha / IBA_RS044 (pSPA covers the entire IBA and addition area enlarged in the north)

The Gornje Pomoravlje IBA is located in an alluvial area in Central Serbia, in the valley of the Velika Morava River. The habitats of this area include remnants of *Salix sp., Populus sp., Alnus sp., Fraxinus sp.,* and *Quercus sp.* forests. It is more than 40 km far from Ćićevac and Stalać in the south to Krušar and Ribare in the north. The area is comprised of several smaller units: Vidovački ključ, Čepursko, Moravište, the mouth of Crnica river and Supski rukavac. Table 14-21 lists the IBA trigger species.

Approximately 125 bird species have been recorded in the IBA area so far, while the total number is about 150. Of that number, 85 species are nesting species. In addition to being important for nesting birds, it is also important as a migration corridor along the north-south direction. Three main species "triggering" the IBA criteria are: Common Tern *Sterna hirundo*, Common Kingfisher *Alcedo atthis,* and Collared Sand Martin *Riparia riparia.* Most of the recorded species inhabit habitats in a narrow strip along the Velika Morava River.

According to Key Biodiversity Areas Partnership (2024) - *Key Biodiversity Areas factsheet: Gornje Pomoravlje*, the area is also recognised as a KBA, with two "trigger species" (*Alcedo atthis* and *Riparia riparia*).

Table 14-21. Population of IBA/KBA trigger species – Gornje Pomoravlje

Species	Current IUCN Red List Category	Season	Year(s) of estimate	Population estimate	IBA Criteria Triggered
Common Tern *Sterna hirundo*	LC	breeding	2016.-2019.	max 20 breeding pairs	C6
Common Kingfisher *Alcedo atthis*	LC	Resident	2010.-2019.	20-40 breeding pairs	B1b, C6
Collared Sand Martin *Riparia riparia*	LC	breeding	2017.-2019.	1,500-2,500 breeding pairs	B1b

pSPA is recognised as ecologically important area, according to Regulation about the ecological network ("Official Gazette of RS", No. 102/2010).

Gornje Pomoravlje pSPA is designated based on the presence of 40 Natura2000 bird species (

Table 14-22), along with 97 other bird species.

Table 14-22. Occurrence of 40 Natura 2000 Annex Bird Species in pSPA from 2000 till 2021

Taxon Valid Name	Bird Directive	IUCN 2020
Alcedo atthis	Annex I	LC

Taxon Valid Name	Bird Directive	IUCN 2020
Anas acuta	Annex IIA, Annex IIIB	LC
Ardea alba	Annex I	LC
Ardea purpurea	Annex I	LC
Ardeola ralloides	Annex I	LC
Aythya ferina	Annex IIA, Annex IIIB	VU
Aythya fuligula	Annex IIA, Annex IIIB	LC
Aythya marila	Annex IIB, Annex IIIB	LC
Aythya nyroca	Annex I	NT
Ciconia ciconia	Annex I	LC
Ciconia nigra	Annex I	LC
Circus aeruginosus	Annex I	LC
Circus cyaneus	Annex I	LC
Coturnix coturnix	Annex IIB	LC
Dryocopus martius	Annex I	LC
Egretta garzetta	Annex I	LC
Emberiza hortulana	Annex I	LC
Falco vespertinus	Annex I	NT
Ficedula albicollis	Annex I	LC
Gallinago gallinago	Annex IIA, Annex IIIB	LC
Haliaeetus albicilla	Annex I	LC
Himantopus himantopus	Annex I	LC
Chlidonias hybrida	Annex I	LC
Ixobrychus minutus	Annex I	LC
Lanius collurio	Annex I	LC
Lanius minor	Annex I	LC
Mareca penelope	Annex IIA. Annex IIIB	LC
Mergellus albellus	Annex I	LC
Microcarbo pygmaeus	Annex I	LC
Nycticorax nycticorax	Annex I	LC
Pandion haliaetus	Annex I	LC
Picus canus	Annex I	LC
Rallus aquaticus	Annex IIB	LC
Spatula clypeata	Annex IIA, Annex IIIB	LC
Spatula querquedula	Annex IIA	LC
Sterna hirundo	Annex I	LC
Streptopelia turtur	Annex IIB	VU
Tringa totanus	Annex IIB	LC
Turdus pilaris	Annex IIB	LC
Vanellus vanellus	Annex IIB	NT

As illustrated in Figure 14-69 and Figure 14-70, the Project does not intersect the Gornje Pomoravlje pSPA and IBA at any point. It is completely outside of the PAoI.

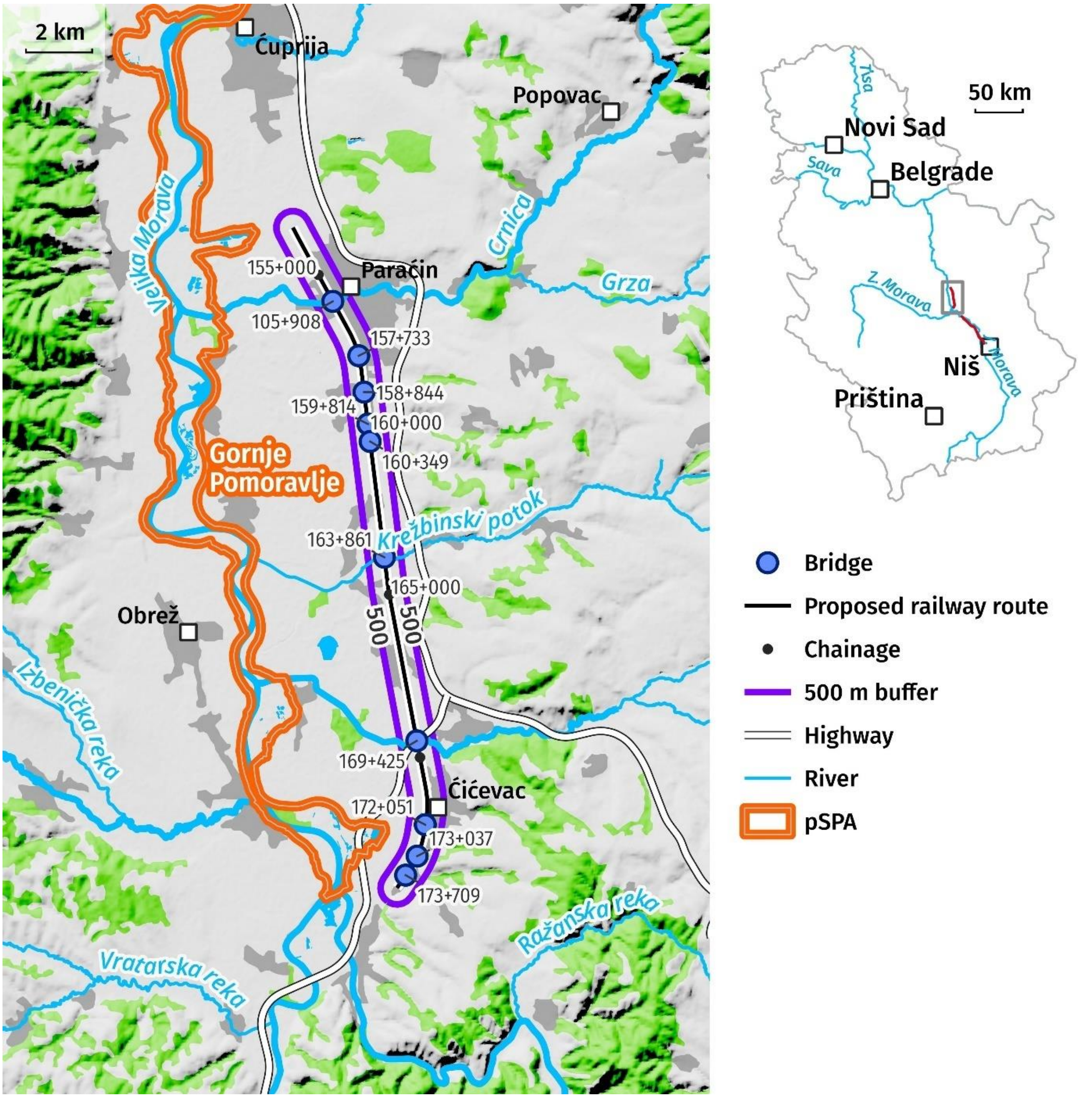


Figure 14-69. pSPA “Gornje Pomoravlje” in 500 m AoI

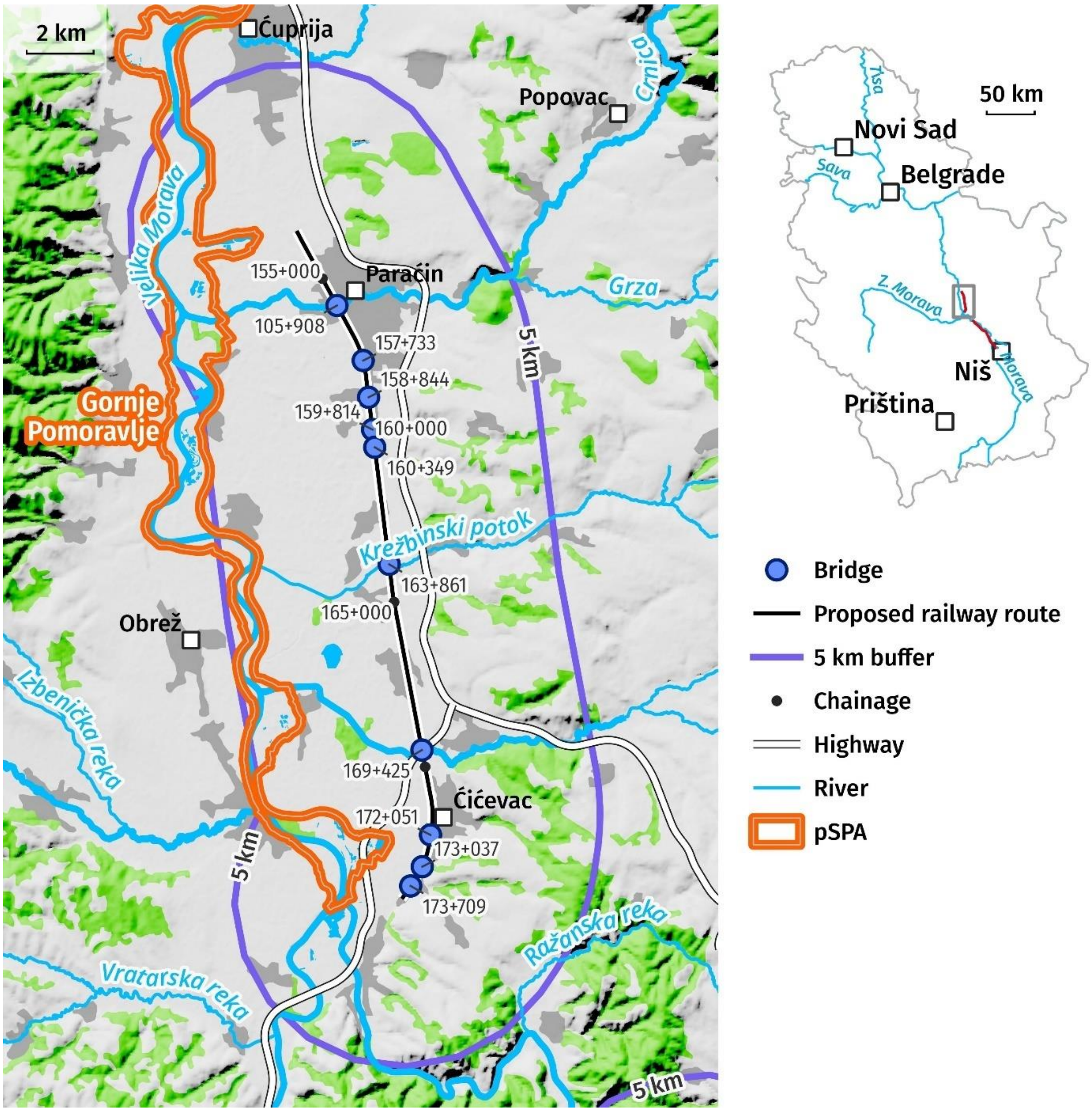


Figure 14-70. pSPA “Gornje Pomoravlje in 5 km wider project area

Ecological network (Ecologically important areas)

The **Južna Velika Morava pSCI** covers an area of 12,745 ha. It is selected as a ‘Top location’ for seven species: *Lutra lutra, Lycaena dispar, Nyctalus noctula, Pipistrellus nathusii, Plecotus austriacus, Theodoxus transversalis, Unio crassus.* The Južna Velika Morava pSCI is located within the northernmost part of the railwayand falls within the 5 km wider Project area, but does not overlap with the PAoI.

The **Južna Morava pSCI** is 3,847 ha in area and has been selected as a ‘Top location’ for two species: Unio crassus and Zerynthia polyxena and three habitats within the complex of Broadleaf xerophilic forests – xerophilic oak forests: 91M0, 91W0, 91Y0. Only the northernmost, peripheral parts of the pSCI fall within the 5 km wider project area, with no expected impacts.

The **Niš pSCI** is 4,315 ha in area and has been selected as a 'Top location' for two species: *Eriogaster catax* and *Pipistrellus kuhlii*. Only the westernmost, peripheral parts of the pSCI fall within the 5 km wider project area, with no expected impacts.

The **Lalinačka slatina pSCI** is 4,315 ha in area and has been selected as a 'Top location' for one habitat type: 1340 - Inland salt meadows. This pSCI is situated 5,15 km in wider project area, with no expected impacts.

The **Obla glava pSCI** is 785 ha in area and has been selected as a 'Top location' for one habitat type: 91M0 - Broad-leaved xerophilous forests; Xerophilous oak forests. Only the westernmost part of the pSCI enters the eastern part of the PAoI, in the area of Aleksinac city. No particular impacts are expected.

The **Poslonske planine pSCI** is 2,165 ha in area and has been selected as a 'Top location' for one habitat type: 91M0 - Broad-leaved xerophilous forests; Xerophilous oak forests. The pSCI peripherally enters the northernmost part of the 5 km wider project area, together with part of the Juzna Velika Morava pSCI, without overlapping with PAoI and with no expected impacts.

The locations of all pSCIs are shown in Figure 14-71, Figure 14-72, Figure 14-73, Figure 14-74.

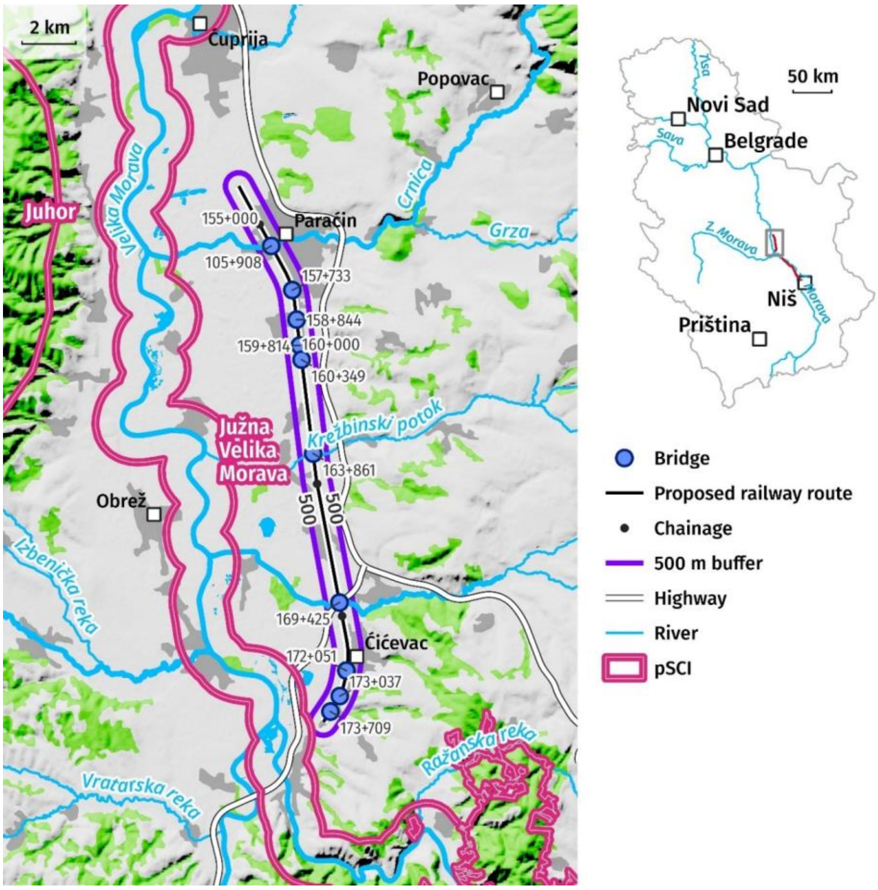


Figure 14-71. pSCI Južna Velika Morava within 500 m AoI (Paraćin - Stalać)

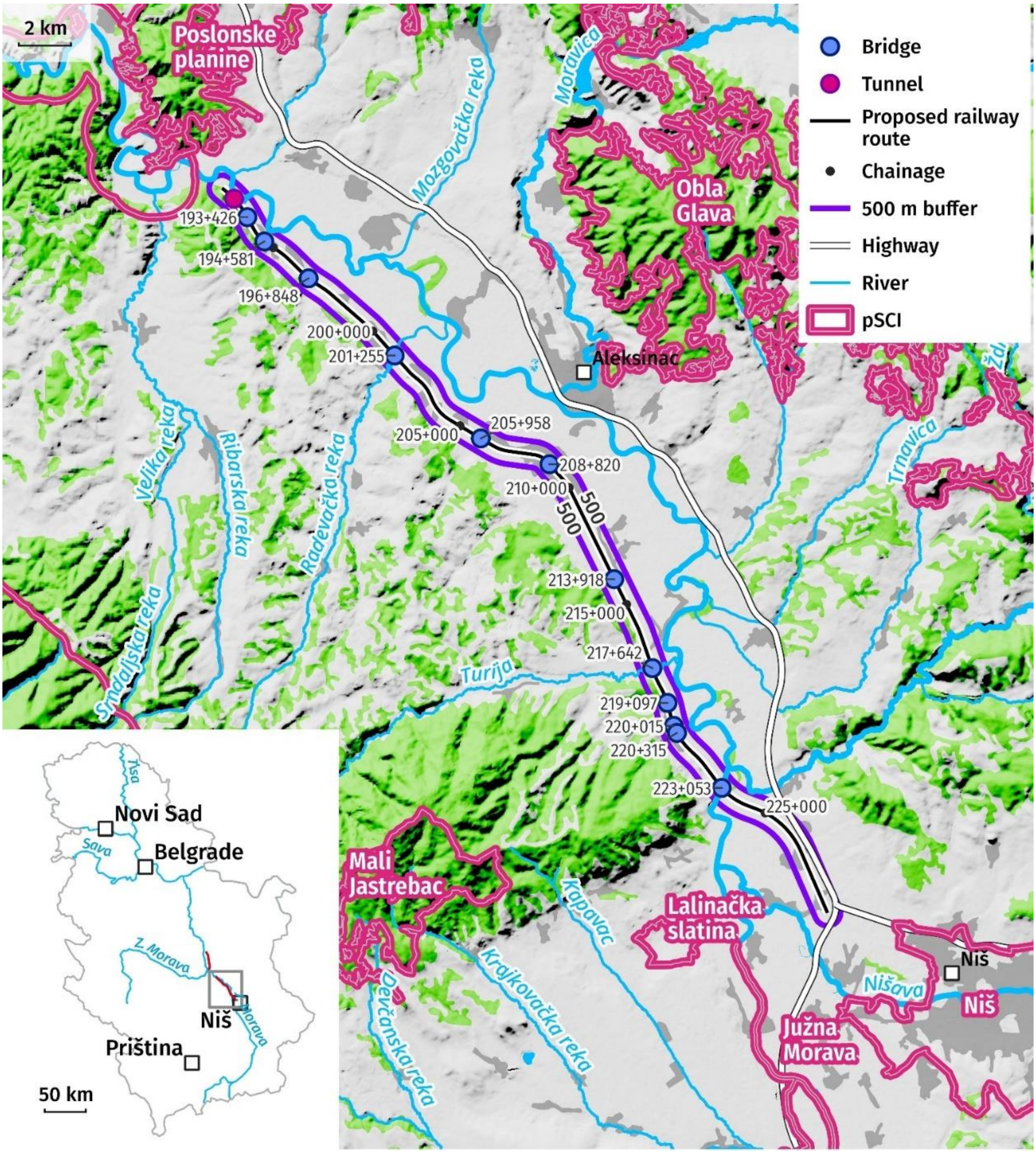


Figure 14-72. pSCI Južna Velika Morava within the 500 m AoI (Đunis - Trupale)

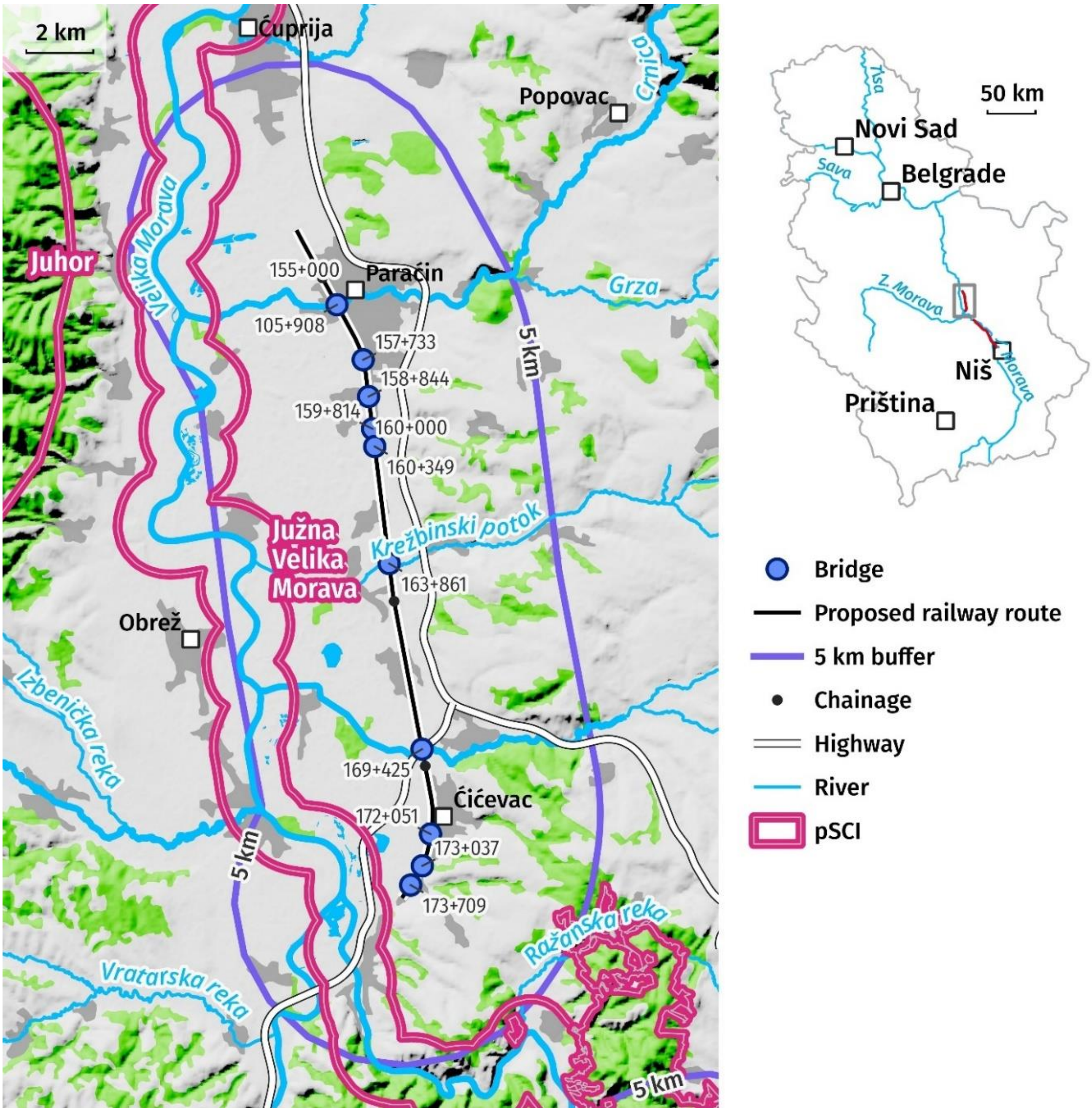


Figure 14-73. pSCIs within the 5 km wider project area Paraćin Stalać

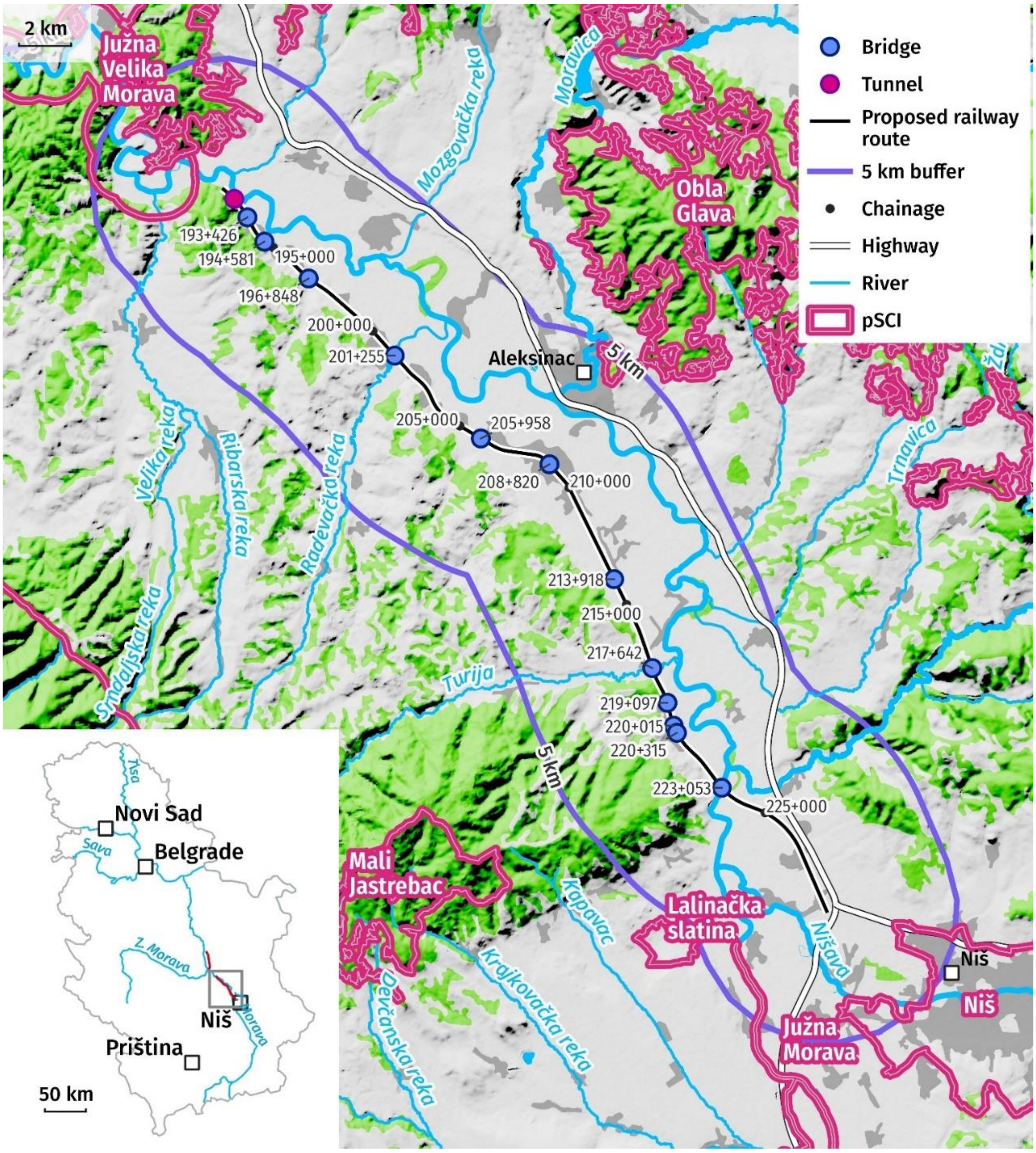


Figure 14-74. pSCIs within the 5 km wider project area Đunis-Trupale

Analysis of the protected areas within the Project corridor

The protected areas listed in Table 14-23 and shown on Figure 14-75 and Figure 14-76 are present in the wider Project area (up to 5 km), but not one is located within the PAoI. All recorded protected areas are located in southern part of the Section 3 (Đunis-Trupale).

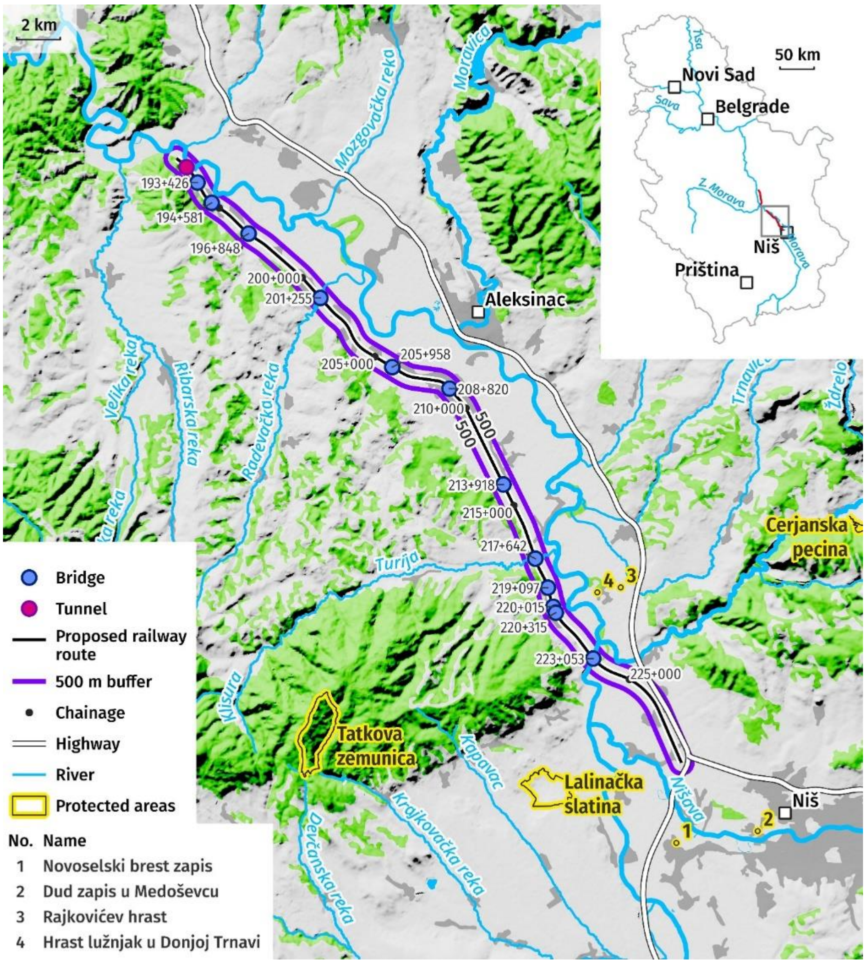


Figure 14-75. Protected areas within Project AoI

Table 14-23. Protected areas within the railway corridor Section III

Name of protected area	National Category	IUCN category	Distance from the railway corridor (km)	The reason for protection
Novoselski brest zapis	Natural monument	III	3.70	Represents a capital specimen, both in terms of age and dimensions. One of the oldest trees and at the same time a „holy tree" in folk tradition
Dud zapis u Medosevcu	Natural monument	III	4.70	Represents a capital specimen, both in terms of age and dimensions
Rajkovicev hrast	Natural monument	III	3.04	Represents a capital specimen, both in terms of age and dimensions and in terms of decoration
Hrast luznjak u Donjoj Trnavi	Natural monument	III	2.12	Represents a capital specimen, both in terms of age and dimensions
Lalinačka slatina	Natural monument	III	5.01	Protection and preservation its basic natural values, which are primarily wetlands and marshland, specific flora and fauna.

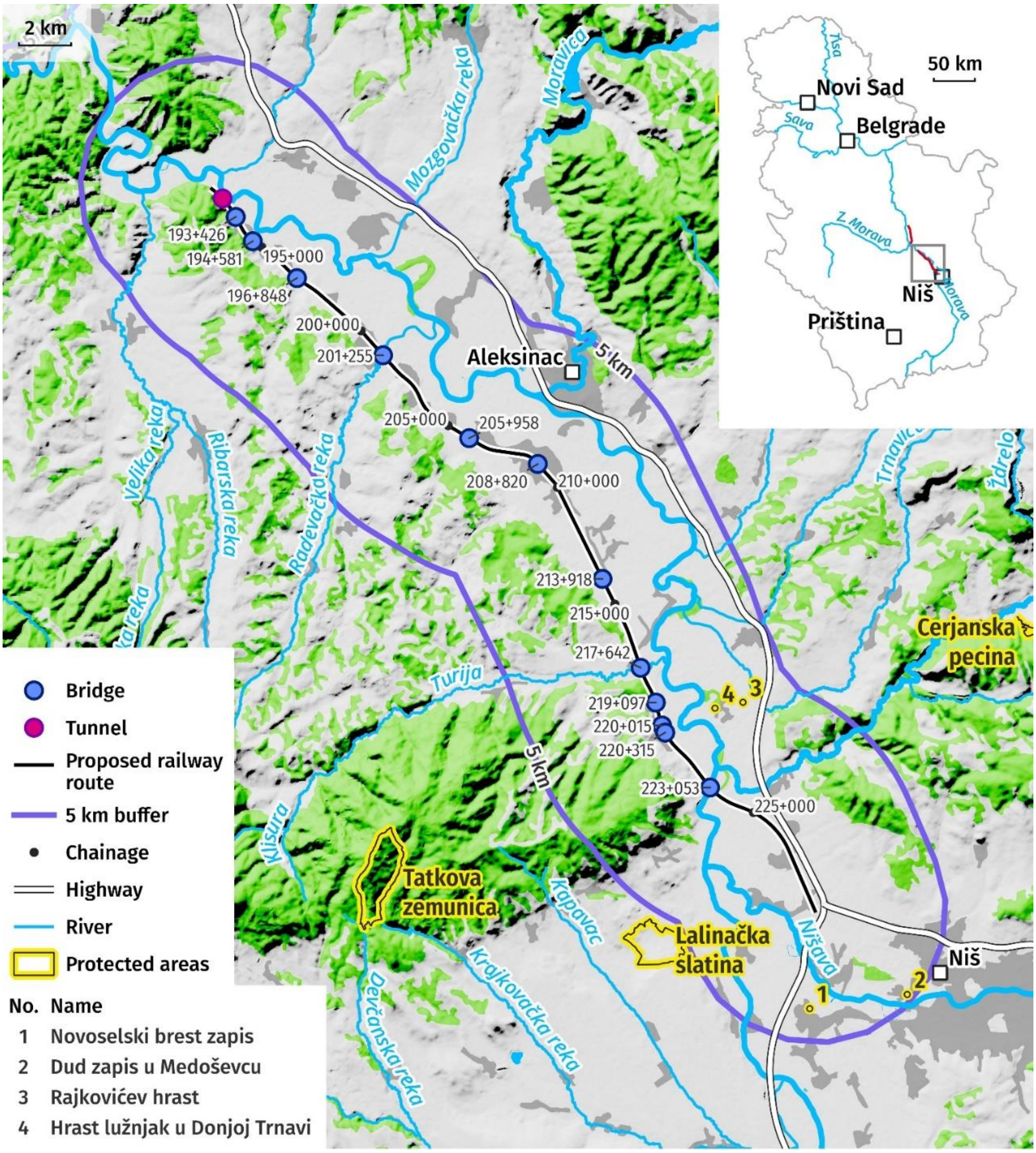


Figure 14-76. Protected areas within 5 km wider project area

14.1.6. Priority biodiversity features and critical habitats

The Scoping process revealed that some habitats and species within the PAoI are potential candidates for priority biodiversity features (PBF) and critical habitat (CH) in line with the EBRD (Table 14-24) and EIB criteria (Table 14-25) while further assessment was supported by results of field surveys.

During the ESIA preparatory stage, a consultation was held with relevant stakeholders, including local activists and inhabitants. The route of railway has been shared with interested parties, and they have been consulted with regard to current state of biodiversity in the area.

The methodology used for determining PBFs and CHs is in accordance with the EBRD Guidance note 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources (v. March, 2023) and follows the logical flow illustrated in Figure 14-77 below.

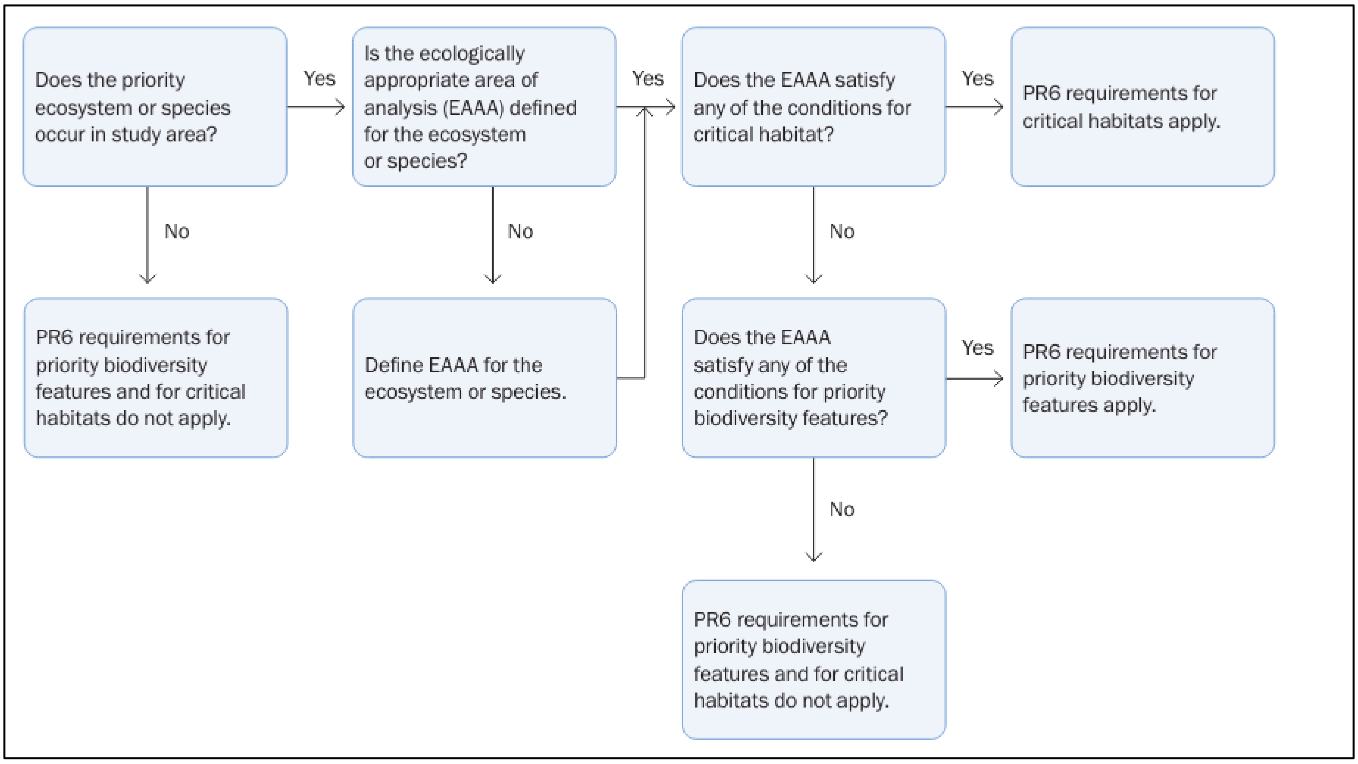


Figure 14-77. Logical flow of critical habitat assessment[30]

The criteria and conditions for identifying PBFs and CHs according to EBRD PR6 are presented in Table 14-24:

[30] *EBRD Guidance note 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources (v. March, 2023)*

Table 14-24. Criteria and conditions for identifying Priority Biodiversity Features and Critical Habitats (EBRD PR6)

	Priority Biodiversity Feature	Critical Habitat
	1. Priority Ecosystems	
Threatened ecosystems a) Habitats listed in Annex 1 of EU Habitats Directive (EU members only) or Resolution 4 of Bern Convention (signatory nations only) b) IUCN Red-List EN or CR ecosystems	(PR6 para. 12-i) EAAA is habitat type listed in Annex 1 of EU Habitats Directive or Resolution 4 of Bern Convention EAAA < 5% of the global extent of an ecosystem type with IUCN status of CR or EN	(PR6 para. 14-i) EAAA is habitat type listed in Annex 1 of EU Habitats Directive marked as "priority habitat type" EAAA ≥5% of global extent of an ecosystem type with IUCN status of CR or EN EAAA is ecosystem determined to be of high priority for conservation by national systematic conservation planning
	2. Priority Species	
Threatened species a) Species and their habitats listed in EU Habitats Directive and Birds Directive (EU members only) or Bern Convention (signatory nations only) b) IUCN Red List EN or CR species c) IUCN Red List, or nationally/regionally VU species d) Nationally or regionally (e.g., Europe) listed EN or CR species	(PR6 para. 12-ii) a) EAAA for species and their habitats listed in Annex II of Habitats Directive, Annex I of Birds Directive, or Resolution 6 of Bern Convention b) EAAA supports < 0.5% of global population OR < 5 reproductive units of a CR or EN species. c) EAAA supports VU species d) EAAA for regularly occurring nationally or regionally listed EN or CR species	(PR6 para. 14-ii) a) EAAA for species and their habitats listed in Annex IV of the Habitats Directive (See EU restrictions) b) EAAA supports ≥ 0.5% of the global population AND ≥ 5 reproductive units of a CR or EN species c) EAAA supports globally significant population of VU species necessary to prevent a change of IUCN Red List status to EN or CR, and satisfies threshold d) EAAA for important concentrations of a nationally or regionally listed EN or CR species
Range-restricted species	(PR6 para. 12-ii) a) EAAA for regularly occurring range-restricted species	(PR6 para. 14-iii) (a) EAAA regularly holds ≥ 10% of global population AND ≥ 10 reproductive units of the species***
Migratory and congregatory species	(PR6 para. 12-ii) (a) EAAA identified per Birds Directive or recognised national or international process as important for migratory birds (esp. wetlands)	(PR6 para. 14-iv) (a) EAAA sustains, on a cyclical or otherwise regular basis, ≥ 1 percent of the global population at any point of the species' lifecycle (b) EAAA predictably supports ≥10 percent of global population during periods of environmental stress

The criteria and conditions for Identifying CH according to EIB (2022) Standard are shown in Table 14-25. The EIB's standards only have the designation for CHs, not PBFs.

Table 14-25. Criteria and Conditions for Identifying Critical Habitats according to ESS 4

Criterion	Critical Habitat (CH)
Criterion 1: Highly threatened or unique ecosystem	a) Priority Habitats listed in Annex I of the Habitats Directive and habitats considered to be their equivalent in countries outside the EU; b) ≥5% of the global extent of an ecosystem type meeting the criteria for IUCN's Red List of Ecosystems with a status of critically endangered or endangered; c) Examples of ecosystems outside the EU and not yet assessed by IUCN, but determined to be of high priority for conservation on the basis of regional or national-level systematic conservation planning or informed specialist input
Criterion 2: Critically endangered, endangered or vulnerable species	a) A population of an IUCN Red-listed endangered or critically endangered species that is ≥ 0.5% of the global population and/or ≥ 5 established reproductive units of an endangered or critically endangered species; b) Significant concentration of an IUCN Red-listed vulnerable species or of multiple IUCN Red-listed vulnerable species, especially where the loss of the area would result in the change of the IUCN Red List status to endangered or critically endangered; c) Nationally or regionally-important concentration of a species listed as endangered or critically endangered on a regional/national IUCN Red List, or equivalent on national/regional listing. d) A population of species listed in Annex II and IV of the Habitats Directive.
Criterion 3: Endemic or restricted-range species	a) They regularly hold ≥10% of the global population size and support ≥10 reproductive units of an endemic or restricted-range species. b) They are considered by relevant specialists to support unique or rare assemblages of species that occur there habitually, predictably or repeatably. The constituent species may not meet other critical habitat thresholds mentioned here in their own right, but may present assemblages that are considered important to maintain high biodiversity in the area.
Criterion 4: Migratory species and/or congregatory species	a) Areas sustain ≥ 1%of the global population of a migratory or congregatory species at any point of the species' lifecycle on a cyclical or otherwise regular basis. b) Areas are needed to support migratory or congregatory species during periods of environmental stress.
Criterion 5: Biodiversity and/or ecosystems with significant social, economic, or cultural importance to local communities and indigenous groups	Areas of semi-natural and natural habitat used by indigenous peoples and local communities to obtain essential or priority benefits will be considered critical from an ecosystem service perspective
Criterion 6: Habitat of key scientific value and/or associated with key evolutionary processes	This may include, but is not limited to, exceptional representations of: a) Landscapes with high spatial heterogeneity and therefore high levels of species diversity; b) Environmental gradients, also known as ecotones, that produce transitional habitat which is associated with the process of speciation and high species and genetic diversity; c) Edaphic interfaces that juxtapose soil types (e.g. serpentine outcrops, limestone and gypsum deposits), which have led to the formation of unique plant communities; d) Connectivity between habitats (e.g. biological corridors) with importance for species migration and gene flow, which is especially important in fragmented habitats and for the conservation of metapopulations. This also includes biological corridors across altitudinal and climatic gradients and from "crest to coast." e) Sites of demonstrated importance to climate change adaptation for either species or ecosystems

It is important to note that, despite being mainly aligned in the approach, some differences between the EBRD and EIB designations of CH are present. In case of differences, the more stringent criterion was applied. Namely, in order to meet the EIB's CH criteria, species has to be listed in both Annex II and IV to the Habitats Directive, while EBRD only requires presence on the Annex IV. In this case, the EBRD's criterion was applied. Additionally, in the case of species meeting criteria for both PBF and CH, the CH designation was applied in further analysis.

Table 14-26. Identification of Priority Biodiversity Features within the Project AoI

General criteria	Priority Biodiversity Feature criteria	Identification of Priority Biodiversity Features within the Project AoI
1. Priority ecosystems		
Threatened ecosystems	(PR6 para. 12-i) EAAA** is habitat type listed in Annex 1 of EU Habitats Directive or Resolution 4 of Bern Convention EAAA < 5% of the global extent of an ecosystem type with IUCN status of CR or EN	Habitat types listed in Annex I to EU Habitats Directive: 91F0 Riparian mixed forests of *Quercus robur, Ulmus laevis* and *Ulmus minor, Fraxinus excelsior* or *Fraxinus angustifolia*, along the great rivers (*Ulmenion minoris*) 91M0 Pannonian-Balkanic turkey oak – sessile oak forests 3150 Natural eutrophic lakes with *Magnopotamion* or *Hydrocharition* -type vegetation 3260 Water courses of plain to montane levels with the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation Habitat types listed only in Resolution 4 of Bern Convention: C3.2 Water-fringing reedbeds and tall helophytes other than canes Other criteria are not met within this project.
2. Priority Species and their Habitats		
Threatened species	(PR6 para. 12-ii) EAAA for species and their habitats listed in Annex II of Habitats Directive, Annex I of Birds Directive, Resolution 6 of Bern Convention EAAA supports < 0.5% of global population OR < 5 reproductive units of a CR or EN species. EAAA supports VU species EAAA for regularly occurring nationally or regionally listed EN or CR species	Species listed in Annex II to the Habitats Directive: *Nymphalis vaualbum* *Lycaena dispar* *Euphydryas aurinia* *Morimus asper* *Cerambyx cerdo* *Lucanus cervus* *Theodoxus transversalis* *Unio crassus* *Cobitis elongata* *Cobitis teaenia* *Cottus gobio* *Barbus meridionalis* *Leuciscus aspius* *Rhodeus amarus* *Romanogobio albipinnatus* *Romanogobio kesslerii* *Romanogobio uranoscopus* *Zingel streber* *Zingel zingel* *Bombina variegata* *Testudo hermanni* *Emys orbicularis*

General criteria	Priority Biodiversity Feature criteria	Identification of Priority Biodiversity Features within the Project AoI
		Canis lupus *Lutra lutra* *Myotis bechsteinii* *Miniopterus schreibersii* Species listed in Annex I to the Birds Directive: *Accipiter brevipes* *Pernis apivorus* *Pandion haliaetus* *Circaetus gallicus* *Falco peregrinus* *Falco vespertinus* *Acrocephalus melanopogon* *Anthus campestris* *Dendrocopos syriacus* *Dryocopus martius* *Leiopicus medius* *Alcedo atthis* *Aythya nyorka* *Ciconia ciconia* *Ciconia nigra* *Ixobrychus minutus* *Botaurus stellaris* *Emberiza hortulana* *Lanius collurio* *Lanius minor* *Milvus migrans* *Ardea alba* *Ardea purpurea* *Ardeola ralloides* *Sterna hirundo* *Nycticorax nycticorax* *Egretta garzetta* *Recurvirostra avosetta* *Circus aeruginosus* *Circus cyaneus* *Circus pygargus* *Emberiza hortulana* *Tringa glareola* *Asio flammeus* *Coracias garrulus* *Crex crex* *Ficedula albicollis* *Himantopus himantopus* *Microcarbo pygmaeus* *Sylvia nisoria* Species listed in Resolution 6 of Bern Convention: *Lycaena dispar*

General criteria	Priority Biodiversity Feature criteria	Identification of Priority Biodiversity Features within the Project AoI
		Morimus asper *Cerambyx cerdo* *Nymphalis vaualbum* *Euphydryas aurinia* *Theodoxus transversalis* *Unio crassus* *Cobitis elongata* *Cobitis taenia* *Barbus meridionalis* *Rhodeus amarus* *Romanogobio albipinnatus* *Romanogobio kesslerii* *Romanogobio uranoscopus* *Cottus gobio* *Zingel streber* *Zingel zingel* *Emys orbicularis* *Testudo hermanni* *Bombina variegata* *Accipiter nisus* *Accipiter brevis* *Pandion haliaetus* *Circaetus gallicus* *Falco peregrinus* *Falco vespertinus* *Ardea alba* *Ardea purpurea* *Ardeola ralloides* *Botaurus stellaris* *Aythya nyorka* *Dendrocopos syriacus* *Dryocopus martius* *Lanius collurio* *Lanius minor* *Ciconia ciconia* *Ciconia nigra* *Ixobrychus minutus* *Emberiza hortulana* *Dendrocopos major* *Nycticorax nycticorax* *Egretta garzetta* *Recurvirostra avosetta* *Circus aeruginosus* *Circus cyaneus* *Circus pygargus* *Sterna hirundo* *Tringa glareola* *Alcedo atthis* *Milvus migrans*

General criteria	Priority Biodiversity Feature criteria	Identification of Priority Biodiversity Features within the Project AoI
		Coracias garrulus *Crex crex* *Ficedula albicollis* *Himantopus himantopus* *Microcarbo pygmaeus* *Sylvia nisoria* *Canis lupus* *Myotis bechsteinii* *Miniopterus schreibersii* **IUCN Global Red list** Vulnerable (VU): *Cerambyx cerdo, Morimus asper, Streptopelia turtur, Aythya ferina, Vormela peregusna, Miniopterus schreibersii, Testudo hermanni* Endangered (EN): *Theodoxus transversalis, Unio crassus* **Species listed as VU, EN or CR in the Red Book of Serbia:** Vulnerable (VU): *Zingel streber, Zingel zingel, Streptopelia turtur, Ardea purpurea, Sterna hirundo, Cettia cetti, Coturnix coturnix, Perdix perdix,* Endangered (EN): *Nymphalis vaualbum, Milvus migrans,, Theodoxus transversalis, Unio crassus* Critically Endangered (CR): *Gallinago gallinago* Other criteria are not met within this project.
Range-restricted species	(PR6 para. 12-ii) EAAA for regularly occurring range-restricted species	Not been identified within this project
Migratory and congregatory species	(PR6 para. 12-ii) EAAA identified per Birds Directive or recognised national or international process as important for migratory birds (esp. wetlands)	Potential Natura 2000 sites (pSPAs) known to be inhabited by migratory species: pSPA Gornje Pomoravlje and pSPA Dobrić-Nišava. Congregatory species: *Myotis bechsteinii* *Myotis mystacinus* *Nyctalus noctula* *Plecotus austriacus* *Vespertilio murinus* *Miniopterus schreibersii* *Pipistrellus nathusii*

Table 14-27. Identification of Critical Habitats within the Project AoI

General criteria	Critical Habitat criteria	Identification of Critical Habitats within the Project AoI
1. Priority ecosystems		

General criteria	Critical Habitat criteria	Identification of Critical Habitats within the Project AoI
Threatened ecosystems	(PR6 para. 14-I, ESS 4 Criterion 1) EAAA is habitat type listed in Annex 1 of EU Habitats Directive or Resolution 4 of Bern Convention marked as "priority habitat type" EAAA ≥5% of global extent of an ecosystem type with IUCN status of CR or EN EAAA is ecosystem determined to be of high priority for conservation by national systematic conservation planning	Annex I priority habitat type: 91E0* Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-Padion, Alnion incanae, Salicion albae*) Other criteria are not met.
2. Priority Species and their Habitats		
Threatened species	(PR6 para. 14-ii, ESS 4 Criterion 2) EAAA for species and their habitats listed in Annex IV of the Habitats Directive (See EU restrictions) EAAA supports ≥ 0.5% of the global population and/or ≥ 5 established reproductive units of a CR or EN species (a) EAAA suports significant concentration of an IUCN Red-listed vulnerable species or of multiple IUCN Red-listed vulnerable species, especially where the loss of the area would result in the change of the IUCN Red List status to endangered or critically endangered EAAA for Nationally or regionally-important concentration of a species listed as endangered or critically endangered on a regional/national IUCN Red List, or equivalent on national/regional listing EAAA for population of species listed in Annex II and IV of the Habitats Directive (d)	Species listed to Annex IV of the Habitats Directive: *Lycaena dispar* *Nymphalis vaualbum* *Parnassius mnemosyne* *Phengaris arion* *Zerynthia polyxena* *Cerambyx cerdo* *Theodoxus transversalis* *Unio crassus* *Rana dalmatina* *Bombina variegata* *Testudo hermanni* *Emys orbicularis* *Podarcis muralis* *Lacerta viridis* *Natrix tessellata* *Zamenis longissimus* *Dolichophis caspius* *Canis lupus* *Myotis bechsteinii* *Myotis mystacinus* *Nyctalus noctula* *Plecotus austriacus* *Vespertilio murinus* *Miniopterus schreibersii* *Pipistrellus nathusii* Following species are listed on Annex II and IV of the Habitats Directive: *Lycaena dispar* *Nymphalis vaualbum* *Cerambyx cerdo* *Theodoxus transversalis* *Unio crassus* *Emys orbicularis* *Testudo hermanni* *Bombina variegata* *Myotis bechsteinii* *Miniopterus schreibersii* *Canis lupus*

General criteria	Critical Habitat criteria	Identification of Critical Habitats within the Project AoI
		Lutra lutra Other criteria are not met within this project.
Range-restricted species	(PR6 para. 14-iii, ESS 4 Criterion 3) EAAA regularly holds ≥ 10% of global population AND ≥ 10 reproductive units of the species	Have not been identified within this project.
Migratory and congregatory species	(PR6 para. 14-iv, ESS 4 Criterion 4) EAAA sustains, on a cyclical or otherwise regular basis, ≥ 1 percent of the global population at any point of the species' lifecycle EAAA predictably supports ≥10 percent of global population during periods of environmental stress	Migratory and congregatory species were recorded during desktop and field surveys; however, their concentrations in the PAoI do not represent regionally or globally important populations at any point of the species' lifecycle
Biodiversity and/or ecosystems with significant social, economic, or cultural importance to local communities and indigenous groups	(ESS 4 Criterion 5) EAAA is an area of semi-natural and natural habitat used by indigenous people and local communities to obtain essential or priority benefits	Have not been identified within this project.
Habitat of key scientific value and/or associated with key evolutionary processes	(ESS 4 Criterion 6) EAAA is a landscape with high spatial heterogeneity and high levels of species EAAA is an ecotone that produces transitional habitat which is associated with the process of speciation and high species and genetic diversity EAAA has led to the formation of unique plant communities EAAA represents biological corridor with importance for species migration and gene flow EAAA demonstrates importance to climate change adaptation for either species or ecosystems	Within this project Južna Morava River is identified as ecological corridor.

As previously mentioned, if a species meets the criteria for both PBF and CH, it is treated as CH due to the more stringent requirements for its conservation. As an example, we can highlight species *Unio crassus* and *Streptopelia turtur*. *Unio crassus* is listed as EN by the IUCN Red List but the threshold for CH (≥ 0.5% of the global population and/or ≥ 5 reproductive units) is not met. Additionally, *Streptopelia turtur* is species listed as VU in the national Red Book and as a result meet the PBF criteria. As VU species, they had the potential to meet the CH criteria as well; however, the project does not represent a risk to the population status locally, nationally or globally. This means that the criteria for CH related to the change of VU status to EN or CR as a result of project construction or operation is not met.

The EAAA was assessed for all species/habitats identified as PBF or CH. The maps and key ecological data for every PBF and CH are presented in Section 14.3. The EAAA primary habitats that support the priority biodiversity features and critical habitats and their locations are shown in Table 14-28.

Table 14-28. EAAAs that support priority biodiversity features and/or critical habitats

Priority biodiversity feature (PBF) or critical habitat (CH)	EAAA that support priority biodiversity feature/critical habitat and expected impacts
G1.11 Riverine *Salix* woodland (91E0* Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-Padion, Alnion incanae, Salicion albae*)) (CH)	Along the bank of Južna Morava River.
G1.223 Southeast European *Fraxinus - Quercus - Alnus* forests (91F0 Riparian mixed forests of *Quercus robur, Ulmus laevis* and *Ulmus minor, Fraxinus excelsior* or *Fraxinus angustifolia*, along the great rivers (*Ulmenion minoris*)) (PBF)	Within the project area this habitat is mixed with other forest types.
G1.76 Balkano-Anatolian thermophilous *Quercus* forests (91M0 Pannonian-Balkanic turkey oak – sessile oak forests) (PBF)	Sporadically where specific conditions for their occurrence are present. Within the project area this habitat is mixed with other forest types.
C1.33 Rooted submerged vegetation of eutrophic waterbodies (3150 Natural eutrophic lakes with *Magnopotamion* or *Hydrocharition* - type vegetation) (PBF)	Within the 5 km wider project area near to Mezgraja settlement (around chainage 223+000 km), Vrtište village (between chainages 225+000 km and 226+000 km, cca 228+000 km).
C3.2 Water-fringing reedbeds and tall helophytes other than canes (PBF)	Within the 5 km wider project area near to Mezgraja settlement (cca 223+00 km, cca 225+000 km, between 225+000 km and 226+000 km, cca 227+000 km and cca 228+000 km)
Theodoxus transversalis (CH) *Unio crassus* (CH) *Cobitis elongata* (PBF) *Cobitis teaenia* (PBF) *Cottus gobio* (PBF) *Barbus meridionalis* (PBF) *Leuciscus aspius* (PBF) *Rhodeus amarus* (PBF) *Romanogobio albipinnatus* (PBF) *Romanogobio kesslerii* (CH) *Romanogobio uranoscopus* (PBF) *Zingel streber* (PBF) *Zingel zingel* (PBF)	11 watercourses intersected by the railway route.
Accipiter brevipes (PBF) *Pernis apivorus* (PBF) *Pandion haliaetus* (PBF) *Circaetus gallicus* (PBF) *Circus cyaneus* (PBF) *Circus pygargus* (PBF) *Falco peregrinus* (PBF) *Falco vespertinus* (PBF) *Acrocephalus melanopogon* (PBF) *Anthus campestris* (PBF) *Alcedo atthis (PBF)* *Ardea alba (PBF)* *Ardea purpurea* (PBF) *Ardeola ralloides* (PBF) *Aythya ferina* (PBF)	pSPA Dobrić-Nišava

Priority biodiversity feature (PBF) or critical habitat (CH)	EAAA that support priority biodiversity feature/critical habitat and expected impacts
Aythya nyorka (PBF) *Ciconia ciconia (PBF)* *Ixobrychus minutus* (PBF) *Botaurus stellaris* (PBF) *Dendrocopos major (PBF)* *Egretta garzetta (PBF)* *Recurvirostra avosetta* (PBF) *Emberiza hortulana (PBF)* *Lanius collurio (PBF)* *Lanius minor (PBF)* *Nycticorax nycticorax (PBF)* *Streptopelia turtur (PBF)* *Tringa glareola (PBF)* *Asio flammeus* (PBF) *Coracias garrulus* (PBF) *Crex crex* (PBF) *Ficedula albicollis* (PBF) *Himantopus himantopus* (PBF) *Microcarbo pygmaeus* (PBF) *Sylvia nisoria* (PBF)	
Gornje Pomoravlje (IBA) *Sterna hirundo (PBF)* *Alcedo atthis (PBF)* *Riparia riparia (PBF)*	pSPA Gornje Pomoravlje *Note: pSPA Gornje Pomoravlje is excluded from further assessment due to its distance from the project AoI. Detailed explanation provided in Appropriate Assessment.*
Lycaena dispar (CH) *Unio crasus (CH)* *Theodoxus transversalis (CH)* *Nyctalus noctula (CH)* *Plecotus austriacus (CH)* *Pipistrellus nathusii (CH)* *Lutra lutra (CH)* *Pannonian-Balkanic turkey oak - sessile oak forests* (91M0) (PBF)	pSCI Južna Velika Morava *Note: pSCI Južna Velika Morava is excluded from further assessment due to its distance from the project AoI. Detailed explanation provided in Appropriate Assessment*
91M0 (PBF) 91W0 (PBF) 91Y0 (PBF) *Unio crassus (CH)* *Zerynthia (Zerynthia) polyxena* (CH)	pSCI Južna Morava *Note: pSCI Južna Morava is excluded from further assessment due to its distance from the project AoI. Detailed explanation provided in Appropriate Assessment*
Eriogaster catax (CH) *Pipistrellus kuhlii.* (CH)	pSCI Niš *Note: The species Eriogaster catax and Pipistrellus kuhlii were excluded from further assessment as impact of pSCI Niš are not anticipated as a result of this Project. Detailed explanation provided in Appropriate Assessment*
1340 - Inland salt meadows	pSCI Lalinačka Slatina *Note: The habitat* 1340 – Inland salt meadows *was excluded from further assessment as impact of pSCI Lalinačka Slatina are not anticipated as a result of this Project. Detailed explanation provided in Appropriate Assessment*
91M0 - Broad-leaved xerophilous forests; Xerophilous oak forests (PBF)	pSCI Obla glava *Note: pSCI Obla glava is excluded from further assessment due to its distance from the project AoI. Detailed explanation provided in Appropriate Assessment*
91M0 - Broad-leaved xerophilous forests; Xerophilous oak forests (PBF)	pSCI Poslonske planine *Note: pSCI Poslonske planine is excluded from further assessment due to its distance from the project AoI. Detailed explanation provided in Appropriate Assessment*

Priority biodiversity feature (PBF) or critical habitat (CH)	EAAA that support priority biodiversity feature/critical habitat and expected impacts
Lycaena dispar (CH) *Nymphalis vaualbum (CH)* *Zerynthia polyxena (CH)* *Parnassius mnemosyne (CH)* *Phengaris arion (CH)* *Euphydryas aurinia* (PBF) *Cerambyx cerdo (CH)* *Lucanus cervus* (PBF) *Morimus asper* (PBF) *Cettia cetti* (PBF) *Ciconia nigra* (PBF) *Sterna hirundo* (PBF) *Perdix perdix* (PBF) *Milvus migrans* (PBF) *Dryocopus martius* (PBF) *Leiopicus medius* (PBF) *Circus aeruginosus* (PBF)	agricultural mosaics, cropland, woodland and forest areas
Myotis mystacinus (CH) *Myotis bechsteinii* (CH) *Nyctalus noctula* (CH) *Vespertilio murinus* (CH) *Miniopterus schreibersii* (CH) *Plecotus austriacus* (CH) *Pipistrellus nathusii* (CH)	There are no registered caves within the working corridor; woodland and forest, agricultural mosaics, cropland, urban areas
Testudo hermanni (CH) *Emys orbicularis (CH)* *Bombina variegata* (PBF) *Podarcis muralis* (PBF) *Lacerta viridis* (PBF) *Natrix tessellata* (PBF) *Zamenis longissimus* (PBF) *Dolichophis caspius* (PBF) *Rana dalmatina* (CH)	rivers and lakes, wetlands, woodland and forest, cropland, grassland, heathland and shrub, gallery forests
Canis lupus (CH)	woodland and forest, agricultural mosaics

14.2. Impact assessment

This chapter presents the findings of the assessment of potential impacts on biodiversity receptors (when compared to baseline conditions) during both the construction and operations phases of the Project, in line with the requirements of EBRD PR 6and EIB ESS 4. Within the PAoI, impacts on biodiversity caused by the following activities will be considered: construction of new part of the corridor, stations, construction of tunnel, crossings and access roads, as well as construction of bridges. Mitigation measures to avoid or minimise negative impacts, are proposed. The assessment methodologies applied are detailed, and the data sources used are listed.

Impacts were assessed following methodology and grades were given based on type of impact, its magnitude, spatio-temporal scale, environment sensitivity and likelihood (Table 14-29):

Table 14-29. Grades of overall effects on biodiversity

		Effect (sum of magnitude, spatial and temporal size of the impact, environmental sensitivity)									
		3	4	5	6	7	8	9	10	11	12
Likelihood	1	4	5	6	7	8	9	10	11	12	13
	2	5	6	7	8	9	10	11	12	13	14
	3	6	7	8	9	10	11	12	13	14	15
	4	7	8	9	10	11	12	13	14	15	16

In order to assess the likely impacts of the project on habitats, the methodology outlined below (Table 14-30 to Table 14-33) was applied:

Table 14-30. Definition of grades for Magnitude – Habitat loss and fragmentation

MAGNITUDE Habitat loss and fragmentation	GRADE
Low impact: Small size of temporary loss of habitats within working corridor (0-1% of the AoI);	1
Moderate impact: Medium-size of temporary loss of habitats within working corridor (1-15% of the AoI);	2
Severe impact: Large size of temporary loss of habitats within working corridor (15-30% of the AoI);	3
Very severe negative, or extremely beneficial, impact: Very large size of temporary loss of habitats within working corridor (over 30% of the AoI)	4

Table 14-31. Definition of grades for and Size and Duration (combined Spatiotemporal)

SPATIOTEMPORAL				
	Temporary, only during construction	Short term – less than 5 years	Medium term – between 5 and 20 years	Long term/Permanent – more than 20 years
Very localised habitat loss within the working corridor or/and in the zone of tunnel, bridges and crossings and access roads construction	1	1	2	3
Habitat loss in Project AoI	1	1	2	3
Regional / National habitat loss	2	2	3	4

International habitat loss	2	2	3	4

To establish a methodology for assessing habitat sensitivity (Table 14-32), the status of habitats was considered in relation to the Habitats Directive, Bern convention and the national *Rulebook on criteria for the designation of habitat types, on habitat types, sensitive, endangered, rare and habitat types of priority for protection and on protection measures for their conservation* (Official Gazette of RS, No. 35/2010). Within the national Rulebook, habitat types are classified according to following criteria: 1) risk of habitat disappearance from natural areas of the Republic of Serbia due to anthropogenic and/or natural factors; 2) rarity of habitats in the Republic of Serbia due to anthropogenic or natural regression; 3) rarity of habitats in the Republic of Serbia due to natural limitations; 4) sensitivity to external influences due to functional instability of the habitat; 5) sensitivity to external influences due to low habitat regeneration capacity; 6) exceptional representativeness of the habitat within the territory of the Republic of Serbia; 7) habitat importance for the conservation of endemic, migratory, endangered, rare and protected species.

Table 14-32. Definition of Grades for Sensitivity (Environmental Receptors)

SENSITIVITY OF ENVIRONMENTAL RECEPTOR		GRADE
Low	Loss of wide distributed and very common habitats	1
Moderate	Loss of wide distributed Annex I and /or habitats listed in Resolution 4 of the Bern convention	2
High	Loss of Annex I priority habitats and habitats listed in Resolution 4 of the Bern convention marked as fragile habitats in Serbia and wide distributed	3
Very high	Loss of Annex I habitats, marked as fragile habitats in Serbia and extremely rare	4

Table 14-33. Definition of Grades for Likelihood

LIKELIHOOD	GRADE
Habitat loss has a very low probability of occurring, or will occur rarely within the PAoI	1
Habitat loss will possibly occur, or will occur intermittently within the PAoI	2
Habitat loss is likely to occur or will occur frequently within the PAoI	3
Habitat loss will occur with certainty within the PAoI	4

In order to assess the impact of proliferation of invasive plants on habitats and flora, the methodology outlined below (Table 14-34 to Table 14-37) was applied:

Table 14-34. Definition of grades for Magnitude

MAGNITUDE	GRADE
Low impact:	1

Small size of temporary native flora loss within working corridor caused by establishment of population of 1 to 2 different invasive plant species	
Moderate impact: **Medium-size of temporary native flora loss within working corridor caused by establishment of population of 3 to 5 different invasive plant species**	2
Severe impact: **Large size of temporary native flora loss within working corridor caused by establishment of population of 6 to 10 different invasive plant species**	3
Very severe negative, or extremely beneficial, impact: **Very large size of temporary native flora loss within working corridor caused by establishment of population of over 10 different invasive plant species**	4

Table 14-35. Definition of grades for Size and Duration (combined Spatiotemporal)

SPATIOTEMPORAL	GRADE
Very localised proliferation of invasive plants (within the working corridor), only during construction	1
Very localised (within the working corridor) proliferation of invasive plants, that it will be last between 5 and 20 years	2
Proliferation of invasive plants within Project AoI, that it will be last between 5 and 20 years	2
Proliferation of invasive plants within Project AoI, that it will be last permanent – more than 20 years	3
Proliferation of invasive plants within region that it will be permanent – more than 20 years	4

Table 14-36. Definition of Grades for Sensitivity (Environmental and Social Receptors)

SENSITIVITY OF ENVIRONMENTAL RECEPTOR		GRADE
Low	Native flora composed mainly of ruderal plants	1
Moderate	Native flora composed of wide distributed and common plant species	2
High	Native flora composed of of species with status VU (vulnerable), and/or Endangered (EN), according to the IUCN List of Threatened Species	3
Very high	Native flora composed of endemic, relict and/or very rare species	4

Table 14-37. Definition of Grades for Likelihood

LIKELIHOOD	GRADE
Proliferation of invasive plants has a very low probability of occurring, or will occur rarely within working corridor	1
Proliferation of invasive plants will possibly occur, or will occur intermittently within working corridor	2
Proliferation of invasive plants is likely to occur or will occur frequently within Project AoI	3
Proliferation of invasive plants will occur with certainty within the Project AoI	4

The key terminology used throughout the impact assessment is the **working corridor** which refers to the area 60 m-wide (30 m on each side of the corridor) and refers to the area under potential impact during construction, and the **corridor maintenance zone** (15 m on each side of the corridor) which refers to the area under permanent impact during railway operation.

14.2.1. Assumptions and Limitations

At the time of conducting the assessment, the location of certain Project components, including laydown areas, construction camps, and spoil disposal areas, had not yet been finalised. Consequently, this assessment is limited to evaluating impacts directly associated with the known footprint of the railway, along with stations, crossings, bridges, viaducts, access roads and Djunis tunnel. However, the assessment outlines mitigation measures, including the procedures to be followed for project components that currently lack detailed information, species avoidance measures where applicable, and additional assessments to be conducted during the detailed design phase.

14.2.2. Construction Phase

Flora and habitats

Construction activities in those sections of the Project where the existing railway alignment will be raligned to allow for increased train speeds (e.g. on curves) will cause habitat loss, degradation and fragmentation.

The majority of direct impacts on habitats are expected to be limited to the area within a working corridor (30 m on either side of the footprint). Also, construction of stations, tunnel, crossings, bridges and access roads will directly affect habitats and produce the same effects .Temporary loss of habitat can be expected for those Project components (access roads, construction camps, spoil disposal sites) where siting is not available in the Design at the time of finalisation of the ESIA package. To avoid adverse impacts, the constructions of these components is strictly forbidden within avoidance zones, later defined under 14.3.1. Pre-construction phase. As it is difficult to estimate the exact habitat loss that will occur as a result of the construction of the railway, a conservative approach has been taken. The habitat loss for the tunnel was calculated using a 30-meter zone of interest around the tunnel entrance and tunnel exit, as well as a 30-meter zone along both sides of the railway. There will be no additional habitat loss for the habitats overlying the tunnel route. The impact of crossings, access roads and bridge construction on habitats was assessed using a 30-meter zone of interest for crossings and access roads and 30-meter zone of interest for bridges. Regarding the stations, habitat loss will be limited to the working corridor.

The Table 14-38 below presents the total area of each habitat type within the PAoI (500 m + 500 m) alongside the percentage of the PAoI that each habitat occupies. It also includes the area of each habitat type within the working corridor (30 m + 30 m) and the percentage of that habitat's total area that falls within the working corridor.

Table 14-38. Area of habitats affected during construction phase

EUNIS		EU Habitats Directive		Area (ha) in the PAoI	Habitat coverage (%) within the PAoI	Area (ha) within working corridor	Habitat area (%of total area in PAoI) within working corridor	Area (ha) impacted by construction of crossings and access roads	Area (ha) impacted by bridges construction	Area (ha) impacted by tunnel construction
Code	Name of habitat	Code	Name of habitat							
C1.33	Rooted submerged vegetation of eutrophic waterbodies	3150	Natural eutrophic lakes with *Magnopotamion* or *Hydrocharition* - type vegetation	7.83	0.13	0.26	0.08	0	0.32	0
C3.2	Water-fringing reedbeds and tall helophytes other than canes	-	-	15.88	0.26	1.30	0.41	0	0	0
E2.6	Agriculturally-improved, re-seeded and heavily fertilised grassland, including sports fields and grass lawns	-	-	37.87	0.63	1.00	0.32	0.02	0.03	0
E3	Wet or seasonally wet grasslands	-	-	22.30	0.37	1.73	0.55	0	1.23	0
E5.1	Anthropogenic herb stands	-	-	0.82	0.01	0	0	0	0	0
F9.35	Riparian stands of invasive shrubs	-	-	3.86	0.06	0.29	0.09	0	0	0
FA.3	Species-rich hedgerows of native species	-	-	18.59	0.31	11.66	3.72	0.30	0.12	0
G1	Broadleaved deciduous woodland	-	-	9.50	0.16	1.28	0.41	0	0	0
G1.11	Riverine *Salix* woodland	*91E0	Alluvial forests with *Alnus glutinosa and Fraxinus excelsior (Alno-Padion, Alnion incanae, Salicion albae*)	76.26	1.27	1.59	0.51	0.02	0.78	0
G1.223	Southeast European *Fraxinus - Quercus - Alnus* forests	91F0	Riparian mixed forests of *Quercus robur, Ulmus laevis and Ulmus minor, Fraxinus excelsior* or *Fraxinus angustifolia*, along the great rivers (*Ulmenion minoris*)	60.32	1.004	1.56	0.50	0	1.03	0
G1.76	Balkano-Anatolian thermophilous *Quercus* forests	91M0	Pannonian-Balkanic turkey oak – sessile oak forests	269.42	4.49	5.58	1.78	2.24	0	1.20
G1.C3	*Robinia* plantations	-	-	8.01	0.13	3.11	0.99	0.04	0.14	0
G5	Lines of trees, small anthropogenic woodlands, recently	-	-	167.48	2.79	4.21	1.34	0.92	0	0

EUNIS		EU Habitats Directive		Area (ha) in the PAoI	Habitat coverage (%) within the PAoI	Area (ha) within working corridor	Habitat area (%of total area in PAoI) within working corridor	Area (ha) impacted by construction of crossings and access roads	Area (ha) impacted by bridges construction	Area (ha) impacted by tunnel construction
Code	Name of habitat	Code	Name of habitat							
	felled woodland, early-stage woodland and coppice									
I1.1	Intensive unmixed crops	-	-	2489.42	41.47	105.89	33.75	37.66	2.51	0
I1.5	Bare tilled, fallow or recently abandoned arable land			11.20	0.19	0	0	0	0	0
J1.1	Residential buildings of city and town centres	-	-	152.67	2.54	5.01	1.60	0.04	0.13	0
J1.2	Residential buildings of villages and urban peripheries	-	-	1348.94	22.47	55.66	17.74	11.76	0.33	0
J1.4	Rural industrial and commercial sites still in active use	-	-	53.44	0.89	2.76	0.88	0.30	0.04	0
J1.6	Urban and suburban construction and demolition sites	-	-	20.41	0.34	0.68	0.22	0	0	0
J4.2	Road networks	-	-	152.40	2.54	10.44	3.33	7.40	0.11	0
J4.3	Rail networks	-	-	75.79	1.26	55.38	17.65	5.43	1.30	0
J4.7	Constructed parts of cemeteries	-		1.21	0.02	0	0	0	0	0
X07	Intensively-farmed crops interspersed with strips of natural and/or semi-natural vegetation	-	-	962.06	16.02	42.03	13.68	17.31	1.20	0.90
X25	Domestic gardens of villages and urban peripheries	-	-	30.94	0.52	1.42	0.45	2.51	0.06	0
Total				6002.90	100	312.50	100	85.95	9.33	2.1

[1]Percentage of habitat coverage in relation to the total area of all habitats in AoI
[2]Percentage of habitat coverage in relation to the total area of all habitats in the working corridor (30m+30m)

The main negative impacts of the Project on flora and habitats are:

- Habitat loss and fragmentation,
- Habitat degradation,
- The spread of invasive flora species, and dust generated as a result of construction activities.

Habitat loss and fragmentation

During the construction phase, a percentage of habitat will be temporarily lost within the defined working corridor. Temporary and permanent removal of vegetation during the construction phase of the railway line, as well as clearing vegetation to construct bridges, tunnel, crossings and access roads, will result in habitat loss and fragmentation. The habitats within the defined maintenance corridor will, however, be permanently lost.

A total of 25 habitat types were identified through desk-based research and field surveys within PAoI. Only 3 habitats are not recorded within working corridor (E5.1 Anthropogenic herb stands, I1.5 Bare tilled, fallow or recently abandoned arable land and J4.7 Constructed parts of cemeteries). The majority of the impacted habitat types (described below) are anthropogenic within the working corridor, as well as within PAoI.

All natural habitats (CH, PBFs, G1 and E3 habitat types) are located within Đunis -Trupale subsection. These natural habitats are not recorded within PAoI of Paraćin-Stalać subseto stronger anthropogenic pressure.

The impact significance score for habitats is calculated according to the matrix in Table 14-29, based on the final assessment grades given in Table 14-30 to Table 14-33 and using the formula: (Magnitude + Size & Duration + Sensitivity) + Likelihood = Significance.

I1.1 Intensive unmixed crops (2489.42 ha in PAoI), **J1.2** Residential buildings of villages and urban peripheries (1348.94 ha in PAoI) and **X07** Intensively-farmed crops interspersed with strips of natural and/or semi-natural vegetation (962.06 ha in PAoI) will be the most affected by construction activities. Total habitat loss calculated for **I1.1** is 146.06 ha (105.89 ha in the working corridor + 37.66 ha in the zone of crossings and access roads and 2.51 ha in the zone of bridges construction), which is 5.87% of the total habitat surface within PAoI, for **J1.2** is 76.14 ha (55.66 ha in the working corridor + 11.76 ha in the zone of crossings and access roads and 0.33 ha in the zone of bridges construction), which is 5.64% of the total habitat surface within PAoI and for **X07** is 64.49 ha (42.03 ha in the working corridor + 17.31 ha in the zone of crossings and access roads + 1.20 ha in the zone of bridges construction and 0.90 in the zone of tunnel construction), which is 6.70% of the total habitat surface within PAoI. The habitat loss will be temporary, very localised (within the working corridor) and it will last less than 5 years. These habitats have a specific capacity to spontaneously regenerate vegetation cover after some time. Locations where vegetation has been damaged or removed are highly susceptible to invasive species takeover, as well as the introduction of new invasive species. Invasive species have already established populations across all locations of these habitats. Construction activities may induce more rapid spread of invasive species. These anthropogenic habitats are widespread and very common within the PAoI. Loss of habitat will with certainty occur within the working corridor; therefore, the impact significance of the project might be assessed as moderate (Table 14-39).

In addition to these habitats, the following anthropogenic habitats will also be directly affected: **J4.2** Road networks, **J4.3** Rail networks, **E2.6** Agriculturally-improved, re-seeded and heavily fertilised grassland, including sports fields and grass lawns, **F9.35** Riparian stands of invasive shrubs, **G1.C3** Robinia plantations, **G5** Lines of trees, small anthropogenic woodlands, recently felled woodland, early-stage woodland and coppice**, J1.1** Residential buildings of city and town centres, **J1.4** Rural industrial and commercial sites still in active use, **J1.6** Urban and suburban construction and demolition sites and **X25** Domestic gardens of villages and urban peripheries. All of these habitats are widespread and very common within the PAoI. Removal of vegetation in the working corridor will result in temporary habitat loss, which will be localised, and will last less than 5 years. Loss of habitat will with certainty occur within the working corridor; therefore, the impact significance of the project might be assessed as moderate (Table 14-39). The areas lost for thesehabitats are shown in Table 14-38. These habitats have a specific capacity to spontaneously regenerate over time, as ruderal plant species are dominant. The reproductive strategy of these species contributes to their rapid spread, especially in disturbed spaces. Additionally, areas where damage or removal of vegetation has occurred will be more susceptible to the spread of invasive plant species, including both those already established at all localities and new invasive species.

The total area of **C1.33** Rooted submerged vegetation of eutrophic waterbodies (3150 Natural eutrophic lakes with *Magnopotamion* or *Hydrocharition* -type vegetation) is 7.83 ha within PAoI. The loss of this habitat due to the removal of vegetation is calculated for the working corridor and bridge construction sites on the Južna Morava River (cca 223+000 km) and it is 0.58 ha (0.26 ha + 0.32 ha), which is 7.41% of total surface of this habitat in the PAoI. During the field surveys, populations of species with high conservation significance were not identified within these habitats. It is important to emphasise that this habitat is an Annex I habitat and it is widespread in Serbia. These habitats are not classified as fragile in Serbia. Removal of vegetation during construction will be temporary , and will last between 5 and 20 years. Habitat loss will occur with certainty within the working corridor and in construction zones of bridges. Accordingly, the impact significance of the project is assessed as moderate (Table 14-39).

C2.3 Permanent non-tidal, smooth-flowing watercourses was not recorded during the field surveys. They are likely to be present in the reparian zone of Južna Morava River within the PAoI. This is a fragile habitat in Serbia. It is widespread in riparian zones of big rivers.

C3.2 Water-fringing reedbeds and tall helophytes other than canes occupies a total area of 15.88 ha in the PAoI. The loss of these habitats due to the removal of vegetation is calculated for the working corridor and it is 1.30 ha (at cahinages between 225+000 km and 226+000 km), which is 20.64% of total surface of this habitat in PAoI. Temporary habitat loss will occur with certainty within the working corridor. It is important to emphasise that dominant species (of these habitats, *Typha* sp.) may respond to disturbances and degradation of habitat by spreading vegetatively at a rapid rate, which is why it is expected that habitat loss will last less than 5 years. These habitats are not classified as fragile, and are widespread in Serbia. The habitat is listed in Resolution 4 of the Bern convention. In accordance with all of the above, the impact significance can be assessed as moderate (Table 14-39).

E3 Wet or seasonally wet grasslands occupies a total ara of 22.30 ha within PAoI. It was recorded at several locations within the Project AoI. The loss of these habitats due to the removal of vegetation in the working corridor and bridge construction is 2.69 ha (cca 223+000 km), which is 12.07 % of the total surface of this habitat in the

PAoI. The floristic composition of these habitats indicates a strong anthropogenic influence within the observed area. Therefore, plant species of high conservation value have not been recorded. These habitats are widespread in Serbia and are not considered fragile. Removal of vegetation in the working corridor will certainly result in temporary habitat loss, lasting less than 5 years. The impact significance of the project is assessed as moderate (Table 14-39**Error! Reference source not found.**).

G1.11 Riverine *Salix* woodlands (*91E0 Alluvial forests with *Alnus glutinosa and Fraxinus excelsior (Alno-Padion, Alnion incanae, Salicion albae*)) are widespread in Serbia, however, are considered fragile habitats. Riverine *Salix* woodlands are Annex I priority habitats. These habitats occupy a total area of 76.26 ha in the PAoI. The loss of Riverine *Salix* woodland is 2.39 ha due to the removal of vegetation within the working corridor, and for crossings, access roads and bridges, which is 3.13% of total surface of this habitat in the PAoI. The habitat loss will be temporary, but very localised within the working corridor and zones of construction of crossings, access roads and bridges, and it will last between 5 and 20 years. Accordinglly, the impact significance can be assessed as high (Table 14-39). The habitat is impacted by the Project at chainages cca 193+000 km and between 225+000 and 226+000 km.

G1.223 Southeast European *Fraxinus - Quercus - Alnus* forests (91F0 Riparian mixed forests of *Quercus robur, Ulmus laevis* and *Ulmus minor, Fraxinus excelsior* or *Fraxinus angustifolia*, along the great rivers (*Ulmenion minoris*)) occupies a total area of 60.32 ha in the PAoI. The loss of these habitats due to the removal of vegetation in the working corridor and for bridge construction is 2.39 ha, which is 3.96% of total surface of this habitat in PAoI. The habitat is impacted by the project at chainages 217+500 km and cca 219+000 km. The habitat loss will be temporary, but very localised and it will last between 5 and 20 years. These forests are considered to be fragile habitats but are widespread in Serbia. Accordinglly, the impact significance can be assessed as moderate (Table 14-39).

G1.76 Balkano-Anatolian thermophilous *Quercus* forests (91M0 Pannonian-Balkanic turkey oak – sessile oak forests) are also widespread in Serbia but considered to be fragile habitats. These forests are clima zonal vegetation of Serbia. They are an Annex I habitat. These habitats occupy a total area of 269.42 ha within the PAoI. They will be impacted by tunnel construction at chainages cca 192+000 km and cca 193+000 km, as well as by the construction of new sections of the railway alignment at cca 195+000 km and 218+000 km. The loss of these habitats due to the removal of vegetation in the working corridor and for the construction of crossings and acess roads and tunnel is 9.02 ha, which is 3.35 % of total surface of this habitat in the PAoI. The habitat loss will be temporary, but very localised and it will last between 5 and 20 years. Accordinglly, the impact significance can be assessed as moderate (**Error! Reference source not found.**).

G1 Broadleaved deciduous woodland are fragmented and occupy small areas within the PAoI. Ruderal and invasive plants are dominant within this habitat due to strong anthropogenic impact from nearby settlements. This habitat type is not classified as CH or PBF and it is widespread in Serbia. However, these forests provide habitat for many animal species and their preservation is important. They occupy a total area of 9.50 ha within the PAoI. These habitats will be impacted by the project at chainages between 199+300 km and to 200+000 km within working corridor. The temporary habitat due to the removal of vegetation calculated for the working corridor is 1.28 ha, which is 13.47 % of total surface of this habitat in PAoI. The habitat loss will be very localised it will last between 5 and 20 years. The impact significance can be assessed as moderate (**Error! Reference source not found.**).

As outlined above, the Project envisages the correction of curves in certain sections of the railway to facilitate increased train speeds. Figure 14-78 to Figure 14-88 present locations of curve corrections that will impact natural habitats.The exact locations of curve corrections are given in Annex II.

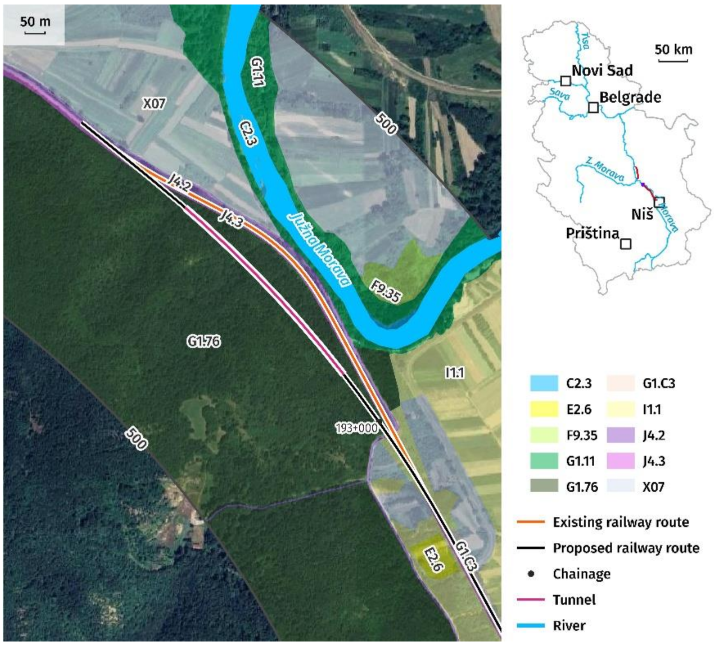


Figure 14-78. New railway corridor alignment from 192+050 km to 193+200 km – Đunis–Trupale subsection

The Figure 14-78 shows the planned correction of the curve from 192+050 km to 193+200 km. The total area of the RoW of the existing railway that will no longer be used is 7.39 ha, of which G1.11 habitat type occupies an area of 0.29 ha, and G1.76 habitat type 2.14 ha.

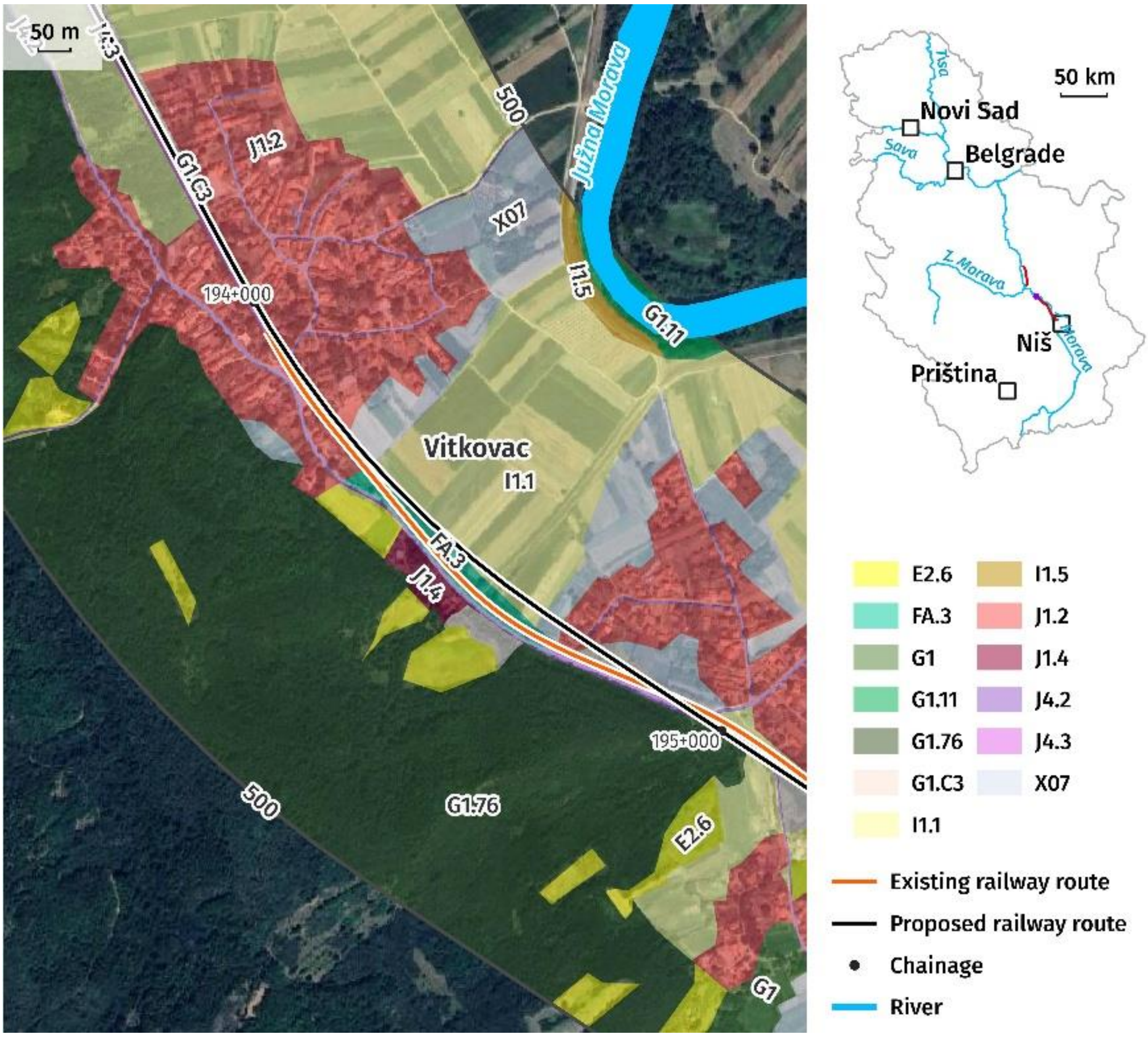


Figure 14-79. New railway corridor alignment from 194+050 km to 194+900 km – Đunis–Trupale subsection

The Figure 14-79 shows the planned correction of the curve from 194+050 km to 194+900 km. The total area of the RoW of the existing railway that will no longer be used is 5.19 ha, of which G1.76 habitat type occupies an area of 0.31 ha.

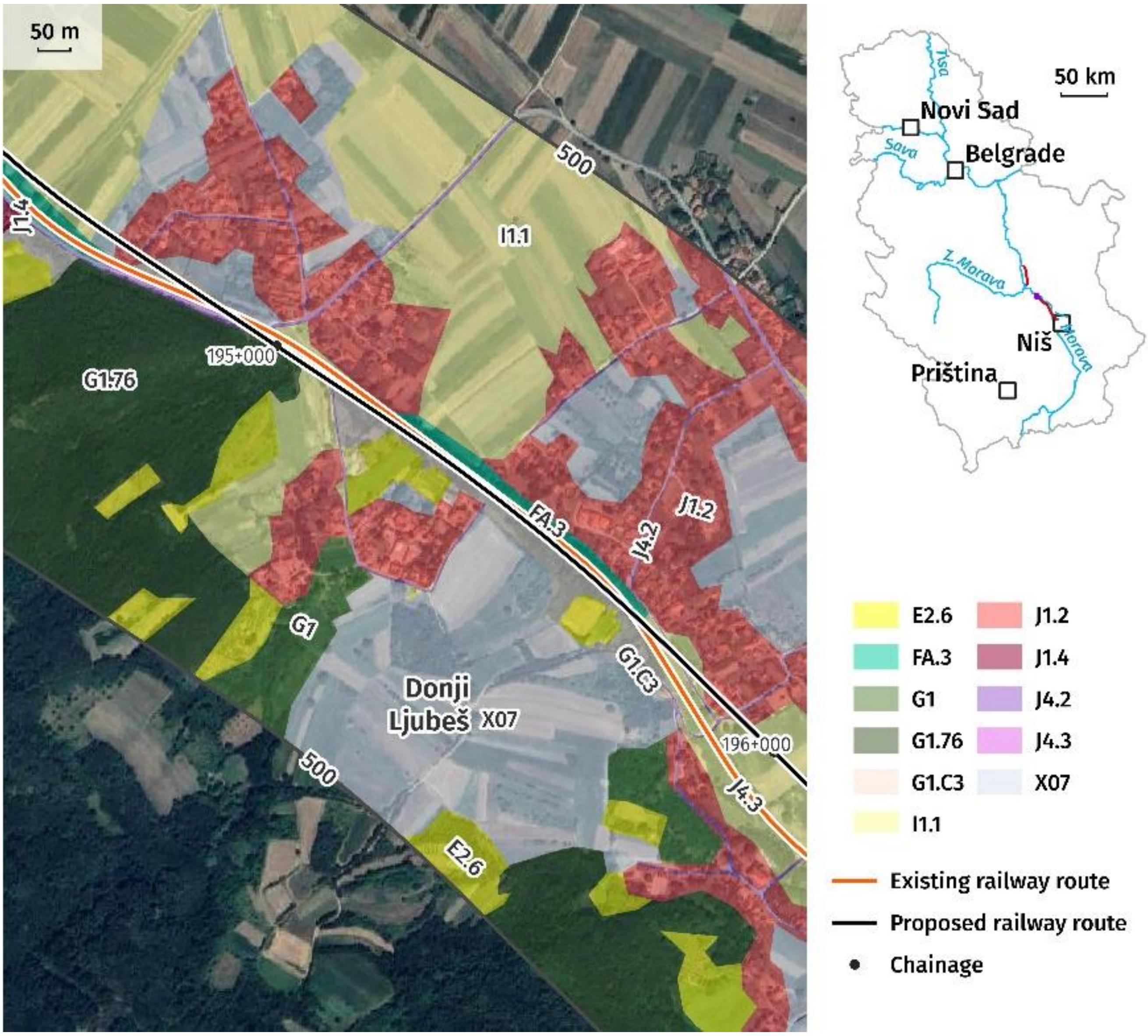


Figure 14-80. New railway corridor alignment from 194+900 km to 195+700 km - Đunis – Trupale subsection

The Figure 14-80 shows the planned correction of the curve from 194+900 km to 195+700 km. The total area of the RoW of the existing railway that will no longer be used is 4.81 ha, of which G1.76 habitat type occupies an area of 0.24 ha.

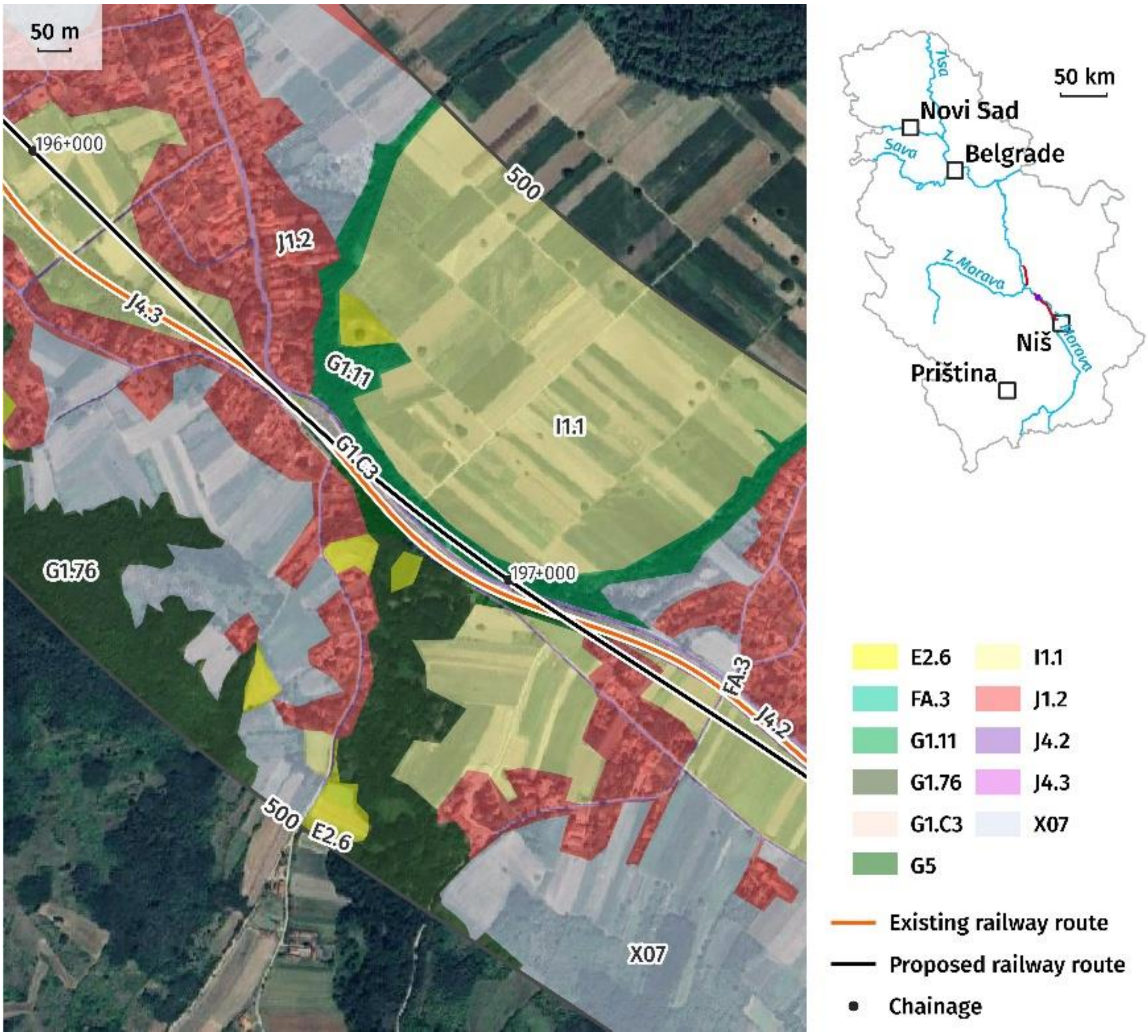


Figure 14-81. New railway corridor alignment from 196+600 km to 197+100 km - Đunis – Trupale subsection

The Figure 14-81 shows the planned correction of the curve from 196+600 km to 197+100 km. The total area of the RoW of the existing railway that will no longer be used is 4.81 ha, of which G1.76 habitat type occupies an area of 0.17 ha and G1.11 habitat type 0.42 ha.

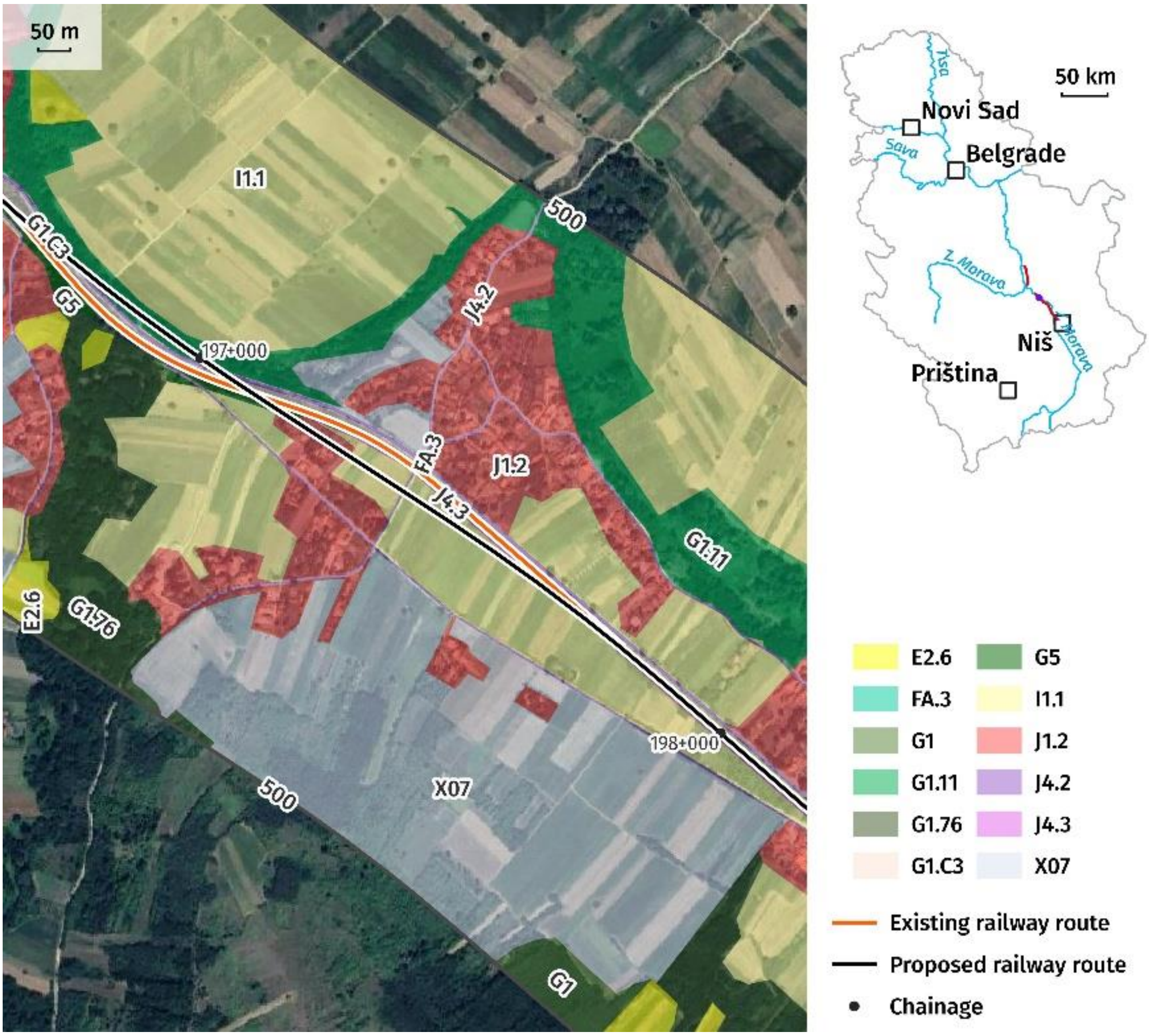


Figure 14-82. New railway corridor alignment from 197+100 km to 197+800 km – Đunis–Trupale subsection

The Figure 14-82 shows the planned correction of the curve from 197+100 km to 197+800 km. The total area of the RoW of the existing railway that will no longer be used is 4.26 ha, of which G1.11 habitat type occupies an area of 0.10 ha.

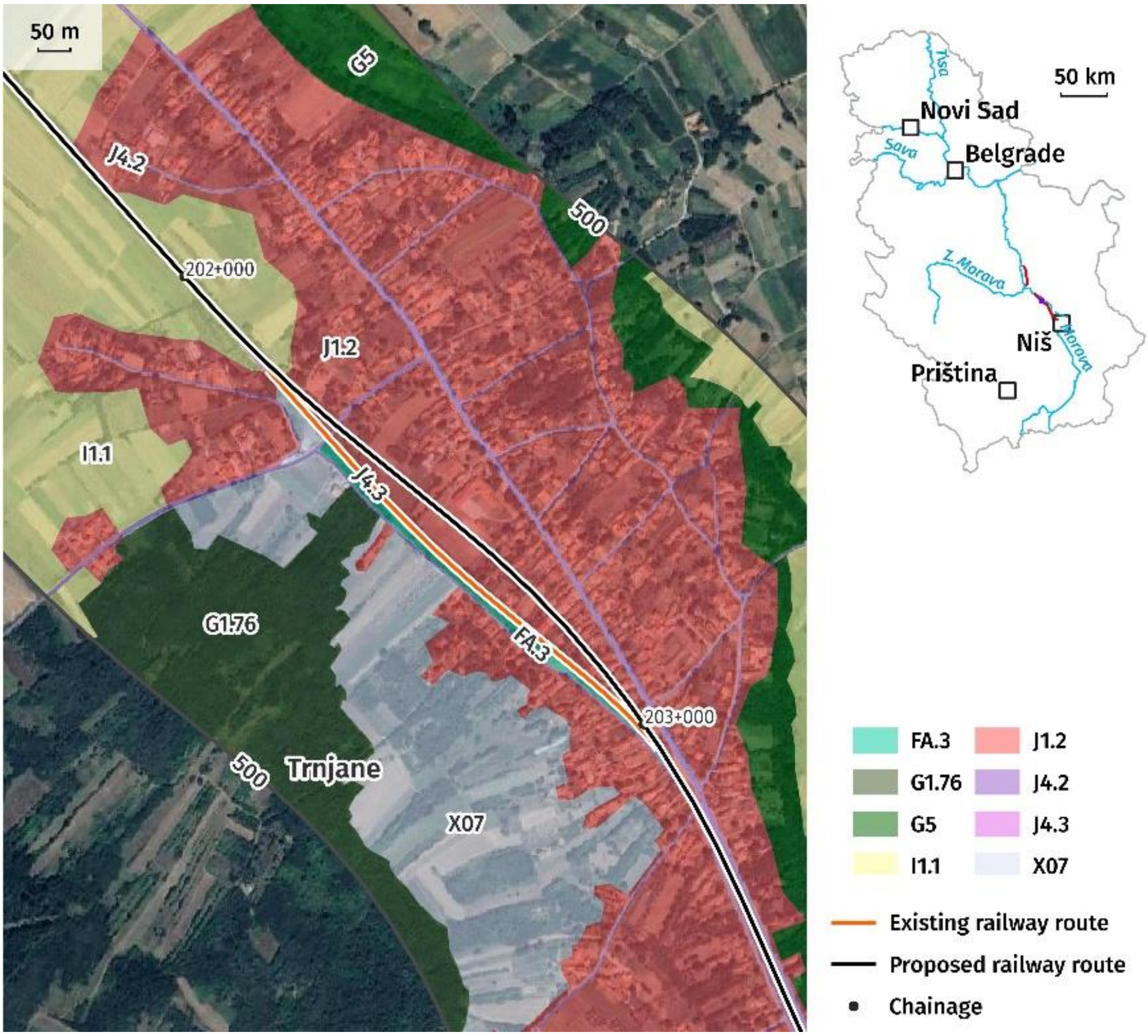


Figure 14-83. New railway corridor alignment from 202+200 km to 203+050 km – Đunis–Trupale subsection

The Figure 14-83 shows the planned correction of the curve from 202+200 km to 203+050 km. The total area of the RoW of the existing railway that will no longer be used is 5.10 ha, of which G1.76 habitat type occupies an area of 0.04 ha.

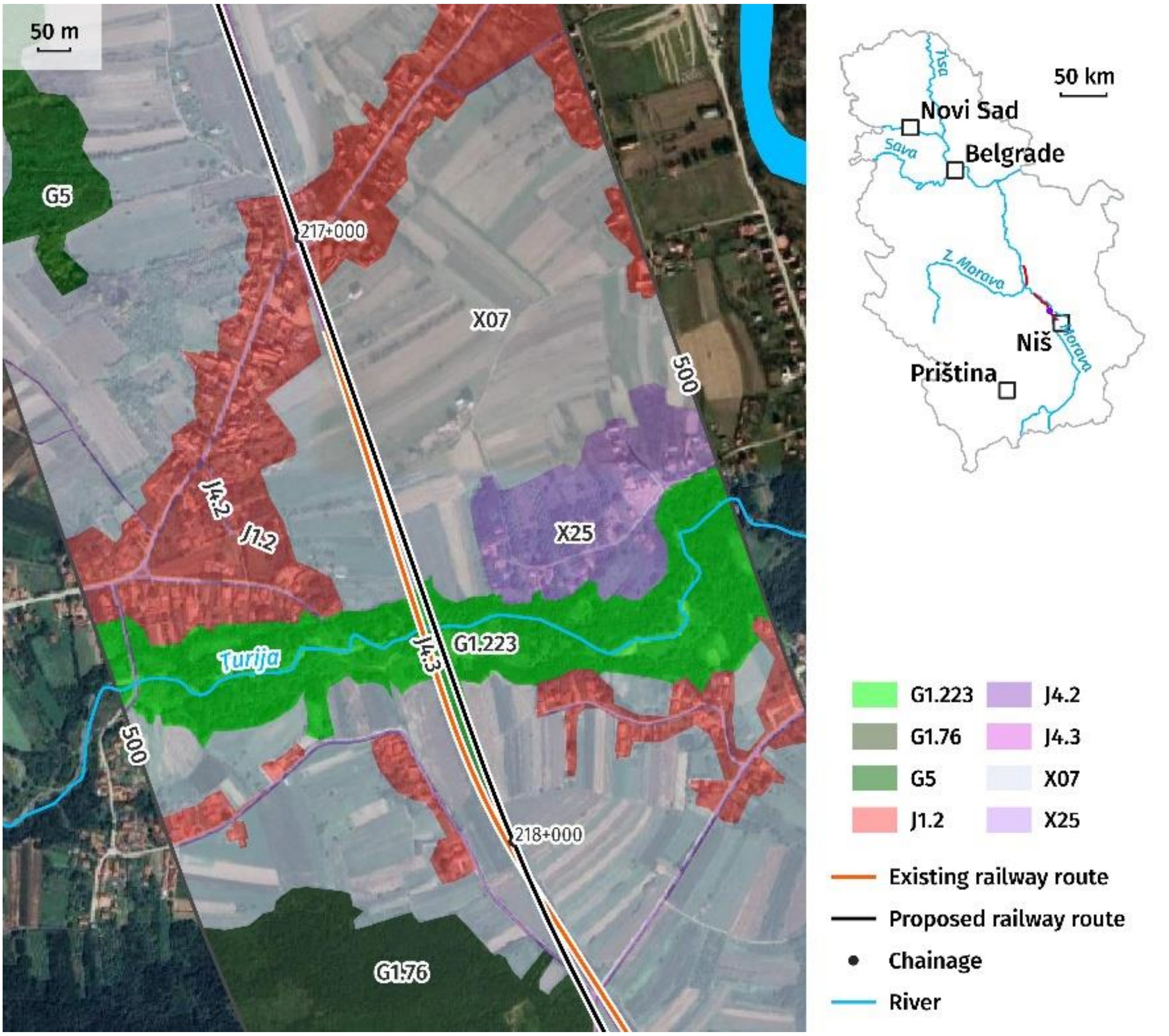


Figure 14-84. New railway corridor alignment from 217+150km to 218+050 km – Đunis–Trupale subsection

The Figure 14-84 shows the planned correction of the curve from 217+150 km to 218+050 km. The total area of the RoW of the existing railway that will no longer be used is 4.48 ha, of which G1.223 habitat type occupies an area of 0.97 ha.

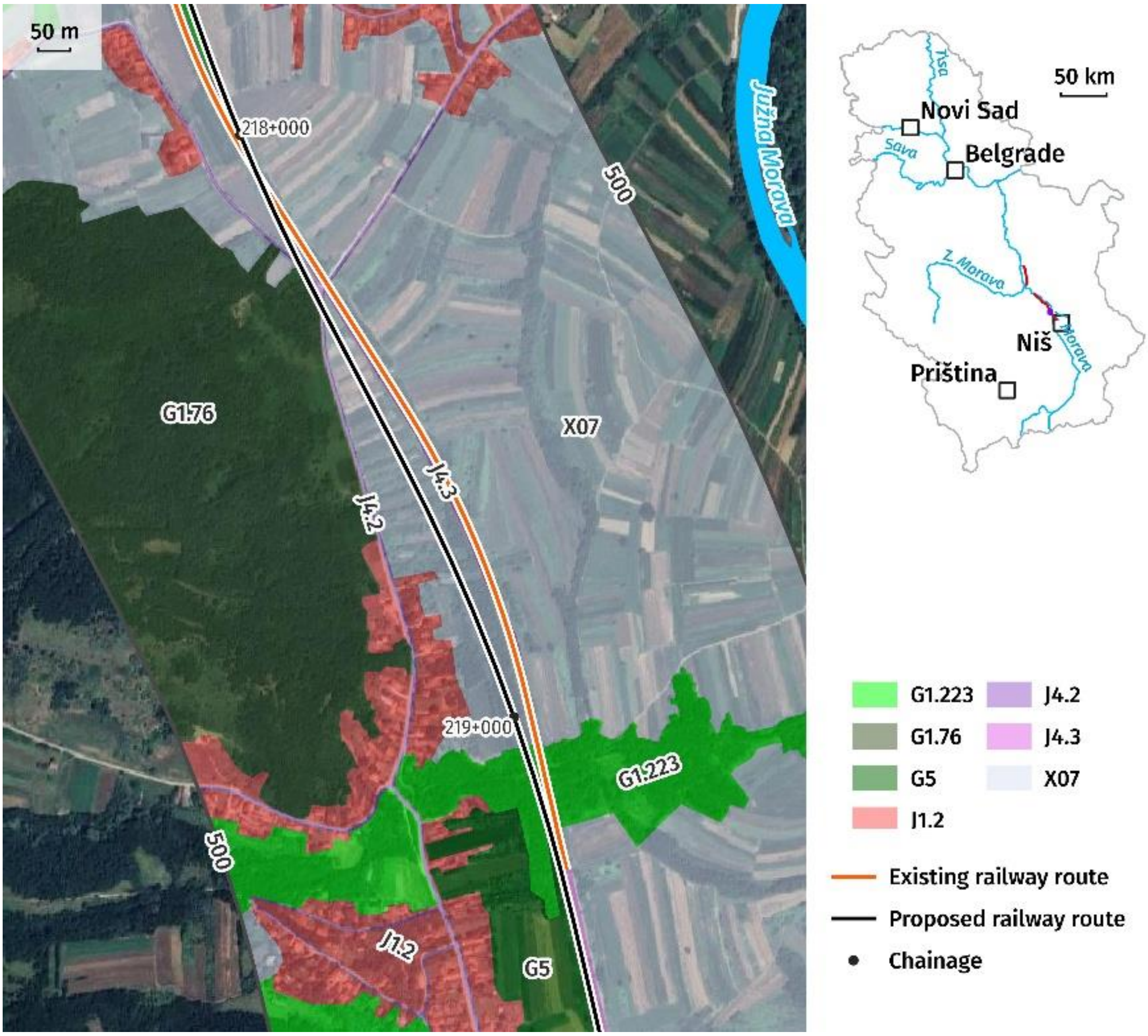


Figure 14-85. New railway corridor alignment from 218+050 km to 219+250 km – Đunis–Trupale subsection

The Figure 14-85 shows the planned correction of the curve from 218+050 km to 219+250 km. The total area of the RoW of the existing railway that will no longer be used is 7.19 ha, of which G1.76 habitat type occupies an area of 0.06 ha and G1.223 habitat type 0.70 ha.

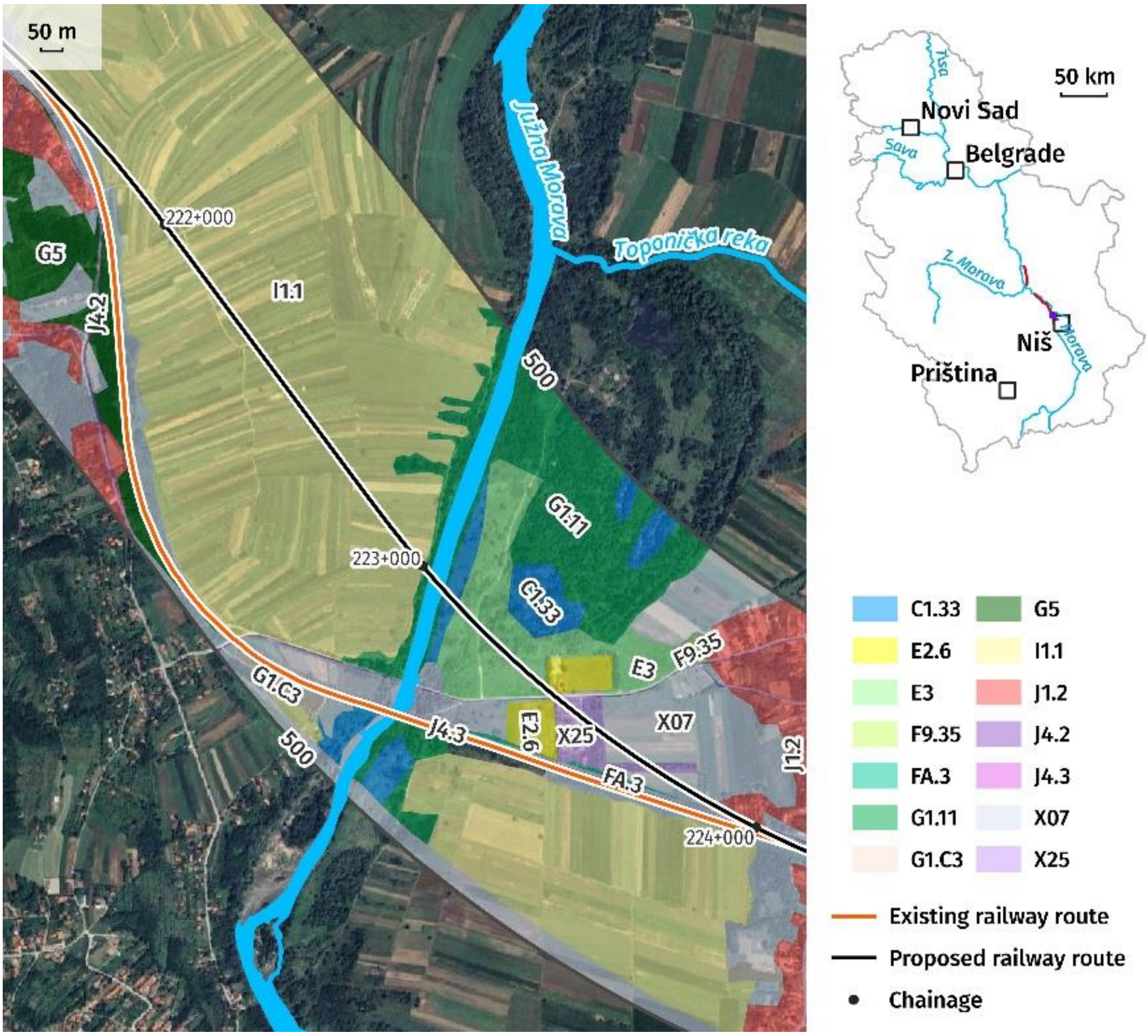


Figure 14-86. New railway corridor alignment from 221+450 km to 224+100 km – Đunis–Trupale subsection

The Figure 14-86 shows the planned correction of the curve from 221+450 km to 224+100 km. The total area of the RoW of the existing railway that will no longer be used is 15.28 ha, of which G1.11 habitat type occupies an area of 0.36 ha and C1.33 habitat type 0.16 ha.

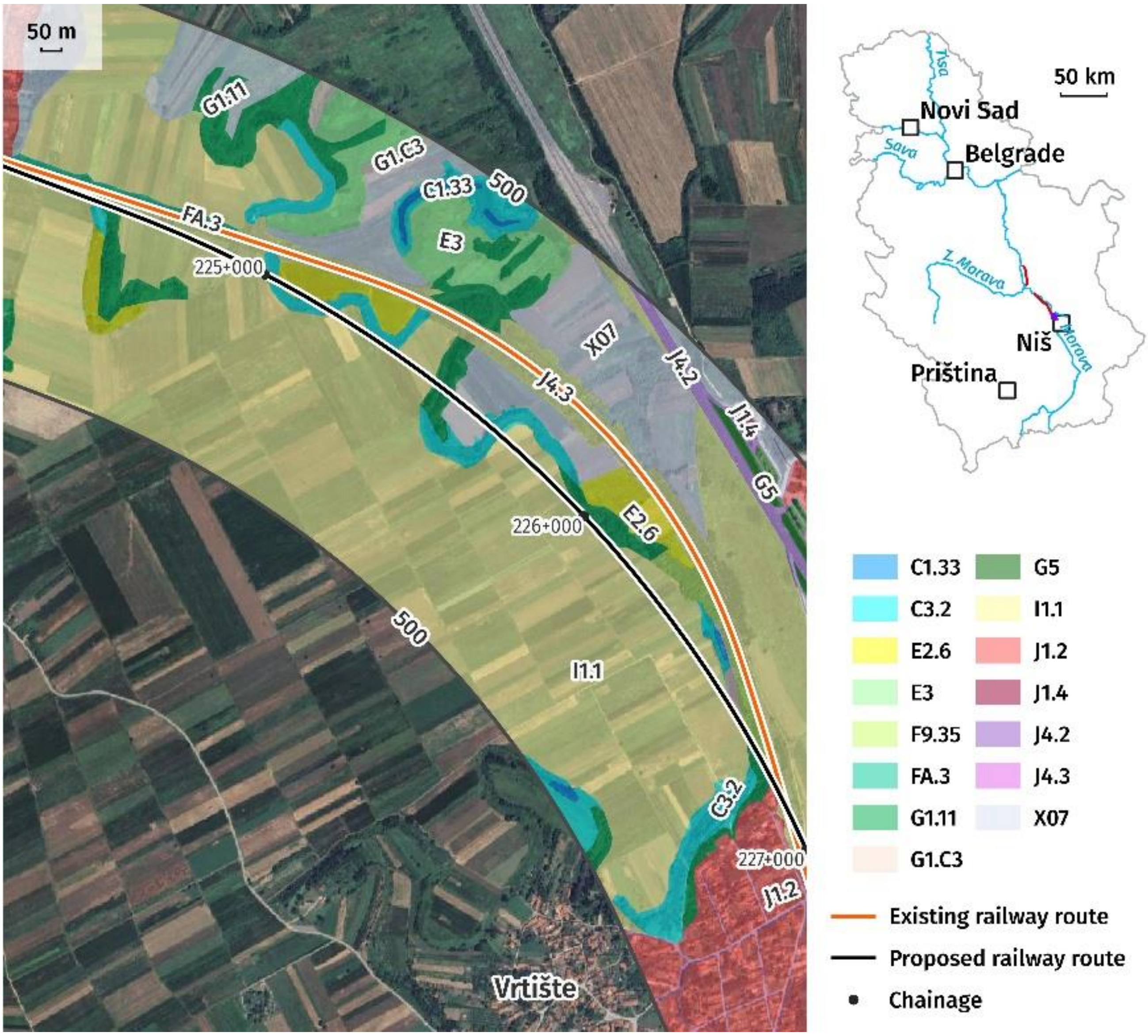


Figure 14-87. New railway corridor alignment from 224+100 km to 226+900 km – Đunis–Trupale subsection

The Figure 14-87 shows the planned correction of the curve from 224+100 km to 226+900 km. The total area of the RoW of the existing railway that will no longer be used is 17.42 ha, of which G1.11 habitat type occupies an area of 0.49 ha and C1.33 habitat type 0.02 ha and C3.2 habitat type 0.11 ha.

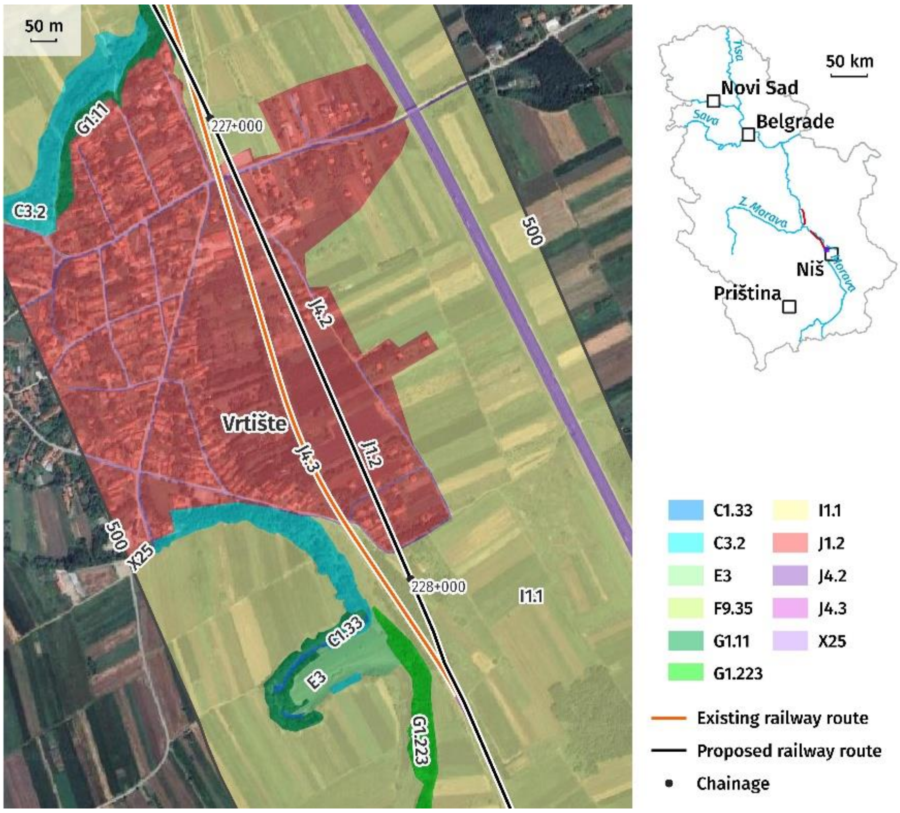


Figure 14-88. New railway corridor alignment from 226+900 km to 228+250 km – Đunis–Trupale subsection

The Figure 14-88 shows the planned correction of the curve from 226+900 km to 228+250 km. The total area of the RoW of the existing railway that will no longer be used is 8.19 ha, of which G1.11 habitat type occupies an area of 0.08 ha.

Construction of certain new parts of the railway and moving the railway away from C1.33 habitat (from 221+450 km to 224+100 km , from 224+100 km to 226+900 km), G1.11 habitat (from 192+050 km to 193+200 km, from 196+600 km to 197+100 km, from 197+100 km to 197+800 km, from 221+450 km to 224+100 km, from 224+100 km to 226+900 km and from 226+900 km to 228+250 km), G1.223 habitat (from 217+150km to 218+050 km , from 218+050 km to 219+250 km), G1.76 habitat (from 192+050 km to 193+200 km, from 194+050 km to 194+900 km, from 194+900 km to 195+700 km, from 196+600 km to 197+100 km, from 202+200 km to 203+050 km, from 218+050 km to 219+250 km,) and C3.2 habitat (from 224+100 km to 226+900 km) reduces the impact to these habitats and produces an opportunity for habitat restoration, providing additional habitat for fauna species.

The project envisages the construction of crossings and access roads along the railway alignment. As outlined above, the construction of crossings and access roads is expected to have direct, negative impact on habitats. The predicted loss of habitats is illustrated under Figure 14-89 to Figure 14-116.

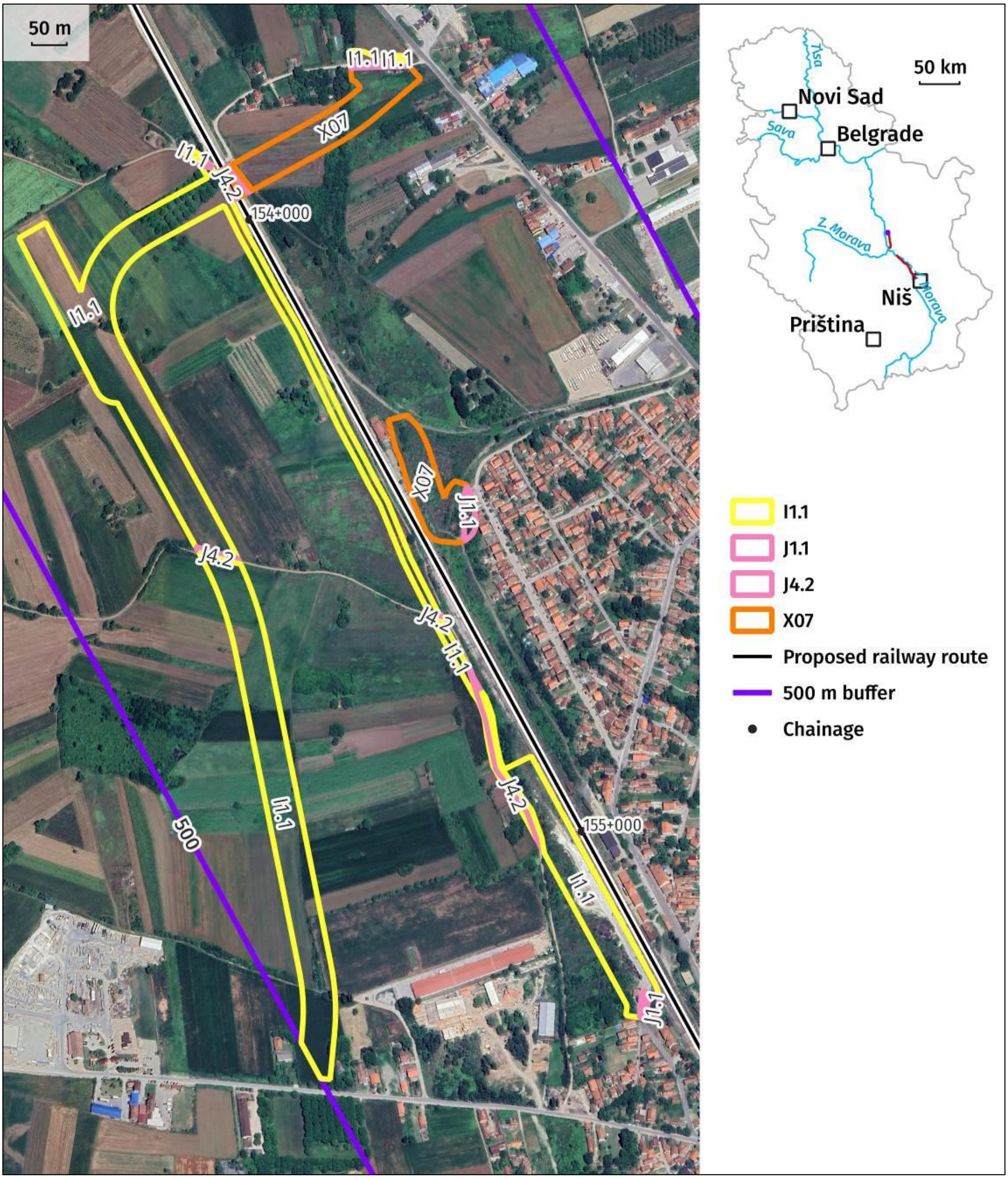


Figure 14-89. A crossing and access road at 153+942 km – Paraćin-Stalać subsection

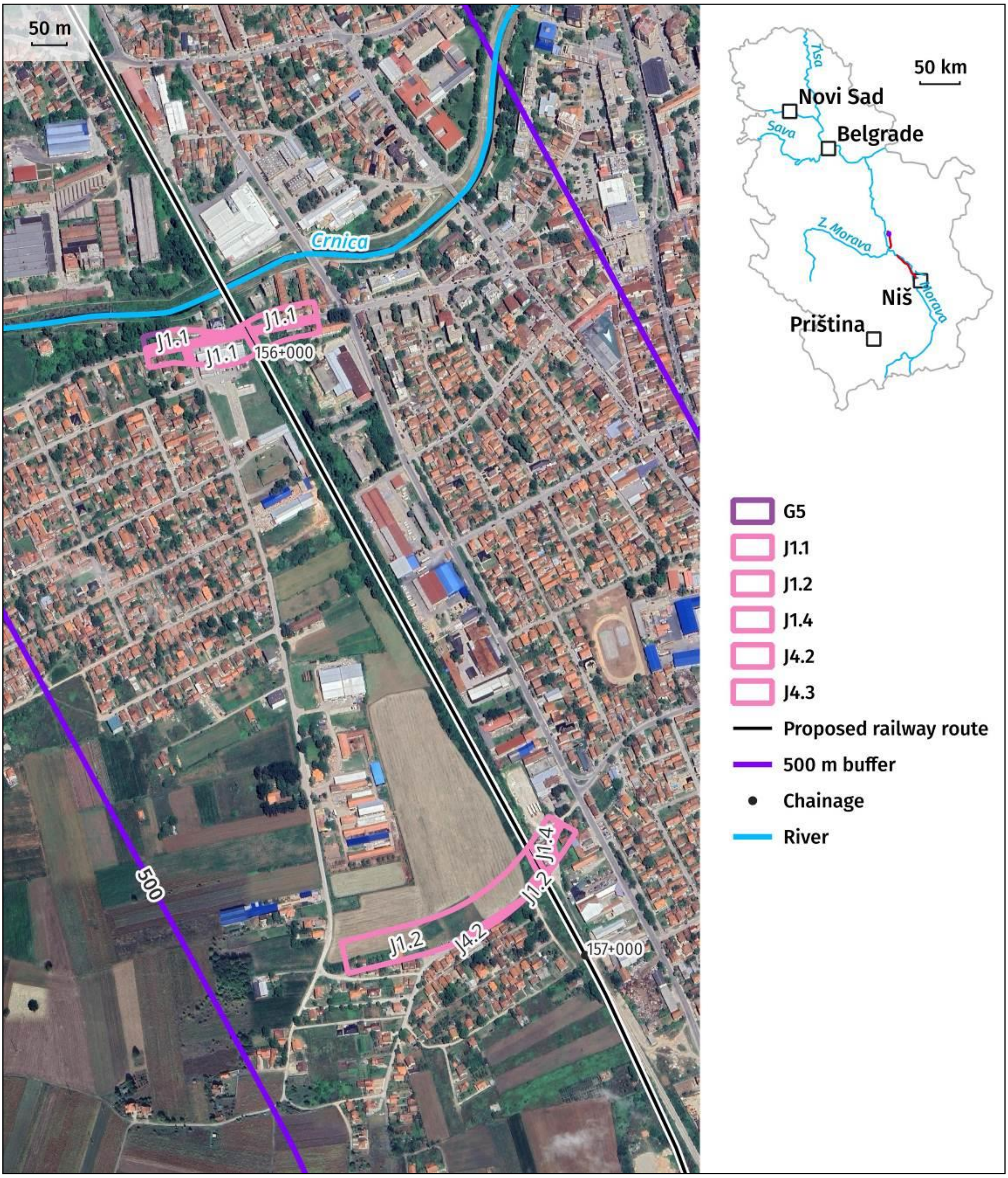


Figure 14-90. A crossings at 155+991 km and 156+852 km – Paraćin-Stalać subsection

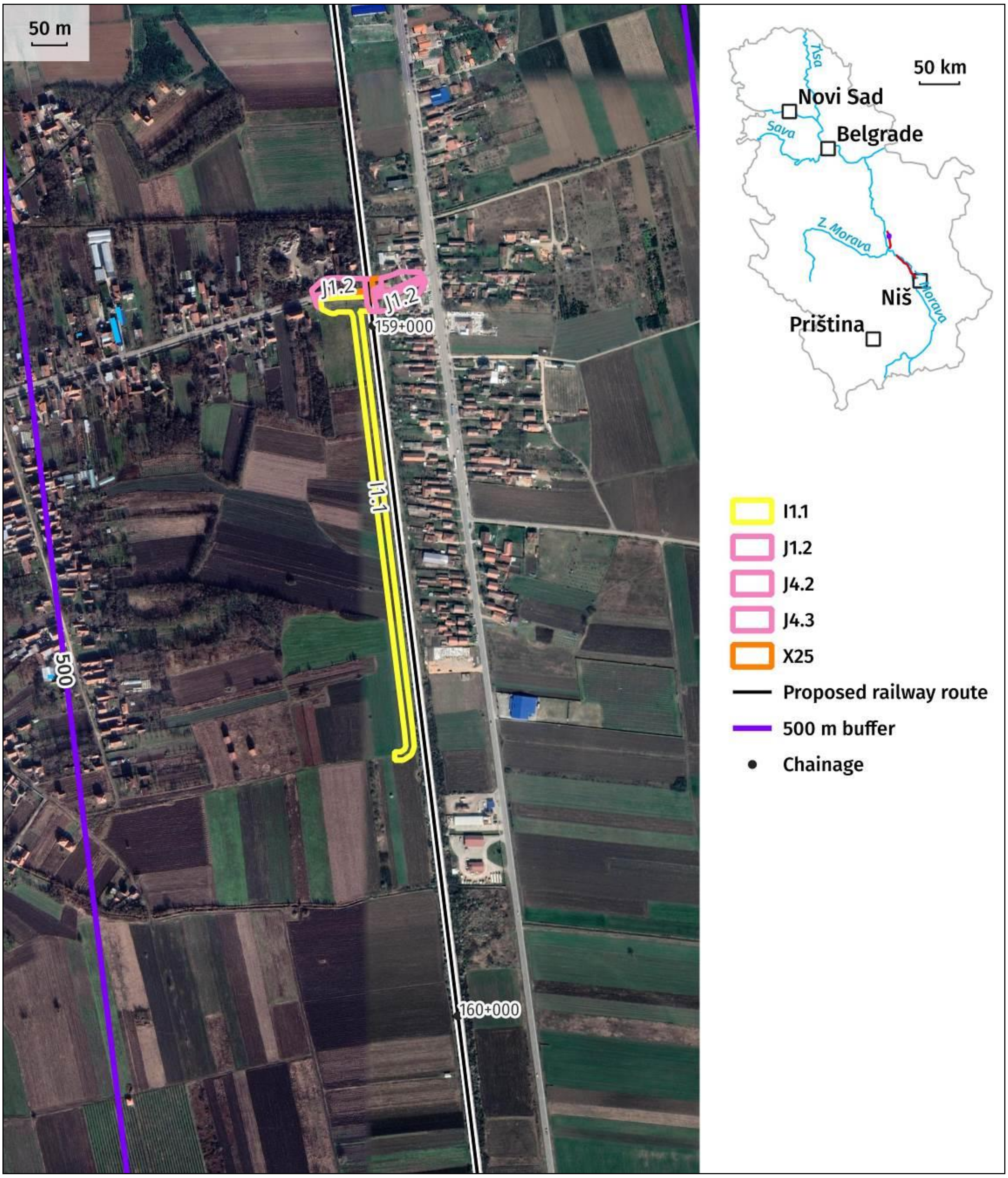


Figure 14-91. A crossing and access road at 158+955 km – Paraćin-Stalać subsection

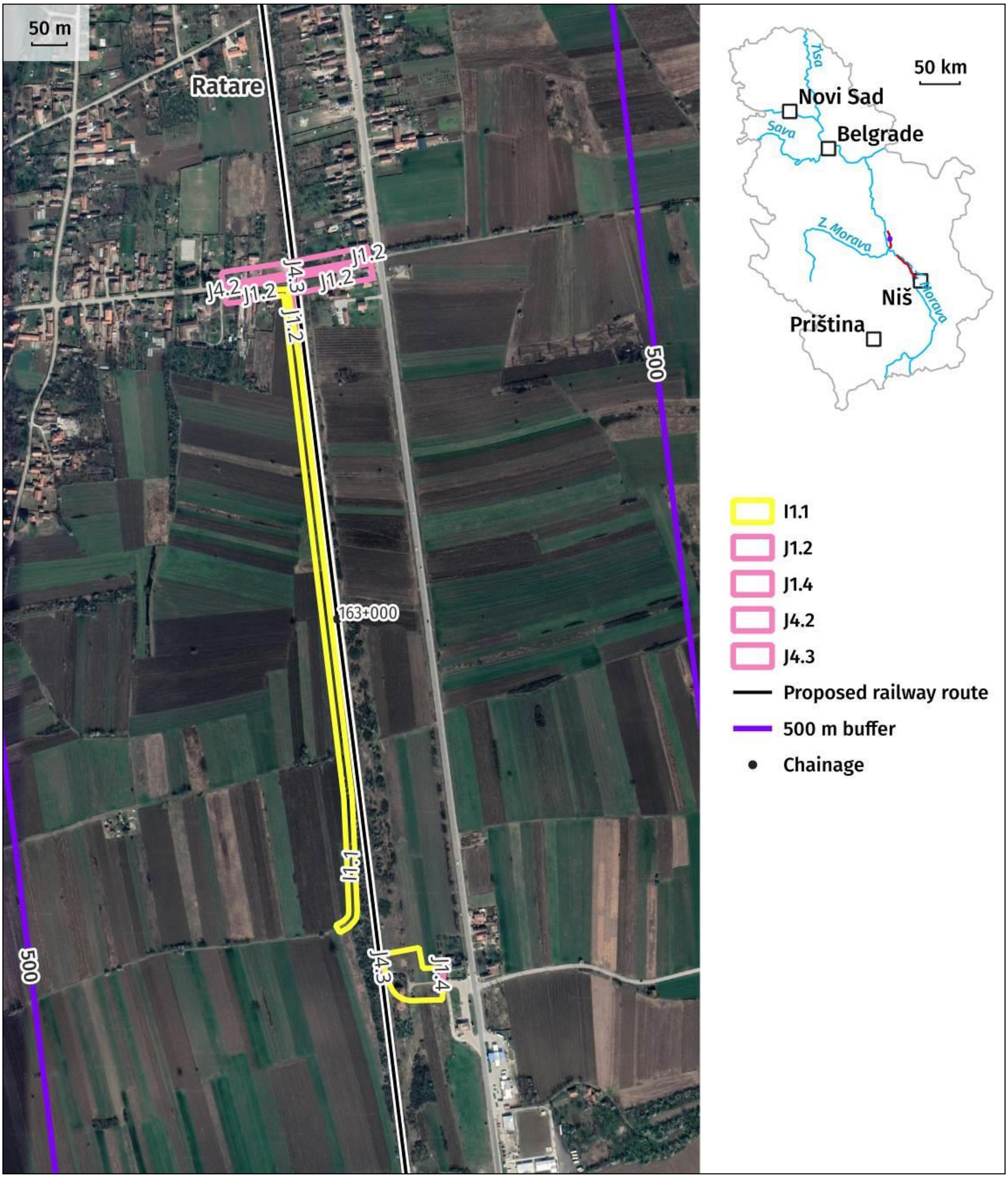


Figure 14-92. A crossing and access road at 162+505 km – Paraćin-Stalać subsection

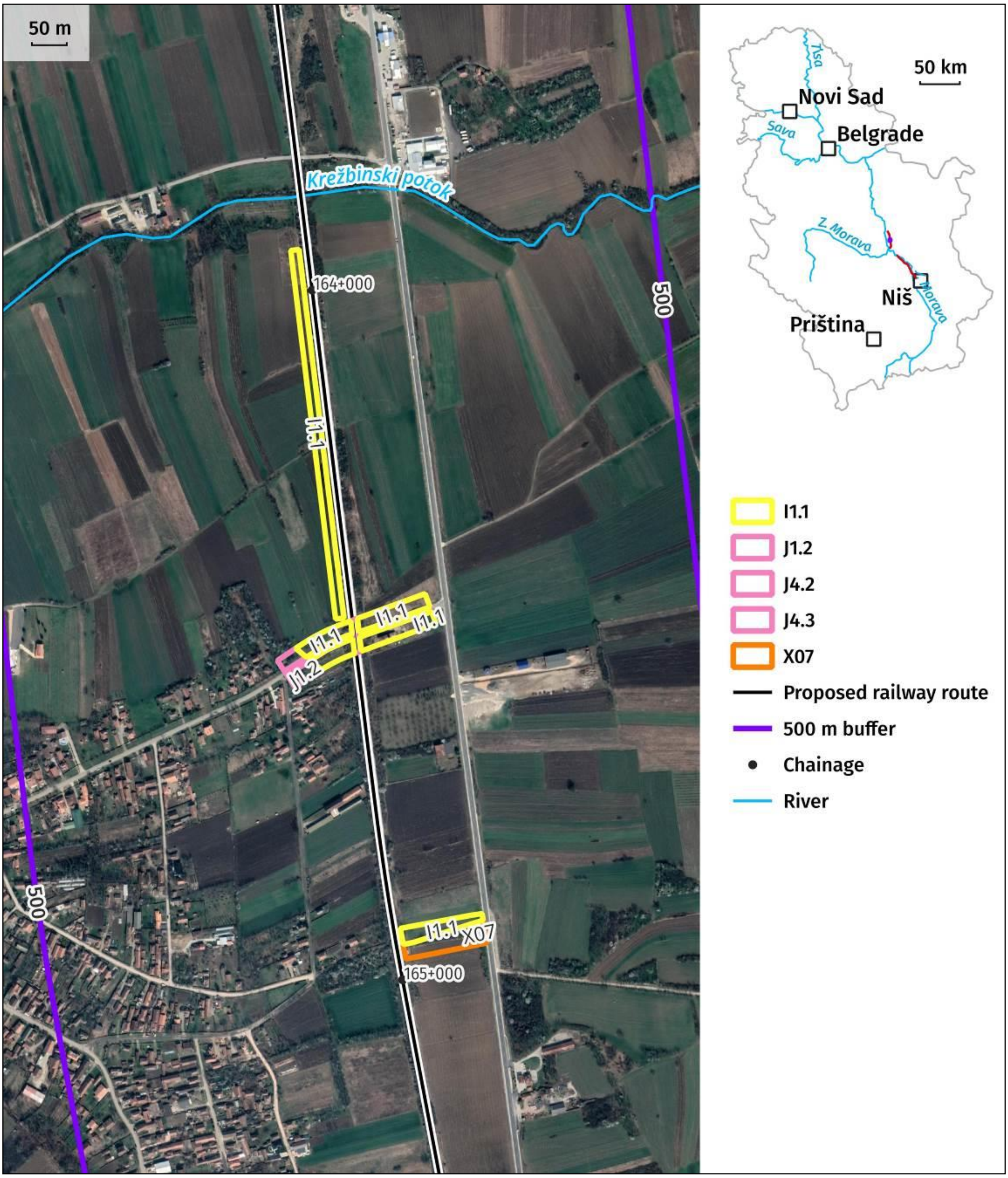


Figure 14-93. A crossing and access road at 164+503 km – Paraćin-Stalać subsection

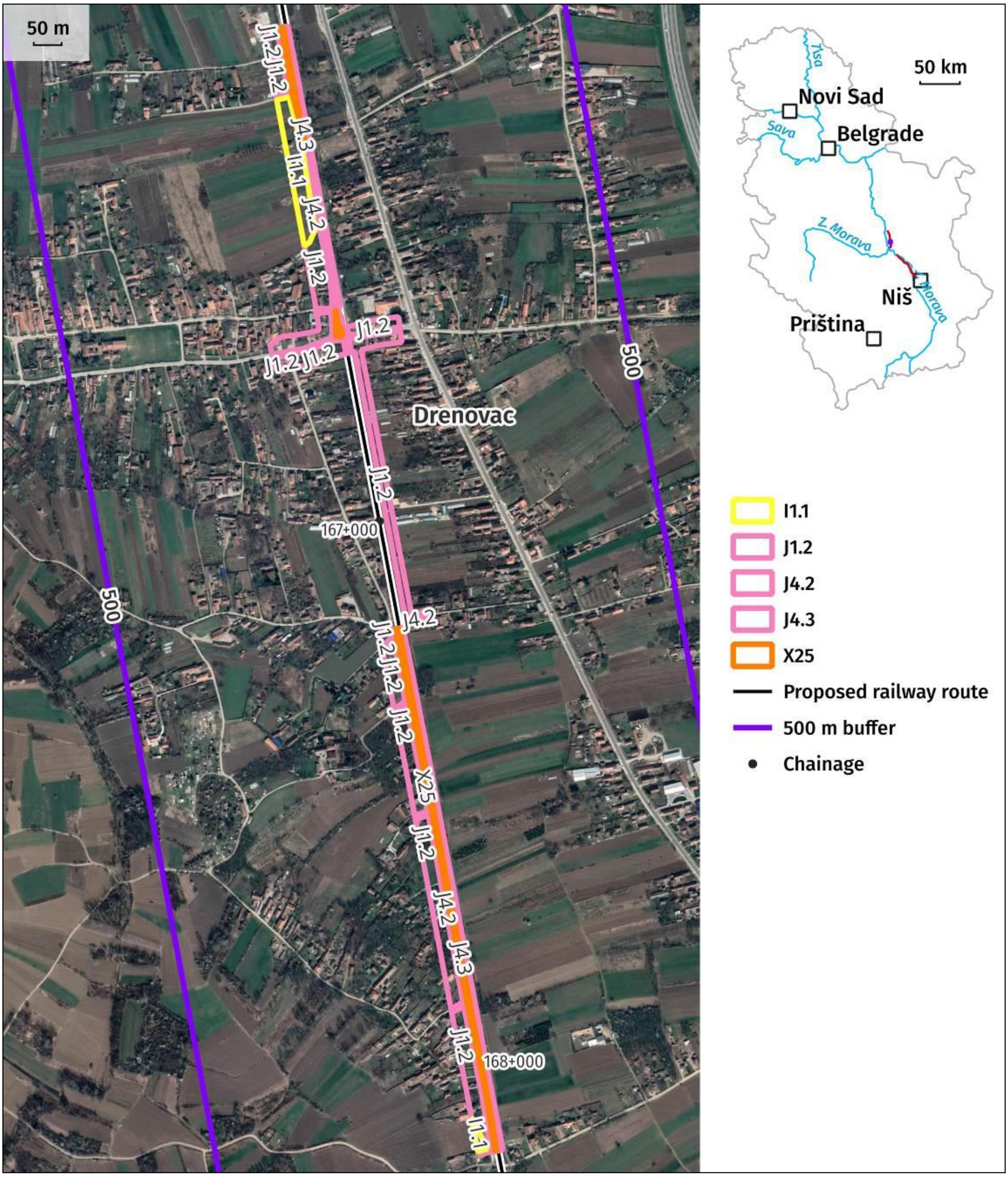


Figure 14-94. A crossing and access roads at 166+670 km – Paraćin-Stalać subsection

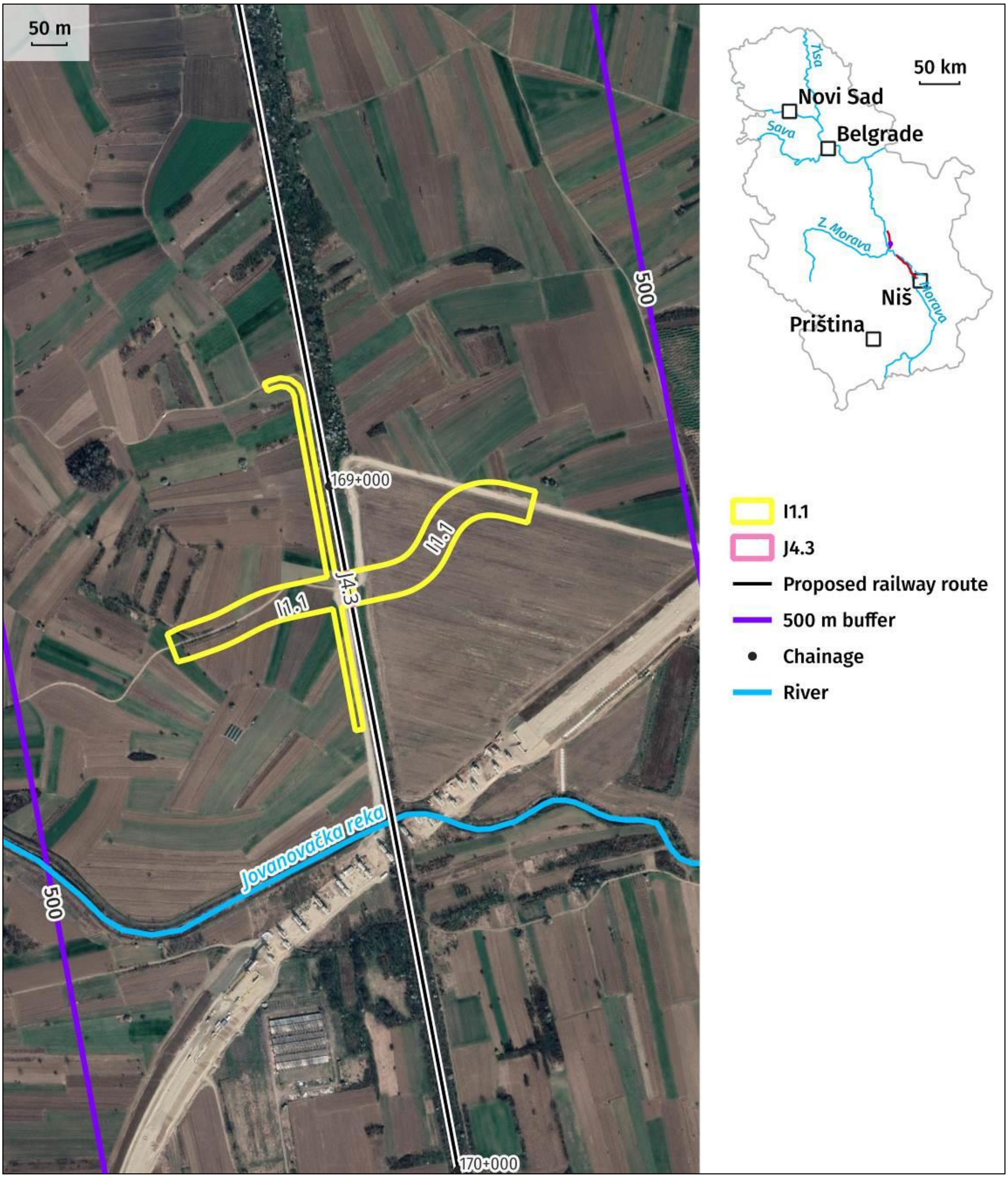


Figure 14-95. A crossing and access road at 169+151 km – Paraćin-Stalać subsection

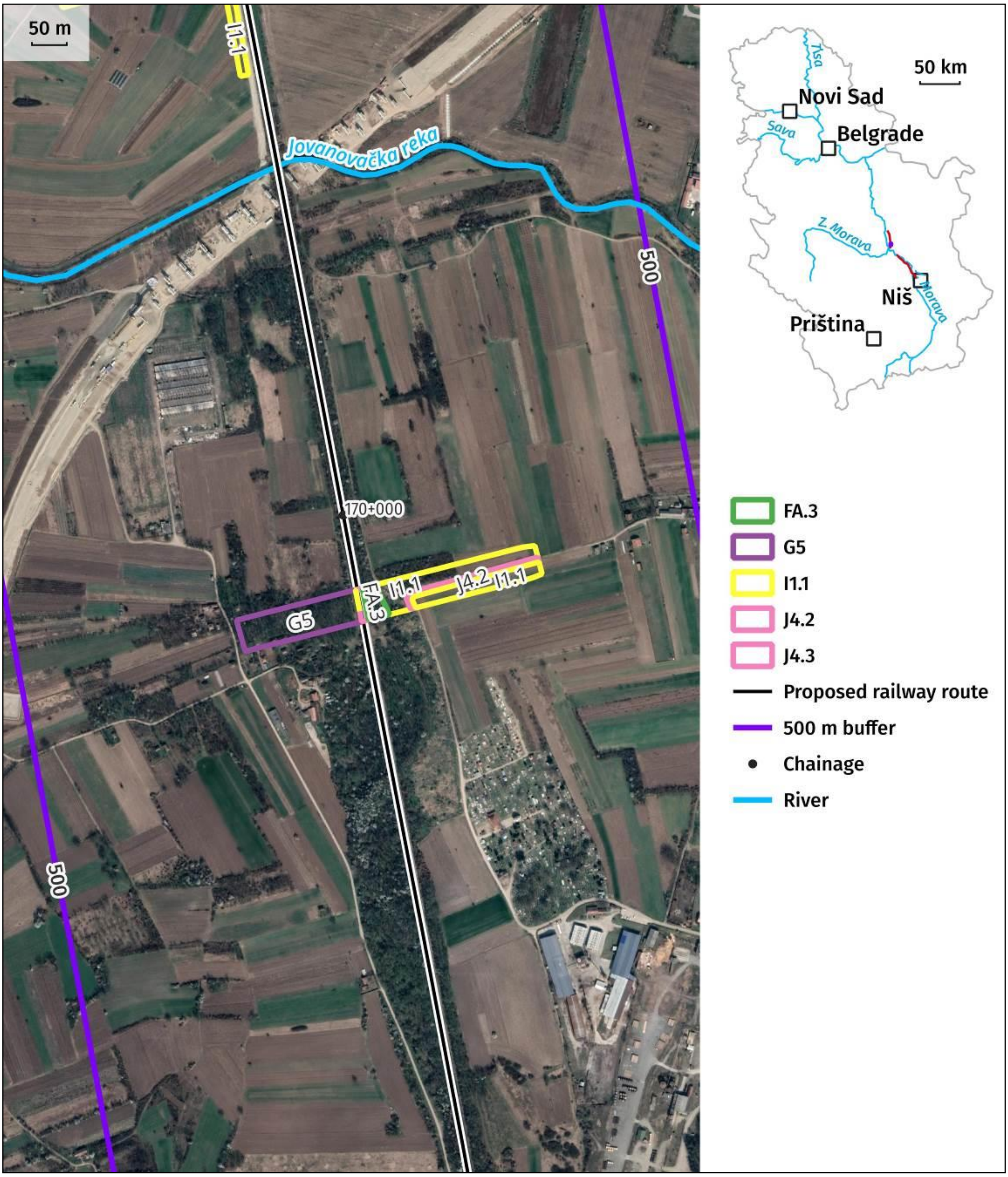


Figure 14-96. A crossing and access road at 170+132 km – Paraćin-Stalać subsection

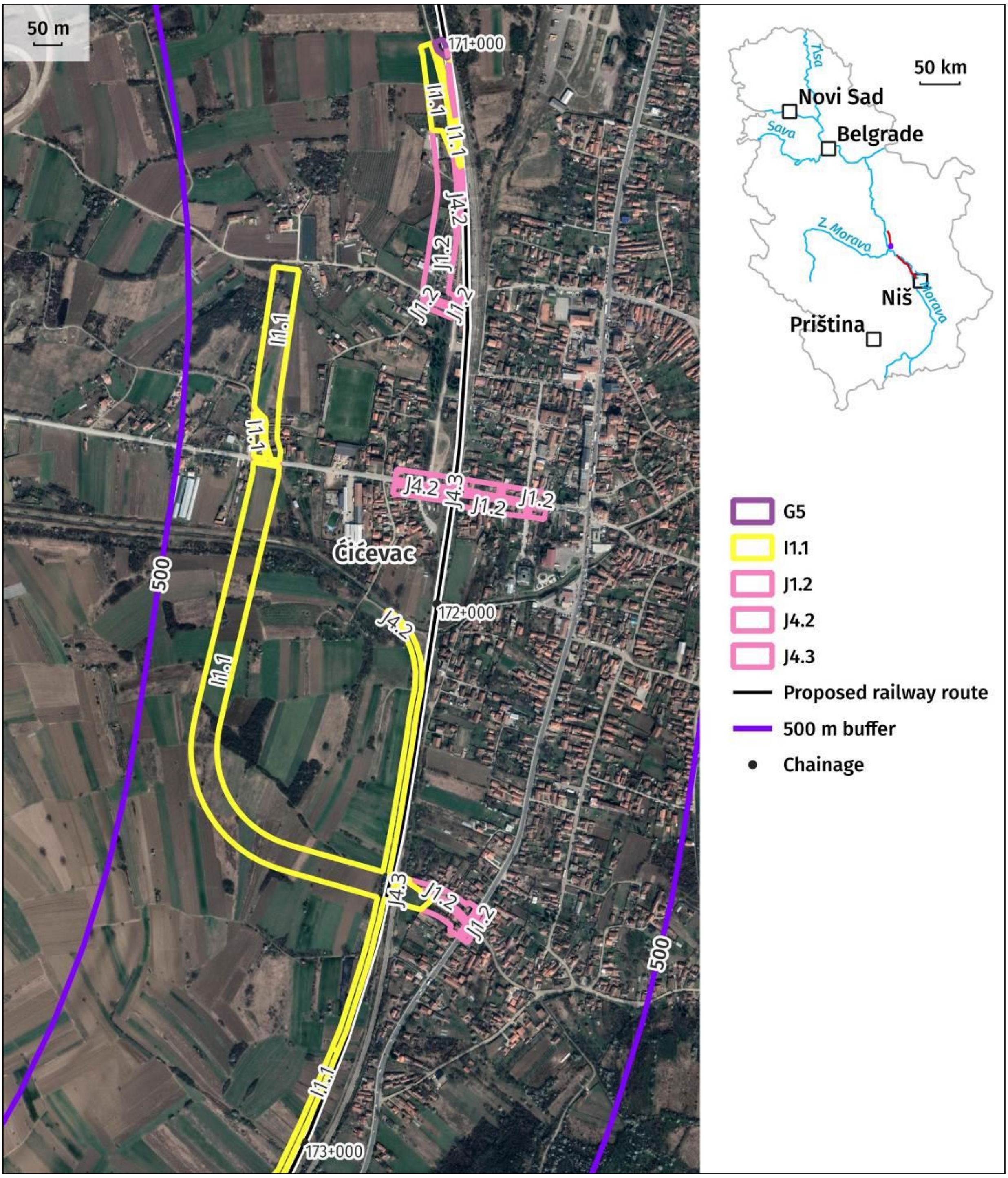


Figure 14-97. The crossings and access road at 171+793 km and 172+516 km – Paraćin-Stalać subsection

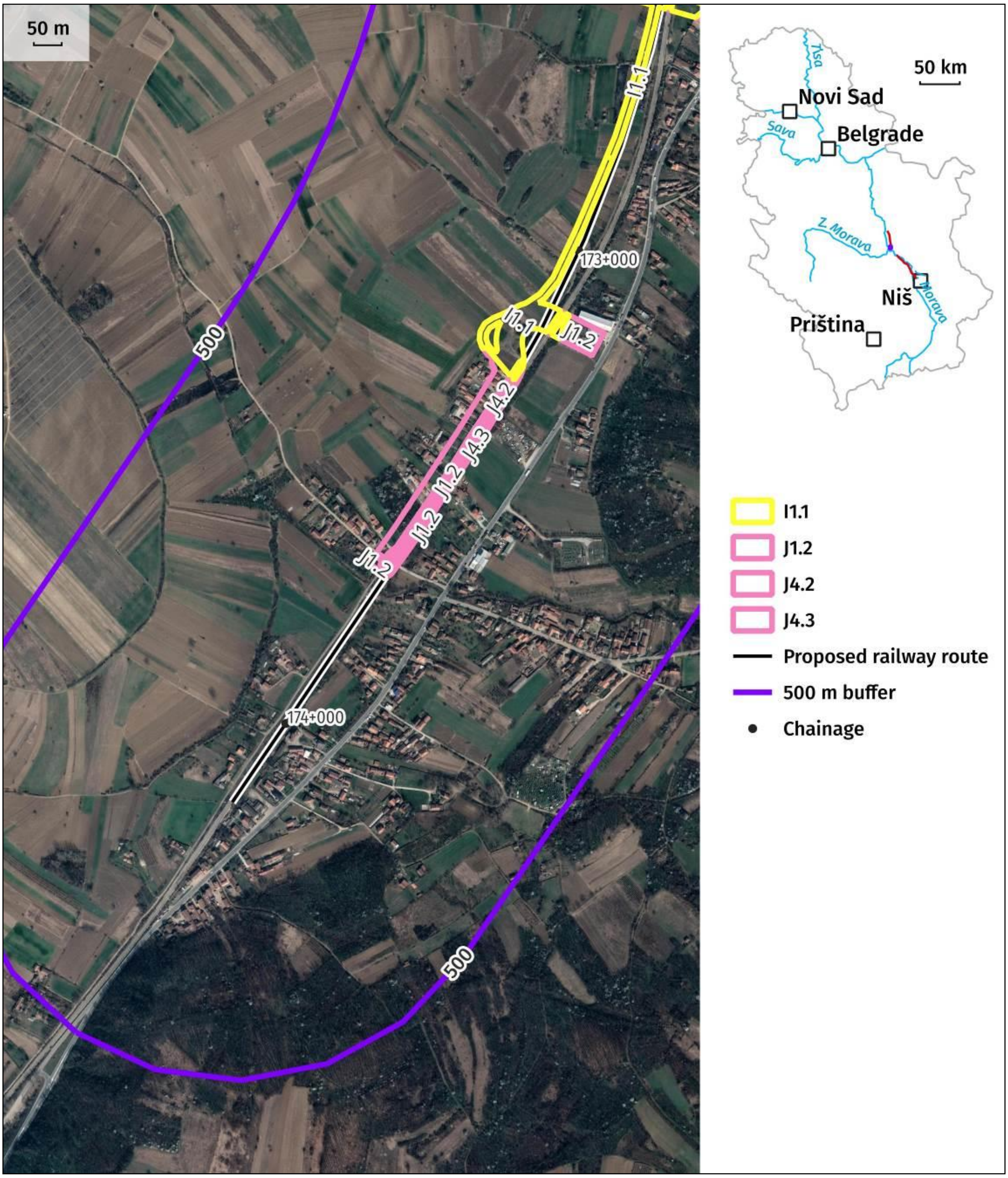


Figure 14-98. A crossing and access road at 173+134 km – Paraćin-Stalać subsection

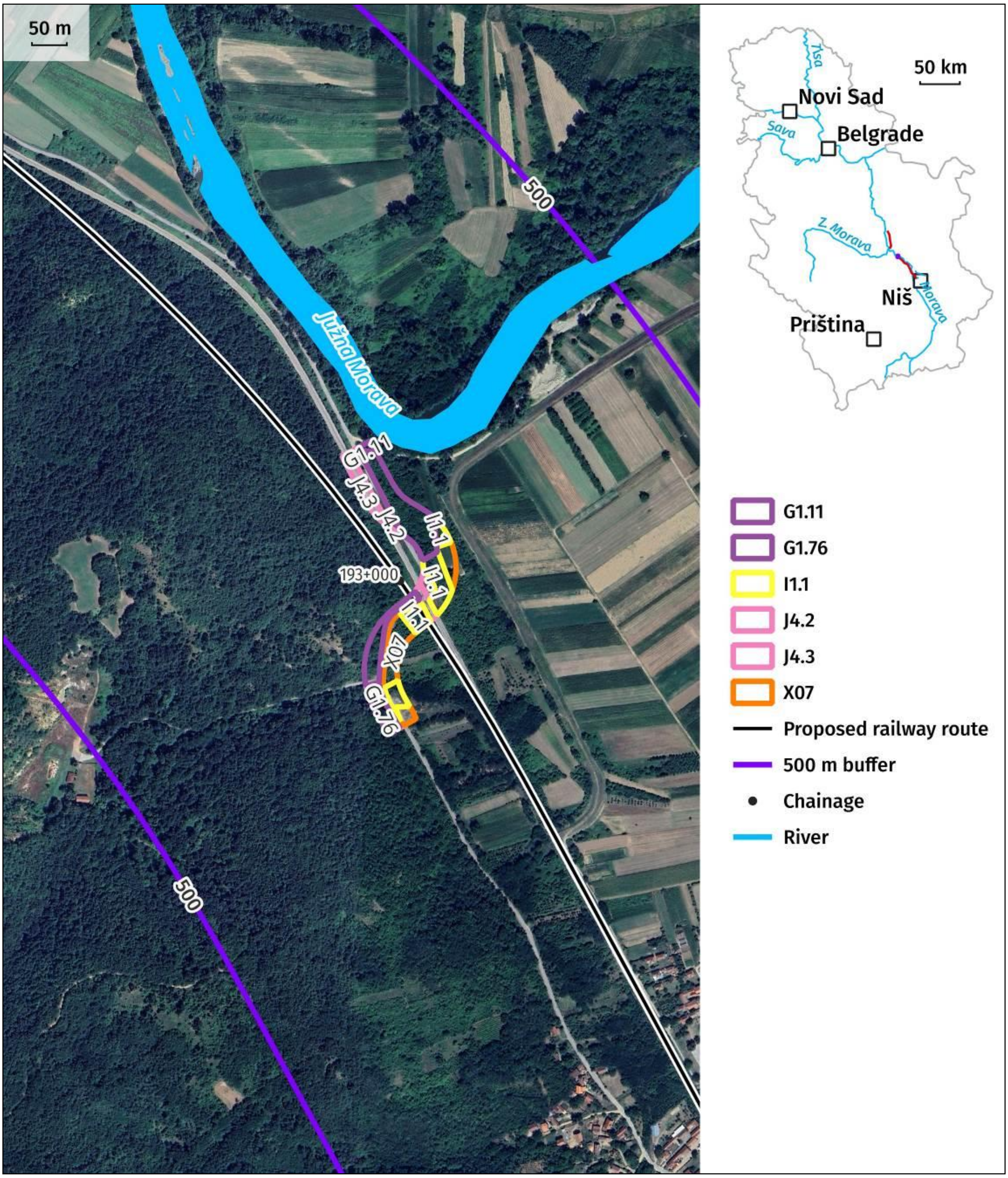


Figure 14-99. A crossing at 193+052 km – Đunis-Trupale subsection

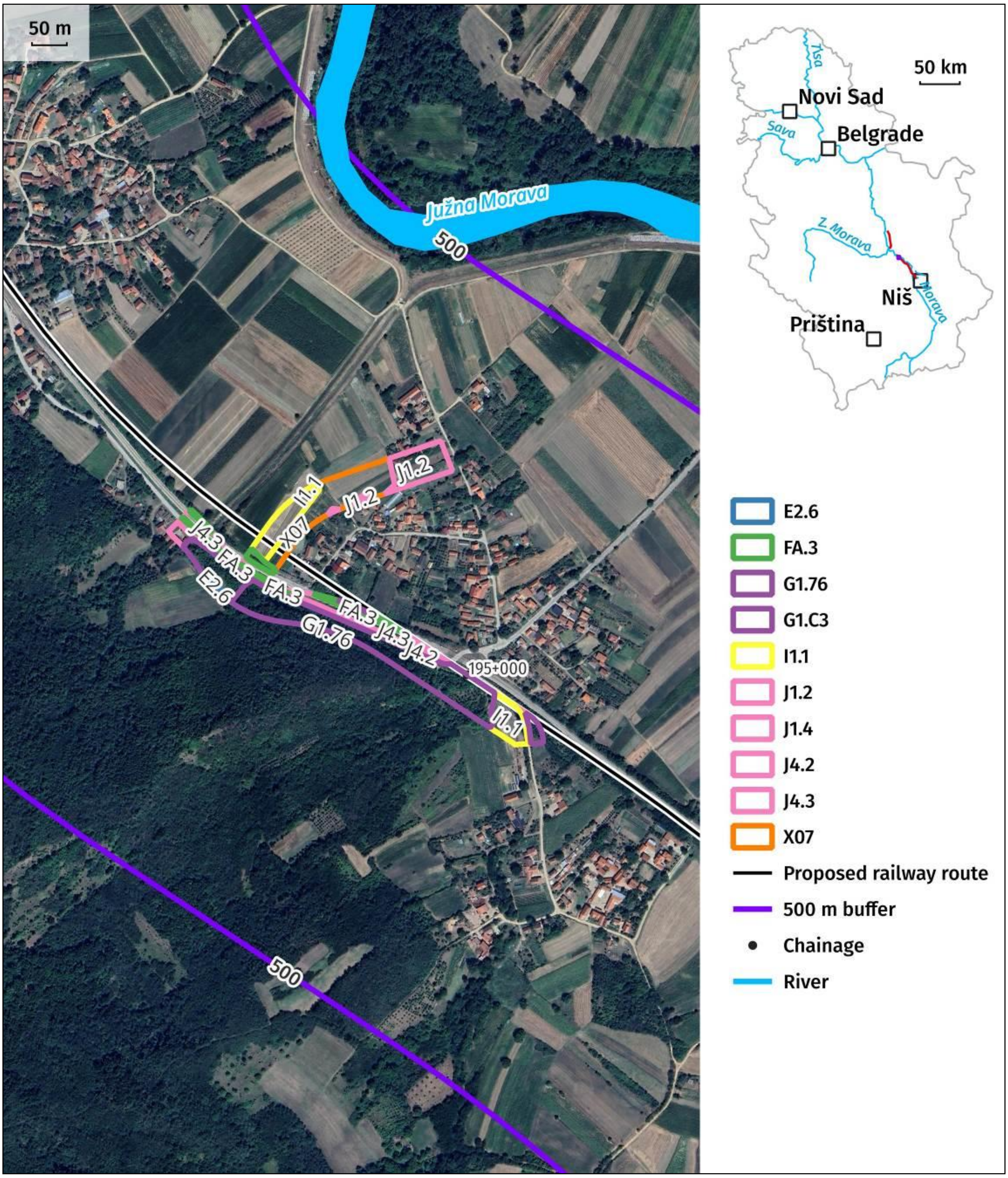


Figure 14-100. A crossing at 194+666 km – Đunis-Trupale subsection

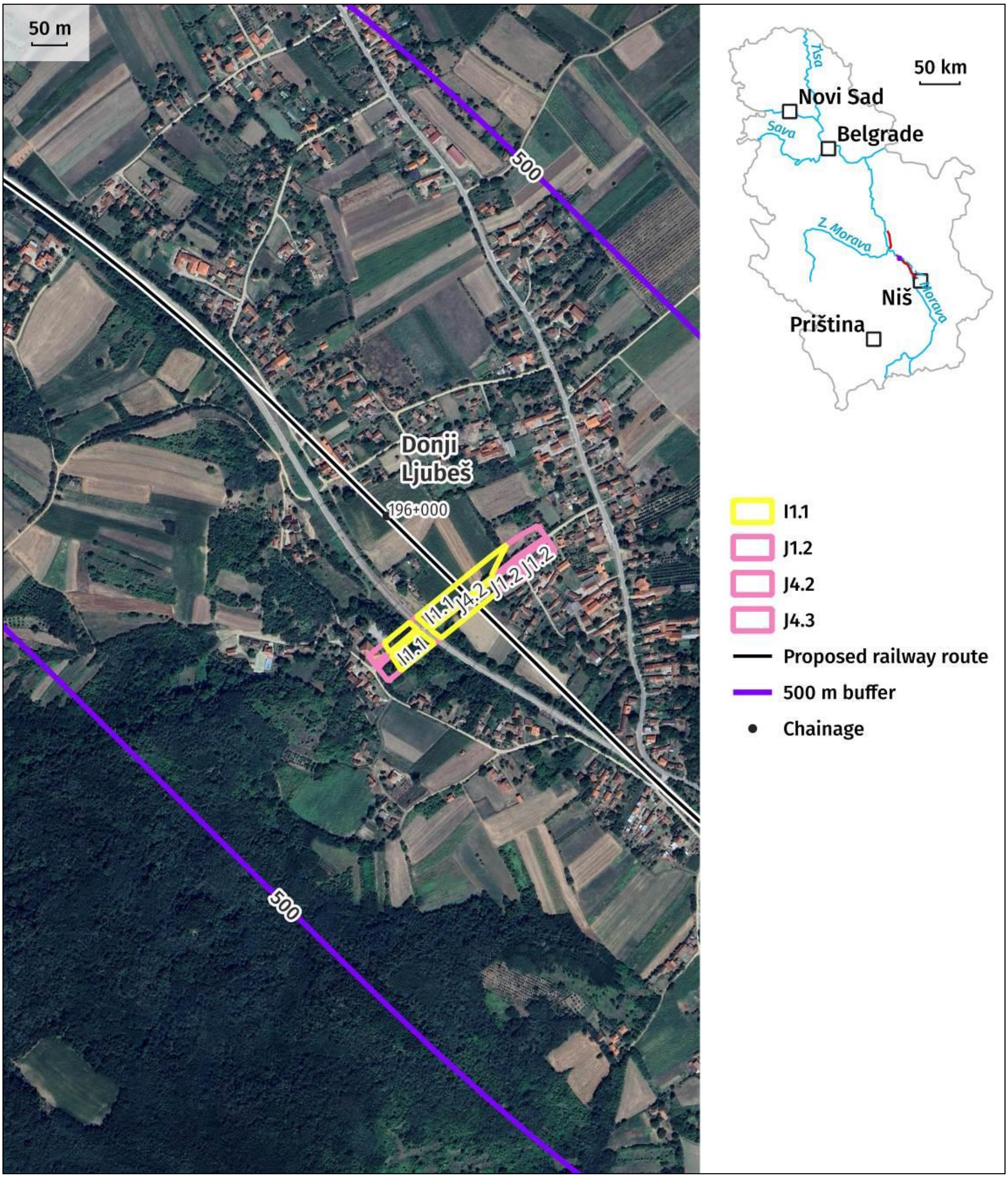


Figure 14-101. A crossing at 196+165 km – Đunis-Trupale subsection

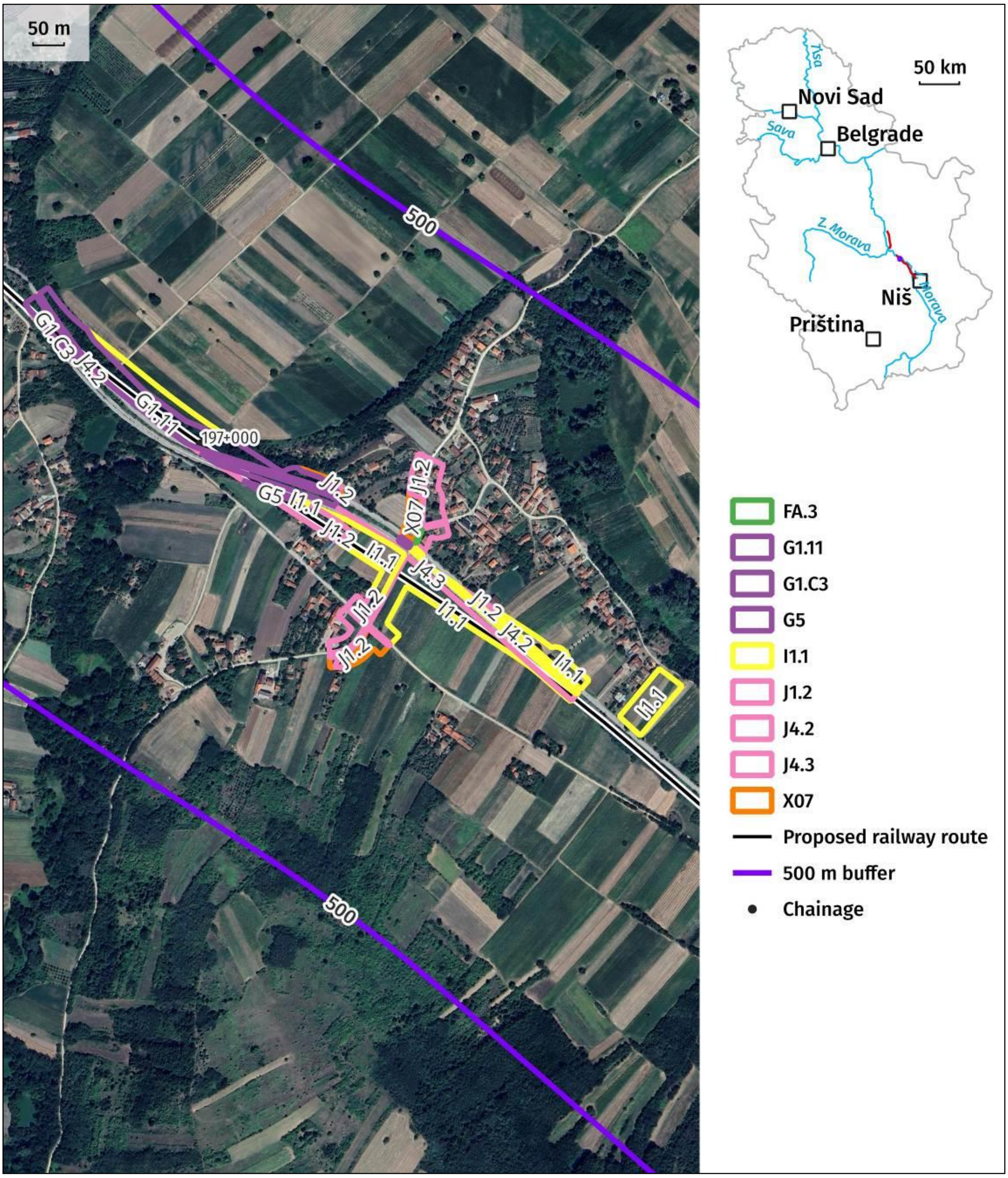


Figure 14-102. A crossing and access road at 197+384 km – Đunis-Trupale subsection

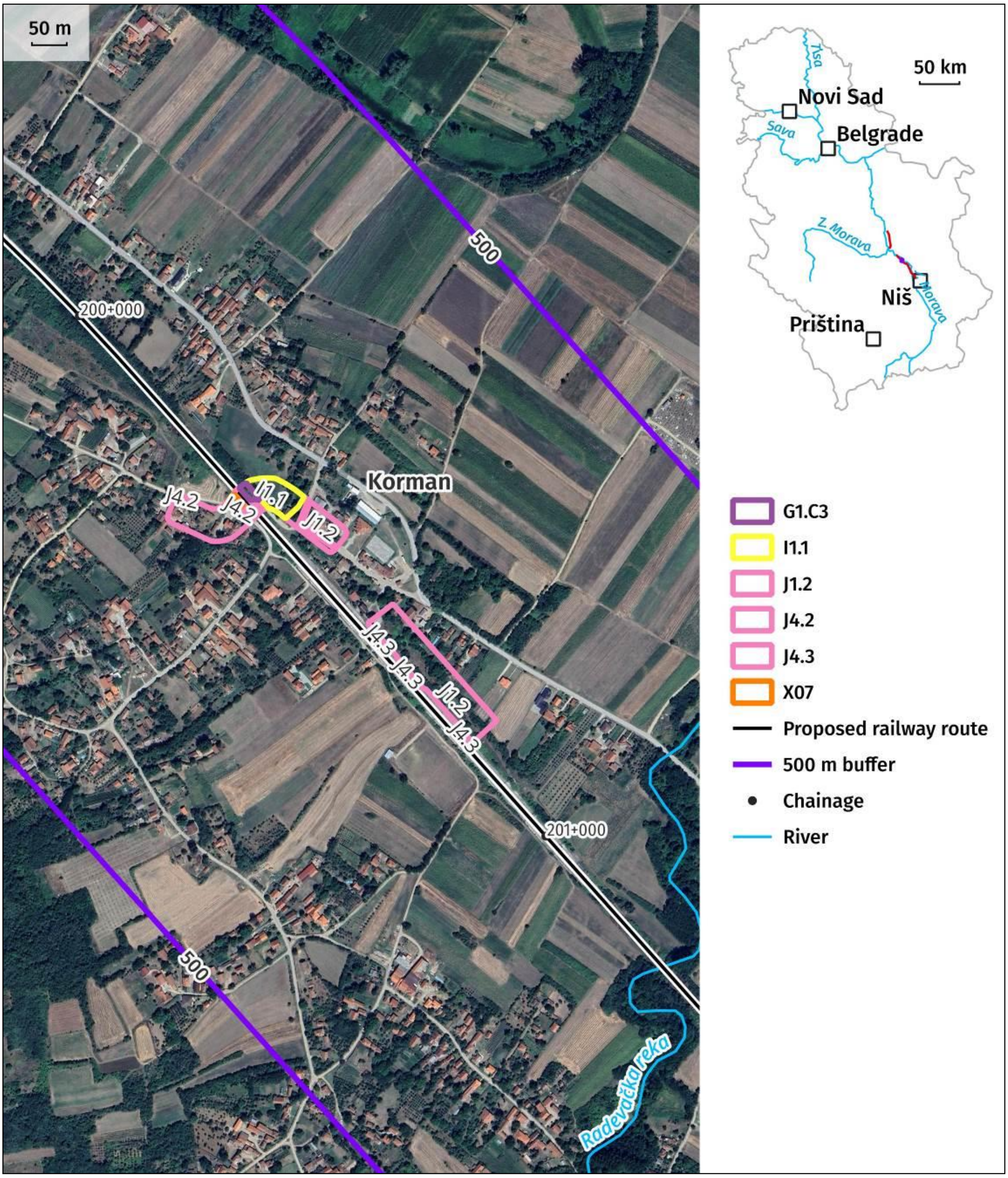


Figure 14-103. A crossing at 200+278 km – Đunis-Trupale subsection

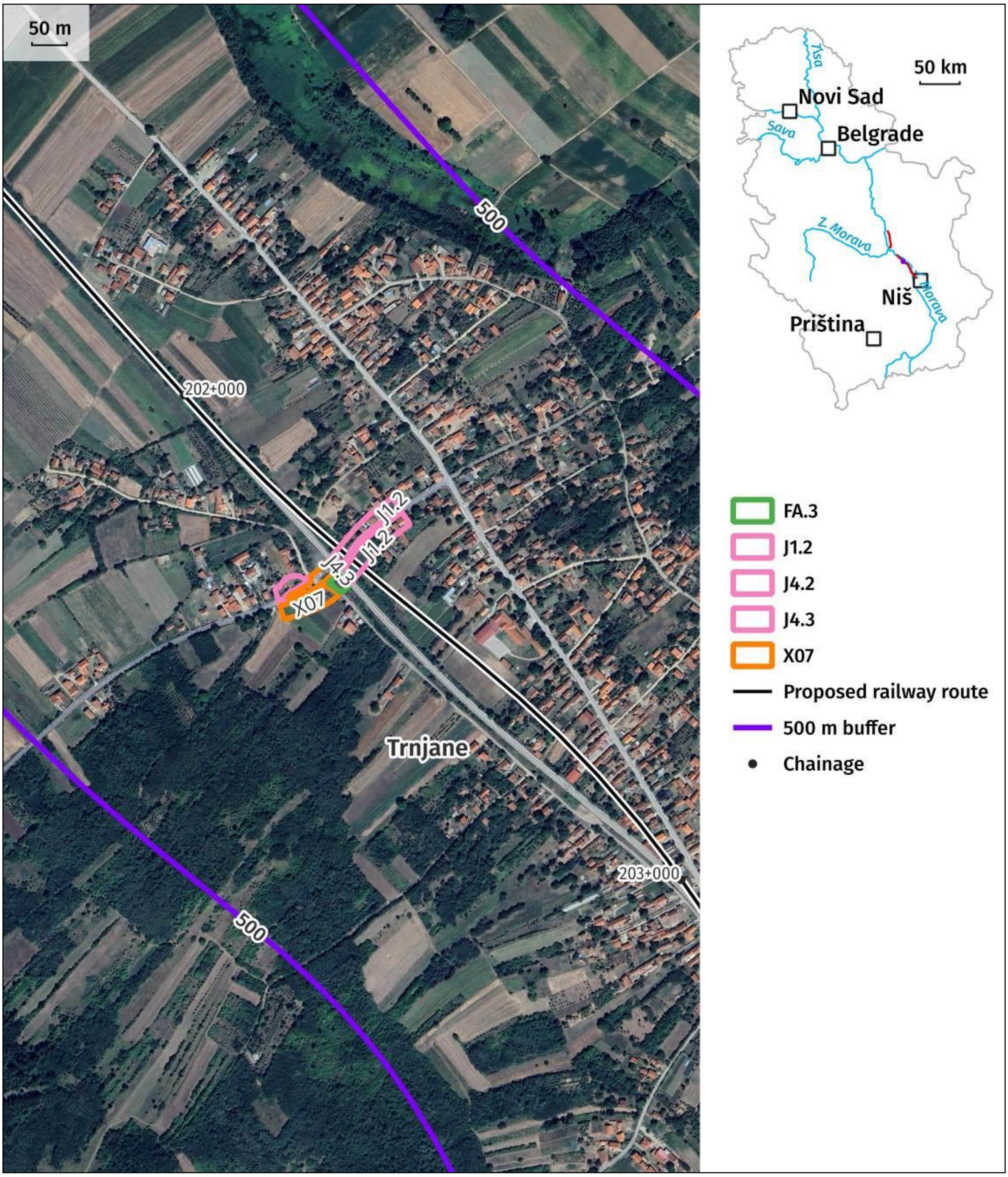


Figure 14-104. A crossing at 202+340 km – Đunis-Trupale subsection

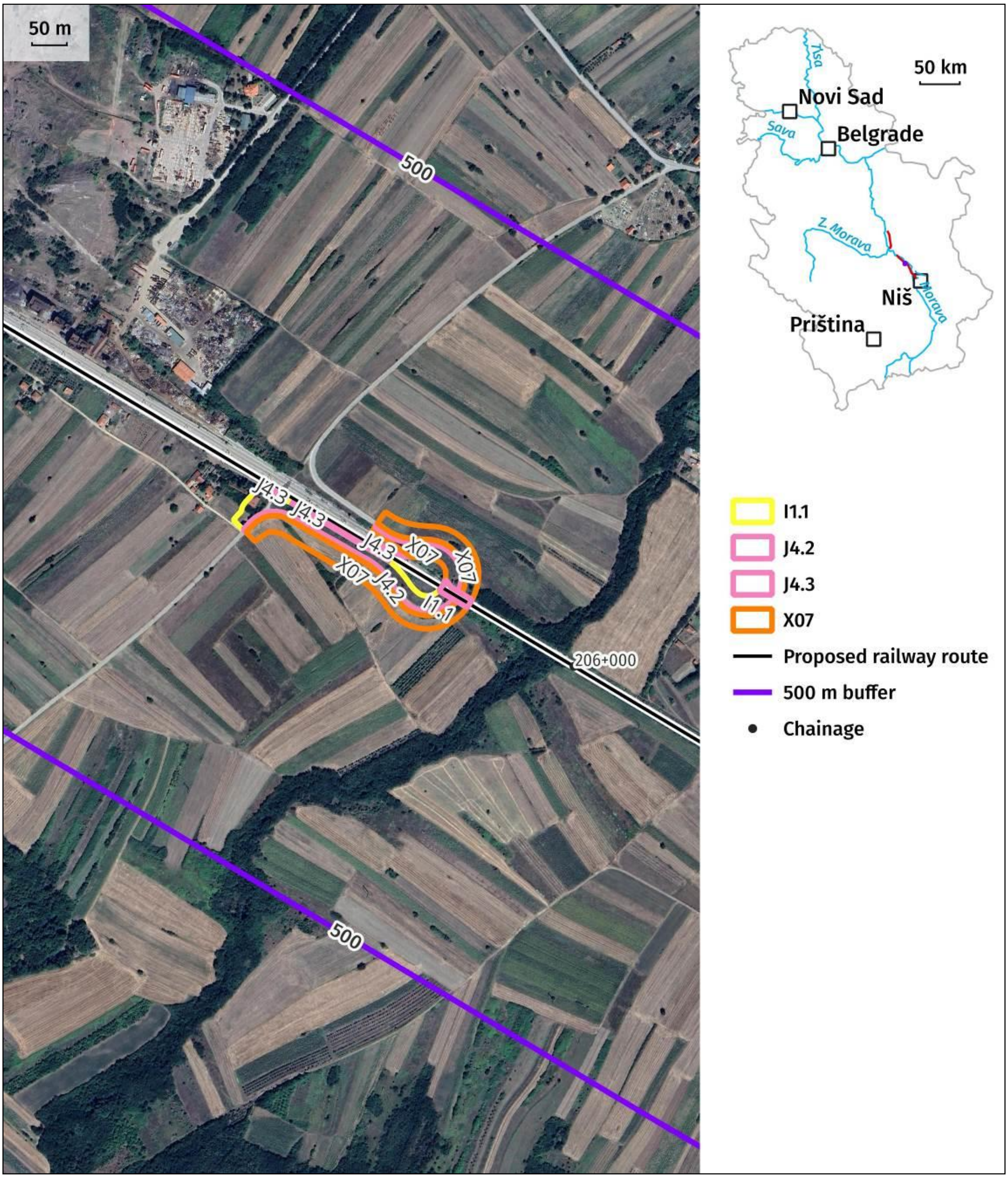


Figure 14-105. A crossing at 205+802 km – Đunis-Trupale subsection

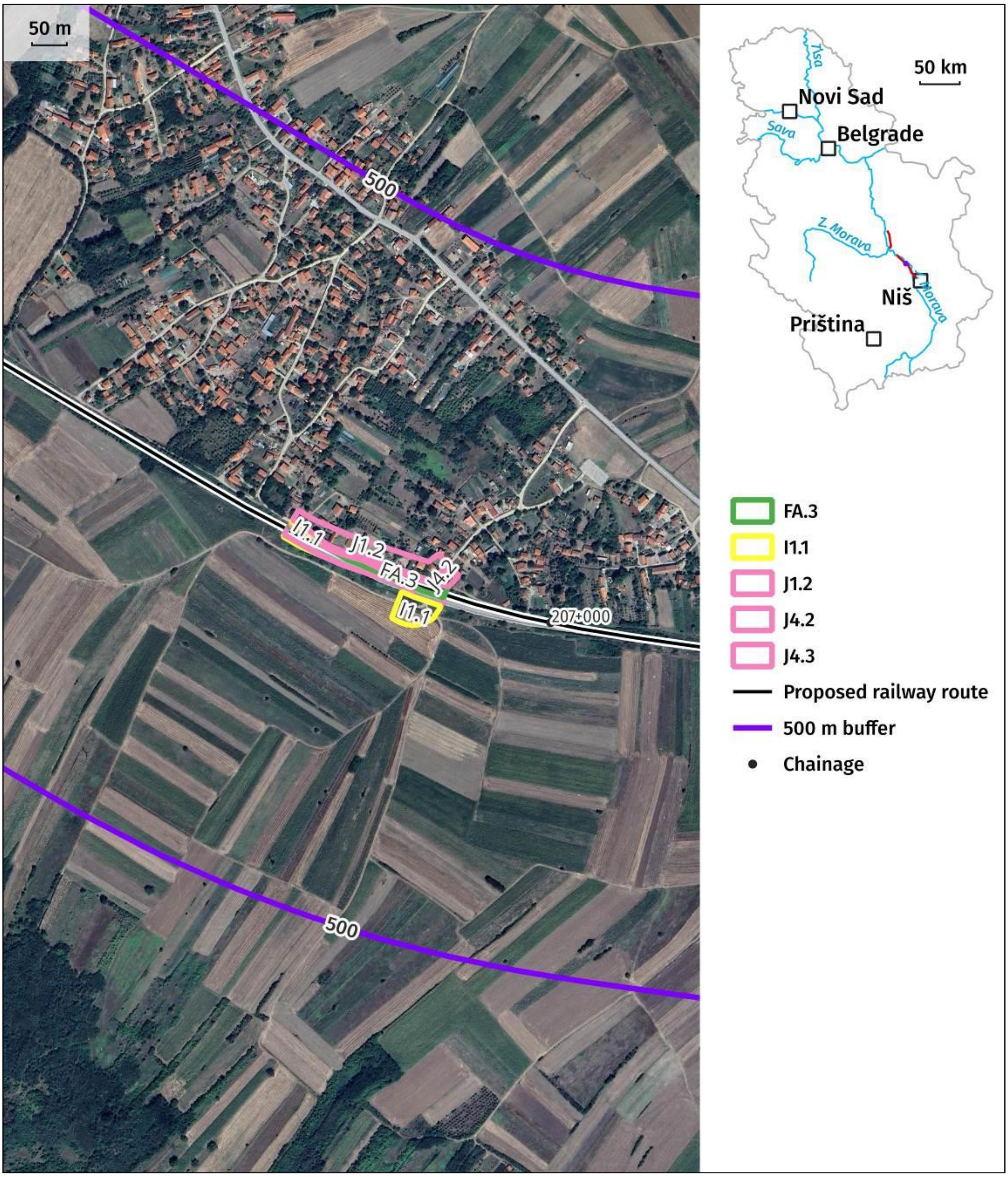


Figure 14-106. A crossing at 206+822 km – Đunis-Trupale subsection

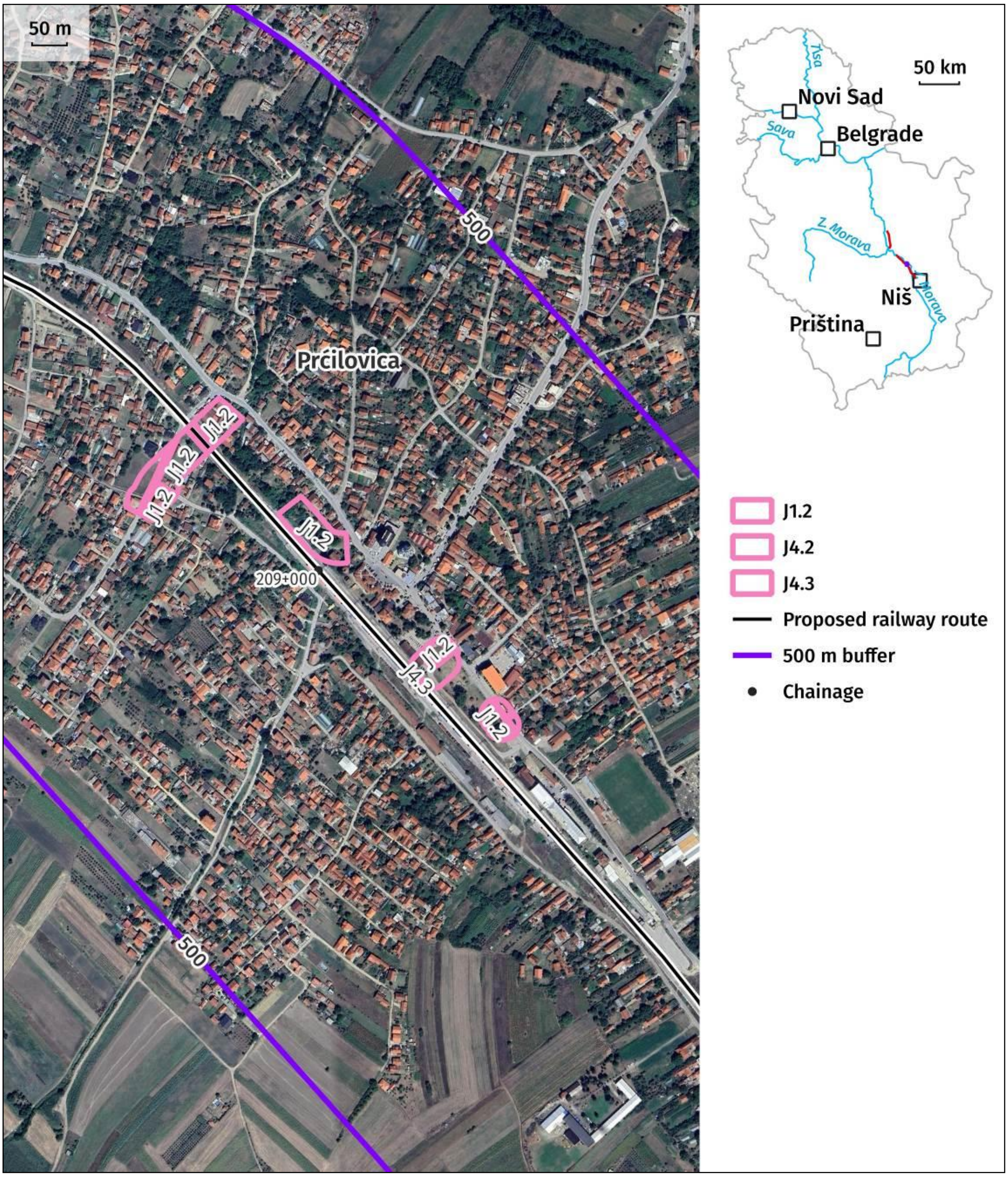


Figure 14-107. A crossing at 208+746 km – Đunis-Trupale subsection

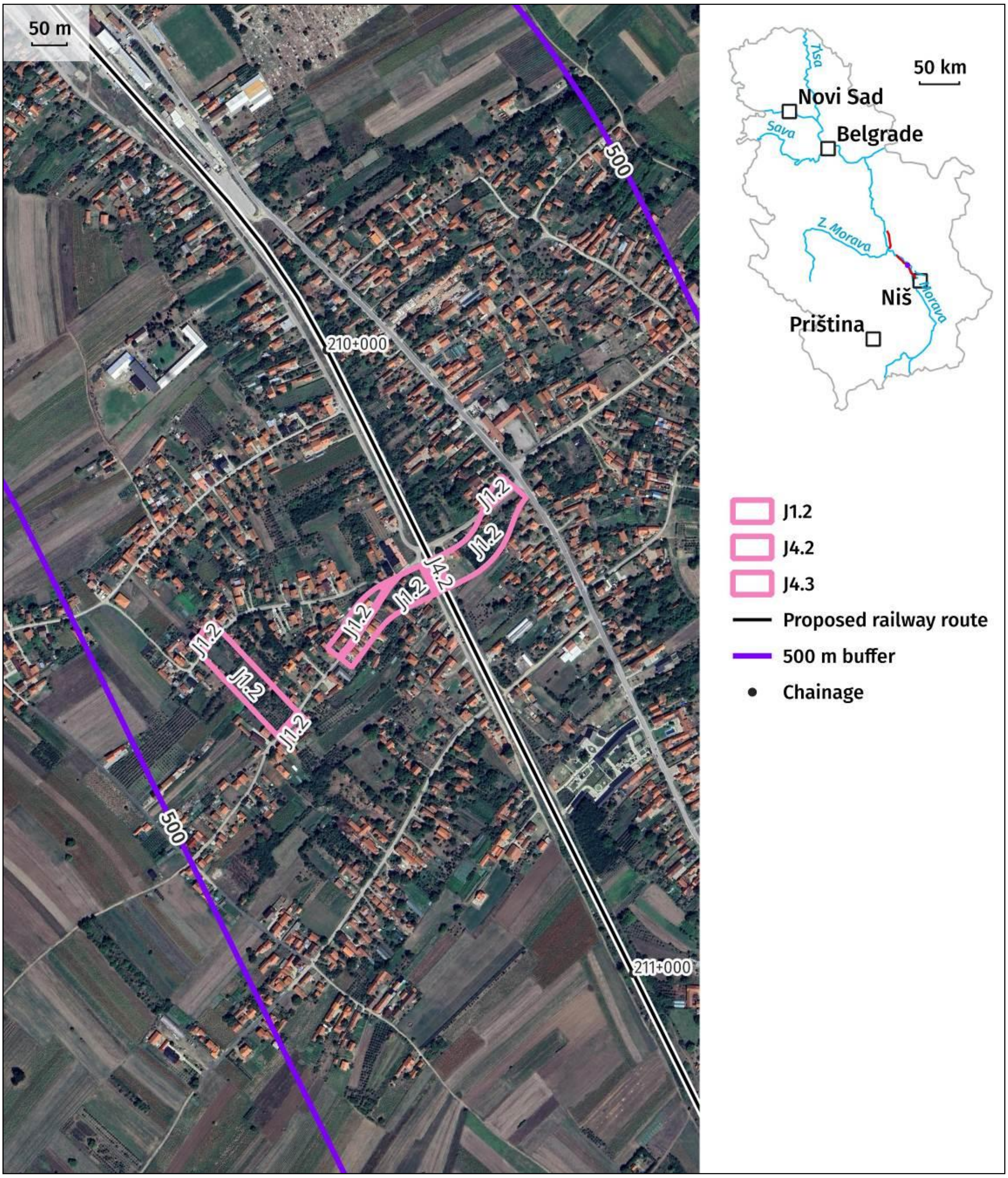


Figure 14-108. A crossing and access road at 210+361 km – Đunis-Trupale subsection

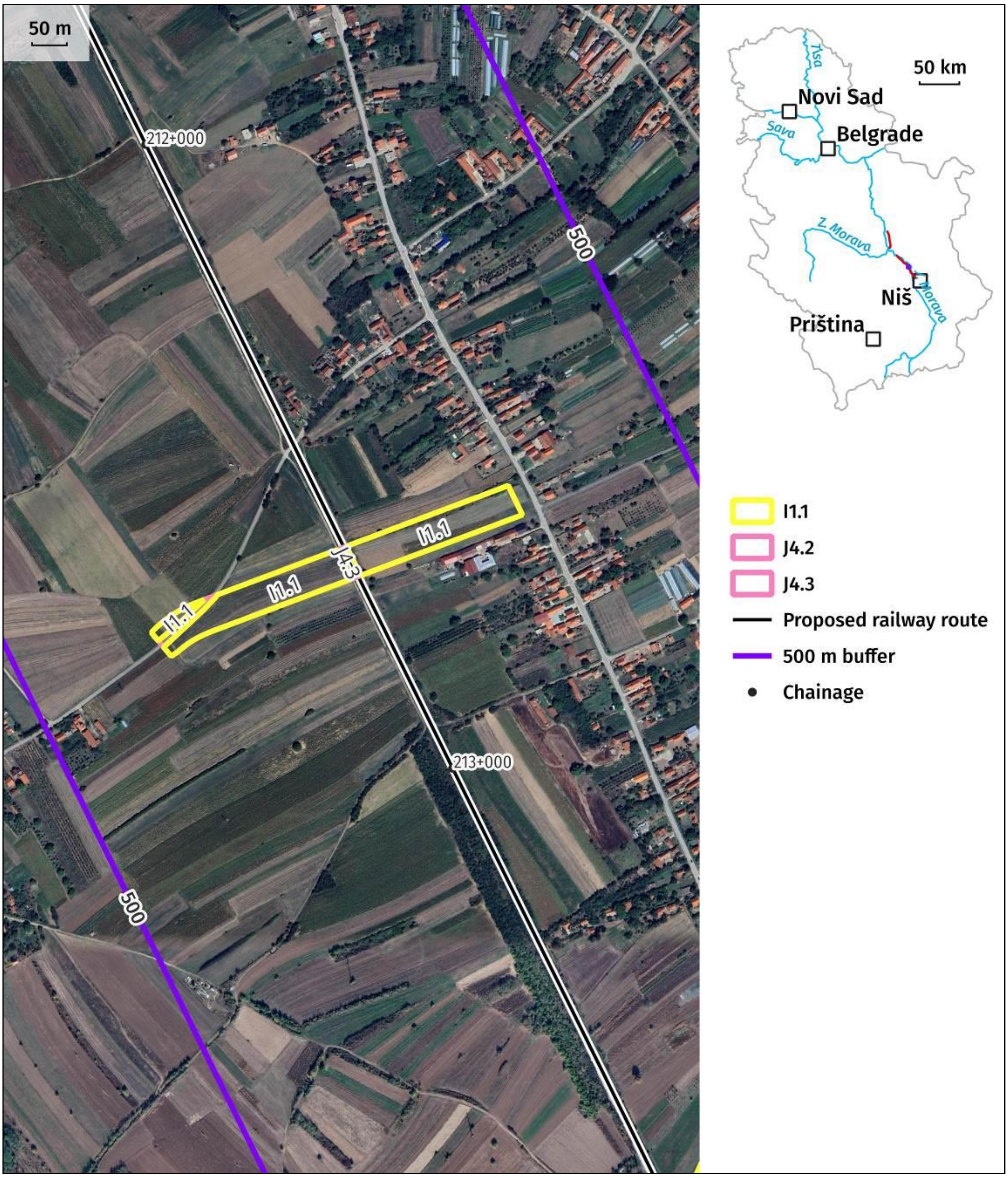


Figure 14-109. A crossing at 212+668 km – Đunis-Trupale subsection

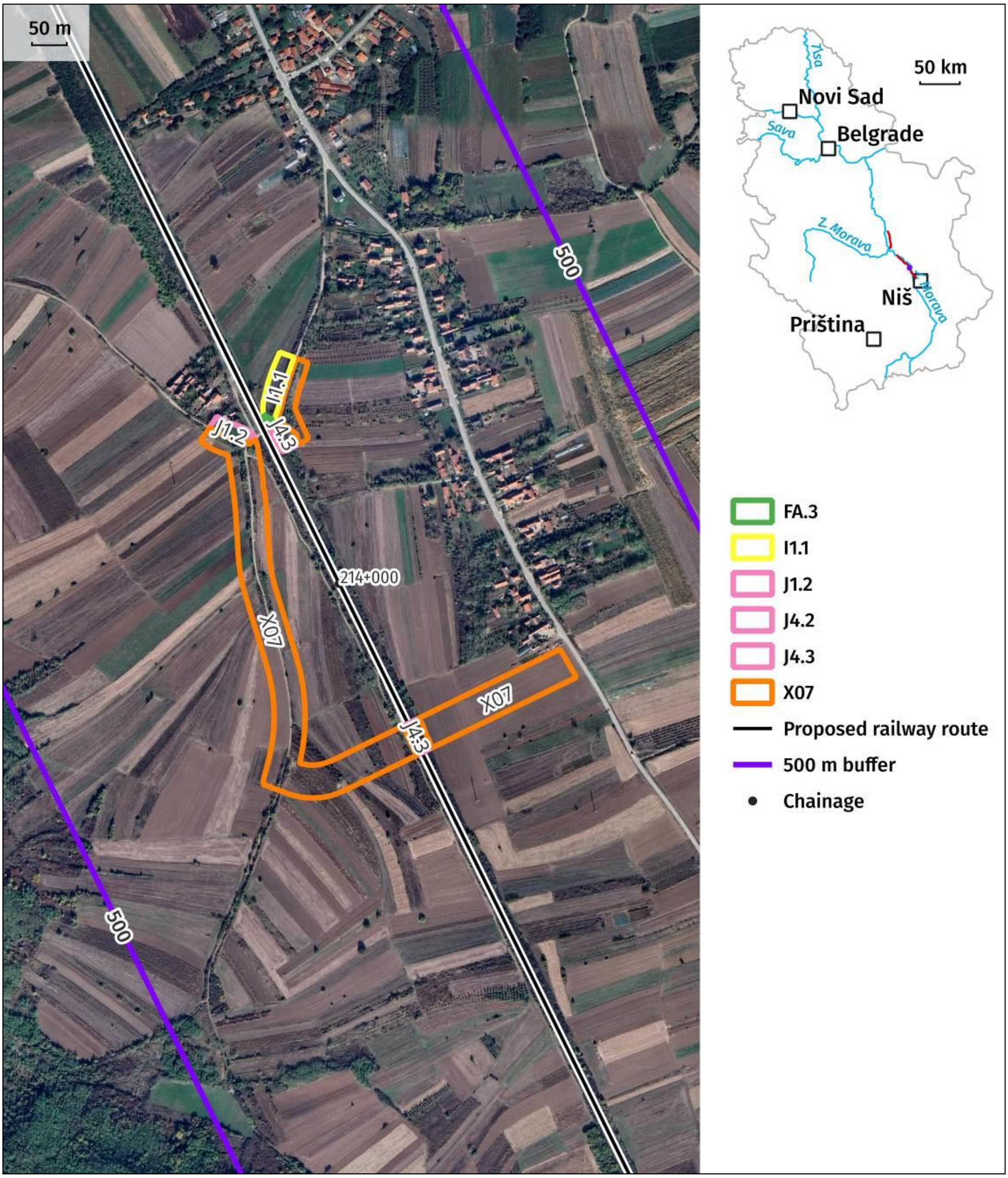


Figure 14-110. A crossing and access road at 214+250 km – Đunis-Trupale subsection

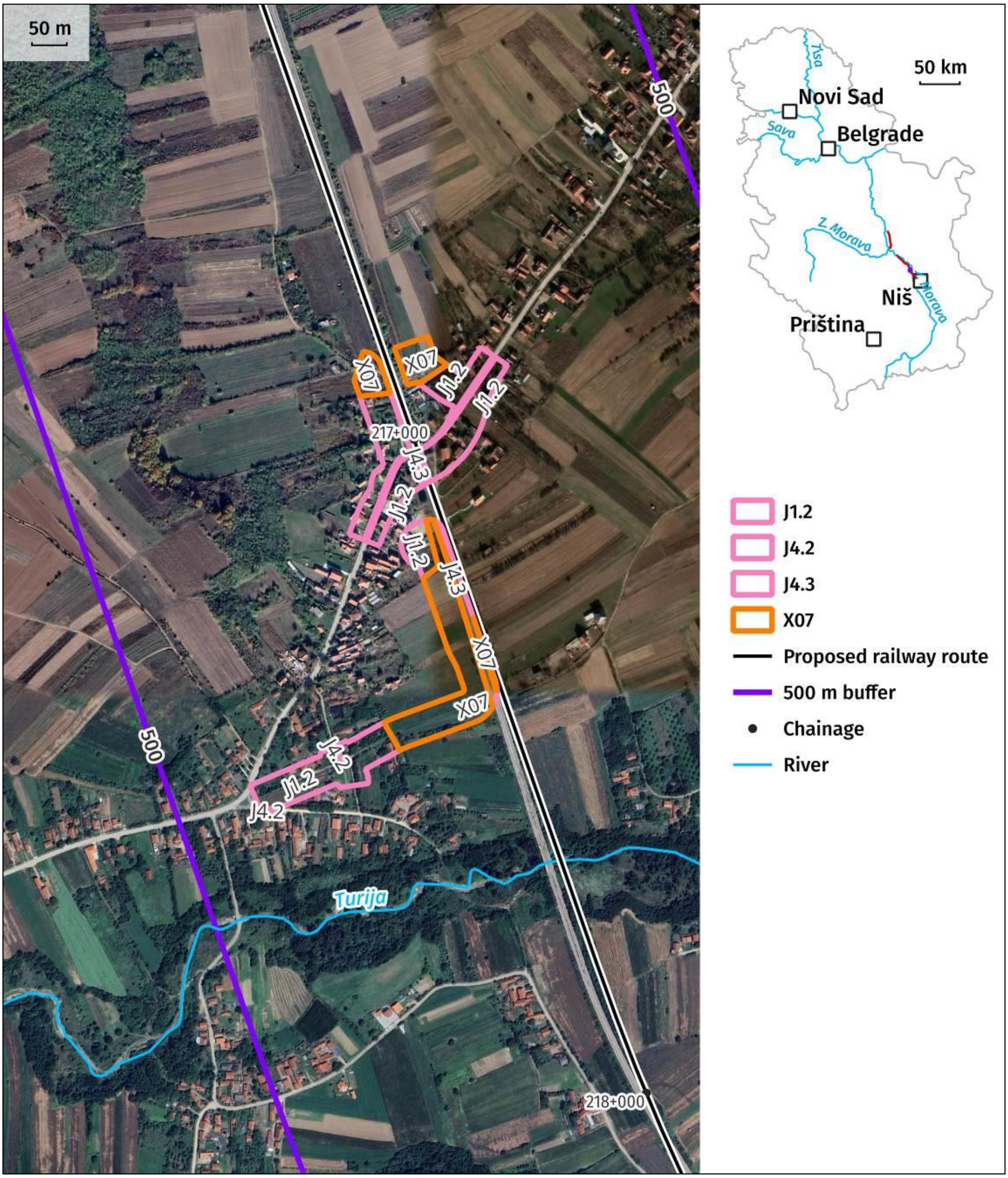


Figure 14-111. A crossing and access road at 217+044 km – Đunis-Trupale subsection

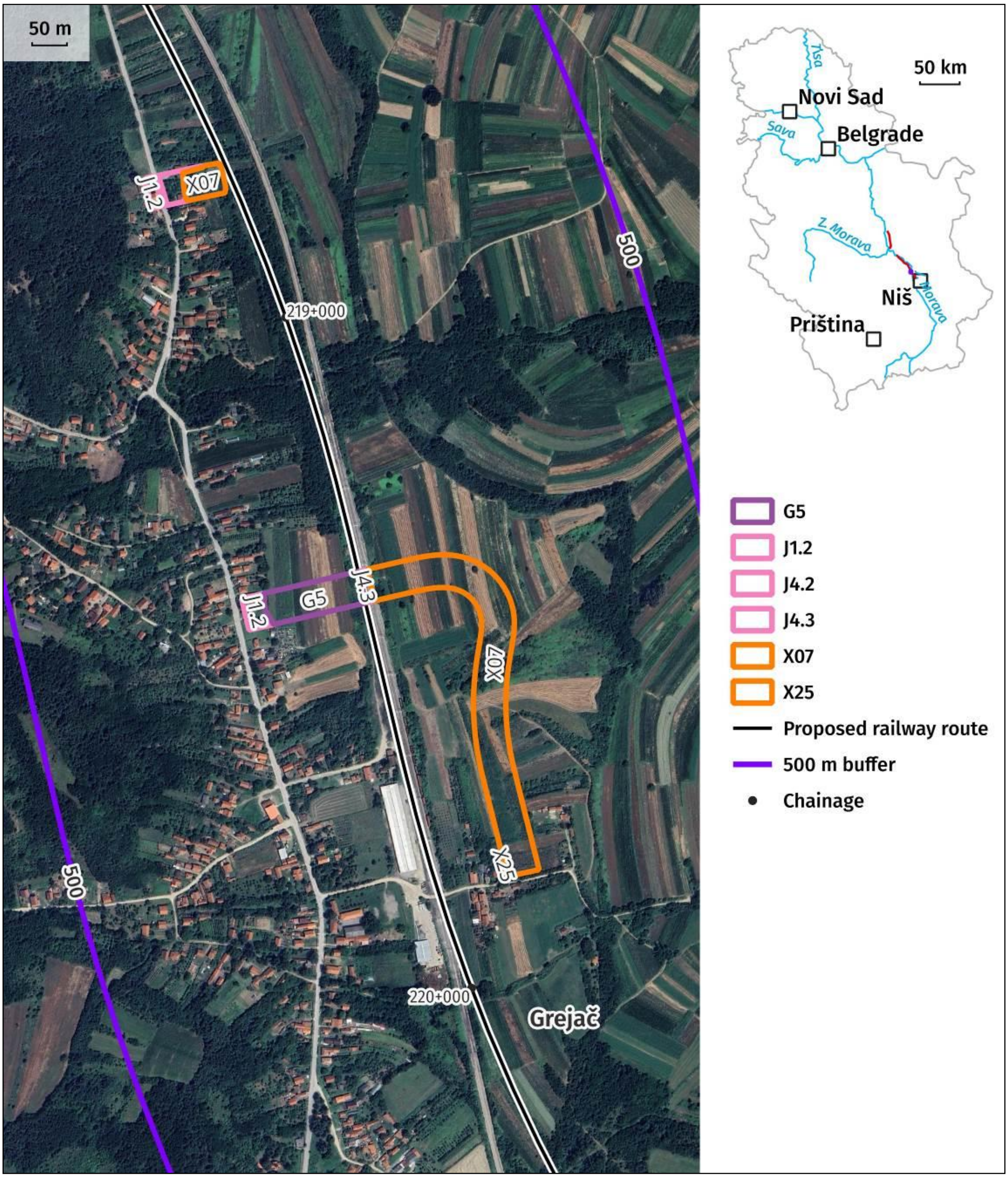


Figure 14-112. A crossing and access road at 219+405 km – Đunis-Trupale subsection

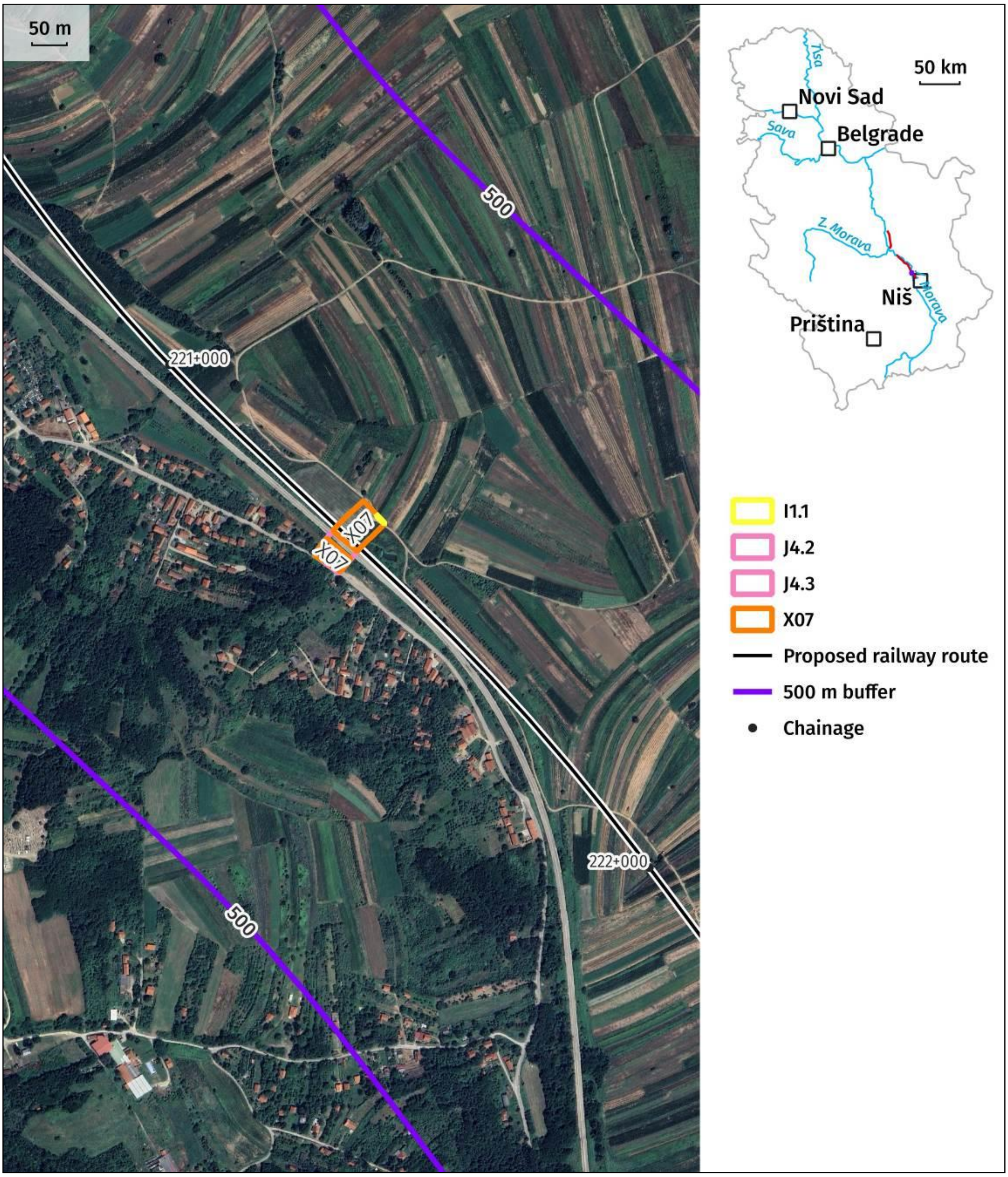


Figure 14-113. A crossing at 221+359 km – Đunis-Trupale subsection

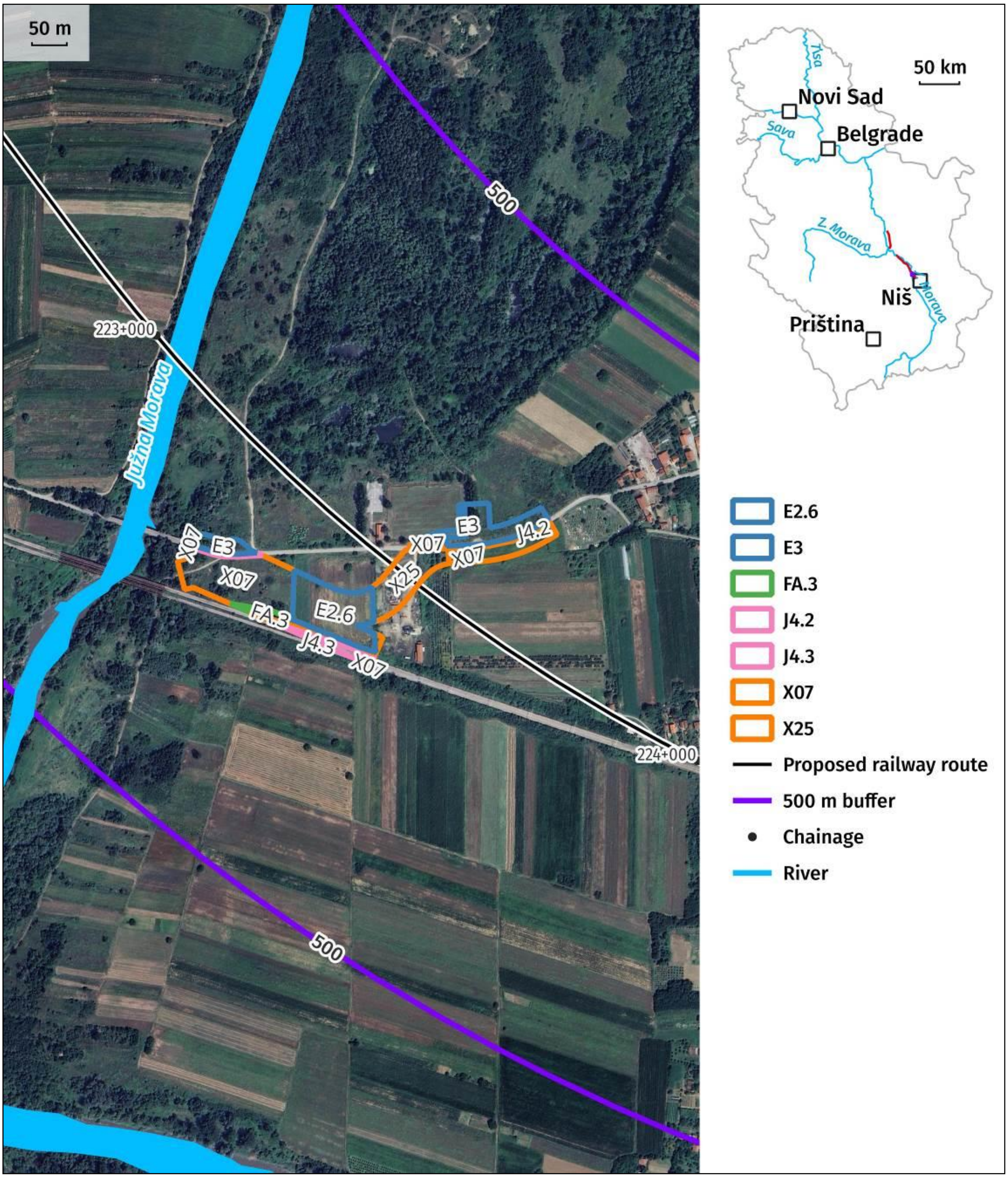


Figure 14-114. A crossing at 223+500 km – Đunis-Trupale subsection

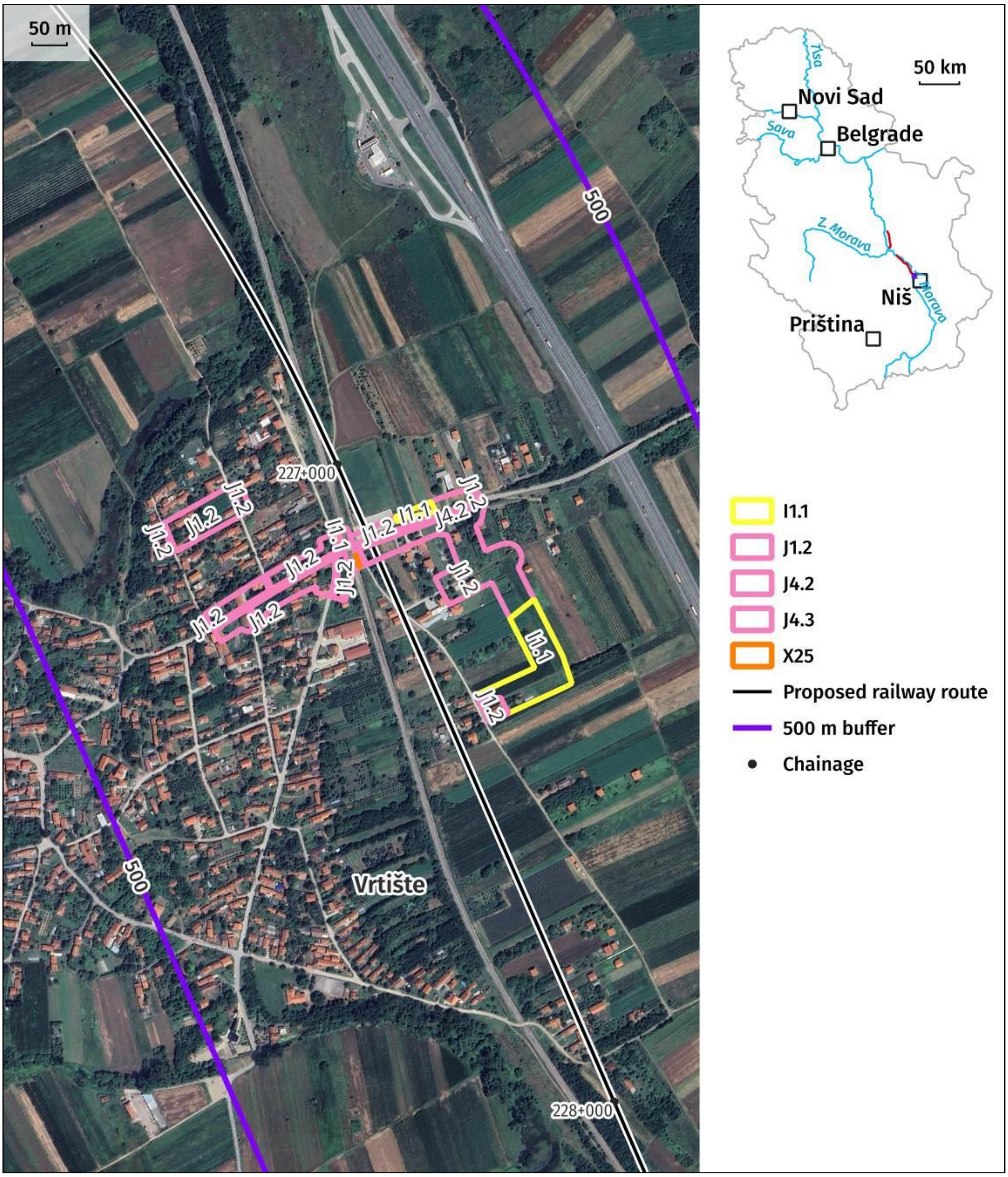


Figure 14-115. A crossing at 227+127 km – Đunis-Trupale subsection

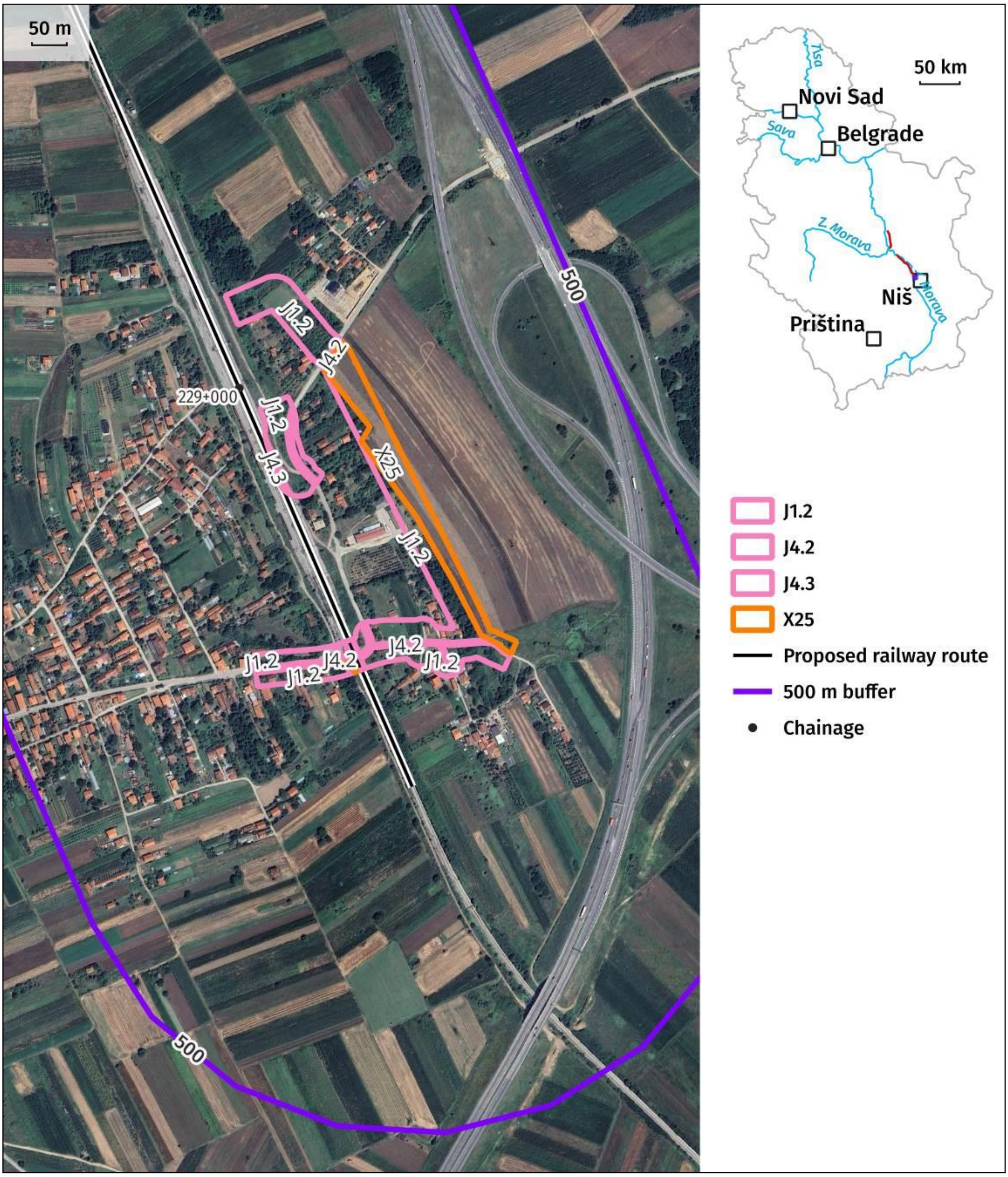


Figure 14-116. A crossing and access road at 229+420 km – Đunis-Trupale subsection

Bridges construction will also cause habitat loss and degradation. Along the project corridor constructions of 12 bridges are planned (Figure 14-117 to Figure 14-129).

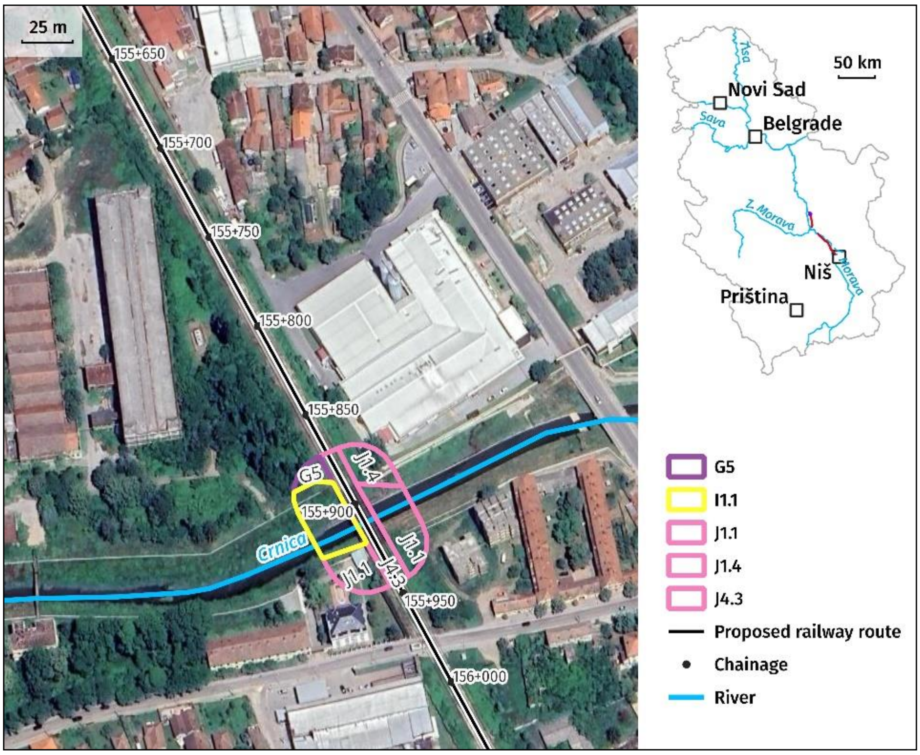


Figure 14-117. Bridges at km 155+908.80 – Paraćin-Stalać subsection

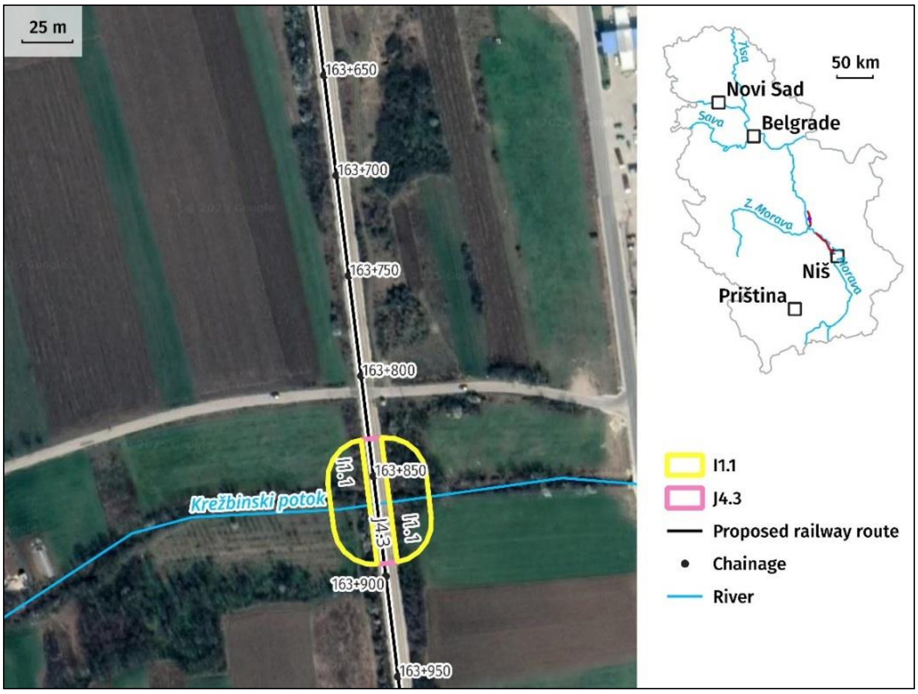


Figure 14-118. Bridges at km 163+861.90 – Paraćin-Stalać subsection

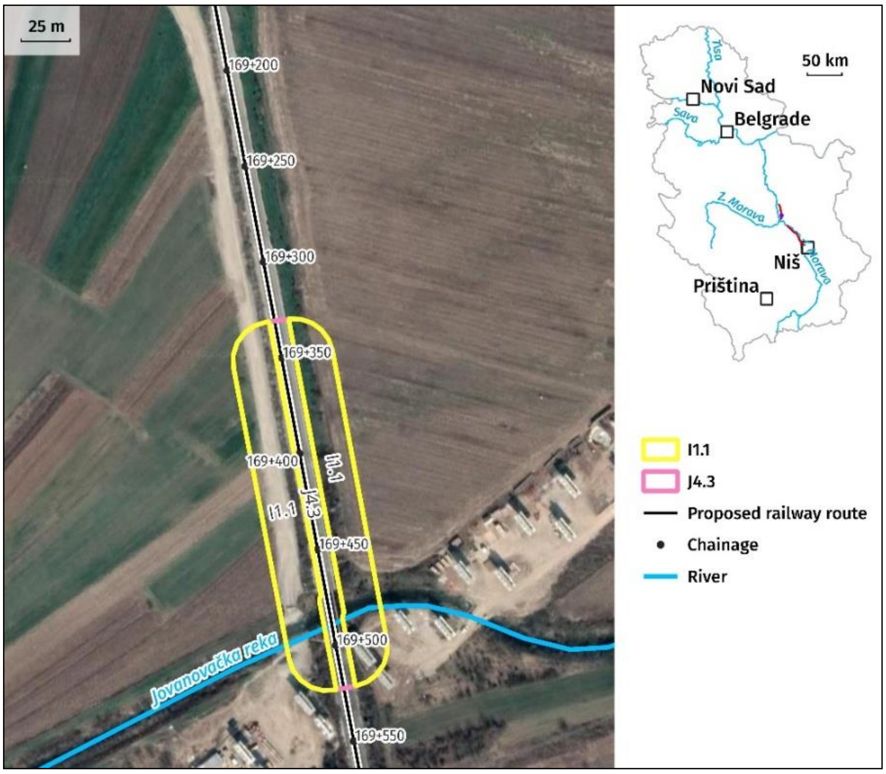


Figure 14-119. Bridges at km 169+425.70 – Paraćin-Stalać subsection

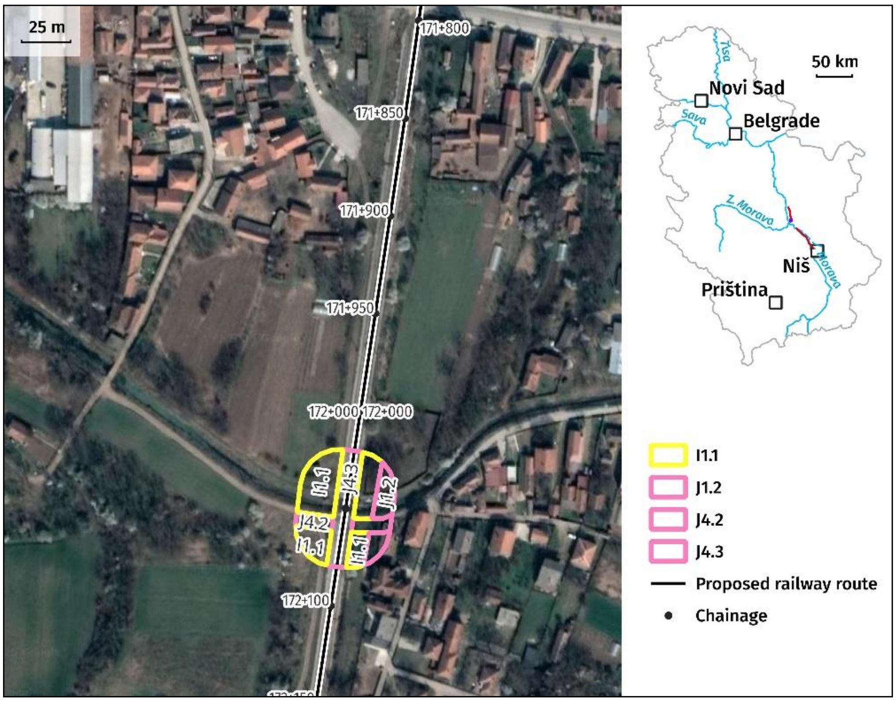


Figure 14-120. Bridges at km 172+051.85 – Paraćin-Stalać subsection

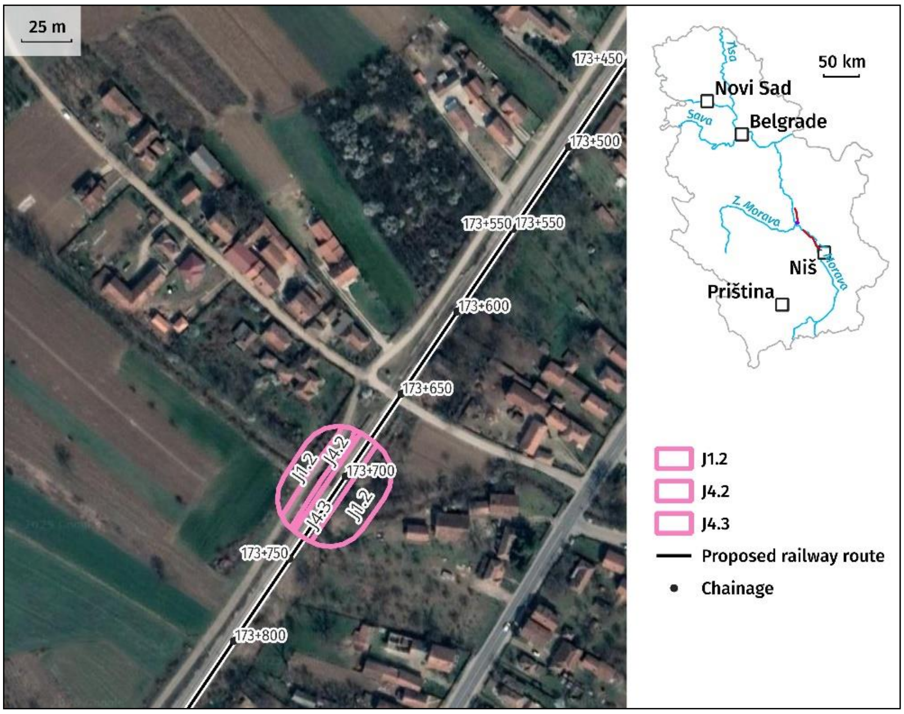


Figure 14-121. Bridges at km 173+709.21 – Paraćin-Stalać subsection

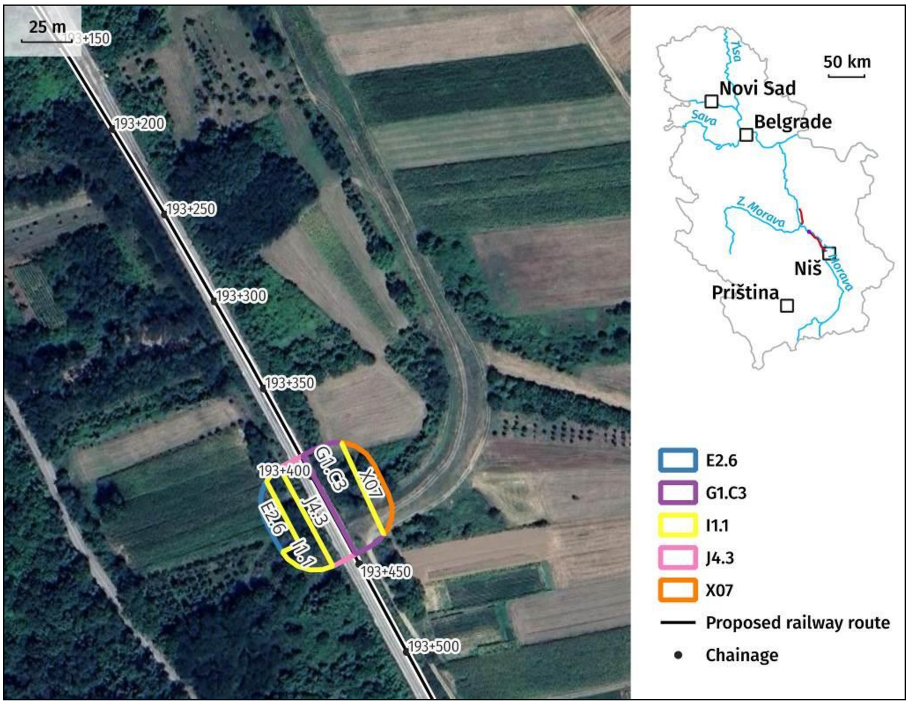


Figure 14-122. Bridges at km 193+426.23 – Paraćin-Stalać subsection

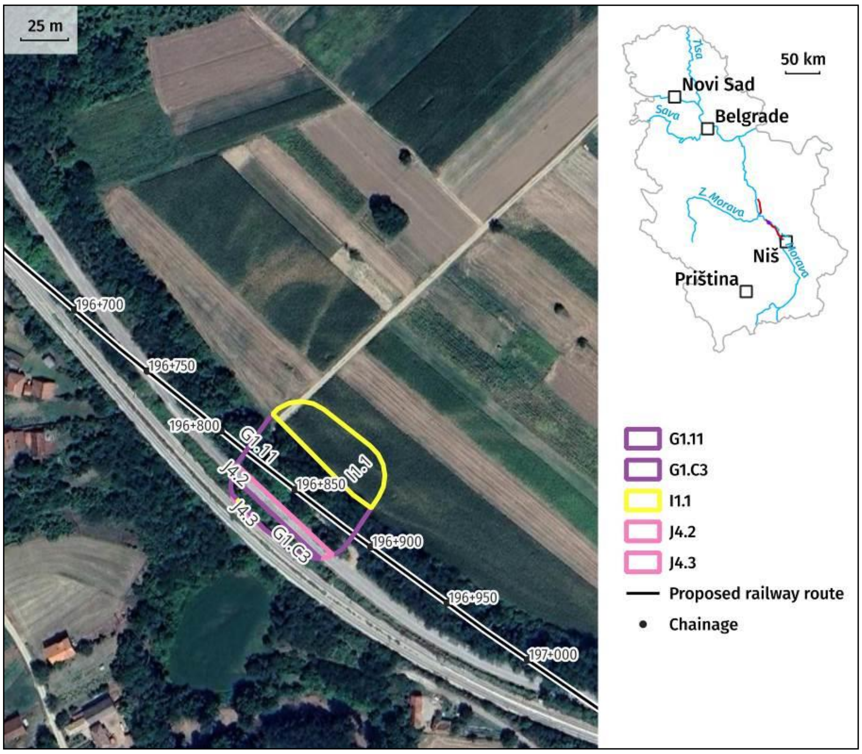


Figure 14-123. Bridges at km 196+848.21 – Đunis-Trupale subsection

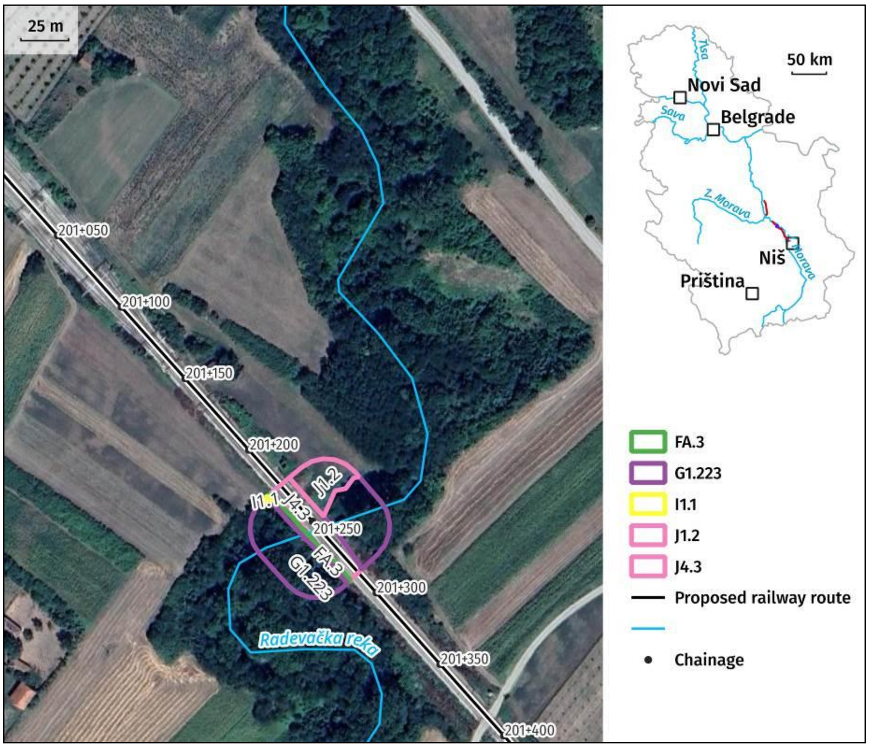


Figure 14-124. Bridges at km 201+255.67 – Đunis-Trupale subsection

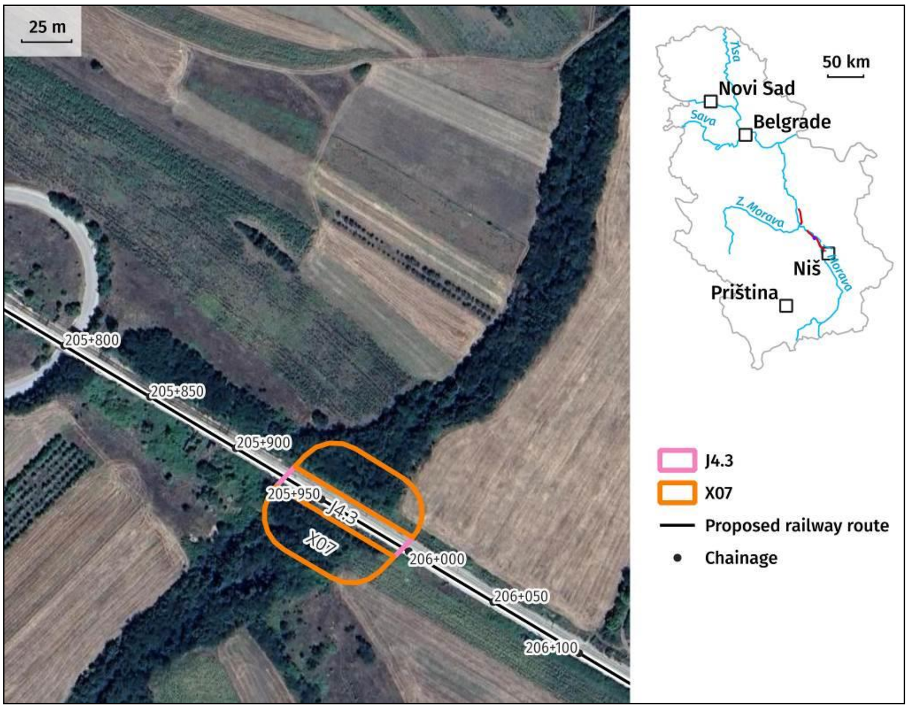


Figure 14-125. Bridges at km 205+958.44 – Đunis-Trupale subsection

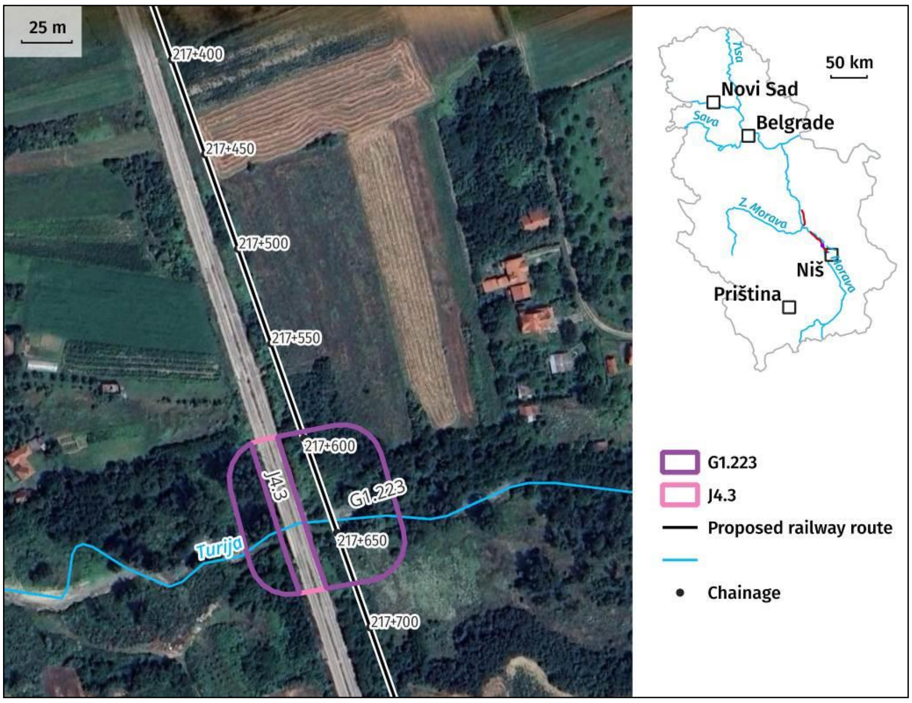


Figure 14-126. Bridges at km 217+642.36 – Đunis-Trupale subsection

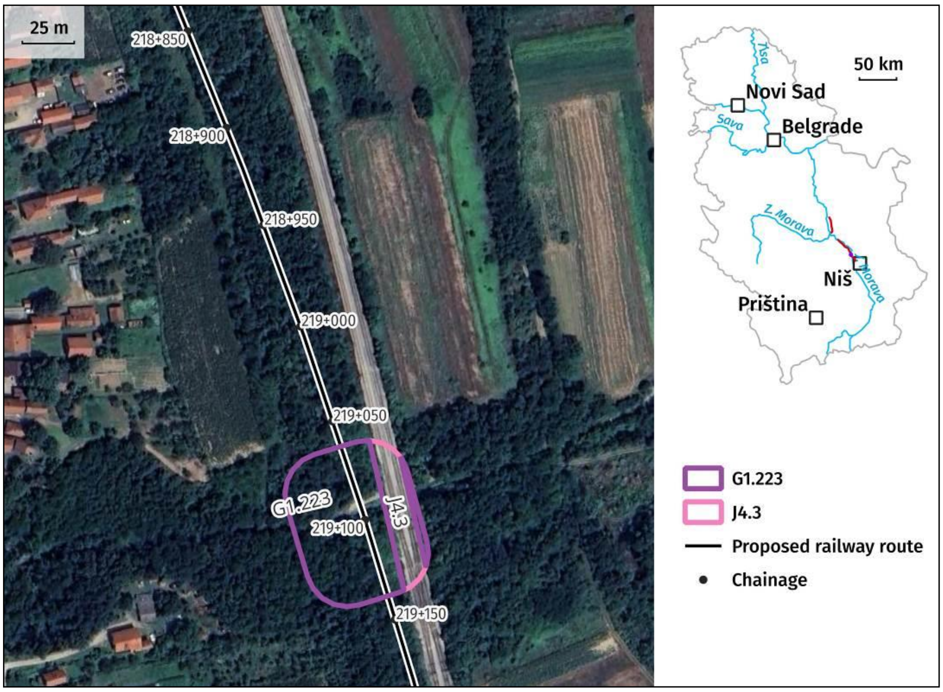


Figure 14-127. Bridges at km 219+097.12 – Đunis-Trupale subsection

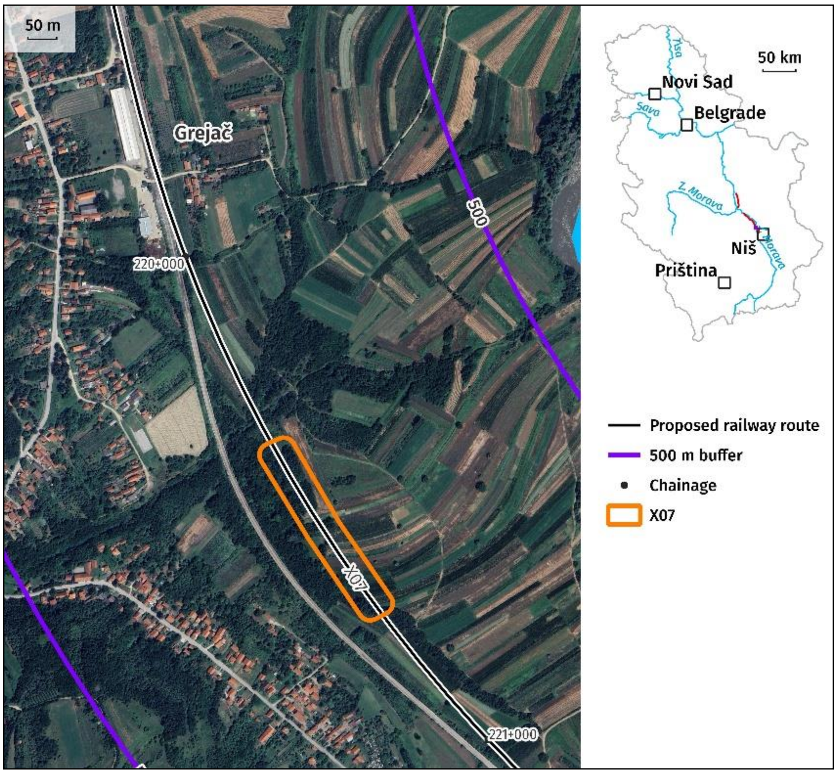


Figure 14-128. Viaduct at km 220+544.70 – Đunis-Trupale subsection

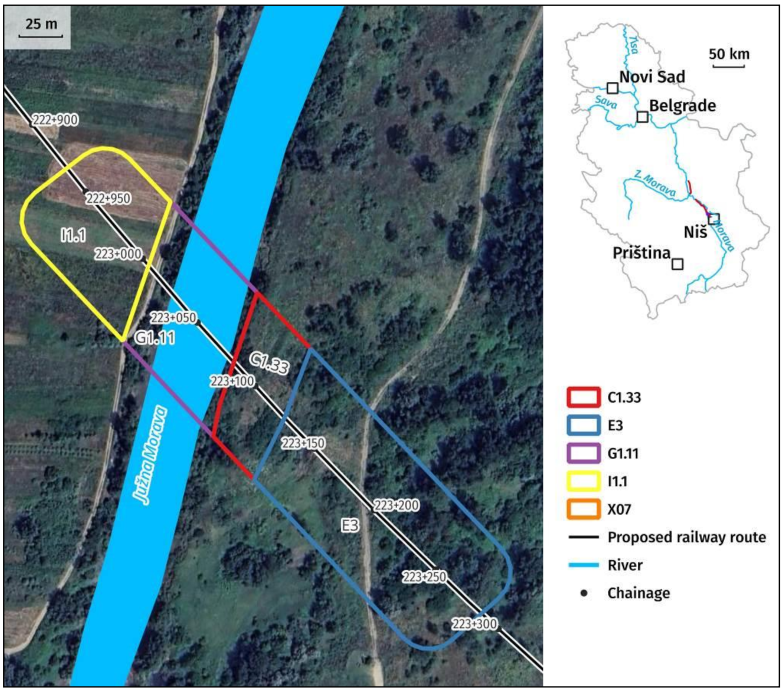


Figure 14-129. Bridges at km 223+053 and Viaduct at km 223+205.49 – Đunis-Trupale subsection

One tunnel will be constructed between at chainages cca 192+000 km and cca 193+000 km (Figure 14-130). The tunnel construction will cause loss of **G1.76** Balkano-Anatolian thermophilous *Quercus* forests (91M0 Pannonian-Balkanic turkey oak – sessile oak forests). The habitat loss is 1.20 ha.

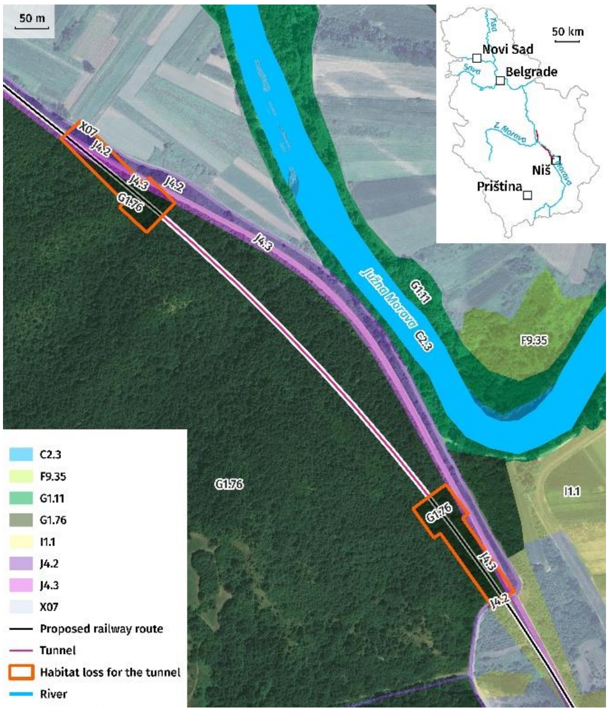


Figure 14-130. Tunnel at chainages cca 192+000 km and cca 193+000 km – Đunis-Trupale subsection

Habitat degradation

Habitat degradation will be the most prevalent impact on habitats along the corridor, seeing as the largest scope of works will involve the reconstruction of the existing railway. Habitat degradation is expected to be caused by accidental movement of machinery and workers during construction activities outside the working corridor, as well as the spread of invasive plant species and the siting of Project components. These activities are predicted to particularly impact natural habitats located in the Project AoI.

Natural habitats recorded within the PAoI are all CH and PBFs, as well as G1 and E3 habitats. As explained above, all of these habitats are located within the working corridor. These habitats are also recorded within a larger zone of the PAoI.

Degradation of C1.33 and G1.11 habitats can be caused by the curve corrections from 224+100 km to 226+900 km. This will cause the change of hydrographic regime within these habitats, ultimately resulting in degradation. To avoid this, appropriate mitigation measmust be proposed and implemented.

As the location of certain Project components, including laydown areas, construction camps, and spoil disposal areas, is not finalised, quantification of habitat degradation cannot be assessed. Potential habitat degradation could be expected within PAoI, outside the working corridor. To avoid degradation of CHs, PBFs, G1, and E3 habitats within the PAoI, appropriate mitigation measures will be proposed in the form of avoidance zones that strictly prohibit movement and encroachment into PBF and CH habitats.

The spread of invasive flora species, and dust generated as a result of construction activities

The flora species recorded within the Project AoI are all known to be widespread in Serbia. Endemic, relict, or rare species were not recorded. However, the spread of invasive plant species within the PAoI could result in changes to the floristic structure of native plant communities. The proliferation of invasive plants could be caused by the movement of construction machinery and the workforce along the Project corridor.

Intense competition between invasive plants and native flora for critical resources regulating ecosystem functioning may lead to the "invasion melt down"[31]. The invasion meltdown hypothesis states that the establishment of one invasive species in a new environment makes it easier for other invasive plant species to invade. In accordance with this hypothesis to assess the impact of proliferation of invasive plants on habitats and flora, the methodology outlined in Table 14-34 to Table 14-37was applied.

Proliferation of invasive plants will occur with certainty within the PAoI. Within the working corridor, as well as in the PAoI, the establishment of invasive plant populations of three to five different species at the same location has been recorded. Given that invasive plants easily invade space and form stable populations, this impact can be

[31] *Simberloff D., Von Holle B. (1999). Positive interaction of nonindigenous species: invasional meltdown? Biological Invasions.1:21–32.*

expected to last between 5 and 20 years, not only in the work corridor but also in the wider Project area. Native flora within P AoI is composed of widespread and common plant species. Accordingly, the impact significance can be assessed as moderate (Table 14-39).

Additionally, dust generated due to construction activities can negatively affect the process of photosynthesis and the condition of flora. It is expected that a layer of dust will form on vegetation located adjacent to or near to the construction works (especially downwind of excavations, access roads and spoil disposal areas).

Table 14-39. Assessment of the significance of impacts on Habitat and Flora during the Construction Phase

Receptor	Description of impact	Magnitude	Spatiotemporal scale	Sensitivity	Likelihood	Grades of overall effects	Impact evaluation outcome
Habitats							
C1.33 Rooted submerged vegetation of eutrophic waterbodies	Habitat loss, fragmentation and potential degradation	2	2	2	3	9	moderate
C3.2 Water-fringing reedbeds and tall helophytes other than canes	Habitat loss, fragmentation and potential degradation	3	1	2	4	10	moderate
E2.6 Agriculturally-improved, re-seeded and heavily fertilised grassland, including sports fields and grass lawns	Habitat loss, fragmentation and potential degradation	2	1	1	4	8	moderate
E3 Wet or seasonally wet grasslands	Habitat loss, fragmentation and potential degradation	2	1	1	4	8	moderate
E5.1 Anthropogenic herb stands	Potential habitat degradation	1	1	1	1	4	low
F9.35 Riparian stands of invasive shrubs	Habitat loss and degradation	2	1	1	4	8	moderate
FA.13 Species-rich hedgerows of native species	Habitat loss and degradation	2	3	1	4	10	moderate
G1 Broadleaved deciduous woodland	Habitat loss, fragmentation and potential degradation	2	2	2	4	10	moderate
G1.11 Riverine Salix woodland	Habitat loss, fragmentation and potential degradation	2	3	3	4	12	high
G1.223 Southeast European Fraxinus -	Habitat loss, fragmentation and potential degradation	2	2	2	4	10	moderate

Receptor	Description of impact	Magnitude	Spatiotemporal scale	Sensitivity	Likelihood	Grades of overall effects	Impact evaluation outcome
***Quercus - Alnus* forests**							
G1.76 Balkano-Anatolian thermophilous Quercus forests	Habitat loss, fragmentation and potential degradation	2	2	2	4	10	moderate
G1.C3 Robinia plantations	Habitat loss and fragmentation	2	1	1	4	8	moderate
G5 Lines of trees, small anthropogenic woodlands, recently felled woodland, early-stage woodland and coppice	Habitat loss and degradation	2	1	1	4	8	moderate
I1.1 Intensive unmixed crops	Habitat loss, fragmentation, and degradation	2	1	1	4	8	moderate
I1.5 Bare tilled, fallow or recently abandoned arable land	Potential degradation	1	1	1	1	4	low
J1.1 Residential buildings of city and town centres	Habitat loss, fragmentation, and degradation	2	1	1	4	8	moderate
J1.2 Residential buildings of villages and urban peripheries	Habitat loss, fragmentation, and degradation	2	1	1	4	8	moderate
J1.4 Rural industrial and commercial sites still in active use	Habitat degradation	2	1	1	4	8	moderate
J1.6 Urban and suburban construction and demolition sites	Habitat loss and degradation	2	1	1	4	8	moderate
J4.2	Habitat degradation	2	1	1	4	8	moderate
J4.3	Habitat degradation	2	1	1	4	8	moderate
J 4.7	Potential degradation	1	1	1	1	4	low
X07 Intensively-farmed crops interspersed with strips of natural and/or semi-natural vegetation	Habitat loss, fragmentation and degradation	2	1	1	4	8	moderate
X25 Domestic gardens of villages and urban peripheries	Habitat loss and degradation	2	1	1	4	8	moderate

Receptor	Description of impact	Magnitude	Spatiotemporal scale	Sensitivity	Likelihood	Grades of overall effects	Impact evaluation outcome
Flora	Loss of native flora due to invasive alien plant species proliferation within the native habitats. Disturbance by dust, affects the photosynthesis, potential necrosis of the plant tissue due to impacts to plant stomata	2	3	1	4	10	moderate

Fauna

The following potential impacts on fauna are expected during the construction phase:

- Habitat loss and fragmentation
- Impact of changes in hydro-morphological characteristics of surface waters
- The impact of noise, vibration and light

Impacts were assessed within the defined PAoI, as well as within the working corridor . A total of 235 insect species, 83 macroinvertebrate species, 36 fish species, 11 amphibian and reptile species, 109 bird species, and 24 mammal species are found within the PAoI, based on both the relevant literature and field data surveys. Of these, nine insect, two macroinvertebrate, 13 fish, ten amphibian and reptile, 19 bird and eight mammal species (in total 61 species) are considered to be species of "conservation concern"'.

Habitat loss and fragmentation

The impacts of habitat loss and fragmentation on fauna species are assessed based on impact of habitat loss and fragmentation presented above under habitats assessment. Both terrestrial and aquatic fauna species are considered.

Terrestrial habitats

The most dominant habitats within the PAoI, are Intensive unmixed crops (I1.1; 2489,42 ha), Residential buildings of villages and urban peripheries (J1.2; 1348,94 ha) and areas with intensively farmed crops interspersed with strips of natural and/or semi-natural vegetation (X0.7; 962,06 ha) (Table 14-25). Loss and fragmentation of these habitats due to the removal of vegetation has been calculated for the working corridor, including the zones of crossings, access roads and construction zones of bridges, and is 146.06 ha for I1.1, 76.14 ha for J1.2 and 64.49 ha for X0.7, which are 5.86%, 5.64% and 6.70% respectively of these habitats within the PAoI. These habitats are important for snakes, lizards and small mammals as shelters and foraging areas. It also serves as a nesting area for *Streptopelia turtur* , and hunting area for birds of prey. The edges of these habitats are also important for insects, namely butterflies. For bats, J1.2 habitats could serve as roosting and foraging sites, temporary shelters for reproduction and hibernation, while I1.1. and X0.7 habitats are typical foraging grounds.

Forested areas in PAoI are also inhabited by some species of conservation concern, such as *Lucanus cervus, Zamenis longissimus, Pernis apivorus, Canis lupus.* There are G1 Broadleaved deciduous woodland (9.50 ha), G1.76 Balkano-Anatolian thermophilous *Quercus* forests (269.42 ha), G1.223 Southeast European *Fraxinus - Quercus - Alnus* forests (60.32 ha) and G5 Lines of trees, small anthropogenic woodlands, recently felled woodland, early-stage woodland and coppice (167.47 ha), with losses of 16.82 ha (3.23%) in total for all above-mentioned habitats within the working corridor.

During vegetation clearance, loss and fragmentation of habitats within the working corridor can potentially lead to damage and removal of shelters, nests and dens for animals inhabiting the area. Twenty-three species of insects, reptiles and mammals and 13 bird species of conservation concern are impacted by habitat loss and fragmentation due to removal of vegetation in agriculture and forested areas. Total size of the area where habitat loss and fragmentation are expected under the working corridor is 5.86% for I1.1, 5.64% for J1.2, 6.70% for X07 and 3.23% for forested areas. The abovementioned will have adverse impacts of moderate magnitude to fauna species, in reference to temporary, medium-sized losses and fragmentation within working corridor (1-15% of the AoI) (Table 14-30).

These losses will be localised within the working corridor or/and in the zone of tunnel, bridges and crossings and access roads construction. In these zones, the losses will be long-term and permanent. None of the recorded species are associated with one, specific type of habitat, with suitable habitat remaining available within the PAoI, allowing them to adapt their territories accordingly. Therefore, the impact on fauna populations will be low, spatially restricted and temporary.

Table 14-40. Definitions of sensitivity for fauna species

SENSITIVITY OF RECEPTOR – Fauna		GRADE
Low	Fauna species present in two or more wide distributed and very common (anthropogenic) habitats and/or two or more native habitats that are Annex I and /or habitats listed in Resolution 4 of the Bern convention	1
Moderate	Fauna species present in one wide distributed and very common (anthropogenic) habitats and one native habitats that are Annex I and /or habitats listed in Resolution 4 of the Bern convention	2
High	Fauna species present in one priority habitat marked as fragile habitat in Serbia and wide distributed	3
Very high	Fauna species present only in one fragile habitat in Serbia and extremely rare	4

Aquatic habitats

Loss and fragmentation of aquatic habitats disrupts the ecosystem by eliminating essential shelter, food, and breeding grounds for fish and macroinvertebrates. Fish may lose critical protection from predators and access to food sources like small organisms living in plants, leading to reduced survival rates. In addition, removing vegetation from aquatic habitats could lead to the loss of specific habitats that are important for reproduction. Similarly, macroinvertebrates, which rely on plants for shelter and food, could face increased predation and food scarcity. The removal of vegetation also negatively impacts water quality by reducing oxygen levels, increasing turbidity, and disrupting nutrient cycling, which can lead to harmful algal blooms. Sedentary macroinvertebrates are particularly sensitive to these impacts. After the completion of works, fauna is expected to return, and aquatic communities are likely to recover. However, a permanent loss of habitat is expected at the locations where bridge pillars are placed. Furthermore, the absence of native plants can allow invasive species to take over, further harming the biodiversity and stability of the habitat. To reduce impacts on aquatic and riparian habitats, appropriate mitigation measures have been provisioned.

The loss of aquatic habitats will occur with certainty within the working corridor and in the construction zones of bridges at km 157+733 (Tekijski stream), at km 158+844 (Bačijski stream), at km 159+814 (Burdeljski stream), at km 160+349 (Slatinski stream), at km 163+861 (Planski stream), at km 169+425 (Jovanovačka river), at km 172+051 (Kočanski stream), at km 173+037 (Bezimeni stream), at km 173+709 (Akalavica stream), at km 193+426 (Simin stream), at km 194+581 (Jankov stream), at km 196+848 (Srezovačka river), at km 201+255 (Radevačka river), at km 205+958 (Suvi stream), at km 208+820 (Suhotnički stream), at km 213+918 (Mlada Belja), at km 217+642 (Turija river), at km 219+097 (Dašnička river), at km 220+015 (Grejač stream), at km 220+315 (Drenovački stream), and at km 223+053 (Južna Morava). Bridge piers will be built in the water. Hydro-morphological modifications from activities like rechannelling, trenching, and lining along both the Južna Morava River (km 222.000–224.000) and Crnica River (km 155.000–157.000) are likely to alter flow regimes, increase sedimentation, reduce biodiversity, and interfere with natural sediment and nutrient cycling, ultimately impacting ecological integrity. Total surface and loss of aquatic habitats are presented above under the habitats section.

Some amphibians, reptiles and birds of conservation importance, such as *Bombina variegata, Rana dalmatina, Emys orbicularis, Natrix tessellata*, *Picus viridis, Merops apiaster, Dendrocopos major, Remiz pendulinus, Alcedo atis, Cettia cetti, Charadrius dubius, Locustella luscinoides, Emberiza schoeniclus, Cyanister caeruleus, Anas platyrhynchos, Fulica atra* inhabit aquatic habitats recorded along the Section III: C3.2 Water-fringing reedbeds and tall helophytes other than canes (15.88 ha in AoI), E3 Wet or seasonally wet grasslands (22.30 ha in AoI), G1.11 Riverine *Salix* woodland (76.26 ha in AoI), G1.223 Southeast European *Fraxinus - Quercus - Alnus* forests (60.32 ha in AoI). Those habitats are assessed by the expert as being areas with 'bad conditions, need to preserve', meaning that habitats where these species breed are not in good condition and potential loss of habitat due to project construction activities might have negative impact on the local populations.However, total area where removal of vegetation in the working corridor is expected is 9.24 ha (5.29%) of these habitats. Compared to overall area , this loss will be very localised and will last more than 20 years. The loss of these habitats will occur with certainty within the working corridor.

Fifteen species of macroinvertebates, fishes, reptiles and amphibians and 14 bird species of conservation concern, are impacted by habitat loss and fragmentation due to removal of vegetation in aquatic habitats. Considering the abovementioned, habitat loss due to removal of vegetation has moderate magnitude on fauna species in aquatic habitats (Table 14-30). This impact is long term/permanent – more than 20 years and relates to the habitat loss in PAoI. Aquatic ecosystems are fragile, and the species they support are highly sensitive, as they are strictly dependent on aquatic habitats, which are often considered priority and fragile in Serbia.

Overall impact of habitat loss and fragmentation on terrestrial and aquatic fauna species has a moderate magnitude, considering the medium-sized temporary loss of habitats within the working corridor (1-15% of the PAoI). In the maintenance corridor and the zone of tunnel, bridges and crossings and access roads construction the impact will be long-term and permanent. Sensitivity of terrestrial fauna species on habitat loss and fragmentation is low to moderate, considering almost all species inhabit two or more widely distributed habitats. On the other hand, sensitivity of aquatic fauna species is high, because they inhabit one priority, fragile habitat. Within the working corridor, habitat loss and fragmentation are likely to occur and may significantly impact fauna species.

Impact of reduction in water quality on aquatic fauna

Under the Chapter 9 Surface Waters**,** detailed assessment of this impact is provided for ecological and human receptors. A reduction in water quality can significantly impact species of conservation interest, especially sedentary macroinvertebrate species *Unio crassus* and *Theodoxus transversalis*, recorded in the PAoI.Aquatic species in general are especially vulnerable to changes in water chemistry, requiring clean waters of flowing rivers. Contaminants, such as pollutants or sedimentation, can harm aquatic species in directly through toxicity, or indirectly by reducing food availability and altering water temperature or oxygen levels. Water pollution may temporarily affect feeding or reproductive success, while more significant water quality deterioration, such as high toxin levels or oxygen depletion, can lead to severe health issues, displacement, or even mortality. Protected species, often already vulnerable, are at higher risk, and the impacts may result in long-term declines in population numbers or loss of critical habitats, making recovery difficult.

During construction it is expected that impact of reduction in water quality on aquatic fauna will occur with certainty due to several reasons: the need for excavations which can result in surface runoff carrying mobilised pollutants into nearby watercourses, the use of hazardous materials (which can be spilled onto the ground and mobilised in surface runoff or spilled directly into watercourses), the potential for oil/fuel leaks from construction machinery/vehicles (either onto the ground or watercourses so that they contaminate). Construction activities and vegetation clearance lead to soil erosion and runoff, increasing sediment load in water bodies. This raises turbidity, reduces light penetration, and negatively affects aquatic plant growth and overall ecosystem health. Also, tunnel construction activities are expected to result in the accumulation of water containing suspended particles and pollutants such as heavy metals and concrete leachate, which, if discharged untreated into the Južna Morava River (km 192.000–196.000), could degrade water quality and aquatic habitats.

Taking into account baseline data provided in the Surface Waters Chapter (Table 9 11. Specific evaluation of anticipated changes in surface water quality), it is expected that this impact will have a moderate magnitude on aquatic fauna species.

Based on Sensitivity of ecological receptors also defined based on changes in the surface waters baseline data, macroinvertebrate species have **'Very high' sensitivity** as endangered (EN) species in the wild and protected aquatic areas, where any disturbance could cause significant or irreversible ecological damage. These species are recorded in the Južna Morava River (from km 192.000 to km 196.000). *Cobitis elongata, Cobitis taenia, Leuciscus aspius, Rhodeus amarus, Romanogobio albipinnatus, Romanogobio kesslerii, Romanogobio uranoscopus, Barbus balcanicus, Zingel streber and Zingel zingel* which are either migratory species or those with sensitive breeding areas, are descibed as '**Highly' sensitive**. These species are recorded at the Južna Morava River (from km 222.000 to at km 224.000). Moderate sensitivity is expected for fish species that are not threatened (classified as Least Concern, LC), but may still be vulnerable to habitat changes or human activities. This also applies to aquatic habitats of moderate ecological value, which are relatively common or adaptable, but still require effective management to prevent adverse impacts. These are foundat the Crnica river (from km 155.000 to at km 157.000): *Sabanejewia balcanica, Cottus gobio, Barbus balcanicus.*

The duration of the impact will be limited to the construction phase of the Project, and during works that impact individual watercourses. The impacts are also expected to be very localised affecting specific watercourses (Južna Morava River and Crnica River). Therefore, the impact on fauna populations will be low, spatially restricted and temporary.

The impact of noise, vibration and light

Indirect, negative impacts on fauna as a result of increased noise and vibration during the construction phase are expected, with moderate magnitude, due to construction work and operation machinery. Fauna activity within the PAoI will be temporarily disrupted, especially nesting fauna, or mammals in their dens. Sensitivity of this impact is moderate, it will be exacerbated during construction work.The most extensive negative impact from noise and vibrations is expected to be in the vicinity of aquatic habitats that are used as breeding grounds by most species of herpetofauna whose breeding behaviour may become disrupted, temporarily inducing avoidance behaviour to avoid disturbance. Artificial light pollution, especially during any work conducted at night, can result in potential negative impacts to nocturnal animals, including insects, birds and bats, also inducing avoidance behaviour. However, it is expected that following completion of the works, these animals would return, provided that suitable habitat is maintained. Magnitude of artificial light pollution is high for nocturnal animals. The potential for habitat substitution is limited. Although night-time lighting is necessary during construction, the positioning of light sources can be adjusted to minimise impacts. These impacts are localised, temporarily restricted to the construction phase, and have low significance.

Impacts on insects

Potentially negative impacts on insects of conservation concern during the construction phase (*Lycaena dispar*, *Phengaris arion*, *Zerynthia polyxena, Nymphalis vaualbum, Parnassius mnemosyne, Euphydryas aurinia*, *Cerambyx cerdo, Morimus asper* and *Lucanus cervus)* are expected due to habitat loss and fragmentation, as a result of vegetation removal from terrestrial habitats and the impact of artificial lighting during any night working activities. These impacts are expected to be temporarily restricted to the construction phase, reversible, and localised.

Loss of grasslands and woodlands is especially significant for these species. The area of grasslands within PAoI, habitat for some of the species (e.g. *Phengaris arion*), is small; while most of the agricultural land is permanently arable. Most of the grasslands in the PAoI are of anthropogenic origin and dominated by ruderal species. However, habitat loss and fragmentation will not have significant impact on the population of insect species within the PAoI, and they will be able to use habitats In the wider Project area. Residual impacts for these species are assessed as low, and measures to achieve net gain are not directly required. However, it is possible that this might be achieved in any case through revegetation and restoration of habitats.

Impacts on macroinvertebrates

Two species of aquatic macroinvertebrates with conservation concern (*Unio crassus* and *Theodoxus transversalis*) have been recorded in the PAoI. According to the Global IUCN Red List, both species are listed as endangered (EN), and both are listed in Annexes II and IV of Habitats Directive and Resolution 6 of Bern Convention. These species are especially vulnerable to any changes in water chemistry, as previously discussed. Thus, the introduction of any contaminants and a decrease in water quality, especially a reduction in dissolved oxygen concentrations would be a major threat to these species. In addition, since these species are filter feeders, any increase in turbidity and suspended particles would have a significant impact on their population. The placement of bridge piers within the riverbed is expected to negatively impact these macroinvertebrates by altering the water flow and creating areas of turbulence or stagnation that will disrupt their natural habitat. Construction activities may also result in increased sediment loads causing these animals to be smothered. Targeted mitigation and monitoring measures are needed to ensure no residual impacts remain.

Impacts on ichthyofauna

The magnitude of the impact of habitat loss and fragmentation in aquatic habitats on fish during construction will be moderate. Construction of new bridges could lead to the loss of specific habitat types that serve as shelters and could interrupt fish migration. In addition, the introduction of any kind of contaminant (particulate, solid, or fluid waste) may reduce water quality and negatively impact fish populations (success of respiration, predator and prey detection, poisoning, etc.). However, these impacts are expected to be temporary and short-term, in case small amount of fuel leaks from construction machines. Fish population recovery might be seen within a few months to

1–2 years. However, if larger leaks happen, such as those from a cracked fuel tank or major system failure, then they can release more fuel, potentially spreading over a larger area. Then, it may take 5–10 years or more to fully recover fish population.

The main potential negative impact on fish populations within the defined fishing grounds is as a result of habitat degradation, which may lead to the loss of critical habitats and interrupt fish migration. The introduction of bridge piers in a riverbed can disrupt the natural flow of water, creating turbulence and altering current patterns, which may make it difficult for fish to navigate, especially those species that rely on specific flow conditions for spawning or migration (such as *Barbus barbus*)[32]. The piers can also create physical barriers that block fish movement, especially those species that migrate upstream or downstream (e.g, *Barbus barbus*, *Chondrostoma nasus, Leuciscus aspius, Leuciscus idus, Vimba vimba)*[33]. Additionally, the construction process can stir up sediments, leading to increased turbidity, which can suffocate fish eggs, reduce feeding efficiency, and harm sensitive species. As a result, fish may temporarily relocate to more favourable areas. Once the disturbance ceases and environmental conditions improve (such as the reduction of turbidity and recovery of water quality) fish are expected to recolonise the area. Thus, it is expected that after the completion of the works, the individuals will return to their original territory.

Impacts on Herpetofauna

During construction, negative impacts on reptile and amphibian priority species (*Bombina variegate, Rana dalmatina*, *Emys orbicularis, Testudo hermanni, Podarcis muralis, Lacerta viridis, Dolichophis caspius, Zamenis longissimus, Natrix tessellata*) will be mainly due to disturbances from noise and vibration, especially if reconstruction work is planned during the breeding season (springtime). Displacement is also expected as a result of increase in noise and vibration, due to the presence of machinery and workers. Disturbance due to vibration is especially concerning for snakes (*Dolichophis caspius, Zamenis longissimus, Natrix tesselata*), because in periods of the breeding season, they become very active, leave their hibernaculum and could have an increase in avoidance behaviour, resulting in displacement from important breeding sites. The greatest negative impact due to noise and vibrations can be expected near aquatic or wetland habitats (such as wet meadows in Donje Međurovo, as well as the banks of the Južna Morava River), where most of the aforementioned species of amphibians and reptiles are known to breed, thus sensitivity of this receptor is high. These habitats are already fragmented due to the presence of previously constructed operational railways and highways. Magnitude of this impact is moderate; depends on type of activities and frequency of work, it is present only during construction activities and it is very localised.

[32] *Kuipers, E., 2024. Integrated field-& agent-based modelling: understanding the dynamics of the common barbel in the Meuse river (Master's thesis).*

[33] *Lucas, M. and Baras, E., 2008.* Migration of freshwater fishes. *John Wiley & Sons.*

Waste generated during construction work may attract some reptile species, which may then be killed by heavy machinery/construction vehicles. Mitigation is proposed to minimise this impact.

Impacts on Birds

During the construction phase, migratory bird species are impacted by habitats loss and fragmentation, noise, vibration and lights especially during breeding period (species such as *Ciconia ciconia, Falco tinnunculus, Falco subbuteo, Cettia cetti, Lanius collurio, Pernis apivorus, Streptopelia turtur, Tringa glareola, Egretta garzetta, Ardea purpurea* and *Sterna hirundo*).

Following bird species of conservation concern: *Cettia cetti, Ciconia nigra, Sterna hirundo, Perdix perdix, Milvus migrans, Dryocopus martius, Leiopicus medius, Circus aeruginosus* are impacted by habitat loss and fragmentation due to removal of vegetation in agriculture and forested areas under the working corridor (5.86% for I1.1, 5.64% for J1.2, 6.70% for X07 and 3.23% for forested areas). Loss and fragmentation of such habitats assessed to be under bad conditions, can increase negative impact on birds and their populations. However, the EAAA of the majority of bird species, not only those defined as PBF (Table 14-28), but also breeding species found along the railway route (Table 14-13), is the entire areas of pSPA Dobrić-Nišava and pSPA Gornje Pomoravlje. All recorded species can use two or more habitats for breeding, so in case one preferred habitat is lost and fragmentated during construction, they will use another suitable habitat in the vicinity. Considering enough suitable habitats in these areas exist, no long-term impacts of habitats loss and fragmentation, noise, vibration and lights on populations of birds can be expected. This implies moderate magnitude of these impacts on bird species.

Impacts on Mammals

Negative impacts on mammals during the construction phase are habitat loss and fragmentation and noise, vibrations, lights. The nocturnal species are highly sensitive to construction activities being conducted during the night, disturbed by light and noise. The main negative impact on game animals will be disturbance caused by increased noise levels and the presence of workers and construction machinery. Magnitude of these impacts (noise, vibration and lights) is moderate, temporary, only during construction, on wider project area. These impacts will occur with certainty. Ecological connectivity is not expected to be lost (disruption of corridors for daily movement or migration), keeping in mind that habitats are already fragmented by existing facilities (existing railway, motorway), so existing populations already established areas of activities and corridors. Impact of habitat loss and fragmentation on mammals is permanent, occurs within the wider project area. These impacts will occur with certainty.

Impacts on Bats

As a group, bats frequently interact with transport networks due to their broad distribution and landscape-scale movements. All bat species identified within the PAoI are strictly protected in Serbia.

Impact on bats during the construction phase (*Myotis bechsteinii, Myotis mystacinus, Nyctalus noctula, Miniopterus schreibersii, Pipistrellus nathusii, Vespertilio murinus, Plecotus austriacu*s) are caused by disturbance due to increased intensity of light during nighttime construction activities, and noise. Potential negative impacts include roost abandonment, avoidance of foraging areas, dysfunctional allocation of time and energy resources to vigilance behaviours, and degradation of physiological conditions and social order. Some level of tolerance and habituation to noise does occur in some species that colonise bridges in large numbers.

Most of the bridges planned for reconstruction go over smaller rivers (except for the bridge over the South Morava), whose banks are shallow, so the bridges likely will not have a considerable height or other dimensions relevant to batsIn this sense, it is not expected that they will be particularly suitable as a shelter for bats. Only bridges with higher pillars, such as viaducts, can demonstrate such possibilities.

Within the PAoI, there are no breeding or hibernating sites for bats, so the impacts on bats' habitats will be limited, mainly to foraging areas. The bat fauna will be impacted mostly during the construction phase (more in sense of disturbance) and spatially limited. Both within and outside the PAoI the dominant landscape matrix is mosaic of agricultural land, alluvial forests, forest patches, hedges, tree rows, settlements. These are very suitable foraging areas for bats. Therefore, the implementation of mitigation measures as found in the literature regarding providing replacement habitat[34][35] (e.g., artificial roosts) are not considered to be necessary.

Table 14-41. Assessment of the significance of impacts on fauna during the Construction Phase

Fauna Receptors	Impact	Magnitude	Spatiotemporal scale	Environment sensitivity	Likelihood	Grades of overall significance	Impact evaluation outcome
Insects Reptiles Birds Mammals	Loss of habitats and fragmentation - terrestrial habitats	2	3	2	3	10	Moderate
Macroinvertebrates Fish	Impact of reduction in water quality on aquatic fauna	2	1	4	4	11	High
Macroinvertebrate	Loss of habitats and	2	3	3	4	12	High

[34] *Erickson, J. & Adams, M. (2003). A comparison of bat activity at low and high elevations in the Black Hills of western Washington. Northwest Science, 77(2), 126–130.*

[35] *Johnston, D., Tatarian, D. G. & Pierson, E. (2004). California bat mitigation techniques, solutions and effectiveness. H. T. Harvey and Associates. Prepared for California Department of Transportation (Caltrans) Office of Biological Studies and Technical Assistance, Sacramento, California 127 pp.*

Amphibians Reptiles Fish Birds	fragmentation - aquatic habitats						
Insects Birds Mammals Bats	The impact of noise, vibration and light	2	1	3	4	10	Moderate

Protected areas

Nationally protected areas

A total of five protected areas have been registered in the wider area of Section III railway route (up to 5 km). All of them are categorized as 'Natural monuments, belonging to IUCN category III'. Four of them are representative individual trees (two oak trees, one elm tree and one mulberry tree: Novoselski brest zapis, Dud zapis u Medosevcu, Rajkovicev hrast, Hrast luznjak u Donjoj Trnavi) and the fifth one is the "Lalinačke slatine" protected area.

All Natural monuments are located outside of the PAoI and workingcorridor and are only adjacent to sections of the Project route where reconstruction works will occur, not re-alignment. Direct and indirect impacts to these features are not expected.

"Lalinačka slatina" is protected as a Natural monument as well.The area is designated as pSCI, selected as a 'Top location' for one habitat type: ht1340 - Central Balkan salt marshes and salt steppes. The area covers 4,315 ha south-east of the project area, at the distance of 5,01 km of the railway. Based on the analysis it is unlikely that the Project will have any impacts to the integrity of.Disturbance to birds and bats from noise and light is unlikely. Casualties are not expected during the operation phase, taking into consideration that this is already a functioning and existing railway, birds and bats established their daily migratory routes to avoid area around the railway.

The integrity and natural values of the protected area are not assessed to be degraded during construction phase.

Internationally protected areas and Natura 2000 sites

A detailed assessment of the potential impact of the Project to potential Natura 2000 sites in Serbia and internationally recognized protection areas (i.e. pSPA, pSCI) is presented in the "Appropriate Assessment"'. Proposed Natura2000 sites coincide significantly with internationally protected areas (IBA, KBA), what is also noted in Appropriate Assessment.

Sensitivity of receptor – protected areas

- **'Very high' sensitivity receptors:** protected areas with very high biodiversity, where any disturbance could cause significant or irreversible ecological damage, with established effective management, in the most part of the project AoI.
- '**High' sensitivity receptors:** protected areas with high biodiversity values, whose smaller part is in project AoI.
- **'Moderate' sensitivity receptors:** protected areas with moderate ecological value that are relatively common or adaptable but still require effective management to avoid adverse effects, in project AoI.
- **'Low' sensitivity receptors:** protected areas with biodiversity features less vulnerable to disturbance, requiring minimal management efforts, out of project AoI.

Table 14-42. Definition of magnitude for protected areas

MAGNITUDE	GRADE
Low impact of project on biodiversity values in protected areas that are out of project AoI	1
Moderate impact of project on common biodiversity values in protected areas that are in project AoI	2
Severe impact of project on high biodiversity values in protected areas that are in project AoI	3
Very severe negative, or extremely beneficial, impact of project on protected areas with significant biodiversity values	4

"Gornje Pomoravlje" (IBA RS044; pSPA 039)

During the Construction phase, activities such as the construction of local roads throughout the pSPA, removal of vegetation, storage of construction materials, waste disposal, excavation of soil or gravel, change of the hydrological regime (drainage), etc., or any occupation of space are prohibited by law since natural and semi-natural types of ecosystems within the pSPA are recognized as "fragile". Considering the distance of the pSPA from the PAoI, significant impacts on pSPA and IBA can be excluded.

Based on data provided under baseline, and all mentioned above, the integrity and natural values of the pSPA are not expected to be degraded during construction phase.

"Dobrić-Nišava" (IBA RS048; pSPA042)

During the construction phase, activities such as removal of forest vegetation (particularly riverine, along the Južna Morava and Nišava rivers and other watercourses as well), storage of construction materials, waste disposal, excavation of soil or gravel, change of the hydrological regime (drainage), etc., or any occupation of space are typically prohibited. It is also expected that the local road network will be adequate for the purpose of construction. However, considering the Project passes through this pSPA, some negative impacts could be expected such as removal of existing vegetation, removal and excavation of soil cover or storage of construction materials. Such activities, according to national legislation could only be permitted to the minimum extent necessary and in a limited area, in locations where the basic natural values will not be endangered.

During construction, animals are expected to avoid the wider Project area due to light pollution and increased noise levels. Some fatalities are also possible during construction, especially to slow-moving animals. However, taking into consideration that they are expected to avoid construction sites, this impact is not considered to be likely. The dense network of settlements along the existing and planned Project alignment provides an unfavourable habitat for many species, particularly large mammals and birds. The Project overlaps with the pSPA in its easternmost and peripheral part. Sensitivity of this protected area is assessed as high since "Dobrić-Nišava" is an internationally protected area with high biodiversity, whose smaller part is located in PAoI. It is part of the ecological network, which is also defined as pSPA, designated based on the presence of 50 Natura2000 bird species. However, most habitats in this protected area are artificial with agricultural crops and settlements. Magnitude of possible, abovementioned impacts mentioned during construction is high consideringthe high biodiversity values intersected by the PAoI (the pSPA/IBA "Dobrić-Nišava" is located on the southernmost part of the Project, from 220+315 km to the end of Section 3). These impacts can be long term/permanent – more than 20 years and localised in wider Project area. The impacts are likely to occur .

Significance of impacts of the project on protected area pSPA „Dobrić-Nišava" is moderate. This means a significant, short term impact during construction phase which requires the implementation of mitigation measures to avoid and/or reduce harm to birds.As it was assessed above, during the construction phase sensitivity of bird species (especially migratory species) on habitat loss and fragmentation is moderate. Magnitude of impact is moderate, it is temporary, only during construction, and covers the wider Project area.

Based on data provided under baseline, and all mentioned above, the integrity and natural values of the pSPA are not assessed to be degraded during construction phase.

"Južna Velika Morava" (pSCI SRBPEZ051)

The railway route does not pass through pSCI Južna Velika Morava, and this site is out of the PAoI. It is not expected that the project will cause degradation of habitats suitable for the target species.

Negative impacts on pSCI Južna Velika Morava in both construction and operation phases, can be excluded, During the Construction phase, similar to IBA and pSPA Gornje Pomoravlje, activities such as the construction of local roads throughout the pSCI, removal of vegetation, storage of construction materials, waste disposal, excavation of soil or gravel, change of the hydrological regime (drainage), etc., or any occupation of space are typically prohibited by law since natural and semi-natural types of ecosystems within the pSCI are recognized as fragile. The Južna Velika Morava pSCI does not overlapwith the Project. Based on data provided in the baseline, and all of the abovementioned, the integrity and natural values of the pSCI are not expected to be degraded during construction phase.

"Južna Morava" (pSCI SRBPEZ050)

Only a small proportion of the northernmost part of the pSCI overlaps with the 5 km wider Project area The shortest distance between the pSCI and the Project is app. 3.65 km. No impacts are therefore expected on the pSCI during the construction phase.

„Niš" (pSCI SRBPEZ090)

Only a small proportion of the westernmost part of the pSCI overlaps with the 5 km wider Project area. The shortest distance between the pSCI and the Project is app 2.63 km. No impacts are therefore expected on the pSCI during the construction phase.

„Lalinačka slatina" (pSCI SRBPEZ191)

This pSCI is situated in 5,15 km wider Project area. As such there are no expected direct impacts during the construction phase.

„Obla glava" (pSCI SRBPEZ255)

Only a small proportion of the westernmost part of the pSCI overlaps with the 5 km wider Project area close to Aleksinac city. The shortest distance between the pSCI and the Project is app. 3.84 km. No impacts are therefore expected on the pSCI during the construction phase.

„Poslonske planine" (pSCI SRBPEZ262)

This pSCI overlaps with the northernmost part of the 5 km wider Project area within the Đunis-Trupale sub-section but does not overlap with the railway. The shortest distance between the pSCI and the Project is app. 1.39 km, and there are therefore no expected impacts during construction.

14.2.3. Operation phase

Habitats and flora

No additional habitat loss, degradation and fragmentation is anticipated during the operations phase, as land take will occur only during construction. Following that, the majority of impacts on habitats are limited to a corridor maintenance zone, and zones of construction bridges, crossings and access roads, as well as tunnel construction

(Table 14-43). The habitat loss for the tunnel was calculated using a 30-meter zone of interest around the tunnel entrance and tunnel exit, as well as a 30-meter zone along both sides of the railway. There will be no additional habitat loss for the habitats overlying the tunnel route. The impact of crossings, access roads and bridge construction on habitats was assessed using a 30-meter zone of interest for crossings and access roads and 30-meter zone of interest for bridges.

Table 14-43. Habitats affected during operations phase

EUNIS		EU Habitats Directive		Area (ha) in the PAoI	% of the area in the 500 +500 m corridor – PoA[1]	Area (ha) within corridor maintenance zone	Area (ha) impacted by construction of crossings and access roads	Area (ha) impacted by bridges construction	Area (ha) impacted by tunnel construction
Code	Name of habitat	Code	Name of habitat						
C1.33	Rooted submerged vegetation of eutrophic waterbodies	3150	Natural eutrophic lakes with *Magnopotamion* or *Hydrocharition* - type vegetation	7.83	0.13	0.13	0	0.32	0
C3.2	Water-fringing reedbeds and tall helophytes other than canes	-	-	15.88	0.26	0.60	0	0	0
E2.6	Agriculturally-improved, re-seeded and heavily fertilized grassland, including sports fields and grass lawns	-	-	37.87	0.63	0.35	0.02	0.03	0
E3	Wet or seasonally wet grasslands	-	-	22.30	0.37	0.38	0	1.23	0
E5.1	Anthropogenic herb stands	-	-	0.82	0.01	0	0	0	0
F9.35	Riparian stands of invasive shrubs	-	-	3.86	0.06	0.10	0	0	0
FA.3	Species-rich hedgerows of native species	-	-	18.59	0.31	5.23	0.30	0.12	0
G1	Broadleaved deciduous woodland	-	-	9.50	0.16	0.51	0	0	0
G1.11	Riverine *Salix* woodland	*91E0	Alluvial forests with *Alnus glutinosa and Fraxinus excelsior* (*Alno-Padion,*	76.26	1.27	0.87	0.02	0.78	0

EUNIS		EU Habitats Directive		Area (ha) in the PAoI	% of the area in the 500 +500 m corridor – PoA[1]	Area (ha) within corridor maintenance zone	Area (ha) impacted by construction of crossings and access roads	Area (ha) impacted by bridges construction	Area (ha) impacted by tunnel construction
Code	Name of habitat	Code	Name of habitat						
			Alnion incanae, Salicion albae)						
G1.223	Southeast European *Fraxinus - Quercus - Alnus* forests	91F0	Riparian mixed forests of *Quercus robur, Ulmus laevis and Ulmus minor, Fraxinus excelsior* or *Fraxinus angustifolia*, along the great rivers (*Ulmenion minoris*)	60.32	1.004	0.86	0	1.03	0
G1.76	Balkano-Anatolian thermophilous *Quercus* forests	91M0	Pannonian-Balkanic turkey oak – sessile oak forests	269.42	4.49	2.77	2.24	0	1.20
G1.C3	*Robinia* plantations	-	-	8.01	0.13	1.95	0.04	0.14	0
G5	Lines of trees, small anthropogenic woodlands, recently felled woodland, early-stage woodland and coppice	-	-	167.48	2.79	2.10	0.92	0	0
I1.1	Intensive unmixed crops	-	-	2489.42	41.47	44.87	37.66	2.51	0
I1.5	Bare tilled, fallow or recently abandoned arable land			11.20	0.19	0	0	0	0
J1.1	Residential buildings of city and town centres	-	-	152.67	2.54	1.65	0.04	0.13	0
J1.2	Residential buildings of villages and urban peripheries	-	-	1348.94	22.47	20.04	11.76	0.33	0
J1.4	Rural industrial and commercial sites still in active use	-	-	53.44	0.89	0.89	0.30	0.04	0
J1.6	Urban and suburban construction	-	-	20.41	0.34	0.13	0	0	0

EUNIS		EU Habitats Directive		Area (ha) in the PAoI	% of the area in the 500 +500 m corridor – PoA[1]	Area (ha) within corridor maintenance zone	Area (ha) impacted by construction of crossings and access roads	Area (ha) impacted by bridges construction	Area (ha) impacted by tunnel construction
Code	Name of habitat	Code	Name of habitat						
	and demolition sites								
J4.2	Road networks	-	-	152.40	2.54	7.00	7.40	0.11	0
J4.3	Rail networks	-	-	75.79	1.26	47.17	5.43	1.30	0
J4.7	Constructed parts of cemeteries	-		1.21	0.02	0	0	0	0
X07	Intensively-farmed crops interspersed with strips of natural and/or semi-natural vegetation	-	-	962.06	16.02	17.53	17.31	1.20	0.9
X25	Domestic gardens of villages and urban peripheries	-	-	30.94	0.52	0.67	2.51	0.06	0
Total				6002.90	100	155.81	85.91	9.33	2.1

[1]Percentage of habitat coverage in relation to the total area of all habitats in the buffer zone

Invasive plants could easily and quickly spread along the corridor.

To define the impact of the spread of invasive plants on habitats and flora in the operational phase, the methodology shown in the Table 14-34 to Table 14-37 was applied. Proliferation of invasive plants will occur with certainty within the PAoI. Within working corridor, as well as in the PAoI, the establishment of invasive plant populations of three to five different species at the same location has been recorded. Given that invasive plants easily invade space and form stable populations, this impact can be expected to last between 5 and 20 years in the PAoI. It is expected that the impact will be mitigated by implementing appropriate measures . PAoI is composed of wide distributed and common plant species. The significance of the impact can be assessed as moderate.

Table 14-44. Assessment of the significance of impacts on habitats and flora during the Operations Phase

Receptor	Description of impact	Magnitude	Spatiotemporal scale	Environment sensitivity	Likelihood	Grades of overall effects	Impact evaluation outcome
Habitats	Proliferation of invasive plants	2	2	3	3	10	moderate
Flora	Loss of native flora due to invasive alien	2	2	2	3	9	moderate

	plant species proliferation within the native habitats.						

Fauna

Three general types of impacts on fauna during the operational phase are reported [36], with the most obvious being direct mortality due to **wildlife-train collision (WTC)**. The remaining impacts are **electrocution** and **disturbance of fauna (noise, vibrations and light)**[37]

These, plus other identified potential impacts on fauna during the operations phase have been assessed as follows:

- Collision of fauna with trains (WTC),
- Disturbance of fauna (noise, vibrations and light),
- Impact of reduction in water quality on aquatic species
- Electrocution.

Collision of fauna with trains

WTC is the most common cause of mortality of fauna on railways. Manywildlife species traverse or utilise the land altered by railways and are, therefore, at risk of collision. During field research, no wildlife crossing hotspots were observed. Proposed measures are therefore general, to minimise potential risk of collision.

The potential for negative impacts on fauna due to collisions with trains, particularly ornithofauna, bats and large mammals, still persits. The Project design includes fencing to comply with the safety standards in Serbia, depending on the species of animal expected to be present. However, fences will not stop birds and bats, as it is very difficult for birds to avoid trains at speeds of higher than 60-80 km/h.The planned speeds for the reconstructed railway are up to 200 km/h. Additionally, when hunting, raptors, owls and wading birds fly low over the railway corridor, which increases the possibility of collision with trains and overhead lines. According to EU practice, one of the key factors for reducing collisions with trains and lines is the height of the surrounding vegetation. In the case when the vegetation is higher than the upper structure of the railway (electrical lines and poles), a natural barrier is created that the birds fly over and thus avoid the area of train traffic. During monitoring activities in operational phase, ECoW will report about casualties of birds and bats due to collisions with trains and if necessary to implement new measures, according to current situation. To minimise collision risk in operation phase, it is

[36] Dorsey, B., Olsson, M., & Rew, L. J. (2015). Ecological effects of railways on wildlife. In R. van der Ree, D. J. Smith, & C. Grilo (Eds.), Handbook of road ecology (pp. 219–227). Chichester: John Wiley & Sons. https://doi.org/10.1002/9781118568170.ch26

[37] van der Grift, Edgar. (1999). Mammals and railroads: Impacts and management implications. Lutra 42 (1999), 77-98. 42.

important to implement good EU practice to keep the surrounding vegetation as high as possible, preserving forest habitats along the railway corridor. Details regarding collision of birds with train is provided under section Impacts on birds.

According to the findings during the field research, critical locations for snakes are Donje Medjurovo and Vrtište where the railway line passes through their habitat (wet meadow and pond/canal), and possible collision risk is higher.

In areas where the railroad crosses turtle habitat, there is a risk of collision between turtles and trains. Turtles are slow and can get stuck between sleepers (locations of Donje Medjurovo, Vrtiste and Mezgraja).

Sensitivity of receptors

- **Low sensitivity** – common fauna species, no migratory behaviour on ground/in air (Insects, Amphibians)
- **Moderate sensitivity** - common fauna species, with migratory behaviour on ground (Reptilia)
- **High sensitivity** - fauna species in diurnal/nocturnal migration routine that occur in low concentrations on ground/in air (Birds, mammals, bats)
- **Very high** - species that migrate along well defined routes and occur in high concentrations in air (Migratory birds).

Table 14-45. Definition of grades of magnitude for collision

MAGNITUDE	GRADE
Low impact of collision on common fauna species without migratory behaviour	1
Moderate impact of collision on common fauna species, with migratory behaviour	2
Severe impact of collision on fauna species in daily migration routine that occur in low concentrations	3
Very severe negative, or extremely beneficial, impact of collision on species that migrate along well defined routes and occur in high concentrations	4

Table 14-46. Definition of grades for Size and Duration

SPATIOTEMPORAL				
	Temporary, only during operation	Short term – less than 5 years	Medium term – between 5 and 20 years	Long term/Permanent – more than 20 years
Very localized in certain parts of railway	1	1	2	3
Wider project area along the railway	1	1	2	3
Regional / National	2	2	3	4
International	2	2	3	4

Table 14-47. Definition of grades for Likelihood

LIKELIHOOD	GRADE
The impact has a very low probability of occurring, or will occur rarely during operation	1
The impact will possibly occur, or will occur intermittently during operation	2
The impact is likely to occur or will occur frequently during operation	3
The impact will occur with certainty during operation.	4

The magnitude of collision impact forfauna species is assessed as moderate. Different groups of species have different sensitivity to this impact. The most sensitive are fauna species that migrate along well-defined routes and thus occur in high concentrations. This impact is long term and present during the operation of trains. Although the impact may occur across the wider project area, it is likely to be more localized in areas with a higher concentration of affected populations. The impact may occur intermittently, depending on traffic intensity and seasonal factors.

Impact of electrocution

This is one of the most significant causes of the endangering bird populations of many species (raptors, owls, wading birds). Electrocution of birds can potentially be expected in railways when power lines and grounding poles are at a distance apart that most bird species can easily cover. Namely, electrocution can occur on parts of grounding poles where the insulators are not spaced far enough apart. . Since the load-bearing poles of the lines are often the highest points in the environment, birds instinctively use them to observe the surrounding territory. Therefore, depending on the design of the pole itself, large birds can potentially close the circuit between two conductors or the conductor and the ground and suffer electrocution, with a noticeable disturbance in the electrical network. Therefore, it is extremely important that on all parts of the pole, the conductors are separated by 1-1.4 m from other parts of the supporting structure to prevent the risk of a bird closing the circuit between the conductor and the ground (supporting structure) (BirdLife International, 2003).

Sensitivity of receptor

- **Low sensitivity** – common birds, with small wingspan and bats
- **Moderate sensitivity** – common birds with high fly hights
- **High sensitivity** – birds of prey with medium wingspan and moderate fly hights
- **Very high** - medium to large birds with larger wingspan

Table 14-48. Definiton of grades of magnitude for electrocution

MAGNITUDE	GRADE
Low impact of electrocution on common birds, with small wingspan and bats	1
Moderate impact of electrocution on common birds with high fly hights	2

Severe impact of electrocution on birds of prey with medium wingspan and moderate fly hights	3
Very severe negative, or extremely beneficial, impact of electrocution on medium to large birds with larger wingspan (raptors, owls)	4

Table 14-49. Definition of grades for Size and Duration

SPATIOTEMPORAL				
	Temporary, only during operation	Short term – less than 5 years	Medium term – between 5 and 20 years	Long term/Permanent – more than 20 years
Very localized in certain parts of railway	1	1	2	3
Wider project area along the railway	1	1	2	3
Regional / National	2	2	3	4
International	2	2	3	4

Table 14-50. Definition of grades for Likelihood

LIKELIHOOD	GRADE
The impact has a very low probability of occurring, or will occur rarely during operation	1
The impact will possibly occur, or will occur intermittently during operation	2
The impact is likely to occur or will occur frequently during operation	3
The impact will occur with certainty during operation.	4

Sensitivity of receptors to this impact is mostly moderate,considering that the most frequently recorded species are common birds with high fly hights. Magnitude of this impact is moderate and can be reduced by the use of insulated and twisted conductors. This impact is long-term and present during the operation of The railway. Although the impact may occur across the wider project area, it is likely to be more localized in areas with a higher concentration of affected populations. The impact may occur intermittently, depending on traffic intensity and seasonal factors.

Disturbance of fauna (noise, vibrations and light)

Disturbance from artificial light, noise and vibration can potentially harm fauna. During operation of the railway, noise and vibration emissions are expected from moving trains (at speeds of up to 200 km/h), which can have a potentially negative impact on fauna within the PAoI. This will manifest in the form of disturbance and stress, which may induce avoidance behaviour. Research has shown that noise generated by rail traffic reduces the hunting efficiency of acoustic predators, such as bats[38,39] and interferes with the communication of birds, especially forest

[38] *Schuab, A., Ostwald, J., Siemers M. B. (2008): Foraging bats avoid noise,* J Exp Biol. *211 (19): 3174–3180*

[39] *Bunkley, J. P., Barber, J. R. (2015): Noise Reduces Foraging Efficiency in Pallid Bats (Antrozous pallidus), Ethology 121 (11): 1116-1121*

birds in the part of the route where forest habitats are dominant. Lights on trains and lighting at stops and stations can potentially attract insects and consequently bats, which increases the possibility of collisions between bats and vehicles. Furthermore, light pollution can have a deterrent effect on some animal species (e.g. game and large game). The potentially negative impact can be reduced by installing environmentally friendly lighting at stops and stations.

Sensitivity

- **Low sensitivity** – diurnal species
- **Moderate sensitivity** – diurnal/nocturnal species
- **High sensitivity** - predator species and species in periods of breeding
- **Very high sensitivity** - acoustic predators and nocturnal animals

Table 14-51. Definition of grades for Magnitude

MAGNITUDE	GRADE
Low impact on diurnal species	1
Moderate impact on common species with diurnal/nocturnal behaviour	2
Severe impact on predator species and species in periods of breeding	3
Very severe negative, or extremely beneficial, impact on acustic predators and nocturnal animals	4

Sensitivity to this impact is low to moderate, considering that individuals have possibility to move from the source of disturbance, with very high sensitivity for acoustic predatos and nocturnal animals. Magnitude of disturbance impact on fauna caused by noise, vibration and light during operation is moderate, affecting their daily and nocturnal behavior.Artificial light pollution is high for nocturnal animals. The impact is long-term, during the entire operation phase, on wider project area. It will possibly occur, or will occur intermittently, depending on frequency of traffic during operation.

Impact of reduction in water quality on aquatic species

The impact of reduction in water quality on aquatic species (macroinvertebrates and fish) during the operational phase of the railway due to pollutants such as chemicals, sediments, or nutrients entering water bodies. These pollutants can harm or disrupt the health, behaviour, reproduction, and survival of aquatic species. The operational phase typically involves longer-term risks from ongoing railway activities such as runoff from tracks, maintenance facilities, or transportation of goods and passengers. Detailed direct causes of changes in surface water quality are presented in Chapter 9.3.3. Operation phase impacts.

Sensitivity of receptors

- **Low sensitivity** – common aquatic fauna species, which populations occur in wider aquatic habitats
- **Moderate sensitivity** - common aquatic fauna species which populations occur in low concentrations in some aquatic habitats
- **High sensitivity** – protected aquatic fauna species sedentary and in diurnal/nocturnal migration routine which populations occur in high concentrations in some aquatic habitats
- **Very high** - protected sedentary species which population occur in very high concentrations in some aquatic habitats.

Table 14-52. Definition of grades of magnitude for reduction in water quality on aquatic species

MAGNITUDE	GRADE
Low impact of reduction in water quality on common aquatic fauna species which populations occur in wider aquatic habitats	1
Moderate impact of reduction in water quality on common aquatic fauna species which populations occur in low concentrations in some aquatic habitats	2
Severe impact of reduction in water quality on protected aquatic fauna species sedentary and in diurnal/nocturnal migration routine which populations occur in high concentrations in some aquatic habitats	3
Very severe negative, or extremely beneficial, impact of reduction in water quality on protected sedentary species which population occur in very high concentrations in some aquatic habitats.	4

Table 14-53. Definition of grades for Size and Duration

SPATIOTEMPORAL				
	Temporary, only during operation	Short term – less than 5 years	Medium term – between 5 and 20 years	Long term/Permanent – more than 20 years
Very localized in certain parts of aquatic bodies	1	1	2	3
Wider project area of aquatic bodies along the railway	1	1	2	3
Regional / National	2	2	3	4
International	2	2	3	4

Table 14-54. Definition of grades for Likelihood

LIKELIHOOD	GRADE
The impact has a very low probability of occurring, or will occur rarely during operation	1
The impact will possibly occur, or will occur intermittently during operation	2
The impact is likely to occur or will occur frequently during operation	3
The impact will occur with certainty during operation.	4

Sensitivity of aquatic species to reduction in water quality ishigh, accounting for their lifecycle dependencies and behaviour. . The magnitude of the impact due to water pollution is severe to aquatic species. It is determined by factors such as the concentration and type of pollutants, the duration of exposure, the sensitivity of the affected species, and the size of the area impacted. This impact is short-term and present while the causative agent is active. It can occur in the wider Project area, especially downstream of the discharge areas and in areas with higher concentration of populations exposed to this impact. the impact is likely to occurr, depending on factors mentioned above.

Impacts on insects

Impacts on insects during operation are mainly connected to disturbance of nocturnal insects by light. The impact is long-term, during the entire operation phase, on wider project area. It will possibly occur, or will occur intermittently, depending on frequency of traffic during operation. In terms of that, the impact magnitude is low to moderate, and the overall impact significance is low. Collisions with trains occur occasionally, and largely depend on sizes of populations and seasonal activity. Males are particularly affected, as they are known to undertake longer daily migrations (especially dragonfly males) than their female counterparts. However, depending on the abovementioned factors, and given that this Project largely consists of reconstruction, the impact to insect species is low to moderate, and the overall impact significance is assessed as low.

Impacts on macroinvertebrates

During the operations phase macroinvertebrates will be highly sensitive to reduction in water quality. The magnitude of reduction in water quality to the species *Unio crassus* and *Theodoxus transversalis* is severe, as they are sedentary organisms and, therefore, more threatened. Both species rely on stable riverbed environments.. This impact on macroinvertebrates is short-term and present while the causative agent is active. It can occur in the wider Project area, especially downstream of the discharge areas, and in areas with higher concentration of populations exposed to this impact. The impact is likely to occur, depending on factors mentioned above.

Impacts on ichthyofauna

During the operation phase, fishes will be highly sensitive to reduction in water quality. Magnitude of this impact is high, taking into account the presence of species of conservation concern, such as *Cobitis elongata, Cobitis taenia,* and other species presented in Table 14-10. All species rely on stable riverbed environments.This impact on fish is short-term and present while the causative agent is active. It can occur in wider project area, especially downstream of the discharge areas, and in areas with higher concentration of populations exposed to this impact. The impact is likely to occur, depending on factors mentioned above. To minimise possible impact of polluting the aquatic habitats and aquatic fauna, mitigation measures are prescribed.

Impacts on Herpetofauna

During the operations phase, WTC are a likely impact to herpetofauna. This is especially the caseduring spring and autumn migrations, when herpetofauna is likely to frequently move from aquatic to terrestrial habitats. It has also been observed that many species of reptiles such as wall lizards and snakes use railway tracks as a place for basking. The most likely locations for collision with a train to occur are where the railway line cuts through or passes near to the habitats of amphibians and reptiles in the areas of Donje Medjurovo, Vrtište i Mezgraja. Although the greatest diversity of amphibians and reptiles is present in these areas (with wetland habitats), the impact magnitude is expected to be moderate, as no areas of increased frequency of collisions were reported during field surveys. The impact is long-term, during the entire operation phase, and may affect the wider Project area. It may occur intermittently, depending on traffic frequency during operation.

Impacts on Birds

The main impact during operation on birds will be due to WTC, especially to raptors,white storks, and waterbirds, that forage around the railway (agriculture crops and surrounding pastures and meadows, wetlands and water habitats). A key aspect of the field surveys included recording the flight height of birds along the existing railway, to assess possible and future collision risk with trains. However, during the field research, no specific locations with a higher frequency of bird flights over the tracks were recorded.

For assessments regarding the flight height, only species around the railway route, species whose conservation status is unfavourable, as well as species that are important for protection in Serbia and at the international level, were assessed. Flight height is not given for other species because it is estimated that they are not at high risk of collision with a train.

An overview of the flight heights for the target species is given in the Table 14-55.

Table 14-55. Flight height for bird species of conservation concern

English name	Latin name	Flight height (m)
Western marsh harrier	*Circus aeruginosus*	0-400
Great White Egret	*Ardea alba*	0-200
Purple heron	*Ardea purpurea*	0-200
Black kite	*Milvus migrans*	0-800
European Turtle-dove	*Streptopelia turtur*	0-150
White Stork	*Ciconia ciconia*	0-400 (0-150)

English name	Latin name	Flight height (m)
Black stork	*Ciconia nigra*	0-400
Ortolan	*Emberiza hortulana*	0-50
Syrian Woodpecker	*Dendrocopos syriacus*	0-100
Black Woodpecker	*Dryocopus martius*	0-100
Middle spotted woodpecker	*Leiopicus medius*	0-100
Wood Sandpiper	*Tringa glareola*	0-150 (0-30)
Common Kingfisher	*Alcedo atthis*	0-100
Cetti's warbler	*Cettia cetti*	0-50
Common tern	*Sterna hirundo*	0-100 (1-50)
Red-backed shrike	*Lanius collurio*	0-300
Lesser Grey Shrike	*Lanius minor*	0-300
Black-crowned Night Heron	*Nycticorax nycticorax*	0-100
Grey Partridge	*Perdix perdix*	0-100

Bird communities may differ significantly between sites and bird activity may increase near to the railway with changes in relative species abundances. However, birds show a significant tendency to avoid flying across the “unsecured zone” where collision with trains is possible to occur. According to EU practices, most bird collisions with trains occur on bridges and/or relatively low viaducts. The project foresees the construction of 2 viaducts: at km 220+544.70 and km 223+205.49, both in Đunis-Trupale subsection. The second one will be positioned near small woodland fragments of **G1.76** Balkano-Anatolian thermophilous *Quercus* forests, which are habitats of many bird species. In this area higher risk of bird collisions might be expected and measures are proposed to mitigate this impact.

When hunting raptors, owls and wading birds fly low over the railway corridor, which increases the possibility of collision with trains and lines.

Streptopelia turtur is a VU species that is known to nest along the railway from Paraćin to Trupale within areas of the most dominant habitats (I1.1 Intensive unmixed crops (cover 2489,42 ha or 41.77% of the AoI) and X07 Intensively farmed crops interspersed with strips of natural and/or semi-natural vegetation (cover 962,06 ha or 16.03% of the AoI). In addition, following birds are evidenced in and around agricultural areas, pastures with bushy vegetation: *Lanius collurio, Lanius minor, Emberiza hortulana*, *Perdix perdix.* Collisions of European Turtle-doves and other birds menitoned can be expected,however during the field surveys, nests of these species were not recorded along the Project route.

Dendrocopos syriacus, Dryocopus martius, Leiopicus medius, Tringa glareola, Sterna hirundo, Cettia cetti, Alcedo atthis, Milvus migrans, Circus aeruginosus, Cicconia cicconia, Cicconia nigra, Ardea purpurea, Ardea alba and *Nycticorax nycticorax* are specific to wetland and aquatic habitats (E3 Wet or seasonally wet grasslands, 22.30 ha, 0.37% of the AoI), riverine woodlands and woodlands (G1.11 Riverine *Salix* woodland, G1.223 European *Fraxinus - Quercus - Alnus* forests, G1 Broadleaved deciduous woodland, G1.76 Balkano-Anatolian thermophilous *Quercus* forests, covering in total 415.5 ha, or 6.92% of the AoI) and G5 Lines of trees, small anthropogenic woodlands, recently felled woodland, early-stage woodland and coppice (covering area of 167.48 ha, or 2.79%). However, during the field surveys of these habitats, increased frequency of bird flights was not registered.

All of these species already exhibit alternative flight patterns during migration and the breeding period to avoid collisions with existing trains. Therefore, an increase in the frequency of bird flights over the reconstructed railway is not expected.

Impacts on Mammals

For those mammal species with very large territories (e.g. Wolf, Wild boar, Roe deer), there is the potential for a loss of ecological connectivity due to the introduction of a metal fence along the railway, which may disrupt daily movements and/or migration. However, there is an existing fence between the motorway and the railway, which already presents a barrier, therefore, this is only expected to have an impact on the other side of the railway.

An important impact during the operational phase on mammals is the WTC, especially on small mammals. Although the reconstructed railway will have fences on both sides, small and medium-sized mammals can still pass through and collide with trains.

During the operational phase, the disturbance of game may be caused by the passing of the high-speed trains.

Collisions with high-speed train and increased noise and light levels could both negatively impact bat populations. Noise impacts will be substantially reduced compared with impacts during the construction phase, in terms of constantly present noise from working machines, during day and night. Signal masking can be significant if noise from high-speed trains substantially interferes with information transfer during echolocation, communication, or passive listening. However, because the spectra of traffic and construction noise do not overlap with most bat echolocation calls or their hearing of them, echolocation in most species of bats is unlikely to be affected by high-speed train noise. Due to multiple behavioural and physiological defensive mechanisms they have developed to prevent noise overexposure, most bats are likely effectively shielded from most trauma events that would result from high-speed train noise.

Some data from southern England suggests that the activity of bats fell from 30-50% each time a train passed for at least two minutes. Depending on the density of rail traffic, nocturnal bat activity could therefore be reduced by one-fifth of the time at sites with median rail traffic, and two-thirds or more of the time at the busiest sites. Such activity changes imply repeated evasive action and/or exclusion from otherwise favourable environments. Hence, disturbance by passing trains may disadvantage bats in most rail-side habitats[40].

Mathews et al. (2023)[41] suggest that the collisions of bats with trains are much rarer than the collisions on the roads or in the air. As such, collisions are not expected to be of very high magnitude to decrease the favourable conservation status of identified bat species.

Some authors[42] pointed out the importance of railway verges as foraging/commuting habitats and suggested that during the exploitation (operational) phase of the railway, management decisions could take bats into account through a move from clear-cutting to more extensive management (e.g., selected cutting and late-mowing), enabling the maintenance of some linear structures and allowing the reproduction of many insect species that constitute the bats' preys. However, authors also pointed out that this strategy could be successful only in highly modified, human-dominated landscapes (i.e., highly intensive agriculture areas or urban areas), and would be less relevant in a more natural landscape, where the species association is composed of more specialist species linked to woodland and of gleaner-type. Since the natural and semi-natural habitats are well represented in the AoI, this mitigation measure is not recommended, particularly keeping in mind that some data suggest that train passes impact the nocturnal activity of bats[41]

Additionally, their nocturnality, and use of echolocation mean bats are likely to be affected by light and noise emitted by trains.

Table 14-56. Assessment of the significance of impacts on fauna during the Operations Phase

Receptor	Impact	Magnitude	Spatiotemporal scale	Environment sensitivity	Likelihood	Grades of overall effects	Impact evaluation outcome
Insects Herpetofauna Birds Mammals	Collision of fauna with trains	2	3	3	2	10	moderate

[40] *Jerem, P. & Mathews, F. (2021). Passing rail traffic reduces bat activity. Scientific Reports 11:20671. https://doi.org/10.1038/s41598-021-00101-3*

[41] *Matthews, J., Claireau, F., Dekker, J., Gazaryan, S., Karapandža, B., Mathews, F., Presetnik, P., Raynor, R. & Roemer, Ch. (2023). Guidance on the consideration of bats in traffic infrastructure projects. EUROBATS.AC27.4, DRAFT v.14.03.2023 for AC27.*

42 Vandervelde, J. C., Bouhours, A., Julien, J. F., Couvet, D. & Kerbiriou, C. (2014). The Activity of European common bats along railway verges. Ecol. Eng. 64, 49–56.

Insects Herpetofauna Birds Mammals	Disturbance of fauna (noise, vibrations and light)	2	3	1	2	8	moderate
Birds Bats	Electrocution	2	3	3	2	10	moderate
Macroinvertebrate, Fishes	Reduction in water quality	3	2	3	2	10	moderate

Protected areas

During the operation phase, most of the potential impacts during the construction phase will be eliminated or reduced. As outlined above, the collision of some animal species (primarily birds and bats) with high-speed trains is a potential impact, although this is not expected for larger terrestrial mammals as access to the railway will be significantly hampered by the planned fence and surrounding urban areas.

Only one protected area, pSPA/IBA "Dobrić Nišava", can be scoped for the assessment of impacts during the operation phase, since it is crossed by the railway from 220+315 km. All impacts on fauna species mentioned above that appear during operation is applicable to this project area. Sensitivity of this protected area during operation is assessed as high, since "Dobrić-Nišava" is an internationally protected area with high biodiversity values. Magnitude of possible impacts during operation is severe especially in terms of risk of bird collision with trains. This impact is long term and localized in wider project area. The impacts are likely to occur or will occur frequently.

Significance of impacts of the project on protected area pSPA „Dobrić-Nišava"is moderate. This means significant, long-term impacts during operation phase can be expected, requiring the implementation of mitigation measures to avoid and/or reduce harm to biodiversity features of the site, particularly birds.

A detailed assessment of impacts and proposed mitigation measures are provided in the Appropriate Assessment.

14.2.4. Priority biodiversity features and critical habitats assessment

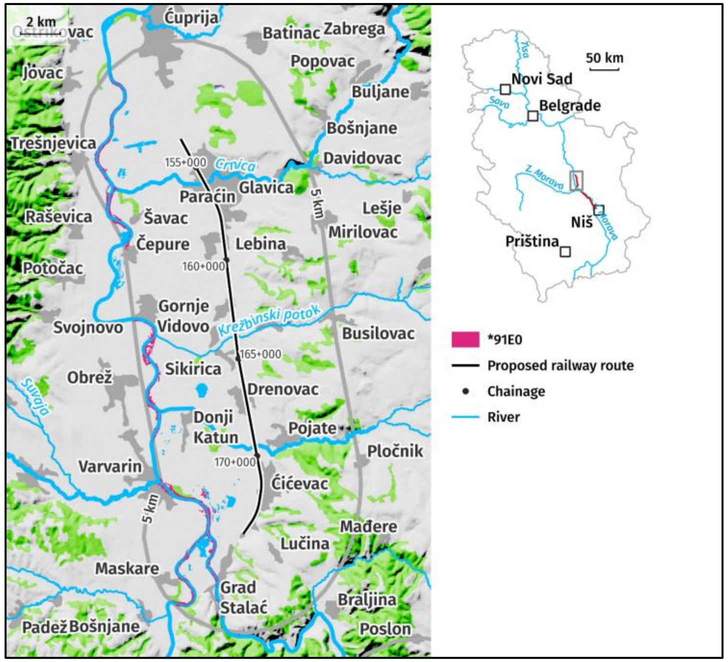
Impact assessment regarding Priority Biodiversity Features (PBF) and Critical Habitats (CH) during the construction and operations phases of the Project, together with affected habitats, are presented in the tables below. Maps with presented EAAAs are given within the table, indicating suitable habitat for PBF/CHs in relation to the railway.

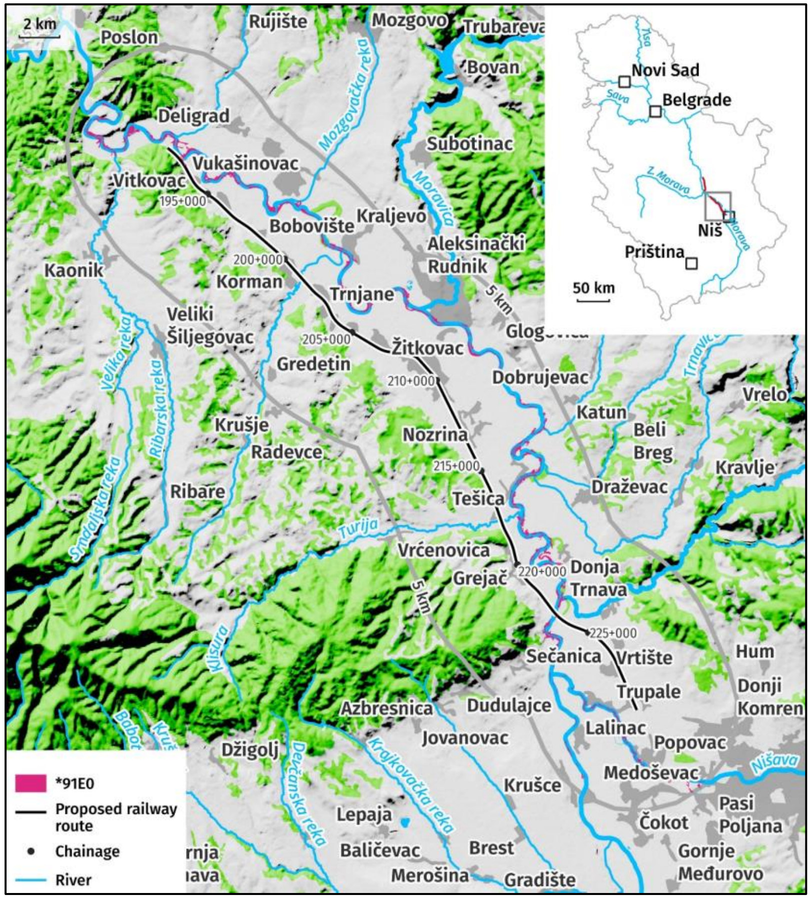
For fauna species, the EAAA was mapped by taking all suitable habitat types for the species in the wider area. Some species use multiple habitats, which is clearly indicated for each species. If a habitat is only marginally suitable for the species—meaning the species may occur there occasionally or sporadically—but it does not provide critical or core habitat functions, it was not mapped as a part of the EAAA for the species. In the PAoI, the species predominantly use the suitable habitats for foraging, but some are also used for mating or larvae laying. Bird species are assessed as part of pSPA/IBA. Also, insect species are assessed as part of pSCI and for suitable habitats that are known to beregularly used by these species. This approach is based on the fact that these species are primarily trigger species for pSPA and pSCI, or on other available information regarding their distribution. When it comes to PBF/CH impact assessment, the main assumption is the same as for other biodiversity receptors - construction phase will result in the temporary disturbance of habitats within the 30 m + 30 m working zone, while permanent losses are expected in the operational maintenance zone of 15 m + 15 m from the Project footprint, which will persist into the operational phase. For disturbed and habitats permanently lost, it is necessary to implement active restoration and/or compensation efforts.

The impacts during the construction phase were assessed for all PBF and CH to determine the magnitude of impact and the level of effort required for habitat restoration during construction, as well as the direction that restoration efforts should take. Certain conclusions were also drawn regarding potential permanent impacts in cases where suitable habitat for PBF/CH is absent from the working corridor, resulting in no anticipated impacts.

However, even if there is potential habitat loss, it does not necessarily constitute a permanent loss for the habitats and species, as the impact assessment pertains solely to the construction phase and to a working corridor extending 30 m on each side of the railway alignment. The type of impact anticipated during this phase is often limited to disturbance rather than permanent land take. Impacts on certain habitat types are limited to the construction phase through vegetation removal or indirect impacts such as noise and dust. Such habitat disruption, wherever noted, must be remedied through natural revegetation taking place upon completion of works, ensuring no net loss persists for habitats of concern surrounding the railway.

Table 14-57. Overview of anticipated impacts and losses of PBF/CH in construction and operation phases

PBF or CH	Comment	Ecologically appropriate area of analysis	Area affected during construction (ha)	Area affected during operation (ha)
91E0* Alluvial forests with Alnus glutinosa and *Fraxinus excelsior* (*Alno-Padion, Alnion incanae, Salicion albae*) **(CH)** **Total surface of EAAA: 863.95 ha** **In PAoI: 76.26 ha**	91E0* Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* is an Annex I priority habitat. It is a fragile habitat, but widespread in Serbia. This habitat type was recorded within the buffer zone and the future RoW. These forests will be directly impacted by the Project at chainages cca 193+000 km, cca 196+800 km, cca 223+000 km and between 225+000 and 226+000 km. The impacts during the construction works in the working corridor will be temporary. The impact will be permanent in the corridor maintenance zone and zones of construction of bridges and crossings. Impacts on these habitats could be minimizsed through the implementation of avoidance zones. Impact cannot be fully avoided, resulting in need for active restoration and compensation of lost area.	 **Figure 14-131. EAAA *91E0 Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-Padion, Alnion incanae, Salicion albae*) – subsection Paraćin-Stalać**	2.39	1.67

2 km
*91E0
Proposed railway route
Chainage
River
Novi Sad
Belgrade
Niš
Priština
50 km

		Figure 14-132. EAAA *91E0 Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-Padion, Alnion incanae, Salicion albae*) – subsection Đunis-Trupale		

<table>
<tr>
<td>91F0 Riparian mixed forests of Quercus robur, Ulmus laevis and Ulmus minor, Fraxinus excelsior or Fraxinus angustifolia, along the great rivers (Ulmenion minoris)

(PBF)

Total surface of EAAA: 2,264.11 ha

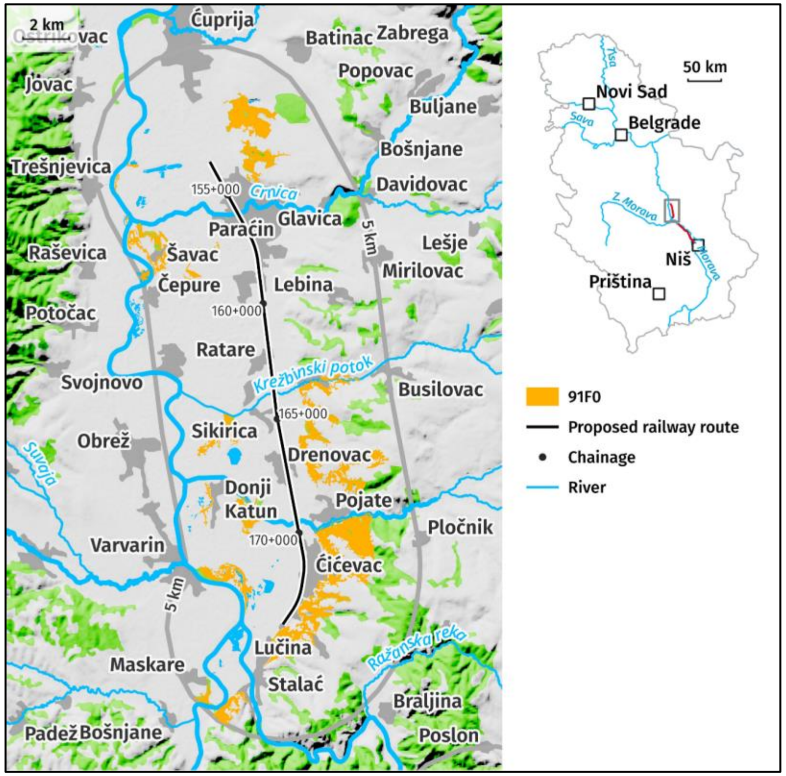
In PAoI: 60.32 ha</td>
<td>This habitat is a fragile habitat, but widespread in Serbia. It listed in Annex I to EU Habitats Directive. These habitats are recorded both within and outside the working corridor. During construction works these habitats will be directly impacted by the construction of bridges at chainages: cca 201+500 km, 217+500 km and cca 219+100 km. In the working corridor impact will be temporary.
During operation phase, habitat loss in the corridor maintenance zone will be permanent.
In order to avoid further impacts on these habitats within the PAoI, areas outside of the working corridor must be marked as avoidance zones. Impact cannot be fully avoided, resulting in need for restoation and compensation of lost area.</td>
<td>

Figure 14-133. EAAA 91F0 Riparian mixed forests of Quercus robur, Ulmus laevis and Ulmus minor, Fraxinus excelsior or Fraxinus angustifolia, along the great rivers (Ulmenion minoris) – subsection Paraćin-Stalać</td>
<td>2.59</td>
<td>1.89</td>
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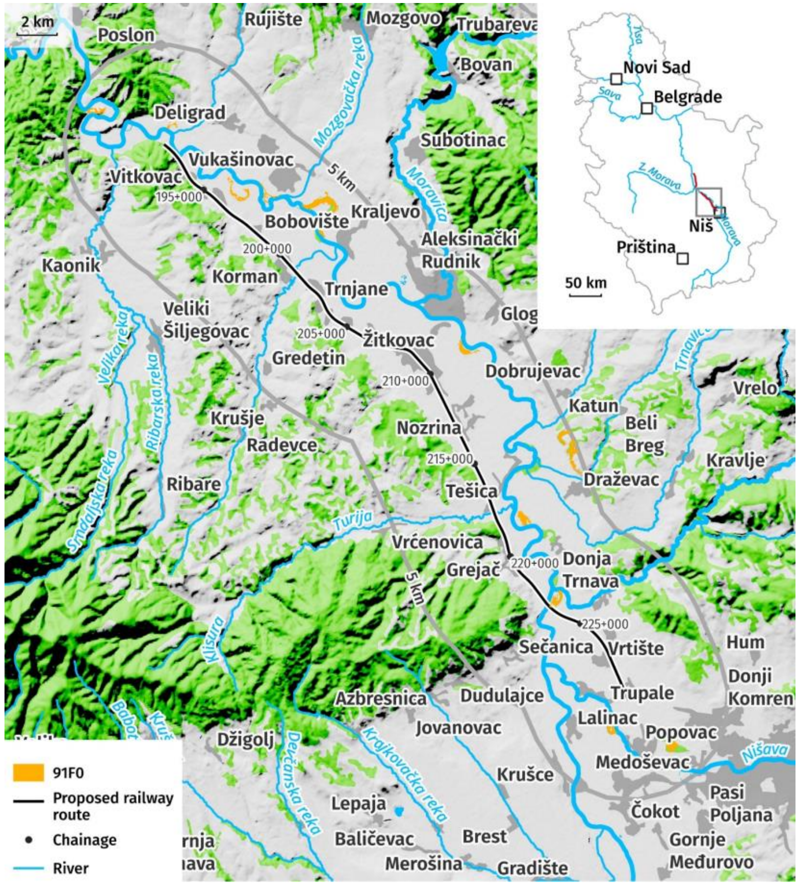


Figure 14-134. **EAAA 91F0 Riparian mixed forests of *Quercus robur, Ulmus laevis* and *Ulmus minor, Fraxinus excelsior* or *Fraxinus***

<table>
<tr><td></td><td></td><td>angustifolia, along the great rivers (Ulmenion minoris) – subsection Đunis - Trupale</td><td></td><td></td></tr>
<tr><td>91M0 Pannonian-Balkanic turkey oak – sessile oak forests

(PBF)

Total surface of EAAA: 14,246.55 ha

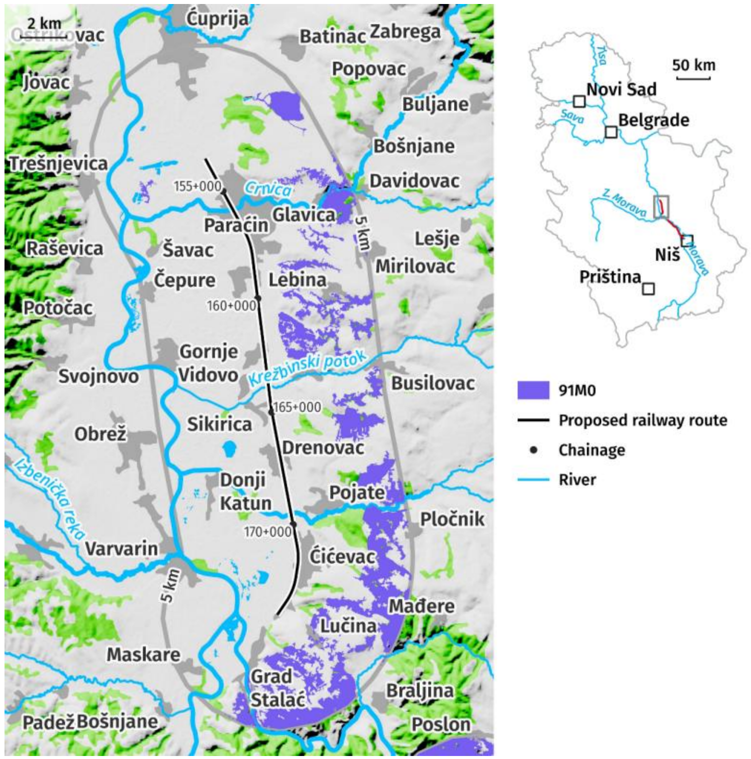
In PAoI: 269.42 ha</td><td>These habitats represent potential natural vegetation of Serbia. They are fragile habitats, but widespread in Serbia. This habitat type was recorded both within the buffer zone and within the future RoW. These habitats will be directly impacted by tunnel construction at chainages cca 192+000 km and cca 193+000 km, as well as by construction of the new part of the corridor at cca 195+000 km, cca 202+200 km and cca 218+000 km..
The impact during the construction works in the working corridor will be temporary. During the operation phase, the impact will be permanent.
To avoid any further additional impacts on these habitats within the PAoI, areas outside of the working corridor must be marked as avoidance zones. Impact cannot be fully avoided, resulting in need for restoration and compensation of lost area.</td><td>

Figure 14-135. EAAA 91M0 Pannonian-Balkanic turkey oak – sessile oak forests – subsection Paraćin-Stalać</td><td>9.02</td><td>6.21</td></tr>
</table>

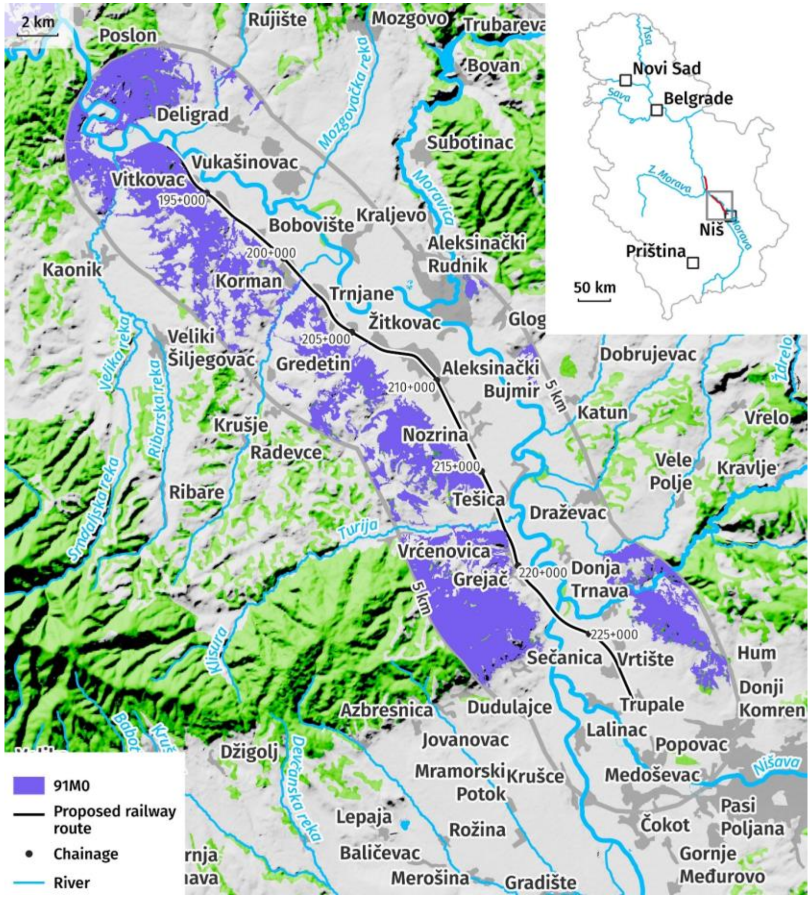
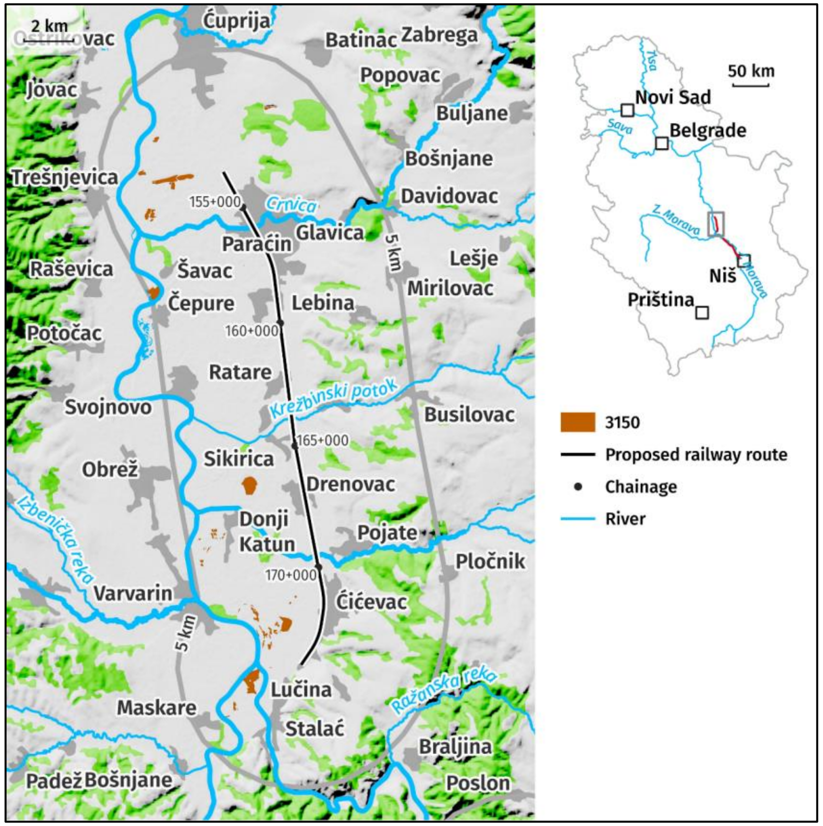


Figure 14-136. **EAAA 91M0 Pannonian-Balkanic turkey oak – sessile oak forests – subsection Đunis – Trupale**

3150 Natural eutrophic lakes with *Magnopotamion* or *Hydrocharition* -type vegetation **(PBF)** **Total surface of EAAA: 206.75 ha** **In PAoI: 7.83 ha**	This habitat is listed in Annex I (EU Directive). It is not a fragile habitat type and it is widespread in Serbia. The loss of this habitat due to the removal of vegetation will be temporary within the working corridor. During operation, the habitat loss will be permanent within the corridor maintenance zone and bridge construction. To avoid any additional impacts on these habitats, areas within the buffer zone have to be designated as avoidance zones.	 **Figure 14-137. EAAA 3150 Natural eutrophic lakes with Magnopotamion or Hydrocharition - type vegetation – subsection Paraćin-Stalać**	**0.58**	**0.45**

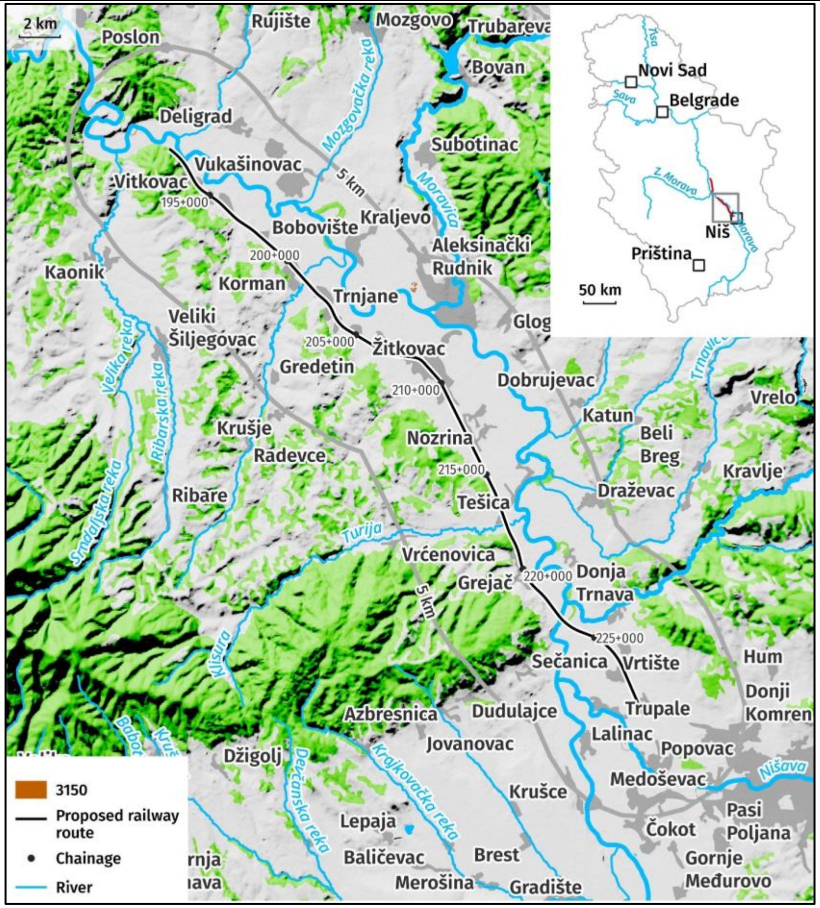
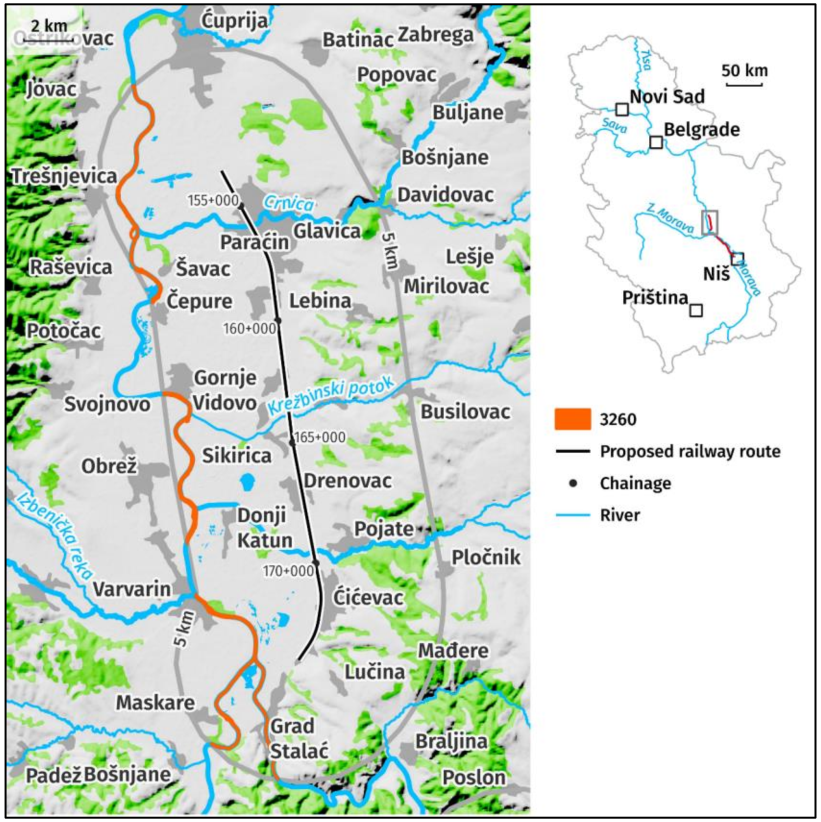


Figure 14-138. **EAAA 3150 Natural eutrophic lakes with *Magnopotamion* or *Hydrocharition* - type vegetation – subsection Đunis – Trupale**

3260 Water courses of plain to montane levels with the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation **(PBF)** **Total surface of EAAA: 646.88 ha**	This habitat is listed in Annex I (EU Habitat Directive). In Serbia, it is a fragile habitat. During the field surveys, this habitat type was not recorded. However, this habitat could potentially be found in the riparian zones of the Južna Morava River. To avoid or minimise potential impact on this habitat type, it is necessary to perform additional field surveys of the aquatic habitats in riparian zone of Južna Morava River within PAoI.	 **Figure 14-139. EAAA 3260 Water courses of plain to montane levels with the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation- subsection Paraćin-Đunis**		

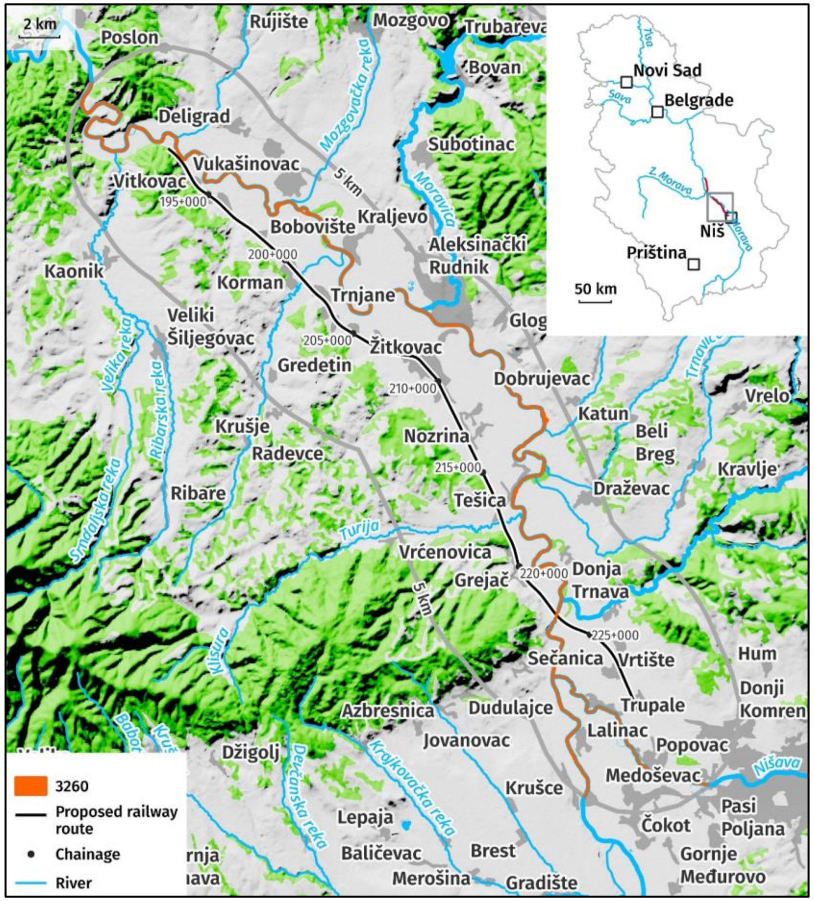
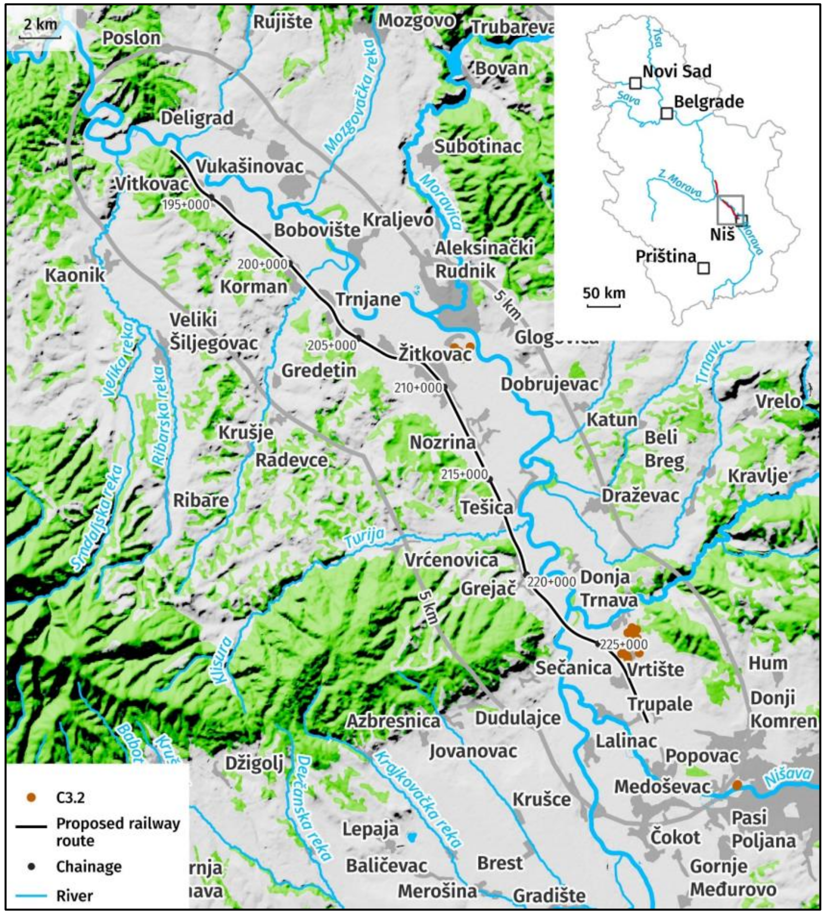
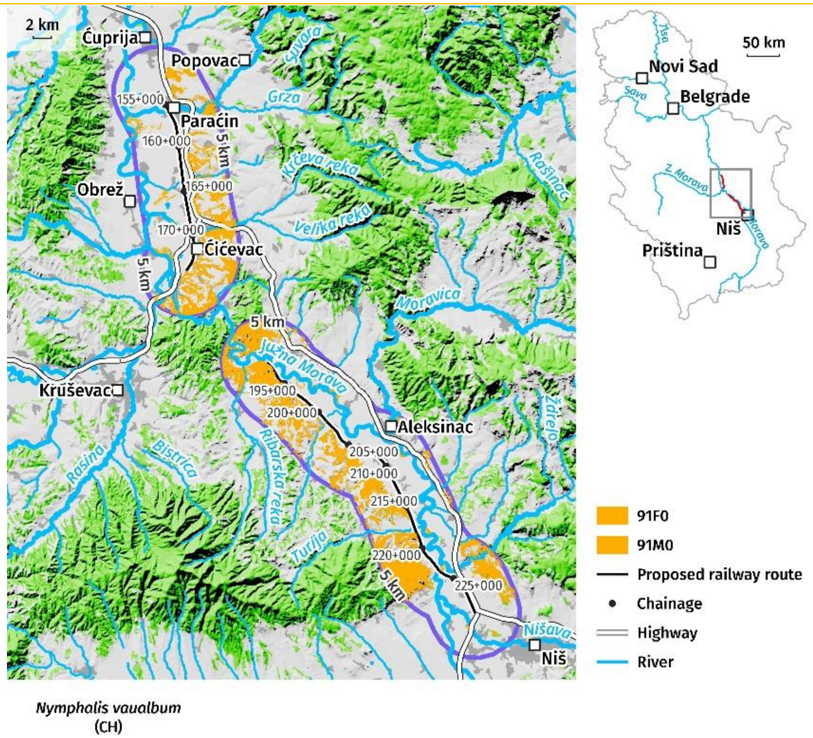
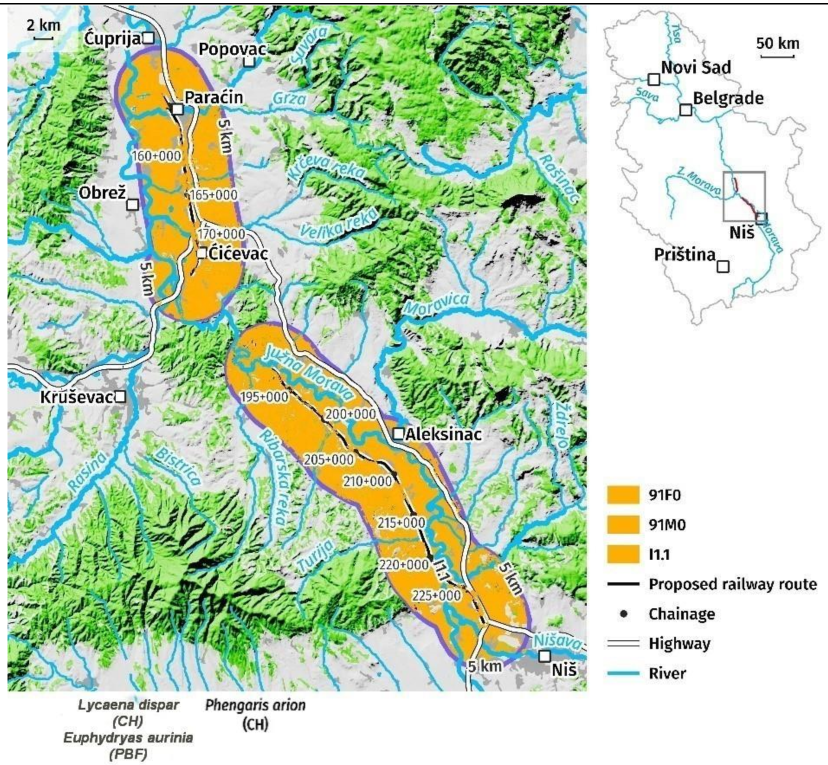
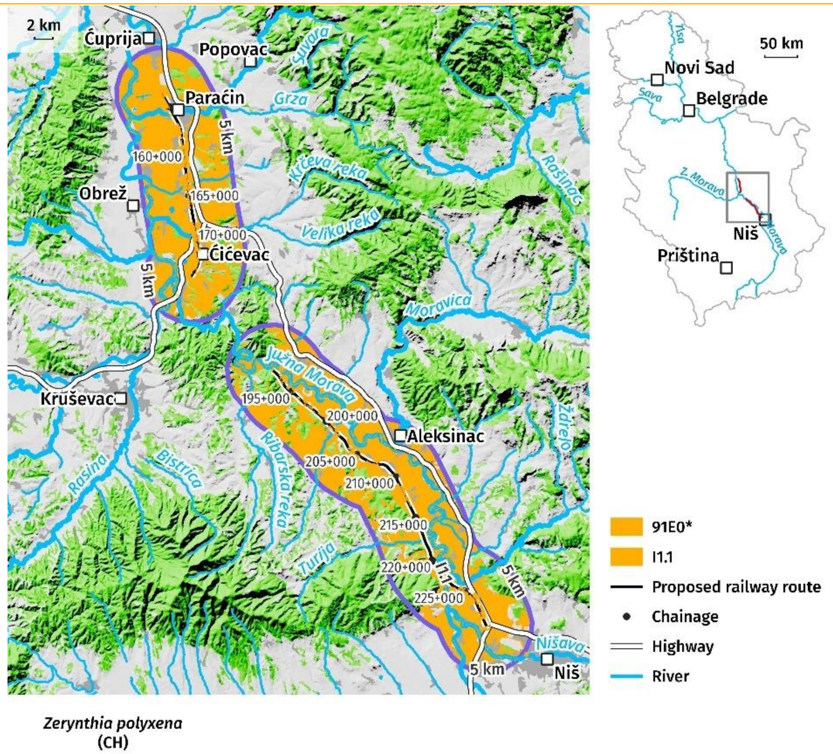


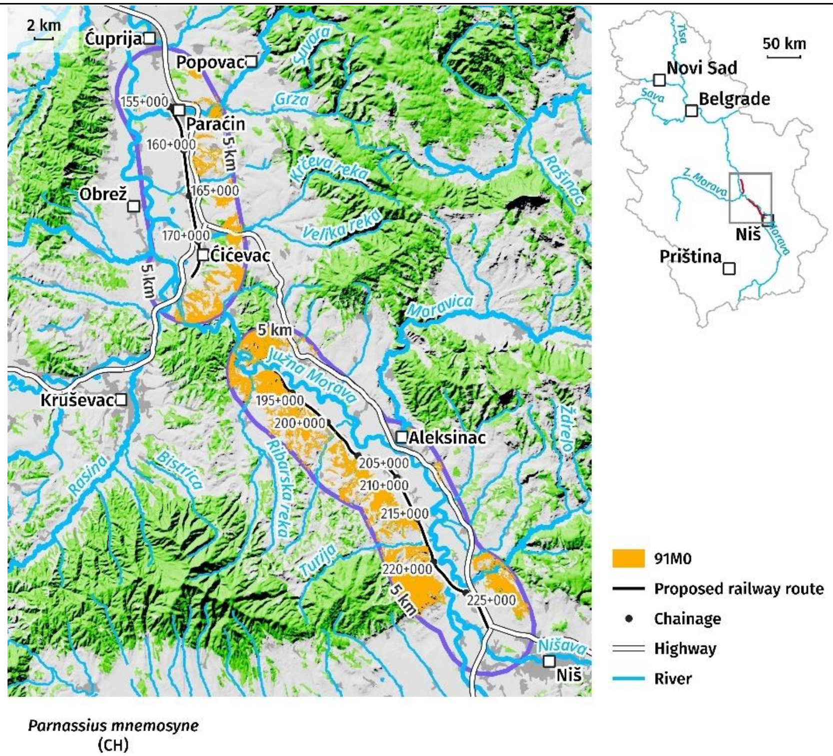
Figure 14-140. **EAAA 3260 Water courses of plain to montane levels with the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation – subsection Đunis - Trupale**

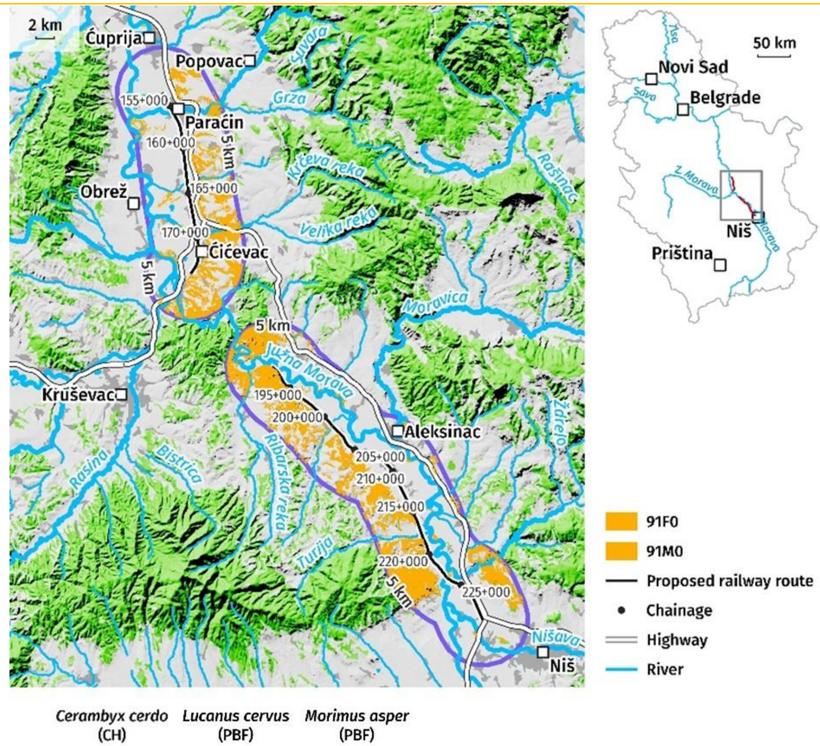
C3.2 Water-fringing reedbeds and tall helophytes other than canes **(PBF)** **Total surface of EAAA: 48 ha**	This habitat is listed in Resolution 4 of Bern Convention. In Serbia, these habitats are widespread. It was recorded within the PAoI and the working corridor. The impact on the habitat will be temporary within the working corridor, during construction activities (between 225+000 km and 226+000 km). During operation, the impact will be permanent. Avoidance zones must be established in areas outside the working corridor, to prevent further degradation.	 **Figure 14-141. EAAA C3.2 Water-fringing reedbeds and tall helophytes other than canes – subsection Đunis – Trupale**	**1.30**	**0.60**

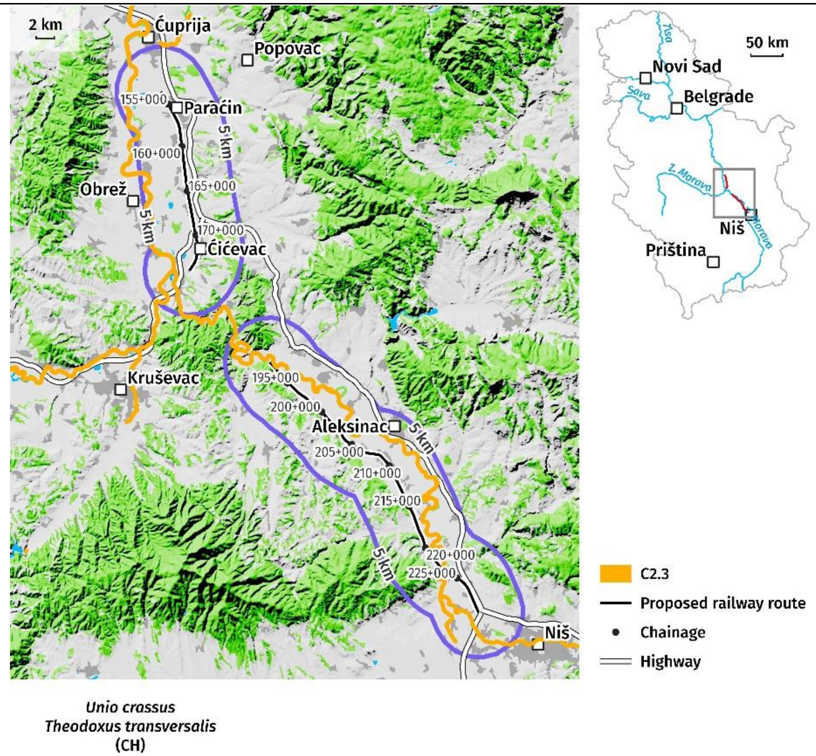
Nymphalis vaualbum **(CH)** **Total surface of EAAA: 16,510.66 ha** **329.74 ha within the PAoI**	<u>EAAA</u>: 91M0 Pannonian-Balkanic turkey oak – sessile oak forests, 91F0 Riparian mixed forests of *Quercus robur, Ulmus laevis and Ulmus minor, Fraxinus excelsior* or *Fraxinus angustifolia*, along the great rivers (*Ulmenion minoris*) Temporary impact during construction may occur in the form of disturbance. A possible permanent impact is expected on the butterfly population in habitats that cover the territory of 0.02% of the total EAAA. Given the availability of suitable habitats in the broader Project area, the project does not have the potential to affect long-term survival of the species.	 **Figure 14-142. EAAA *Nymphalis vaualbum***	10.41 ha	3.63 ha

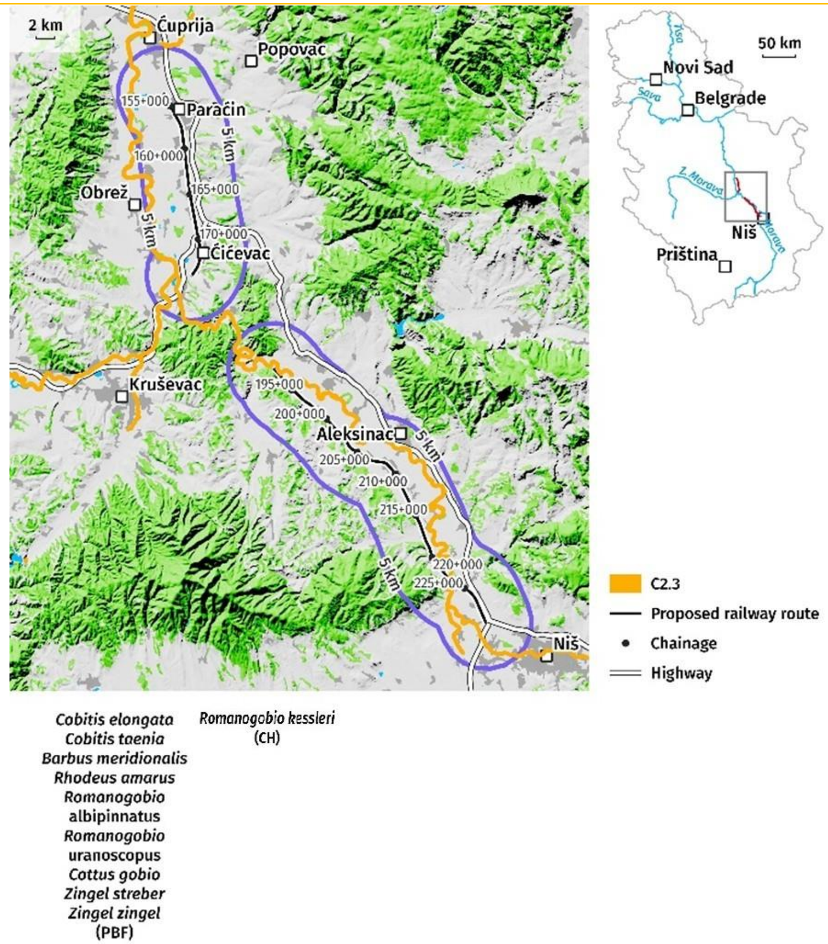
Lycaena dispar ***Phengaris arion*** (CH) ***Euphydryas aurinia*** (PBF) Total surface of EAAA: 60,988.86 ha **In the PAoI: 2,819.16 ha**	EAAA: 91M0 Pannonian-Balkanic turkey oak – sessile oak forests, 91F0 Riparian mixed forests of *Quercus robur, Ulmus laevis and Ulmus minor, Fraxinus excelsior* or *Fraxinus angustifolia*, along the great rivers (*Ulmenion minoris*) I1.1: Intensive unmixed crops Temporary impact during construction may occur in the form of disturbance. A possible permanent impact is expected on the butterfly populations of both species in habitats that cover territory of 0.08% of the total EAAA. Given the availability of suitable habitats in the broader Project area, the project does not have the potential to affect long-term survival of the species.	 **Figure 14-143. Aggregated of EAAA *Lycaena dispar, Euphydryas aurinia and Phengaris arion***	129.54	48.5 ha

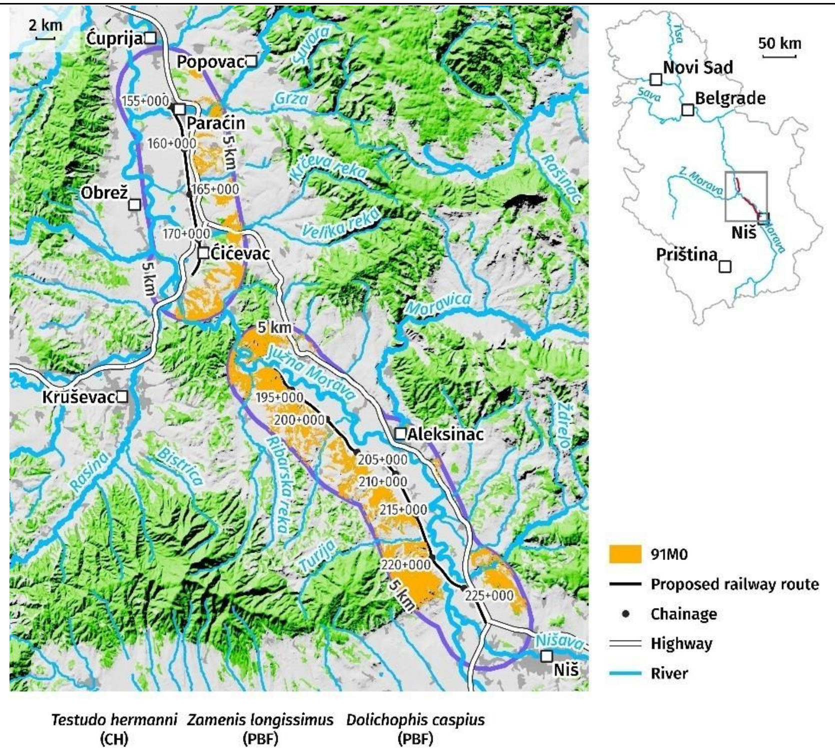
Zerynthia polyxena (CH) Total surface of EAAA: 45,342.15 ha **3,353.37 ha within the PAoI**	EAAA: 91E0* Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior (Alno-Padion, Alnion incanae, Salicion albae*), I1.1 Intensive unmixed crops Temporary impact during construction may occur in the form of disturbance. A possible permanent impact is expected on the butterfly population in habitats that cover territory of 0.10% of the total EAAA. Given the availability of suitable habitats in the broader Project area, the project does not have the potential to affect long-term survival of the species. Additionally, the restoration efforts of priority habitat **91E0* will compensate for the loss of habitat for this species.	 **Figure 14-144. EAAA *Zerynthia polyxena***	121.52 ha	45.74

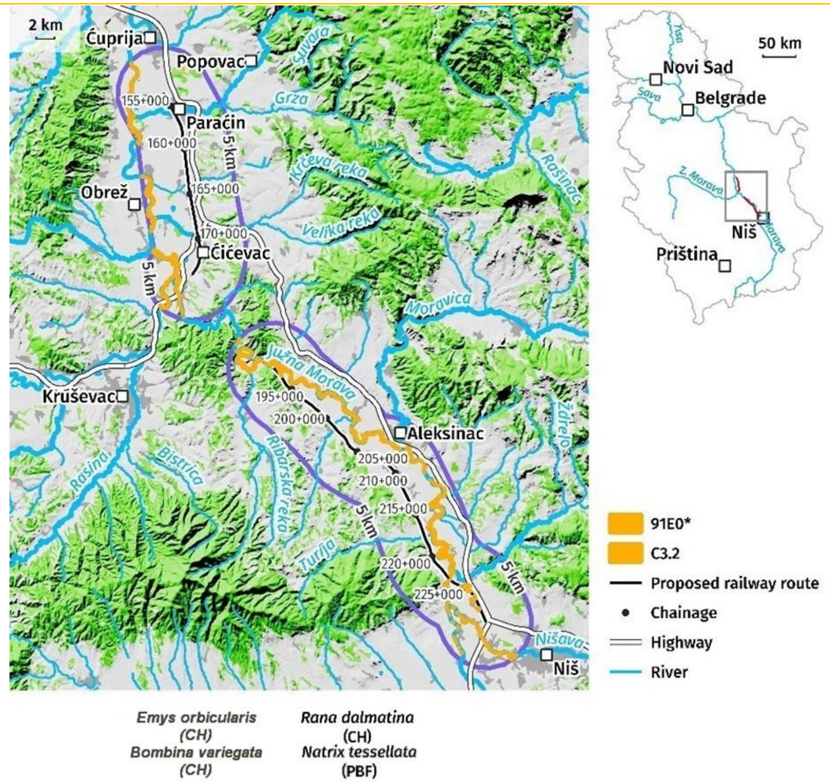
Parnassius mnemosyne (CH) Total surface of EAAA: 14,246.55 ha **269.42 ha within the PAoI**	EAAA: 91M0 Pannonian-Balkanic turkey oak – sessile oak forests Temporary impact during construction may occur in the form of disturbance. A possible permanent impact is expected on the butterfly population that cover the territory of 0.04% of the total EAAA. Given the availability of suitable habitats in the broader Project area, the project does not have the potential to affect long-term survival of the species.	 **Figure 14-145. EAAA *Parnassius mnemosyne***	**9.02**	**6.21**

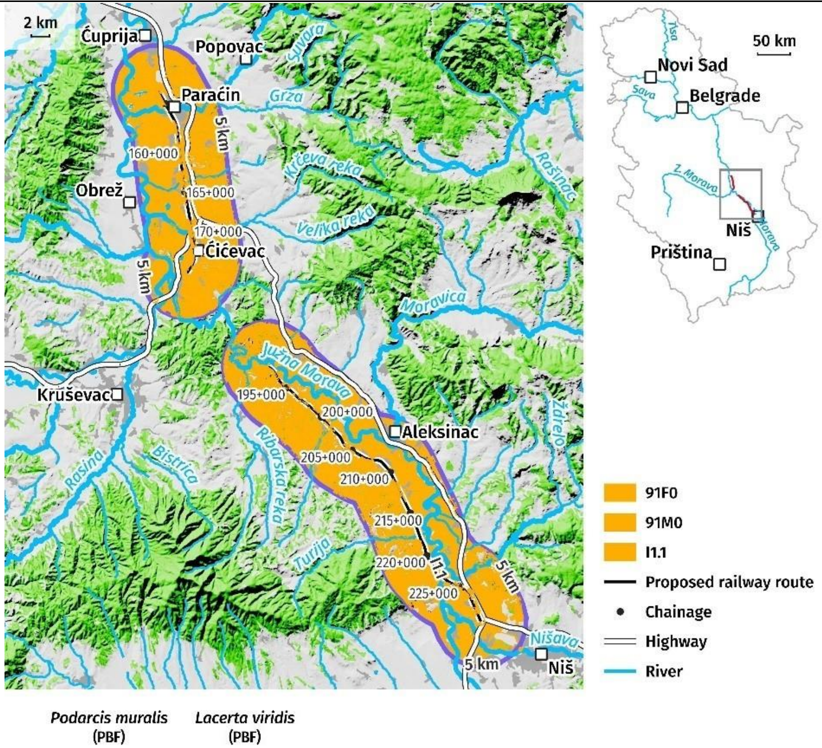
Cerambyx cerdo (CH) ***Lucanus cervus*** ***Morimus asper*** **(PBF)** Total surface of EAAA: 16,510.66 ha **329.74 ha within the PAoI**	EAAA: 91M0 Pannonian-Balkanic turkey oak – sessile oak forests, 91F0 Riparian mixed forests of *Quercus robur, Ulmus laevis and Ulmus minor, Fraxinus excelsior* or *Fraxinus angustifolia*, along the great rivers (*Ulmenion minoris*) Temporary impact during construction may occur in the form of disturbance. A possible permanent impact is expected on the population in habitats that cover the territory of 0.02% of the total EAAA. Given the availability of suitable habitats in the broader Project area, the project does not have the potential to affect long-term survival of the species.	 **Figure 14-146. EAAA of *Cerambyx cerdo, Lucanus cervus* and *Morimus funereus***	10.41 ha	3.63 ha

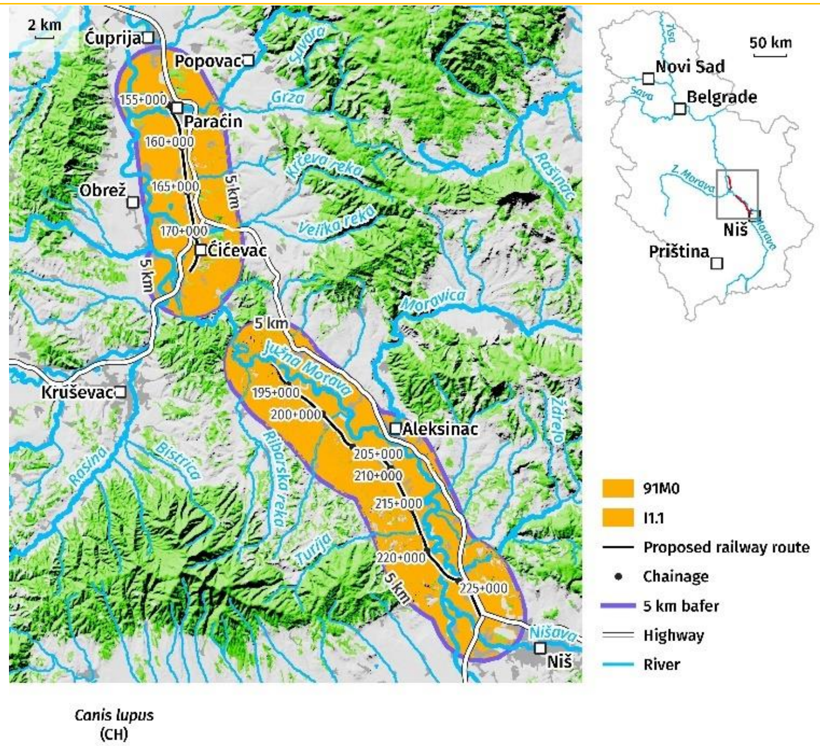
Unio crassus *Theodoxus transversalis* (CH) Total surface of EAAA: 646.88ha **6.3 ha within the PAoI**	EAAA: C2.3 Permanent non-tidal, smooth-flowing watercourses Direct impact on these species during construction is expected at km 223+054.78, where the piers of the Bridge over the Južna Morava River will be built in the water. During the reconstruction of other bridges, vegetation removal from aquatic habitats may indirectly impact these species, particularly if they are present in smaller watercourses. During the construction of the pillars, an impact may arise in the form of material collapse, which can lead to short-term turbidity of the water. These species, as sedentary organisms, are sensitive to this impact. However, the mentioned impacts are limited to the construction phase and are localised to the area of the works. Permanent impacts are not expected, although close monitoring of populations is prescribed.	 **Figure 14-147. Aggregated EAAA of *Unio crassus* and *Theodoxus transversalis***	During the field surveys this habitat type was not recorded. Furthermore, this habitat type is not included in the database of the Institute for nature conservation of Serbia. However, this habitat could potentially be found in the riparian zone of the Južna Morava River.	None

Cobitis elongata *Cobitis taenia* *Barbus meridionalis* *Rhodeus amarus* *Romanogobio albipinnatus* *Romanogobio uranoscopus* *Cottus gobio* *Zingel streber* *Zingel zingel* (PBF) ***Romanogobio kessleri*** **(CH)** Total surface of EAAA: 646.88 ha **6.3 ha within the PAoI**	EAAA: C2.3 Permanent non-tidal, smooth-flowing watercourses During the construction of bridges, especially at km 223+053 on the Južna Morava River, where the bridge piers will be placed in the riverbed. Material collapse (rocks, trees, soil) into the water can lead to short-term increases in turbidity and a temporary change in the physical and chemical characteristics of the surface water. However, the impacts are expected to be limited to the construction phase and localised to the immediate area of the work. The impact on the long-term survival of the species cannot be anticipated as a result of the Project implementation.	 **Figure 14-148. EAAA of fish species**	During the field surveys this habitat type was not recorded. Furthermore, this habitat type is not included in the database of the Institute for nature conservation of Serbia. However, this habitat could potentially be found in the riparian zone of the Južna Morava River.	None

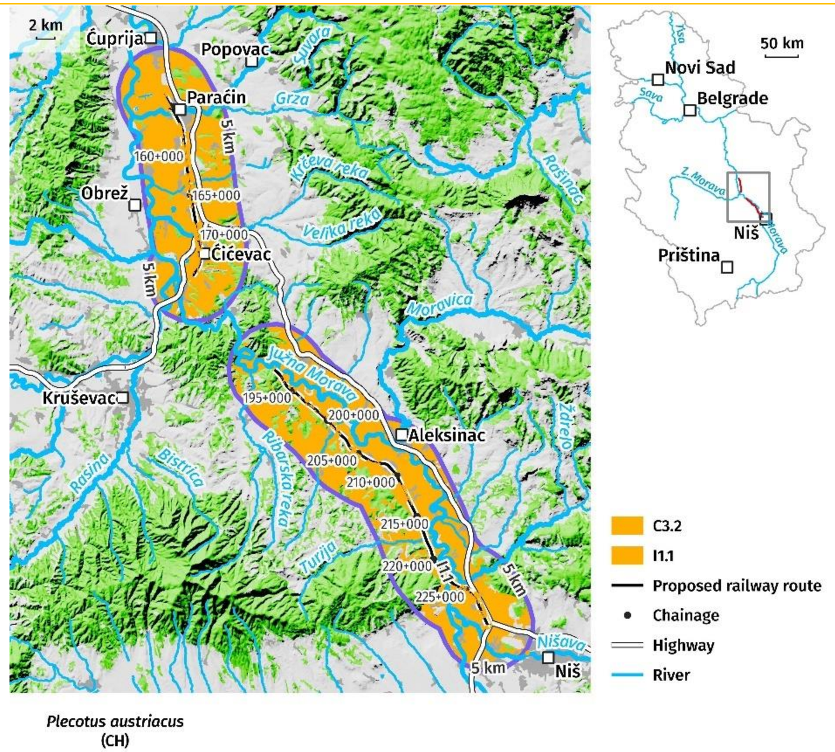
Zamenis longissimus Dolichophis caspius **(PBF)** *Testudo hermanni* (CH) Total surface of EAAA: 14,246.55 ha **269.42 ha within the PAoI**	<u>EAAA:</u> 91M0 Pannonian-Balkanic turkey oak – sessile oak forests Impacts expected on the population of this species during construction are disturbance and temporary degradation of habitats. During operation, permanent loss of habitats will cover territory of 0.04% of the total EAAA. Given the availability of suitable habitats in the broader Project area, the project does not have the potential to affect the long-term survival of the species.	 **Figure 14-149. Aggregated EAAA of *Testudo hermanni, Dolichophis caspius, Zamenis longissimus***	9.02 ha	6.21 ha

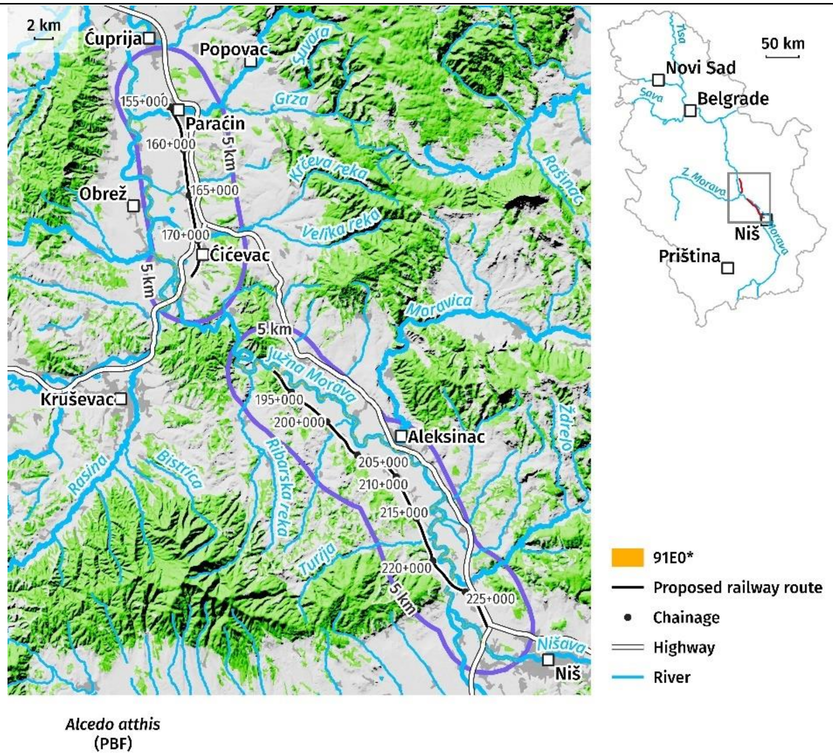
Emys orbicularis ***Bombina variegata*** ***Rana dalmatina*** (CH) Natrix tessellata (PBF) Total surface of EAAA: 911.95 ha **92.14 ha within the PAoI**	EAAA: 91E0* *Alluvial forests with Alnus glutinosa and Fraxinus excelsior (Alno-Padion, Alnion incanae, Salicion albae*), C3.2 Water-fringing reedbeds and tall helophytes other than canes Impacts expected on the populations of these species during construction are disturbance and temporary degradation of habitats. During operation, permanent loss of habitats will cover territory of 0.18% of the total EAAA. Given the availability of suitable habitats in the broader project area, the project does not have the potential to affect the long-term survival of the species.	 **Figure 14-150. Aggregated EAAA of *Emys orbicularis, Bombina variegata, Rana dalmatina, Natrix tessellata***	3.69 ha	1.67 ha

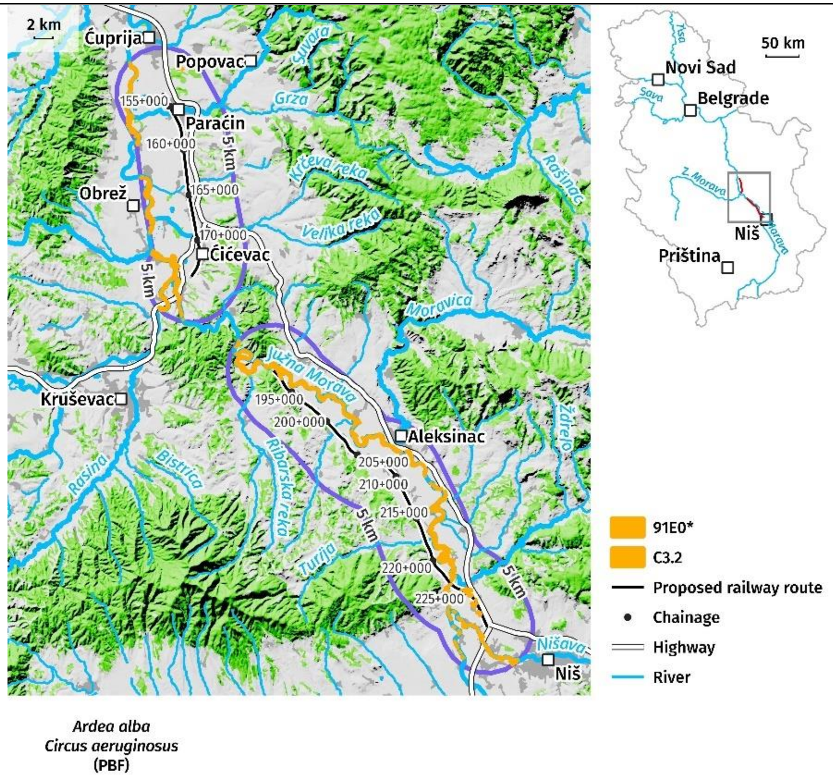
Podarcis muralis *Lacerta viridis* (PBF) Total surface of EAAA: 60,988.86 ha, **2,819.16 ha within the PAoI**	EAAA: This species is present in 91M0 Pannonian-Balkanic turkey oak – sessile oak forests, 91F0 Riparian mixed forests of *Quercus robur, Ulmus laevis and Ulmus minor, Fraxinus excelsior* or *Fraxinus angustifolia*, along the great rivers (*Ulmenion minoris*) I1.1: Intensive unmixed crops Temporary impact during construction may occur in the form of disturbance. A possible permanent impact is expected on the population of this species in habitats that cover territory of 0.08% of the total EAAA. Given the availability of suitable habitats in the broader Project area, the Project does not have the potential to affect the long-term survival of the species. This species is very common in the P AoI and wider area.	 **Figure 14-151. Aggregated EAAA of *Podarcis muralis, Lacerta viridis***	129.54 ha	48.5 ha

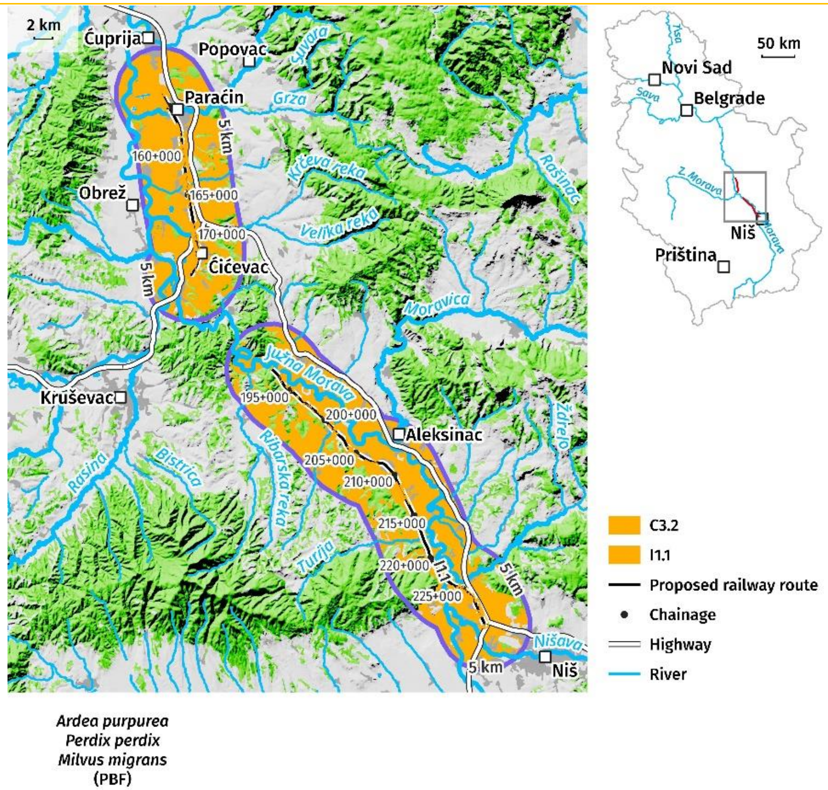
Canis lupus (CH) Total surface of EAAA: 16,510.66 ha, **329.74 ha within the PAoI**	<u>EAAA</u>: 91M0 Pannonian-Balkanic turkey oak – sessile oak forests, 91F0 Riparian mixed forests of *Quercus robur, Ulmus laevis and Ulmus minor, Fraxinus excelsior* or *Fraxinus angustifolia*, along the great rivers (*Ulmenion minoris*) Temporary impact during construction may occur in the form of disturbance. A possible permanent impact on the population is expected in habitats that cover a territory of 0.02% of the total EAAA. Given the availability of suitable habitats in the broader Project area, the Project does not have the potential to affect the long-term survival of the species.	 **Figure 14-152. EAAA *Canis lupus***	10.41 ha	3.63 ha
Myotis bechsteinii *Myotis mystacinus* *Nyctalus noctula*	<u>EAAA</u>: 91F0 Riparian mixed forests of *Quercus robur, Ulmus laevis* and *Ulmus minor, Fraxinus excelsior* or *Fraxinus angustifolia*, along the great rivers (*Ulmenion*	Refer to Figure 14-151.	129.54	48.5 ha

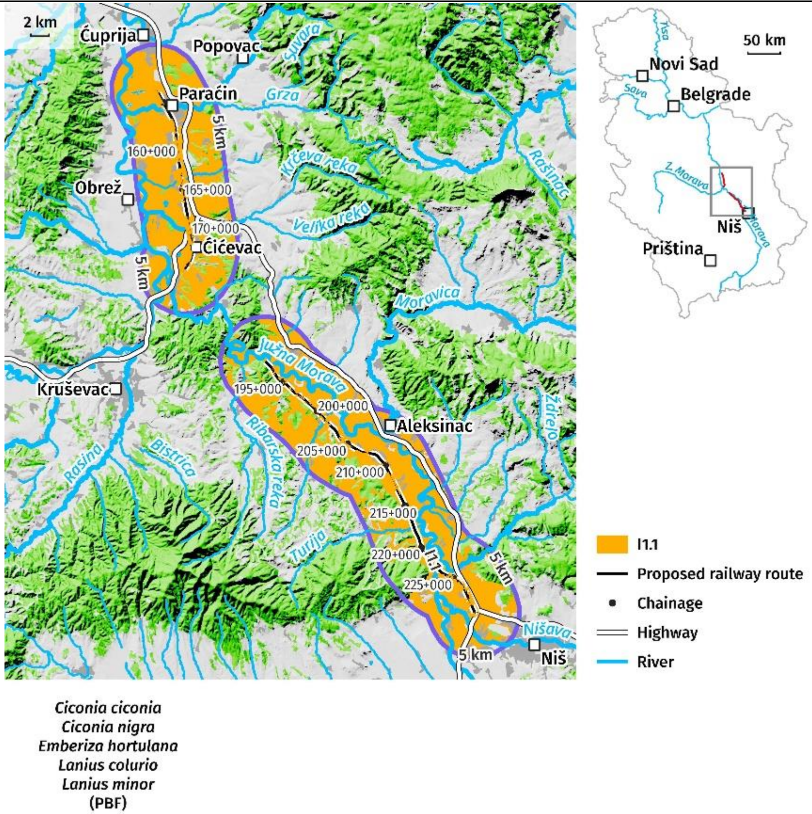
Vespertilio murinus (CH) Total surface of EAAA: 60,988.86 ha, **2,819.16 ha within the PAoI**	*minoris*), 91M0 Pannonian-Balkanic turkey oak – sessile oak forests, I1.1: Intensive unmixed crops Temporary impact during construction may occur in the form of disturbance, for which targeted mitigation measures will be implemented. A possible permanent impact is expected on the population of this species in habitats that cover territory of 0.08% of the total EAAA. Given the availability of suitable habitats in the broader Project area, the Project does not have the potential to affect the long-term survival and migratory behaviour of the species.			

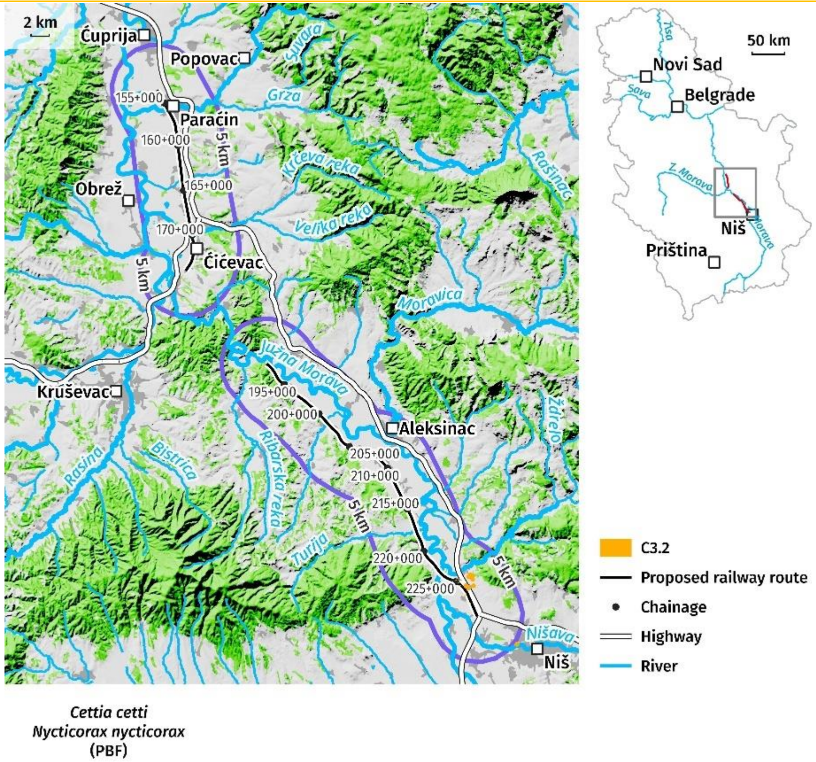
Plecotus austriacus (CH) Total surface of EAAA: 44,526.2 ha, **2,505.30 ha within the AoI**	EAAA: I1.1 Intensive unmixed crops, C3.2 Water-fringing reedbeds and tall helophytes other than canes Temporary impact during construction may occur in the form of disturbance, for which targeted mitigation measures will be implemented. . A possible permanent impact is expected on the population in habitats that cover the territory of 0.10% of the total EAAA. Given the availability of suitable habitats in the broader Project area, the Project does not have the potential to affect the long-term survival of the species.	 **Figure 14-153. EAAA of *Plecotus austriacus***	120.43 ha	42.89 ha
Miniopterus schreibersii *Pipistrellus nathusii* (CH) Total surface of EAAA:	EAAA: 91M0 Pannonian-Balkanic turkey oak – sessile oak forests, 91F0 Riparian mixed forests of *Quercus robur, Ulmus laevis and Ulmus minor, Fraxinus excelsior* or *Fraxinus angustifolia*, along the great rivers (*Ulmenion minoris*)	Refer to Figure 14-146	10.41 ha	3.63

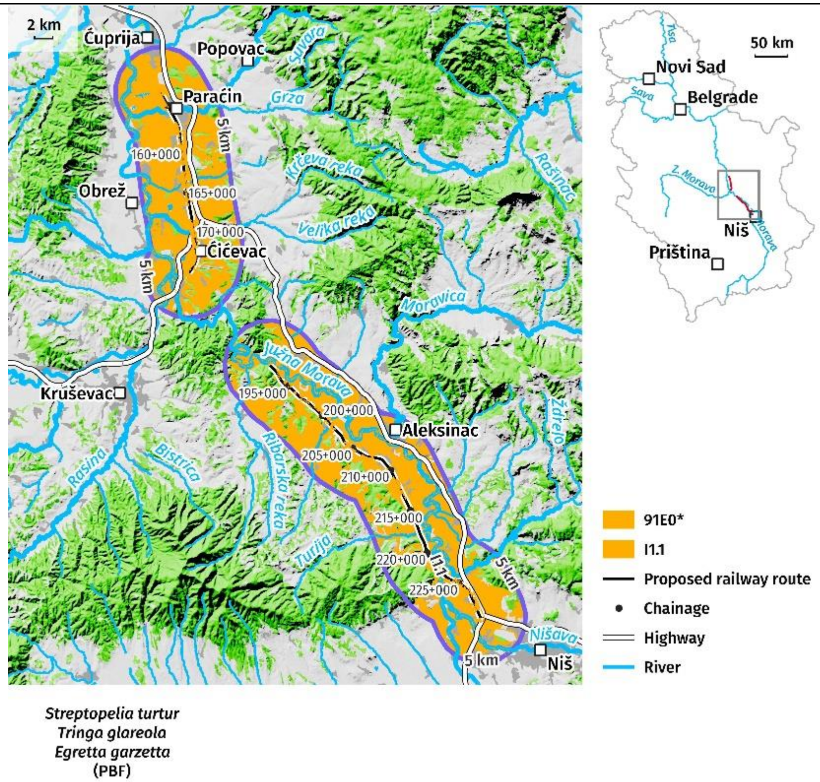
16,510.66 ha, **329.74 ha within the PAoI**	Temporary impact during construction may occur in the form of disturbance, for which targeted mitigation measures will be implemented. . Possible permanent impact is expected on the population in habitats that cover the territory of 0.02% of the total EAAA. Given the availability of suitable habitats in the broader Project area, the Project does not have the potential to affect the long-term survival of the species.			
Alcedo atthis (PBF) Total surface of EAAA: 863.95 ha **76.26 ha within the PAoI**	<u>EAAA:</u> 91E0* Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-Padion, Alnion incanae, Salicion albae*) Individuals of this species are associated with aquatic habitats for nesting and foraging. Possible disturbance during construction is expected, but no nest of this species has been recorded in the PAoI. In addition, it is unlikely that individuals of this species, which rely on aquatic habitats for nesting and where foraging opportunity is abundant, will fly towards the railway corridor, into the zone of direct impact. A possible permanent impact is expected on the population of this species in the habitat that_covers the territory of 0.19% of the total EAAA. In terms of that, the project does not have the potential to affect the long-term survival of the species. Additionally, through restoration of **91E0* forests, part of habitat loss will be accounted for.	 **Figure 14-154. EAAA *Alcedo athis***	2.39 ha.	1.67 ha

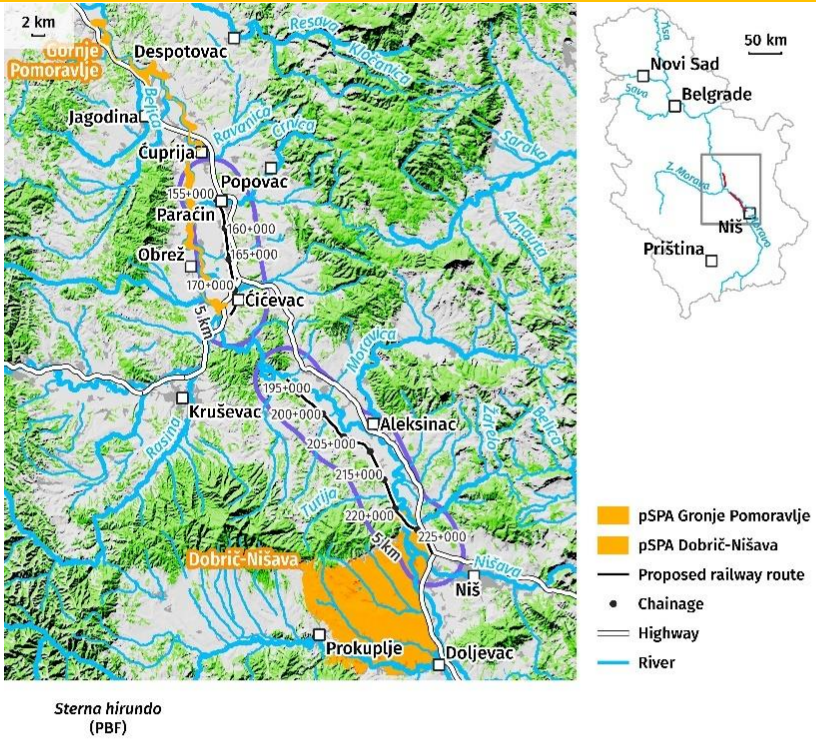
Ardea alba *Circus aeruginosus* (PBF) Total surface of EAAA: 911.95 ha **92.14 ha within the PAoI**	EAAA: 91E0* Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-Padion, Alnion incanae, Salicion albae*), C3.2 Water-fringing reedbeds and tall helophytes other than canes These are migratory species, present in these areas temporarily and during that time, they need good conditions for breeding. In terms of that, they are sensitive to any disturbance during the breeding period between April and June, when the impact is medium. These species are present in agricultural lands and inhabited areas, which are present in PAoI at a high percentage.	 Figure 14-155. EAAA *Ardea alba* and *Circus aeruginosus*	3.69 ha	1.67 ha

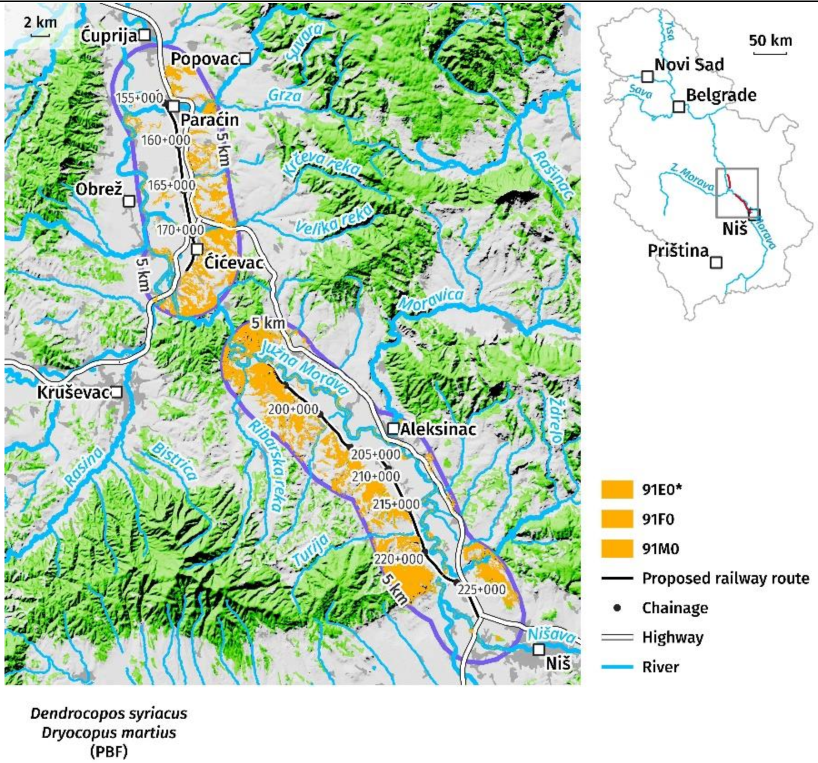
Ardea purpurea *Perdix perdix* ***Milvus migrans*** (PBF) Total surface of EAAA: 44,526.2 ha, **2,505.30 ha within the AoI**	<u>EAAA:</u> I1.1 Intensive unmixed crops, C3.2 Water-fringing reedbeds and tall helophytes other than canes These are migratory species, present in these areas temporarily and during that time, they need good conditions for breeding. In terms of that, they are sensitive to any disturbance during the breeding period between April and June, when the impact is medium. These species are also present in agricultural lands and inhabited areas, which are present in PAoI at a high percentage. A possible permanent impact is expected on the population of these species in habitats that cover a territory of 0.1% of the total EAAA. Given the availability of suitable habitats in the broader Project area, the Project does not have the potential to affect the long-term survival of the species.	 **Figure 14-156. EAAA *Ardea purpurea, Perdix perdix, Milvus migrans***	120.43 ha	42.89 ha

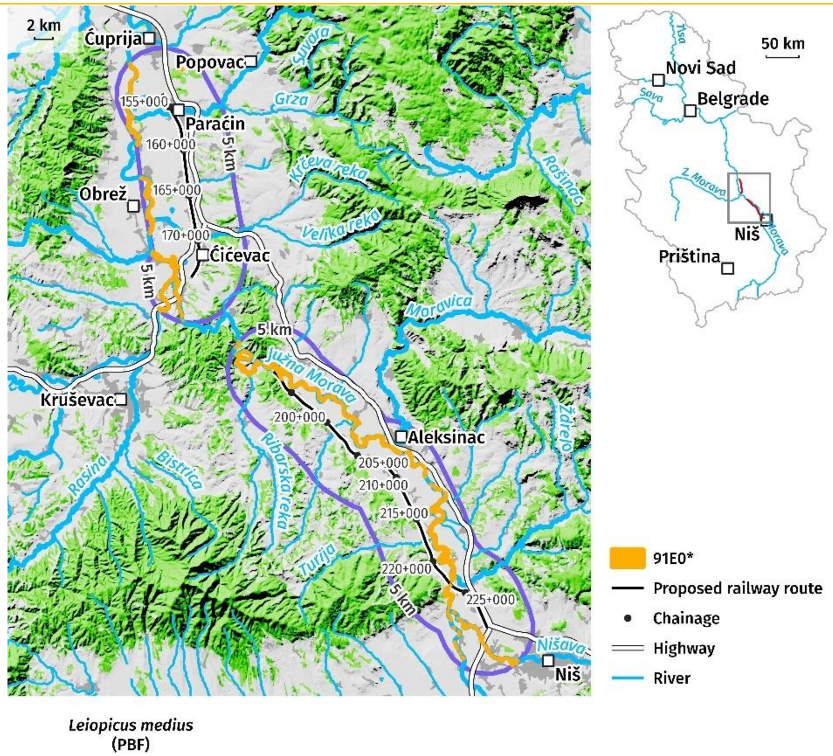
Ciconia ciconia *Ciconia nigra* *Emberiza hortulana* *Lanius colurio* *Lanius minor* (PBF) Total surface of EAAA: **44,478.2** ha, **2,457.3 ha within the PAoI**	<u>EAAA:</u> I1.1 Intensive unmixed crops All species are migratory, present in these areas temporarily during that period, when they need good conditions for breeding and aresensitive to any disturbance, particularly betweenApril and June, when the impact is medium. These species are present in agricultural lands and inhabited areas, which are present in PAoI in high percentages. A possible permanent impact is expected on the population of these species in habitats that cover a territory of 0.09% of the total EAAA. Given the availability of suitable habitats in the broader Project area, the Project does not have the potential to affect the long-term survival of the species.	 **Figure 14-157. EAAA *Ciconia ciconia, C. nigra, Emberiza hortulana, Lanius colurio, L. minor***	119.13 ha	42.29 ha

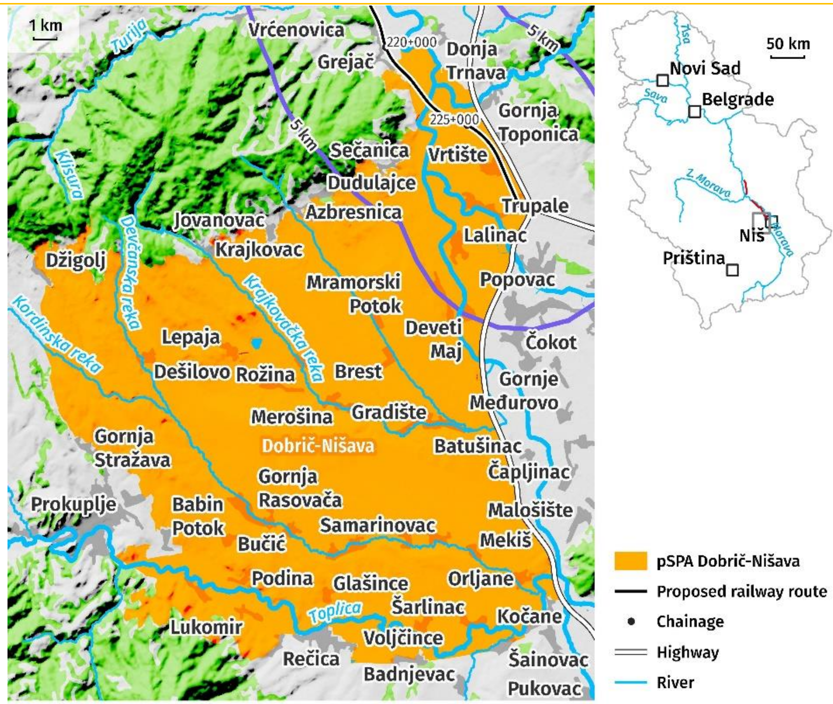
Cettia cetti *Nycticorax nycticorax* (PBF) Total surface of EAAA: 48 ha **15.88 ha within the PAoI**	<u>EAAA:</u> C3.2 Water-fringing reedbeds and tall helophytes other than canes These are migratory species present in these areas temporarily and during that time, they need good conditions for breeding. In terms of that, they are sensitive to any disturbance during the breeding period between April and June. A possible permanent impact is expected on the population of these species in habitats that cover a territory of 1.25% of the total EAAA. Given the availability of suitable habitats in the broader Project area, the Project does not have the potential to affect the long-term survival of the species.	 **Figure 14-158. EAAA *Cettia cetti* and *Nycticorax nycticorax***	1.30 ha	0.6 ha

Streptopelia turtur *Tringa glareola* *Egretta garzetta* PBF 45,342.15 ha **3,353.37 ha within the PAoI**	<u>EAAA</u>: 91E0* Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-Padion, Alnion incanae, Salicion albae*), I1.1 Intensive unmixed crops These are migratory species present in these areas temporary and during that time they need good conditions for breeding (between April and June). In terms of that, they are sensitive to any disturbance during the breeding period, when the impact is medium. These species are known to depend on meadows and agricultural lands for foraging, while woodland, steppe and semi-desert habitats are used for breeding. In the PAoI it can be found foraging in open habitat types and agricultural lands (I1.1, present in PAoI in high percentage). A possible permanent impact is expected on the population of this species in habitats that cover a territory of 0.1% of the total EAAA. Given the availability of suitable habitats in the broader Project area, the Project does not have the potential to affect the long-term survival of the species.	 **Figure 14-159. EAAA *Streptopelia turtur, Tringa glareola,* and *Egretta garzetta***	121.52 ha	45.74 ha

Sterna hirundo (PBF) Total surface of aggregated EAAA: 41,309 ha	Common Tern was recorded on Velika Morava River, near Stalać. This is a triggerspecies for IBA Gornje Pomoravlje, and has also been recorded in pSPA Dobrić-Nišava. However, near its nesting place, a lot of work was done on the construction of a new motorway in the past, so the nesting of the species has not been proven. But, since this is a migratory species present in these areas temporarily during the period April to June, when it needs good conditions for breeding and is sensitive to any disturbance, a possible permanent impact is expected on the population of this species in habitats that cover a territory of 0.1% of the total EAAA. Given the availability of suitable habitats in the broader Project area, the Project does not have the potential to affect the long-term survival of the species.	 **Figure 14-160. EAAA *Sterna hirundo***	EAAA is entire pSPA Gornje Pomoravlje and pSPA Dobrić-Nišava.	42.89

Dendrocopos syriacus *Dryocopus martius* (PBF) Total surface of EAAA: 17,374.61 ha, **406 ha within the PAoI**	<u>EAAA</u>: *91E0 Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-Padion, Alnion incanae, Salicion albae*), 91F0 Riparian mixed forests of *Quercus robur, Ulmus laevis* and *Ulmus minor, Fraxinus excelsior* or *Fraxinus angustifolia*, along the great rivers (*Ulmenion minoris*), 91M0 Pannonian-Balkanic turkey oak – sessile oak forests These are breeding resident birds. They nest in holes in tree trunks that they make themselves. They are very numerous and nest all over PAoI. In the period from the beginning of April to the end of June, during the breeding period, these birds are sensitive to any disturbance. The aggregated EAAA for these species is large and it is not expected that the populations of these species will be impacted by the Project. A possible permanent impact is expected on the population of these species in habitats that cover a territory of 0.06% of the total EAAA. Given the availability of suitable habitats in the broader Project area, the Project does not have the potential to affect the long-term survival of the species.	 **Figure 14-161. EAAA *Dendrocopos syriacus* and *Dryocopus martius***	14 ha	9.77 ha

Leiopicus medius (PBF) Total surface of EAAA: 863.95 ha **76.26 ha within the PAoI**	EAAA: 91E0* Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-Padion, Alnion incanae, Salicion albae*), This is a breeding resident bird. It nests in hollows of dying or dead trees or larger branch. In PAoI inhabits alluvial forests. In the period from the beginning of April to the end of May, during the breeding period, these birds are sensitive to any disturbance. EAAA for this species is not large, but it is not expected that population of this species will be impacted by the Project. The impact on habitats of this species will be permanent in the corridor maintenance zone and zones of construction of bridges and crossings, and covers 0,19% of the total EAAA . Therefore, it is not expected that the populations of this species will be impacted by the Project.	 **Figure 14-162. EAAA *Leiopicus medius***	2.39 ha	1.67 ha
EAAA for protected areas				

pSPA/IBA Dobrić-Nišava Total surface of EAAA: 35,389 ha	pSPA/ IBA "Dobrić-Nišava" is crossed by the existing railway from the chainage km 220+315 to the end of the Section 3. This mostly agricultural flat area is interspaced with hilly tops, villages, rivers, creeks, gravel pits and one lake (Oblačinsko jezero). Most of the existing habitats within the IBA (92%) are artificial and terrestrial, covered with perennial crops, orchards and groves. During the construction phase of the project, it is expected that vegetation cover will be removed at least within the working corridor, but after the finalisation of construction, the vegetation cover is expected to spontaneously recover so the impact will be temporary. Therefore, there will be no permanent net loss of vegetation cover that provides a possible feeding area for identified bird species in pSPA. During the construction, bird and bat species will be disturbed due to increase in noise, vibrations and frequency of human presence, which will induce avoidance behaviour. Neither the physical nor ecological integrity of the pSPA is expected to deteriorate. Detailed assessments are provided in the AA.	 pSPA/IBA Dobrič-Nišava (PBA) **Figure 14-163. EAAA pSPA/IBA Dobrić-Nišava**	120.43	42.89

14.3. Mitigation measure for the identified impacts

14.3.1. Pre-construction phase

The impact of obstructing the movement of fauna may occur during the construction phase and continue through the operations phase. However, pre-emptive mitigation measures can be implemented prior to construction commencing to limit the significance of this impact. Furthermore, to limit or avoid potential impacts on EAAAs of PBFs and CHs, and G1 and E3 habitat types, the implementation of certain pre-construction activities will be necessary.

The following mitigation measures must be prescribed to occur prior to the commencement of any construction works:

- All habitats that are classified as CH and PBF as well as autochthonous forest with EUNIS code G1 and E3 Wet or seasonally wet grasslands which are inhabited by species triggering CH/PBF designation have to be marked as **avoidance zones**:
  - C1.33 - Rooted submerged vegetation of eutrophic waterbodies (3150 Natural eutrophic lakes with Magnopotamion or Hydrocharition -type vegetation) – chainages: 225+000 km and 226+000 km and cca 228+000 km.
  - C3.2 Water-fringing reedbeds and tall helophytes other than canes – chainages: cca 223+00 km, cca 225+000 km, cca 227+000 km and cca 228+000 km.
  - E3 Wet or seasonally wet grasslands – chainages: cca 225+000 km, between 225+000 km and 226+000 km and cca 228+000 km.
  - G1 Broadleaved deciduous woodland – chainages: cca 192+200 km, cca 196+000 km, cca 198+000 km, cca 199+000 km.
  - G1.11 Riverine *Salix* woodlands (*91E0 Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-Padion, Alnion incanae, Salicion albae*) – chainages: between 192+000 km and 193+000 km, cca 197+000 km, cca 197+000 km, cca 200+000 km, cca 223+000 km, cca 225+000 km, cca 226+000 km, cca 227+000 km and cca 228+000.
  - G1.223 Southeast European *Fraxinus* - *Quercus* - *Alnus* forests (91F0 Riparian mixed forests of *Quercus robur*, *Ulmus laevis* and *Ulmus minor, Fraxinus excelsior* or *Fraxinus angustifolia*, along the great rivers (*Ulmenion minoris*)) – chainages: between 219+000 km and 220+000 km.
  - G1.76 Balkano-Anatolian thermophilous Quercus forests (91M0 Pannonian-Balkanic turkey oak – sessile oak forests) – chainages: between 191+500 km and 195+200 km, between 196+500 km and 197+300 km, between 198+100 km and 199+500 km, between 202+200 km and 203+200 km, between 204+800 km and 205+100 km, between 218+000 km and 219+200 km and cca 205+000 km.
  - All aquatic habitats in riparian zone of Južna Morava River within project area and wider area.
  - The locations of the habitats that must be delineated as Avoidance Zones are shown in Figure 14-164 to Figure 14-171

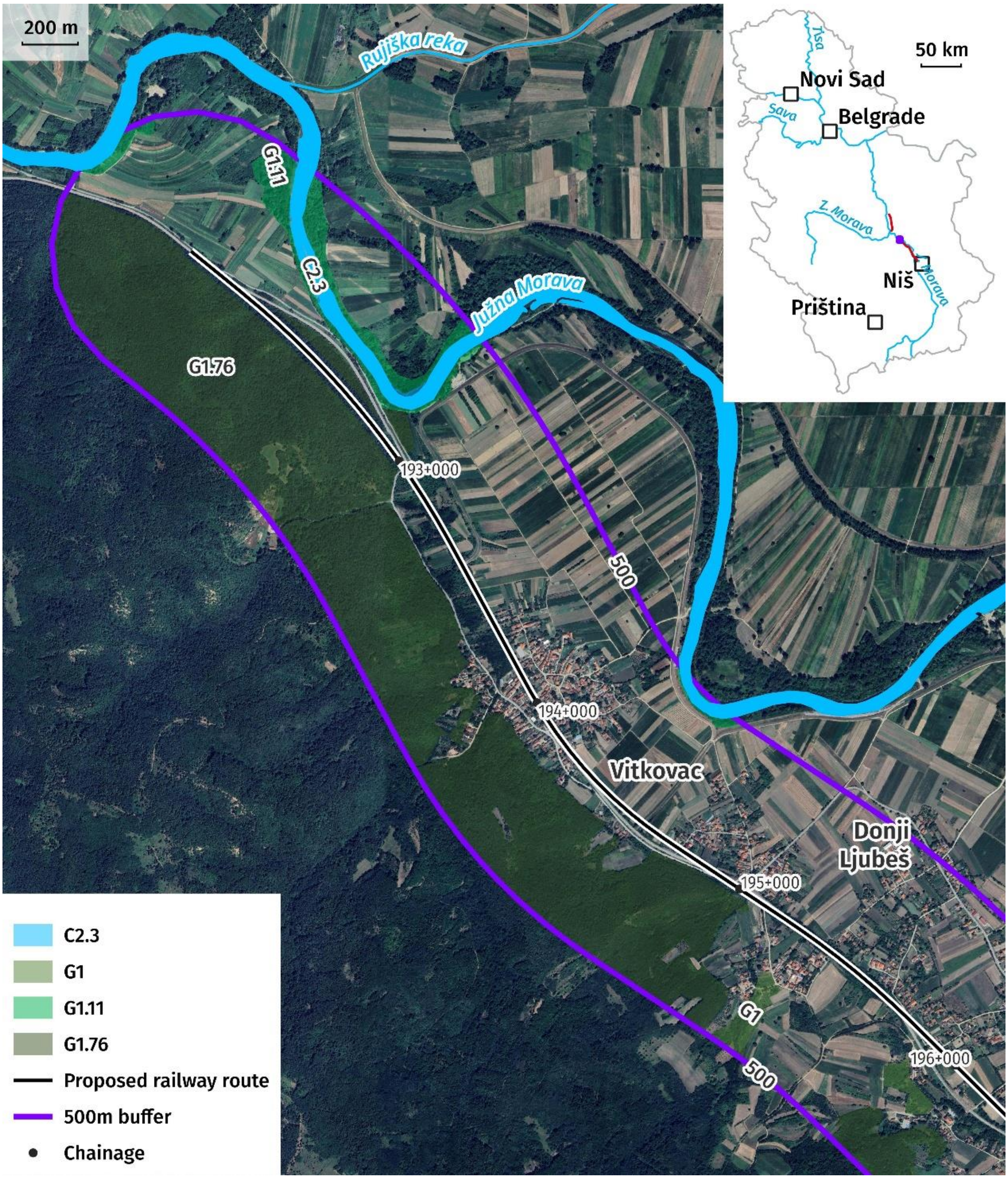


Figure 14-164. Map of the avoidance zones within the project AoI (segment 1)

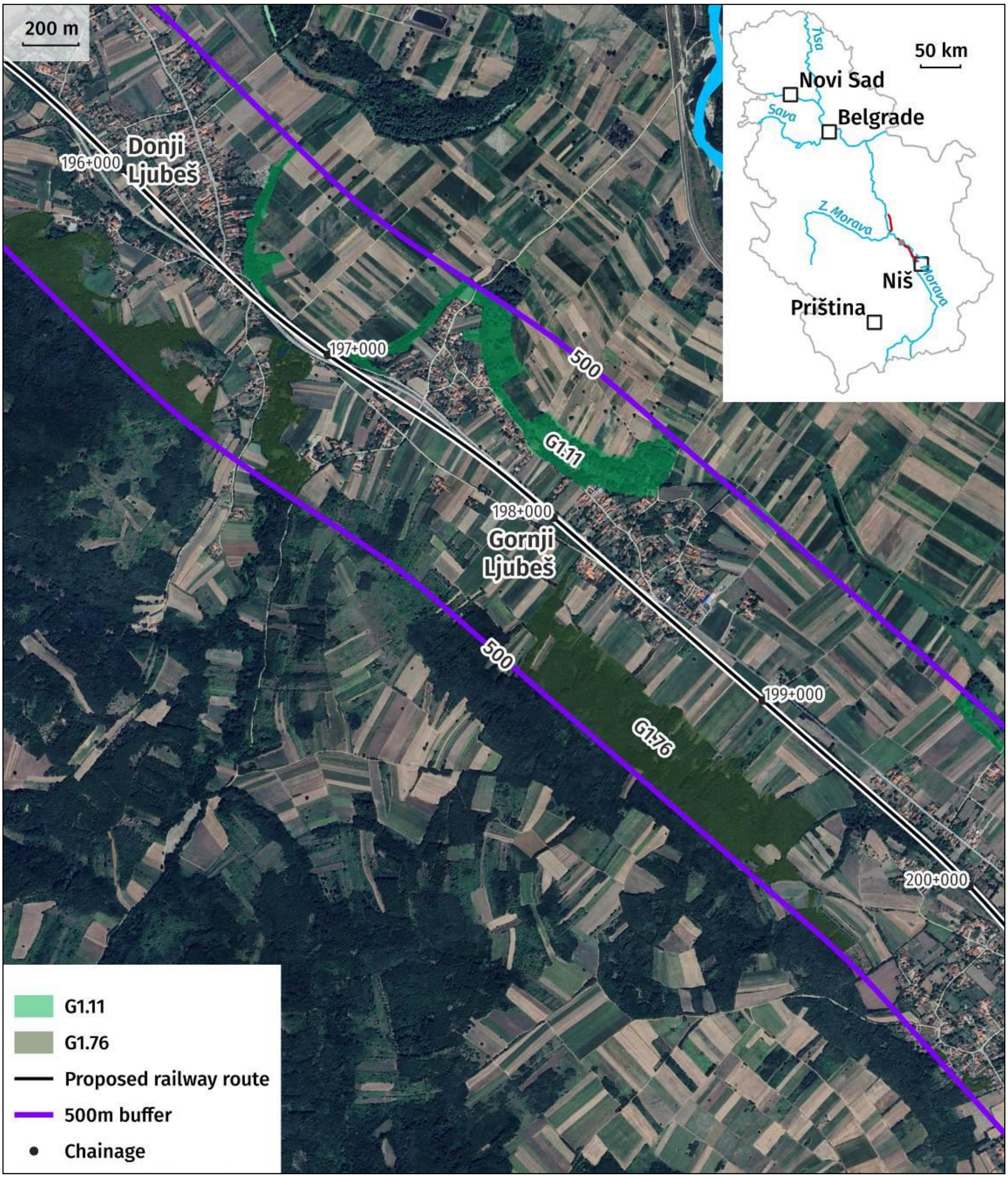


Figure 14-165. Map of the avoidance zones within the project AoI (segment 2)

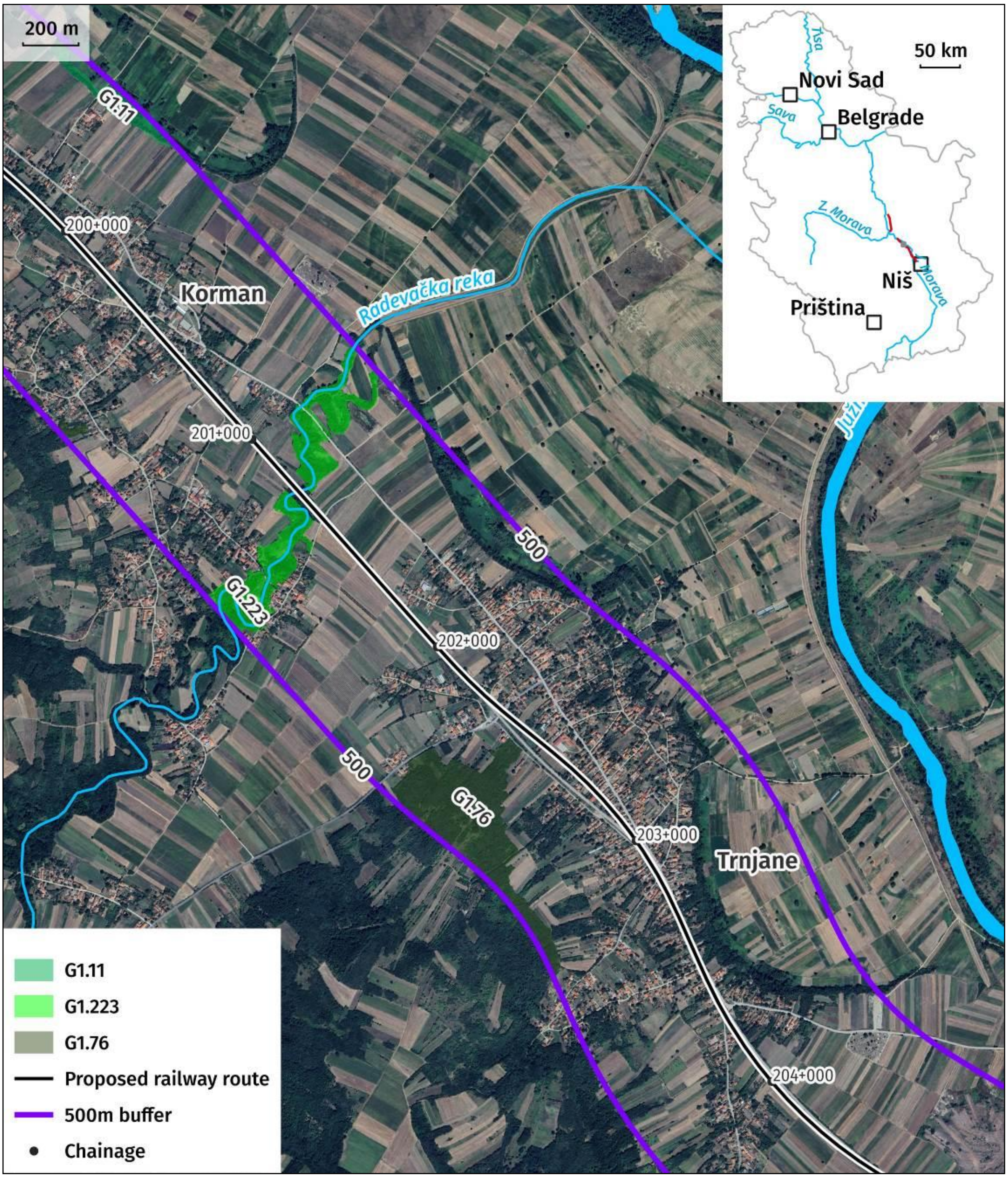


Figure 14-166. Map of the avoidance zones within the project AoI (segment 3)

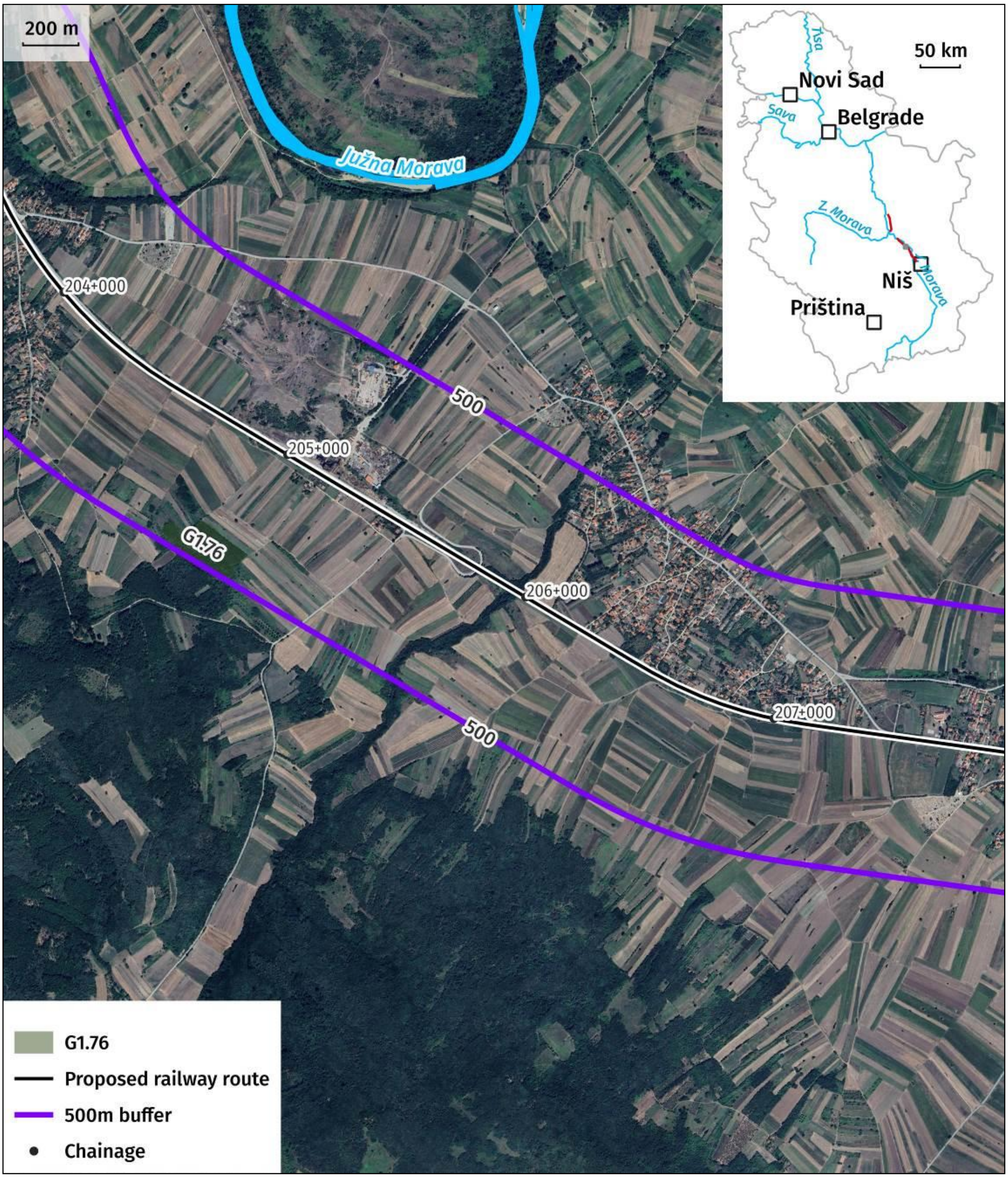


Figure 14-167. Map of the avoidance zones within the project AoI (segment 4)

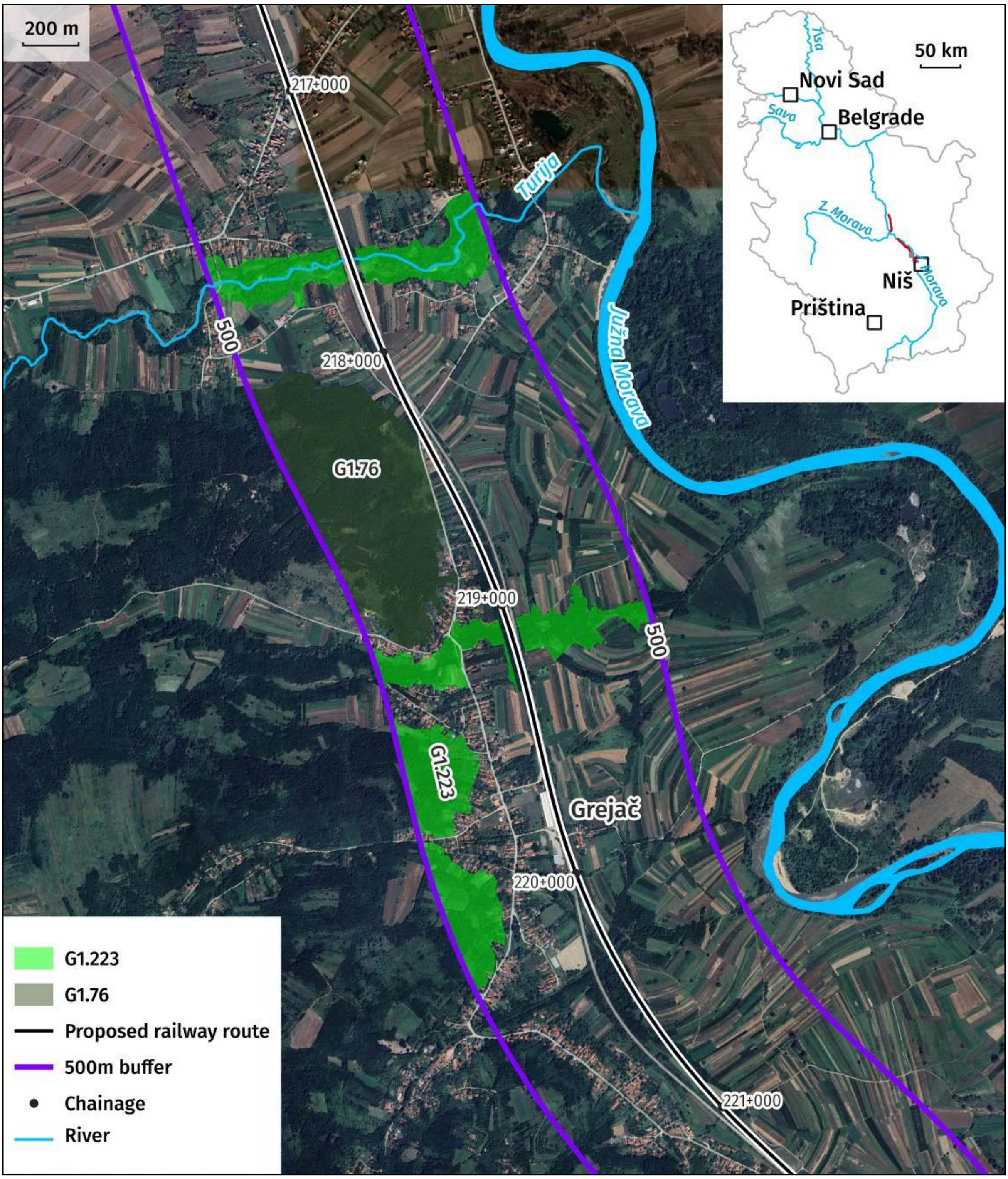


Figure 14-168. Map of the avoidance zones within the project AoI (segment 5)

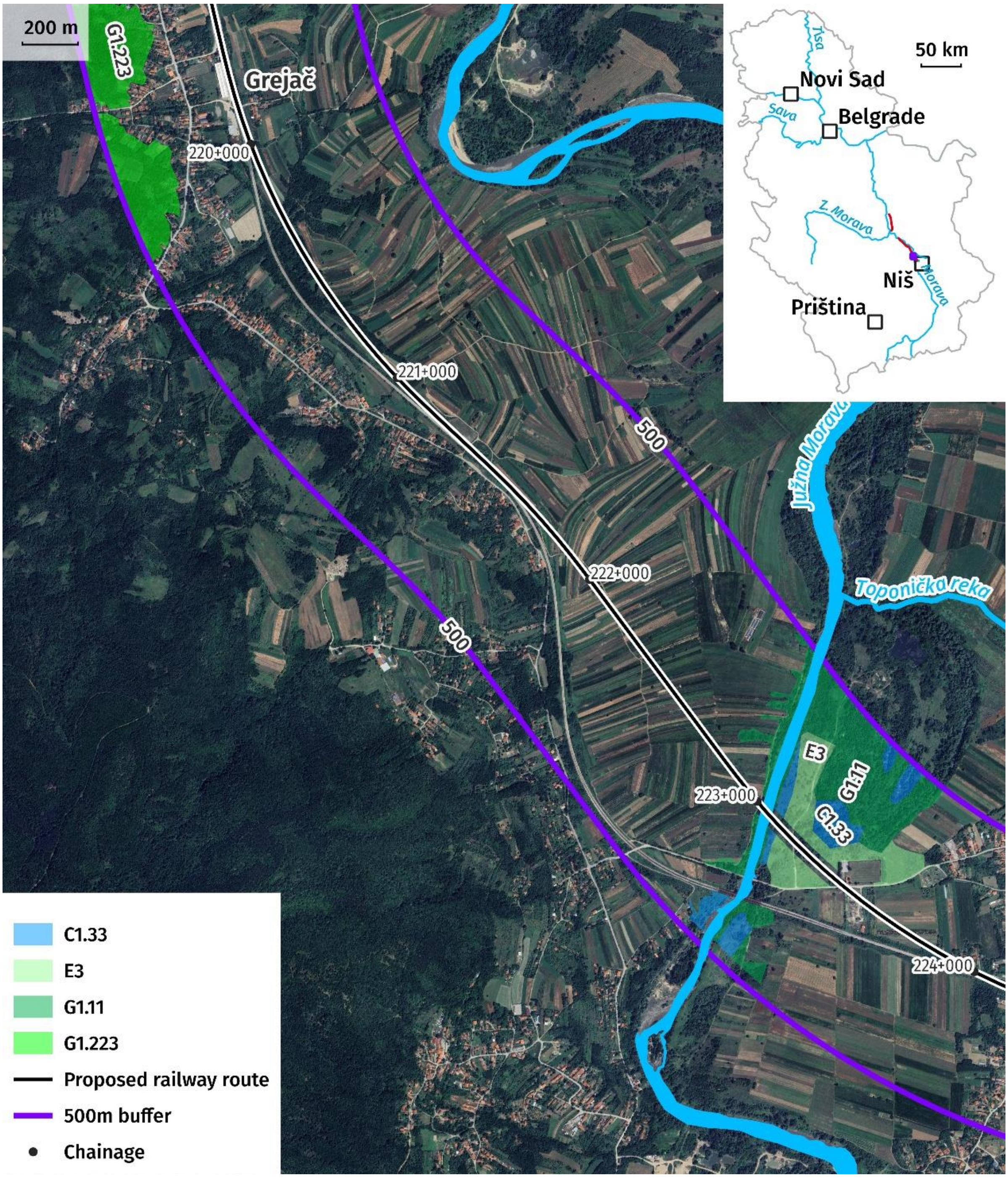


Figure 14-169. Map of the avoidance zones within the project AoI (segment 6)

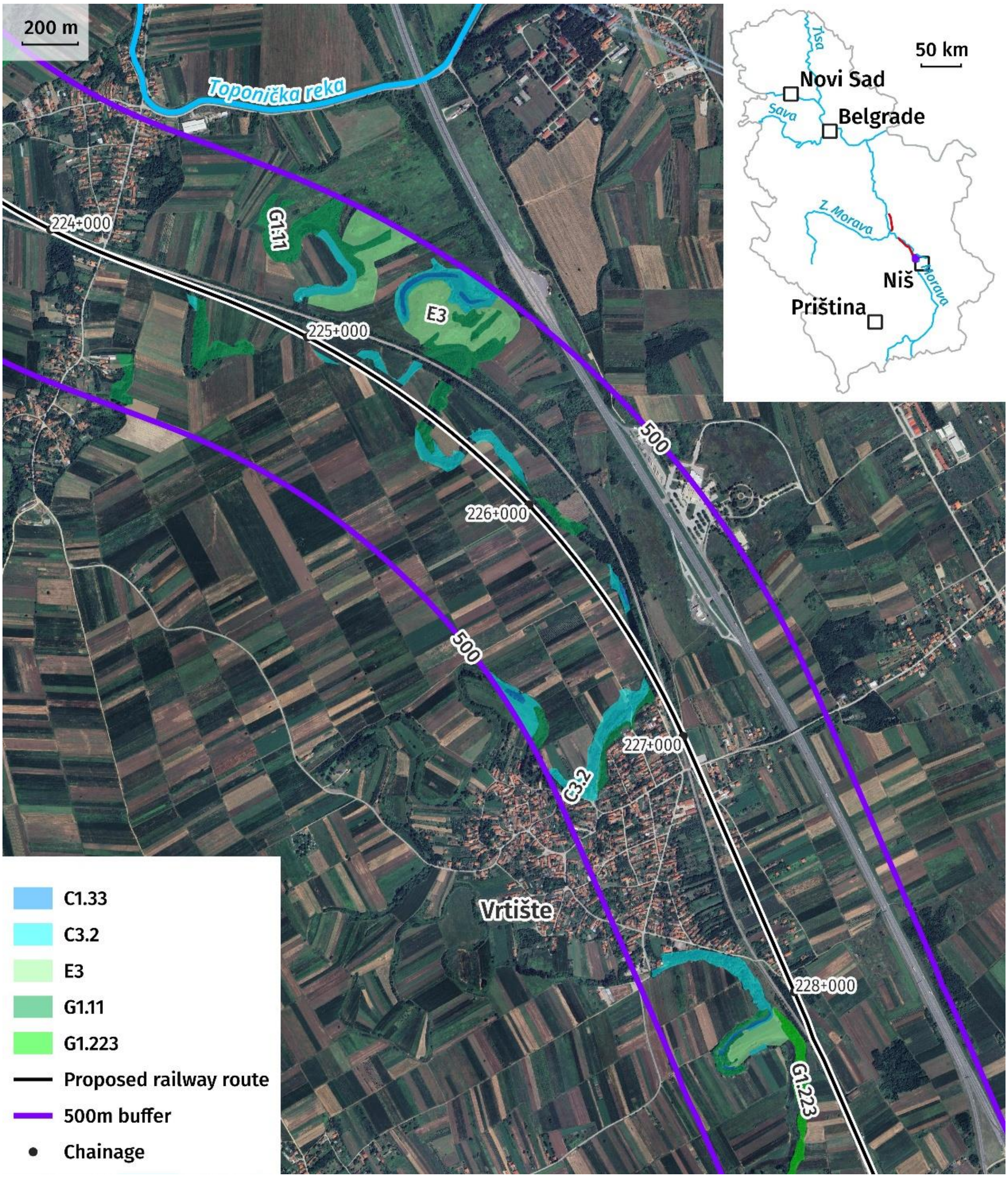


Figure 14-170. Map of the avoidance zones within the project AoI (segment 7)

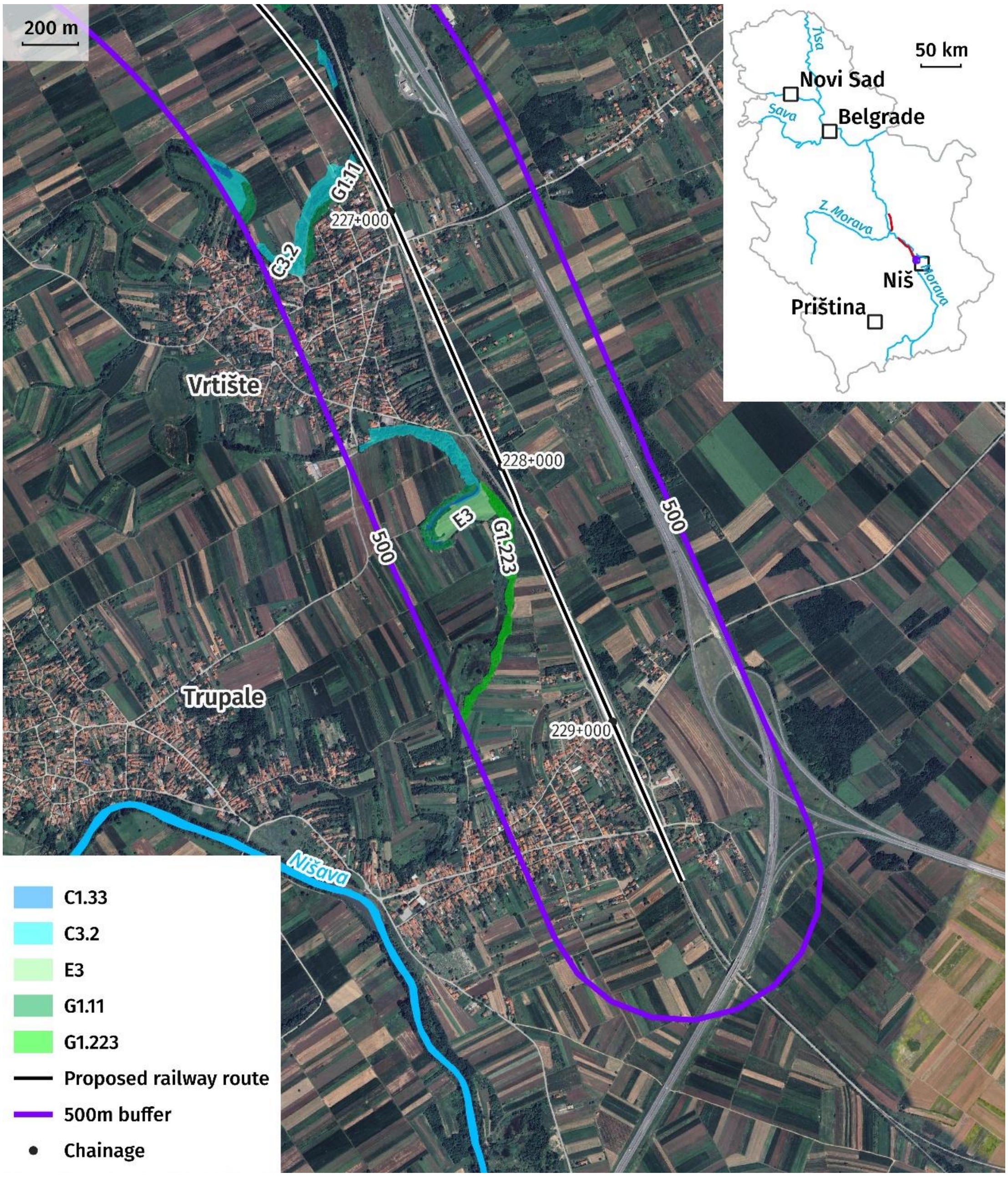


Figure 14-171. Map of the avoidance zones within the project AoI (segment 8)

- More detailed survey of aquatic habitats in the riparian zone of Južna Morava River must be undertaken to map their exact locations and boundaries; to confirm avoidance of these habitats or facilitate the identification and implementation of additional mitigation measures if they cannot be avoided.
- Abutments of the proposed bridges must be designed to retain habitats along the waterways and the associated movement of species.
- Include project crossing structures for amphibians and reptiles in the detailed Project design, based on obtained location conditions from the authorized Institution for nature protection, and following the Rulebook about special

technical-technological solutions that enable uninterrupted and secure communication of wild animals ("Official Gazette of RS", No. 72/2010). The Rulebook prescribes crossings for amphibians and reptiles in the form of tunnels with structures that direct the movement of animals, with openings at both ends. The opening of the crossing can be circular, rectangular or elliptical, and the diameter varies concerning the length of the tunnel, so that the minimum values diameters range from 0.4 to 1.2 m. Structures that direct the movement of animals are placed vertically on the edge of the tunnel, with a minimum height of 50 cm.

- Ensure the relocation of pond turtles (*Emys orbicularis*) at Vrtiste locality, in the area of new railway corridor alignment from 226+900 km to 228+250 km - Đunis – Trupale subsection. Pond turtles have been recorded in ponds which will be destroyed during construction due to correction of the curve (current ponds at location 43.379980N and 21.805960E). New possible location is proposed in the vicinity of the railway (ponds at location 43.365540N and 21.810460E). This must be done in consultation with a qualified herpetologist familiar with the habitat requirements of the species, and the success of relocation must be closely monitored.
- It is necessary to provide water culverts at chainages 225+170 km, as well as 225+525 km, in order not to change the hydrographic regime of C1.33 and G.11 habitats.
- The detailed design must include the installation of insulator covers and good insulation of conductors on catenary and electrical infrastructure to prevent the electrocution of birds and bats.
- The project area is interspersed with small streams and melioration canals which represent movement corridors and are likely to support local migrations. Include the requirement for an amphibian/reptile protection fence to be installed in the length of 50 m before and after every bridge/culvert in the Main Design. This is done to prevent small fauna fatalities caused by amphibians and reptiles entering the RoW.
- A Restoration Plan for the re-establishment of all habitats identified as Priority Biodiversity Features and Critical Habitat has to be developed.

14.3.2. Construction phase

Table 14-58 describes the mitigation measures proposed to mitigate the identified impacts.

Table 14-58. Proposed Mitigation Measures during Construction

Impact	Location	Mitigation measures
		Habitats and flora
Habitat loss and fragmentation. **Habitat degradation.** **Loss of native flora due to invasive alien plant species proliferation within the**	Within the working corridor	An appropriate number of Ecological Clerks of Works (ECoW) must be engaged by the Contractor to conduct onsite monitoring and ensure that works are carried out in accordance with legislative requirements and relevant Project construction phase Management Plans. During the pre-construction phase, the ECoW must monitor identified species of conservation concern in order to map potential locations where such species are nesting. ECoW to prepare Ecological Chance Finds Procedure. ECoW to perform rapid ecological survey in the siting of temporary works and laydown areas prior to vegetation clearance. Prepare the manual and induction training for construction workers and other personnel on important species and habitats and their identification (including no go or avoidance zones), as well and guidelines for their preservation and actions if encountered during their work.

Impact	Location	Mitigation measures
native habitats. **Deposition of dust caused by construction activities.**		Project facilities (workers camps, waste dump sites, etc.) must be located outside of PBFs and CHs, G1 and E3 habitat type in order to prevent any additional habitat loss and degradation. Special attention should be given to the preservation of *91E0 habitats as outlined under avoidance zones, given that no further net loss of this habitat is allowed. These habitats must be avoided during culverting and construction of structures such as bridges, tunnel, viaducts, access roads etc. Identify and mark avoidance zones (EAAAs of PBFs and CHs and G1 habitat type) in the vicinity of the construction sites. Avoidance zones must be clearly demarcated with marking flags, rope, biodegradable paint or other clearly visible markings. Ensure avoidance zones are considered in the Management of Change procedures (including for the identification of locations for all temporary construction areas, access roads and supporting facilities). If an avoidance zone cannot be avoided, take measures to minimise and mitigate impacts and for any potentially significant impacts implement measures to achieve no net less or net gain of the affected habitats and/or species. Develop a Habitat Restoration Plan for the re-establishment of all habitats, especially ones identified as PBF and CH temporarily affected during construction within the working corridor. Implement natural and aided regeneration of plant species in the area of E3 Wet or seasonally wet grasslands (approx. km 223+000) to account for areas where impact cannot be avoided. Regular control and monitoring activities must be undertaken. In order to successfully carry out restoration and avoid possible overgrowth of disturbed habitats with invasive plant species, it is necessary to carry out the following procedure: • Collect seeds from native E3 habitats that will be degraded during the construction phase. Seeds have to be collected before the beginning of construction activities from immediately adjacent habitat, preserved and stored appropriately based on advice of the ECoW. To ensure flora diversity, the seeds have to be collected from as many native growing plants as possible. Equal amounts of seed from each plant should be mixed together before planting. • Alternatively, where feasible, seeds may be collected from adjacent, undisturbed areas of target habitats at the time of restoration, in order to reduce long-term storage and handling risks. • Equal amounts of seed from each species must be mixed before sowing to avoid dominance of any single species. • Topsoil within these habitats has to be stripped before the beginning of construction activities. Topsoil will be used for restoration, as it contains the seed bank and is therefore an essential component of the revegetation plan. Topsoil must be stored as described in the BMP. • Upon completion of construction in the target chainages of railway, return topsoil that was previously removed and stored. • Plant collected seeds for assisted restoration. • The Invasive Alien Plant Species Management Plan must be implemented within habitats where natural and aided revegetation is planned. Implement in situ habitat revegetation of degraded forest habitat (marked as CH/PBFs) directly impacted by the project with native deciduous trees, as much as possible: • 91E0* at chainages cca 193+000 km, cca 196+800 km, cca 223+000 km and between 225+000 and 226+000 km.

Impact	Location	Mitigation measures
		• 91F0 at chainages: cca 201+500 km, 217+500 km and cca 219+100 km • 91M0 at chainages: cca 192+000 km, cca 193+000 km, cca 195+000 km, cca 202+200 km and cca 218+000 km. Afforestation has to be carried out with autochthonous species in coordination with the Public Enterprise "Srbijašume" which will appoint the appropriate afforestation areas in the wider project area. Regular control and monitoring activities will be undertaken in line with 14.5. Monitoring program. Implement offset measures for 91E0* Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior (Alno-Padion, Alnion incanae, Salicion albae*), 91F0 Riparian mixed forests of *Quercus robur, Ulmus laevis and Ulmus minor, Fraxinus excelsior or Fraxinus angustifolia* and 91M0 Pannonian-Balkanic turkey oak – sessile oak forests, as outlined in BMP. Implement revegetation of old part of railway corridor with native deciduous tree species. Implement natural and aided regeneration of C3.2 Water-fringing reedbeds and tall helophytes other than canes at chainages between 225+000 km and 226+000 km through maintaining or restoring water levels and preventing spread of invasive plant species. Maintaining and restoring of water levels will be done through designing culverts or small retention areas. Shallow depressions must be designed so as to retain water during seasonal high-flow periods, aiming for a depth of 30 to 50 cm. Replant species such as *Typha latifolia*, *Schoenoplectus lacustris*, or *Iris pseudacorus* where natural regeneration is unlikely due to soil compaction or hydrological disruption. Preserve of 3150 Natural eutrophic lakes with *Magnopotamion* or *Hydrocharition* -type vegetation within the buffer zone at cca 223+100 km. Maintain avoidance zones, silt fences and control runoff to help preserve water quality. Work on ecological improvement of existing anthropogenically impacted rail corridor by using of native plants in landscape design. Continuous supervision during construction works by ECoW is required to prevent unnecessary movement of vehicles outside of area designated for the implementation of construction activities to preserve surrounding habitats. ECoW to clearly demarcate places for parking and turning of construction machinery during the construction and extension of tracks in order to avoid additional degradation of soil. Vehicle access tracks, turning areas and parking places must be clearly demarcated and continuous supervision during construction works is required to prevent unnecessary movement of vehicles/machinery outside of designated areas to preserve surrounding habitats. Maximum use of existing access roads to avoid construction of new temporary access roads for bringing material and vehicles, which will minimise loss and fragmentation of vegetation and natural semi-natural habitats.

Impact	Location	Mitigation measures
		The clearance/removal of vegetation must be limited to the working corridor (30 m + 30 m), and done only where necessary. Develop and implement The Invasive Alien Plant Species Management Plan as a part of the Construction Environmental and Social Management Plan to prevent the spread of alien species. The Invasive Alien Plant Species Management Plan must be developed before the beginning of construction activities. Dust suppression measures through water spraying of aggregate stockpiles and unpaved access roads must be undertaken regularly (and particularly during hot, dry periods) to limit dust generation and deposition on surrounding habitats.
Fauna		
Habitat loss and fragmentation **Impact of reduction in water quality on aquatic fauna** **The impact of noise, vibration, and lights.**	Within the Project AoI and buffer zone up to 5km	ECoW to do field surveys prior to vegetation clearance to collect updated biodiversity data, in order to avoid destruction of bird nests or shelters of wild animals that can be destroyed by railway construction works if found. If bird nests or animal shelters require relocation, ECoW must inform SRI and contact Institute for Nature Conservation to obtain expert opinion and guidance for next steps. Avoid dawn-dusk and night-time works, during the activity of nocturnal animals such as carnivorous species and bats. Incorporate other biodiversity seasonal constraints on the timing of construction activities as defined in Section 5.2 of the BMP into the final construction schedule and work plan. The construction of bridges and other construction works near water courses are to be carried out during the dry season (during summer period) and confirmed by regular monitoring of official data on the current status of the hydrological regime. During the construction of the bridges at km 223+053 on the Južna Morava River, natural fish migration must be maintained. The clearance of vegetation must be limited to the working corridor (30m + 30m) Water from the construction site needs to be run-off from areas without any hazardous materials that can potentially contaminate surface water. Install silt fences, sediment basins, and sediment traps to prevent sediment from entering water bodies. Construction materials must be stored away from watercourses. Wastewater to be contained, treated and discharged only after treatment or transported to a wastewater management facility, where relevant. Dust suppression measures through water spraying of aggregate stockpiles and unpaved access roads must be undertaken regularly (and particularly during hot, dry periods) to limit dust generation and deposition. The use of biodegradable, non-toxic construction materials and chemicals must be prioritised to limit potential water contamination. Ensure all machinery is well-maintained to prevent leaks of oil, fuel, and other harmful substances.

Impact	Location	Mitigation measures
		Minimise vegetation clearance and major earthworks during the spring (April/May) period, to reduce the risk of sediment generation in the areas of major river crossings and ensure that the potential influence on spawning is diminished. Implement ecological surveys and an Ecological Chance Finds Procedure including habitat and species avoidance in the siting of temporary works and laydown areas.

14.3.3. Operation phase

Table 14-59. Proposed Mitigation Measures during Operation phase

Impact	Location	Mitigation measures
Habitats and proliferation of invasive plants	Within whole AoI	Develop the Invasive Species Management Plan as a part of the Operational Environmental and Social Management plan and implement it for all invasive plant species, with regular monitoring performed two times per year along the entire Project corridor in order to prevent their further spread. Ensure mechanical removal methods are used in preference to any herbicides. Monitoring of natural and aided restoration of E3 Wet or seasonally wet grasslands (cca km 223+000) and C3.2 Water-fringing reedbeds and tall helophytes other than canes (between 225+000 km and 226+000 km). Monitoring of conservation of 3150 Natural eutrophic lakes with *Magnopotamion* or *Hydrocharition* -type vegetation in line with 14.5. Monitoring program. Monitoring of restoration of 91E0* Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior (Alno-Padion, Alnion incanae, Salicion albae*), 91F0 Riparian mixed forests of *Quercus robur, Ulmus laevis* and *Ulmus minor, Fraxinus excelsior* or *Fraxinus angustifolia*, along the great rivers (*Ulmenion minoris*) and 91M0 Pannonian-Balkanic turkey oak – sessile oak forests.
Collision of fauna with trains Electrocution Disturbance of fauna (noise, vibrations and light) Reduction in water quality	Within the AoI	Keep the railway track clean and regularly remove garbage from the immediate vicinity of the track. Implement regulatory patrols of the railway route for carcass removal. According to EU practice, one of the key factors for reducing collisions with trains and lines is the height of the surrounding vegetation. In the case when the vegetation is higher than the upper structure of the railway (electrical lines and poles), a natural barrier is created that the birds fly over and thus avoid the area of train traffic. This should discourage low-altitude flight paths across the railway for bird species defined under the operation phase and are to serve as "hop overs". Locations for these activities are to be determined upon the first year of bird and bat mortality monitoring. During monthly monitoring activities in operational phase, ECoW will report about accidental death of birds and bats due to collisions with train and if necessary, suggest the implementation of new measures, according to current situation. Special attention of ECoW to be paid in the area of two viaducts at km 220+544.70 and km 223+205.49, both in Đunis-

Impact	Location	Mitigation measures
		Trupale subsection. Avoid degradation of following habitats along the railway corridor to minimise risk of collision with trains and lines for birds: • G1 Broadleaved deciduous woodland – chainages: from cca 192+200 km, cca 196+000 km, cca 198+000 km, cca 199+000 km and from 199+300 km to 200+000 km. • G1.11 Riverine *Salix* woodlands (*91E0 Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-Padion, Alnion incanae, Salicion albae*) – chainages: between 192+000 km and 193+000 km, cca 193+000 km, cca 197+000 km, cca 197+000 km, cca 200+000 km, cca 223+000 km, cca 225+000 km, between 225+000 km and 226+000 km, cca 226+000 km, cca 227+000 km and cca 228+000. • G1.223 Southeast European *Fraxinus* - *Quercus* - *Alnus* forests (91F0 Riparian mixed forests of *Quercus robur, Ulmus laevis* and *Ulmus minor, Fraxinus excelsior* or *Fraxinus angustifolia*, along the great rivers (*Ulmenion minoris*)) – around: cca 217+500 km, cca 219+000 km, between 219+000 km and 220+000 km, cca 228+000 km. • G1.76 Balkano-Anatolian thermophilous *Quercus* forests (91M0 Pannonian-Balkanic turkey oak – sessile oak forests) – between 191+500 km and 195+200 km, between 196+500 km and 197+300 km, between 198+100 km and 199+500 km, between 202+200 km and 203+200 km, between 204+800 km and 205+100 km, between 218+000 km and 219+200 km and cca 205+000 km. • All aquatic habitats in riparian zone of Južna Morava River within project area and wider area. Undertake planting with native, autochthonous species, where feasible, near pre-existing forest fragments to ensure habitat connectivity and near potential movement corridors (i.e. clearings leading to water bodies), where activity of these species is increased. Maintain surface water drainage systems to prevent runoff of contaminants such as oils, lubricants, and heavy metals from the railway tracks into water bodies. Maintain sediment traps and filtration systems within the drainage system to reduce sedimentation and nutrient loading in nearby water bodies. Ensure levels of noise, vibration and light are within regulatory limits. ECoW to monitor collisions during maintenance activities and implement a reporting protocol for drivers and maintenance workers to report any collisions or electrocutions. Register any suspected mortalities (including the production of an annual mortality report) and define a threshold for further preventive action. Analyse results of monitoring to identify any collision or electrocution hot-spots, including for sensitive species, and undertake adaptive management and implement additional mitigation measures as required to reduce impacts. To minimise electrocution, it is extremely important that on all parts of the pole, the conductors are separated by 1-1.4 meters from other parts of the supporting structure to prevent the risk of a bird closing the circuit between the conductor and the ground (supporting structure). (BirdLife International, 2003). To minimise potentially negative impact of lights on fauna, install environmentally friendly lighting at stops and stations.

Impact	Location	Mitigation measures
		To minimise the bad practice of possible collision, appropriate culverts should be designed, based on conditions issued by the Institute for Nature Conservation and following the Rulebook about special technical-technological solutions that enable uninterrupted and secure communication of wild animals ("Official Gazette of RS", No. 72/2010). The rulebook prescribes crossings for amphibians and reptiles in the form of tunnels with structures that direct the movement of animals, with openings at both ends. The opening of the crossing can be circular, rectangular, or elliptical, and the diameter varies concerning the length of the tunnel so that the minimum values diameters range from 0.4 to 1.2 m. Structures that direct the movement of animals are placed vertically on the edge of the tunnel, with a minimum height of 50 cm. It is planned that all 43 of the existing road level crossings will be abolished and replaced with 30 new deleveled crossings, which may not be in the same location as the existing road level crossings (Table 14-10). The existing road level crossings may be used by reptiles, amphibians, and mammals as daily migration corridors. To minimise the bad practice of possible collision, appropriate structures/crossings for small mammals must be designed, based on conditions issued by the Institute for Nature Conservation and following the Rulebook about special technical-technological solutions that enable uninterrupted and secure communication of wild animals ("Official Gazette of RS", No. 72/2010). The Rulebook prescribes that crossing for small wild animals (weasels, hedgehogs, otters, badgers, foxes, rabbits, etc.), can be only underground crossings, round or rectangular, dimensions adapted to the type of animal for which they are intended. A protective fence should be placed on both sides of the crossing, which prevents animals from accessing the road/railway, whose minimum length is 100-500 m. The minimum dimension values can be 0.6 m or 0.6 x 0.6 m (width x height) up to 2 m or 2 x 1.8 m, in case the length is 15-30 m. Include required measures for the effective containment and clean up of hazardous/polluting materials in case of major spills, rail accidents, fire, etc. in the Emergency Preparedness and Response Plan Establish buffer zones or strips along surface water courses where herbicides must not be used, to reduce the risk of surface water contamination. Maintain a buffer of 10 to 30 meters, depending on site conditions. Use wider buffers (20–30 m) near sensitive or protected areas. Undertake maintenance work on bridges in periods of low flows where possible; Sanitary wastewater from the station facilities will not be discharged to surface water recipients without prior treatment.

14.4. Residual impacts

14.4.1. Construction phase

Habitats and flora

The assessment of the significance of residual impacts on habitats and flora during the Project construction phase, following the implementation of proposed mitigation measures is presented in Table 14-60. It is expected that a portion of habitats that are lost to facilitate construction of new sections of the railway, tunnel, crossings, access roads and bridges will be restored. The extent of habitat loss must be mitigated through the development and implementation of a Habitat Restoration Plan by the Contractor; to ensure no net loss/net gain of the PBFs and CH. Revegetation using seeds and seedlings harvested locally from the same forests is recommended, where feasible.

The significance of residual impacts are assessed according to methodology shown in the Table 14-30 to Table 14-37. The significance of residual impacts on habitat and flora receptors has the following common assessment grades:

- Magnitude: low (1) the risk of habitat loss, fragmentation and degradation, loss of native flora due to invasive alien plant species proliferation and disturbance by dust will be substantially decreased by mitigation measures at certain sites during construction
- Spatiotemporal: all impacts are expected to be short term (less than 5 years) and very localised (2) after implementation of adequate mitigation measures.
- Sensitivity: along the railway all recorded habitats are widespread in Serbia. There are no rare or extremely rare habitats. Generally, the habitat sensitivity can be assessed as low (1) to high (3).
- Likelihood: all identified potential impacts are considered to have a very low probability of occurring or will occur rarely following the implementation of proposed mitigation measures (1).

Table 14-60. Assessment of Residual Impacts on Biodiversity Features during Construction Phase

Receptor	Description of impact	Magnitude	Spatiotemporal scale	Environment sensitivity	Likelihood	Grades of overall effects	Overall Significance
Habitats							
C1.33 Rooted submerged vegetation of eutrophic waterbodies	Potential habitat degradation	1	2	2	1	6	low
C2.3 Permanent non-tidal, smooth-flowing watercourses	Potential habitat degradation	1	2	2	1	6	low
C3.2 Water-fringing reedbeds and tall helophytes other than canes	Potential habitat degradation	1	2	2	1	6	low
E2.6 Agriculturally-improved, re-seeded and heavily fertilized grassland, including sports fields and grass lawns	Habitat degradation	1	1	1	1	4	low

Receptor	Description of impact	Magnitude	Spatiotemporal scale	Environment sensitivity	Likelihood	Grades of overall effects	Overall Significance
E3 Wet or seasonally wet grasslands	Habitat fragmentation, degradation and loss	1	2	1	1	5	low
E5.1 Anthropogenic herb stands	Habitat degradation	1	1	1	1	4	low
F9.35 Riparian stands of invasive shrubs	Habitat degradation	1	2	1	1	5	low
FA.13 Species-rich hedgerows of native species	Habitat loss and degradation	1	2	1	1	5	low
G1 Broadleaved deciduous woodland	Potential habitat degradation	1	2	2	1	6	low
G1.11 Riverine Salix woodland	Potential habitat degradation	1	2	3	1	7	low
G1.223 Southeast European Fraxinus - Quercus - Alnus forests	Potential habitat degradation	1	2	2	1	6	low
G1.76 Balkano-Anatolian thermophilous Quercus forests	Potential habitat degradation	1	2	2	1	6	low
G1.C3 Robinia plantations	Potential habitat degradation	1	2	1	1	5	low
G5 Lines of trees, small anthropogenic woodlands, recently felled woodland, early-stage woodland and coppice	Habitat degradation	1	2	1	1	5	low
I1.1 Intensive unmixed crops	Habitat fragmentation, degradation and loss	1	2	1	1	5	low
I1.5 Bare tilled, fallow or recently abandoned arable land	Potential habitat degradation	1	2	1	1	5	low
J1.1 Residential buildings of city and town centres	Habitat degradation	1	2	1	1	5	low
J1.2 Residential buildings of villages and urban peripheries	Habitat degradation	1	2	1	1	5	low
J1.4 Rural industrial and commercial sites still in active use	Habitat degradation	1	2	1	1	5	low
J1.6 Urban and suburban construction and demolition sites	Habitat degradation	1	2	1	1	5	low
J4.2 Road networks	Habitat degradation	1	2	1	1	5	low
J4.3 Rail networks	Habitat degradation	1	2	1	1	5	low
J4.7 Constructed parts of cemeteries	Habitat degradation	1	1	1	1	4	low
X07 Intensively-farmed crops interspersed with strips of natural and/or semi-natural vegetation	Habitat fragmentation, degradation and loss	1	2	1	1	5	low

Receptor	Description of impact	Magnitude	Spatiotemporal scale	Environment sensitivity	Likelihood	Grades of overall effects	Overall Significance
X25 Domestic gardens of villages and urban peripheries	Habitat degradation	1	2	1	1	5	low
Flora	Loss of native flora due to invasive alien plant species proliferation within the native habitats. Disturbance by dust, affects the photosynthesis, potential necrosis of the plant tissue due to impacts to plant stomata	1	2	1	1	5	low

Fauna

The assessment of the significance of residual impacts on fauna during the Project construction phase, following the implementation of proposed mitigation measures is presented in Table 14-61.

The significance of residual impacts on fauna receptors has the following common assessment grades:

- Magnitude: low (1) the risk of habitat loss and fragmentation, low risk in reduction in water quality on aquatic fauna and low risk of distrubance due to noise, vibration and lights. By implementing mitigation measures during construction, impact to fauna will be substantially decreased
- Spatiotemporal scale: all impacts are expected to be short term (less than 5 years) and very localised (2) after implementation of adequate mitigation measures.
-
- Sensitivity: all recorded species are widely distributed in Serbia and inhabits more than one habitats along the railway. Sensitivity can be assessed as low (1) to moderate (2)
- Likelihood: all identified potential impacts are considered to have a very low probability of occurring or will occur rarely following the implementation of proposed mitigation measures (1).

Table 14-61. Assessment of Residual Impacts on Fauna during Construction Phase

Fauna Receptors	Impact	Magnitude	Spatiotemporal scale	Environment sensitivity	Likelihood	Grades of overall effects	Overall Significance
Macroinvertebrates Insects Fishes Reptiles Birds	Habitat loss and fragmentation	1	1	2	2	6	low

Mammals							
Macroinvertebrate Amphibians Fish Birds	Impact of reduction in water quality on aquatic fauna	1	1	2	2	6	low
Birds Bats Mammals	The impact of noise, vibration and light	1	1	1	1	4	low

14.4.2. Operation phase

Habitats and flora

The assessment of the significance of residual impacts on habitats and flora during the Project operations phase, following the implementation of proposed mitigation measures is presented in Table 14-62.

The significance of residual impacts on habitats and flora receptors has the following common assessment grades (Table 14-62):

- Magnitude: low (1) the risk of invasive plants proliferation within habitats will be substantially decreased by mitigation measures along the corridor during operation.
- Spatio-temporal scale: all impacts are expected to be short term (less than 5 years) and very localised (2) after implementation of adequate mitigation measures.
- Sensitivity: along the railway all recorded habitats are widespread in Serbia. There are no rare or extremely rare habitats. Generally, the habitat and flora sensitivity can be assessed as moderate (2).
- Likelihood: all identified potential impacts are considered to have a very low probability of occurring, or will occur rarely following the implementation of proposed mitigation measures (1)

Table 14-62. Assessment of Residual Impacts on Biodiversity Features during Operational Phase

Receptor	Description of impact	Magnitude	Spatiotemporal scale	Environment sensitivity	Likelihood	Grades of overall effects	Overall Significance
Habitats	Proliferation of invasive plants	1	2	2	1	6	low
Flora	Loss of native flora due to invasive alien plant species proliferation within the native habitats.	1	2	1	1	5	low

Fauna

The assessment of the significance of residual impacts on fauna during the Project operations phase, following the implementation of proposed mitigation measures is presented in

Table 14-63.

The significance of residual impacts on habitats and flora receptors has the following common assessment grades:

- Magnitude: low (1) the risk of collision and electrocution will be substantially decreased by mitigation measures along the corridor during operation.
- Spatio-temporal scale: all impacts are expected to be short term (less than 5 years) and very localized (2) after implementation of adequate mitigation measures
- Sensitivity: all recorded species are widely distributed in Serbia and inhabits more than one habitats along the railway. Sensitivity can be assessed as low (1) to moderate (2)
- Likelihood: all identified potential impacts are considered to have a very low probability of occurring, or will occur rarely following the implementation of proposed mitigation measures (1)

Table 14-63. Assessment of Residual Impacts on fauna during Operation Phase

Receptor	Impact	Magnitude	Spatiotemporal scale	Environment sensitivity	Likelihood	Grades of overall effects	Overall Significance
Insects Reptiles Birds Mammals	Collision of fauna with trains	1	1	2	2	6	low
Insects Amphibians Reptiles Birds Mammals	Disturbance of fauna (noise, vibrations and light)	1	1	1	2	5	low
Amphibians Fish	Disturbance of fauna (chemical pollution of water bodies)	2	1	2	2	7	low
Birds Bats	Electrocution	1	1	2	2	6	low

14.4.3. Residual impacts on PBF/CH

Detailed analysis of possible impacts gave conclusion that only the part of the route that will be newly constructed and is planned on dominantly agricultural land may have impacts on habitats (degradation, loss and fragmentation).

Within the maintenance zone there will be permanent habitat loss (15 m + 15 m railway corridor) of mostly cultivated land, urban fabric, non-irrigated arable land, land principally occupied by agriculture with significant areas of natural vegetation and fragments of broad-leaved forest.

Here within operation phase, calculated net loss of above stated habitats refers to areas on which the railway route will be realigned. These habitats (I1.1 Intensive unmixed crops, G1 Broadleaved deciduous woodland) are widely distributed in Serbia and also in wider project area, and measures for their preservation are provisioned, therefore impact is expected to be low.

Based on the requirement of the PR 6 paragraph 13 and 15, critical habitat must not be further fragmented, converted or degraded to the extent that its ecological integrity or biodiversity importance is compromised. No net loss of habitats and species that triggered PBF is allowed, and project must be designed to deliver net gains for features that triggered CH. Similarly, EIB ESS4 requires that, for critical habitats, projects must achieve a Net Positive Impact on biodiversity and ecosystem services. EBRD's and EIB's requirements can only be achieved through specific and targeted mitigation in line with mitigation hierarchy of avoiding the negative impact to these habitats and species. Mitigation measures for all species of conservation concern have been given in BMP and this ESIA and must be implemented effectively, adequately and timely.

Considering the above, no such impact regarding critical habitat fragmentation and conversion is expected by the project. However, minor negative indirect impacts can occur and such will be addressed in accordance with EBRD and EIB requirements and are predominantly associated with disturbance during construction and operation, which are subject to avoidance, minimization and mitigation measures as given in

Table 14-64. After implementation of such measures, some residual impacts remain, in the form of unavoidable and permanent net loss of habitat on the project footprint, primarily the parts of the railway that will be newly constructed. Following the EBRD PR 6 implementation of the project if it compromises biodiversity can be done if no other viable alternatives within the region exist for development of the project in habitats of lesser biodiversity value which applies to this project. Same is addressed by EIB Standard 4 which states that no project activities should implement in areas of critical habitat unless no other viable alternatives for the project exist either in terms of location or design, and there is rigorous justification of overriding public interest based on human health, public safety considerations and/or beneficial consequences of primary importance for the environment.

For following priority biodiversity features/critical habitats net loss has been identified:

- Habitat types :
    - 91E0* Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-Padion, Alnion incanae, Salicion albae*) (CH)
    - 91F0 Riparian mixed forests of *Quercus robur, Ulmus laevis and Ulmus minor, Fraxinus excelsior* or *Fraxinus angustifolia*, along the great rivers (*Ulmenion minoris*) (PBF)
    - 91M0 Pannonian-Balkanic turkey oak – sessile oak forests (PBF)
    - 3150 Natural eutrophic lakes with *Magnopotamion* or *Hydrocharition* -type vegetation (PBF)
    - C3.2 Water-fringing reedbeds and tall helophytes other than canes (PBF)
- Suitable habitats of PBF and CH species:

  - 91E0* as a suitable habitat for CH: *Zerynthia polyxena, Rana dalmatina, Emys orbicularis, Bombina variegata, Natrix tesselata,*
  - 91E0* as a suitable habitat for PBF: *Alcedo atthis, Ardea alba, Streptopelia turtur, Tringa glareola, Egretta garzetta, Leiopicus medius, Circus aeruginosus*
  - 91F0 as a suitable habitat for CH: *Nymphalis vaualbum*, *Lycaena dispar, Phengaris arion, Cerambyx cerdo, Lucanus cervus, Podarcis muralis, Lacerta viridis, Canis lupus, Myotis bechsteinii, Myotis mystacinus, Nyctalus noctula, Vespertilio murinus, Miniopterus schreibersii, Pipistrelus nathusii*
  - 91F0 as a suitable habitat for PBF: *Euphydryas aurinia*
  - 91M0 as a suitable habitat for CH: *Nymphalis vaualbum*, *Lycaena dispar, Phengaris arion, Parnassius mnemosyne, Cerambyx cerdo, Testudo hermanni, Zamenis longissimus, Dolichophis caspius, Podarcis muralis, Lacerta viridis, Canis lupus, Myotis bechsteinii, Myotis mystacinus, Nyctalus noctula, Vespertilio murinus, Miniopterus schreibersii, Pipistrelus nathusii*
  - 91M0 as a suitable habitat for PBF: *Lucanus cervus, Euphydryas aurinia*
  - C3.2 as a suitable habitat for CH: *Rana dalmatina, Emys orbicularis, Bombina variegata, Natrix tesselata, Plecotus austriacus*
  - C3.2 as a suitable habitat for PBF: *Ardea alba, Ardea purpurea, Cettia cetti, Nycticorax nycticorax, Perdix perdix, Milvus migrans, Circus aeruginosus*
  - I1.1 as a suitable habitat for CH: *Lycaena dispar, Phengaris arion, Zerynthia polyxena, Podarcis muralis, Lacerta viridis, Myotis bechsteinii, Myotis mystacinus, Nyctalus noctula, Plecotus austriacus, Vespertilio murinus*
  - I1.1 as a suitable habitat for PBF: *Euphydryas aurinia, Ardea purpurea, Ciconia ciconia, Ciconia nigra, Emberiza hortulana, Lanius collurio, Lanius minor, Streptopelia turtur, Tringa glareola, Egretta garzetta, Perdix perdix, Milvus migrans*
  - C2.3 as a suitable habitat for CH: *Unio crasus, Theodoxus transversalis, Romanogobio kessleri*
  - C2.3 as a suitable habitat for PBF: *Cobitis elongata, Cobitis taenia, Barbus meridionalis, Rhodeus amarus, Romanogobio albipinnatus, Romanogobio uranoscopus, Cottus gobio, Zingel streber, Zingel zingel*
- Potential Natura 2000 sites (PBFs):
  - pSPA/IBA Dobrić-Nišava

It is important to note that the habitat types that are suitable for CH and PBF species are very abundant in the wider project area, which is particularly true for I1.1 habitat type. In order to assess and demonstrate habitat availability and lack of detrimental effect of the ecological and conservation status of the critical habitats, the proportion of area of habitat present in the EAAA and area of habitat present in the maintenance zone was performed (

Table 14-64). The results have shown that negligibly small parts of suitable habitats are located within the maintenance corridor, varying between 0.37 ha for reptile species already preferring habitats along the RoW due to them being warm and rocky, to *Plecotus austriacus* that only seldom finds suitable foraging habitats near the project.

Table 14-64. Analysis of proportions of PBF and CH habitat within EAAA affected by the railway

Receptor	Area of EAAA (ha)	Area in project footprint (ha)	% of EAAA in project footprint
CHs			
Habitat 91E0*	863.95	1.67	0.19
Nymphalis vaualbum	16,510.66	3,63	0,02
Lycaena dispar	60,988.868	48.5	0.08
Euphydryas aurinia	**60,988.868**	**48.5**	**0.08**
Phengaris arion	60,988.868	48.5	0.08
Zerynthia polyxena	45,342.15	45.74	0.1
Parnassius mnemosyne	14,246.55	6,21	0,04
Cerambyx cerdo	16,510.66	3,63	0,02
Unio crassus	646.88	-	-
Theodoxus transversalis	646.88	-	-
Romanogobio kessleri	646.88	-	-
Rana dalmatina	911.95	1.67	0.18
Testudo hermanni	14,246.55	6.21	0.04
Emys orbicularis	911.95	1.67	0.18
Bombina variegata	**911.95**	**1.67**	**0.18**
Podarcis muralis	60,988.86	48.5	0.08
Lacerta viridis	60,988.86	48.5	0.08
Dolichophis caspius	14,246.55	6.21	0.04
Natrix tesselata	7,345.04	27.35	0.37
Zamenis longissimus	14,246.55	6.21	0.04
Canis lupus	16,510.66	3,63	0.02
Myotis bechsteinii	60,988.86	48.5	0.08
Myotis mystacinus	60,988.86	48.5	0.08
Pipistrellus nathusii	16,510.66	3.63	0.02
Plecotus austriacus	44,526.2	42.89	0.1
Nyctalus noctula	60,988.86	48.5	0.08
Miniopterus schreibersii	16,510.66	3.63	0.02
Vespertilio murinus	60,988.86	48.5	0.08
PBFs			
Habitat 91F0	2264.11	1.89	0.08
Habitat 91M0	14246.55	6.21	0.04
Habitat 3150	206.75	0.45	0.22
Habitat C3.2	48	0.60	1.25
Lucanus cervus	16,510.66	3,63	0,02
Cobitis elongata	646.88	-	-
Cobitis taenia	646.88	-	-
Barbus meridionalis	646.88	-	-
Rhodeus amarus	646.88	-	-
Romanogobio albipinnatus	646.88	-	-
Romanogobio uranoscopus	646.88	-	-
Cottus gobio	646.88	-	-
Zingel streber	646.88	-	-
Zingel zingel	646.88	-	-

Receptor	Area of EAAA (ha)	Area in project footprint (ha)	% of EAAA in project footprint
Alcedo atthis	863.95	1.67	0.19
Ardea alba	911.95	1.67	0.18
Ardea purpurea	44,526.2	42.89	0.30
Ciconia ciconia	44,478.2	42.29	0.09
Ciconia nigra	44,478.2	42.29	0.09
Emberiza hortulana	44,478.2	42.29	0.09
Lanius collurio	44,478.2	42.29	0.09
Lanius minor	44,478.2	42.29	0.09
Cettia cetti	48	0.6	0.01
Nycticorax nycticorax	48	0.6	0.01
Streptopelia turtur	45,342.15	45.74	0.1
Tringa glareola	45,342.15	45.74	0.1
Egretta garzetta	45,342.15	45.74	0.1
Perdix perdix	44,526.2	42.89	0.30
Milvus migrans	44,526.2	42.89	0.30
Leiopicus medius	863.95	1.67	0.19
Circus aeruginosus	911.95	1.67	0.18
pSPA/IBA Dobrić-Nišava	35,389	42.89	0.1
Not PBF/CH but important habitats of PBF/CH species			
I1.1	44,478.2	42.29	0.09

Based on the observations on habitats and species collected through fieldwork, literature analysis and stakeholder consultations, as well as subsequent impact assessment, it can be concluded that the project does not have the capacity to cause significant harm to biodiversity of the surroundings nor cause significant impacts.

Taking into account the biogeographic characteristics of the wider area around the railway, predominantly occupied by agricultural land, similar species composition can be expected throughout the PAoI, showing the lack of plausible alternatives that could have a smaller effected on PBFs/CHs. This project entails reconstruction of an operating railway following the existing RoW with minor realignment and curve-straightening needs for the purpose of reaching desired speed. Any deviation from the existing corridor for the purpose of avoiding small fragments of habitats of concern may result in other ecological impacts of larger scale. Other options could cause more severe impacts on biodiversity and would not serve the overall public interest.

As a last resort, and only in response to unavoidable residual impacts, compensation measures aimed at achieving at least no net loss (for PBFs) and net gain (for CHs) of biodiversity must be provided. For the project, the residual impacts, observing each receptor individually, do not represent major residual impacts that could affect long-term survival of the project in PAoI.

To establish the offset strategy and area needed to ensure no net loss, the approach by Treweek et al. (2010) was used. This approach requires levels of “distinctiveness” and “condition” to be assigned to areas of habitat which will be exposed to an impact and also to land which might be used for an offset. The existing condition of the habitat and its distinctiveness was assessed based on field survey results. This methodology assesses the habitats based on the offset scoring matrix:

Table 14-65. The existing condition of the habitat and its distinctiveness

		Biodiversity distinctiveness			
		Very low (0)	Low (2)	Medium (4)	High (6)
Condition	Optimum (4)	0	8 [0.33]	16 [0.67]	24 [1.00]
	Good (3)	0	6 [0.25]	12 [0.50]	18 [0.75]
	Moderate (2)	0	4 [0.17]	8 [0.33]	12 [0.50]
	Poor (1)	0	2 [0.08]	4 [0.17]	6 [0.25]

The area of habitat to be lost, multiplied by the score from the matrix gives the credits, or "habitat units" required for the offset. To achieve No Net Loss the offset must deliver an overall ratio of 1:1 i.e. like-for-like (or better) when offset gains are compared with the predicted losses due to development. The offset credits required are calculated by multiplying the area affected and the matrix score:

Table 14-66. Area affected

Habitat type	Area affected (ha)	Condition	Distinctiveness	Matrix score	Offset credits required
91E0* Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-Padion, Alnion incanae, Salicion albae*)	2.39	Moderate	Medium	0.33	0.79
91F0 Riparian mixed forests of *Quercus robur, Ulmus laevis* and *Ulmus minor, Fraxinus excelsior* or *Fraxinus angustifolia*, along the great rivers (*Ulmenion minoris*)	2.59	Moderate	Medium	0.33	0.85
91M0 Pannonian-Balkanic turkey oak – sessile oak forests	9.02	Moderate	Medium	0.33	2.98
3150 Natural eutrophic lakes with *Magnopotamion* or *Hydrocharition* -type vegetation	0.58	Moderate	Medium	0.33	0.19
C3.2 Water-fringing reedbeds and tall helophytes other than canes	1.30	Moderate	Medium	0.33	0.43
I1.1 Intensive unmixed crops	146.06	Poor	Low	0.08	3.87

Due to the selected offset strategy – on-site habitat enhancement, an additional analysis of restoration gains is needed in order to establish the area needed for adequate offset. Compensation for the loss of habitat type I1.1

would be challenging to implement, as this habitat is not a natural but anthropogenic habitat, heavily dependent on ongoing human use and agricultural practices. Attempting to restore I1.1 would likely require converting existing natural or semi-natural habitats, resulting in the permanent loss of more ecologically valuable habitat types. Furthermore, habitat type I1.1 is widespread in the broader Project area, which predominantly consists of agricultural land, reducing the significance of its localized loss.

Table 14-67. Area to be restored

Habitat type	Area to be restored (ha)	Targeted future habitat condition	Distinctiveness	Matrix score	Offset credits gained
91E0* Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-Padion, Alnion incanae, Salicion albae*)	2.39	Moderate	Medium	0.33	0.79
91F0 Riparian mixed forests of *Quercus robur, Ulmus laevis* and *Ulmus minor, Fraxinus excelsior* or *Fraxinus angustifolia*, along the great rivers (*Ulmenion minoris*)	2.59	Moderate	Medium	0.33	0.85
91M0 Pannonian-Balkanic turkey oak – sessile oak forests	9.03	Moderate	Medium	0.33	2.98
3150 Natural eutrophic lakes with *Magnopotamion* or *Hydrocharition* -type vegetation	0.58	Moderate	Medium	0.33	0.19
C3.2 Water-fringing reedbeds and tall helophytes other than canes	1.30	Moderate	Medium	0.33	0.43
I1.1 Intensive unmixed crops	35.39	Moderate	Medium	0.33	11.68

In accordance with applied methodology, to achieve no net loss, it is necessary to restore at least 2.39 ha of 91E0* Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-Padion, Alnion incanae, Salicion albae*) of moderate condition. Considering the proportion of the project footprint regarding in the EAAA (1.67 ha/863.95 ha = 0.19% of the EAAA), and applied impact assessment methodology, the magnitude is low. The habitat loss will be permanent, but very localized (within the corridor maintenance zone and zones of construction of crossings and access roads and bridges) and it will last more than 20 years. This habitat is Annex I priority habitat and it is listed in Resolution 4 of the Bern convention, widespread in Serbia. Accordingly, the impact significance can be assessed as high at the scale of the EAAA. Net gain can be achieved by revegetation of degraded riverbanks with native trees, such as *Salix alba, Populus* sp. and native shrubs, as well as increasing the area of these habitats through restoration of these habitats in relevant locations (same habitat type along the Velika Morava River and Južna Morava River) in the EAAA.

To achieve no net loss compensate for the loss of 91F0 Riparian mixed forests of *Quercus robur, Ulmus laevis* and *Ulmus minor, Fraxinus excelsior* or *Fraxinus angustifolia*, along the great rivers (*Ulmenion minoris*), a minimum area of 2.59 ha must be restored. Taking into account the proportion of the project footprint regarding in the EAAA (1.89ha/2264.11 ha = 0.08% of the EAAA), and applied impact assessment methodology, the magnitude is low. The habitat loss will be permanent, but very localized (within the maintaining area and zones of the construction of bridges) and it will last more than 20 years. This habitat is Annex I habitat and it is listed in Resolution 4 of the Bern convention, widespread in Serbia. Accordingly, the impact significance can be assessed as moderate at the scale of the EAAA. No net loss can be reach by increasing the area of these habitats through restoration of these habitats in relevant locations in the EAAA (in the area between settlements Ćićevac and Pojate at cca km 170+000, as well as in the near of Tešica settlement at cca km 217+000).

According to applied methodology, in order to reach no net loss, it is necessary to restore at least 9.03 ha of 91M0 Pannonian-Balkanic turkey oak – sessile oak forests of moderate condition. Considering the proportion of the project footprint regarding in the EAAA (9.02 ha/14246.55 ha = 0.06% of the EAAA), and applied impact assessment methodology, the magnitude is low. The habitat loss will be permanent, but very localized (within the maintaining area and zones of construction of crossings and access roads and tunnel) and it will last more then 20 years. This habitat is Annex I habitat and it is listed in Resolution 4 of the Bern convention, widespread in Serbia. Accordingly, the impact significance can be assessed as moderate at the scale of the EAAA. No net loss can be achieved by increasing the area of these habitats through restoration of these habitats in relevant locations in the EAAA (in the near of Korman settlement at cca km 220, as well as in the near of Gredetina vilage cca km 205+000), as well as, planting the seeds and seedlings (harvested locally from the same forest) in the locations where G5 habitat type is recorded (between 215+000 and 216+000 km and at cca 221 km).

In order to reach no net loss, it is necessary to restore at least 0.58 ha of 3150 Natural eutrophic lakes with *Magnopotamion* or *Hydrocharition* -type vegetation. Considering the proportion of the project footprint regarding in the EAAA (0.58 ha/206.75 ha = 0.28% of the EAAA), and applied impact assessment methodology (Table 14-29 to Table 14-33), the magnitude is low. The habitat loss will be permanent, but very localized (within the maintaining area and zones of construction of bridges) and it will last more than 20 years. This habitat is Annex I habitat and it is listed in Resolution 4 of the Bern convention, widespread in Serbia. Accordingly, the impact significance can be assessed as moderate at the scale of the EAAA. No net loss will be achieved by preservation of these habitats within the buffer zone at cca 223+100 km. 3150 is located in the working corridor at the site where the bridge is planned to be built. When the bridge is built, this habitat will be under the bridge. Before the bridge construction begins, this habitat should be marked and fenced off in order to protect it.

As regards C3.2 Water-fringing reedbeds and tall helophytes other than canes, to reach no net loss, 1.30 ha have to be restored. Taking into account the proportion of the project footprint regarding in the EAAA (1.30 ha/48 ha = 2.71% of the EAAA), and applied impact assessment methodology (Table 14-29 to Table 14-33), the magnitude is low. The habitat loss will be permanent, but very localized (within the maintaining area and zones of construction of crossings and access roads) and it will last more than 20 years. This habitat is listed in Resolution 4 of the Bern convention and widespread in Serbia. Accordingly, the impact significance can be assessed as moderate at the scale of the EAAA. *Typha* sp. are dominant species within this habitat. Within degraded habitat, *Typha* sp. populations may respond by spreading vegetatively at a rapid rate. Regular monitoring of this habitat should be carried out during operation.

Additionally, net gain can be achieved by increasing the area of these habitats through restoration in the area of the old railway where the same habitat types were recorded. Construction of certain new parts of the railway will result in moving the corridor away from C1.33 habitat (from 221+450 km to 224+100 km , from 224+100 km to 226+900 km), G1.11 habitat (from 192+050 km to 193+200 km, from 196+600 km to 197+100 km, from 197+100 km to 197+800 km, from 221+450 km to 224+100 km, from 224+100 km to 226+900 km and from 226+900 km to 228+250 km), G1.223 habitat (from 217+150km to 218+050 km , from 218+050 km to 219+250 km), G1.76 habitat (from 192+050 km to 193+200 km, from 194+050 km to 194+900 km, from 194+900 km to 195+700 km, from 196+600 km to 197+100 km, from 202+200 km to 203+050 km, from 218+050 km to 219+250 km,) and C3.2 habitat (from 224+100 km to 226+900 km). These areas can be used as an area where the restoration of specifically impacted habitats can be achieved. In these parts, the area under listed natural habitats can be enlarged by revegetation with native deciduous tree species what will contribute to achievement of net gain and increased connectivity between previously separated forest fragments.

14.5. Monitoring program

Regular monitoring should be undertaken throughout the construction and operation phases of the Project to ensure that the requirements of the Biodiversity Management Plan (and other relevant Plans), Lenders' Policies, and ESIA commitments are being met. Furthermore, any changes to baseline conditions should be monitored, to verify that the mitigation measures being implemented by the construction contractor and SRI to prevent or limit potentially significant negative impacts are adequate and effective. Where monitoring indicates that negative impacts are occurring despite the requirements of Management Plans being met, additional mitigation measures may be required, and Management Plans revised accordingly.

14.5.1. Construction phase

The monitoring activities which have to be implemented during construction phase are presented in the Table below (

Table 14-68**Error! Reference source not found.**).

Table 14-68. Monitoring activities during construction phase

Monitoring activities	Description	Frequency /Timing	KPI	Responsibility
Habitats monitoring	Natural habitats adjacent to construction sites shall be regularly monitored for the presence of avoidable and unintentional disturbance, such as habitat loss and fragmentation (caused by footprint creep, soil erosion, presence of stagnant water etc.), increased exposure to atmospheric pollutants (caused by airborne dust), exposure to contaminants due to accidental spills, waste management and disposal etc. Any incidental observation made during construction activities shall also be registered.	During construction phase monitoring shall be performed monthly. Results should be presented within the Annual Biodiversity Report.	No increase in area beyond the permitted footprint. If an increase of 1% or more is detected per segment, work is to be halted immediately, and buffer zones must be enforced.	Contractor
Habitat restoration	Monitoring of the habitats where the measures of restoration are stipulated by the BMP (all PBFs and CH and E3 habitat types,) have to be performed in order to ensure the correct re-vegetation of the area upon completion of works. Surveys should be performed by an experienced botanist and suported by EcoW.	The monitoring surveys within these localities have to be done very three months during the vegetative season (from April to September).	Beginning of revegetation after completion of construction works. Revegetation should aim to achieve a minimum of 50% vegetation coverage within the first two months post-construction, with a survival rate of at least 70% for planted species by the end of the first growing season. Remedial actions may be necessary after the first two years of the "establishment" phase if there has been a loss of 30% of planted trees or more, or less than 90% coverage of vegetation (not trees).	Contractor to engage external experienced botanist, EcoW to support
Invasive plants monitoring	Flora surveys will be undertaken in order to monitor presence and spread of invasive plants within the project area. Areas monitored will include areas recently disturbed such as soil and topsoil stockpiles, access road sides, reclamation sites, etc.	The surveys should be performed by an experienced botanist, every month during the vegetative season (from April to October).	If invasive plant cover exceeds 10% of vegetation cover in any 100 m^2 plot, management actions shall be triggered, (manual removal, targeted herbicide application, or other	Contractor to engage additional expertise, if needed

Monitoring activities	Description	Frequency /Timing	KPI	Responsibility
			appropriate control measures)	
		Fauna		
Disturbance and fauna mortality	Organise pre-construction monitoring of land areas before construction activities start, to minimise disturbance of fauna. Surveys will include direct observation, camera trapping and observing nests, scat, burrows etc. If species protected on national level are found, Institute for Nature Conservation must be informed. In that case, work in the area will be postponed until relocation, stronger fencing, temporal work restrictions or other measures in line with the Institue'sopinion are to be implemented.	At least two weeks before the commencement of construction in each sector	Monitoring report No disturbance to protected species and response measures initiated if needed	Contractor (ECoW), Contractor to engage additional external biodiversity expertise, if needed
	Organise pre-construction monitoring of water areas before construction of bridges start, to minimise disturbance of fauna. This will include netting, visual census and electrofishing if needed. If migratory or spawning species are present, construction timing must be adapted to avoid critical periods. In such cases, environmental authorities must be notified and species-specific mitigation applied.	Two to four weeks before the commencement of construction of each bridge or any in-stream works	Monitoring report No in-stream work during critical breeding/migration periods, mitigation response within 5 days.	Contractor (ECoW), Contractor to engage additional external biodiversity expertise, if needed
	Conduct pre-construction surveys of birds in the year scheduled for construction to ensure up-to-date data is collected, given the potential for changes in habitat conditions. Focus will be on the parts of the route that intersect the pSPA "Dobrić-Nišava" (from km 220+315). Surveys will be conducted by a qualified ornithologist, who is to record species presence, abundance, breeding behaviour, and habitat use.	During peak breeding season (April–June), at least twice, every 2 – 3 weeks	Identification of any breeding pairs or nesting activity within the impact zone. Survey report with spatial data.	Contractor (if ECoW is an ornithologist), Contractor to engage additional external biodiversity expertise, if needed
	Check the area before construction to ensure that no breeding or wintering birds are present. This	Between March and July/August prior to	No disturbance of birds during breeding period	Contractor (ECoW), Contractor to engage

Monitoring activities	Description	Frequency /Timing	KPI	Responsibility
	must be conducted at least twice, once in the early breeding season and once in peak breeding season. If active nests are found, a buffer zone of at least 50 meters must be established and no construction will occur in this zone until fledging is complete.	commencement of works	Minimum 50 m buffer enforced around active nests	additional external ornitologist, if needed
	Check water bodies, ponds and wetland areas to minimise disturbance of amphibians during breeding period. This will be done through night-time visual encounter surveys, egg mass counts, as well as dip-netting. If breeding is detected, exclusion zones, stronger fencing or careful relocation must be implemented.	Between April and June	No disturbance of amphibians during breeding period Minimum 25 m buffer established around confirmed breeding sites	Contractor (ECoW), Contractor to engage additional external herpetologist, if needed
Pollution events	Monitor water quality at all bridge construction sites and construction areas near bodies of water to record any leaks of oil, fuel, and other harmful substances during construction. This will include visual inspections (oily sheen, algal bloom), measurements (pH, turbidity), and lab analysis (hydrocarbons, heavy metals). Environmental authorities must be notified of all accidents, which will be managed in line with spill response procedures.	Daily visual inspection during the construction phase, laboratory analysis if accidents occur. Continuous monitoring done by managers of Fishing areas	No exceedance national water quality thresholds. Pollution events documented and emergency response initated.	Contractor, accredited laboratory
	Monitor discharge of all contaminated effluents in water, to preserve macroinvertebrate and fishes, prior to any discharge into natural sources. Test for suspended solids, chemical oxygen demand (COD), biological oxygen demand (BOD), hydrocarbons, and pH.	During construction phase, after heavy rainfall.	Biodegradable, non-toxic construction materials and chemicals used Potential water contamination minimized	Contractor (EcoW)

14.5.2. Operational phase

The monitoring activities which have to be implemented during operation phase are presented in the table below (Table 14-69).

Table 14-69. Monitoring activities during operation phase

Monitoring activities	Description	Frequency / Timing	KPI	Responsibility
Monitoring of restored areas	Monitoring of restoration of temporarily disturbed grasslands; regular control and monitoring activities to compare with existing similar plots of **E3** Wet or seasonally wet grasslands (cca 223+000 km) and C3.2 Water-fringing reedbeds and tall helophytes other than canes (between 225+000 km and 226+000 km).	Annually, in spring	Species composition and richness comparable to adjacent similar habitats Presence and cover in % of positive indicator species (e.g. *Alopecurus pratensis, Agrostis alba, Hordeum secalinum, Poa trivialis* for E3 habitat; *Typha* sp. for C3.2)	Contractor to engage experiences botanist, ECoW to support (from completion of construction and during Contract warranty period or similar) Company (SRI) thereafter
Monitoring of forest habitat offsets	Monitoring of restoration of 91E0* Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-Padion, Alnion incanae, Salicion albae*) 91F0 Riparian mixed forests of *Quercus robur, Ulmus laevis* and *Ulmus minor, Fraxinus excelsior* or *Fraxinus angustifolia*, along the great rivers (*Ulmenion minoris*) and 91M0 Pannonian-Balkanic turkey oak – sessile oak forests	Every 6 months for 5 years	Survival rate of planted trees of at least 30 % At least 80% vegetation cover in revegetated areas, with native species representing 90% of the composition. Presence and cover in % of positive indicator species (e.g. *Salix alba and Populus alba* for 91E0* habitat, *Quercu robur, Fraxinus excelsior. F. angustifolia* for 91F0 habitat, *Quercus cerris* and *Q. frainetto* for 91M0) Revegetation success will be evaluated through comparing results to pre-disturbance conditions. If monitoring reveals that revegetation efforts are not meeting success (such as low survival species rates, poor growth) adaptive management have to be triggered. Adaptive management implies implementation of corrective actions such as replanting with different planting	Contractor to engage experiences botanist, ECoW to support (from completion of construction and during Contract warranty period or similar) Company (SRI) thereafter

Monitoring activities	Description	Frequency / Timing	KPI	Responsibility
			techniques, controlling invasive species, adjusting the timing of planting etc.	
Monitoring of conservation	Monitoring of conservation of 3150 Natural eutrophic lakes with *Magnopotamion* or *Hydrocharition* - type vegetation.	Every 6 months for 5 years	Monitoring will aim to assess the species composition and dominance of pecies such as *Ceratophyllum demersum*, *Potamogeton* spp. Data will be compared with pre-project baseline conditions and adjacent, similar habitats. Vegetation must be stable or increasing, with no increase in invasive species coverage.	Contractor to engage experiences botanist, ECoW to support (from completion of construction and during Contract warranty period or similar) Company (SRI) thereafter
Invasive plants monitoring	The monitoring of the status of invasive plant species is to be continued and regularly performed during the operational phase.	Every three months during the vegetative season (from April to October)	Invasive plant cover does not exceed 5% of total vegetative cover in sensitive or priority habitat areas No net annual increase in cumulative invasive plant cover across monitored sites	Contractor to engage experiences botanist, ECoW to support (from completion of construction and during Contract warranty period or similar) Company (SRI) thereafter
Fauna				
Collision mortality	Organise monitoring to report on accidental deaths of reptiles, birds and mammals, due to collision and/or electrocution. The surveys may be conducted by maintenance staff, train operational staff etc. The surveyor must track the number of carcasses per km of the railway route. Hotspots of collision must be noted, and consider installing flight diverters, denser fencing to keep fauna out, insulation and line markers for poles identified as a risk for electrocution.	Monthly during the first year in operation phase	Monitoring reports The data will be compiled and analysed, and in case the number of carcasses exceeds 10 per km of the route, corrective measures must be put in place.	SRI

Monitoring activities	Description	Frequency / Timing	KPI	Responsibility
Habitat connectivity	Proposed bridges/passes for amphibians, reptiles and mammals must be monitored annually to ensure that there are no blockages and maintained for the lifetime of the railway	Monthly during active months for amphibians and reptiles	Bridges/passes maintained in the appropriate way	SRI
	The fence along the railway should be monitored on a regularly basis, to ensure it is effective in preventing the passage of animals across the railway line and not broken.	Every three years	No broken fence	SRI
Species presence	Establish monitoring programme to evaluate whether the breeding species found within the PAoI and noted in Table 14-13 that moved on during construction due to disturbance/loss of habitats, came back. Monitoring will begin in the first breeding season and continue for a minimum of five years. Conduct targeted field surveys during these periods for some umbrella species selected to represent different ecological needs of disturbed birds – e.g. *Streptopelia turtur*, *Dryocopus martius*, *Alcedo atthis* and *Coturnix coturnix*. This must be done in consultation with an ornithologist. The newly acquired data will be compared to baseline data, any barriers to species return will be noted. Annual monitoring results will be compiled into technical reports, with summary tables of species presence/absence, breeding confirmation, and habitat status	Annually	Number of confirmed breeding pairs or territories re-established for umbrella species. Return of at least 60% of displaced breeding species by year 3. If target species do not return or breed within three years, a corrective action plan (habitat enhancement, noise reduction, predator control) must be developed and implemented.	SRI
Offset success	Establish monitoring programme to assess the presence and habitat use of fauna species associated with the project's net gain and CH/PBF offset requirements. Methods of surveys should correspond to each target species group. Monitoring should aim to assess habitat quality and ecological connectivity through indicators of vegetation cover, water quality, presence of invasive species. An adaptive management framework should be in place to respond to	Annually	All species triggering PBF/CH recorded in offset area within two years from offset area instatement Minimum 80% occupancy rate of expected suitable habitat patches by target species within 3 years	Contractor to engage varying biodiversity expert (during Contract warranty period or similar) Company (SRI) thereafter

Monitoring activities	Description	Frequency / Timing	KPI	Responsibility
	monitoring outcomes, ensuring offset performance goals are achieved.			

ANNEX 1 - LIST OF FLORA AND FAUNA SPECIES WITH THEIR NATIONAL AND INTERNATIONAL CONSERVATION STATUS RECORDED WITHIN PAOI

Table 14-70. List of flora species with their national and international conservation status

Latin name	Common name	IUCN	Red Book of Serbia	HD	BERN	Rulebook
Acer campestre	Field maple	LC				
Acer negundo	Boxelder maple					
Acer pseudoplatanus	Sycamore maple					
Acer tataricum	Tatar Maple	LC				
Achillea millefolium	Yarrow	LC				P
Adonis flammea	Large pheasant's eye					
Adonis aestivalis	Summer pheasant's-eye					
Aegonychon purpurocaeruleum	Purple gromwell					
Agrimonia eupatoria	Common agrimony					
Agrostemma githago	Corncockle					
Agrostis alba	Black bent					
Agrostis capillaris	Common ben					
Ailanthus altissima	Tree of heaven					
Ajuga reptans	Black scallop					
Alliaria petiolata	Garlic mustard					
Alopecurus pratensis	Meadow foxtail					
Althea officinalis	Marsh mallow					
Amaranthus retroflexus	Red-root amaranth					
Ambrosia artemiisifolia	Common ragweed					
Amorpha fruticosa	Indigo bush					
Anchusa officinalis	Common bugloss					
Anisantha sterilis	Barren brome					
Antoxanthum odoratum	Sweet vernal grass					
Arctium lappa	Greater Burdock	LC				P
Aristolochia clematitis	European birthwort					
Arrhenatherum elatius	Bulbous oat grass					
Artemisia annua	Sweet wormwood					
Artemisia vulgaris	Mugwort	LC				
Asclepias syriaca	Common milkweed					
Astragalus glycyphyllos	Milk Vetch	LC				
Atriplex hastata	Spear-leaved orache					
Ballota nigra	Black Horehound	LC				
Bellis perennis	Daisy					
Betonica officinalis	Common hedgenettle	LC				
Bidens tripartite	Three-lobe beggarticks					
Bolboschoenus sp.	Purua grass					
Brachypodium silvaticum	False-brome					
Briza media	Quaking grass					
Bromus mollis	Soft brome					
Bromus violaceus	Brome grass					
Calamagrostis epigejos	Bushgrass					
Calystegia sepium	Hedge Bindweed	LC				
Campanula rapunculoides	Creeping bellflower					
Capsella bursa-pastoris	Shepherd's purse					
Cardamine bulbifera	Coral-wort					
Carex acutiformis	Lesser Pond-Sedge	LC				
Carex hirta	Hairy sedge	LC				

Latin name	Common name	IUCN	Red Book of Serbia	HD	BERN	Rulebook
Carex riparia	Greater Pond-Sedge	LC				
Carex sylvatica	Wood sedge					
Carex vesicaria	Bladder sedge					
Carex vulpina	True Fox Sedge	LC				
Carpinus betulus	Common hornbeam	LC				
Carpinus orientalis	Oriental hornbeam	LC				
Castanea sativa	Sweet chestnut	LC				P
Chaerophyllum temulum	Rough chervil					
Chamaenerion angustifolium	Fireweed	LC				
Chelidonium majus	Greater Celandine	LC				
Chenopodium album	White goosefoot					
Cichorium intybus	Common chicory					
Cirsium arvense	Creeping thistle					
Clematis vitalba	Old man's beard					
Conium maculatum	Hemlock					
Consolida regalis	Orking larkspur					
Convolvulus arvensis	Field bindweed					
Convolvulus cantabrica	Dwarf morning glory					
Cornus mas	Cornelian Cherry	LC				P
Cornus sanguinea	Common dogwood					
Coryllus avellana	Common hazel					
Cotinus coggygria	Smoke-bush	LC				
Crataegus monogyna	Hawthorn	LC				P
Crataegus rhipidophylla	English hawthorn	LC				
Cruciata laevipes	Crosswort					
Cynodon dactylon	Scutch grass					
Cynosurus cristatus	Crested dog's-tail					
Dactylis glomerata	Cock's-foot					
Danthonia alpina	Heathgrass					
Datura stramonium	Thorn apple					
Daucus carota	Wild carrot					
Dioscorea communis	Black bryony	LC				
Dipsacus laciniatus	Cutleaf teasel					
Echinocystis lobata	Wild Cucumber					
Echinochloa crus-galli	Barnyard Grass	LC				
Echium vulgare	Viper's-bugloss					
Eleocharis palustris	Common spike-rush	LC				
Elytrigia repens	Common couch					
Equisetum palustre	Marsh Horsetail	LC				
Epilobium parviflorum	Hoary Willowherb	LC				
Erigeron annus	Daisy fleabane					
Erigeron canadensis	Horseweed					
Eryngium campestre	Field eryngo					
Erodium cicutarium	Common stork's-bill					
Euonymus europaeus	Spindle	LC				
Euphorbia amygdaloides	Wood spurge					
Euphorbia cyparissias	Cypress spurge					
Euphorbia esula	green spurge					
Euphorbia helioscopia	Sun spurge					
Euphorbia lathyris	Caper spurge					
Euphorbia platyphyllos	Broad-leaved spurge					
Festuca valesiaca	Covar sheep fescue					
Fragaria vesca	Wild strawberry	LC				P
Frangula alnus	Glossy Buckthorn					

Latin name	Common name	IUCN	Red Book of Serbia	HD	BERN	Rulebook
Fraxinus angustifolia	Narrow-leaved ash	LC				
Fraxinus excelsior	Common Ash	NT				
Fraxinus ornus	Manna ash	LC				
Fumaria officinalis	Common fumitory					
Galega officinalis	Goat's Rue	LC				
Galium aparine	Cleavers	LC				
Galium palustre	Marsh-bedstraw	LC				
Galium rotundifolium	Round-leaved bedstraw					
Galium verum	Lady's Bedstraw	LC				
Geranium columbinum	Long-stalked crane's-bill					
Geranium dissectum	Cut-leaved crane's-bill					
Geranium purpureum	Little-robin					
Geranium robertianum	Herb-Robert					P
Geum urbanum	Wood Avens	LC				
Glechoma hederacea	Ground-ivy	LC				
Glechoma hirsuta	Stor Jordreva	DD				
Hedera helix	English ivy					
Helianthemum nummularium	Common rock-rose					
Helianthus tuberosus	Jerusalem artichoke					
Helleborus odorus	Fragrant hellebore					
Hordeum murinum	False Barley	LC				
Hordeum sativum	Wall barley					
Hypericum perforatum	St. John's-wort	LC				P
Humulus lupulus	Hop	LC				
Iris pseudacorus	Yellow iris	LC				
Juglans regia	English walnut	LC				
Koeleria macrantha subsp. macrantha	Junegrass					
Lactuca serriola	Prickly Lettuce	LC				
Lamium maculatum	Spotted deadnettle					
Lamium purpureum	Red dead-nettle					
Lathyrus tuberosus	Tuberous pea					
Lemna minor	Common duckweed	LC				
Leontodon taraxacum	Common dandelion					
Leopoldia comosa	Tassel hyacinth					
Lepidium draba	Whitetop					
Leucojum vernum	Spring Snowflake	LC				P
Ligustrum vulgare	Common privet					
Linaria genistifolia	Broomleaf toadflax					
Lolium perenne	Perennial ryegrass					
Lotus corniculatus	Bird's-foot trefoil	LC				
Lycium barbarum	Chinese wolfberry					
Lychnis coronaria	Rose campion					
Lycopu europaeus	Gypsywort	LC				
Lysimachia nummularia	Creeping - Jenny	LC				
Lysimachia vulgaris	Garden loosestrife	LC				
Lythrum salicaria	Purple Loosestrife	LC				
Malva silvestris	Common mallow					
Malus pumila	Apple					
Marubium peregrinum	Horehound					
Matricaria chamomilla	Chamomile	LC				
Medicago arabica	Spotted medick	LC				
Medicago sativa	Lucerne					
Mentha aquatica	Water mint	LC				

Latin name	Common name	IUCN	Red Book of Serbia	HD	BERN	Rulebook
Mentha longifolia	Horse mint	LC				
Mentha pulegium	Pennyroyal	LC				
Melilotus albus	Honey-clover	LC				
Melilotus officinalis	Yellow Sweet-clover	LC				
Melissa officinalis	Lemon balm					
Mercurialis perennis	Dog's mercury					
Morus alba	White mulberry					
Myosotis arvensis	Field forget-me-not					
Myriophyllum spicatum	Spiked Water-milfoil	LC				
Oenothera biennis	Common evening- primrose					
Ononis spinosa	Spiny restharrow	LC				
Orlaya grandiflora	White laceflower					
Ornithogalum sphaerocarpum	Star-of-Bethlehem					
Ornithogalum umbellatum	Star of Bethlehem					
Petrorhagia dubia	Hairy pink					
Paliurus spina-christi	Jerusalem Thorn					
Papaver dubium	Long-headed poppy					
Papaver rhoeas	Common Poppy	LC				
Papaver somniferum	Opium poppy					
Parietaria officinalis	Eastern pellitory-of-the-wall					
Persicaria lapathifolia	Pale smartweed	LC				
Phragmites australis	Common red	LC				
Physalis alkekengi	Bladder cherry					
Phytolacca americana	Pokeweed					
Pyrus communis subsp. pyraster	Wild pear					
Plantago lanceolata	Ribwort plantain	LC				
Plantago major	Common plantain	LC				
Plantago media	Hoary plantain					
Poa pratensis	Kentucky bluegrass					
Polygonatum multiflorum	Solomon's seal					
Polyygonum aviculare	Common knotgrass					
Populus × canescens	Grey Poplar					
Populus alba	White Poplar	LC				
Populus nigra	Black popular	DD				
Populus tremula	Eurasian Aspen	LC				
Portulaca oleracea	Common purslane	LC				
Potamogeton nodosus	Pondweed	LC				SP
Potentilla argentea	Silver cinquefoil					
Potentilla recta	Sulphur cinquefoil					
Potentilla reptans	European cinquefoil					
Pyrus communis	Pear	LC				
Prunus domestica	Plum	DD				
Prunus spinosa	Blackthorn	LC				
Quercus cerris	Turkey oak					
Quercus frainetto	Hungarian oak	LC				
Quercus robur	European Oak	LC				P
Ranunculus fluitans	River Water-crowfoot	LC				
Ranunculus acris	Meadow buttercup					
Ranunculus cassubicus	Kashubian buttercup					
Ranunculus polyanthemos	Multiflowered Buttercup					
Ranunculus repens	Creeping buttercup					
Ranunculus sardous	Hairy buttercup					
Ranunculus sceleratus	Celery-leaved buttercup	LC				

Latin name	Common name	IUCN	Red Book of Serbia	HD	BERN	Rulebook
Rapistrum perenne	Perennial bastard cabbage					
Rhinanthus rumelicus	Deep-yellow hay rattle					
Reynoutria japonica	Japanese knotweed					
Robinia pseudoacacia	Black locust					
Rosa arvensis	Field rose					
Rosa canina	Dog-Rose	LC				P
Rubus fruticosus	Raspberry					
Rumex crispus	Curly dock					
Rumex dentatus	Toothed dock					
Rumex patientia	Patience dock					
Salix alba	White willow	LC				
Salix purpurea	Purple Willow	LC				
Salvia nemorosa	Balkan Clary					
Sambucus ebulus	Dwarf elder	LC				
Sambucus nigra	Elder	LC				
Sanguisorba minor	Salad burnet					
Saponaria officinalis	Wild Sweet William	LC				
Schoenoplectus lacustris	Common club-rush	LC				
Scutellaria altissima	Somerset Skullcap					
Senecio vulgaris	Groundsel					
Setaria glauca	Green bristlegrass					
Setaria viridis	Green foxtail					
Silene latifolia	White campion					
Silene vulgaris	Bladder Campion	LC				
Silphiodaucus prutenicus	Broadleaved ermountain					
Sinapis arvensis	Charlock	LC				
Stellaria media	Common chickweed	LC				
Stellaria nemorum	Wood stitchwort					
Stellaria holostea	Greater stitchwort					
Solanum dulcamara	Bittersweet					
Solanum nigrum	Black Night Shade					
Sorghum halepense	Johnson grass					
Stachys officinalis	Common hedgenettle					
Symphyiotrichum spp.	Asters					
Symphytum officinale	Comfrey	LC				P
Syringa vulgaris	Common lilac	LC				
Sysimbrium officinale	Common hedge-mustard					
Thalictrum aquilegifolium	Greater meadow-rue					
Tanacetum vulgare	Golden buttons					
Teucrium chamaedrys	Wall germander	LC				P
Thymus sp.						
Tilia platyphyllos	Large-leaved linden	LC				
Tilia tomentosa	Silver Lime	LC				P
Tragopogon dubius	Yellow salsify					
Trifolium pratense	Red clover					
Trifolium purpureum	Purple clover					
Trifolium repens	White clover					
Triticum aestivum	Common wheat					
Trisetum flavescens	Yellow oatgrass	LC				
Typha angustifolia	Lesser Bulrush	LC				
Typha latifolia	Broadleaf Cattail	LC				
Ulmus glabra	Wych Elm	DD				
Ulmus laevis	European white elm					
Ulmus minor subsp. minor	Field Elm	DD				

Latin name	Common name	IUCN	Red Book of Serbia	HD	BERN	Rulebook
Urtica dioica	Common nettle					
Valerianella locusta	Common cornsalad					
Verbascum phlomoides	Orange mullein	LC				
Verbena officinalis	Vervain	LC				
Veronica anagallis-aquatica	Véronique Faux Mouron	LC				
Vicia cracca	Bird vetch					
Vicia dumetorum	Vetch					
Vicia grandiflora	Large yellow vetch					
Vicia hirsuta	Hairy tare					
Vicia sativa	Common vetch	LC				
Vinca major	Greater periwinkle					
Viola arvensis	Field pansy					
Viola odorata	Sweet violet	LC				
Vitis vinifera	Grapevine					
Xanthium strumarium	Rough cocklebur					
Xeranthemum annuum	Annual everlasting					
Zea mays	Maize					

Table 14-71. List of insects with their national and international conservation status

Latin name	Common name	IUCN global red list	Red Book of Serbia	HD	BERN	Rulebook
			Lepidoptera			
Acontia trabealis	Spotted Sulphur					
Aglais io	Peacock butterfly	NE				
Aglais urticae	Small tortoiseshell					
Amata phegea	Nine-spotted moth					
Anthocharis cardamines	Orange-tip					
Apatura ilia	Lesser purple emperor					SP
Aphantopus hyperantus	Ringlet					
Aporia crataegi	Black-veined white					
Araschnia levana	Map	LC	LC			
Argynnis pandora	Cardinal					SP
Argynnis paphia	Silver-washed fritillary					
Aricia agestis	Brown Argus	LC	LC			
Boloria dia	Weaver's Fritillary					
Brenthis daphne	Marbled Fritillary					
Brintesia circe	Great Banded Grayling					
Callophrys rubi	Green hairstreak					
Carcharodus alceae	Mallow Skipper					
Carcharodus flocciferus	Tufted Marbled Skipper	LC	LC			
Celastrina argiolus	Holly blue					
Coenonympha arcania	Pearly heath					
Coenonympha glycerion	Chestnut heath					
Coenonympha leander	Russian heath					
Coenonympha pamphilus	Small heath					

Latin name	Common name	IUCN global red list	Red Book of Serbia	HD	BERN	Rulebook
Colias alfacariensis	Berger's Clouded yellow					
Colias croceus	Clouded yellow	NE	NE			
Cupido alcetas	Provençal short-tailed blue					
Cupido argiades	Short-tailed blue					
Cupido minimus	Small blue					
Erynnis tages	Dingy skipper					
Euphydryas aurinia	Marsh fritillary	LC		II	II, I(6)	
Fabriciana niobe	Niobe fritillary					
Favonius quercus	Purple hairstreak					
Glaucopsyche alexis	Green-underside blue					
Gonepteryx rhamni	Common brimstone					
Hamearis lucina	Duke of burgundy					
Hesperia comma	Silver-spotted skipper					
Iphiclides podalirius	Scarce swallowtail					
Issoria lathonia	Queen of Spain fritillary					
Kirinia roxelana	Lattice brown					
Lasiommata megera	Wall brown					
Leptidea sinapis	Wood white					
Limenitis camilla	White admiral					
Limenitis reducta	Southern white admiral					
Lycaena alciphron	Purple-shot copper					
Lycaena dispar	Large Cooper	LC	LC	II, IV	II, I(6)	SP
Lycaena hippothoe	Purple-edged copper		DD			
Lycaena phlaeas	Small copper					
Lycaena thersamon	Lesser fiery copper					
Lycaena tityrus	Sooty copper					
Lysandra bellargus	Adonis blue					
Maniola jurtina	Meadow brown					
Melanargia galathea	Marbled white					
Melitaea athalia	Heath fritillary					
Melitaea cinxia	Glanville fritillary					
Melitaea didyma	Spotted fritillary					
Melitaea phoebe	Knapweed Fritillary					
Melitaea trivia	Lesser spotted fritillary					
Minoa murinata	Drab Looper					
Minois dryas	Dryad					
Neptis sappho	Pallas' sailer					
Nymphalis antiopa	Mourning cloak					SP
Nymphalis polychloros	Large tortoiseshell					
Nymphalis vaualbum	Compton Tortoiseshell	NE	EN	II, IV	II, I(6)	SP
Nymphalis xanthomelas	Yellow-legged tortoiseshell	LC	NT			SP
Ochlodes sylvanus	Large skipper					
Papilio machaon	Old World swallowtail	LC	LC			SP
Pararge aegeria	Speckled wood					
Parnassius mnemosyne	Clouded Apollo	LC	LC	IV	II	SP
Perconia strigillaria	Grass Wave					
Phengaris arion	Large blue	NT	LC	IV	II	SP
Pieris brassicae	Cabbage butterfly	LC	LC			SP
Pieris napi	Green-veined white					
Pieris rapae	Cabbage white					
Plebeius argus	Silver-studded blue					

Latin name	Common name	IUCN global red list	Red Book of Serbia	HD	BERN	Rulebook
Plebeius argyrognomon	Reverdin's blue					SP
Plebejus idas	Idas blue					
Polygonia c-album	Comma					
Polyommatus amandus	Amanda's blue					
Polyommatus daphnis	Meleager's blue					
Polyommatus icarus	Common blue					
Pontia edusa	Eastern bath white					
Pseudopanthera macularia	Speckled yellow					
Pseudophilotes vicrama	Eastern baton blue	NT	LC			SP
Pyrgus alveus	Large Grizzled skipper					
Pyrgus carthami	Safflower skipper					
Pyrgus malvae	Grizzled skipper					
Pyronia tithonus	Gatekeeper					
Satyrium acaciae	Sloe hairstreak					SP
Satyrium ilicis	Ilex hairstreak					
Satyrium pruni	Black hairstreak		NT			
Satyrium spini	Blue spot hairstreak					
Satyrium w-album	White-letter hairstreak					SP
Spialia orbifer	Orbed red-underwing skipper					
Thymelicus lineola	Essex skipper					
Thymelicus sylvestris	Small skipper					
Thyris fenestrella	Pygmy					
Tyta luctuosa	Four-spotted moth					
Vanessa atalanta	Red admiral					
Vanessa cardui	Painted lady					
Zerynthia cerisy	The eastern festoon	NT	NE			
Zerynthia polyxena	Southern festoon	NE	LC	IV	II	SP
Hymenoptera						
Vespula germanica	German wasp					
Bombus terrestris	Buff-tailed bumblebee					
Xylocopa violacea	Violet Carpenter Bee	LC				
Coleoptera						
Abax carinatus						
Abax parallelepipedus	-					
Abax parallelus	Scilly Shoulder Blade					
Acmaeoderella flavofasciata	-					
Agapanthia gasped	-					
Agapanthia kirbyi	-					
Agapanthia viti	-					
Agonum antennarium	-					
Amara aenea	-					
Amara saphyrea	-					
Anacaena globulus	-					
Anisoplia tempestiva	-					
Anthaxia scorzonerae	-					
Anthrenus verbasci	Varied carpet beetle					
Apalus bipunctatus	-					
Aphodius fimetarius	-					

Latin name	Common name	IUCN global red list	Red Book of Serbia	HD	BERN	Rulebook
Aphthona nonstriata	Iris flea beetle					
Blaps mucronate	Churchyard Beetle					
Brassicogethes aeneus	Rapeseed pollen beetle					
Callidium violaceum	Violet tanbark beetle					
Calosoma inquisitor	-					
Cantharis livida	-					
Cantharis pellucida	-					
Cantharis rustica	Sailor beetle					
Carabus convexus	-					
Carabus coriaceus	-					
Carabus ullrichii	-					SP
Carinatodorcadion aethiops	-					
Carinatodorcadion fulvum	-					
Cephennium fallax	-					
Cerambyx cerdo	The great capricorn beetle	VU		II, IV	II, I(6)	SP
Cetonia aurata	Rose chafers					
Chrysolina coerulans	Blue mint beetle					
Chrysolina haemoptera	Plantain leaf beetle					
Chrysolina rossia	-					
Chrysolina sturmi	-					
Chrysomela vigintipunctata	Spotted willow leaf beetle					
Cicindela campestris	Green tiger beetle					
Cydnopus pilosus	-					
Clytra laeviuscula	Ant bag beetle					
Clytus rhamni	-					
Coccinella septempunctata	Seven-spot ladybird					
Cortodera villosa	-					P
Cryptocephalus anticus	-					
Cryptocephalus bipunctatus	-					
Cryptocephalus coryli	Hazel pot beetle					
Cryptocephalus violaceus	-					
Dorcus parallelipipedus	Lesser stag beetle					
Elaphrus aureus	-					
Galeruca tanaceti	Tansy leaf beetle					
Gnaptor spinimanus	-					
Harmonia axyridis	Harlequin					
Harpalus distinguendus	-					
Helophorus aquaticus	-					
Hister quadrimaculatus	-					
Holochelus aequinoctialis	April beetle					
Hydrobius fuscipes	-					
Labidostomis lucida	-					
Lachnaia sexpunctata	-					

Latin name	Common name	IUCN global red list	Red Book of Serbia	HD	BERN	Rulebook
Leptinotarsa decemlineata	Colorado potato beetle					
Longitarsus lycopi	-					
Lucanus cervus	European stag beetle	LC		II	III, I(6)	SP
Malachius aeneus	Scarlet malachite beetle					
Malachius bipustulatus	Green malachite Bbeetle					
Melinopterus prodromus						
Meloe proscarabaeus	European oil beetle					
Meloe violaceus	Violet oil beetle					
Melolontha melolontha	Melolontha				III	
Morimus asper	Beech longhorn beetle	VU		II	I (6)	SP
Musaria affinis						
Mycterus tibialis	-					
Nebria brevicollis	-					
Neodorcadion bilineatum	-					
Oberea euphorbiae	-					
Oedema femorata	-					
Oedemera podagrariae	-					
Oryctes nasicornis	European rhinoceros beetle					SP
Oxythyrea funesta	Mediterranean spotted chafer					
Pachytodes erraticus	-					
Pedestredorcadion pedestre	-					
Pentodon idiota	-					
Phosphuga atrata	-					
Phyllobius glaucus	-					
Phyllotreta vittula	Barley flea beetle					
Plagionotus floralis	-					
Protaetia cuprea	Copper chafer					
Pseudoophonus rufipes	-					
Pseudovadonia livida	Fairy-ring longhorn beetle					
Psyllobora vigintiduopunctata	22-spot ladybird					
Pterostichus melas	-					
Pygopleurus diffusus	-					
Rhagonycha fulva	Common red soldier beetle					
Silpha obscura	-					
Stenopterus rufus	-					
Stenurella bifasciata	-					
Stenorella melanura	-					
Stromatium unicolor	-					
Subcoccinella vigintiquatuorpunctata	24-spot ladybird					
Thanasimus formicarius	Ant beetle					
Trichodes crabroniformis	-					

Latin name	Common name	IUCN global red list	Red Book of Serbia	HD	BERN	Rulebook
Trichodes favarius	-					
Tropinota hirta	-					
Xanthogaleruca luteola	Elm-leaf beetle					
Orthoptera						
Vichetia oblongicollis	-					
Tessellana vittata	-					
Odonata						
Aeshna affinis	Southern migrant hawker	LC				
Aeshna isoceles	Small hawker	LC				
Anax imperator	Blue emperor	LC				
Anax parthenope	Lesser Emperor	LC				
Brachytron pratense	Hairy hawker	LC				
Calopteryx splendens	Banded demoiselle		NA			
Calopteryx virgo	Beautiful demoiselle	LC	NA			
Coenagrion ornatum	Ornate bluet	LC				
Coenagrion puella	Azure bluet	LC				
Coenagrion pulchellum	Variable bluet	LC				
Coenagrion scitulum	Dainty bluet	LC				
Cordulia aenea	Downy emerald	LC				
Crocothemis erythraea	Broad scarlet	LC				
Ischnura elegans	Common bluetail	LC				
Ischnura pumilio	Small bluetail	LC				
Libellula depressa	Broad-bodied chaser	LC	NA			
Libellula fulva	Blue chaser	LC				
Onychogomphus forcipatus	Green-eyed hooktail	LC				
Orthetrum albistylum	White-tailed skimmer	LC				
Orthetrum cancellatum	Black-tailed skimmer	LC				
Orthetrum coerulescens	Keeled skimmer	LC				
Platycnemis pennipes	White-legged damselfly	LC	NA			
Pyrrhosoma nymphula	Large red damsel	LC				
Sympecma fusca	Common winter damsel	LC				
Sympetrum meridionale	Southern darter	LC				
Sympetrum sanguineum	Ruddy darter	LC				

Table 14-72. List of macroinvertebrates with their national and international conservation status

Latin name	Common name	IUCN global list	IUCN list in Serbia	HD	Bern	Rulebook
Family: Physidae						
Physa acuta						
Family: Lymnaeidae						
Radix peregra		LC				
Family: Planorbidae						
Anchylus fluviatilis						
Gyraulus laevis		LC				
Sphaerium corneum						
Family: Naididae						
Nais sp.						
Family: Erpobdellidae						
Erpobdella octoculata						
Family: Gammaridae						
Gammarus balcanicus						
Family: Gomphidae						
Gomphus vulgatissimus	common clubtail	LC				
Onychogomphus forcipatus		LC				
Family: Caenidae						
Caenis macrura						
Caenis horaria						
Family: Ephemeridae						
Ephemera danica						
Family: Elmidae						
Elmis sp.						
Family: Melanopsidae						
Amphimelania holandri		LC				
Fagotia acicularis						
Family: Aphelocheiridae						
Aphelocherius aestivalis						
Family: Asellidae						
Asellus aquaticus						
Family: Athericidae						
Ibisia marginata						
Family: Beatidae						
Beatis rhodani						
Baetis vardarensis						PS
Family: Chironomidae						
Cardiocladius fuscus						
Chironomus bernensis						
Chironomus obtusidens						
Chironomus riparius						
Chonchapelopia melanops						
Cladotanytarsus sp						
Cricotopus annulator						
Cricotopus bicinctus						
Cricotopus trifascia						
Cryptochironomus sp						
Demicryptochironomus vulneratus						
Endochironomus albipennis						
Eukiefferiella clypeata						
Eukiefferiella ilkleyensis						
Eukiefferiella lobifera						
Microtendipes pedellus						
Nanocladius rectinervis						

Latin name	Common name	IUCN global list	IUCN list in Serbia	HD	Bern	Rulebook
Orthocladius euorthocladius						
Orthocladius orthocladiusl						
Paracladopelma laminatum						
Paraleptophlebia lacustris						
Parametriocnemus stylatus						
Paratrichocladius rufiventris						
Paratrissocladius excerptus						
Paratanytarsus dissimilis						
Paratendipes albimanus						
Polypedilum convictum						
Polypedilum laetum						
Polypedilum scalaenum						
Potthastia longimanus						
Procladius sp						
Prodiamesa olivacea						
Rheocricotopus chalybeatus						
Rheopelopia sp						
Rheotanytarsus sp						
Saetheria reissi						
Synorthocladius semivirens						
Tanytarsus sp						
Thienemanniella majuscula						
Tvetenia calvescens						
Family: Hydropsychidae						
Chneumatopsyche lepida						
Hydropsyche angustipennis						
Hydropsyche contubernalis						
Hydropsyche fulvipes						
Family: Heptagenidae						
Ecdyonurus venosus						
Heptagenia sulphurea						
Family: Goeridae						
Lithax niger						SPS
Family: Lumbricidae						
Eiseniella tetraedra						
Family: Haemopidae						
Haemopis sanguisuga						
Family: Limoniidae						
Hexatoma bicolor						
Family: Hydrobiidae						
Lithoglyphus naticoides		LC				
Family: Nemouridae						
Protonemura meyeri			VU			SPS
Family: Philopotamidae						
Philopotamus montanus						
Wormaldia subnigra			NT			PS
Family: Planaridae						
Schmidtea lugubris						
Family: Psychomiidae						
Psychomyia pusilla						
Family: Rhyacophilidae						
Rhyacophila sp						
Family: Sericostomatidae						
Sericostoma personatum						

Latin name	Common name	IUCN global list	IUCN list in Serbia	HD	Bern	Rulebook
Family: Neritidae						
Theodoxus danubialis		LC				
Theodoxus transversalis		EN	EN	Anex II, IV	Res. 6	
Family: Tubificidae						
Tubifex tubifex						
Family: Unionidae						
Unio crassus		EN	EN	Anex II, IV	Res. 6	SPS

Table 14-73. List of ichthyofauna species with their national and international conservation status

Latin name	Common name	IUCN global list	IUCN list in Serbia	HD	BERN	Rulebook	Other
Fam. Cobitidae							
Cobitis elongata	Balkan spined loach	LC	LC	II	III, I(6)	SP	Ban on fishing
Cobitis taenia	Spined loach	LC	LC	II	III, I(6)	P	-
Sabanajewia balcanica	Balkan spined loach	LC	LC			SP	Ban on fishing
Fam. Cottidae							
Cottus gobio	Bullhead	LC	LC	II	III, I(6)	SP	
Fam. Cyprinidae							
Abramis brama	Common bream	LC	LC	-	-	P	L, MLM, ODU
Alburnoides bipunctatus	Schneider	LC	LC	-	III	P	
Alburnus alburnus	Common bleak	LC	LC	-	-	-	
Barbus balcanicus	Danube barbel	LC	LC	V	I(6)	P	MLM, ODU
Barbus barbus	Common barbel	LC	LC	V	-	P	L, MLM, ODU
Barbus meridionalis	Mediterranean barbel	NT	LC	II, V	III, I(6)	-	
Blicca bjoerkna	White bream	LC	LC	-	-	-	
Carassius carassius	Crucian carp	LC	LC	-	-	SP	Ban on fishing
Carassius gibelio	Prussian carp	LC	Alien	-	-	-	-
Chondrostoma nasus	Common nase	LC	LC	-	III	P	L, MLM, ODU
Cyprinus carpio	Eurasian carp	VU	LC	-	III	P	L, MLM, ODU
Gobio gobio	Gudgeon	LC	LC	-	-	P	MLM
Gobio obtusirostris	Danube gudgeon	LC	LC	-	-	P	MLM
Leuciscus aspius	Asp	LC	LC	II, V	III, I(6)	P	L, MLM, ODU
Leuciscus idus	Ide	LC	LC	-	-	P	L, MLM, ODU
Rhodeus amarus	European bitterling	LC	LC	II	III, I(6)	-	Ban on fishing
Romanogobio albipinnatus	White-finned gudgeon	LC	LC	II	III, I(6)	P	
Romanogobio kesslerii	Kessler's gudgeon	LC	LC	II, IV	III, I(6)	P	
Romanogobio uranoscopus	Danubian gudgeon	LC	LC	II	III, I(6)	P	
Rutilus rutilus	Common roach	LC	LC	-	-	-	
Squalius cephalus	Chub	LC	LC	-	-	P	L, MLM, ODU
Scardinius erythrophthalum	Rudd	LC	LC	-	-		
Tinca tinca	tench	LC	LC	-	-	SP	Ban on fishing
Vimba vimba	Vimba bream	LC	LC	-	III	P	MLM, ODU
Fam. Esocidae							
Esox lucius	Northern pike	LC	LC	-	-	P	L, MLM, ODU
Fam. Gobidae							
Neogobius fluviatilis	Monkey gobi	LC	Alien	-	-	-	
Fam. Nemachelidae							

Latin name	Common name	IUCN global list	IUCN list in Serbia	HD	BERN	Rulebook	Other
Barbatula barbatučla	Stone loach	LC	LC	-	-	-	
Fam. Percidae							
Perca fluviatilis	European perch	LC	LC	-	-	P	MLM
Sander lucioperca	Pike perch	LC	LC	-	-	P	L, MLM, ODU
Zingel streber	Danube streber	LC	VU	II	III, I(6)	SP	Ban on fishing
Zingel zingel	Zingel	LC	VU	II, V	III, I(6)	SP	Ban on fishing
Fam. Siliridae							
Silurus glanis	Wels catfish	LC	LC	-	III	P	L, MLM, ODU

Table 14-74. List of herpetofauna species and amphibians with their national and international conservation status

Latin name	Common name	IUCN global red list	Red Book of Serbia	HD	BERN	Rulebook
Bombina variegata	Yellow-bellied toad	LC	LC	II, IV	II, I(6)	SP
Rana dalmatina	Agile frog	LC	LC	IV	II	SP
Pelophylax ridibundus	Marsh frog	LC	LC	V	III	P
Testudo hermanni	Hermann's Tortoise	NT	NT	II, IV	II, I(6)	P
Emys orbicularis	European pond turtle	NT	DD	II, IV	II, I(6)	SP
Podarcis muralis	Common wall lizard	LC	LC	IV	II	/
Lacerta viridis	Eastern green lizard	LC	LC	IV	II	/
Natrix natrix	European grass snake	LC	LC	/	III	SP
Natrix tessellata	Dice snake	LC	LC	IV	II	SP
Zamenis longissimus	Aesculapian snake	LC	LC	IV	II	SP
Dolichophis caspius	Caspian whip snake	NE	DD	IV	II	SP

Table 14-75. List of ornithofauna species and amphibians with their national and international conservation status

Latin name	English name	IUCN global	Red Book of Serbia	EU Bird Directive	BERN	BONN	Rulebook
Falco tinnunculus	Common Kestrel	LC	LC, LC		II	II	SP
Falco subbuteo	Eurasian Hobby	LC	LC, LC		II	II	SP
Falco peregrinus	Peregrine	LC	EN, NT	I	II, I(6)	I, II	SP
Falco vespertinus	Red-footed Falcon	NT	VU, LC	I	II, I(6)	I, II	SP
Milvus migrans	Black Kite	LC	EN, DD	I	II, I(6)	II	SP
Corvus monedula	Eurasian Jackdaw	LC	LC, LC	IIB			P
Carduelis carduelis	European Goldfinch	LC	LC, LC		II		SP
Chloris chloris	European Greenfinch	LC	LC, LC		II		SP
Streptopelia decaocto	Eurasian Collared-dove	LC	LC, LC	IIB	III		P
Streptopelia turtur	European Turtle Dove	VU	VU, VU	IIB	III	II	P
Buteo buteo	Eurasian Buzzard	LC	LC, LC		II	II	SP
Passer montanus	Eurasian Tree Sparrow	LC	LC, LC		III		P

Passer domesticus	House Sparrow	LC	LC, LC				P
Sylvia nisoria	Barred Warbler	LC	-	I	II, I(6)	II	SP
Ficedula albicollis	Collared Flycatcher	LC	LC, LC	I	II, I(6)	II	SP
Himantopus himantopus	Black-winged Stilt	LC	NT, LC	I	II, I(6)	II	SP
Chlidonias hybrida	Whiskered Tern	LC	-	I	II, I(6)	II	SP
Ixobrychus minutus	Little Bittern	LC	-	I	II, I(6)	II	SP
Acrocephalus melanopogon	Moustached Warbler	LC	LC, LC	I	II	II	SP
Anthus campestris	Tawny Pipit	LC	LC, LC	I	II, I(6)	II	SP
Corvus corone	Carrion Crow	LC	LC, LC	IIB			P
Corvus frugilegus	Rook	LC	LC, LC	IIB			P
Pica pica	Eurasian Magpie	LC	LC, LC	IIB			P
Corvus corax	Common Raven	LC	LC, LC		III		P
Coracias garrulus	Roller	LC	LC, LC	I	II, I(6)	I	
Crex crex	Corncrake	LC	LC, LC	I	II, I(6)	II	SP
Sturnus vulgaris	Common Starling	LC	LC, LC	IIB			P
Emberiza schoeniclus	Reed Bunting	LC	LC, LC		II		SP
Columba palumbus	Common Woodpigeon	LC	LC, LC	IIA; IIIA			P
Columba livia f. domestica	Feral Dove	LC	NA, NA	-	-		-
Picus viridis	Eurasian Green Woodpecker	LC	LC, LC		II		SP
Troglodytes troglodytes	Northern Wren	LC	LC, LC		II		SP
Aegithalos caudatus	Long-tailed Tit	LC	LC, LC		II		SP
Alauda arvensis	Eurasian Skylark	LC	LC, LC		II		SP
Garrulus glandarius	Eurasian Jay	LC	LC, LC	IIB			P
Cyanistes caeruleus	Eurasian Blue Tit	LC	LC, LC		II		SP
Turdus merula	Eurasian Blackbird	LC	LC, LC	IIB	III		SP
Emberiza cirlus	Cirl Bunting	LC	LC, LC		II		SP
Dendrocopos syriacus	Syrian Woodpecker	LC	LC, LC	I	II, I(6)		SP
Dryocopus martius	Black Woodpecker	LC	LC, LC	I	II, I(6)		SP
Scolopax rusticola	Eurasian Woodcock	LC	LC, LC	IIA; IIIB	III		SP
Gallinago gallinago	Common Snipe	LC	CR, LC	IIA; IIIB	III		SP
Ardea alba	Great White Egret	LC	LC, LC	I	II, I(6)	II	SP
Ardea cinerea	Grey Heron	LC	LC, LC		III	II	P
Ardea purpurea	Purple Heron	LC	VU, LC	I	II, I(6)	II	SP
Ardeola ralloides	Squacco Heron	LC	LC, LC	I	II, I(6)	II	SP
Recurvirostra avosetta	Avocet	LC	EN,LC	I	II, I(6)	II	SP
Botaurus stellaris	Eurasian bittern	LC	LC, LC	I	II, I(6)	II	SP
Parus major	Great Tit	LC	LC, LC		II		SP
Dendrocopos major	Great Spotted Woodpecker	LC	LC, LC		II, I(6)		SP
Leiopicus medius	Middle Spotted Woodpecker	LC	LC, LC	I	II		SP
Dryobates minor	Lesser Spotted Woodpecker	LC	LC, LC		II		SP
Phalacrocorax carbo	Great Cormorant	LC	LC, LC		III		P
Anas platyrhynchos	Mallard	LC	LC, LC	IIA, IIIA	III	II	P
Aythya ferina	Pochard	VU	LC, EN	IIA, IIIB	III	II	P
Aythya nyorka	Ferruginous Duck	NT	-	I	III, I(6)	I,II	SP
Accipiter nisus	Eurasian Sparrowhawk	LC	LC, LC		II, I(6)	II	SP
Accipiter brevipes	Levant sparrowhawk	LC	LC, LC	I	II, I(6)	II	SP
Pernis apivorus	Honey Buzzard	LC	-	I	II, I(6)	II	SP
Pandion haliaetus	Osprey	LC	RE, EN	I	III, I(6)	I,II	SP
Circaetus gallicus	Short-toed Eagle	LC	LC, LC	I	II, I(6)	II	SP
Tachybaptus ruficollis	Little Grebe	LC	LC, LC		II	II	SP
Fulica atra	Common Coot	LC	LC, LC	IIA; IIIB	III	II	P

Gallinula chloropus	Common Moorhen	LC	LC, LC	IIB	III		P
Sterna hirundo	Common Tern	LC	VU, LC	I	II, I(6)		SP
Alcedo atthis	Common Kingfisher	LC	LC, LC	I	II, I(6)		SP
Acrocephalus arundinaceus	Great Reed Warbler	LC	LC, LC		II	II	SP
Acrocephalus palustris	Marsh Warbler	LC	LC, LC		II	II	SP
Acrocephalus scirpaceus	Eurasian Reed Warbler	LC	LC, LC		II		SP
Acrocephalus schoenobaenus	Sedge Warbler	LC	LC, LC		II		SP
Cettia cetti	Cetti's Warbler	LC	VU, DD		II	II	SP
Ciconia ciconia	White Stork	LC	LC, LC	I	II	II	SP
Ciconia nigra	Black Stork	LC	NT, LC	I	II	II	SP
Nycticorax nycticorax	Black-crowned Night Heron	LC	LC, LC	I	II, I(6)		SP
Egretta garzetta	Little Egret	LC	LC, LC	I	II, I(6)	II	SP
Circus aeruginosus	Western Marsh Harrier	LC	NT, LC	I	II, I(6)	II	SP
Circus cyaneus	Hen Harrier	LC	-, VU	I	II, I(6)	II	SP
Circus pygargus	Montagu's Harrier	LC	EN, LC	I	II, I(6)	I	SP
Coturnix coturnix	Common Quail	LC	VU, LC		III		P
Curruca communis	Common Whitethroat	LC	LC, LC		II	II	SP
Phylloscopus collybita	Common Chiffchaff	LC	LC, LC		II		SP
Emberiza calandra	Corn Bunting	LC	LC, LC		II		SP
Emberiza citrinella	Yellowhammer	LC	LC, LC		II		SP
Emberiza hortulana	Ortolan Bunting	LC	LC, LC	I	III		SP
Hirundo rustica	Barn Swallow	LC	LC, LC		II		SP
Locustella luscinioides	Savi's Warbler	LC	LC, LC		II	II	SP
Luscinia megarhynchos	Common Nightingale	LC	LC, LC		II	II	SP
Merops apiaster	European Bee-eater	LC	LC, LC		II	II	SP
Motacilla flava	Western Yellow Wagtail	LC	LC, LC		II	II	SP
Perdix perdix	Grey Partridge	LC	VU, NA		III		P
Sylvia atricapilla	Eurasian Blackcap	LC	LC, LC		II	II	SP
Tringa glareola	Wood Sandpiper	LC	/, LC	I	II, I(6)	II	SP
Tringa ochropus	Green Sandpiper	LC	/, LC		II		SP
Actitis hypoleucos	Common Sandpiper	LC	LC, LC		II		SP
Vanellus vanellus	Northern Lapwing	NT	LC, LC		II	II	SP
Lanius collurio	Red-backed Shrike	LC	LC, LC	I	II, I(6)	II	SP
Lanius minor	Lesser Grey Shrike	LC	LC, LC	I	II, I(6)		SP
Lullula arborea	Woodlark	LC	LC, LC	I	II, I(6)		SP
Upupa epops	Common Hoopoe	LC	LC, LC		II		SP
Oriolus oriolus	Eurasian Golden Oriole	LC	LC, LC		II	II	SP
Athene noctua	Little Owl	LC	LC, LC		II		SP
Asio flammeus	Short-eared owl	LC	LC, LC	I	II, I(6)	II	SP
Charadrius dubius	Little Ringed Plover	LC	LC, LC		II	II	SP
Cuculus canorus	Common Cuckoo	LC	LC, LC		III		SP
Erithacus rubecula	European Robin	LC	LC, LC		II		SP
Fringilla coelebs	Common Chaffinch	LC	LC, LC		III		SP
Galerida cristata	Crested Lark	LC	LC, LC		III		SP
Phasianus colchicus	Common Pheasant	LC	NA, NA	IIA; IIIA	III		P
Microcarbo pygmaeus	Pygmy Cormorant	LC	-	I	II, I(6)	II	SP

Table 14-76. List of mammals with their national and international conservation status

Latin name	Common name	IUCN	Red Book	HD	BERN	Rulebook

			of Serbia			
Talpa europaea	European mole	LC	LC			P
Erinaceus roumanicus	Northern white-breasted hedgehog	LC			III	P
Sorex minutus	Pigmy shrew	LC	LC		III	P
Micromys minutus	Harvest mouse	LC	NT			SP
Mus spicilegus	Steppe mouse	LC	LC			
Microtus arvalis	Field vole	LC	LC			
Rattus norvegicus	Brown rat	LC	LC			
Lepus europaeus	European hare	LC	LC		III	P
Canis aureus	Golden jackal	LC	LC	V		P
Vulpes vulpes	Red fox	LC	LC			P
Martes foina	Stone marten	LC	LC		III	P
Meles meles	Badger	LC	LC		III	P
Lutra lutra	Eurasian otter	NT	-	II, IV	II, I(6)	SP
Canis lupus	Wolf	LC	NT	II, IV, V	II, I(6)	SP
Vormela peregusna	Marbled polecat	VU	VU	II, IV	II, I(6)	SP
Sus scrofa	Wild boar	LC	LC			P
Capreolus capreolus	Roe deer	LC	LC		III	P
Myotis bechsteinii	Bechstein's bat	NT	NT	II, IV	II, I(6)	SP
Myotis mystacinus	Whiskered bat	LC	LC	II, IV	II	SP
Nyctalus noctula	Common noctule	LC	LC	II, IV	II	SP
Plecotus austriacus	Grey long-eared bat	LC	LC	IV	II	SP
Vespertilio murinus	Parti-coloured bat	LC	LC	II, IV	II	SP
Miniopterus schreibersii	Common bent-wing bat	NT	LC	II, IV	II, I(6)	SP
Pipistrellus nathusii	Nathusius' pipistrelle	LC	LC	II, IV	II	SP

LEGEND FOR ALL LISTS

IUCN *Red List of Threatened Species. Standardized categories, based on the IUCN Red List of Endangered Species and the Red Book of Fauna of Serbia III- Birds, with an assessment of breeding and non-breeding part of the population for each species in Serbia:*

- *VU – Vulnerable*
- *NT – Near Threatened*
- *LC – Least Concern*
- *NA – Not Applicable*
- *DD - Deficient Data.*
- *RE – Regionally Extinct*

HD *(Habitat Directive) - Council Directive 92/43/EEC on the Conservation of natural habitats and of wild fauna and flora*

- *Annex II species requiring designation of Special Areas of Conservation,*
- *Annex IV species in need of strict protection*

BERN (*The Convention on the Conservation of European Wildlife and Natural Habitats):*

- *Appendix II - Strictly protected fauna species,*
- *Appendix III - Protected fauna species.*

BONN *The Convention on the Conservation of Migratory Species of Wild Animals (Official Journal of SRJ, No. 11/2001, "Official Gazette of the RS", 102/2007b): Appendix I – endangered migratory species, and Appendix II – species which have an unfavorable conservation status and which require international agreements for their conservation and management;*

Red Books of fauna of Serbia:

- *LC (Least concern),*
- *NT (Near Threatened)*
- *DD (Data deficient)*
- *CR (Critically Endangered).*

Rulebook on the proclamation and protection of strictly protected and protected wild species of plants, animals and fungi Republic of Serbia ("Official Gazette of RS", No. 5/2010, 32/2011, 32/2016, 98/2016):

- *SP strictly protected wild species.*
- *P protected wild species.*

EU Birds Directive: *Annex I*

L - Prohibition of hunting during spawning, MLM - Minimum hunting measure, ODU - Daily catch limit

ANNEX 2 – NEW RAILWAY CORRIDOR ALIGNMENT (ANTHROPOGENIC HABITATS)

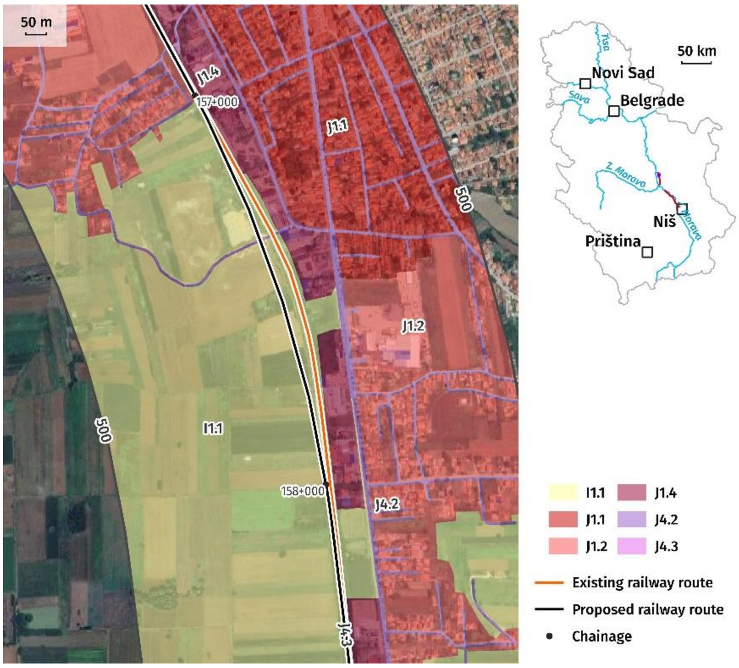


Figure 14-172. New railway corridor alignment from 157+100 km to158+000 km – Paraćin–Stalać subsection

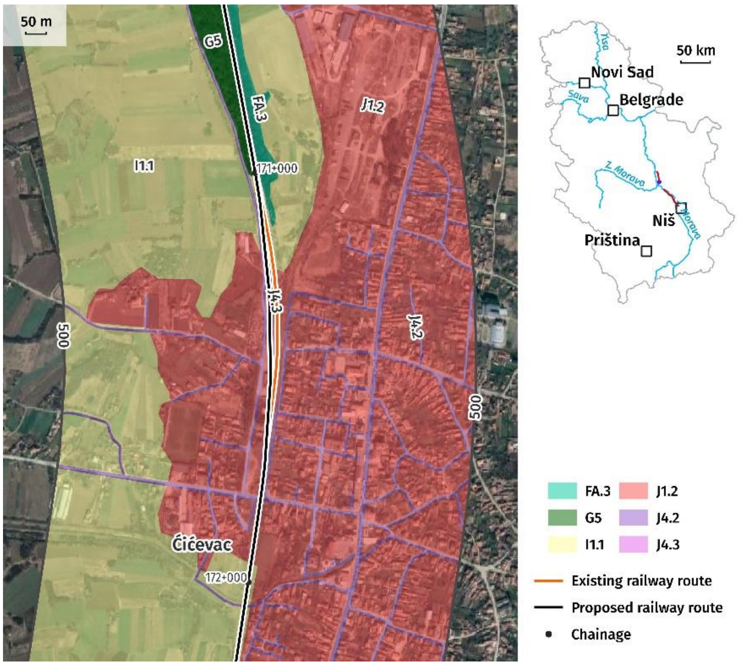


Figure 14-173. New railway corridor alignment from 171+000 km to 171+650 km – Paraćin–Stalać subsection

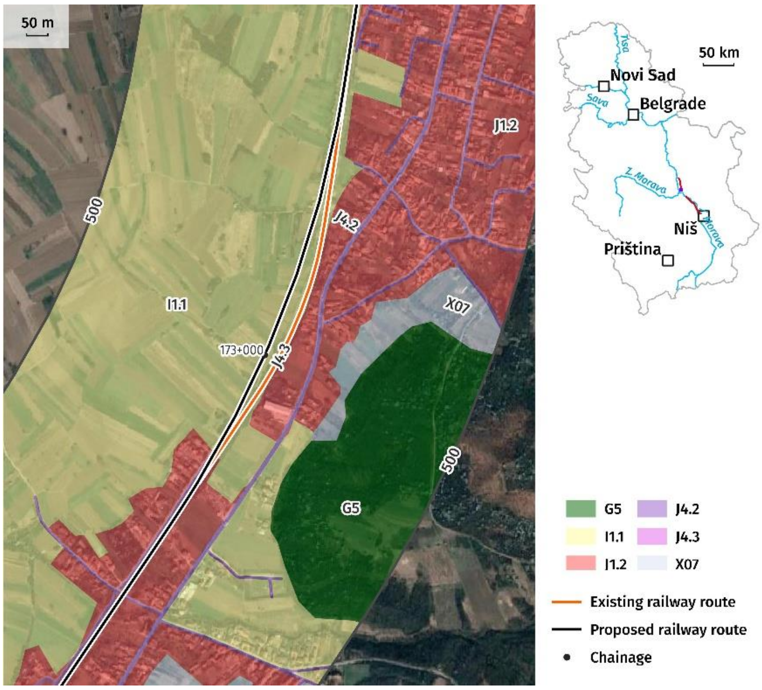


Figure 14-174. New railway corridor alignment from 172+350 km to 173+300 km – Paraćin–Stalać subsection

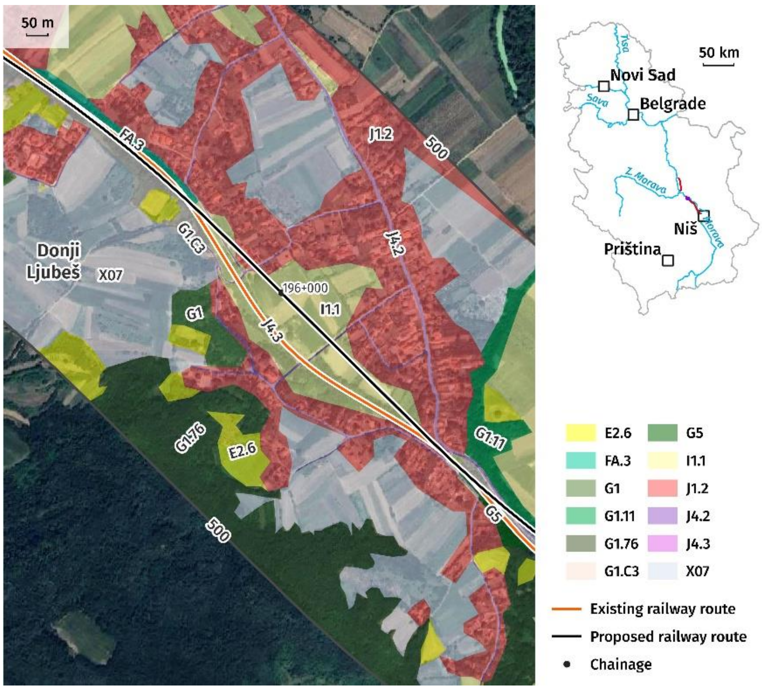


Figure 14-175. New railway corridor alignment from 195+700 km to 196+550 km – Đunis–Trupale subsection

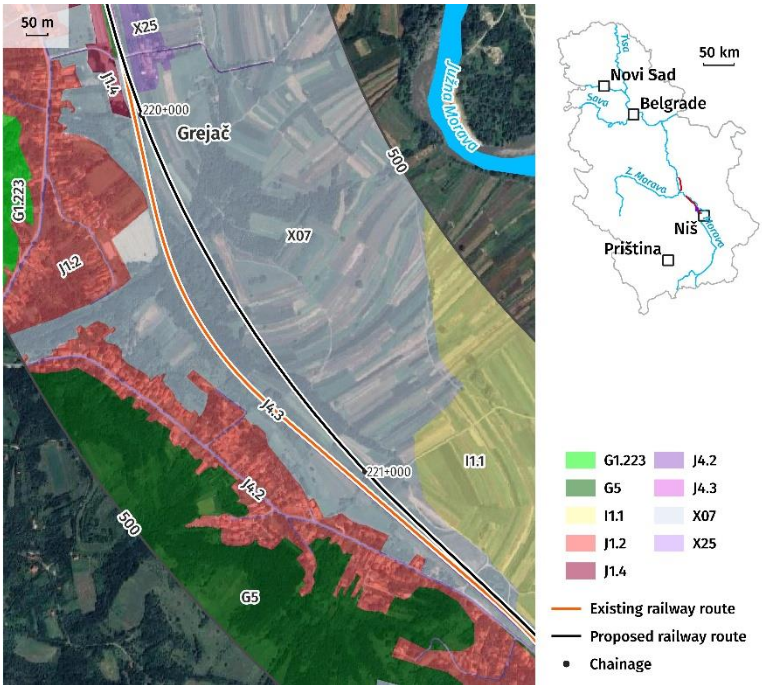


Figure 14-176. New railway corridor alignment from 219+850 km to 221+450 km – Đunis–Trupale subsection

Republic of Serbia
Ministry of European Integration

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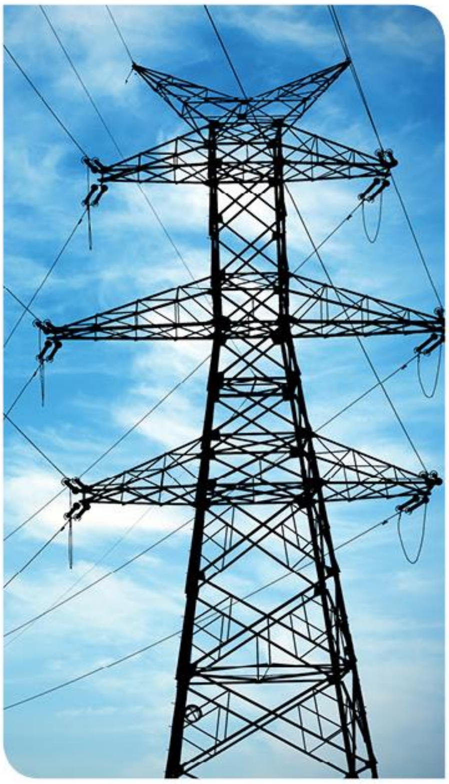

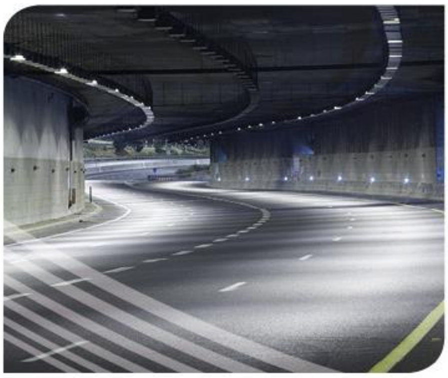

RAILWAY LINE BELGRADE–NIŠ, SECTION III, Paraćin to Trupale (Niš) Environmental and Social Impact Assessment, 15. CULTURAL HERITAGE

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PROJECT PREPARATION FACILITY

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LIST OF ABBREVIATIONS AND ACRONYMS

AoI	Area of Influence
CH	Cultural Heritage
CHMP	Cultural Heritage Management Plan
EBRD	European Bank for Reconstruction and Development
EIB	European Investment Bank
ESS	Environmental and Social Standard
E&S	Environmental and Social
EU	European Union
ICH	Intangible Cultural Heritage
PR	Performance Requirement
SRI	Serbian Railways Infrastructure

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15. CULTURAL HERITAGE

This Chapter presents the findings of the assessment of potential impacts on tangible and intangible cultural heritage during both the construction and operations phases of the Project.

15.1. Legislative and Policy Framework

15.1.1. EU Requirements

Key EU legislative instruments relevant for cultural heritage include:

- **Convention for the Protection of the Architectural Heritage of Europe (Granada Convention, 1985)**: This Council of Europe convention sets out principles for the conservation and enhancement of architectural heritage, influencing national legislation and policies within EU member states.
- **European Convention on the Protection of the Archaeological Heritage (Revised) (Valletta Convention, 1992)**: This convention provides a framework for the protection of archaeological heritage, guiding EU member states in their legislative measures.
- **Framework Convention on the Value of Cultural Heritage for Society (Faro Convention, 2005)**: This convention emphasizes the role of cultural heritage in building a peaceful and democratic society and promotes public involvement in heritage protection.

15.1.2. EBRD Requirements

Performance Requirement (PR) 8 sets specific standards for identifying, assessing, and mitigating potential impacts of projects on cultural heritage. This is supported by other PRs, including10 that, address interrelated aspects such as stakeholder engagement and community rights. EBRD's approach seeks to balance development needs with the safeguarding of cultural heritage, ensuring that projects respect local traditions, preserve historical assets, and enhance long-term community benefits.

PR 8 requires an assessment of the potential impacts of a project on cultural heritage and the identification of measures to avoid, minimize, or mitigate impacts. This assessment should be informed by meaningful consultation with all key stakeholders. Additionally, PR 8 requires that provisions are made for managing chance finds (i.e. tangible cultural heritage encountered unexpectedly). Projects located near legally protected heritage sites must comply with national and international legislation.

15.1.3. EIB Requirements

Environmental and Social Standard (ESS) 10 outlines requirements for identifying, assessing, and managing potential impacts on cultural heritage in EIB-financed projects. It is complimented by other EIB standards related to biodiversity, stakeholder engagement, and involuntary resettlement, which provide additional cultural heritage safeguards. The EIB emphasizes the protection of cultural heritage while ensuring that projects respect local traditions, historical assets, and community values.

ESS10 requires a thorough assessment of potential impacts on cultural heritage and the implementation of measures to avoid, minimize, or mitigate adverse effects. This process must involve meaningful consultation with affected communities and relevant stakeholders. Additionally, ESS10 mandates procedures for managing chance finds (i.e., unexpected discoveries of cultural heritage) to ensure proper preservation and evaluation. Projects near legally protected cultural heritage sites must comply with national and international legal frameworks. For projects involving the commercial use of cultural heritage, fair benefit-sharing with affected communities is required.

15.1.4. National Legislative Framework

The central legislation for the protection, preservation, and management of cultural heritage in Serbia is the '**Law on Cultural Goods - Official Gazette of the Republic of Serbia, Nos. 71/94, 52/2011'**, and subsequent amendments. Key provisions include:

- Defining cultural goods, including immovable, movable, and intangible heritage;
- Procedures for designating cultural properties and their protection status;
- Responsibilities of institutions for the preservation and management of cultural goods;
- Measures for the prevention of damage or destruction of cultural heritage;
- Procedures for archaeological research and findings.

Additionally, the following laws are applicable to the protection of cultural heritage:

- **Law on the Protection of Cultural Goods in Emergency Situations**: Regulates the protection of cultural heritage during emergencies, including natural disasters, conflicts, and accidents. Includes provisions for safeguarding and emergency planning for cultural properties.
- **Law on Planning and Construction - Official Gazette of the Republic of Serbia, Nos. 72/2009, 132/2014, and subsequent amendments**: Stipulates requirements for the protection of cultural heritage in the context of urban planning and construction. Requires prior consent from relevant cultural heritage authorities for construction projects near or involving cultural sites
- **Law on Nature Protection - Official Gazette of the Republic of Serbia, Nos. 36/2009, 14/2016, and subsequent amendments:** Addresses natural features with cultural and historical significance (e.g., landscapes, sacred natural sites). Ensures the integration of cultural heritage considerations into environmental protection measures.
- **Law on Public Information and Media**: Regulates the promotion and awareness of cultural heritage in Serbia through public communication channels. Encourages the dissemination of information about the importance of cultural preservation.

Furthermore, the Rulebook on Archaeological Research establishes guidelines and requirements for conducting archaeological surveys and excavations. Includes provisions for protecting discovered artifacts and cultural sites during research activities.

International Conventions Ratified by Serbia

Serbia is a signatory to key international conventions that influence national legislation on cultural heritage:

- UNESCO World Heritage Convention (1972)
- Convention for the Safeguarding of the Intangible Cultural Heritage (2003)
- European Convention on the Protection of the Archaeological Heritage (Valletta, 1992)
- Convention for the Protection of the Architectural Heritage of Europe (Granada, 1985)

National Plans and Strategies

- The 'Strategy for Cultural Development of the Republic of Serbia' (2017–2027): Aims to improve cultural heritage management, increase public awareness, and promote sustainable use of cultural properties.
- The 'Spatial Plan of the Republic of Serbia': Integrates cultural heritage considerations into spatial and urban planning.

15.2. Baseline conditions

15.2.1. Area of Influence

The Area of Influence (AoI) for cultural heritage has been defined as a **500-meter-wide corridor on each side of the planned railway alignment**. This buffer zone was established in accordance with best international practices in cultural heritage impact assessment, ensuring the identification of potential direct and indirect impacts on both tangible and intangible heritage resources.

The delineation of this corridor was guided by a comprehensive review of official data from the Institute for the Protection of Cultural Monuments. The selected buffer accounts for potential visual and environmental impacts, as well as possible indirect effects on the setting, context, and integrity of cultural heritage sites and archaeological remains.

Within this defined corridor, all known cultural heritage and archaeological sites registered in the Institute's central database were reviewed and mapped. The proximity of these sites to the proposed railway alignment was assessed in detail. Furthermore, the official location conditions issued for the Spatial Plan for the Special Purpose Area of the railway corridor confirmed that no registered cultural or archaeological sites within the AoI will require relocation or physical intervention due to the implementation of the Project.

It is also important to note that during the development of the Spatial Plan the subject of cultural heritage was addressed with Stakeholders indirectly. During this process, the wider PPF9 Project team (including spatial planners, environmental experts, and social specialists) maintained continuous communication with representatives of all Municipalities located along the railway corridor. Although cultural heritage was not the primary focus of these meetings, it was included in broader discussions related to spatial development and land use planning.

While these discussions were conducted through regular and active engagement with local authorities, the exchange of information was primarily verbal and informal. Valuable insights were also gathered during on-site activities by members of the social team and the ESIA team. During these field visits, which were carried out in relation to a range of technicl components of the Project, interactions with local residents provided anecdotal information on locally significant landmarks and features of cultural value. These findings are integrated into the narrative of this chapter to enhance the understanding of the local cultural context.

15.2.2. Baseline

The key national institutions responsible for the protection of cultural heritage are the Ministry of Culture and Information and the Institute for Protection of Cultural Monuments of Republic of Serbia. The Institute for the Protection of Cultural Monuments of Serbia in Belgrade is tasked with recording, examining, protecting and presenting cultural heritage, including the oldest prehistoric and antique monuments, works of medieval sacral and fortification architecture, traditional architecture and monuments created in the recent history, and contemporary works, which are now comprising significant cultural and historical, artistic, educational and aesthetical value for Serbia and Serbian people.

The Institute keeps a central registry of all cultural heritage assets in the country. In the Central Catalogue, there are currently 2,644 registered immovable cultural properties, including 2,272 monuments of culture, 95 spatial cultural-historical units, 198 archaeological sites, and 79 landmarks. There are 782 classified immovable cultural properties, of which 200 are of exceptional importance and 582 of great importance. Amongst the immovable cultural properties of exceptional importance, there are 155 monuments of culture, 11 spatial cultural-historical units, 18 archaeological sites, and 16 landmarks. Amongst the cultural properties of great importance, there are 512 monuments of culture, 28 spatial cultural-historical units, 25 archaeological sites, and 17 landmarks.

Amongst the categorized immovable cultural resources, the serial property of Stari Ras and Sopoćani was the first to be inscribed on the UNESCO World Heritage List of cultural and natural heritage sites in 1979, followed by the Studenica Monastery in 1986, the Dečani Monastery in 2004, the Monastery of Gračanica and the Patriarchate of Pec and the Church of Holy Virgin of Ljeviša in Prizren in 2006, along with the archaeological site of Gamzigrad – Romuliana in 2007.

Figure 15-1 and Figure 15-2 below show the Project alignment in relation to the location of known cultural heritage assets that are **protected by the Republic of Serbia**, none of which are classified as being of exceptional or great importance and only comprise Cultural Monuments. Based on the location conditions issued for the Spatial plan for the special purpose of the railway corridor, covering the Project, there are no archaeological sites or archaeological zones in the AoI within either of the Paraćin – Stalać or Đunis – Trupale sub-sections, hence these are not included in Figure 15-1 and Figure 15-2.

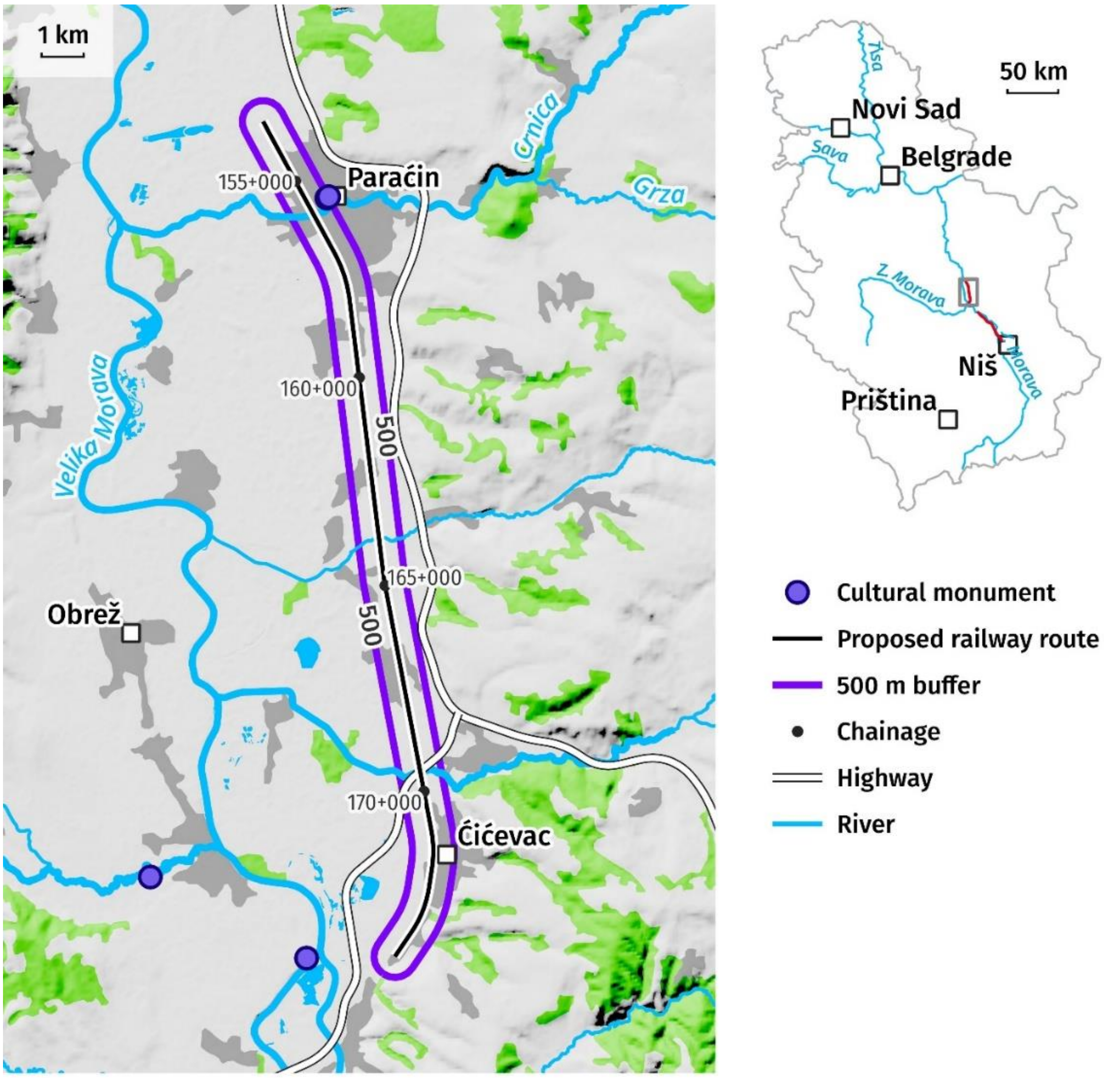

Figure 15-1. Protected cultural heritage assets (Paraćin – Stalać sub-section)

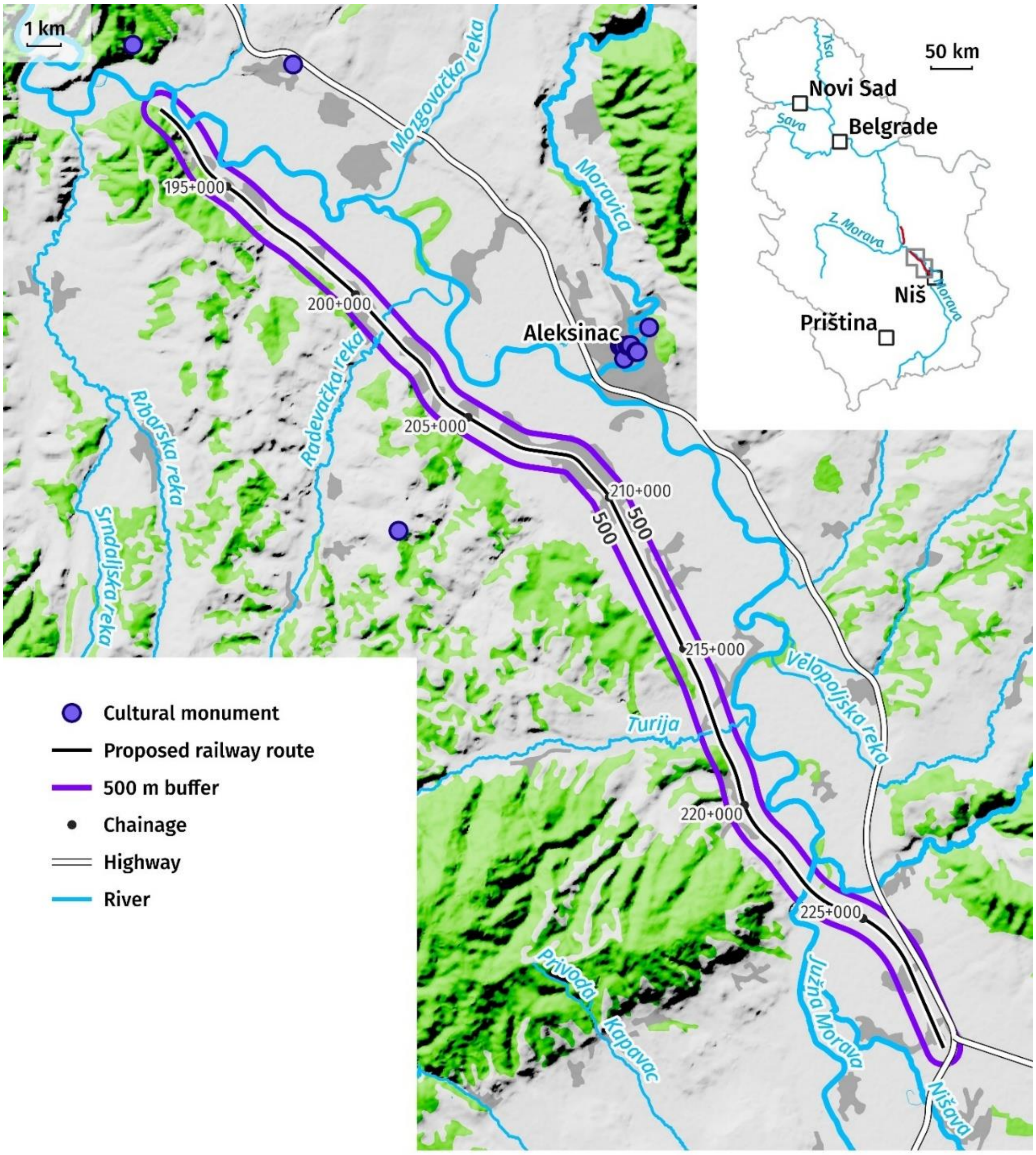

Figure 15-2. Protected cultural heritage assets (Đunis – Trupale sub-section)

Building at Branka Krsmanovića 47 street' in Paraćin – National library Dr Vićentije Rakić

As illustrated in Figure 15-1 and Figure 15-2, there is only 1 'Cultural Monument' located within the AoI, namely the 'Building at Branka Krsmanovića 47 street' in Paraćin – National library Dr Vićentije Rakić. Table 15-1 below provides detailed information relating to this Cultural Monument.

Table 15-1. Cultural monuments in the AoI

1
Name: Building at Branka Krsmanovića 47 street in Paraćin - National library Dr Vićentije Rakić
Municipality: Paraćin
Place: Paraćin
Authorised institution: Regional Institute for Protection of Cultural Monuments in kragujevac
Number in central cadastre: SK 739
Type: Monument of Culture
Category: Immovable Cultural Property
Coordinates: 43.8621, 21.4074
Chainage: km 156+000
Distance from railway line: 490m
Description:  At 47 Branka Krsmanovića Street in Paraćin, there is a building that once housed the Paraćin elementary school and is now used by the city library "Dr Vićentije Rakić." The building was constructed in the 1880s on the site of a small school building that previously existed there. This structure was designed as a closed atrium-type school, with a distinctive feature of having two atriums, a ground floor, and an upper floor. The building's layout is rectangular, with the main façade slightly wider than the overall width of the rest of the structure. The front of the building faces Branka Krsmanovića Street and is symmetrically designed, featuring a prominent central risalite and a decoratively adorned portal. Apart from the classically styled portal, the façade is modestly executed, with simple ornamentation on the roof cornices and window parapets. A vertical division of the building is prominently expressed.

Supovac tower

Supovac tower is also within the AoI and has cultural heritage significance but is not protected or recognised by the Republic of Serbia as a Cultural Monument. The tower is located next to the existing railway bridge in Supovac (Chainage: km 223+000). The location of the tower is shown in Figure 15-6. Its architectural and historical value lies in its testimony to military strategy and the protection of infrastructure during turbulent times. The tower is shown in Figure 15-3.

The bunker can be classified as part of the cultural heritage of the Republic of Serbia due to its role in history and its potential to educate future generations about past events and construction techniques. Preserving it would contribute to a better understanding of local and national history and as such, it is included in this assessment.

Figure 15-3. Supovac tower

Memorial to the Fallen Soldiers (1912–1918) in Drenovac

A monument dedicated to General Ilija Gojković and the fallen soldiers from the Drenovac area is located next to the railway line, within the zone of the future underpass at km 166+670. The monument bears the names of 104 soldiers from Drenovac who lost their lives in the wars of 1912–1918. Although the monument is not officially protected or registered as a cultural heritage site by the relevant institutions, it holds significant value for the local community and their collective memory of the fallen soldiers from the region. The memorial is shown on Figure 15-4.

Figure 15-4. Memorial to the Fallen Soldiers (1912–1918) in Drenovac

15.3. Assessment of Potential Impacts

Assumptions and limitations

The specific placement of various Project construction components, including construction camps, laydown areas, access roads, borrow pits, and spoil disposal areas, has not yet been determined. Consequently, this assessment focuses solely on evaluating impacts related to the currently known Project footprint. However, the construction Contractor will be required to develop a Cultural Heritage Management Plan (CHMP) for the Construction Phase of the Project. The CHMP will define measures that must be implemented for the protection of cultural heritage assets, and ensure compliance with applicable national regulations and international best practice including that siting of construction camps, access roads, borrow pits, or other temporary facilities will be prohibited in close proximity to cultural heritage sites. It will also include the Chance Finds Procedure that will effectively mitigate any impacts on undiscovered cultural heritage assets.

15.3.1. Impact Assessment Methodology

The standard methodology for assessing the impacts of the construction phase of the Project on Cultural Heritage is outlined in Chapter 5 of this ESIA. There are not expected to be any significant, direct negative impacts on Cultural Heritage assets and therefore, the assessment has not been taken further. The justification for scoping Cultural Heritage Impacts out of the assessment is detailed in the following sections.

15.3.2. Assessment of Impacts on Tangible cultural heritage

Building at Branka Krsmanovića 47 street' in Paraćin – National library Dr Vićentije Rakić

As illustrated in Figure 15-5, the protected cultural heritage building is located in an urban area of Paraćin, approximately four city blocks (or nearly 500 meters) away from the existing railway line. Given this distance and its location outside of the construction zone, any potential impacts during both the construction and operational phases can be ruled out.

During the construction phase, access roads to the construction site will not pass through the Branka Krsmanovića street where the protected building is located because this would require construction traffic to pass directly over the main square in Paraćin, through the city center, which will not be allowed. This eliminates the possibility of direct impacts from heavy machinery, material transport, or increased traffic-related vibrations. Furthermore, at a distance of 500 meters, construction-induced vibrations from activities such as piling, excavation, or track replacement will dissipate well before reaching the protected structure.

Regarding construction noise, the protected building is effectively shielded by multiple rows of intervening buildings, which act as a natural sound barrier. This significantly reduces any potential noise propagation from construction activities. Additional details on noise and vibration assessments are provided in Chapter 12 (Noise and Vibration).

During the operational phase, no adverse impacts are anticipated. The modernization of the railway line includes noise barriers and vibration mitigation measures throughout the Paraćin urban area, ensuring that operational noise and vibration levels remain within acceptable limits. Given these mitigation measures and the significant distance between the railway and the protected building, no measurable impact is expected.

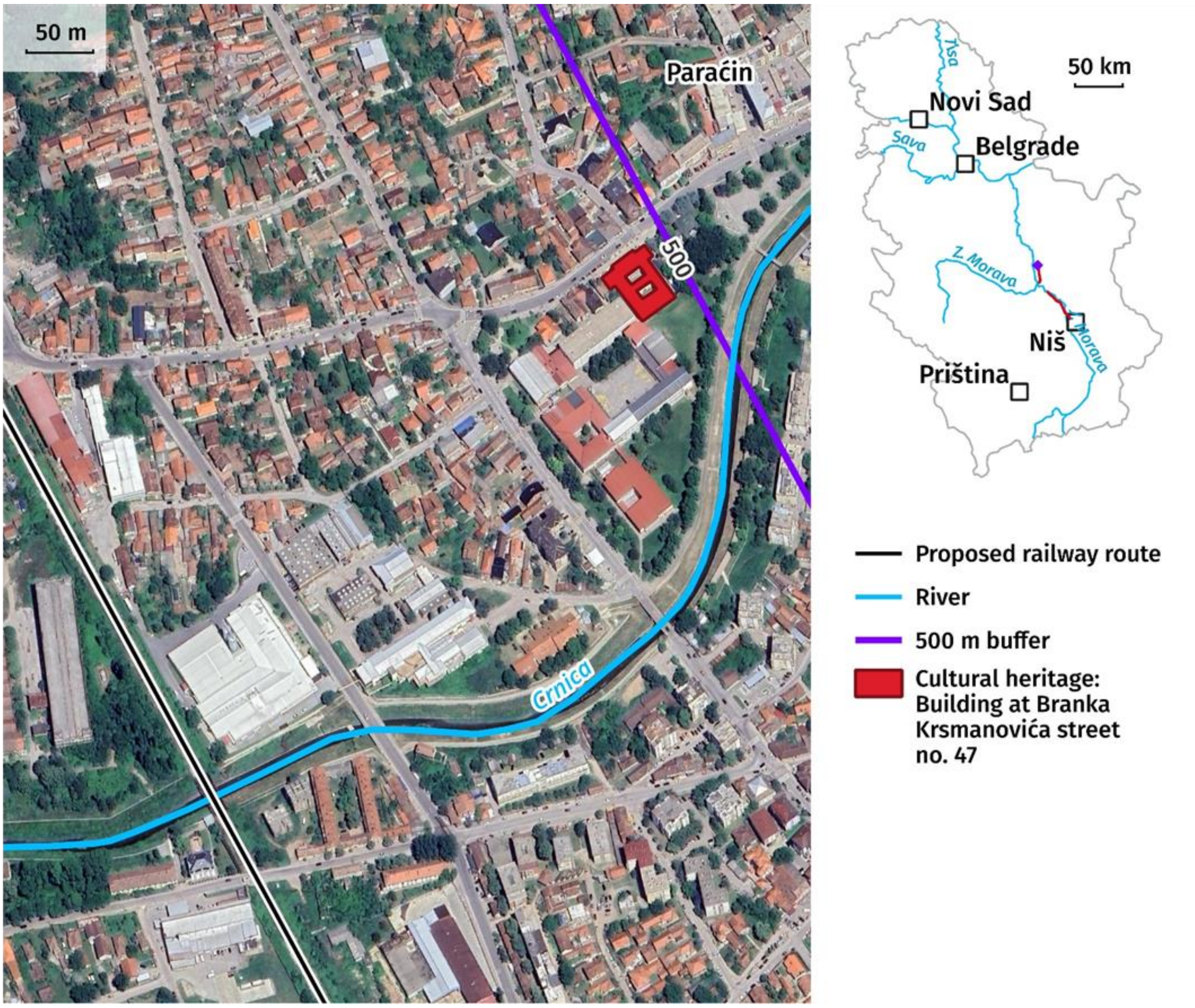

Figure 15-5. Paraćin cultural heritage in relation to the railway line

Supovac tower

The tower is located next to the existing railway bridge in Supovac (Chainage: km 223+000). The location of the tower is shown in Figure 15-6. At this location, the entire railway line is newly designed to deviate to the east, starting from km 222+000 to km 223+500. During the construction phase, works will take place along the new alignment and the new bridge over the Južna Morava, which is located almost 500 meters to the north. Given the standard bridge construction technology and the realignment of the railway, the execution of works on the new railway route cannot affect the Supovac tower. Furthermore, the local road network, as shown in Figure 15-6, is situated far enough from the tower itself to prevent any impacts from the passage of heavy machinery, as routing construction traffic near the tower would require passing through unsuitable or restricted areas, which will not be allowed.

During the operational phase, no impact on the Supovac tower is anticipated. The increased distance between the realigned railway and the tower, combined with modern track-bed design and vibration mitigation measures, ensures that potential effects commonly associated with railway operations—such as noise and ground-borne vibration—will be negligible. Additionally, the new bridge over the Južna Morava is located almost 500 meters to the north, further reducing the possibility of any indirect effects. Given these factors, no adverse impact on the structural stability or heritage value of the Supovac tower is expected.

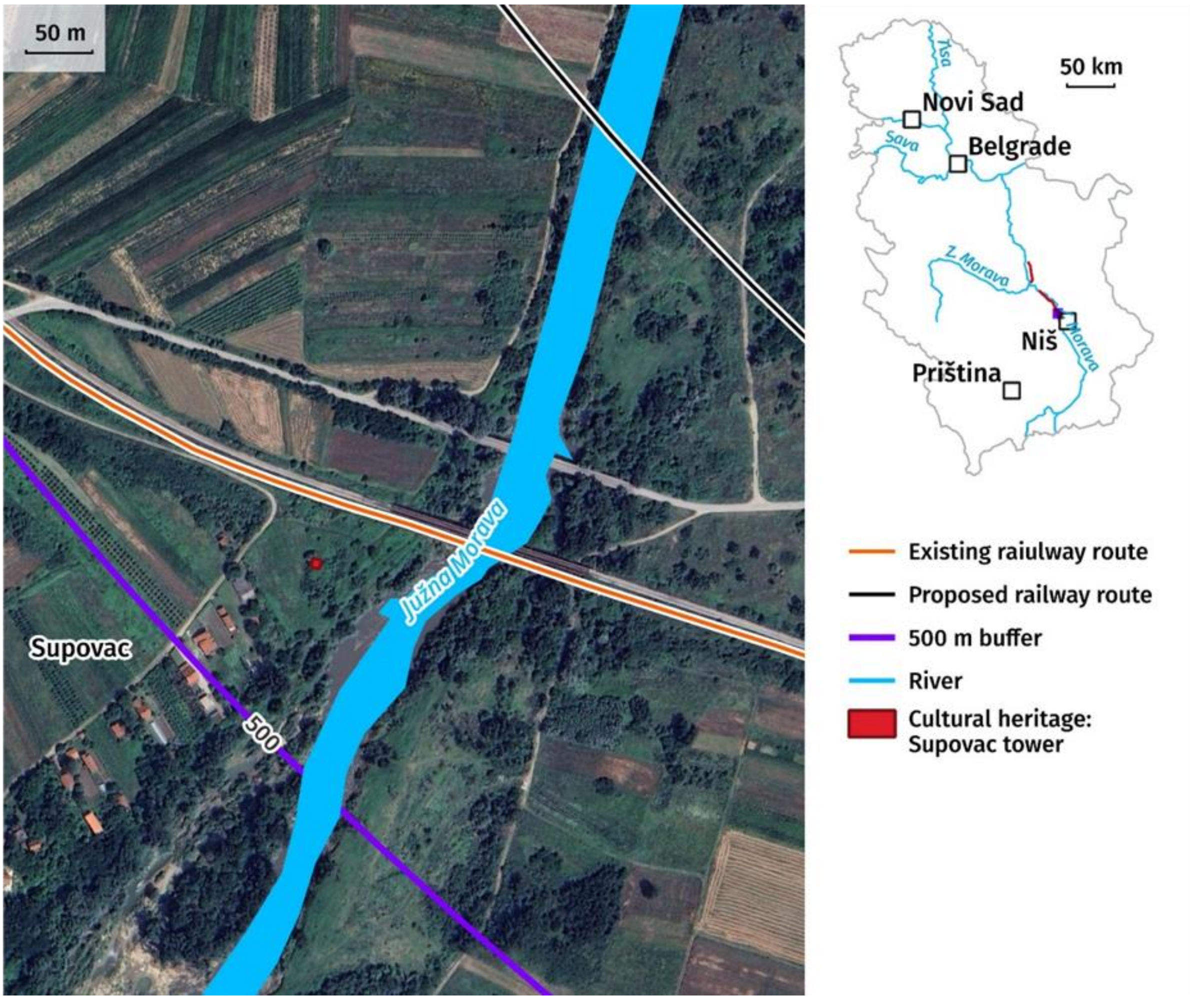

Figure 15-6. Location of Supovac tower, old military bunker

Memorial to the Fallen Soldiers (1912–1918) in Drenovac

As shown in Figure 15-4, the monument dedicated to General Ilija Gojković and the fallen soldiers from the Drenovac area is located next to the railway line, within the zone of the planned underpass. Construction of the underpass at this location would require the relocation of the monument. However, the local administration in Drenovac, together with members of the association "General Ilija Gojković" and the Association of Descendants of Serbian Warriors from 1912 to 1920, have been actively working for several years on the development of a new memorial monument and centre dedicated to the soldiers from Drenovac who died in the wars of 1912–1918. As part of this initiative, the relocation of the existing monument has already been planned, along with the installation of a statue of General Ilija Gojković at a designated location within the village of Drenovac. The relocation and installation are scheduled to take place in August 2025.

Given that the monument will in any case be relocated to a site outside the Area of Influence (AoI), no further impacts during the construction works are expected.

Given the potential for encountering undiscovered cultural heritage (CH) assets during construction and operations, a Chance Finds Procedure will be developed and implemented. During the construction phase, the Contractor will be responsible for implementing the procedure, ensuring that any previously unrecorded CH assets encountered are appropriately managed. In the operations phase, the SRI will take over responsibility for the procedure. This approach will ensure that any potential impacts on undiscovered cultural heritage assets are effectively mitigated through immediate protective actions, documentation, and, if necessary, preservation or relocation efforts.

15.3.3. Assessment of Impacts on Intangible cultural heritage

Intangible cultural heritage" (ICH) is defined by UNESCO as the practices, representations, expressions, knowledge, skills – as well as the instruments, objects, artefacts and cultural spaces associated therewith – that communities, groups and, in some cases, individuals recognise as part of their cultural heritage. This intangible cultural heritage, transmitted from generation to generation, is constantly recreated by communities and groups in response to their environment, their interaction with nature and their history, and provides them with a sense of identity and continuity, thus promoting respect for cultural diversity and human creativity. Intangible cultural heritage is manifested notably in oral traditions and expressions (including language), performing arts; social practices, rituals and festive events; knowledge and practices concerning nature and the universe; traditional craftsmanship.

Serbia has 6 ICH elements inscribed in the UNESCO List of Representative List of the Intangible Cultural Heritage of Humanity:

- 2024: Naïve painting practices of Kovačica (note: this village is located in northern Serbia in the municipality of Kovačica at a distance of over 100 km from Belgrade and Niš railway)
- 2022: Social practices and knowledge related to the preparation and use of the traditional plum spirit – šljivovica

- 2020: Zlakusa pottery making, hand-wheel pottery making in the village of Zlakusa (note: this village is located in western Serbia in the municipality of Užice at a distance of over 100 km from Belgrade and Niš railway)
- 2018: Singing to the accompaniment of the Gusle
- 2017: Kolo, traditional folk dance
- 2014: Slava, celebration of family saint patron's day

None of the above practices or traditions are practiced only in or are deeply rooted in the settlements of regions crossed by the Project. Discussions with local communities during the development of the Corridor E&S assessment report did not identify any significant traditional practices that could be affected, including those listed above under UNESCO protection.

None of the UNESCO protected ICH practices or traditions known to exist in Serbia are only practiced in, or deeply rooted in, the settlements of regions transected by the Project. Additionally, discussions with local communities during the development of the Corridor E&S assessment Report (2022) did not identify any ICH practices or traditions that could be affected. As it is considered to be highly unlikely that the Project will result in any impacts on ICH practices or traditions, no further verification of the conclusions of the Corridor E&S assessment report was undertaken with local communities to inform this assessment.

Impacts on intangible cultural heritage are considered highly unlikely, have been scoped out and are not subject to further assessment.

15.4. Mitigation

Although the Project is not expected to result in significant adverse impacts on identified cultural heritage assets, a number of preventive and protective measures will be implemented to ensure full compliance with national regulations and international best practice.

A Cultural Heritage Management Plan (CHMP) will be developed by the Construction Contractor prior to the start of works, in coordination with the relevant authorities and implemented throughout the construction phase. The CHMP will define procedures and responsibilities for the protection of known and undiscovered cultural heritage assets during the construction phase. Specifically, the CHMP will include:

- Provisions for managing chance finds outlined within a Chance Finds Procedure, including the immediate cessation of works and notification of the relevant heritage authorities in the event of a discovery;
- Restrictions on the siting of construction-related infrastructure (such as construction camps, access roads, borrow pits, and spoil disposal sites) in proximity to any known cultural heritage sites or areas of sensitivity;
- Measures for raising awareness amongst workers on the importance of cultural heritage protection.

During the operational phase, the responsibility for cultural heritage management will be transferred to the Serbian Railways Infrastructure (SRI). An equivalent Cultural Heritage Management Plan should be developed and implemented by the SRI, including the following measures:

- All personnel undertaking intrusive below-ground maintenance activities must be made aware of the potential for encountering undiscovered buried heritage remains;
- A version of the Chance Finds Procedure will remain in place during the operational phase to ensure an appropriate response to any accidental discoveries.

All mitigation measures, including for chance finds, will be implemented in consultation with the competent Institute for the Protection of Cultural Monuments, ensuring compliance with Serbian legal requirements and alignment with EIB ESS10 and EBRD PR8.

15.5. Conclusion

Whilst there are two tangible cultural heritage assets located within the Project AoI, one of which is a protected Cultural Monument, owing to their locations in relation to the Project alignment, it is not anticipated that there will be any significant direct negative impacts on these assets, either during the construction or operations phases of the Project.

The proposed design includes buffer zones and other protective measures to avoid inadvertent damage to surrounding buildings during construction. A Chance Finds Procedure will be developed and implemented by the Construction Contractor and SRI during the construction and operations phases respectively, which will effectively mitigate any impacts on undiscovered CH assets.

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ЗА ТЕБЕ

RAILWAY LINE BELGRADE–NIŠ, SECTION III PARAĆIN TO TRUPALE (NIŠ),
Environmental and Social Impact Assessment,
16. WASTE AND MATERIALS

EU PPF
PROJECT PREPARATION FACILITY

General

DOCUMENT CONTROL SHEET

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1 WASTE AND MATERIALS

This Chapter presents the findings of the assessment of environmental and social impacts from the use of materials and the generation of waste during both the construction and operation phases of the Project. The types and sources of materials to be used and waste streams generated are identified, with an assessment of their potential impacts on human receptors (communities and workers) and environmental receptors (soil, air and water quality). Mitigation measures to avoid or minimise negative impacts, are proposed. The methodology and data sources used are listed.

1.1 Legislative and Policy Framework

In the Republic of Serbia (RoS), legislation and policy on waste is inherently connected with that on materials, and they share regulatory frameworks and principles under EU Directives and Lenders' standards. As such, the requirements listed below apply to both waste and materials management.

1.1.1 EU requirements

The Waste Framework Directive (2008/98/EC) sets the basic concepts and definitions related to waste management, including definitions of waste, recycling and recovery. The definition of waste is: *'any substance or object which the holder discards or intends or is required to discard'*.

It requires that waste be managed:

- without endangering human health and harming the environment
- without risk to water, air, soil, plants or animals
- without causing a nuisance through noise or odours
- and without adversely affecting the countryside or places of special interest

It explains when waste ceases to be waste and becomes a secondary raw material, and how to distinguish between waste and by-products. The Directive also introduces the "polluter pays principle" and the "extended producer responsibility".

The foundation of EU waste management is the five-step "waste hierarchy", established in the Waste Framework Directive. It establishes an order of preference for managing and disposing of waste. The hierarchy of waste management is a well-known guide used in the evaluation of the most favourable option to the least favourable one, for addressing waste generation in construction projects (see Figure 1-1). It practices from represents the best practicable options that protect the environment alongside resource and energy consumption within the chain of priorities for waste management, starting from the optimal situation of waste reduction (also referred to as prevention) and extending up to waste disposal which is the end-of-pipe solution. The waste hierarchy comprises the 3Rs of waste minimisation (i.e., reduction, reuse & recycling), followed by recovery of energy (e.g., incineration or pyrolysis and gasification) and final disposal.

Figure 1-1. Waste Hierarchy

- Prevention – using less material in design and manufacture; keeping products for longer; re use; using less hazardous materials;
- Preparing for reuse – checking, cleaning, repairing, refurbishing, whole items or spare parts;
- Recycling – turning waste into a new substance or product; can include composting if materials meet quality protocols;
- Recovery – anaerobic digestion; incineration with energy recovery; gasification and pyrolysis which produce energy (fuels, heat and power); recovering materials from waste; some backfilling; and
- Disposal – landfill and incineration without energy recovery.

Preventing the generation of waste is the best possible option, and sending waste to landfill is the least desirable and as such, should be seen as the last resort.

1.1.2 EBRD requirements

The EBRD's project requirements, contained in the EBRD's environmental and social policy, relevant to this chapter, are as follows:

- PR3: Resource Efficiency and Pollution Prevention and Control – to avoid or, where avoidance is not possible, to minimise adverse impacts on human health and environment by avoiding or minimising pollution directly arising from projects and to identify project-related opportunities for waste reduction. Specifically, PR 3 Paragraph 11 emphasizes waste management and minimization strategies through the application of the waste hierarchy: avoid, reduce, reuse, recover, treat, and/or dispose of in an environmentally sound and safe manner.

1.1.3 EIB requirements

Standard 3 – Resource Efficiency and Pollution Prevention of the EIB Environmental and Social Standards (EIB, Environmental and Social Standards, 2022), outlines the promoter's responsibilities for ensuring an integrated approach to resource efficiency, pollution prevention and control of emissions, as well as waste management and the safe use of hazardous substances and pesticides, avoiding the shift of pollution from one environmental medium to another, ensuring consistency with the "Do Not Significant Harm" principle and thus contributing to the achievement of the "zero pollution" EU ambition target. The Specific requirements are applicable to all projects regardless of their location, unless specified otherwise:

- Reduce inefficiencies in the use of materials and substances or in the direct or indirect use of natural resources such as non-renewable energy sources, raw materials, water and land at one or more stages of the life cycle of products and assets, including in terms of durability, reusability, upgradability, reparability, recyclability or, where applicable, easy disassembly and adaptability of products and assets;
- Promote waste prevention, reuse and recycling in accordance with the waste hierarchy;
- Avoid activities that would lead to a significant increase in the generation, incineration or disposal of waste.

1.1.4 National Legislative Framework

Serbia's Law on Waste Management harmonizes with EU directives, covering waste types, management planning, entities, responsibilities, and obligations. It incorporates EU regulations on waste disposal, packaging waste, and Waste Electrical and Electronic Equipment. Specific regulations include managing hazardous waste, such as PCBs, asbestos, and others. The Regulation on construction and demolition waste management (No. 93/2023 and 94/2023) details procedures for collection, sorting, transportation, and storage, ensuring compliance with waste management laws. It mandates separate handling of hazardous construction waste and specifies transport requirements to prevent environmental harm.

The owner of construction and demolition waste (CDW) can treat construction and demolition waste independently or hand over the waste to an operator who has a permit for the treatment of this type of waste.

This regulation prescribes the types of treatment that will be used to treat all hazardous construction waste and demolition waste containing hazardous substances. The types of treatment are in accordance with the instructions for determining labels procedure of reuse (R) and waste disposal (D). Non-hazardous construction and demolition waste can be treated with reuse operations R1 to R12. Hazardous waste from construction and demolition can be treated by disposal operations D1, D5, D9, D10, D12, D13, D14 and D15 (Instructions for determining the markings of reuse (R) and waste disposal (D) procedures, 2010).

As an exception, construction and demolition waste, which is determined by the test report to be inert waste, can be used to cover landfills, if it meets the limit values of the parameters for disposal of inert waste.

1.1.5 International Conventions, Protocols and Standards

Serbia is a signatory to the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal. The Basel Convention regulates international hazardous waste movement and disposal to protect the environment and human health. Serbia became a signatory to the Convention in 2000.

2 BASELINE CONDITIONS

2.1.1 Area of Influence

The area of influence for the Waste and Materials chapter includes:

- Direct Influence: The project corridor, including construction sites, materials storage areas, and access roads where materials are sourced, handled, and stored, as well as locations where waste is generated, stored, treated, or disposed of during construction and operation.
- Indirect Influence: Surrounding areas affected by the transportation of materials and waste, including supply chains for material sourcing and routes for waste removal. This includes impacts on nearby communities, ecosystems, and infrastructure.

This ensures that impacts on baseline conditions for resource availability, waste management capacity, and environmental sensitivities within and beyond the railway's immediate footprint are considered.

2.1.2 Introduction

Baseline information was obtained through the acquisition and review of reports, documents, policies and general information relevant to waste management for the Project during construction and operation. Consideration of the following was made to characterise the baseline for the Proposed Project:

- Review of current waste management in Serbia including regional and local waste management facilities and practices;
- Review of the waste management practices of Serbian Railway Infrastructure (SRI);
- Overview of the management of Construction and Demolition Waste (CDW) and auxiliary components; and
- Review of construction waste management practices associated with international infrastructure projects.

2.1.3 Waste management in Serbia

As a part of the negotiations for accession to the EU, the RoS has begun the process of establishing a waste management system and adapting it to the EU goals based on the Waste Management Program in the RoS for the period 2022 - 2031 ("Official Gazette of RS", No. 30/18). Progress has been made in harmonising waste management regulations with the EU requirements, in institutional strengthening and reaching regional agreements for the establishment of joint waste management, as well as in the construction of a number of sanitary landfills.

The Law on Waste Management ("Official Gazette of RS", no. 36/09, 88/10, 14/16 and 95/2018 - other laws and 35/2023-68) defines the waste types, waste management planning, obligations and responsibilities regarding waste management, management of special waste streams, permission requirements and procedures, reporting, supervision and other relevant aspects of waste management. Waste management plans are regulated by the Law on Waste Management and all local government units are legally obliged to develop a waste management plan. The plan is intended to guide, develop and monitor waste management and represents a platform for engagement, information and communication with the public and other stakeholders. All plans are interconnected with national strategies and programs, as well as with the local waste management plan, local development plan and other relevant planning documents and public policies.

According to the National Waste Management Strategy, the closure and reclamation of existing landfills and the construction of 29 regional sanitary landfills are planned. So far, 12 sanitary landfills have been built, of which 10 are regional and 2 are local landfills. Sanitary landfills incorporate of modern and environmentally safe waste management technologies, in accordance with the Landfill Directive.

In the RoS, the infrastructure for recycling construction waste is underdeveloped, and reusing materials is the primary approach whenever possible. Currently, there is only one facility for processing waste from construction and demolition sites, located at the landfill complex in Vinča, Belgrade. This plant has a capacity of 200,000 tons per year and has been in operation since August 2021. It recycles construction waste and produces materials that can be used for road surfacing and similar applications.

The collection and disposal of construction and demolition waste (CDW) is subject to the polluter pays principle, which means that the waste producer is solely responsible for the legal and safe disposal (final disposal or recycling) of the waste generated. Mineral construction waste, as well as mixed construction waste, is mostly disposed on inadequate local landfills that are generally unsanitary and do not meet minimum technical standards.

In the case of large infrastructure works, a temporary location for a CDW landfill is agreed in between the project developer and the Contractor. The producer of CDW is obliged to draw up a construction and demolition waste management plan (Waste Management Plan), obtain approval for the Plan and organize its implementation, because the works are being carried out on a category G facility. The category refers to the Serbian Regulation on the Classification of Structures (*Pravilnik o klasifikaciji objekata*), according to which transport infrastructure facilities are categorized as 'Category G' structures. In Serbia, municipalities have a role in the approval and permitting of temporary landfills for CDW, even when established for large infrastructure works. The local municipality is responsible for local land use plans and any temporary landfill site must be located on land zoned or approved for such use. Even if the site is agreed between the developer and contractor, it must align with municipal spatial and urban plans.

Along with the request for the issuance of a permit for the removal of the facility, or part of the facility, the investor submits a decision on consent to the Waste Management Plan to the competent authority. Along with the request for issuing a decision on a construction permit, a special permit for the execution of preparatory works, a temporary permit and a permit for the execution of works, a decision on consent to the Waste Management Plan is submitted. For objects for which the construction permit is issued by the Ministry of Construction, Transportation and

Infrastructure of the RoS, consent to the Waste Management Plan is issued by the Ministry of Environmental Protection of the Republic of Serbia. [1]

There are also a large number of operators engaged in the reception, transport and treatment of different types of non-hazardous waste, which can be found on the SEPA website (SEPA, 2024). The list is provided in **Annex 1**.

In 2020, 79.45% of municipal waste was deposited in landfills and in RoS, only 15.45% of municipal waste was recycled. As such, landfills are essential for maintaining existing municipal waste management arrangements.

However, as existing landfills reach capacity, there are fewer sites available for waste disposal. There are currently four landfills in the vicinity of the Project that currently have capacity to accept CDW, namely Gigoš Landfill (Current capacity: 55,000 tons/year), Željkovac Landfill (Current capacity: 73,670 tons/year), Vinča (CDW plant) Landfill (Current capacity: 200,000 tons/year0 and Vrbak Landfill (Current capacity: 192,000 tons/year).

2.1.4 Waste management practices of ‘Serbian Railway Infrastructure’ (SRI) Joint Stock Company (a.d)

SRI generates waste as part of their operations but does not treat or permanently dispose of waste. SRI categorises the waste prior to temporarily storing and selling/handing over the waste to authorized operators. Based on Article 26 of the Law on Waste Management ("Official Gazette of RoS" No. 36/2009-115, 88/2010-170, 14/2016-17, 95/2018-267 - other laws, 35/2023- 68 and Article 24 of the Statute of the Public Railway Infrastructure Management Company "Railway Infrastructure of Serbia", Belgrade ("Official Gazette of RS", No. 60/15, 73/15)), the Board of Directors of SRI a.d. adopt the ‘**Waste Management Plan of the SRI a.d.**[2]. Based on the Law on Waste Management, the Executive Director appointed a person responsible for waste management by Decision No. 53/3-2020 dated 09.12.2020. The person is part of the Human Resources Sector, within the Environmental Protection Department, and is currently holding the position of Project Manager for a Project of Special Importance for the Railway

[1] RoSª (2023) Regulation on the manner and procedure of waste management from construction and demolition ("Official Gazette of the RS", No. 93/2023 and 94/2023 - corrected)

[2] SRI (2018) Waste Management Plan of the ‘Serbian Railway Infrastructure’ a.d., Belgrade

SRI is a well-established rail operator with systems in place for materials procurement and supply chain, and waste management across all its operations. The SRI Waste Management Plan (SRIWMP) relates to all waste management practices of the company and will be followed throughout the duration of the Project. The SRIWMP covers the following:

- Objectives and Methodology
- Legal Framework
- Types, Categories and Quantities of Waste During Operation
- The Procedure of Separating Different Types of Waste Particularly Hazardous Waste and Waste to be Reused in order to Reduce the Amount of Waste To be Disposed Of.
- Methods of Storage, Treatment and Disposal
- Environmental Protection
- Safety and Health at Work
- Fire and Explosion Protection Measures
- Implementation Plan and Improvement

The SRI WMP is dated 2018 and therefore although it is considered appropriate for the Project waste management requirements, an update of the SRIWMP is considered necessary (see Section 4 below). The SRIWMP states that an update is scheduled every three years, indicating that an update is overdue. It is understood that the process by which SRI deals with significant amounts of waste material can include public bidding, following consent from the Government of the Republic of Serbia. The public tender is published on the company's website https://infrazs.rs.

The waste streams generated by SRI as a result of their train operations and regular maintenance include various hazardous wastes such as batteries, waste steel accumulators, oils and oil impacted wastes (filters, rags, packaging, transformers), steel accumulators, fluo tubes and mercury tubes, railway sleepers and electronic waste. Non-hazardous waste streams include waste copper, tyres and waste track metal accessories (nuts, screws, couplings etc).

2.1.4.1 Anticipated Waste Streams to be generated by the Project

The waste streams that are expected to be generated from the Project are as follows:

Non-hazardous

- Shrubs and wood/ waste vegetation (cut trees, bushes, shrubs, branches etc.);
- Sand, gravel, crushed stone as a result of building construction;
- Soiled curtain material;
- Spoil: soil, sand, gravel, clay, loam, stone as a result of earthworks and excavation;
- Old ballast;
- Wood (pillars, remains of demolished buildings, etc.);

- Metal waste (rails, shavings, remains of installations, pipes, etc.);
- Rubble (remains of construction material);
- Packaging (plastic, wooden pallets, glass, foil, cardboard, paper, shavings, etc.);
- Concrete, bricks, mortar, gypsum, aerated concrete, natural stone as a result of building construction;
- Wood, plastic, paper, cardboard, metal, cables, and other mixed waste on the construction site as a result of other construction works.

Hazardous

- Wooden sleepers,
- bitumen (asphalt) or cement material,
- used batteries,
- asbestos,
- cooling oils,
- fuels and oils, grease for lubrication and repair of vehicles and machinery,
- paints, varnishes.

The Law on Waste Management (Official Gazette of the Republic of Serbia, No. 36/2009, 88/2010, 14/2016, 35/2023) allows for different types of hazardous wastes to be temporarily stored (in practice several months to a maximum of 1 year is tolerated), observing all the prescribed measures to protect against contamination, until they are handed over to a licensed waste operator. Failure to hand hazardous wastes over to a licensed operator within the prescribed time period may result in fines, environmental liability issues, damage to the reputation of the responsible person, or temporary suspension or restrictions on further construction activities.

Tables Table 2-1 and Table 2-2 show the existing warehouses, located in the Lapovo and Zaječar Station zones, where hazardous and non-hazardous waste can be temporarily stored on the territory of SRI a.d.in relation to the Project.

Table 2-1. SRI Warehouses of for temporary storage of hazardous and non-hazardous waste (Lapovo station zone)

Section	Warehouse number	Location	Organizational form
Lapovo	62	Lapovo	Lapovo (central warehouse)
	70	Lapovo	OC ZOP Lapovo, OJ railway section Lapovo
	72	Jagodina	OC ZOP Jagodina, OJ railway section Jagodina
	73	Paraćin Triangle	OC ZOP Paraćin, OJ railway section Paraćin
	74	Stalać	OC ZOP Paraćin, OJ railway section Stalać
	76	Aleksinac	OC ZOP Paraćin, OJ railway section Aleksinac

Section	Warehouse number	Location	Organizational form
	77	Despotovac	OC ZOP Paraćin, OJ railway section Svilajnac
	79	Paraćin	OC ZOP Paraćin, construction workshop
	80	Palanka	Sector ETP, OJ section SS Palanka
	81	Lapovo	Sector ETP, OJ section KM Lapovo
	83	Paraćin	Sector ETP, OJ section SS Paraćin
	84	Paraćin	Sector ETP, OJ section TT Paraćin
	86	Paraćin	Sector ETP, OJ section KM Paraćin

Table 2-2. SRI Warehouses of for temporary storage of hazardous and non-hazardous waste (Zaječar station zone)

Section	Warehouse number	Location	Organizational form
Zaječar	241	Majdanpek	Sector for construction works, OJ pruž. section Majdanpek Sector for construction works
	305	Zaječar	OC ZOP Zaječar (central warehouse)
	306	Svrljig-Matejevac	Sector for construction works, OC ZOP Zaječar, OJ railway section Matejevac
	311	Negotin	Sector for construction works, OC ZOP Zaječar, OJ section Negotin
	312	Bor	Sector for construction works, OC ZOP Zaječar, OJ railway section Bor
	318	Zaječar	OC ZOP Zaječar, OJ railway section Zaječar
	961	Zaječar	ETP sector, OC ETP Zaječar, OJ section JS
	962	Zaječar	ETP sector, OC ETP Zaječar, OJ section TT sector
	963	Zaječar	ETP sector, OC ETP Zaječar, OJ section SS
	304/999	Zaječar	Sector for train traction, OJ for train traction Zaječar, fuel and lubricant warehouse (central warehouse)

Currently, waste wooden sleepers are handed over to Elixir Group Prahovo, with which SRI has a contract, for further management (treatment). Approx. 17,000 tons of wooden sleeper waste was processed in 2022 and 8,000 tons processed in 2023. If testing determines that the sleepers are not contaminated, they can be re-used and installed on commuter railways. Also rails track that are not contaminated can be used for the same purposes. If they are shown to be contaminated, they will be treated as hazardous waste as outlined above. The capacity of the plant to accept to estimated number of dismantled railway sleepers requires confirmation. The details of the plant and confirmation that the sleepers can be treated at the facility should be included in the CWMP.

Elixir Prahov is working to obtain an IPPC permit for a new waste-to-energy plant by December 2026, when it will start operating. The new waste-to-energy plant will produce thermal energy through the thermal treatment of waste. The types of waste that can be accepted at the new site include are industrial, commercial and municipal waste streams that cannot be recycled, as well as some types of hazardous waste including wooden sleepers. The obtained thermal energy will be used to produce steam, which will be further used for the operation of industrial plants in Elixir Prahovo. The total capacity of the Plant is designed for the thermal treatment of 12.5 t/h of waste, i.e. 100,000 t/year, for 8,000 h per year, while the total capacity of the Plant's boiler will be 30 MW.

2.1.4.2 Materials used during construction

The following materials are anticipated to be required for the construction phase of the Project:

Non-hazardous

- natural gravel
- gravelly-sandy material
- crushed stones or rocks of various granulations used for ballast
- sand
- soil
- steel for rails, columns for walls for noise protection and reinforcement
- concrete for thresholds and other concrete constructions
- iron for fastening accessories
- material for making embankments of railway bodies
- materials for making the transition layer and the buffer layer
- materials to increase load capacity
- revision panes
- drainage pipes and other types of pipes

Hazardous

- bituminized aggregate, asphalt concrete for pavement construction at the approach to road crossings and station buildings, etc.
- cement
- additives for concrete
- Bitumen (for asphalt)
- fuels/oils
- lubricants
- paint

Materials obtained from the demolition of existing embankments will, where possible, be reused or selectively separated for use in constructing new embankments subject to geotechnical supervision and construction phase on-site testing to confirm material quality (discussed further in Sec. 2.1.5 below).

The Contractor can obtain suitable granulated gravel from borrow pits or buy them on the market from licensed vendors. Should the Contractor opt for their own borrow pit, they will have to obtain valid operational licenses and valid Environmental and Water Permits, which will guarantee that their work complies with Serbian environmental and water regulations, and they will be subject to supervision from licensed environmental and water management inspectors.

2.1.5 Management of Construction and Demolition Waste (CDW)

During the construction phase, the type and scope of works required are expected to include excavations, concreting, assembly works, and the transport of materials and equipment, which will determine the types and quantities of waste generated. At this stage of the Project, the exact handling and management plans for spoil (the predominant waste stream expected from the construction phase) are unknown. A Construction Waste Management Plan (CWMP) that will be developed by the principal contractor, will include for the management of CDW and will be based on confirmed design calculations and a better understanding of the potential for reuse of inert and non-hazardous waste generated. As stated in the SRIWMP (discussed in Sec 2.1.4 above), there is a procedure that requires waste segregation as much as possible to identify waste materials that can be reused, thereby reducing the amount of waste to be disposed of.

Based on previous experience of railway construction and development by SRI, it is anticipated that at this stage of the Project, approximately 90%[3,4,5,6] of construction waste will be inert (shrubs and trees from clearing vegetation, earth and stones from excavations, ballast, plaster, broken concrete, iron, steel, metals, wood, plastic, paper, etc.). The removal of trees and shrubs will be undertaken by the competent (local) forestry authority. Excess material

[3] CCME (2019) Guide for identifying, evaluating and selecting policies for influencing construction, renovation and demolition waste management, Canadian Council of Ministers of the Environment, pp 21-22

[4] EPD (2020) Introduction to Construction Waste, What is Construction Waste? Environmental Protection Department, The Government of the Hong Kong https://www.epd.gov.hk/epd/misc/cdm/introduction.htm

[5] Waste management, Waste Type Classification https://www.epd.gov.hk/eia/register/report/eiareport/eia_2832022/HTML/Section_6.htm

[6] BMTPC (2018) Utilisation of Recycled Produce of Construction & Demolition, Waste Building Materials & Technology Promotion Council, Ministry of Housing & Urban Affairs Government of India, New Delhi, India

generated from excavations during construction activities (i.e. spoil) will be disposed of on the temporary construction waste landfills, which will be designed and operated for this purpose further to an agreement between SRI and the Contractor.

It is anticipated, also based on previous earthworks undertaken by SRI, that excavated spoil reuse will be considered for embankment use. Given the anticipated volumes of spoil removal and material requirement for new embankments (see Table 3-7 below), there is anticipated to be a deficit and a requirement for the import of material for the construction phase. There is also the potential for spoil to be sourced from other nearby infrastructure projects (not known at this time). Should the spoil excavated as part of the Project not be considered suitable for use on Project embankments, other possibilities for utilisation can be found, in cooperation with the local authorities. Possible options are environmental mitigation earthworks fill for this Project, or construction material / flood protection bund material in other projects. Part of the material is likely to be used for the construction of the access roads. Topsoil (up to 0.4 m thick) and agricultural subsoil will be stripped and temporarily stockpiled in dedicated areas for later use (restoration, landscaping, etc).

A relatively small proportion of waste (approximately 5%) will be hazardous. This is expected to include, asphalt binder or waste containing asbestos, asbestos insulation materials (from the demolition and reconstruction of buildings at railway stations), and wooden sleepers.

The current waste management practice in SRI (as stated in the SRIWMP) is that waste from decommissioned railways is re-used as much as possible and re-installed on minor (local service) railways. It is likely that the tracks will be mainly reused. Part of the sleepers will certainly not be possible to recover and as they are likely to be contaminated by fungicides, oil, diesel residuals, etc., and therefore, they should be considered hazardous waste and managed accordingly. SRI has a clear recognition of the environmental and health hazards associated with creosote-treated wooden sleepers due to the presence of toxic and carcinogenic compounds, including polycyclic aromatic hydrocarbons (PAHs) (waste code 17 02 04*). SRI currently disposes of old sleepers at the Elixir Prahovo plant. It is understood that SRI will arrange for the wooden sleepers to be recycled by the operator that can provide appropriate waste collection, transportation and treatment/storage permits as well as favorable capacities for the admission of planned quantities. For the purposes of this assessment, this is considered to be Elixir Prahov but this should be confirmed in the CWMP. There is also the potential for the works to encounter asbestos-containing materials (ACM) during the construction of the station in Lapovo. As per the SRIWMP, all Asbestos will be dealt with in accordance with specific regulations, such as the "Regulation on handling waste containing asbestos “Official Gazette of RS No. 75/2010”. These regulations provide guidelines for safely managing asbestos-containing waste to minimize health risks and environmental contamination.

A relatively small amount of municipal waste (up to 5%) is produced by employees. Municipal waste generated on construction sites during construction is approximately the same as waste material generated in households (food, packaging, office waste, sanitary waste). SRI has already established the Waste Material Management Procedure (number 300/2011-981), according to which it is required that for each section of the route, a temporary location for the storage of materials and equipment for the storage of municipal waste and regular removal by public companies in which is in possession. Municipal waste is generated during both the construction and operation phases of the project.

Table 2-3 shows the non-hazardous waste types that are expected to be generated during the construction of the railway, classified by group from the Waste Catalogue[7]. Table 2-4 shows the equivalent information for hazardous waste.

Table 2-3. Categorization of non-hazardous waste that is expected to be generated during the construction of the railway

Code	Waste
15 00 00	Waste packaging - absorbents, wiping cloths, filter materials and protective clothing not otherwise specified
16 00 00	Wastes not otherwise specified in the list
17 00 00	CDWs (including excavated soil from contaminated sites)
20 00 00	Municipal wastes (household waste from worker accommodation and similar commercial) including separately collected fractions

Table 2-4. Categorization of hazardous waste that is expected to be generated during the demolition and construction of the railway

Code	Waste
17 05 03*	Contaminated soil and stones
17 02 04*	Glass, plastic, and wood containing or contaminated with hazardous substances (This code applies to wood waste that has been treated with hazardous substances, such as creosote oil, which is commonly used to preserve railway sleepers)
17 06 05*	Construction materials containing asbestos
17 04 09*	Metal waste contaminated with hazardous substances
17 03 01*	Bituminous mixtures containing coal tar
13 05 08*	Contaminated ballast (e.g., oil or chemicals)
15 01 10*	Packaging containing hazardous substances
16 01 07*	Oil filters
20 01 21*	Fluorescent tubes and other mercury-containing waste

[7] RoS (2024) Regulation on categories, testing and classification of waste ("Official Gazette of RS" No. 56/2010, 93/2019, 39/2021 and 65/2024)

13 02 08*	Other engine, gear, and lubricating oils
16 02 13*	Discarded equipment containing hazardous components (e.g., electrical components with PCB)

The categories of waste that are expected to be generated during the operation of the railway are given in Table 2-5, (classified by group from the Waste Catalogue).

Table 2-5. Categorization of waste that will be generated during the operation of the railway

Code	Waste	Hazardous/Non-Hazardous
08 00 00	Wastes from the manufacture, formulation, supply, and use (MFSU) of coatings (paints, varnishes, vitreous enamels), sealants, and printing inks	Hazardous
13 00 00	Oil wastes and wastes of liquid fuels (except edible oils, 05 and 12)	Hazardous
15 00 00	Waste packaging - absorbents, wiping cloths, filter materials, and protective clothing not otherwise specified	Can be hazardous or non-hazardous depending on contamination
19 00 00	Wastes from waste management facilities, and the preparation of water intended for human consumption and water for industrial use	Can be hazardous or non-hazardous depending on the source
20 00 00	Municipal wastes (household waste and similar commercial, industrial, and institutional wastes) including separately collected fractions	Non-Hazardous (in general, unless contaminated)

2.1.6 Auxiliary components: signalling systems, transformers and substations

Since the document ***Waste Management Plan of SRI a.d. Belgrade, March 2018 (SRIWMP),*** does not specifically address waste from auxiliary components such as signalling systems, transformers, and substations, this Chapter will briefly present the procedure for managing these components as a distinct waste category. This category includes various types of waste, both hazardous and non-hazardous. In the aforementioned plan, these components are only mentioned in Table 2-1: Lists of waste generated in SRI a.d. In this table, old transformers with the index number 20 01 35* are recorded as having been collected in 2017 in a total quantity of 0.815 tons, which accounts for only 0.71% of the total hazardous waste collected in that year. It is considered that the SRIWMP requires updating to include for these components since they contain hazardous materials (See Section 4).

2.1.6.1 Storage Practices at SRI a.d.

At SRI a.d., fenced storage areas in open spaces are used as temporary storage for old (non-functional) energy transformers, including 25/0.22 kVA power transformers, 110 kVA voltage measuring transformers, and current measuring transformers. Storage facilities must be equipped with specialized equipment for storing hazardous waste including mobile tanks for transformer oil, emergency response equipment (e.g., oil and chemical absorbents such as absorbent socks, absorbent mats, and absorbent snakes), plastic bags and plastic sheeting, and Personal Protective Equipment (PPE). Additionally, the storage area must display fire hazard warnings to ensure compliance with safety regulations.

2.1.7 Waste and materials Overview

The generation of construction waste can be due to various activities/issues that are highlighted in relevant literature, with different levels of significance and impact. Alhawamdeh (2020) gives a synthesis of the overview of this research, with the Project phases each resulting in the causes of CDW and errors that occur across the design, procurement, materials handling and on-site operations.

Table 2-6. Common Causes of CDW Generation in Construction Projects (Alhawamdeh 2020)

Project phase	Causes of CW	Reference
Design	- Errors in contract documents - Blueprint errors - Detailing errors - Design changes - Complexities in design - Poor coordination and communication (late information, last minute client requirements, slowdrawing revision and distribution) - Unclear/unsuitable specification	Nagapan et al. (2012c),Ajayi and Oyedele (2018a), Nursin et al. (2018), Akinade et al. (2018), Osmani (2008, 2013), Banihashemi et al. (2018), Polat et al. (2017),Al-Hajj and Hamani (2011).
Procurement	- Shipping errors/ suppliers' error - Ordering errors - Late/incorrect timing of deliveries - Leftovers due to over estimation - Packaging materials - Incorrect quantity estimation - Use of low-quality materials	Nagapan et al. (2011), Mahamid and Elbadawi (2014), Ajayi and Oyedele(2018b), Ajayi et al. (2017b), Kolaventi et al. (2020), Ajayi (2020), Kern et al. (2015).
Handling of materials	- Improper storage/deterioration - Improper handling (off-site and on-site) - Materials supplied in loose form	Mahamid and Elbadawi (2014), Nagapan et al. (2011), Oko and Emmanuel (2013), Najafpoor et al. (2014).
On-site operations	- Rework due to errors - Improper project planning - Equipment malfunctions - Use of incorrect material - Poor workmanship - Leftovers from cutting and shaping/ materials off-cuts - Poor site conditions - Poor supervision - Lack of waste minimisation plans	Udawatta et al. (2015), Al-Hajj and Hamani (2011) Bekr (2014), Al-Rifai and Amoudi (2016), Osmani etal. (2006), Arshad et al. (2017), Polat et al. (2017),Oko and Emmanuel (2013), Kolaventi et al. (2020), Muhwezi et al. (2012), Patil and Pataskar (2013).
Others	- Poor weather conditions - Environmental disasters - Accidents - Theft and vandalism	Bekr (2014), Karunasena and Amaratunga (2016), Domingo and Luo (2017), Muhwezi et al. (2012), Vasconcelos and Junior (2015).

Table 2-7 shows data on the quantities of components of railway track that are scheduled for removal, or for installation. Data on quantities were obtained on the basis of the currently developed technical documentation for the Project (Conceptual design).

Table 2-7. Components of the railway track intended for removal, or for installation

Removal		Installation	
Type of components	**Quantity**	**Type of components**	**Quantity**
Subsection Paraćin-Stalać			
Rails	96 982 m	Rails	96 982 m
Sleepers	80 819 pcs.	Sleepers	80 819 pcs.
Fastening accessories	323 276 pcs.	Fastening accessories	323 276 pcs.
Turnouts	41 pieces	Turnouts	41 pieces
Gravel	328 000 m^3	Gravel	328 000 m^3
Subsection Đunis-Trupale			
Rails	173 890 m	Rails	172 100 m
Sleepers	144 909 pcs.	Sleepers	143 418 pcs.
Fastening accessories	579 636 pcs.	Fastening accessories	573 672 pcs.
Turnouts	90 pcs.	Turnouts	89 pcs.
Gravel	594 000 m^3	Gravel	587 887 m^3
Total Section 3 Paraćin – Trupale (Niš)			
Rails	270 872 m	Rails	269 082 m
Sleepers	225 728 pcs.	Sleepers	224 237 pcs.
Fastening accessories	902 912 pcs.	Fastening accessories	896 948 pcs.
Turnouts	131 pcs.	Turnouts	130 pcs.
Gravel		Gravel[i]	915 887 m^3

Table 2-8. Materials that should be removed and materials needed for railway construction

Removal		Construction	
Material	**Quantity**	**Material**	**Quantity**
Excavation (soil removal) on the open railway	65 291 m^3	Embankment	742 201.6 m^3
		Concrete – lower part of railway infrastructure	18 202 m^3
		Gravel	131 516 m^3

At the time of this assessment, it is unconfirmed whether the estimates provided in Table 2-8 include spoil generated from tunnel construction. Although the spoil generated from excavation works will likely be inert and non-hazardous, the volumes are expected to be considerable. The approved main contractor will be required to include for the appropriate management of the spoil in the CWMP following detailed design estimates.

General estimates of specific types of materials that will be required for construction can be provided based on standard practices and available data as follows:

- Subgrade and Subbase Materials:
    - Subbase material estimates are approximately 250 m^3 per kilometer[12].
    - For 58 km, this equals 14,500 m^3.
- Additional Materials:
    - These include fastenings, signalling equipment, and other infrastructure components, which are project-specific[13].

Table 2-9. Total estimated waste generation during the construction phase

Material Type	Demolition (tons)	Construction (tons)	Total Waste (tons)
Metal (Rails, Rebar)	16,297.32	1,681.77	17,979.09
Wood (Sleepers)	15,800	-	15,800 (treated at Elixir Prahovo)
Concrete & Brick	1,425	6,607.09	8,032.09
Railway Ballast	516,320	19,233.62	535,553.62
Miscellaneous (Plastic, etc.)	-	75	75
Total	549,842.32	27,597.48	577,439.80

3 ASSESSMENT OF POTENTIAL IMPACTS

This Section is focused on the assessment of potential impacts resulting from the generation and management of waste and the management and consumption of materials during the Construction and Operational Phases of the Project. The impacts associated with each phase will be specific to the environmental and socio-economic context, spatial and temporal aspects of the railway. The potential impacts associated with waste will primarily be associated with poor management practices, which could result in waste materials and substances escaping into the surrounding environment, impacting upon soil, groundwater, surface water, air quality, flora and fauna and people.

Potential impacts resulting from waste and materials include:

Waste

- Impacts on the environment from waste arisings and potential poor handling; and
- Nuisance and health impacts on humans from loose waste, odour, dust and vermin.

Materials

- Impacts on the environment from over consumption and supply chain issues.

Assumptions and limitations

In contrast to the other environmental and social technical disciplines assessed within this ESIA Report, the assessment of impacts is considered part of the Project design, and as such it is not realistic to consider any situation in which no mitigation would be carried out.

The assessment relies on regional and national data to understand material availability, acknowledging limitations in the data, particularly regarding estimated quantities required, to identify potential significant effects. Similarly, the assessment considers the impacts on national waste management infrastructure, considering limitations in the availability of information, particularly regarding estimated waste volumes, to determine potential significant effects.

The basic assumption for materials procurement is that they will be procured from Serbia, from domestic producers, provided that they meet the conditions in terms of quality, quantity and delivery. However, the availability of data for material resource trends and waste recovery is limited in RoS, and not available at a regional level. National waste baseline data has been produced for the year 2022.

During the construction phase, given that a site-specific assessment has not been undertaken in terms of the sensitivity of the environment and humans (e.g. locations of critical habitats, locations of settlements in relation to the waste generation, storage and transportation routes etc), the impact assessment is therefore based on the worst-case scenarios and the sensitivity grade will be ‘very high’. Mitigation during the construction phase will subsequently define 'no-go zones' that prohibit waste being stored on or disposed of where impacts would occur to very high sensitivity receptors.

It is also considered that railway sleepers are viewed as potential construction materials by the general public and therefore potentially either offering to purchase sleepers or obtaining them by other means (bribery or theft) must be addressed and managed carefully during the works. Former railway sleepers are considered as hazardous waste due to the creosote content and therefore pose health risks to humans if used as construction materials.

3.1.1 Impact Assessment Methodology

The standard methodology for assessing the Waste and Materials impacts of the Project is outlined in Chapter 5 of this ESIA. Any deviations from this methodology are outlined in the following Sections of this Chapter.

Key design information collected and analysed to inform this assessment included:

- The type of materials that will be used during the Project, including details of any content recycled material.
- The type of waste that will be generated as a result of Project activities, with details of the planned recovery and/or methods of disposal (e.g. on-site reuse, off-site recycling, landfill).
- The cut and fill balance.
- Details of any materials to be specified, where sustainability credentials (particularly those that improve resource efficiency) afford performance beyond expected industry standards.

3.1.2 Magnitude

The definition of the magnitude of impacts relating to waste arisings on the environment and humans is outlined in Tables Table 3-1 and Table 3-2 respectively.

Table 3-1. Definition of Magnitude for Waste Arisings into the Environment

MAGNITUDE	Definition	GRADE
Low Impact	Slight short-term exceedances of permissible pollutant levels with no long-term impacts and reversible.	1
Moderate Impact	Moderate exceedances of permissible pollutant levels with no long-term impacts and reversible with mitigation.	2
Severe Impact	High levels of contamination with pollutant levels exceeding permissible levels requiring longer term remediation.	3
Very Severe Impact	Severe and irreversible degradation of the environment, making it unfit for its original use.	4

Table 3-2. Definition of Magnitude for Waste Arisings on Humans

MAGNITUDE	Definition	GRADE

Low Impact	Minor nuisance and health effects e.g. some intermittent odour and dust, and small noticeable visual impacts.	1
Moderate Impact	Moderate nuisance and health effects e.g. daily intermittent odour and dust, intrusive visual impacts.	2
Severe Impact	Major nuisance and health effects e.g. constant unpleasant odour and dust, large visual impacts.	3
Very Severe Impact	Extreme nuisance and health effects e.g. unbearable odour and dust and visual impacts.	4

3.1.3 Sensitivity

For the purposes of this assessment, the sensitivity of environmental and social receptors as outlined in Chapter 5 are applicable. Receptors considered sensitive to changes in waste management practices are as follows:

Table 3-3. Receptors considered sensitive to changes in waste management practices

Sensitive Receptors		Justification
Type	**Description**	
Natural Environment	Soil, Air, Water Resources	Improper and inadequate management or disposal of waste, during the Project construction and operation can potentially result in pollution of the natural environment.
Humans	Local communities and workers	Nuisance and health impacts from the improper and inadequate management or disposal of waste including disturbance of workforce and nearby communities due to vehicle movements. Also includes visual impacts.

It should be noted that as it has not been possible to undertake a site-specific assessment in terms of the sensitivity of the environment and humans (e.g. locations of critical habitats, locations of settlements in relation to the waste generation, storage, disposal and transportation routes etc.), the impact assessment for the construction phase (in Sections 3.2.1 and 3.2.2) are therefore based on the worst case scenarios and the sensitivity grades are allocated as ‘very high’.

3.2 Construction Phase Impacts

The construction phase will involve the placement of new sections of rail track, the construction of 12 replacement bridges plus one new bridge, 2 new viaducts, 11 overpasses and 19 underpasses and the Đunis tunnel. These will all require the construction of embankments. The construction phase will also necessitate the removal of old rail track sections and embankments, the demolition of 12 existing bridges and the excavation of cuts, the tunnel and underpasses resulting in the generation of waste, the majority of which will be inert (as discussed in the Baseline Section).

Initial quantitative waste arising estimates have been provided by SRI, with more detailed estimates for each waste stream to be included in the Construction Waste Management Plan. Waste streams for which high quantities of waste are anticipated to be produced comprise excavated soil and organic material (shrubs, vegetation) during excavations and site clearance.

The potential impacts arising from the generation of construction and demolition wastes include:

- Impacts on the environment from waste arisings and poor handling; and
- Nuisance and health impacts on humans from loose waste, odour, dust, visual intrusion and vermin.

Materials required for the Project construction phase are not considered to be in limited supply, and it is not expected that their consumption will result in the depletion of natural resources. Requirements for gravel will be met locally from borrow pits, thereby reducing the need for third party suppliers and longer transport routes. Impacts resulting from the requirement for materials for the Project are therefore limited to:

- Impacts on the environment from over consumption and supply chain issues.

3.2.1 Impact on the Natural Environment from Waste Arisings and Potential Poor Handling

The generation of non-hazardous waste will occur as part of the construction phase, as outlined in Section 2.1.7. Although the hazardous fraction of construction waste such as used oil, machinery lubricants and paints, etc. will represent a very small proportion of the total amount of construction waste, it will require special attention for management and disposal. Further, the management of dismantled railway sleepers must be considered a priority due to their perceived value as a construction material by the general public local to the railway lines.

3.2.1.1 Magnitude

Anticipated waste volumes are large, given the scale of the Project. The majority of the waste generated will be inert or non-hazardous, and likely to be reused elsewhere in the Project. However, the Project will also generate sufficient volumes of hazardous waste that, without adequate management, are expected to result in permissible pollutant levels in soils, ground/surface waters being exceeded. As such, the magnitude of the impact is considered to be moderate (2).

3.2.1.2 Spatiotemporal impact (Spatial Extent and Duration)

The impact will range between very localized and regional, depending on the locations chosen for temporary storage and disposal of waste (which may be beyond the Project construction sites) and short-term (less than 5 years) during the construction phase. As such, this impact is considered to have a 'spatiotemporal' grade of 2.

3.2.1.3 Sensitivity

Waste impacting the environment due to poor handling could potentially result in the creation of open and unsanitary landfills that are a common feature across Serbia and additionally could result in direct contamination of soils and surface/groundwaters from leachate and/or run-off, or spills/leaks of hazardous liquid wastes. As the locations for the temporary storage and disposal of waste and hazardous waste are not known at the time of this assessment, a worst-case scenario has been assumed whereby the impacted environmental components could have very high value, be extremely rare or protected, or are unable to be substituted. The sensitivity of the receptor is therefore assessed to be very high (grade 4).

3.2.1.4 Likelihood

It is anticipated that the approved principal contractor for the Project will be required to demonstrate that they meet minimum standards in terms of waste handling and management. However, given the complexity of the construction phase, there remains the possibility for poor handling of wastes to occur (see Table 2-6 above). The likelihood is therefore graded as 3.

The assessment of the significance of the impact of waste arisings and poor handling on the environment during the construction phase of the Project is summarised in the following Table:

Table 3-4. The significance of the impact of waste arisings and poor handling on the environment

Receptor	Magnitude	Spatio-temporal impact	Sensitivity	Likelihood	Overall significance
Environment	The construction phase will generate hazardous waste that will result in contamination of soil/water resources unless adequately managed. (2)	Waste will be generated throughout the construction phase, which will be for approximately 3 years. (2)	There is the potential for high value or rare environmental components to be impacted. (4)	The impact is likely to occur without mitigation. (3)	M (2) + ST (2) + S (4) + L (3) = 11 *High*

3.2.2 Nuisance and Health Impacts on Humans

The improper and/or inadequate storage and/or disposal of waste during the Project construction phase can result in nuisance and health impacts on human receptors including the workforce and communities due to loose waste, odour, dust, vermin, visual intrusion etc. as well as the potential use of dismantled railway sleepers by locals.

3.2.2.1 Magnitude

It is not known at the time of this assessment where waste will be temporarily stored, or disposed of, and the anticipated volumes of waste that will be generated during construction are large. However, as the majority of the waste will be inert or non-hazardous, and likely to be reused elsewhere in the Project, the magnitude of the impact, is considered to be moderate (grade 2) as any remaining poorly stored waste on construction sites/camps, or waste being disposed of in unformal, open landfills is only predicted to result in intermittent nuisance effects to human receptors including odour, dust and visual intrusion.

3.2.2.2 Spatiotemporal impact (Spatial Extent and Duration)

The impact will range between very localized and regional, depending on the locations chosen for temporary storage and disposal of waste (which may be beyond the Project construction sites) and short-term (less than 5 years) during the construction phase. As such, this impact is considered to have a 'spatiotemporal' grade of 2.

3.2.2.3 Sensitivity

As the locations for the temporary storage and disposal of waste and hazardous waste are not known at the time of this assessment, a worst-case scenario has been assumed whereby there could be nuisance impacts on human receptors from loose waste, dust, odour, the increased presence of vermin, or visual intrusion that are already vulnerable and/or have no capacity to adapt to changes in baseline conditions. The sensitivity of the receptor is therefore assessed to be very high (grade 4).

3.2.2.4 Likelihood

It is anticipated that the approved principal contractor for the Project will be required to demonstrate that they meet minimum standards in terms of waste handling and management. However, given the complexity of the construction phase, there remains the possibility for poor handling of wastes, potentially including small quantities of hazardous waste, to occur (see Table 2-6 above), including the unauthorized use of dismantled sleepers by locals considering them as potential building materials. The likelihood is therefore graded as 3.

The assessment of the significance of nuisance impacts on humans during the construction phase of the Project is summarised in the following Table:

Table 3-5. The significance of nuisance and health impacts on humans

Receptor	Magnitude	Spatio-temporal impact	Sensitivity	Likelihood	Overall significance
Humans	A large proportion of waste (spoil) is likely to be reused. Any remaining poorly managed waste will result in intermittent nuisance impacts. (2)	Waste will be generated throughout the construction phase, which will be for approximately 3 years. (2)	There is the potential for impacts to already vulnerable receptors who do not have the capacity to adapt to changes due to the poor management of waste. (4)	The impact is likely to occur without mitigation. (3)	M (2) + ST (2) + S (4) + L (3) = 11 *High*

3.2.3 Impacts on the environment from over consumption and supply chain issues

The construction phase requires the intensive use of raw materials such as aggregates, metals, wood, and concrete. The anticipated volumes of materials required (see Sec 2.1.7 above) will require efficient management and use of resources and management of supply chains to ensure the sustainability of materials.

3.2.3.1 Magnitude

Intensive material consumption can potentially lead to resource loss and/or the depletion of natural reserves, resulting in environmental disruption. However, the raw materials required for the Project are considered to be easily available and their supply is not limited. As such the impact is not expected to result in long term or irreversible impacts or any environmental degradation (grade 1).

3.2.3.2 Spatiotemporal Impact (Spatial Extent and Duration)

The impact is regional (materials are expected to be supplied as locally as possible) and short term (less than 5 years. The spatiotemporal impact is therefore 2.

3.2.3.3 Sensitivity

Given that the majority of raw materials required for the Project, whilst having some value, are relatively common, and it is assumed that there is the potential for them to be substituted, the sensitivity of the receptor is considered to be Moderate (grade 2).

3.2.3.4 Likelihood

There may be some supply chain issues that are out of the control of the Project and therefore the likelihood is considered to be grade 2.

The significance of the impact of material over consumption and supply chain issues on the environment during the construction phase of the Project is summarised in the **Error! Reference source not found.** below.

Table 3-6. Significance of impact of material over consumption and supply chain issues during the construction phase

Magnitude	Spatio-temporal impact	Sensitivity	Likelihood	Overall significance
The materials required for the Project are in good supply (1)	The impact is assessed as regional and short-term. (2)	Raw materials required for the Project are moderately common and there is the potential for substitution. (2)	The impact is likely to occur intermittently (2)	M (3) + ST (2) + S(2) + L(3) = 7 *Low*

3.3 Operational Phase Impacts

In the operational phase of the Project, waste will also be generated as a result of railway facilities maintenance and the operation of stations. These include metal waste, packaging contaminated with hazardous substances, greasy cloths, municipal waste and packaging waste etc. Track maintenance waste and ancillary infrastructure waste can be expected along the route and their quantities will depend on the maintenance activity. Waste will be removed from the route immediately upon completion of the work.

During the long-term operation phase, the project will require ongoing material inputs. However, annual volumes of materials requirements will be significantly lower than during the construction phase and more in line with the current requirements of the existing railway infrastructure. As such, there are considered to be negligible impacts from materials consumption during the operational phase, which are expected to be in line with current, baseline material requirements that are not considered to have an impact on environmental receptors. Supply chains are established and there are no issues sourcing materials required to sustain operations.

Furthermore, given that the Project will continue to be managed by SRI and the new areas of railway infrastructure are not significantly different from the existing infrastructure in terms of waste management, management of wastes will revert to the current operational management procedures identified in SRI's existing Waste Management Plan (SRIWMP).

The following potential impact from the generation and management of waste during the operational phase has been assessed:

- Degradation of the natural environment resulting from poor waste management practices.

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3.3.1 Degradation of the Natural Environment from Poor Waste Management

3.3.1.1 Magnitude

The magnitude of this impact is considered low (grade 1), as waste volumes will be similar to those currently being generated during the operation of the railway, and the existing waste management practices adopted by SRI in accordance with the SRIWMP will continue.

3.3.1.2 Spatiotemporal Impact (Spatial Extent and Duration)

Waste, albeit at relatively low volumes, is expected to be generated continuously throughout the operation phase, over the long term, and throughout the wider Project area (Grade 3).

3.3.1.3 Sensitivity

SRI's Waste Management Plan will ensure that waste is not stored or disposed of, in a way or at locations that would result in environmental degradation, in accordance with the Law of Waste Management. As such, the sensitivity of the receptor is assessed as being low (grade 1) as it is assumed that waste generated during the operation phase will not impact on any environmental components of more than low value or rarity, or which have any important or unique uses or features.

3.3.1.4 Likelihood

Based on the expectation that waste management will continue to be managed effectively by SRI during the operational phase, in accordance with their existing Waste Management Plan, the likelihood of the impact is considered to be (Grade 1), i.e. have a low probability of occurring.

The assessment of the significance of the impact of degradation of the natural environment resulting from poor waste management practices during the operation phase of the Project is summarized below:

Table 3-7. The significance of the impact of degradation of the natural environment resulting from poor waste management during the operation phase

Magnitude	Spatio-temporal impact	Sensitivity	Likelihood	Overall significance
Waste volumes generated and waste management practices	Waste will be generated throughout the	Operational waste will be managed in accordance with the SRIWMP and not impact	Operational waste will be managed in accordance with the SRIWMP, which	M (1) + ST (3) + S(1) + L(1) = 6 Low

are not expected to differ from baseline operational conditions (1)	opertion phase and the wider project area. (3)	on any valuable, rare or important environmental components. (1)	is effective in preventing environmental degradation (1)	

3.4 Summary of Impacts

Table 3-8. Summary of significance of construction and operation phase waste and materials

Project phase	Impact	Positive/Negative	Overall significance before mitigation measures are implemented
Construction Phase	Impacts on the environment from waste arisings and poor handling	Negative	High
	Nuisance and health impacts on humans	Negative	High
	Impacts on the environment from over consumption and supply chain issues	Negative	Low
Operation Phase	Environment – degredation of the natural environment as a result of poor waste management	Negative	Low

4 MITIGATION MEASURES

4.1 Construction Phase

Waste mitigation measures proposed for the construction phase are aimed at protecting sensitive receptors (i.e. humans and the environment). The mitigation measures provided refer to both non-hazardous and hazardous wastes. Whilst some mitigation measures are specific to ether non-hazardous or hazardous waste streams many measures are applicable to both and therefore this section does not consider these measures separately, unless specified.

In order to minimise the impacts resulting from waste generation during the construction phase, the total amount of construction waste generated must be reduced to the greatest extent possible.

It is assumed that SRI will require the Main Contractor to minimise the waste generated from the construction activities where practicable, and that waste management measures that facilitate the re-use and recovery of excavated material and diversion of waste from landfilling in line with the waste hierarchy (prevention, re-use, recycling, recovery, and disposal) will be expected.

The Main Contractor will develop a **Construction Waste Management Plan (CWMP)** to cover all activities associated with the generation, storage, handling and transport and disposal of waste during the construction phase and to maximise the reuse and recycling of waste products. The CWMP should also include specific mitigation measures that must be implemented during decommissioning of the existing railway (where applicable), and for the management of construction spoil. The Plan should confirm the specific types and quantities of waste likely to arise during the construction process, including at least municipal and construction waste; as well as excavated, construction and demolition materials.

The following table defines the mitigation measures proposed to mitigate the identified impacts on the environment and humans, which should as a minimum be included in the CWMP to be developed and implemented by the Contractor.

Table 4-1. Proposed Waste Mitigation Measures during Construction

Impact	Mitigation measures
Waste Arisings and Poor Management	▪ The contractor must define No-Go Zones' where the establishment of waste disposal or temporary storage sites is strictly prohibited. These zones must include all biodiversity protected areas (including nationally and internationally designated sites), officially designated groundwater protection zones, and a buffer zone of at least 50 meters from surface water bodies. In addition, areas in close proximity to sensitive social receptors, such

	as schools, healthcare facilities, and residential zones, must be covered by the 'avoidance zones' due to potential health, safety, and nuisance impacts.
	▪ Given that the local municipality is responsible for local land use plans, any temporary landfill must be located on land zoned or approved for such use. Even if the site is agreed between the developer and contractor, it must align with municipal spatial and urban plans.
	▪ Should the main Contractor opt for their own borrow pit, they must obtain valid operational licenses and valid Environmental and Water Permits, which will guarantee that their work complies with Serbian environmental and water regulations, and they will be subject to supervision from licensed environmental and water management inspectors.
	▪ The SRIWMP should be updated and should include for the management of signalling systems, transformers and substations that are considered to contain hazardous materials. This must be managed according to appropriate legislation.
	▪ The majority of excavated material that will be generated must be reused, if suitable, either as engineering fill material or in the environmental mitigation earthworks of the project;
	▪ Opportunities must be sought for the appropriate utilisation of surplus excavation material or material not suitable as engineering fill, e.g. regional construction projects, flood protection, etc.
	▪ Decommissioned rails must be stored prior to disposal in a designated area with the following measures:
	  ▪ Impermeable surfaces; use of concrete pads or similar impermeable bases to prevent contamination migration into soil and groundwater
	  ▪ Containment systems: Include bunds or barriers around storage areas to capture runoff
	▪ Any removal of waste from site will be done by licensed sub-contractors in compliance to the Serbian regulatory requirements on transfer, treatment and disposal of waste and accompanied with appropriate documentation.
	▪ An immediate spill response protocol must be developed to address the accidental spillages of hazardous liquid waste and must be included in the CWMP.
	▪ Material Safety Data Sheets to be provided and easily available wherever hazardous waste is being stored.
	▪ Hazardous waste storage areas to be clearly labelled as such, well-lit and ventilated, have an impermeable floor, be covered and lockable and hazardous waste containers to be clearly labelled.
	▪ Dismantled railway sleepers are proposed to be fully recycled at the Elixir Prahov facility. The ability for the plant to accept the anticipated number of sleepers must be confirmed.
	▪ Confirmation that the Elixir Prahov plant is equipped to incinerate the contaminated wooden sleepers at an appropriate temperature as per Directive 2010/75/EU (depending on the type of contamination this could be 1,100 °C) must be sought in advance of works commencing on the Project.
	▪ Disposal of contaminated spoil in accordance with hazardous waste regulations by using licensed facilities that can handle and treat contaminated material.
	▪ Liquid waste to be stored in leak-proof, sealed containers.
	▪ Adequate secondary containment (110% of the volume of the container) to be provided for any hazardous liquid wastes

	▪ Waste to be segregated at source to facilitate re-use and recycling. ▪ Security arrangements to be put in place to prevent unauthorised railway sleeper acquisition by locals. ▪ Recyclable waste streams to be collected/stored in dedicated, separate containers, clearly labelled as to their contents (e.g. paper, wood, metal, glass, plastic). ▪ Stockpiles should be designed to minimise soil quality degradation, damaged and loss of material. Measures to consider include the stockpile location, soil type and condition, prevention of erosion and leachate generation and use of appropriate signage. ▪ Drainage from higher areas will be diverted around stockpile areas to prevent erosion. ▪ During dry or windy weather, stockpiles will be dampened down using a water spray to minimise the potential for wind pick-up.
Nuisance and health impacts on humans	▪ The contractor must define 'no-go zones' for the temporary storage and/or disposal of waste that include any sites within or immediately adjacent to populated areas. ▪ The open burning of waste materials is strictly prohibited. ▪ Detailed plans should be developed for the routing of traffic transporting waste in order to minimise impacts on communities. ▪ Engage with affected communities to inform them of construction waste management arrangements and gather feedback on potential siting concerns. ▪ Secure spoil storage/disposal areas with barriers and signage to prevent unauthorized access, especially by children or other vulnerable populations. ▪ Temporary waste storage areas to be adequately fenced to provide a visual barrier and to prevent unauthorised possession of dismantled sleepers by locals as construction materials. ▪ Adequate waste containment must be provided to prevent loose/windblown waste migration and odour.

Materials Over Consumption and Supply Chains	▪ Sustainable Material Sourcing
	    ▪ Source materials locally to minimize transportation impacts and support local economies, thereby reducing the carbon footprint associated with material transport.
	▪ Efficient Design and Planning
	    ▪ Design for Resource Efficiency:
	    ▪ Implement design strategies that minimize material use, such as optimizing structural designs and using advanced modeling techniques to reduce waste.
	    ▪ Modular Construction:
	    ▪ Utilize modular construction techniques that allow for prefabrication and reduce on-site waste generation. These include Track Panels (preassembled track sections including rails and sleepers, transported and laid in segments), Bridge and Culvert Components (prefabricated concrete or steel structures for quick installation), Signalling and Control Systems (prewired and pretested control units and signal cabins), and Utility Ducts and Cable Troughs (manufactured off-site and installed rapidly).
	▪ Provide training for construction workers on best practices for material handling, waste reduction, and recycling to promote a culture of sustainability on-site.

4.2 Operations Phase

Based on the assumption that SRI will update and continue to implement its three-year Operational Waste Management Plan in accordance with the national Law on Waste Management, no further operational phase mitigation measures are proposed.

4.3 Monitoring

The monitoring measures proposed for waste and materials management during the construction phase are designed to protect sensitive receptors by ensuring that waste is properly handled, stored, transported, and disposed of while minimizing material consumption and resource loss. These measures include continuous visual inspections, regular review of transfer documentation, and periodic audits to verify compliance with the Waste and Materials Management Plan and applicable standards. The Contractor will develop a Construction Waste and Materials Management Plan that clearly outlines the monitoring procedures and responsibilities required to mitigate the negative impacts associated with waste generation and materials used during construction activities.

Similarly, during the operations phase, the monitoring approach is focused on the long-term management of waste streams and the efficient use of materials. This phase emphasizes periodic inspections, performance evaluations, and the use of automated monitoring systems to continuously assess the effectiveness of waste processing, storage, and resource utilization. By implementing such measures, the project ensures that any deviations from established protocols are promptly identified and addressed, thereby safeguarding environmental quality and protecting human health (including that of workers and local communities).

Overall, the integrated monitoring strategy across both phases aims to provide a robust framework for continuous improvement in waste and materials management, ensuring that the project complies with regulatory requirements and maintains a sustainable balance between resource use and environmental protection.

The following tables delineate monitoring requirements for both the construction and operational phases, ensuring that unique needs during long-term operations are adequately addressed alongside the more frequent and immediate monitoring activities of the construction phase. They are designed to ensure that materials management is continuously monitored throughout the construction and operational phases, helping to maintain compliance with project requirements and standards.

Table 4-2. Waste Monitoring – Construction and Operations Phases

Monitoring Requirement	Frequency	Location	Method
Construction Phase			
Continuous visual inspections of waste management practices	Daily (or continuous)	All project facilities, worksites	On-site inspections by designated personnel using standardized checklists
Review of waste transfer notes	Weekly	Project facilities	Documentation review to verify compliance with the Waste and Materials Management Plan
Audit against requirements of the Construction Waste and Materials Management Plan	Monthly	Project facilities, worksites,	Internal audits using detailed checklists to assess adherence to waste management procedures
Audit the volume of waste generated recycled, reused and disposed of to landfill (by waste stream) to identify opportunities for increased recycling/reuse	Monthly	All Project facilities and worksites	Documentation review
Operations Phase			
Periodic visual inspections of operational waste disposal practices	Quarterly	Operational facilities,	On-site inspections supplemented by remote monitoring (e.g., CCTV, sensor data)
Review of long-term waste management records and performance reports	Monthly	Operational Facilities	Analysis of records and performance data against environmental standards
Annual audit against the SRI Waste Management Plan and regulatory requirements	Annually	All operational sites and facilities	Comprehensive external/internal audits, including review of historical data and corrective actions

Table 4-3. Materials Monitoring – Construction and Operations Phases

Construction Phase			
Monitoring Requirement	Monitoring Requirement	Monitoring Requirement	Monitoring Requirement
Audit against the Waste and Materials Management Plan	Monthly	Project facilities, worksites, and storage facilities	Internal audits using detailed checklists to assess adherence to materials management procedures
Operations Phase			
Monitoring Requirement	Monitoring Requirement	Monitoring Requirement	Monitoring Requirement
Annual audit against the operational Materials Management Plan and regulatory compliance	Annually	All operational sites and facilities	Comprehensive audits including on-site verification and document review to ensure long-term adherence

			and continuous improvement

4.4 Residual Impacts Assessment

Table 4-4 presents an assessment of the residual significance of impacts on the natural environment and humans during the construction phase of the Project due to the poor management of waste, following implementation of the mitigation measures defined above. For the operation phase, impacts were assessed as low prior to mitigation measures and are therefore not included in the following table.

Table 4-4. Residual Impacts Assessment

Phase	Impact	Negative or Positive	Overall significance before mitigation	Summary of mitigation	Assessment of impact after mitigation	Overall significance after mitigation
Construction	Impact of waste arisings and poor handling on the environment	Negative	High	*Avoidance of defined 'no-go zones' for the temporary storage and/or disposal of waste. Re-use of excavated material as far as possible. Use of licensed waste disposal contractors Store all waste in accordance with good international practices (GIP). Segregate waste at source to facilitate recycling.*	*Adhering to GIP will reduce the magnitude of impact (1), the impact remains temporary (only during construction) and potentially regional (2), avoidance of defined no-go zones will reduce the sensitivity of the receptor to low (1) following the implementation of mitigation measures, the impact considered has a very low probability of happening (1)*	*M (1) + ST (2) + S (1) + L (1) = 5 (Low)*
Construction	Nuisance and Health Impacts on Human Receptors	Negative	High	*Avoidance of defined 'no-go zones' for the temporary storage and/or disposal of waste. Strictly prohibit the open burning of waste materials. Develop plans for routing of traffic transporting waste in order to minimise impacts on communities. Maintain engagement with communities on waste management arrangements. Secure spoil areas with barriers and signage to prevent unauthorized access. Adequately fence and contain temporary waste storage areas to prevent nuisance impacts.*	*By implementing the proposed mitigation measures, the magnitude of impact will be reduced (1), the impact is temporary only during the construction and expected to be localized (2), avoidance of defined no-go zones and implementation of the defined mitigation measures will reduce the sensitivity of the receptor to low (1) the impact considered has a very low probability of happening (1)*	M (1) + ST (2) + S (1) + L(1) = 5 *Low*

5 CONCLUSION

The assessment of waste and materials impacts highlights the potential for significant environmental degradation, and nuisance impacts to human receptors if waste generated by the Project during the construction phase is not temporarily stored, handled, and disposed of correctly and at locations where there are no environmental components with high value, or which are rare or protected or human receptors that are already vulnerable and/or have no capacity to adapt to changes in baseline conditions.

Mitigation measures to prevent or minimise impacts will be included in the Waste Management Plan to be developed and implemented by the construction contractor. These will include the definition of 'no-go zones' for the temporary storage and/or disposal of waste to avoid sensitive environmental and human receptors, the re-use of excavated material as far as possible, the use of only licensed waste disposal contractors, involvement of local communities in the development of waste management arrangements and the implementation of accepted good international waste management practices.

During the operations phase, it is expected that the volume and type of waste generated from the operation and maintenance of the railway will not change substantially, and that SRI will effectively manage the waste generated in accordance with their existing Waste Management Plan. As such, this will not result in significant environmental degradation.

Monitoring of waste generation and management will be required throughout the construction and operations phases of the Project to ensure that the mitigation measures being implemented by the construction contractor and SRI to prevent or limit potentially significant negative impacts are adequate and effective. Where monitoring indicates that negative impacts are occurring despite the requirements of Management Plans being met, additional mitigation measures may be required, and Management Plans revised accordingly to safeguard human receptors and the environment across the Project area.

6 ANNEXES

Annex 1. Operators in the field of hazardous waste management (SEPA, 2024)

Operator	Municipality	Treatment	Storage	Disposal
		discarded equipment containing free asbestos 16 02 12*		
Ivan Ivić Pr Profil	Požarevac	P	P	P
Dra Group doo Subotica	Subotica	P	P	P
E-Reciklaža Ns	Нови Сад	P	P	P
Eko Metal doo Vrdnik	Irig	P	P	P
Elixir Zorka - Mineralna Đubriva Doo Šabac	Šabac	P	P	P
Inos-Napredak doo Mišar	Šabac	P	P	P
Jakob Becker	Ruma	P	P	P
Kemeko Doo Valjevo	Valjevo	P	P	P
Maksi-Co doo Donji Adrovac	Aleksinac	P	P	P
Metal-Forma Kos	Pančevo	P	P	P
Operator	**Municipality**	**Treatment**	**storage**	
		contaminated sleepers 17 02 04*		
Eko Metal doo Vrdnik	Irig	P	P	
Fcc Eko	Belgrade-Voždovac	P	O	
Kimex-Reciklaža doo Novi Sad	Novi Sad	P	P	
Lafarge Bfc Srbija doo Beočin	Beočin	P	P	
Letač	Indjija	P	O	
Modekolo doo Beograd	Belgrade	P	O	
Brem Group	Belgrade- Rakovica	O	P	
Dra Group doo Subotica	Subotica	O	P	
Elixir Prahovo doo[8]	Prahovo	O	P	
Elixir Zorka - Mineralna Đubriva doo Šabac	Šabac	O	P	
Jablanovica doo Raška	Raška	O	P	

[8] Since 2022, SRI has contracted Elixir to process wooden sleepers, with approx. 17,000 tons already processed in 2022 and 8,000 tons in 2023

Jakob Becker	Ruma	O	P
Kemeko doo Valjevo	Valjevo	O	P
PWW doo NIŠ	Niš-Crveni Krst	O	P
Stara Varoš doo Topola	Topola	O	P
Operator	**Municipality**	**Collecting and transportation**	
		waste fluorescent tubes containing mercury and other lighting devices 20 01 21	**waste from electrical and electronic products and other hazardous and non-hazardous waste 16 02 09-16**
Božić i sinovi	Pančevo	P	P
Operator	**Municipality**	**collection and transportation of non-hazardous construction waste and demolition waste - 17 (01-09)**	
Imetak doo	Smederevo	P	
Operator	**Municipality**	**storage and treatment of waste oils, emulsions and oily water (hazardous waste) and collection of hazardous waste - 13 03 01* 13 08 99***	
Ekosekund doo.	Krnjača	P	
Operator	**Municipality**	**collection and transportation of non-hazardous waste - Minerals (e.g. sand and stone) 19 12 09**	
Porr-Werner&Weber - Jagodina doo	Jagodina	P	

6.1 Bibliography

Abubakar, I.R., Maniruzzaman, K.M., Dano, U.L., AlShihri, F.S., AlShammari, M.S., Ahmed, S.M.S., Al-Gehlani, W.A.G., Alrawaf, T.I. (2022). Environmental Sustainability Impacts of Solid Waste Management Practices in the Global South. Int J Environ Res Public Health. 2022 Oct 5;19(19):12717. https://doi: 10.3390/ijerph191912717.

Alhawamdeh, M. (2020). An Interpretivist Approach for the Development of a Behavioural Framework to Support the Adoption of Waste Minimisation Behaviour of Contractors: The Case Study of Jordan. Manchester, UK: School of Science, Engineering and Environment, University of Salford Manchester.

Almusawi, M.B.H.; Karim, A.T.B.A.; Ethaib, S. (2022). Evaluation of Construction and Demolition Waste Management in Kuwait. Recycling, 7, 88. https://doi.org/10.3390/recycling7060088

Andreas Seidler, Melanie Schubert, Yasmin Mehrjerdian, Klaus Krapf, Christian Popp, Irene van Kamp, Mikael Ögren, Janice Hegewald. (2024). Health effects of railway-induced vibration combined with railway noise – A systematic review with exposure-effect curves, Environmental Research, Volume 251, Part 1, 15 June 2024, Pages 118658. Environmental Research, Volume 233, 2023, 116480. https://doi.org/10.1016/j.envres.2023.116480.

Andrić, J.M.; Wang, J.; Zhong, R. (2019). Identifying the Critical Risks in Railway Projects Based on Fuzzy and Sensitivity Analysis: A Case Study of Belt and Road Projects. Sustainability, 11, 1302. https://doi.org/10.3390/su11051302

Awasthi, A. (1999). ENVIRONMENTAL DEGRADATION: A CASE STUDY OF RAILWAYS AND DEFORESTATION IN INDIA IN THE NINETEENTH AND TWENTIETH CENTURIES. Proceedings of the Indian History Congress, 60, 572–581. http://www.jstor.org/stable/44144125

Barrientos, F., Moral, A., Rodríguez, J., Martínez, C., Campo, F., Carnerero, R., Parra, M., Benítez, J.M., & Sainz, G. (2016). Knowledge-based Minimization of Railway Infrastructures Environmental Impact, Transportation Research Procedia, Volume 14, Pages 840-849. https://doi.org/10.1016/j.trpro.2016.05.032

Bekr, G. A. (2014). *Study of the Causes and Magnitude of Wastage of Materials on Construction Sites in Jordan. Journal of Construction Engineering, 2014, 1–6.* doi:10.1155/2014/283298

BMTPC (2018) Utilisation of Recycled Produce of Construction & Demolition, Waste Building Materials & Technology Promotion Council, Ministry of Housing & Urban Affairs Government of India, New Delhi, India

B. S. Kumar & V. Chowdary. (2024). Handbook of Vibroacoustics, Noise and Harshness Garg et al. (eds.), Springer Nature Singapore Pte Ltd. https://doi.org/10.1007/978-981-99-4638-9_2-11

Butera, S., Christensen, T. H., & Astrup, T. F. (2014). Composition and leaching of construction and demolition waste: Inorganic elements and organic compounds. Journal of Hazardous Materials, 276, 302–311. doi:10.1016/j.jhazmat.2014.05.033

CCME (2019) Guide for identifying, evaluating and selecting policies for influencing construction, renovation and d emolition waste management, Canadian Council of Ministers of the Environment, pp 21-22

Chang, T., Graff Zivin, J., Gross, T., & Neidell, M. (2016). Particulate Pollution and the Productivity of Pear Packers. American Economic Journal: Economic Policy, 8(3), 141–169. https://doi.org/10.1257/pol.2015008

Conell Hatch. Estimated Construction Site Water Consumption - non-potable. https://eisdocs.dsdip.qld.gov.au/Jilalan%20Rail%20Yard/SEIS/Appendix/appendix-c-estimated-construction-site-water-consumption.pdf

Cook E, Velis CA and Black L (2022) Construction and Demolition Waste Management: A Systematic Scoping Review of Risks to Occupational and Public Health. Front. Sustain. 3:924926. doi: 10.3389/frsus.2022.924926

De Bortoli, A., Bouhaya, L., Feraille Fresnet, A. (2020) A life cycle model for high-speed rail infrastructure: environmental inventories and assessment of the Tours-Bordeaux railway in France. International Journal of Life Cycle Assessment, 2020, 25 (4), pp.814-830. 10.1007/s11367-019-01727-2. hal-02518936

Di Palma, L., & Petrucci, E. (2014). Treatment and recovery of contaminated railway ballast. TURKISH JOURNAL OF ENGINEERING AND ENVIRONMENTAL SCIENCES, 38, 248–255. doi:10.3906/muh-1404-9

EBRD. (2019). Environmental and Social Policy. London, UK: European Bank for Reconstruction and Development.

Edvardsson, K., & Magnusson, R. (2009). Monitoring of dust emission on gravel roads: Development of a mobile methodology and examination of horizontal diffusion. Atmospheric Environment, 43(4), 889–896. doi:10.1016/j.atmosenv.2008.10.052

EC (2023) Implementation of the Waste Framework Directive, Environment, European Commission h ttps://environment.ec.europa.eu/topics/waste-and-recycling/implementation-waste-framework-directive_en

EIB. (2022). Environmental and Social Standards. Luxembourg: European Investment Bank. https://www.eib.org/en/publications/eib-environmental-and-social-standards

EIB. The EIB Circular Economy Guide. https://www.eib.org/attachments/lucalli/20230140_the_eib_circular_economy_guide_en.pdf

EPD (2020) Introduction to Construction Waste, What is Construction Waste? Environmental Protection Department, The Government of the Hong Kong https://www.epd.gov.hk/epd/misc/cdm/introduction.htm

European Commission. (2024). CDW-recycling on LIFE Public Database, Innovative solution for the separation of construction and demolition waste. https://webgate.ec.europa.eu/life/publicWebsite/project/LIFE11-ENV-FR-000752/innovative-solution-for-the-separation-of-construction-and-demolition-waste#

EU (2008) Directive 2008/50/EC of the European Parliament and of the Council of 21 May 2008 on ambient air quality and cleaner air for Europe, OJ L 152, 11.6.2008, p. 1–44 https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32008L0050

Harm, H. C. (2024). Alternatives to Incineration. https://global.noharm.org/alternatives-incineration: Health Care Without Harm.

Hossain, M., et al. (2014). Impact of landfill leachate on surface and ground water quality. International Journal of Environmental Science and Technology, 7, 337–346. https://link.springer.com/article/10.1007/s11356-022-21578-z

Huang, Jianling, Yin, Yang, Zheng, Lei, Zhang, Sibo, Zhao, Qingyun, Chen, Huihua. (2022). Life Cycle Assessment of Construction and Demolition Waste from Railway Engineering Projects, Computational Intelligence and Neuroscience, 2022, 6145755, 10 pages. https://doi.org/10.1155/2022/6145755

Instructions for determining the markings of reuse (R) and waste disposal (D) procedures. (2010). Belgrade: Ministry of Environment and Spatial Planning, Environmental Protection Agency, RoS.

Kaewunruen, S., Liao, P. (2020). Sustainability and recyclability of composite materials for railway turnout systems. Journal of Cleaner Production, 124890. doi:10.1016/j.jclepro.2020.124890

Katsumi, T. (2015) Soil excavation and reclamation in civil engineering: Environmental aspects, Soil Science and Plant Nutrition, 61:sup1, 22-29, DOI: 10.1080/00380768.2015.1020506

Khairnar, K.F., Ingle, S.T., Wagh, N.D. & Ingale, L.T. (2011). Monitoring of railway traffic pollution and health effects on exposed population, Nature Environment and Pollution Technology, 10(3):377-384

Khoshand, A.; Khanlari, K.; Abbasianjahromi, H. & Zoghi, M. (2020). Construction and demolition waste management: Fuzzy Analytic Hierarchy Process approach. Waste Management & Research, 38(10):0734242X20910468. https://doi.org/10.1177/0734242X20910468

Kovner, K. (2025) Persistent Organic Pollutants: A Global Issue, A Global Response, EPA, Last updated on January 21, 2025 https://www.epa.gov/international-cooperation/persistent-organic-pollutants-global-issue-global-response#affect

Lee, S., Chang, H. & Lee, J. (2024) Construction and demolition waste management and its impacts on the environment and human health: moving forward sustainability enhancement, Sustain. Cities Soc., 115 , Article 105855, 10.1016/J.SCS.2024.105855

Martí, V. (2014). Human health risk assessment of a landfill based on volatile organic compounds emission, emission and soil gas concentration measurements. Applied Geochemistry, 49, 218–224. https://link.springer.com/article/10.1007/s11356-022-21578-z

Nagapan, S., Rahman, I.A., Asmi, A., Memon, A.M., Zin, R.M. (2012) . Identifying Causes of Construction Waste - Case of Central Region of Peninsula Malaysia, International Journal of Integrated Engineering, Vol. 4 No. 2, p. 22-28 UTHM Publisher. Available from: https://www.researchgate.net/publication/256838800_Identifying_Causes_of_Construction_Waste_-Case_of_Central_Region_of_Peninsula_Malaysia#fullTextFileContent [accessed Jan 03 2025]

NetRegs. (2024, July 11). Burning construction wastes. Retrieved from NetRegs: https://www.netregs.org.uk/environmental-topics/waste/waste-from-construction-and-demolition-sites/burning-construction-wastes/

Palmiotto, M., et al. (2014). Influence of a municipal solid waste landfill in the surrounding environment: toxicological risk and odor nuisance effects. Environmental International, 68, 16–24. https://link.springer.com/article/10.1007/s11356-022-21578-z

Past, V., Yaghmaeian, K., Naderi, M., & Naderi, N. (2023). Management of the construction and demolition waste (CDW) and determination of the best disposal alternative by FAHP (Fuzzy Analytic Hierarchy Process): A case study of Tehran, Iran. Journal of the Air & Waste Management Association, 73(4), 271–284. https://doi.org/10.1080/10962247.2023.2178542

Pons, J. J., Villalba Sanchis, I., Insa Franco, R., & Yepes, V. (2020). Life cycle assessment of a railway tracks substructures: Comparison of ballast and ballastless rail tracks. Environmental Impact Assessment Review, 85, 106444. doi:10.1016/j.eiar.2020.106444

Suman, S. (2020) Construction and Demolition Waste and Its Impact on Environment International Journal of Creative Research Thoughts (IJCRT) Volume 8, Issue 8 August 2020 | ISSN: 2320-2882, 3675-3681

Rak, A., Klosok-Bazan, I., Zimoch, I-, Machnik-Slomka, J. (2022) Analysis of railway ballast contamination in terms of its potential reuse, Journal of Cleaner Production, Volume 378, 10 December 2022, 134440SN - 0959-6526, https://doi.org/10.1016/j.jclepro.2022.134440

RB Rail (2023) Rail Baltica, Technical Specifications for Construction https://www.railbaltica.org/wp-content/uploads/2024/02/Technical-specifications-for-Construction-4.0.pdf?utm_source=chatgpt.com

RoS. (2010). Rulebook on handling waste containing asbestos ("Official Gazette of RS" No. 75/2010).ž

RoS (2021) Republic of Serbia Air Protection Law ("Official Gazette of the RS", no. 36/2009, 10/2013, and 26/2021)in Serbian https://www.paragraf.rs/propisi/zakon_o_zastiti_vazduha.html

RoS. (2023). Law on Waste Management ("Official Gazette of RS" No. 36/2009-115, 88/2010-170, 14/2016-17, 95/2018-267 - other laws, 35/2023- 68)

RoS. (2024). Regulation on categfories, testing and classification of waste ("Official Gazette of RS" No. 56/2010, 93/2019, 39/2021 and 65/2024).

RoS, N. A. (2024, July 15). The law on disaster risk reduction and emergency management. Retrieved from Paragraf Lex doo: https://www.paragraf.rs/propisi/zakon-o-smanjenju-rizika-od-katastrofa-i-upravljanju-vanrednim-situacijama.html

RoS, N. A. (2024, July 16). Instructions on the methodology of preparation and content of disaster risk assessment and protection and rescue plan ("Official Gazette of RS", No. 80/2019). Retrieved from Paragraf Lex doo: https://www.paragraf.rs/propisi/uputstvo-metodologiji-izradu-procene-ugrozenosti-elementarnih-nepogoda.html

RoS, N. A. (2024, July 26). Law on Planning and Construction of the Republic of Serbia. Retrieved from Paragraf Lex doo: https://www.paragraf.rs/propisi/zakon_o_planiranju_i_izgradnji.html

RoSa. (2023). Regulation on the manner and procedure of waste management from construction and demolition ("Official Gazette of the RS", no. 93/2023 and 94/2023 - corrected).

SEPA. (2024, July 3). Registers in the area of waste management. Retrieved from Official website of the Serbian Environmental Protection Agency (SEPA): http://www.sepa.gov.rs/index.php?menu=20174&id=20055&akcija=ShowExternal

Sechan Park, Min-kyeong Kim, Michael Versoza, Jaeseok Heo, Minjeong Kim, Duckshin Park. (2022). Emission of fugitive dust from railway maintenance vehicles operating on gravel track, Transportation Research Part D: Transport and Environment, Volume 112, 103441. https://doi.org/10.1016/j.trd.2022.103441.

Shen, Q., Pan, Y., & Feng, Y. (2023). The impacts of high-speed railway on environmental sustainability: quasi-experimental evidence from China. Humanit Soc Sci Commun, 10, 719. https://doi.org/10.1057/s41599-023-02135-6

SRI (2018). Waste Management Plan of the "Serbian Railway Infrastructure" a.d., Belgrade.

SRI (2019). Regulations on the management of waste material generated in the work process and on disposal and sale of assets, Official Gazette "ŽELEZNICA SRBIJE"- Year XXXIX No 36.

Tzachor, A., Wang, H. & Richards, C.E. (2024). Addressing the excessive water consumption of materials manufacturing. Nat Water, 2, 4–7. https://doi.org/10.1038/s44221-023-00179-1

UIC (2018). Circular Economy (Best Practices in Waste Management for Rail Infrastructure Projects) International Union of Railways, Paris, France https://uic.org/sustainability/circular-economy/

UNEP (2025) Solid waste management, UN Environment Programme, United Nations Avenue, Gigiri Nairobi, Kenya. https://www.unep.org/explore-topics/resource-efficiency/what-we-do/cities/solid-waste-management

Vermont Agency of Transportation (2024) Estimating Quantities https://vtrans.vermont.gov/cost-estimating/estimating-quantities?utm_source=chatgpt.com

Waste management, Waste Type Classification https://www.epd.gov.hk/eia/register/report/eiareport/eia_2832022/HTML/Section_6.htm

WHO (2021)WHO global air quality guidelines: particulate matter (PM2.5 and PM10), ozone, nitrogen dioxide, sulfur dioxide and carbon monoxide, 22 September 2021, | Guideline https://www.who.int/publications/i/item/9789240034228

Yang, H., Junqiang, X., Thompson, J.R., & Flower, R.J. (2017). Urban construction and demolition waste and landfill failure in Shenzhen, China, Waste Management, Volume 63, Pages 393-396..

Republic of Serbia
Ministry of European Integration

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#ЕУ ЗА ТЕБЕ

RAILWAY LINE BELGRADE–NIŠ, SECTION III PARAĆIN–NIŠ,
Environmental and Social Impact Assessment,
17. MAJOR ACCIDENTS AND DISASTERS

EU PPF
PROJECT PREPARATION FACILITY

Republic of Serbia
Ministry of European Integration

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#ЕУ ЗА ТЕБЕ

EU PPF - PROJECT PREPARATION FACILITY

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LIST OF ABBREVIATIONS AND ACRONYMS

AoI	Area of influence
BoE	Beneficiary of Expropriation
CITES	Convention on International Trade in Endangered Species
CDF	Central Feedback Desk
CHIA	Cultural Heritage Impact Assessment
CHMP	Cultural Heritage Management Plan
CLO	Chief Liaison Officer
EBRD	European Bank for Reconstruction and Development
EC	European Commission
EIA	Environmental Impact Assessment
EIB	European Investment Bank
ERTMS	European Rail Traffic Management System
E&S	Environmental and Social
ESA	Environmental and Social Advisor
ESIA	Environmental and Social Impact Assessment
ESS EIB	Environmental and Social Standards (2 February 2022)
ESMP	Environmental and Social Management Plan
ESMMP	Environmental and Social Management and Monitoring Plan
ETCS – L2	L2 European Train Control System – Level 2
European Union	European Union
EUD	European Union Delegation
EUNIS	European nature information system
GHG	Greenhouse gas
HR	Human Resources
IFI	International Financing Institution
ILO	International Labour Organization
IPPC	International Plant Protection Convention
IUCN	International Union for Conservation of Nature
JASPERS	Joint Assistance to Support Projects in European Regions

LRP	Livelihood Restoration Plan
LGAD	Local Grievance Admission Desk
MCA	Multi Criterial Analysis
MCDA	Multi criteria decision analysis
MEI	Ministry of European Integration
MoCTI	Ministry of Construction, Transport, and Infrastructure
MoM	Minutes of Meeting
NGO	Non-Governmental Organizations
NPAA	National Program for the Adoption of the Acquis
OESMS	Operational Environmental and Social Management System
OHS	Occupational Health and Safety
PD	Preliminary Design
PFS	Pre-feasibility study
PPF9	Preparation Project Facilities 9
PRs	EBRD Performance Requirements
PPPPN	Spatial Plan of the Area of Special Purpose
RAP	Resettlement Action Plan
RoW	Right of Way
RPF	Resettlement Policy Framework
SEA/SH	Sexual Exploitation and Abuse/Sexual Harassment
SEECP	South-East European Cooperation Process
SEETO	South-East Europe Transport Observatory
SEP	Stakeholder Engagement Plan
SRI	Serbian Railways Infrastructure
TEN-T	Trans-European Transport Network
TMP	Traffic Management Plan
ToR	Terms of Reference
TSI	Technical Specifications for Interoperability
UNESCO	UNESCO

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1. INTRODUCTION

A major accident is defined as an event, such as a train derailment or major road traffic accident, which results in immediate or delayed serious adverse effects on human health, property, and/or the environment, and requires the mobilisation of resources beyond those of the Project Developer or its contractors to manage. Major accidents may arise from both man-made hazards (e.g., acts of terrorism, vandalism, operational failures) and natural hazards (e.g., earthquakes, floods, landslides, extreme weather events). A disaster is considered to be either a man-made or natural hazard event that has the potential to cause a situation meeting the definition of a major accident, for example, a weather-triggered landslide resulting in a train derailment.

This Chapter presents a high-level assessment of the Project's potential vulnerability to major accidents and disasters, and the associated potentially significant environmental and social impacts, in line with the requirements of Directive 2011/92/EU, as amended by Directive 2014/52/EU (the Environmental Impact Assessment Directive), the Environmental and Social Standards (ESS) of the European Investment Bank (EIB), and the Performance Requirements (PRs) of the European Bank for Reconstruction and Development (EBRD).The assessment considers both external and internal factors during the construction and operational phases, specifically:

- The vulnerability of the Project to major accidents and disasters; and
- The Project’s potential to cause major accidents and disasters.

This assessment should be read in conjunction with other relevant Chapters of this ESIA Report, particularly:

- Chapter 8 (Geology), which assesses the potential for geohazards (e.g., landslides, earthquakes),
- Chapter 11 (Climate Vulnerability Risk Assessment), which addresses risks associated with flooding, extreme weather, and wildfires,
- Chapter 7 (Soil and Land), which considers the potential impacts of rail accidents on soil quality.

The potential major accidents/disasters to which the Project may be vulnerable during the construction and operations phases, and assessed in this Chapter, are listed in Table 1-1 below.

Table 1-1. Major Accident/Disaster Categories and Types

Category	Type
Natural	Geophysical
	Hydrological
	Biological
Technological or Manmade Hazards	Societal

	Industrial and Urban Accidents
	Transport Accidents
	Pollution Accidents
	Utility Failures
	Malicious Attacks
	Engineering Accidents and Failures

This Chapter outlines the relevant baseline conditions, assessment methodology and a summary of likely potentially significant impacts to sensitive receptors resulting from the vulnerability of the Project to major accidents/disasters. Mitigation measures are proposed to prevent or limit any negative impacts.

1.1 Legislative and Policy Framework

1.1.1 EU Requirements

The requirements for assessing the potential impacts of major accidents and disasters within environmental impact assessments are set out in Article 3 of Directive 2011/92/EU, as amended by Directive 2014/52/EU (the Environmental Impact Assessment Directive).

Article 3(2) of the Directive specifically states that: "*Effects referred to in paragraph 1 on the factors set out therein shall include the expected effects deriving from the vulnerability of the project to risks of major accidents and/or disasters that are relevant to the project concerned*."

Recital 15 of Directive 2014/52/EU further emphasises the need for precautionary action: "*In order to ensure a high level of protection of the environment, precautionary actions need to be taken for certain projects which, because of their vulnerability to major accidents, and/or natural disasters (such as flooding, sea level rise, or earthquakes), are likely to have significant adverse effects on the environment*."

In addition, Annex IV of the Directive requires that the Environmental Impact Assessment report shall include: "*A description of the expected significant adverse effects of the project on the environment deriving from the vulnerability of the project to risks of major accidents and/or disasters which are relevant to the project concerned. Relevant information available and obtained through risk assessments pursuant to Union legislation such as Directive 2012/18/EU of the European Parliament and of the Council or Council Directive 2009/71/Euratom or relevant assessments carried out pursuant to national legislation may be used for this purpose provided that the requirements of this Directive are met. Where appropriate, this description should include measures envisaged to prevent or* *mitigate the significant adverse effects of such events on the environment and details of the preparedness for and proposed response to such emergencies.*"

In addition to the Environmental Impact Assessment Directive, the assessment of risks related to major accidents involving hazardous materials must also take into account the applicable requirements for the transport of dangerous goods. These include:

- Directive 2008/68/EC on the inland transport of dangerous goods, which transposes into EU law the rules of international agreements for road (ADR), rail (RID), and inland waterways (ADN) transport; and
- RID – Regulations concerning the International Carriage of Dangerous Goods by Rail, which applies to international rail transport in both the EU and the Republic of Serbia as a Contracting State to OTIF (Intergovernmental Organisation for International Carriage by Rail).

These regulations establish safety requirements for the classification, packaging, labelling, handling, and transport of hazardous substances by rail, and are relevant to the risk assessment of incidents such as derailments or chemical leaks.

1.1.2 National Legislative Framework

The national framework for disaster risk management in Serbia is primarily established under the **Law on Disaster Risk Reduction and Management of Emergency Situations** ("Official Gazette of RS", No. 87/2018).

In accordance with Articles 15 and 17 of the Law, **Disaster Risk Assessments** and **Protection and Rescue Plans** must be developed. The methodology and content for preparing these documents are further detailed in the **Instructions on the Methodology and Content of Creating a Disaster Risk Assessment and Protection and Rescue Plan** ("Official Gazette of RS", No. 80/2019).

Article 1 of the Law stipulates that it regulates:

- The proclamation and management of emergency situations;
- The protection and rescue of people, material and cultural goods, and the environment from natural disasters, technological accidents, terrorism, war, and other major incidents;
- The competencies of state bodies, autonomous provinces, local self-government units, as well as the participation of the police and the Serbian Armed Forces in protection and rescue;
- The rights and duties of citizens, companies, and other legal entities;
- The organization of civil protection activities, financing mechanisms, inspection supervision, and international cooperation.

A key feature introduced by the Law is the establishment of a **Risk Register**, an interactive electronic geographic information system intended to record all hazards and risks across the territory of the Republic of Serbia. The Risk Register is maintained by the Ministry of Internal Affairs, with data contributions from relevant ministries, agencies, and local government units. It is designed to be accessible to all entities engaged in risk assessments and investment planning.

The Law also provides for the designation of **Immediate Risk Zones**, aimed at preventing construction in areas susceptible to floods, earthquakes, landslides, and technological hazards. The identification of these zones is expected to significantly contribute to risk reduction and safer spatial development.

The Law imposes key obligations related to the preparation of three main documents:

- **Disaster Risk Assessment**: Identifies types, origins, and factors influencing risks, assesses potential impacts on human health, environment, infrastructure, and economic activities.
- **Plan for Disaster Risk Reduction**: Developed based on assessed risks and outlines preventive actions.
- **Plan for Protection and Rescue**: Specifies operational measures for responding to disasters and emergencies.

In addition to this Law, the **Decree on Mandatory Funds and Equipment for Personal, Mutual and Collective Protection Against Natural and Other Disasters** ("Official Gazette of RS", No. 3/2011, 37/2015) provides additional regulatory guidance.

Furthermore, the **Law on Planning and Construction** ("Official Gazette of RS", No. 72/2009 and subsequent amendments) sets out obligations for contractors related to construction site safety, including:

- Organizing the construction site to ensure safe access, traffic flow, and environmental protection (Article 152, paragraph 8, item 2);
- Ensuring the safety of facilities, individuals, and surrounding properties (Article 152, paragraph 8, item 3);
- Securing partially completed facilities and the environment in the event of work interruption (Article 152, paragraph 8, item 7).

1.1.3 EIB Requirements

The European Investment Bank (EIB) places significant emphasis on the assessment and management of risks associated with major accidents and disasters. These requirements are embedded in its Environmental and Social Standards (ESSs), which guide project promoters in ensuring resilience, prevention, and preparedness.

ESS 1 requires that the Environmental and Social Impact Assessment (ESIA) report includes: "*A description of the expected significant environmental, climate and/or social adverse effects deriving from the vulnerability of the project to risks of major accidents and/or disasters that are relevant to the project concerned, including those caused by climate change. Where appropriate, a description of the measures planned to prevent such risks, as well as measures regarding preparedness for and response to emergencies (as required by ESS 3 and ESS 9), should be included in the ESMP*."

ESS 3 specifically mandates that the project promoter must establish effective management systems and implement appropriate control measures to ensure prevention, preparedness, and adequate response to major accidents and emergency situations.ESS 9, particularly paragraphs 43 and 44, requires the promoter to identify, assess, and minimise potential health and safety risks posed by natural hazards or extreme weather events, such as floods, droughts, heatwaves, landslides, hurricanes, typhoons, or earthquakes.

Where relevant, the promoter must carry out a vulnerability assessment addressing these risks. Furthermore, the promoter must also consider NaTech[1] risks (Natural Hazard Triggering Technological Accidents), requiring the prevention of, preparedness for, and response to industrial accidents exacerbated by natural events.

Preventative measures include land-use planning and site selection, modification of hazardous activities, disaster risk reduction strategies, emergency preparedness through contingency planning, and strengthening the resilience of project-affected communities to natural and technological disasters.

1.1.4 EBRD Requirements

The European Bank for Reconstruction and Development (EBRD) addresses the risk of major accidents and disasters through specific provisions set out in its Environmental and Social Policy and Performance Requirements (PRs).

The key applicable requirements are summarised below:

- Performance Requirement 4 (PR4): Health, Safety and Security

  PR4 requires clients to take proactive steps to safeguard the health and safety of workers, affected communities, and the environment during all project phases. In particular:

  - Infrastructure, Building, and Equipment Design and Safety: Third-party life and fire safety audits must be conducted for all new public buildings and major refurbishments prior to their commissioning or use.
  - Natural Hazards: Clients must identify and assess risks posed by natural hazards such as earthquakes, droughts, landslides, and floods, and must take measures to avoid or minimise these risks where possible, including risks stemming from land use changes.
  - Emergency Preparedness: Clients are required to identify and assess major accident hazards and implement all necessary measures to prevent or minimise the likelihood and consequences of such accidents. These measures must be incorporated into a major-accident prevention and emergency preparedness policy and management plan, which are to be integrated into the project's Environmental and Social Management System (ESMS).
- Specific Requirements for High-Risk Projects:

  For projects located in areas prone to natural disasters, PR4 requires the incorporation of resilience measures into project design and operations, ensuring that infrastructure can withstand such events and maintain functionality under adverse conditions.

[1] **NaTech accidents** are **Natural Hazard Triggering Technological Disasters**. They refer to the impacts of natural hazard events on chemical installations, pipelines, offshore platforms, and other infrastructure that process, store, or transport dangerous substances, which can cause fires, explosions, and toxic or radioactive releases.

In line with the requirements outlined above, the assessment of major accidents and disasters within this ESIA has been designed to ensure that the Project's vulnerability to natural and man-made hazards is appropriately evaluated, and that effective mitigation and emergency preparedness measures are embedded within the Project's environmental and social management framework.

2. BASELINE CONDITIONS

2.1 Area of Influence

The Area of Influence (AoI) for major accidents and disasters has been defined based on professional judgement and the identification of both internal and external risk factors in proximity to the Project. The determination of the AoI considered the following:

Man-made features:

- Airports and airfields within 13 km of the Project;
- Major Industrial Accident Risk facilities within 3 km;
- Major Accident Hazard pipelines, including gas, fuel, and chemical pipeline systems, within 1 km;
- Fuel retail sites, including Liquified Natural Gas (LNG) and Liquified Petroleum Gas (LPG) installations, within 1 km;
- Rail infrastructure within 500 meters;
- Transmission infrastructure (gas, electrical, oil/fuel) crossing or near the Project alignment.

It should be noted that there are no Seveso[2] establishments located within the Project AoI, according to the official Register of Seveso Facilities in the Republic of Serbia. Additionally, there are no known areas of unexploded ordnance (UXO) within 500 meters of the Project. Industrial activity within the AoI is generally low, with Stalać being the only settlement featuring industrial facilities and minor private enterprises.

Natural features with the potential to create risks include:

- Hydrological and geological risks, such as river flooding, landslides, earthquakes, and unstable ground conditions.

Climatic features:

- Extreme temperatures;
- Extreme precipitation and associated flooding;
- Wildfires.

The delineated AoI captures all relevant natural and man-made hazards that could influence the Project during both construction and operation phases.

In addition, the AoI considers nearby road infrastructure and built-up areas, especially where the railway alignment runs parallel to or intersects with road networks. These features are not only important in terms of direct exposure but also in evaluating cascading risks — such as a derailment affecting an adjacent roadway, utility corridor, or

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[2] *Source: Official Register of Seveso Facilities in the Republic of Serbia, Ministry of Environmental Protection, 2024*

residential zone. While these are low-probability events, their potentially high consequences are factored into the accident scenarios and response measures developed in this chapter.

The Area of Influence has been conservatively defined to encompass both high-likelihood risks and low-probability, high-consequence events, in line with the ALARP (As Low As Reasonably Practicable) principle.

The delineation also considered potential future increases in the frequency and intensity of extreme weather events due to climate change, including extreme precipitation, droughts, and wildfires.

Figure 2-1 illustrates the Area of Influence for major accidents and disasters relevant to the Project based on the factors identified above.

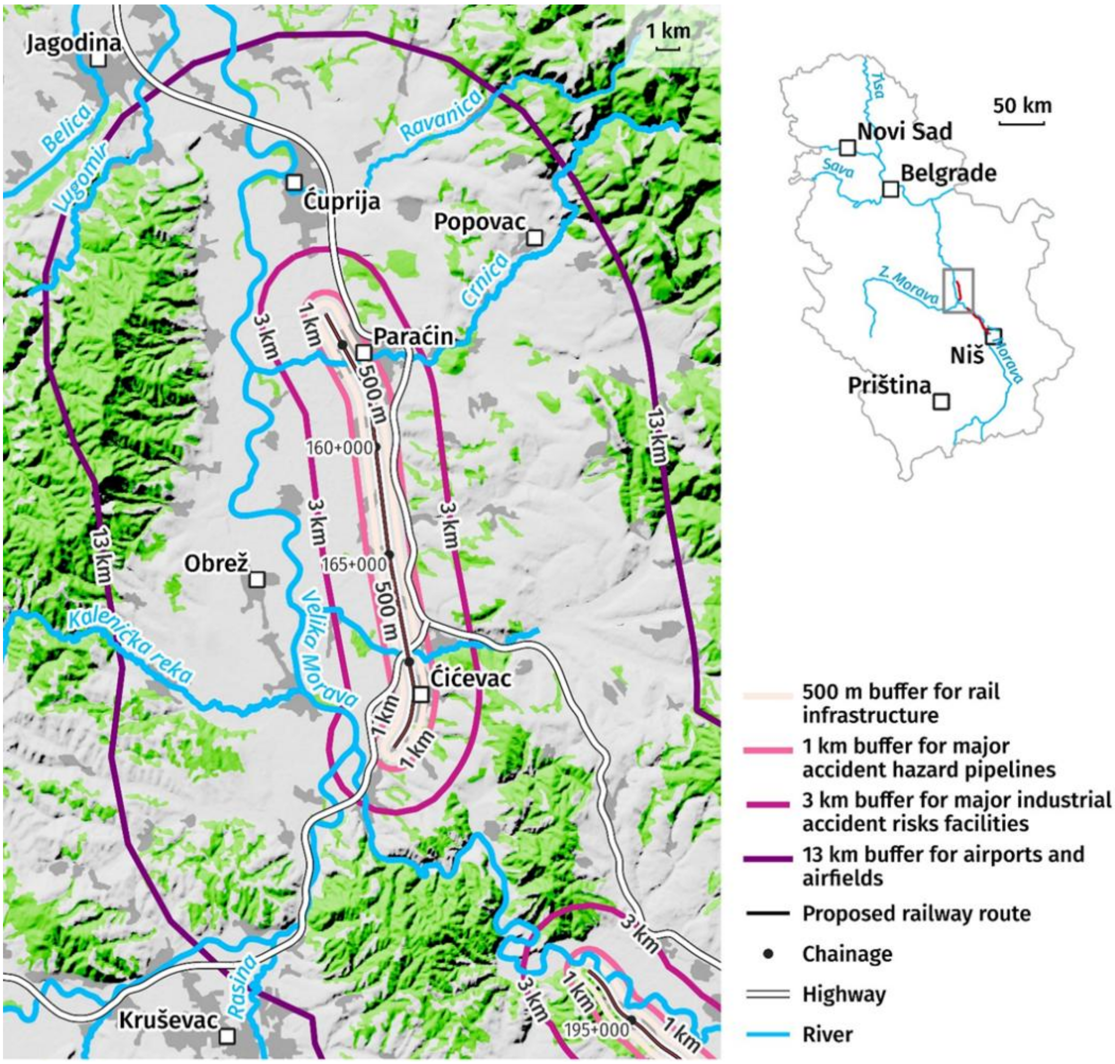

Figure 2-1. Area of Influence for Major Accidents and Disasters on the section 3, part from Paraćin-Stalać

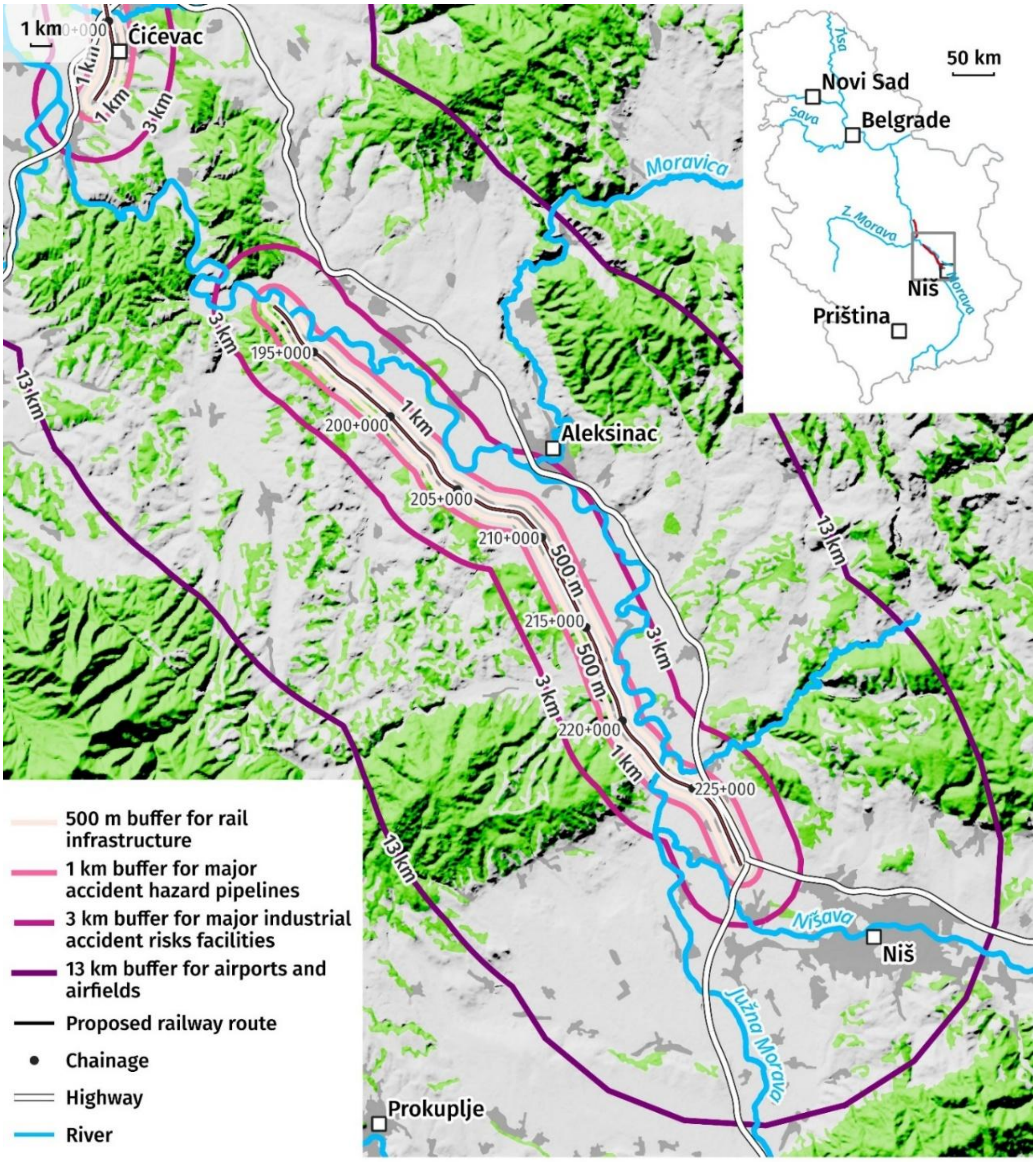

Figure 2-2. Area of Influence for Major Accidents and Disasters on the section 3, part Đunis-Trupale

2.2 Baseline Conditions

This section provides an overview of the baseline conditions relevant to the assessment of the Project's vulnerability to major accidents and disasters. The identification and analysis of baseline conditions are essential for understanding the environmental, climatic, geological, hydrological, infrastructural, and socio-economic factors that may influence the occurrence, severity, or consequences of major accidents or disasters.

In line with Recital 15 of EU Directive 2014/52/EU, the following sensitive receptors have been considered in relation to major accidents and disasters:

- Members of the public and local communities;
- Infrastructure and the built environment;
- The natural environment, including ecosystems, land and soil quality, air quality, surface and groundwater resources, and landscape;
- The historic environment, including archaeology and built heritage;
- The interactions between the factors listed above.

The specific potential sensitive receptors that could be impacted by a major accident or disaster are further discussed in the relevant Chapters of this ESIA Report. However, the key baseline features considered particularly important for the purposes of this assessment are summarised under each topic heading in the sections below.

This assessment of baseline conditions serves as a foundation for the evaluation of potential major risks, the identification of sensitive receptors, and the development of appropriate mitigation and emergency preparedness measures.

2.2.1 Geohazards

2.2.1.1 Earthquakes

The Project is located within a seismically active area. The most recent significant earthquake affecting the Project vicinity occurred in Kruševac on 10 May 2022, with a recorded magnitude of 4.6 on the Richter scale. In addition, several minor earthquakes were registered between 21 and 26 June 2022 in the Kragujevac area, with a maximum magnitude of 3.2.

Further detailed information on seismic conditions, regional geology, and fault systems is provided in Chapter 8 – Geology of this ESIA.

2.2.1.2 Landslides

Landslide susceptibility along the Project route has been assessed using the European Landslide Susceptibility Map (ELSUS V2), which provides a zonation of landslide susceptibility across individual climate-physiographic zones in Europe at a spatial resolution of 200 × 200 metres. According to ELSUS V2, the Project corridor is located within areas of medium landslide susceptibility.

However, the Đunis–Trupale sub-section of the Project, specifically between km 218+250 and km 219+000, exhibits an elevation gradient that is generally insufficient to support landslide occurrence. Additionally, this section is entirely covered with vegetation, which enhances soil stability and significantly reduces the likelihood of landslides.

In addition, based on the results of the completed geotechnical investigation, no other stretches of the Project route alignment have been identified as being significantly at risk of or prone to landslides. The assessment confirms that slope instability is not expected to represent a major risk outside of the Đunis–Trupale sub-sectiont.

Further detailed information regarding slope stability and landslide susceptibility is provided in Chapter 11 – Climate Risk Vulnerability Assessment and Chapter 8 - Geology of this ESIA Report.

2.2.2 Flood Risk

Table 2-1 shows the locations along the Project route that are at risk of flooding from surface watercourses.

Table 2-1. Modelled flood hazard along the railway route

Location	Chainage [km]	Flood zone length [m]	Flood zone depth [m]	Flood zone risk level
Ćićevac	172+500 - 173+340	840	<0.5, 0.5-1.5	Low
Mezgraja	222+700 – 224+480	1780	<0.5, 0.5-1.5, 1.5-4	Low

Pluvial floods (i.e. heavy rainfall-related flooding that is independent of an overflowing body of water) are not recorded along the Project route. More detailed information is provided in Chapter 11 of this ESIA: Climate Risk Vulnerability Assessment. In line with the findings of Chapter 11 – Climate Risk Vulnerability Assessment, no significant increase in flood frequency or severity is projected along the Project corridor. The area remains within a low to moderate flood risk zone, and no critical flood-prone segments of the railway have been identified that would require special adaptation measures.

2.2.3 Wildfires

There is no historical record of major wildfires in the areas adjacent to the Project alignment. However, the Project route passes through regions classified as having 'High' to 'Extreme' fire danger according to the Fire Weather Index (FWI) system, where FWI values are 30 or higher (with values between 21.3 and 38 categorised as high fire danger).

This classification is illustrated in Figure 2-3 below.

Further detailed information on wildfire risks and climate-related vulnerabilities is provided in Chapter 11 – Climate Risk Vulnerability Assessment of this ESIA Report. According to the findings presented in Chapter 11, the likelihood of wildfires is expected to increase slightly in southern vegetated areas of the corridor due to rising temperatures and seasonal dryness. The overall wildfire risk remains moderate and can be managed through preventive measures such as vegetation control and firebreaks.

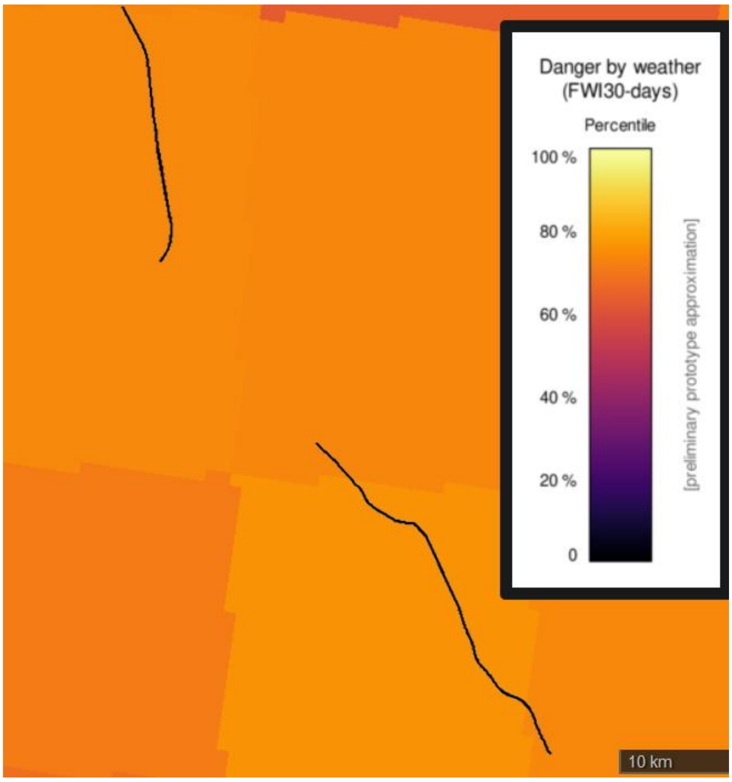

Figure 2-3. Wildfires – danger by weather (number of days with high-to-extreme fire danger by weather (FWI >= 30) (Van Wagner, 1987) – uncertainty aggregation: median value), railway route marked by the black lines

2.2.4 Hazardous Pipelines

The locations where the proposed Project alignment intersects with existing gas pipeline infrastructure are outlined in Table 2-2 below.

Table 2-2. Locations of gas pipeline infrastructure that will intersect with the Project alignment

No	Type of installation	Position / chainage (km)	Note
1	City gas pipeline network MOP 16bar	155+788	Existing installation - crossover
2	Distribution pipeline MOP 4bar	155+791 -155+985	Existing installation -crossover and parallel guidance

No	Type of installation	Position / chainage (km)	Note
3	Polyethylene pipeline - distribution MOP 4 bar	158+955	Existing installation - crossover
4	Polyethylene pipeline - distribution MOP 4 bar	162+505	Existing installation - crossover
5	Polyethylene pipeline - distribution MOP 4 bar	164+510	Existing installation - crossover
6	Main gas pipeline MG08 MOP 55bar	165+789	Existing installation - crossover
7	Polyethylene pipeline - distribution MOP 4 bar	166+143 - 166+615	Existing installation -crossover and parallel guidance
8	Polyethylene pipeline - distribution MOP 4 bar	167+180	Existing installation - crossover with the road
9	Polyethylene pipeline - distribution MOP 4 bar	167+215- 167+313	Existing installation -crossover and parallel guidance
10	Polyethylene pipeline - distribution MOP 4 bar	167+350 - 167+950	Existing installation -crossover and parallel guidance
11	Polyethylene pipeline - distribution MOP 4 bar	168+148	Existing installation - crossover
12	Main gas pipeline MG09 MOP 55bar	169+100 - 169+265	Existing installation - crossover
13	Gas pipeline MOP 55bar	169+450	Existing installation – crossover with Jovanovička river

2.2.5 Water Resources

The locations of surface water courses that will be crossed by the Project (within each sub-section) are given in Table 2-3.

Table 2-3. Total number of watercourse crossings

Đunis-Trupale			Paraćin-Stalać		
	Chainage	Watercourse		Chainage	Watercourse
1	196+848	Srezovačka river	1	155+908	River Crnica
2	201+255	Radevačka river	2	158+844	Bačijski stream
3	205+958	Suvi stream	3	159+814	Stream Burdeljski
4	208+820	Suhotnički stream	4	160+349	Slatinski stream
5	217+642	River Turija	5	163+861	Planski stream
6	219+097	Dašnička river	6	169+425	River Jovanovačka
7	220+315	Drenovački stream	7	172+051	Kočanski stream
8	223+054	Južna Morava	8	173+709	Stream Akalavica

More detailed information is provided in **Chapter 9, Surface Waters.**

The Paraćin–Stalać subsection of the Project passes through the wider zone of sanitary protection of the 'Gorunje' and 'Bahus' water sources, which are both used for the production of bottled water. The Project alignment also passes over a number of groundwater aquifers. More detailed information is provided in **Chapter 10: Groundwaters**.

2.2.6 Cultural Heritage

An overview of identified cultural heritage assets in the area of 500m from Project alignment is provided in the next Table 2-4. More detailed information on cultural heritage is provided in **Chapter 15 of this ESIA: Cultural Heritage.**

Table 2-4. Cultural heritage sites

No.	Cultural heritage	Location	Position in relation to the proposed route	Type of cultural heritage
1.	Building at Branka Krsmanovića 47 street in Paraćin – National library Dr Vićentije Rakić	Paraćin	490m	Monument of Culture
2.	Supovac tower	Supovac	500m	Non protected site of cultural significance

2.2.7 Accidents and incidents

To provide a comprehensive understanding of the risks related to major accidents and disasters, a review of available historical data for the period 2011–2023 was conducted related to the Project route. It is important to highlight that no major accidents or disasters were recorded along the Project alignment during this period. Nevertheless, several minor incidents—such as temporary traffic interruptions or events without significant consequences—have sporadically occurred. These events, although not critical, are presented below to illustrate the typical types of challenges historically encountered on the railway line.

Examples of historically recorded minor incidents are summarised below, to illustrate typical challenges encountered along the railway alignment:

- **17 May 2011** – Between Grejač and Trupale stations: Lightning strike damaged an electric cable at km 232+773, causing interference with signal safety devices.
- **15 May 2014** – Between Paraćin and Stalać stations: Track flooding occurred between km 168+800 and km 169+100, resulting in a 58-hour traffic interruption.
- **8 November 2016** – At Stalać station: Overflow of the Toplički stream caused flooding of tracks, basement rooms, and sewer systems due to heavy rainfall.
- **10 June 2018** – Between Paraćin and Ćićevac stations: A partial tin roof dislodged during a storm and fell onto the contact network at km 159+750.
- **3 July 2023** – Between Ćićevac and Stalać stations: Tree branches and mud obstructed the track at km 173+745 following a stream overflow; traffic interruption lasted 1 hour.
- **20 August 2023** – At Adrovac station: Fire engulfed a sleeper on the track at km 209+890; the fire was extinguished without escalation, and the traffic interruption lasted 1 hour.

Although no major accidents have occurred directly on the Project section in recent years, several significant accidents have taken place on the Serbian railway network. These events highlight the relevance of railway safety and the need for continuous investment in infrastructure maintenance and monitoring. A summary of the most serious railway-related accidents in Serbia over the past three years is provided below:

- **Collapse of the canopy at Novi Sad railway station (1 November 2024)**

  A fatal structural failure occurred when a concrete canopy above the entrance of the newly reconstructed Novi Sad railway station collapsed. The accident resulted in 16 fatalities, including three children, and one serious injury.

- **Derailment and ammonia leak near Pirot (December 2022)**

  A freight train carrying ammonia derailed near the town of Pirot, releasing toxic gas into the environment. The accident caused two deaths and led to the hospitalization of over 60 people with symptoms of poisoning. The root cause was attributed to the poor condition of the railway infrastructure, particularly degraded and broken sleepers.

- **Derailment of wagons carrying phosphoric acid near Zaječar (January 2023)**

  Two wagons transporting phosphoric acid derailed near Zaječar. Although there were no injuries, the incident posed a significant environmental risk. Emergency response measures were promptly implemented to prevent contamination of surrounding soil and water sources.

- **Overturning of a sulfuric acid tank wagon in Vrčin (February 2025)**

  A tank wagon carrying sulfuric acid overturned in Vrčin, near Belgrade. Fortunately, there were no injuries reported, and authorities confirmed that no harmful vapors were released into the environment. The incident highlighted the potential risks associated with the transportation of hazardous materials by rail

2.3 Impact Assessment Methodology

The assessment methodology in this Chapter does not follow the standard ESIA methodology outlined in Chapter 5 of the ESIA Report. For the purposes of this assessment the methodology has been simplified to facilitate a more risk-based approach to determining the Project's potential vulnerability to major accidents and disasters, as well as an evaluation of the environmental and social impacts of any major accidents and disasters. The methodology that has been used is outlined below.

The likelihood of the identified potential major accidents/disasters (hereinafter 'events') occurring has been defined in Table 2-5.

Table 2-5. Definition of likelihood

Likelihood	What it means
Very likely	Expected to occur in most circumstances
Likely	Will probably occur in most circumstances
Unlikely	Might occur occasionally
Very unlikely	Could happen at some time
Extremely unlikely	May happen only in exceptional circumstances

In addition to the qualitative likelihood classification, a simple risk matrix has been used to assess the significance of identified potential major accidents and disasters. The risk matrix combines the likelihood of occurrence with the severity of potential consequences to determine the overall risk rating.

The matrix used for this assessment is presented in Table 2-6 below.

Table 2-6. Risk Matrix for Major Accidents and Disasters

	Minor Consequences	Moderate Consequences	Major Consequences
Extremely Unlikely	Low	Low	Medium
Very Unlikely	Low	Low	Medium
Unlikely	Low	Medium	High
Likely / Very Likely	Medium	High	Very High

Table 2-7. Risk Level Legend

Risk Level	Description
Low	Acceptable risk; no specific mitigation required beyond standard operational controls.
Medium	Risk reduction measures are required to reduce the risk to a tolerable level.
High	Strong mitigation measures are required, and continuous monitoring is necessary.
Very High	Project activities should be redesigned or require exceptional management approval and strong mitigation.

The risk ratings presented in this chapter represent residual risk levels, i.e., the level of risk expected to remain after the implementation of proposed mitigation and control measures. This approach is consistent with the ALARP (As Low As Reasonably Practicable) principle and ensures that the Project prioritises practical and cost-effective mitigation.

Although five likelihood levels were defined for qualitative analysis (Very Likely, Likely, Possible, Unlikely, Very Unlikely), these were grouped into three levels (High, Medium, Low) in the final risk matrix. This simplification supports decision-making and aligns with methodologies used in similar ESIA studies, where risk prioritisation is streamlined for early design phases.

Each event was evaluated in terms of likelihood of occurrence and magnitude of consequence on the affected receptors (people, environment, assets, and operations). Residual risks were then classified according to the combined scoring and presented alongside mitigation measures in Tables 2-8 to 2-10.

2.4 Potential major events

The major accidents/disasters (events) with the potential to result in significant negative impacts on human health, property or environmental sensitive receptors, during the construction or operations phases, are listed in Table 2-8. The justification for the inclusion of each event has been provided, along with the likelihood.

Table 2-8. Potential events (short list)

No.	Major Event Type	Phase	Potential Sensitive Receptors	Potential Impacts	Likelihood	Justification for Inclusion of the event
1	Explosion due to striking a gas main during excavation works	Construction Operation	Workers Rail Users Public and Local Community	Serious injuries and fatalities. Damage to existing railway infrastructure and local buildings. Damage to underground gas pipeline infrastructure and associated fire/explosion risks. Disruption of gas supply to nearby areas, including residential and public buildings. Disruption to the local road network. Increased costs. Delays to construction programme. Operational disruption.	Unlikely	The Project directly crosses existing gas pipeline infrastructure at the following chainage points: 155+788 155+791 -155+985 158+955 162+505 164+510 165+789 166+143 - 166+615 167+180 167+215 - 167+313 167+350 -167+950 168+148 169+100 - 169+265 169+450 As such, there is the potential for gas mains to be struck accidentally during construction (particularly excavations) or maintenance activities.
2	Striking and damaging high voltage underground cables during excavations and/or overhead power lines	Construction	Workers Rail Users Public and Local Community	Serious injury and fatalities. Local power outages and associated disruption. Increased costs Delays to construction programme	Very unlikely	The alignment passes through areas with existing high voltage underground cables and overhead power lines. Construction activities, particularly excavations and the operation of tall equipment, pose a risk of accidental contact with these electrical infrastructures. Such incidents can result in severe injuries or

No.	Major Event Type	Phase	Potential Sensitive Receptors	Potential Impacts	Likelihood	Justification for Inclusion of the event
						fatalities, as well as power outages affecting the local community
3	Collapse of earthworks, slopes, landslides	Construction Operation	Workers Rail Users Public and Local Community Environment	Serious injury and fatalities. Damage to existing railway infrastructure. Damage to nearby buildings, roads or third-party infrastructure. Increased costs Delays to construction programme Rail accidents. Disruption to railway operations. Increased sediment load in surface watercourses.	Unlikely	The alignment passes through areas characterized by varied topography, including slopes and embankments. Construction activities, such as excavation and earthworks, may destabilize these slopes, increasing the risk of collapse or landslides. Additionally, the region is subject to heavy rainfall events, which can further exacerbate slope instability. These factors contribute to the potential for earthwork failures during both construction and operational phases, potentially affecting nearby infrastructure or assets.
4	Extreme/climate related events such as flooding, high winds, snowstorm, wildfires	Construction Operation	Workers Rail Users Public and Local Community Environment	Serious injury and fatalities. Damage to existing railway infrastructure and local buildings Disruption to the local road network Increased costs Delays to construction programme Operational disruptions Destruction of habitat	Unlikely	The Project alignment traverses areas susceptible to extreme weather events, including heavy rainfall, high winds, snowstorms, and wildfires. Climate change is expected to increase the frequency and intensity of such events, posing risks to railway infrastructure and operations.
5	Train derailment	Operation	Environment Properties Workers Passengers	Serious injury and fatalities. Damage to existing railway infrastructure and local buildings. Operational disruption	Very unlikely	The Project alignment includes sections with complex track geometry, including curves and gradients, as well as areas with varying soil conditions. These factors, combined with potential human error or equipment failure,

No.	Major Event Type	Phase	Potential Sensitive Receptors	Potential Impacts	Likelihood	Justification for Inclusion of the event
				Soil contamination and contamination of adjacent surface watercourses and underlying aquifers due to spills/leaks of fuel/oil/other hazardous substances. Wagon overturning and cargo displacement. Air contamination and fire risk, particularly in the case of hazardous material transport. Increased costs		contribute to the risk of train derailment. While the probability is considered very unlikely, the potential consequences are significant, including wagon overturning, cargo displacement, and cascading impacts to adjacent infrastructure.
6	Tunnel failure	Construction (tunneling and excavation), Operation (tunnel maintenance and inspection)	Construction workers, tunnel maintenance staff, train passengers, emergency responders	Injury or fatality, entrapment of workers or passengers, major disruption of railway services, structural damage, need for emergency evacuation, potential environmental damage (e.g. debris or groundwater ingress)	Very unlikely	Planned construction of the 580 m Đunis Tunnel (km 192+274 – 192+854) introduces inherent geotechnical risks. The inclusion of this scenario is based on the need for preventive planning and emergency preparedness in line with best practice, particularly given the complexity of tunnelling works and associated safety considerations.
7	Fire or hazardous incident inside a tunnel	Operation	Passengers, Workers, Emergency responders, Infrastructure, Environment	Fatalities or serious injury due to fire or smoke inhalation; entrapment risk; damage to tunnel infrastructure and systems; disruption of traffic; increased difficulty for emergency response	Very unlikely	Tunnel sections present specific safety challenges due to limited access, confined space, and evacuation difficulties. A fire or incident involving hazardous materials inside a tunnel could result in elevated risk to human life and infrastructure compared to incidents occurring in open sections.

The table below identifies potential major accidents and disasters that could affect the Project during the construction and operational phases. Each event has been assessed based on the likelihood of occurrence and the severity of potential consequences, in accordance with the risk assessment methodology described in Section 2.3.

The Risk Level assigned to each event reflects the outcome of combining the likelihood and consequence ratings using the established Risk Matrix (Table 2-9). This approach ensures a consistent, transparent, and systematic evaluation of risks, aligned with international best practices and the ALARP (As Low As Reasonably Practicable) principle.

The events identified in the table are based on:

- A review of baseline environmental and social conditions,
- An analysis of historical incidents in the region,
- Consideration of technical project characteristics,
- Anticipated climate-related hazards.

Mitigation measures have been developed for each identified event to either prevent the occurrence or minimise the potential consequences, as detailed in the following sections.

Mitigation measures have been developed for each identified event to either prevent the occurrence or minimise the potential consequences, as detailed in the following sections.

Table 2-9. Risk Matrix Outcome

No.	Major Event Type	Phase	Likelihood	Consequence	Risk Level
1	Explosion due to striking a gas main during excavation works	Construction / Operation	Unlikely	Major	High
2	Striking and damaging high voltage underground cables during excavations and/or overhead power lines	Construction	Very Unlikely	Major	Medium
3	Collapse of earthworks, slopes, landslides	Construction / Operation	Unlikely	Major	High
4	Extreme/climate related events such as flooding, high winds, snowstorm, wildfires	Construction / Operation	Unlikely	Moderate	High
5	Train derailment	Operation	Very Unlikely	Moderate	Medium
6	Tunnel failure	Construction / Operation	Very Unlikely	Major	Medium
7	Fire or hazardous incident inside a tunnel	Operation	Very Unlikely	Major	Medium

2.5 Assessment assumptions and limitations

The following key assumptions and limitations are recognized:

- The project is designed and its implementation guided by good practice industry standards and codes, many of which are mandatory. This ensures that infrastructure and systems are designed to eliminate or reduce risks to people and the environment to levels that are As Low as Reasonably Practicable (ALARP).
- Environmental and Social (E&S) impacts during the construction phase of the Project will be managed through the implementation of relevant E&S Management Plans.
- Environmental effects associated with unplanned events that do not meet the definition of a major event (e.g., minor leaks and spills that may be contained within the construction sites) are addressed in other relevant ESIA chapters and mitigation measures provided in the Environmental and Social Management Plan (ESMP).
- It is recognised that the management framework for the Project is not fully defined at this stage; however, an assumption of regulatory compliance, and that good industry practice will be met by the appointed construction contractor and SRI through the management framework has been made.
- The design, installation, commissioning, operation, and maintenance of plant, drainage systems, equipment, and machinery, including associated systems, will adhere to Good Engineering Practice.
- Any transport of dangerous goods will be conducted in full compliance with the RID regulations.
- Railway undertakings operating on the line will be in possession of a valid Safety Certificate and operate under a Safety Management System in line with the EU Rail Safety Directive.
- Rolling stock used on the line will comply with applicable technical requirements and will be regularly maintained in accordance with national and EU safety standards.

2.6 Mitigation and enhancement measures

2.6.1 Interoperability and Common Safety Methods

The Serbian Railways Infrastructure (SRI) adheres to the Technical Specifications for Interoperability (TSI) as well as the Common Safety Methods adopted by the European Union. Certification of the infrastructure will be conducted by a Notified Body (NOBO), ensuring compliance with TSI requirements for interoperability and safety standards.

Additionally, the infrastructure will undergo review by an Assessment Body (AsBO) as part of the adoption of EU Common Safety Methods. This process ensures that safety measures and procedures meet European standards and regulations, contributing to the overall safety and interoperability of Serbia's railway network within the European framework.

In addition to regulatory certification, the reconstructed railway incorporates advanced system-level features that significantly improve safety. These include:

- **European Train Control System (ETCS) Level 2**, enabling continuous supervision of train movement and reducing the likelihood of collision or overspeed incidents.
- **Centralised Traffic Control (CTC)** and **SCADA** systems for real-time monitoring of infrastructure and railway operations.

- **Electronic interlocking** at all stations, integrated into the national control centre.
- **Complete elimination of level crossings** along the alignment, with full grade separation achieved through construction of underpasses and overpasses. This design solution removes all road–rail conflict points and significantly enhances safety for both rail operations and road users.
- **Axle counters** for precise train detection and track section monitoring.
- **Station and tunnel fire protection systems**, including smoke detection, emergency exits, and lighting.
- **GSM-R communications** for secure, interoperable voice and data communication across the network.
- **Perimeter fencing and grade-separated crossings**, reducing third-party intrusion and collision risk.

Together, these technical enhancements form a modern, integrated safety architecture that aligns with EU best practice and addresses both regulatory and operational risks.

2.6.2 Mitigation measures

The construction contractor (during the construction phase) and SRI (during the operations phase) must develop and implement an **Emergency Preparedness and Response Plan** (incorporating a **Major Spill Management Plan**) that considers the risks associated with all of the events identified in Table 2-9 above and includes, as a minimum, the relevant mitigation measures outlined in Table 2-9Table 2-10 below.

In addition, all construction and operational E&S risks must be managed in accordance with the relevant E&S Management Plans, including but not limited to the Water and Soil Management, Air Quality, Traffic and Biodiversity Management Plans.

Table 2-10. Mitigation Measures specific to Potential Incident Risks

No.	Major Event Type	Phases which exacerbate vulnerability	Mitigation and Enhancement Measures
1	Explosion due to striking a gas main during excavation works	Construction Operation	▪ Prior to any excavation works, obtain and verify accurate maps of underground gas pipelines from relevant authorities and utilities. ▪ Conduct on-site detection surveys to confirm the exact location and depth of pipelines. ▪ Clearly mark the location of pipelines on-site using visible signage and barriers. ▪ Establish safe buffer zones around identified pipelines, prohibiting the use of heavy machinery within these zones unless supervised excavation methods are employed. ▪ Train construction workers on the risks associated with working near gas pipelines and on emergency procedures. ▪ Implement Permit-to-Work systems for any excavation activities within pipeline corridors.

No.	Major Event Type	Phases which exacerbate vulnerability	Mitigation and Enhancement Measures
			- Develop and maintain an Emergency Response Plan specifically including pipeline incidents, including immediate notification procedures and evacuation plans. - Maintain continuous communication and coordination with the gas pipeline operator during construction activities near pipelines
2	Striking and damaging high voltage underground cables during excavations and/or overhead power lines	Construction	To prevent accidental strikes on high voltage underground cables and overhead power lines during construction, the following measures will be implemented: - Conduct detailed surveys using modern cable detection equipment (e.g., Ground Penetrating Radar, electromagnetic locators) prior to any excavation activities. - Verify the location and depth of underground cables based on as-built drawings and site investigations. - Clearly mark identified underground cable routes and overhead power line zones with visible signage and physical barriers where necessary. - Establish safe working distances from high voltage infrastructure in accordance with national and international safety standards. - Train construction workers on risks associated with working near electrical infrastructure and emergency response procedures in the event of cable strikes. - Implement a Permit-to-Work system for excavation works in proximity to high voltage cables. - Install additional mechanical protection for existing cables at critical crossing points (e.g., roadways, railway crossings) where accidental damage risk is higher. Develop and maintain an Emergency Response Plan which specifically addresses cable strike incidents, including procedures for the immediate isolation of affected power circuits.
3	Collapse of earthworks, slopes, landslides	Construction Operation	To prevent slope failure, landslides, and the collapse of earthworks during construction and operation, the following measures will be implemented: - Limit the movement of heavy machinery by designating specific access routes, parking, and turning areas to avoid destabilisation of sensitive zones. - Design and implement adequate surface water drainage systems, including the construction of drainage channels, to minimise water infiltration and erosion.

No.	Major Event Type	Phases which exacerbate vulnerability	Mitigation and Enhancement Measures
			- Install inclinometers and other ground movement monitoring devices at critical locations to enable early detection of slope instability. - Stabilise excavations through appropriate engineering methods such as temporary shoring, benching, or the use of retaining structures where required. - Perform all excavation activities in accordance with applicable technical regulations, project documentation, and good engineering practices. - Ensure that all final excavation surfaces are shaped and finished according to project specifications and designed stable slope angles. - Incorporate the findings and recommendations of the seismic hazard study when excavating near platform foundations, ensuring foundations are placed in stable soil layers. - Continuously monitor groundwater levels and earthwork stability throughout the construction phase, using prediction measurements and real-time observations to detect any changes in ground conditions. - Conduct regular geotechnical inspections of embankments, cuttings, and slopes during operation, including both visual checks and instrument-based monitoring where appropriate. - Maintain and periodically clean all surface drainage infrastructure (culverts, ditches) to reduce infiltration and erosion-related destabilisation - Provide training to maintenance staff for recognising and reporting early signs of ground movement or erosion. - Implement vegetation control on embankments and slopes to prevent deep root penetration and to maintain surface integrity, while balancing erosion control and ecological needs. - Establish standard emergency response procedures in the event of observed slope failure (e.g. immediate service suspension, rerouting, notification of authorities).
4	Extreme/climate related events such as flooding, high winds, snowstorm, wildfires	Construction Operation	To prevent and mitigate the risks associated with extreme climate-related events during construction and operation, the following measures will be implemented: - Equip construction sites and operational facilities with fire detection, alarm, and firefighting equipment appropriate to the scale and use of the premises, and ensure all equipment is regularly inspected and maintained.

No.	Major Event Type	Phases which exacerbate vulnerability	Mitigation and Enhancement Measures
			■ Provide manual firefighting equipment that is easily accessible and simple to use by site personnel. ■ Establish early warning systems for extreme weather events (e.g., flooding, high winds, wildfires) and ensure that site management teams are trained to respond appropriately to warnings. ■ Ensure that the Emergency Response Plans for both construction and operational phases adequately address specific natural hazards relevant to the Project area, including flooding, high winds, snowstorms, and wildfires.. ■ Train managerial staff and emergency coordinators in disaster response and evacuation procedures tailored to climate-related risks. ■ Conduct regular public awareness campaigns for local communities on personal safety measures during extreme weather events, using clear and practical information channels (e.g., information boards, community meetings, local media). ■ Implement real-time monitoring of weather conditions during critical construction activities to enable proactive decision-making and timely suspension of works when severe conditions are forecasted.
5	Train derailment	Operation	To prevent derailments and minimise their consequences during the operational phase, the following mitigation measures will be implemented: ■ Although specific Derailment Mitigation Measures (DMMs), such as guardrails or deflecting walls, are not included in the current infrastructure design, derailment risk is addressed through the application of the Common Safety Methodology (CSM). This includes the implementation of ETCS Level 2, electronic interlocking, track geometry compliance, and access control for certified railway undertakings.. ■ Conduct regular inspection and maintenance of track geometry and railway infrastructure to detect and eliminate risks contributing to derailments. ■ Ensure that only railway undertakings certified under national and EU safety regulations have access to the infrastructure, and that they are responsible — in accordance with Serbian railway legislation — for the technical condition, maintenance, and pre-departure inspection of their rolling stock, including wagon frames, suspensions, wheelsets, and loading compliance. ■ Apply rigorous monitoring and maintenance protocols for Signalling and Train Control Equipment to ensure operational reliability and early detection of system failures.

No.	Major Event Type	Phases which exacerbate vulnerability	Mitigation and Enhancement Measures
			■ Implement speed restrictions where necessary, particularly in track sections prone to twisting or other stability risks. ■ Ensure that only railway operators whose staff are appropriately trained in accident prevention and emergency procedures — in accordance with national and EU safety regulations — are granted access to the infrastructure. ■ Ensure that Operation and Maintenance (O&M) manuals are made available to all operational staff prior to the commencement of service, with specific emphasis on derailment risk factors and preventive actions. ■ The SRI Major Incident Response Plan providing emergency response protocols in the event of derailments and other critical incidents should be updated to account for the anticipated higher train speeds (up to 200km/h). This Plan should demonstrate institutional preparedness and alignment with national railway safety procedures. The Plan should outline the definition of responsibilities, communication channels, and on-site response mechanisms, contributing to effective incident management in line with applicable regulations. The Plan should also specifically cover incidents and accidents involving hazardous goods, including those regulated under RID. To ensure continued relevance and effectiveness, the implementation of the Plan — including regular updates, training exercises, and coordination with emergency services — will be monitored as part of the Project's Operation ESMP.
6	Tunnel failure	Construction Operation	To prevent tunnel failure and minimise risks during construction and operation, the following measures will be implemented: During Construction: ■ Undertake detailed geotechnical investigations prior to excavation and continuously update geotechnical assessments based on actual ground conditions encountered during construction. ■ Apply appropriate tunnel excavation methods (e.g., New Austrian Tunnelling Method - NATM or other best practices) based on soil and rock stability conditions. ■ Install temporary and permanent support systems (e.g., rock bolts, shotcrete, steel ribs) as required to ensure tunnel stability. ■ Implement continuous ground and tunnel structure monitoring using inclinometers, extensometers, and convergence

No.	Major Event Type	Phases which exacerbate vulnerability	Mitigation and Enhancement Measures
			monitoring systems to detect ground movement and structural deformation early. - Establish drainage and waterproofing systems to manage groundwater ingress effectively during excavation. - Develop and maintain an Emergency Response Plan specific to tunnel construction incidents, including evacuation procedures and immediate stabilization measures. During Operation: - All tunnel structures are designed and constructed in accordance with Eurocode 8 (EN 1998) for seismic resistance, ensuring resilience to seismic events and other structural stresses. - Implement regular structural inspections and maintenance programs for the tunnel lining, drainage systems, ventilation systems, and emergency infrastructure. - Maintain tunnel safety systems, including fire detection and suppression systems, emergency lighting, and communication systems. Conduct periodic risk assessments and revise the Emergency Response Plan based on operational experience and updated risk profiles.
7	Fire or hazardous incident inside a tunnel	Operation	Implement tunnel-specific safety measures including: - Automatic fire detection and suppression systems, - Smoke extraction and forced ventilation systems, - Clearly marked and accessible emergency exits and signage, - Emergency lighting and communication systems, - Tunnel emergency response plans developed in coordination with local authorities, - Regular drills and training exercises for incident response teams. These measures shall comply with relevant EU tunnel safety regulations and national technical standards.

3. CONCLUSION

The assessment presented in this Chapter demonstrates that the Project has systematically identified and evaluated all relevant risks associated with major accidents and disasters, including both natural and man-made hazards, during the construction and operational phases.

Appropriate mitigation measures have been developed and incorporated into the Project design, construction planning, operational protocols, and emergency response systems. These measures have been structured to prevent incidents where possible and to minimise their potential impacts on workers, rail users, the local community, the environment, and infrastructure.

The Project design and associated safety measures have been developed in full alignment with applicable European and international standards, including the Eurocodes (particularly EN 1998 for seismic design), and in compliance with the EBRD Performance Requirements and EIB Environmental and Social Standards.

All identified risks have been assessed and addressed following the ALARP (As Low As Reasonably Practicable) principle, ensuring that residual risks are reduced to the lowest feasible level through a combination of preventive, protective, and response measures.

Emergency Preparedness and Response Plans have been established, or are being developed where appropriate, to ensure timely and effective management of any incidents that may occur during the Project's lifecycle.

In line with good engineering practice and regulatory expectations, safety-in-design is recognised as an iterative process. The measures outlined in this chapter represent the current stage of risk-informed design and planning, and will be progressively detailed and incorporated into final designs and operational procedures as the Project advances. This ongoing integration will be carried out in coordination with the design teams and in alignment with EU Common Safety Methodology and national railway safety regulations.

As a result, no residual risks of major accidents or disasters are anticipated that could materially affect the feasibility, safety, or sustainability of the Project, provided that the proposed mitigation measures are properly implemented and maintained throughout the construction and operational phases.

4. REFERENCES

- Climate Change Knowledge Portal (2021) Risk Historical Hazards – Serbia. Available at: https://climateknowledgeportal.worldbank.org/country/serbia/vulnerability
- IEMA (2024) Major Accidents and Disasters in EIA Guide. Institute of Environmental Management & Assessment (IEMA), England and Wales. Available at: https://www.iema.net/resources/blog/2020/09/23/iema-major-accidents-and-disasters-in-eia-primer
- International Standards Organization (2009) ISO 31000:2009 Risk Management – Principles and Guidelines.
- UNDRR (2023) GAR Special Report 2023: Mapping Resilience for the Sustainable Development Goals. Available at: https://www.undrr.org/gar/gar2023-special-report
- IEC (2021) IEC 60079-10-1:2021 Explosive Atmospheres – Part 10-1: Classification of Areas – Explosive Gas Atmospheres. Available at: https://www.evs.ee/en/evs-en-iec-60079-10-1-2021
- Ministry of Agriculture, Forestry and Water Management, Republic of Serbia (2024) Bylaws, Republic Directorate for Water. Available at: https://rdvode.gov.rs/podzakonska-akta.php
- Ministry of Construction, Transport and Infrastructure, Republic of Serbia (2024) Information received – Railways and Intermodal Transport, June 19, 2024.
- Infrastructure of Serbian Railways JSC (2025) Network Statement.
- Spatial Plan for the Area of the Special Purpose Infrastructure Corridor of the Belgrade–Niš Railway (2020). ("Просторни план подручја посебне намене инфраструктурног коридора железничке пруге Београд–Ниш", 2020.)
- Scoping Report - Reconstruction and Modernization of the Railway Line Belgrade–Niš up to speed of 200 km/h. Preparation for Feasibility Study, ESIA and Preliminary Design, May 2022.
- Vatrozaštita (2024) Four Categories of Fires. Available at: https://vatrozastita.com/4-kategorije-pozara/

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RAILWAY LINE BELGRADE–NIŠ, SECTION III PARAĆIN TO TRUPALE (NIŠ)
Environmental and Social Impact Assessment, 18. OCCUPATIONAL HEALTH & SAFETY

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LIST OF ABBREVIATIONS AND ACRONYMS

ACM	Asbestos-Containing Material
AoI	Area of Influence
CESMP	Construction Environmental and Social Management Plan
COPD	Chronic Obstructive Pulmonary Disease
EBRD	European Bank for Reconstruction and Development
EIB	European Investment Bank
ERTMS	European Rail Traffic Management System
ESAP	Environmental and Social Action Plan
ESIA	Environmental and Social Impact Assessment
ESMP	Environmental and Social Management Plan
EU	European Union
EUD	Delegation of the European Union to the Republic of Serbia
H&S	Health and Safety
HSMS	Health & Safety Management System
LOTO	Lockout/Tagout
ILO	International Labour Organization
ISO	International Organization for Standardization
MEI	Ministry of European Integration
OHS	Occupational Health and Safety
PPE	Personal Protective Equipment
PPF9	Project Preparation Facility 9
RS	Republic of Serbia
SMS	Safety Management System
SRI	Serbian Railway Infrastructure

Contents

1 INTRODUCTION

This chapter presents the assessment of occupational health and safety (OHS) risks and impacts for the Project. The assessment aims to describe the current state of safety practices relevant to future railway reconstruction works, identify and evaluate potential OHS risks to workers during all stages of the Project, and propose measures to prevent or minimize negative impacts.

The assessment identifies and predicts both positive and adverse impacts, considering direct, indirect, and cumulative impacts on worker health and safety. By analysing potential risks associated with both construction and operation phases, this assessment provides a framework for integrating OHS considerations into Project planning and management.

The findings of this chapter have informed the development of appropriate mitigation measures to eliminate or reduce risks, and the chapter includes an assessment of the significance of residual impacts following their implementation. Additionally, it outlines monitoring activities necessary to evaluate the effectiveness of mitigation measures and ensure continuous improvement in worker safety performance throughout the Project lifecycle.

This assessment serves as a high-level framework that will guide the preparation of more detailed OHS management documents, including the Environmental and Social Management Plan (ESMP) and specific Contractor/SRI Management Plans, ensuring alignment with national regulations and international standards as listed below.

1.1 EU Requirements

General OHS Framework Directives

- Directive 89/391/EEC – Framework Directive on occupational health and safety, establishing general principles for worker protection.
- Directive 92/57/EEC – Temporary or mobile construction sites, specifying minimum safety and health requirements.
- Directive 2009/104/EC – Use of work equipment by workers at work, ensuring safe operation of machinery and tools.

Railway and Transport-Specific Safety Directives

- Directive 2004/49/EC (as amended by Directive 2008/110/EC and replaced by Directive 2016/798) – Railway Safety Directive, requiring risk management in railway operations and construction.
- Directive 2016/797/EU – Interoperability of the railway system, ensuring safety in railway infrastructure and operations.
- Directive 2014/90/EU – Safety requirements for equipment used in railway operations.

Workplace and Construction-Specific Directives

- Directive 89/656/EEC – Use of personal protective equipment (PPE) in the workplace.

- Directive 2003/10/EC – Protection of workers from risks related to exposure to noise.
- Directive 2002/44/EC – Protection of workers from risks related to exposure to vibration.
- Directive 2013/35/EU – Protection of workers from electromagnetic fields (important for electrified railway construction).
- Directive 92/58/EEC – Safety and health signs at work.
- Directive 2019/1937/EU – Protection of whistleblowers reporting safety violations.

Hazardous Substances and Chemical Safety Directives

- Directive 98/24/EC – Protection of workers from risks related to chemical agents.
- Directive 2004/37/EC – Protection of workers from risks related to carcinogens or mutagens at work.
- Directive 2012/18/EU – Control of major-accident hazards involving dangerous substances (Seveso III Directive).

1.2 EBRD Requirements

The approach of European Bank for Reconstruction and Development (EBRD) to OHS is outlined within, but not limited to, Performance Requirement 4 - Health, Safety, and Security, which mandates that projects must ensure a safe and healthy working environment for employees and contractors. The Project should adhere to these requirements through structured risk management, mitigation measures, and ongoing monitoring.

The following is a concise summary and prioritization of these requirements:

General Workplace Safety Requirements

- Ensure a safe and healthy working environment in compliance with national and international standards.
- Implement a Health & Safety Management System aligned with ISO 45001 or equivalent.
- Conduct regular risk assessments and implement mitigation measures.
- Establish emergency preparedness and response plans.
- Ensure proper worksite supervision and enforcement of safety rules.

Risk Management in Construction and Operation

- Identify and control hazards related to railway electrification, heavy machinery, work at height, and confined spaces.
- Implement fall prevention measures, safe scaffolding, and protective barriers.
- Ensure safe handling and operation of railway construction equipment.
- Minimize worker exposure to noise, vibration, dust, and hazardous materials.
- Implement safe traffic and pedestrian management plans for railway construction zones.

Use of Personal Protective Equipment (PPE)

- Provide appropriate Personal Protective Equipment (PPE) (helmets, gloves, high-visibility clothing, respiratory protection, etc.).

- Ensure mandatory PPE use and proper worker training.
- Maintain PPE in good condition and replace defective equipment.

Training and Competency Development

- Provide regular safety training for all workers, including subcontractors.
- Conduct specialized training for high-risk activities (e.g., working near live railway tracks or high-voltage lines).
- Implement worker induction programs before they begin work on-site.

Workers' Welfare and Accommodation

- Ensure access to clean drinking water, sanitation, and hygiene facilities.
- Provide adequate worker accommodation, if required, in compliance with EBRD guidelines.
- Ensure fair working conditions, including compliance with working hours and rest breaks.

Incident Reporting and Emergency Preparedness

- Establish mechanisms for reporting and investigating workplace accidents and near misses.
- Maintain records of injuries, illnesses, and fatalities and take corrective action.
- Conduct regular safety drills and emergency response training.
- Ensure availability of onsite first aid stations and medical personnel.

Worker Engagement and Grievance Mechanisms

- Implement a worker grievance mechanism to allow employees to raise safety concerns.
- Engage with workers and safety representatives in decision-making processes.
- Ensure protection from retaliation for workers who report safety violations.

1.3 EIB Requirements

The European Investment Bank (EIB) follows strict occupational health and safety guidelines to ensure worker protection on financed projects. The Project must comply with the EIB Environmental and Social Standards, specifically ESS 9 – Occupational and Public Health, Safety, and Security.

The following is a concise summary and prioritization of these requirements:

Key EIB Health & Safety Requirements

- Establish a robust Health & Safety Management System (HSMS) in line with international best practices.
- Integrate occupational health and safety risk management into project design, planning, and execution.
- Implement preventative and protective measures to eliminate workplace hazards.
- Promote a culture of safety and worker well-being through awareness campaigns and training.

Hazard Identification and Risk Mitigation

- Conduct comprehensive risk assessments before and during project execution.
- Identify potential exposure to hazardous substances, excessive noise, vibration, and ergonomic risks.
- Ensure safe operation of heavy machinery and railway infrastructure.
- Establish a monitoring system to assess OHS performance and improve measures when necessary.

Emergency Preparedness and Response

- Develop emergency response plans tailored to railway construction and operation risks.
- Ensure access to medical support and emergency evacuation procedures.
- Conduct regular emergency drills involving workers, management, and emergency services.
- Maintain an adequate number of onsite first-aid responders.

Worker Rights and Working Conditions

- Ensure non-discrimination, fair treatment, and equal opportunities for all workers.
- Guarantee compliance with international labour standards (ILO conventions) on working hours, rest breaks, and wages.
- Provide safe and hygienic worker accommodation, if required.
- Establish a grievance mechanism that allows workers to raise safety concerns confidentially.

PPE and Training Requirements

- Ensure the availability and proper use of PPE for all employees and contractors.
- Conduct regular health and safety training sessions for all project workers.
- Train workers in hazard recognition, first aid, and fire safety procedures.
- Provide specialized training for high-risk tasks, such as working with electricity and railway operations.

Monitoring and Compliance

- Implement an OHS monitoring system with regular inspections and audits.
- Establish a data-driven approach for reporting and analysing workplace incidents.
- Ensure continuous improvement through periodic safety reviews and risk assessments.
- Align OHS practices with EIB safeguard policies and best international standards.

1.4 National Legislative Framework

Serbia has ratified all ten Fundamental Conventions of the International Labor Organization (ILO), reinforcing its commitment to core labor rights, including decent work, non-discrimination, the elimination of forced and child labor, and the right to freedom of association and collective bargaining. These conventions form a crucial part of the international labor standards framework and serve as a foundation for Serbia's national occupational health and safety (OHS) legislation and enforcement mechanisms.

This ratification ensures that Serbia's OHS practices align with globally recognized human and labor rights obligations. The Project's OHS framework and contractor requirements are expected to reflect these commitments, particularly in ensuring fair working conditions, safeguarding workers from retaliation, and upholding their right to report safety concerns.

The Project must comply with the Serbian Occupational Health and Safety related laws and regulations listed below. While these rulebooks and laws are among the most essential, they do not exempt compliance with other mandatory legal requirements.

Primary Laws

Law on Safety and Health at Work (Official Gazette of RS, No. 35/23)

- Establishes fundamental requirements for occupational health and safety in all sectors.
- Defines employer and worker obligations regarding workplace safety.
- Introduces risk assessment procedures, worker training and recertification requirements, and employer responsibilities for PPE provision.
- Enhanced protection measures for workers engaged in subcontracted and temporary work.
- Robust inspection and enforcement powers for the Labour Inspectorate, including digital reporting.
- Requirements for psychological health and well-being in the workplace.

Law on Railways (Official Gazette of RS, No. 41/18, 62/23)

- Regulates railway infrastructure construction, operation, and maintenance.
- Covers safety requirements for railway workers and procedures for accident prevention.
- Specifies technical and organizational measures for safe railway operations.
- Alignment with EU interoperability requirements.

Law on Planning and Construction (Official Gazette of RS, No. 72/09, 81/09, 64/10, 24/11, 121/12, 42/13, 50/13, 98/13, 132/14, 145/14, 83/18, 31/19, 37/19, 9/20, 52/21 i 62/23)

- Establishes safety requirements for construction works, including railway infrastructure projects.
- Defines obligations of contractors, engineers, and workers regarding site safety.
- Requires OHS plans to be integrated into project design and execution.
- Centralized e-construction permitting system.

Regulations and Rulebooks Related to OHS

Rulebook on Preventive Measures for Safe and Healthy Work (Official Gazette of RS, No. 21/09, 1/19)

- Specifies general preventive measures for workplace safety across all industries.
- Includes requirements for hazard identification and risk control.

Regulation on Construction Site Safety (Official Gazette of RS, No. 14/09, 95/10, 98/18, 35/23, 76/24)

- Defines safety procedures on construction sites, including railway works.
- Requires implementation of fall protection, electrical safety, and fire prevention measures.
- Mandates proper handling of hazardous materials and safe operation of heavy machinery.

Rulebook on occupational safety on construction site (Official Gazette of RS, No. 53/97, 14/09)

- Prescribes special measures and occupational safety standards when performing construction work.
- Mandates proper managing the construction related activities and equipment.

Rulebook on the method and procedure for risk assessment (Official Gazette of RS, No. 76/24)

- Defines the method and procedure for assessing the risk of occupational injury, disease, and work-related illness.
- Defines the method, measures, and deadlines for their elimination, prevention, or reduction to the lowest possible extent.

Rulebook on Personal Protective Equipment (PPE) (Official Gazette of RS, No. 92/08, 101/18)

- Establishes minimum requirements for PPE use in workplaces.
- Specifies types of PPE required for different occupational risks.
- Provides guidelines for employer responsibilities in providing and maintaining PPE.

Regulation on the Content and Manner of Performing Safety Training for Employees (Official Gazette of RS, No. 109/2016)

- Requires periodic OHS training for workers.
- Establishes the format, duration, and certification process for training programs.

Rulebook on Work Equipment Safety (Official Gazette of RS, No. 23/09, 123/12, 102/15, 101/18))

- Sets technical and operational safety requirements for machinery and equipment.
- Regulates inspection, maintenance, and usage of construction and railway-related equipment.

Regulation on Occupational Health and Safety Measures for Work at Heights (Official Gazette of RS, No. 5/25)

- Defines safety measures for work on elevated surfaces, including scaffolding and railway infrastructure.
- Specifies requirements for fall protection systems.

Rulebook on Noise Protection in the Workplace (Official Gazette of RS, No. 96/11, 78/15, 93/19)

- Limits worker exposure to harmful noise levels in railway construction and operation.
- Requires noise monitoring, engineering controls, and hearing protection measures.

Rulebook on Preventive Measures due to Vibrations Exposure (Official Gazette of RS, No. 93/11, 86/19)

- Limits worker exposure to harmful vibration levels.
- Sets the Employer obligation to eliminate or reduce the risks of vibration exposure.

Regulation on the Classification of Workplaces Based on Risk Level (Official Gazette of RS, No. 15/2018)

- Defines workplace hazard categories and appropriate risk mitigation strategies.
- Guides employers in implementing targeted OHS interventions.

Regulation on Emergency Response (Official Gazette of RS, No. 109/16)

- Establishes requirements for emergency preparedness and response, equipment to be provided, training deadlines and methods.
- Covers construction and railway-related accidents.

Key Rulebooks Governing Railway Operation Safety in Serbia

Law on Safety in Railway Transport (Official Gazette of RS, No. 41/18)

- Establishes general safety requirements for railway operations, including infrastructure, rolling stock, and personnel.
- Defining protocols for accident prevention, emergency response, and risk management.
- Specifies procedures for track maintenance and operational safety of high-speed and electrified railways.

Rulebook on Technical Conditions for Railway Infrastructure (Official Gazette of RS, No. 39/23, 17/24)

- Sets technical standards for railway tracks, overhead lines, signalling, and other infrastructure.
- Requires regular safety inspections and maintenance schedules.
- Regulates permissible operational speeds and braking distances.

Rulebook on Safety Management System and Methods for Railway Exploitation and Maintenance (Official Gazette of RS, No. 124/2020)

- Obligates railway operators to establish and maintain an SMS in line with EU and Serbian regulations.
- Requires continuous risk assessments, safety performance monitoring, and reporting.
- Specifies safety roles and responsibilities for operators, contractors, and railway personnel.

Rulebook on Certification of Railway Workers in Safety-Critical Positions (Official Gazette of RS, No. 66/22)

- Defines certification and training requirements for train drivers, signal operators, and maintenance personnel.
- Mandates periodic health and psychological evaluations for railway staff.
- Ensures compliance with EU Directive 2007/59/EC on train driver certification.

Rulebook on Traffic Management and Signalling in Railway Transport (Official Gazette of RS, No. 34/22, 107/22)

- Defines operational procedures for train movement, track switching, and communication between railway staff.
- Regulates the use of signals, track occupancy rules, and emergency stopping protocols.
- Ensures integration with ERTMS (European Rail Traffic Management System) standards for high-speed railway operations.

Rulebook on Incident Investigation in Railway Transport (Official Gazette of RS, No. 58/19)

- Establishes mandatory emergency preparedness plans for railway operators.
- Specifies incident reporting, investigation procedures, and corrective actions.
- Requires coordination with local emergency services and compliance with EU safety reporting obligations.

Rulebook on Maintenance Standards for Railway Infrastructure and Rolling Stock (Official Gazette of RS, No. 39/23)

- Defines maintenance requirements for tracks, overhead lines, signalling equipment, and rolling stock.
- Mandates periodic safety inspections and defect reporting.
- Aligns maintenance protocols with EU Regulation 2019/779 on the certification of railway maintenance.

2 BASELINE CONDITIONS

2.1 Summary of Project Activities Relevant to OHS

The Project involves the reconstruction of the Belgrade–Niš railway line, Section III (Paraćin–Trupale), and includes multiple components that are associated with significant occupational health and safety (OHS) considerations. The following summary outlines the main project activities and explains their relevance from an OHS perspective:

- **Decommissioning of existing infrastructure** – the Project will involve the dismantling and removal of existing railway assets, including rails, ballast, overhead electrification systems, and station infrastructure exposing workers to a variety of hazards.
- **Track realignment and installation** - this activity involves earthworks, subgrade preparation, ballast laying, and rail installation using heavy machinery.
- **Construction of railway structures** - the Project will include construction of bridges, viaducts, tunnels, underpasses and overpasses, retaining walls, culverts and drainage channels.
- **Electrification and signaling upgrades** - this activity involves works on installation of high-voltage catenary systems, substations, and signaling installations to meet the modern high-speed rail standards.
- **Installation of an ancillary infrastructure** - will include works on construction and installation of fencing and service roads.
- **Material transport, storage, and waste management** - a significant volume of materials, including aggregates, steel, fuels, and hazardous substances, will be transported, handled, and stored on-site.

In summary, the works involve complex, multi-disciplinary activities that expose workers to a wide range of safety risks. These include physical hazards, chemical exposure, electrical risks, high-risk construction tasks, and hazards associated with legacy infrastructure. The OHS impact assessment in the following chapters builds on this activity profile to identify specific risks and recommend targeted mitigation measures that align with Serbian regulations and international best practices.

2.2 OHS Impact Zone

OHS impact zones in a railway construction and operation project encompass all locations where workers are directly engaged, as well as areas that may be indirectly affected by project activities. The OHS impact zone extends beyond construction and operation sites to include critical support facilities and access routes. Considering the specific characteristics of the project area, the OHS impact zones can be categorized as follows:

2.2.1 Construction Phase

Throughout the construction phase of this Project, the potential OHS risks are principally associated with the operational deployment of heavy machinery, participation in high-risk activities (such as excavation, tunnelling, and bridge engineering), and the likelihood of exposure to hazardous materials. Based on the anticipated Project layout and characteristics, the OHS impact zones can be detailed as:

Primary Work Zones:

- **Construction Sites** - these encompass areas designated for major reconstruction activities such as track realignment, earthworks, and the construction of ancillary infrastructure. Key worksites include the 7 railway stations that will be reconstructed, the 2 stops being upgraded to stations, the 1 station that will be decommissioned, the 1 bridges that will be constructed and 12 bridges that will be reconstructed, the 2 viaducts that will be constructed, the tunnel at Đunis, the 30 new deleveled crossings that will be constructed (to replace the 48 existing road level crossings), and the locations where fencing, noise barriers and some access roads will be installed.
- **Material storage and processing areas** - these include temporary depots for aggregate, steel, and other construction hazardous and non-hazardous materials, as well as zones for material preparation. Additionally, specific storage compartments for hazardous and non-hazardous waste, together with waste management and containment infrastructure, are classified as work zones where potential impacts on worker health and safety may occur. The specific locations and extents of these zones will be identified post-site establishment by the contractor and will be explicitly detailed within the contractor's Health and Safety management plan.
- **Temporary worker accommodations and welfare facilities** - facilities that may be set up, typically near urban areas such as Paraćin, Ćićevac, or Stalać to house construction staff and provide amenities. However, the exact locations of —and whether dedicated worker accommodation camps will be established at all—remain uncertain at this stage, as this will depend on the Contractor’s final approach and arrangements.

Secondary Work Areas:

- **Access roads used by construction vehicles** - this is expected to include state roads class IIA (number 23, 158, 217 and 215) and multiple local roads connecting worksites, such as those providing access to construction zones. It also includes temporary access roads to be established by the Contractor as needed, depending on site-specific logistics and requirements.
- **Quarry sites, concrete batching plants, and material stockpiles** - these are likely to be in the nearby areas supplying the construction sites.
- **Power supply stations and temporary utilities for construction** - locations providing electricity to support construction operations, particularly near high-intensity work zones such as bridges and the Đunis tunnel construction zone.

Worker Transportation and Supply Chain Locations:

- **Areas where workers commute to/from the site** - routes used by workers commuting to/from worksites across nearby settlements.
- **Supplier and subcontractor premises** - this includes facilities for steel fabrication, pre-cast concrete plants, and other supply chain contributors located in the wider project area.

Emergency Response and Medical Support Areas:

- **First aid stations and local hospitals/clinics** - with key nearby facilities located in Paraćin, Ćićevac, Aleksinac and Niš.
- **Evacuation routes and emergency assembly points** - strategically located within high-risk zones, such as bridge and tunnel construction sites, to ensure swift response during emergencies.

2.2.2 Operations Phase

During the operations phase, OHS hazards are predominantly associated with railway maintenance, routine inspections, and emergency intervention protocols. The OHS impact zones comprises the following components:

Railway Infrastructure & Operational Facilities:

- **Railway tracks, tunnels, and bridges** - routine maintenance and inspections will take place across major railway infrastructure, including: the 13 bridges, 2 viaducts, Đunis tunnel, and 42 culverts. These structures are integral to the railway's operation and require regular assessments to ensure structural integrity and safety.
- **Stations and depots** - the Project will include nine stations—Paraćin, Ćićevac, Sikirica–Ratare, Korman, Adrovac, Aleksinac, Lužane, Trupale and Tešica. Regular upkeep of these facilities is essential to maintain safe and efficient passenger and freight services.
- **Electrical substations and signalling systems** - Maintenance will be required on new electrification systems and upgraded high-speed railway signalling infrastructure located throughout both sub-sections.

Maintenance and Repair Areas:

- **Permanent workshops and maintenance yards** - dedicated facilities for rolling stock servicing and railway component repairs, likely to be located near Aleksinac, Niš, and Paraćin stations.
- **Storage facilities for spare parts, lubricants, and hazardous materials** - on-site storage facilities for essential railway maintenance materials, including lubricants, fuels, and spare parts.

Operational and Emergency Response Areas:

- **Safety zones along the railway corridor** - Designated safety areas for track workers and emergency response teams, particularly near bridges, tunnels, and areas with high operational complexity.
- **Worker access points and crossing areas** - Identified locations where railway personnel enter and exit work zones, including track crossings and underpasses in both subsections.
- **Medical facilities for occupational injury treatment** - workers will have access to local clinics and hospitals in Paraćin, Aleksinac, and Niš, ensuring timely medical intervention in case of incidents.

The OHS impact zones also incorporate the cumulative risks associated with proximate infrastructure projects, local industries, and community interactions, thereby ensuring that OHS management measures are comprehensive and robust.

2.3 Specific Conditions

Specific H&S Conditions in Serbian construction sector

Serbian health and safety regulations are aligned with EU and international standards, emphasizing a zero-tolerance approach to workplace injuries through mandatory risk assessments, emergency response planning, and continuous monitoring. These regulations require transparent incident reporting, thorough investigations of workplace accidents, and strict enforcement of safety protocols. Employers must provide adequate PPE, ensure proper training for all workers, including subcontractors, and conduct regular inspections to maintain safe working conditions.

However, the health and safety culture in Serbia presents certain sector-specific challenges, particularly in construction, where compliance with international best practices is not always consistent. While the legal framework is robust, on-site enforcement, risk awareness, and adherence to safety measures may vary, necessitating stronger oversight and capacity-building efforts within the industry. These observations—particularly regarding inconsistent on-site compliance, variable risk awareness, and the need for enhanced oversight—are supported by key national sources such as the National Strategy for Occupational Safety and Health in the Republic of Serbia, as well as annual reports from the Serbian Labour Inspectorate. Further evidence is provided in sectoral analyses and reports issued by professional bodies such as the Serbian Chamber of Commerce and various industry associations.

The specific conditions and challenges related to the implementation of H&S in the construction sector in Serbia can be summarized in several key points:

- H&S Managemnt and Organization relies largely on implementation of minimum legal requirements, lacking comprehensive management systems and systematic approach to safety management.
- Legal compliance often can be reactive rather than proactive, with companies prioritizing H&S mainly during inspections or after incidents.
- Construction projects are often driven by tight deadlines and cost pressures, leading to shortcuts in safety procedures. Investors and contractors may prioritize completion speed over safety compliance.
- Risk Assessment and Management is often superficial without detailed analysis of specific hazards or often inadequate risk assessment methods.
- Worker training may frequently be inadequate or informal, particularly among subcontractors, which can result in personnel working without a thorough understanding of health and safety protocol.
- Risk awareness among workers, especially temporary and low-skilled laborers, tends to be limited. H&S regulations are sometimes viewed more as administrative requirements than as essential protective measures..
- Underreporting of accidents is common due to fear of job loss or disciplinary actions. Companies may discourage reporting minor injuries to maintain a clean safety record.
- Avoidance of PPE use due to lack of control and enforcement.
- Independent Monitoring by the Labour Inspections are often limited and insufficient due to resource constraints.

Existing OHS Practices within SRI

The Serbian Railway Infrastructure (SRI) operates under a defined but continuously developing Occupational Health and Safety (OHS) framework that is progressively aligning with EU and national legislation. While the system for managing the H&S is in place, the process of harmonization with international standards such as ISO 45001 is ongoing. The system provides a functional foundation for managing common railway-related risks, but modernization and the complexity of large-scale infrastructure projects—such as this one—will require a more robust and structured approach.

Risk assessments are routinely conducted, particularly for high-risk tasks such as electrification works, track operations, etc. However, the depth, consistency, and implementation of these assessments vary, and coordination challenges remain. SRI maintains an internal health and safety team tasked with compliance and coordination with national authorities, and responsibilities are partially delegated to site-level teams. Nevertheless, limited resources and gaps in oversight can affect uniform implementation across sites.

Training is a central area of focus, with certification required for safety-critical roles. However, many maintenance and operations staff still rely on informal or on-the-job learning. Structured and periodic training programs, especially for high-risk activities (e.g. working at height, tunnel construction, catenary system installation), would significantly enhance worker preparedness. Similarly, while PPE usage is formally mandated, field observations and reporting suggest that compliance varies, often due to user discomfort, lack of supervision, or inadequate provision.

Incident reporting mechanisms exist, but cultural and organizational barriers still lead to underreporting of minor injuries and near-misses. Recent institutional efforts are promoting a shift toward a more proactive safety culture, with increasing emphasis on transparent reporting and preventive learning.

Emergency preparedness measures are generally formalized, but their practical application—including regular drills, first-aid access, and crew-wide familiarization—requires further strengthening. Enhancing response readiness, especially in remote or linear work zones, is vital to ensuring worker safety under time-sensitive or life-threatening conditions.

Oversight of workplace safety is shared across several institutions and regulatory bodies. While inspections are routinely performed, limitations in staffing and technical capacity can constrain the frequency and depth of monitoring.

In summary, SRI's current OHS practices reflect a structured but evolving system. To meet the demands of modern infrastructure reconstruction and comply with IFI and EU standards, SRI—and its contractors—will need to strengthen systemic approaches to safety management. This includes enhanced training, regular audits, improved subcontractor oversight, consistent PPE usage, effective emergency response protocols, and the promotion of a transparent safety culture.

3 Assessment of Potential Impacts

This chapter provides a high-level assessment of potential OHS risks and impacts associated with the reconstruction and operation of the Project. The purpose of this assessment is to identify key OHS hazards that may arise during the construction and operational phases and to outline measures that will inform future management plans and set the basis for future detailed and more comprehensive assessments.

The assessment follows a risk-based approach, considering potential hazards in relation to workforce exposure, task-specific risks, environmental conditions, and existing safety management practices. It does not replace detailed project-specific risk assessments but serves as a framework for identifying priority areas where further mitigation and monitoring will be required. The analysis distinguishes between the construction phase, where risks are primarily associated with activities such as tunnelling, earthworks, track installation, electrification, and working at height, and the operational phase, where hazards are linked to railway traffic, maintenance activities, and emergency response situations.

This high-level assessment aligns with the requirements listed in the introductory part of the document, ensuring that OHS risks are managed in line with international best practices and applicable Serbian regulations.

Assumptions

- The assessment assumes that the reconstruction and operation activities will adhere to current Serbian regulations and international best practices for occupational health and safety (OHS).
- It is based on general and high-level data, with the expectation that more detailed, project-specific risk assessments will follow during subsequent Project stages.
- Workforce exposure, task-specific risks, and environmental conditions considered in this chapter are assumed to represent typical scenarios for similar railway construction and operational projects.
- Existing safety management practices in place are presumed to serve as a baseline for developing enhanced safety measures.

Limitations

- This assessment is not exhaustive and does not replace detailed, site-specific risk evaluations that will need to be conducted by the Contractor and closely monitored by the SRI as the Project progresses.
- Potential unforeseen hazards specific to unique local conditions or unexpected developments during the project may not be fully captured at this stage.
- The analysis is limited by the availability and accuracy of existing data and does not include direct stakeholder consultations or on-site evaluations.
- The outlined mitigation measures are preliminary and subject to refinement as additional information becomes available during further project planning and implementation phases.
- The locations of certain construction-related facilities—such as access roads, construction camps, and material and waste storage areas—are currently unknown, which limits the ability to assess site-specific risks at this stage.

3.1 Impact Assessment Methodology

The methodology for assessing impacts related to OHS risks during the construction and operation phases of the Project adheres to the procedure outlined in Chapter 5 of this ESIA. It is essential to consult this chapter in conjunction with Chapter 5, as it establishes the overall framework for the impact assessment process.

To facilitate a more accurate evaluation of OHS risks, specific impact grading criteria and definitions have been refined to appropriately address the distinct characteristics of occupational hazards and worker safety issues. The details of these adjustments are presented in the subsequent sections, enabling a more customized approach to evaluating the potential risks, impacts, and necessary mitigation measures.

3.1.1 Magnitude

For this assessment, the magnitude of potential impacts on OHS receptors has been defined based on the severity of the consequences resulting from technical issues or hazardous work conditions. The magnitude of an impact reflects the extent of harm caused to workers and the level of disruption to project activities.

Table 18-1 below presents the grades of magnitude, providing clear definitions for each level of severity, ensuring a consistent evaluation of potential hazards and their consequences:

Table 18-1. Definition of grades for Magnitude

MAGNITUDE	Definition	GRADE
Low impact	Injuries in this category are minor, requiring only basic first aid and causing no disruption to work schedules or long-term health effects. These could include things like small cuts or bruises.	1
Moderate impact	Injuries that cause workers to lose time at work but don't have lasting health consequences. Examples might include sprains or minor fractures that heal with time.	2
Severe impact	These injuries or health conditions are significant enough to prevent a worker from continuing their role in the project and may lead to long-term disability. Severe burns or major fractures could fall into this category.	3
Very severe impact	This grade encompasses the most serious injuries or health conditions, including permanent disabilities, life-altering health problems, collective injuries or fatalities. These have a profound effect on worker safety and lives	4

3.1.2 Spatiotemporal grading

The spatiotemporal grading system is designed to account for the fact that temporary and short-term impacts can still be moderate or severe, even if they are confined to a localized or project-specific level. This grading helps to distinguish how long an impact lasts and the geographical extent of its influence on worker health and safety.

For the purposes of this OHS assessment, the spatiotemporal grades have been redefined compared to the one defined in Chapter 5, ensuring that both duration and geographical extent are appropriately considered in the risk evaluation process, allowing for a more precise classification of potential OHS impacts during the construction and operation phases of the Project, as outlined in Table 18-2 below.

Table 18-2. Spatiotemporal grades for OHS risks

SPATIOTEMPORAL				
	Short-term The impact lasts for a few hours to several days and is quickly resolved with no lasting consequences for worker health and safety. This includes minor injuries or short-term disruptions that do not require long-term interventions.	**Medium-term** The impact persists for weeks to months but remains reversible. Workers may require medical attention or temporary work restrictions, but the effects are not permanent.	**Long-term** The impact lasts for months to years, potentially leading to chronic health conditions, prolonged work restrictions, or significant operational adjustments. These impacts may require continuous medical supervision or long-term rehabilitation programs.	**Permanent** The impact results in irreversible consequences for worker health and safety, such as long-term disabilities, fatal incidents, or severe occupational diseases.
Localized The impact is restricted to a specific worksite or a small area within the project footprint. These impacts typically affect a limited number of workers and are contained within a controlled environment.	1	1	2	3
Project-wide The impact extends beyond a single worksite, potentially affecting multiple teams or work locations within the project footprint. Risks at this level could influence project-wide safety protocols and require coordination across different work areas	1	1	2	3
Regional The impact spreads beyond the project boundaries, potentially affecting external stakeholders, adjacent	2	2	3	4

worksites, or the broader workforce operating in the region. This level of impact may require engagement with regulatory bodies or regional safety management teams.				
Widespread The impact extends beyond the immediate project area, affecting the national railway sector, regulatory frameworks, or industry safety standards. This type of risk may lead to changes in national safety policies or enforcement mechanisms.	2	2	3	4

3.1.3 Sensitivity of OHS Receptors

The sensitivity of OHS receptors is determined by the vulnerability, exposure, and resilience of workers to OHS risks. This grading system helps to classify the extent to which different groups of workers or work environments may be affected by hazards during the construction and operation phases of the Project.

The sensitivity grades are defined in Table 18-3 below:

Table 18-3: Sensitivity Grades for OHS Receptors

SENSITIVITY OF OHS RECEPTOR		GRADE
Low Sensitivity	Workers have **low vulnerability** to OHS risks due to well-established **safety protocols, training, and protective measures**. The work environment is **controlled and predictable**, with minimal exposure to hazardous conditions.	1
Moderate Sensitivity	Workers may **occasionally be exposed** to **moderate occupational risks**, but **preventative measures** are in place to manage hazards. Some risks exist due to **intermittent exposure to hazardous tasks**, but they are **manageable** with proper safety compliance.	2
High Sensitivity	Workers are **regularly exposed** to **significant occupational hazards**, such as work at height, heavy machinery, or electrical risks. **Safety measures are**	3

	critical, and failure to implement them properly could result in **serious injury or illness**. Vulnerability increases due to **prolonged exposure** to risks.	
Very High Sensitivity	Workers face **constant exposure** to **severe or life-threatening hazards**, such as high-voltage environments, confined spaces, or railway operations with high-speed trains. **Even minor failures in safety protocols can lead to catastrophic consequences**. This category also includes **vulnerable groups**, such as inexperienced workers, subcontractors with inadequate training, or workers performing high-risk tasks under extreme conditions. Workers cant continue with work permanently.	4

This classification ensures that risk assessments account for varying levels of worker vulnerability, allowing for appropriate mitigation measures to be integrated into the Project's Health & Safety Management Plans.

3.1.4 Likelihood of OHS Impacts

The likelihood of OHS impacts occurring during the construction and operation phases of the Project is assessed based on the probability of hazardous events and unsafe conditions leading to incidents. This grading system ensures a structured approach to identifying and mitigating risks.

The likelihood grades are defined in Table 18-4 below:

Table 18-4: Definition of Grades for Likelihood

LIKELIHOOD DEFFINITION	GRADE
The event is **highly improbable** under normal working conditions. Existing safety measures and operational controls effectively prevent the occurrence of incidents. There is **no history of similar incidents in comparable projects**.	Unlikely (1)
The event **could occur** under certain conditions, but it is **not expected** to happen frequently. It may be triggered by **unexpected failures, procedural lapses, or human error**, though risk controls **generally mitigate the likelihood**. There may be **occasional records of such incidents** in the industry.	Possible (2)

The event is **expected to occur** at some point during the Project's lifecycle. There is **moderate to high exposure** to hazards, and the probability of occurrence is **heightened** due to the nature of the work. Previous railway construction projects indicate that such incidents **have occurred before**.	Likely (3)
The event is **almost certain** to occur due to **constant exposure to hazards**, inadequate risk controls, or high-risk work conditions. Similar incidents have **frequently happened in past projects**, and standard safety measures **alone may not be sufficient** to prevent occurrence.	High Likely/Certain (4)

This classification enables a structured risk assessment, ensuring that higher-probability incidents receive enhanced mitigation and monitoring measures to minimize risks to workers and project personnel.

3.1.5 Impact Significance Scoring

The significance scoring for impact established in Chapter 5 of this ESIA remains unchanged; however, the scoring criteria and corresponding descriptions have been updated to better reflect the specifics of the OHS risk evaluation process, as detailed in Table 18-5 below.

Table 18-5. Impact significance

Impact Significance	Impact Significance Description	Score
Low	A **Low impact** is one where the likelihood of occurrence is minimal, and the potential effect on workers' health and safety is **minor.** Any injuries or adverse effects would **be temporary and easily managed** through routine first-aid or standard protective measures. **No significant disruption** to work activities is expected, and existing safety protocols are generally sufficient.	4-7
Moderate	A Moderate impact indicates an event with the potential to cause **work interruptions, lost time injuries, or moderate disruptions** to work conditions. While the risks are **not critical**, additional mitigation measures may be required to ensure worker safety. This level of impact often requires **enhanced supervision, better training, and enforcement of OHS standards**.	8-10
High	A High impact suggests a **serious risk to worker safety**, where incidents could lead to **severe injuries, long-term health problems, or major work stoppages**. This level of	11-13

	risk requires **urgent corrective actions**, stricter enforcement of safety procedures, and **continuous monitoring** to prevent reoccurrence.	
Very high	A Very High impact represents the **most critical risk level**, with a strong likelihood of **fatalities, permanent disabilities, or catastrophic events** affecting multiple workers. This level of impact demands **immediate intervention, extensive risk mitigation strategies, emergency response readiness, and compliance with the highest OHS standards** to prevent severe consequences.	14-16

3.2 Construction Phase Impacts

The construction phase of the railwayy reconstruction phase of the Project involves various high-risk activities that may pose occupational health and safety hazards to workers. These risks arise from heavy machinery operation, excavation, working at heights, and exposure to hazardous materials. Below is an overview of the key OHS risks and impacts expected during the construction phase:

- **Risk of Accidents and Injuries Due to Heavy Machinery and Equipment Use**
- **Risks Related to Working at Heights**
- **Electrical Hazards from Overhead Lines and Power Supply Systems**
- **Risk of Rockfalls and Gully Erosion**
- **Collision with Utilities (Gas Pipelines, Electrical Cables, Water Mains, etc.)**
- **Noise and Vibration Exposure**
- **Risks related to Exposure to Hazardous Materials**
- **Risk of Confined Space Incidents**
- **Fire and Explosion Risks**
- **Manual Handling and Ergonomic Risks**
- **Risk of Traffic and Worksite Collisions**
- **Psychological and Social Risks**
- **Risks from Exposure to Extreme Weather Conditions**

3.2.1 Risk of Accidents and Injuries Due to Heavy Machinery and Equipment Use

Construction activities involve the operation of excavators, bulldozers, cranes, and rail maintenance machines, increasing the likelihood of crush injuries, struck-by incidents, and collisions. Workers operating or working near moving equipment face risks of being run over or pinned between objects. Sensitive Receptors are:

- Construction Workers
- Visitors – e.g. designers, government or municipal representatives, etc.
- Suppliers

3.2.1.1 Magnitude

The magnitude of this impact is considered **very severe impact** for construction workers. The risk of major injuries or fatalities arises from the potential for machinery collisions, equipment malfunctions, and inadequate operator training. Accidents involving heavy machinery typically result in significant harm or even fatality due to the size, weight, and mechanical power of the equipment. Robust studies in similar construction environments underline the high frequency and severity of such risks, particularly when safety protocols are not meticulously followed.

Although visitors and suppliers are less exposed to direct risks from equipment operation, they remain vulnerable to vehicle movement, falling debris, or proximity to hazardous zones.

These risks are particularly elevated during tunnelling works, where confined spaces, limited visibility, and restricted manoeuvring areas increase the likelihood of machinery-related incidents. In tunnel environments, even minor lapses in coordination or communication can lead to serious accidents due to the complex logistics and simultaneous activities in constrained spaces.

3.2.1.2 Spatiotemporal Impacts

The spatiotemporal impact of this risk is **project-wide** and **permanent**.

- Spatial Extent: for construction workers, the impact is limited to the construction site boundaries. For visitors and suppliers, it is more localized, typically occurring near access points or zones where heavy machinery is operating close to the storage or stockpile.
- Duration: the impact is classified as permanent, as it may result in irreversible consequences for worker health and safety, including long-term disabilities or fatal injuries. This impact can lead to chronic health conditions, prolonged work restrictions, or enduring injuries. In certain instances, affected individuals may require ongoing medical supervision or rehabilitation.

This conclusion is informed by general patterns observed in construction projects of similar scale and scope.

3.2.1.3 Sensitivity

Sensitivity among construction workers is considered **high**, as they are the primary individuals exposed to moving machinery on a daily basis. Their close interaction with these machines increases their vulnerability, meaning that even minor lapses in safety protocols could lead to significant consequences.

On the other hand, while visitors experience lower exposure frequency, their lack of familiarity with site-specific safety procedures can make them vulnerable to unforeseen risks when entering or approaching construction zones.

3.2.1.4 Likelihood

For construction workers, the likelihood of accidents is rated as **likely**. The constant operation of heavy equipment and the dynamic nature of construction environments make such risks a recurring possibility, even with strict safety measures in place. For suppliers and visitors, the likelihood of exposure is lower due to their occasional presence near machinery operations. However, this probability may increase in the event of lapses in access control, inadequate supervision, or insufficient hazard signage, highlighting the need for strict enforcement of entry protocols and clearly marked work zones.

Table 18-6. Significance of the risk of Accidents and Injuries Due to Heavy Machinery and Equipment Use

Magnitude	Spatiotemporal scale	Sensitivity	Likelihood	Overall significance
4	3	3	3	High (13)

3.2.2 Risks Related to Working at Heights

The reconstruction of railway infrastructure necessitates the use of scaffolding, and activities on elevated structures, which may expose workers to fall hazards. Insufficient fall protection measures, improper use of harnesses, or the absence of safety railings could lead to serious injuries or fatalities. These risks primarily concern construction personnel but may also affect occasional visitors such as suppliers, government officials, or client and Engineer representatives. Visitors are generally at risk from falling tools, materials, or debris from elevated work areas. Historical data summarized in the Annual Reports issued by the Labour Inspectorate, highlight instances where bystanders have suffered injuries due to inadequate safety measures like catch nets or barriers.

3.2.2.1 Magnitude

The magnitude of risks associated with working at heights is considered **very severe impact**. This evaluation is based on both professional judgment and data from similar projects. Falls from height are among the leading causes of severe injuries or fatalities in the construction sector. The risk is heightened in railway reconstruction projects, where workers are performing tasks on scaffolds, ladders, bridges, or elevated platforms.

3.2.2.2 Spatiotemporal Impacts

The spatiotemporal impacts of this risk are **localized** and **permanent**.

- Spatial Extent: the impact is restricted to specific elevated work zones within the project footprint, such as scaffolding, bridges and overpasses, and elevated platforms. These areas typically involve a limited number of workers and are managed within a controlled construction environment.
- Duration: the impact may result in irreversible consequences for worker health and safety, including long-term disabilities or fatal incidents, particularly in cases of falls or falling objects.

3.2.2.3 Sensitivity

Sensitivity of the Construction Workers is rated as **high** due to their direct and sustained exposure to elevated work areas. Without comprehensive training and protective measures, any lapse or oversight can lead to serious consequences. When it comes to Sensitivity of the visitors, their exposure is generally infrequent and limited to areas adjacent to elevated work zones. However, their potential unfamiliarity with safety measures heightens their vulnerability.

3.2.2.4 Likelihood

For construction workers, the likelihood of falls or other incidents at heights is assessed as **likely**. Such events are expected to occur at some point during the Project's lifecycle, given the moderate to high exposure to elevated work zones and the inherently dynamic and hazardous conditions of construction sites. The probability of occurrence is further elevated in the absence of rigorous and consistently applied safety protocols.

Table 18-7. Significance of the risk of Accidents and injuries Due to work at height

Magnitude	Spatiotemporal scale	Sensitivity	Likelihood	Overall significance
4	3	3	3	High (13)

3.2.3 Electrical Hazards from Overhead Lines and Power Supply Systems

During the construction phase of the railway reconstruction project, high-voltage overhead lines present a significant electrocution risk to workers handling metal scaffolding, cranes, or working near live electrical components. The risk is heightened due to simultaneous ongoing construction activities, temporary power supply systems, and the potential for accidental contact with existing railway electrification infrastructure.

3.2.3.1 Magnitude

The existing railway electrification system operates at 25 kV AC, 50Hz which can cause **very severe impacts** due to instantaneous fatal electrocution upon direct contact. Additionally, temporary power supply systems, often required for construction activities, introduce additional risks, such as faulty grounding, exposed wiring, and power surges that can lead to severe burn injuries, neurological damage, or secondary trauma from falls due to electrical shock.

3.2.3.2 Spatiotemporal Impacts

Based on the provided grading system, the spatiotemporal impacts are categorized as **localized** and **permanent**.

- Spatial Extent: the impacts are localized to designated worksites within the larger project area—specifically where electrical systems, like overhead lines or substations are being installed or modified or regions where railway electrification is active during phased construction activities. While these areas are distributed throughout the Project footprint, each associated risk is confined to well-defined and controlled environments, generally impacting specific teams or workers operating within those designated zones.
- Duration: the impacts are considered permanent due to the potential for serious, irreversible consequences on worker health and safety—such as long-term disabilities or fatal incidents—if adequate precautions are not taken.

3.2.3.3 Sensitivity

Receptors involved in electrical operations or construction works near active overhead lines are deemed **highly sensitive** to these hazards due to their direct exposure to energized systems.

- Workers face heightened exposure because they often work near live systems that must remain operational to support existing infrastructure.
- Temporary work structures, such as scaffolds or heavy machinery near energized lines, further contribute to the sensitivity of workers during this stage.

3.2.3.4 Likelihood

The likelihood of electrical hazards is rated as **likely** during the reconstruction phase. This assessment is based on:

- The continuous presence of energized systems to support existing railway operations.
- The complex nature of reconstruction work, including rerouting power systems or working around existing electrical infrastructure.

Professional judgment and incident data from similar projects highlight the increased frequency of risks materializing during reconstruction activities compared to other project phases.

Table 18-8. Significance of the Electrical Hazards from Overhead Lines and Power Supply Systems

Magnitude	Spatiotemporal scale	Sensitivity	Likelihood	Overall significance
4	3	3	3	High (13)

3.2.4 Risk of Rockfalls and Gully Erosion

The reconstruction of railway infrastructure, particularly in sections involving tunnel construction, deep cuts, and embankment excavations, poses risks related to identified geohazards including rockfalls and gully erosion, see

Chapter 8 (Geology) of this ESIA Report. While most of the Project route alignment passes through flat terrain, where such risks are minimal, there are specific risks in the hilly terrain near the Đunis tunnel portals, from km 192+275 to km 192+854, and where natural ground conditions increase the risk in combination with engineering interventions (the locations of cuttings and embankments where these risks are higher are provided in Table 8-5 in Chapter 8).

Rockfalls and/or gully erosion may result in injuries to workers, damage to equipment, or delays in construction progress. In more severe cases, such events could compromise the structural integrity of partially completed works.

3.2.4.1 Magnitude

The magnitude of risks related to rockfall, and erosion is considered **very severe**. This assessment is supported by historical data from similar railway and infrastructure projects, particularly those involving excavations or slope exposure. Rockfall incidents can result in traumatic injuries or fatalities for workers, especially during tunnel excavation, slope trimming, or when working at the toe of steep embankments.

3.2.4.2 Spatiotemporal Impacts

The spatiotemporal impacts of this risk are **localized** and **permanent**.

- Spatial Extent: the impacts are limited to specific segments of the alignment where tunnel construction, and embankment formation or deep cuts within potential areas of impact (as defined in Table 8-5), are planned. Most of the alignment is situated in flat terrain with minimal exposure to geohazard risks. However, the specified localized areas present higher vulnerability.
- Duration: the impacts can lead to permanent and irreversible consequences for worker health and safety, including fatal injuries or long-term physical harm due to falling rocks or collapsing soil. Timely mitigation, such as rock bolting, slope reinforcement, and erosion control systems, is essential to reduce long-term exposure.

3.2.4.3 Sensitivity

Sensitivity of Construction Workers is rated as **high** due to their direct involvement in excavation, slope cutting, and tunnel works. Workers are frequently exposed to unstable surfaces and work under conditions where loose rock or soil displacement may occur unpredictably.

3.2.4.4 Likelihood

The likelihood of rockfall or erosion-related incidents is assessed as **possible**. These events are expected to occur throughout the construction phase, particularly in areas with steep slopes or weak geological formations. The probability increases in the absence of proactive geotechnical assessments, slope protection measures, and real-time monitoring systems.

Table 18-9. Significance of the Risks of Rockfall and Erosions

Magnitude	Spatiotemporal scale	Sensitivity	Likelihood	Overall significance
4	3	3	2	High (12)

3.2.5 Risks related to Collision with Utilities

The presence of existing utility infrastructure along the railway alignment, including underground electrical lines (10 kV and 35 kV), aboveground transmission lines (35 kV and 110 kV), and a high-pressure gas pipeline (MOP 55 bar), introduces substantial risks during construction activities. These utilities may intersect with works such as excavation, grading, piling, and the movement of heavy machinery.

Accidental collision or interference with utilities can result in severe health and safety hazards, service disruption, fire or explosion (especially in the case of the gas pipeline), and delays in the construction process. Given the energy intensity of the utility assets involved, even a minor miscalculation during earthworks or lifting operations can lead to critical consequences for workers.

3.2.5.1 Magnitude

The magnitude of risk is considered **very severe**. Collisions with high-voltage electrical infrastructure may result in electrocution, severe burns, or fatalities, while damage to the gas pipeline operating at 55 bar could lead to explosions, fire, or asphyxiation. Beyond immediate threats to life, such incidents can cause significant service outages, environmental damage, and substantial project delays, especially where utility rerouting or emergency response is required.

3.2.5.2 Spatiotemporal Impacts

The spatiotemporal impacts of this risk are assessed as **Localized** and **Permanent**.

- Spatial Extent: The risk is confined to specific zones along the alignment where underground and aboveground utilities are present. These include sections where the railway crosses or runs adjacent to electrical lines or the gas pipeline corridor. Although these segments are limited in area, the nature of the hazard is highly concentrated and requires precise management.
- Duration: The potential consequences of utility strikes can be permanent in nature, such as fatal incidents, severe injuries, or irreversible health effects. The presence of high-pressure gas infrastructure further increases the gravity of consequences. Risk persists throughout the entire construction phase, particularly during excavation, foundation works, and the operation of heavy equipment.

3.2.5.3 Sensitivity

Construction Workers are rated as **highly sensitive**, especially personnel operating excavation machinery, lifting equipment, or working near utility corridors without full knowledge of buried or overhead hazards. They are at direct risk of electric shock, burns, explosion injuries, or being impacted by falling electrical lines.

3.2.5.4 Likelihood

The likelihood of collision with utilities is assessed as **possible**. Although utilities are known and registered along the alignment, and standard pre-construction utility mapping and clearance procedures are expected to be implemented, the risk remains present due to the complexity of field conditions. Factors such as inaccurate as-built documentation, insufficient signage, or poor communication between contractors may lead to accidental strikes.

The risk is elevated near crossing points and at narrow work zones where space limitations increase the chance of encroachment. However, the application of strict control measures, including utility marking, excavation permits, supervision by utility owners, and exclusion zones, will substantially reduce the probability of such events occurring frequently.

Table 18-10. Significance of the Risks related to Collision with Utilities

Magnitude	Spatiotemporal scale	Sensitivity	Likelihood	Overall significance
4	3	3	2	High (12)

3.2.6 Risks related to Noise and Vibration Exposure

Workers will be exposed to high noise levels from heavy machinery, rail grinding operations, and piling activities, which may lead to hearing loss or stress-related conditions. Additionally, continuous vibration exposure from drilling and compacting equipment may contribute to musculoskeletal disorders.

3.2.6.1 Magnitude

The magnitude of risks related to noise and vibration exposure during the reconstruction phase is assessed as **moderate**. High levels of noise are generated by heavy machinery such as drills, excavators, and pile drivers, while vibrations arise from activities like track laying and the operation of power tools. Prolonged exposure can lead to adverse health effects, including hearing loss, tinnitus, and stress-related conditions for workers. Vibrations may also cause physical discomfort and musculoskeletal stress, particularly for those operating equipment or performing tasks near vibration sources. Without proper mitigation, these effects can significantly impair worker health and productivity.

These risks are particularly pronounced during tunnelling works, where enclosed environments amplify noise and vibration levels, and workers are often required to remain in close proximity to the source of exposure for extended periods.

3.2.6.2 Spatiotemporal Impacts

Using the provided grading system, the spatiotemporal impacts are categorized as **localized** and **medium-term**.

- Spatial Extent: the impact is restricted to a specific worksite or a small area within the project footprint, as noise and vibrations are generated by machinery operating across various locations. Specific hotspots include areas with intensive construction activities, such as foundation works or track realignments.

- Duration: Noise and vibration exposure will persist throughout the reconstruction phase, which typically lasts for weeks to months. Workers at certain sites may experience fluctuating exposure levels depending on the intensity and type of activities being carried out.

3.2.6.3 Sensitivity

Sensitivity is rated as **high** for construction workers due to their continuous and direct exposure to noise and vibration sources. Workers operating heavy machinery or performing tasks near vibrating equipment are particularly vulnerable. Prolonged exposure to elevated noise levels above recommended thresholds (e.g., 85 dB averaged over 8-hour working day as per Serbian regulation, EU and IFI standards) significantly increases the risk of hearing impairment and stress. Furthermore, workers in confined or enclosed spaces may experience amplified noise levels, exacerbating their sensitivity.

3.2.6.4 Likelihood

The likelihood of noise and vibration risks occurring during the reconstruction phase is assessed as **likely**. This reflects the routine use of heavy machinery and equipment in railway reconstruction projects. Noise and vibration are inherent byproducts of such activities, and without stringent control measures, these risks are expected to materialize repeatedly throughout the project.

Table18-11. Significance of the Risks related to Noise and Vibration Exposure

Magnitude	Spatiotemporal scale	Sensitivity	Likelihood	Overall significance
2	1	3	3	Moderate (9)

3.2.7 Risks related to Exposure to Hazardous Materials

Construction activities during railway reconstruction expose workers to a variety of hazardous substances. These include diesel and welding fumes, dust from ballast and concrete, solvents. These risks are particularly pronounced during tunnelling works, where poor ventilation, confined working spaces, and limited natural dispersion of fumes and dust significantly increase the likelihood and severity of exposure to hazardous substances. Activities such as welding, cutting, or demolition in tunnels amplify the concentration of airborne contaminants, making robust ventilation systems, continuous air quality monitoring, and the use of appropriate personal protective equipment (PPE) critical for worker safety.

In addition to previously identified risks, the following specific sources of hazardous materials require attention:

- Asbestos Asbestos-containing materials (ACMs) in legacy insulation, piping, and roofing, especially during demolition and refurbishment of station buildings and depots.
- Transformers containing polychlorinated biphenyls (PCBs): Old transformers, particularly in stations and junctions, may contain PCBs—a toxic legacy substance. A detailed inventory and assessment of all transformers along the route is required to identify and manage these risks appropriately.

- Maintenance areas and storage sites for oils and fuels: railway stations and depots often store fuel and lubricants. These sites must be identified and assessed for potential soil and groundwater contamination risks which can pose a health threat to worker engaged in reconstruction activities.
- Hazardous waste sites, such as those where old wooden sleepers (often treated with creosote) are disposed of, must be identified and assessed. These sites pose not only environmental and health risks but also a significant risk of accidental fires. Proper containment, fire prevention measures, and disposal in line with legal requirements are essential.
- Locations of previous derailments involving hazardous materials - historical safety reports and incident records should be reviewed to identify critical areas prone to derailment, especially near curves and bridges. Emergency response and containment plans must be developed for these high-risk areas.

3.2.7.1 Magnitude

The magnitude of risks associated with exposure to hazardous materials during the reconstruction phase is assessed as **severe**. This rating is supported by the potential for serious, long-term health effects arising from both acute and cumulative exposure. These include lung disease (e.g., asbestosis, COPD), cancers (e.g., mesothelioma), chemical burns, and neurological impairments. The risks are particularly high during activities such as demolition, material handling, or excavation of contaminated ground. The severity of these risks underscores the critical need for robust safety controls during this phase.

3.2.7.2 Spatiotemporal Impacts

The spatiotemporal impacts are classified as **localized** and **long-term**.

- Spatial Extent: Exposure to hazardous materials is generally restricted to specific worksites, such as older station buildings, depots, or known contaminated soil zones. These areas typically affect a limited number of workers and are contained within controlled construction environments, such as enclosed demolition sites or soil remediation zones. As such, the impact is localized rather than project wide.
- Duration: The consequences of exposure to certain hazardous substances—particularly asbestos fibres, diesel fumes, and solvents—can persist over months to years, even after the original exposure has ended. Workers may develop chronic health issues or require long-term medical monitoring or rehabilitation. The long-term duration reflects the latent nature of many occupational diseases associated with hazardous materials.

3.2.7.3 Sensitivity

The sensitivity of construction workers to hazardous material exposure is rated as **high**. Workers performing demolition, excavation, welding, or chemical application are at the greatest risk, especially if operating in poorly ventilated spaces or without proper personal protective equipment (PPE). Even brief exposure to certain airborne or surface contaminants can result in significant health outcomes, particularly for those with pre-existing respiratory or skin conditions. Other site personnel such as engineers or inspectors may also be at risk if adequate containment or warning systems are not implemented.

3.2.7.4 Likelihood

The likelihood of exposure to hazardous materials is rated as **likely** during the reconstruction phase. This reflects the expected encounter with such substances, given the nature of railway infrastructure, which often involves older materials and historical contamination. The lack of stringent initial site assessments or improper handling practices can further elevate the probability of exposure incidents.

Table 18-12. Significance of the Risks related to Exposure to Hazardous Materials

Magnitude	Spatiotemporal scale	Sensitivity	Likelihood	Overall significance
3	2	3	3	High (11)

3.2.8 Risk of Confined Space Incidents

During the reconstruction of railway infrastructure, workers may need to enter confined spaces such as the tunnel, drainage systems, culverts, underground utility chambers, or sewage shafts. These environments present a high-risk working condition due to the potential for oxygen deficiency, accumulation of toxic or flammable gases, engulfment hazards, and restricted movement, which complicates emergency responses. Without proper planning and safety controls, confined space incidents can lead to serious or fatal outcomes.

3.2.8.1 Magnitude

The magnitude of risks associated with confined space incidents during the reconstruction phase is assessed as **severe.** This evaluation reflects the likelihood of life-threatening outcomes, including asphyxiation, exposure to noxious gases (e.g., methane, hydrogen sulphide), thermal stress, or injuries due to slips, trips, and falls. These risks are exacerbated by the difficulty of evacuation and limited visibility in such spaces. Confined space incidents are high-consequence events, requiring stringent controls.

3.2.8.2 Spatiotemporal Impacts

Using the grading system, the spatiotemporal impacts are classified as **Localized** – **Permanent**.

- Spatial Extent: Confined space risks are restricted to specific locations within the project footprint—such as culverts, underground chambers, or tunnel access points—where only a limited number of workers operate at any one time.
- Duration: While individual work tasks in confined spaces may be short to medium-term, the health impacts from exposure to hazardous gases, oxygen deficiency, or thermal extremes can result in permanent consequences for affected workers. These include irreversible injuries, neurological damage, or death in extreme cases. Accordingly, the spatiotemporal impact is graded as permanent, reflecting the potential for life-long or fatal outcomes, even if the exposure duration is limited.

3.2.8.3 Sensitivity

Sensitivity to confined space risks is rated as **moderate**, as workers operating within these environments may occasionally be exposed to hazards inherent to confined spaces. Limited ventilation and constrained entry/exit points amplify their vulnerability. Workers without specialized training or access to proper safety equipment are particularly sensitive to these risks, which can escalate quickly in emergency situations.

3.2.8.4 Likelihood

The likelihood of confined space incidents is assessed as **possible**. This reflects that while confined spaces are clearly identified and safety protocols are usually established, failures in monitoring, procedural oversight, or human error can lead to incidents. Historical data from infrastructure projects shows that near-misses and serious incidents in confined spaces can still occur even with controls in place, particularly during unplanned interventions or emergency repairs

Table 18-13. Significance of the Risk of Confined Space Incidents

Magnitude	Spatiotemporal scale	Sensitivity	Likelihood	Overall significance
3	3	2	2	Moderate (10)

3.2.9 Fire and Explosion Risks

The presence of flammable materials (e.g., fuel, solvents, welding gas) increases the likelihood of fire or explosions on-site, especially if safety procedures for hot works and fuel storage are not strictly followed.

3.2.9.1 Magnitude

The magnitude of risks related to fire and explosion during the reconstruction phase is classified as **very severe**. Fire and explosion hazards arise from multiple sources, including flammable materials (fuels, solvents, adhesives), improperly stored chemicals, electrical faults, and operational equipment with heat generation. Such incidents can result in catastrophic consequences, including severe injuries, fatalities, and extensive property damage. The presence of hot work activities like welding and cutting further escalates these risks, especially in enclosed spaces or areas with inadequate ventilation.

3.2.9.2 Spatiotemporal Impacts

Using the provided grading system, spatiotemporal impacts are rated as **project wide** and **permanent**.

- Spatial Extent: These risks span across multiple worksites within the project footprint, particularly in areas where combustible materials, electrical systems, or hot work activities are concentrated. Specific zones may include storage areas, workshops, and confined workspaces

- Duration: The impact results in irreversible consequences for worker health and safety, such as long-term disabilities, fatal incidents, or severe occupational diseases The risks are mitigated once the reconstruction is completed, and all fire prevention measures are established.

3.2.9.3 Sensitivity

Sensitivity to fire and explosion risks is rated as **moderate** due to the vulnerability of construction workers and site personnel exposed to these hazards. Workers handling flammable materials, operating hot work equipment, or working in confined areas are particularly sensitive. Without rigorous adherence to fire prevention protocols, even minor errors can lead to disastrous consequences.

3.2.9.4 Likelihood

The likelihood of fire and explosion incidents occurring during the reconstruction phase is assessed as **possible**. This reflects the continuous presence of potential ignition sources and combustible materials, combined with the complexity of work activities in railway reconstruction projects. Historical data from similar projects suggests that without robust preventive measures, fire and explosion risks are recurring.

Table 18-14. Significance of the Fire and Explosion Risks

Magnitude	Spatiotemporal scale	Sensitivity	Likelihood	Overall significance
3	3	2	2	Moderate (10)

3.2.10 Manual Handling and Ergonomic Risks

Lifting and carrying heavy materials, repetitive movements, and awkward postures can lead to musculoskeletal disorders (MSDs), strains, and chronic pain if ergonomic principles are not applied.

3.2.10.1 Magnitude

The magnitude of risks related to manual handling and ergonomic challenges during the reconstruction phase is assessed as **moderate**. This evaluation considers the nature of tasks that involve lifting, carrying, or manoeuvring heavy equipment and materials. Poor ergonomic practices and prolonged manual handling can lead to musculoskeletal injuries, such as strains, sprains, or chronic back pain. The risks are particularly severe when workers lack proper training or when tools and workstations are not designed ergonomically. Professional judgment and studies from similar projects indicate the potential for significant health impacts if these risks are not managed effectively.

3.2.10.2 Spatiotemporal Impacts

Based on the provided grading system, the spatiotemporal impacts are categorized as **Project-wide** and **Medium-term**.

- Spatial Extent: These risks are prevalent across the project footprint, affecting all teams involved in reconstruction activities, especially in areas requiring frequent manual handling or repetitive motion tasks.
- Duration: The impacts persist throughout the reconstruction phase, lasting weeks to months due to the repetitive nature of tasks requiring manual handling. Workers are exposed to ergonomic risks until mitigation measures, such as equipment adjustments or improved practices, are implemented.

3.2.10.3 Sensitivity

Sensitivity to manual handling and ergonomic risks is rated as **high** among workers, as their physical well-being is directly impacted by prolonged exposure to poor practices. Repetitive tasks, awkward postures, or excessive force exertion significantly increase their vulnerability to injuries. Without effective intervention, these conditions can result in long-term health complications that affect productivity and quality of life.

3.2.10.4 Likelihood

The likelihood of manual handling and ergonomic risks occurring during the reconstruction phase is assessed as **likely.** This is due to the constant physical demands of reconstruction work, which often involve repetitive movements, awkward positions, and heavy lifting. Without adequate training and equipment, these risks are expected to materialize repeatedly throughout the project.

Table 18-15. Significance of Manual Handling and Ergonomic Risks

Magnitude	Spatiotemporal scale	Sensitivity	Likelihood	Overall significance
2	1	3	3	Moderate (9)

3.2.11 Risk Associated with Road and Railway Traffic

The railway corridor is an active transportation route, meaning workers may be exposed to moving trains, road vehicles, and site transportation equipment. The construction works are expected to take place near the existing railway infrastructure, which is anticipated to remain in operation during reconstruction. This presents elevated occupational health and safety risks due to simultaneous presence of construction personnel, machinery, and operational railway traffic within the same corridor. Potential risks include worker injury resulting from being struck by trains or construction vehicles, particularly during night shifts, in low-visibility conditions, or in areas without adequate physical separation. There is also a risk of disruption to railway operations caused by accidental encroachment onto active tracks, equipment fouling the gauge, or interference with signalling systems. Limited response time in emergency situations may occur due to the confined nature of the corridor and potential communication challenges between train control and site personnel. Additionally, interface activities such as switch replacements, catenary adjustments, or bridge modifications over active tracks present heightened safety considerations.

3.2.11.1 Magnitude

The magnitude of risks related to traffic and worksite collisions during the reconstruction phase is assessed as **very severe**. This evaluation reflects the presence of moving trains, heavy machinery, site vehicles, and equipment within confined or shared spaces. The interaction between construction traffic and external vehicles, as well as pedestrian movement near worksites, heightens the likelihood and severity of collisions. Such incidents can lead to serious injuries, fatalities, and equipment damage. Factors contributing to the magnitude include limited visibility in congested work areas, insufficient traffic management protocols, and the complex coordination of vehicle movements required during railway reconstruction activities.

3.2.11.2 Spatiotemporal Impacts

Based on the grading system, the spatiotemporal impacts are categorized as **project wide** and **permanent.**

- Spatial Extent: These risks are present across various work zones within the project footprint, particularly areas with high equipment density and shared access routes between worksites. The interaction between worksite vehicles and external traffic near entry/exit points extends the spatial reach of these risks
- Duration: The impacts can be permanent, persisting throughout the reconstruction phase due to continuous traffic movement and active equipment operation. Proper traffic management strategies can reduce the frequency and duration of collision risks.

3.2.11.3 Sensitivity

Sensitivity to traffic and worksite collision risks is rated as **high** for construction workers, external vehicle operators, and pedestrians near the project boundaries. Workers and drivers directly engaged in operations are particularly vulnerable to collisions due to dynamic and often unpredictable movement patterns within worksites. Similarly, nearby pedestrians and external vehicle operators face elevated sensitivity due to limited awareness of construction activities and hazards.

3.2.11.4 Likelihood

The likelihood of traffic and worksite collisions is assessed as **likely** during the reconstruction phase. This reflects the constant interaction between construction vehicles, heavy machinery, and external traffic flows. Without well-defined traffic management plans and worksite controls, the probability of accidents is expected to be recurrent across project locations.

Table 18-16. Significance of the Risk of Traffic and Worksite Collisions

Magnitude	Spatiotemporal scale	Sensitivity	Likelihood	Overall significance
4	3	3	3	High (13)

3.2.12 Psychological and Social Risks

The demanding nature of railway reconstruction, long working hours, and potential exposure to harsh weather conditions may lead to mental stress, fatigue, and reduced worker well-being. If proper rest breaks, worker welfare facilities, and mental health support are not in place, productivity and safety performance could be affected.

3.2.12.1 Magnitude

The magnitude of psychological and social risks during the reconstruction phase is classified as **moderate**. This assessment reflects the potential mental health challenges and social disruptions workers may face during demanding and prolonged construction activities. Common psychological risks include stress, fatigue, and burnout, stemming from long working hours, tight deadlines, and high-pressure environments. Social risks involve interpersonal conflicts within teams, isolation from family due to extended work schedules, and difficulties adjusting to workplace dynamics. Professional judgment and insights from similar projects underscore the substantial impact these factors can have on workers' well-being and productivity if not properly addressed.

3.2.12.2 Spatiotemporal Impacts

Based on the grading system, the spatiotemporal impacts are categorized as **project-wide** and **long-term**.

- Spatial Extent: Psychological and social risks affect the entire project workforce, spanning multiple teams and locations within the project footprint. They are not confined to specific worksites but are pervasive across the project due to shared pressures and challenges.
- Duration: These impacts are long-term, persisting throughout the reconstruction phase. Without appropriate support systems and interventions, the effects may extend beyond the project's completion, affecting workers' long-term mental health and social relationships

3.2.12.3 Sensitivity

Sensitivity to psychological and social risks is rated as **moderate**, as workers are occasionally impacted by stressful and demanding work conditions. Vulnerable groups may include those with pre-existing mental health conditions, workers experiencing isolation from family, and individuals engaged in high-stress roles or leadership positions. Sensitivity is further heightened when workplace dynamics lack effective communication, support systems, or conflict resolution mechanisms.

3.2.12.4 Likelihood

The likelihood of psychological and social risks materializing during the reconstruction phase is assessed as **possible**. This reflects the inherent pressures of construction projects, which often involve intense schedules and complex coordination. Without proactive measures to support workers' psychological and social well-being, these risks are expected to recur across project teams.

Table 18-17. Significance of the Psychological and Social Risks

Magnitude	Spatiotemporal scale	Sensitivity	Likelihood	Overall significance
2	2	2	2	Moderate (8)

3.2.13 Exposure to Extreme Weather Conditions

Railway construction workers, particularly those involved in outdoor tasks such as earthworks, track laying, bridge and tunnel construction, and material handling, may face heightened exposure to extreme weather conditions including heatwaves, heavy rain, snow, and strong winds. These weather patterns can disrupt worksites, damage materials and equipment, and present health risks such as dehydration, heatstroke, frostbite, and hypothermia.

3.2.13.1 Magnitude

The magnitude of risk during the construction phase is rated as **moderate**. Intense summer heat or winter storms can cause health impacts and disrupt productivity, especially on open or elevated worksites. Sudden weather shifts can also lead to accidents due to slippery surfaces, unstable scaffolding, or limited visibility, potentially affecting large numbers of workers.

3.2.13.2 Spatiotemporal Impacts

- Spatial Extent: Exposure is considered **project-wide**, affecting all outdoor construction zones and worker access routes, extending beyond project boundaries.
- Duration: Typically **short-term**, lasting from several hours to a few days, with potential medium-term delays in case of severe weather. Risks can be managed with adequate forecasting, planning, and protective measures.

3.2.13.3 Sensitivity

Sensitivity is rated as **high** due to the physical nature of construction work and continuous outdoor exposure. Workers on scaffolds, bridges, tunnels, and open excavation sites are particularly vulnerable, especially if not provided with adequate PPE, shaded rest areas, warm clothing, or waterproof gear.

3.2.13.4 Likelihood

The likelihood of exposure during the construction phase is rated as **likely**, based on seasonal weather trends in Serbia. Prolonged exposure is more common during extended project timelines or when construction spans multiple weather seasons.

Table 18-17. Significance of the Psychological and Social Risks

Magnitude	Spatiotemporal scale	Sensitivity	Likelihood	Overall significance
2	1	2	2	Low (7)

3.3 Operational Phase Impacts

Once the construction phase of the Project is completed and the is railway operational, several occupational health and safety risks will remain relevant for railway workers, maintenance crews, and operational staff. These risks primarily stem from the movement of trains, infrastructure maintenance, electrical hazards, and emergency situations. Below is an overview of the key OHS risks and impacts expected during the operational phase:

- **Risk of Collisions and Accidents Involving Railway vehicles**
- **Electrical Hazards from Overhead Catenary Systems**
- **Track and Infrastructure Maintenance Risks**
- **Exposure to Harmful Substances**
- **Fire and Explosion Risks**
- **Risk of Slips, Trips, and Falls in Stations and Work Areas**
- **Psychological and Ergonomic Risks for Train Operators and Staff**
- **Emergency Response and Crisis Management Risks**
- **Exposure to Extreme Weather Conditions**

3.3.1 Risk of Collisions and Accidents Involving Railway Vehicles

Railway employees, including maintenance crews, signaling staff, and station personnel are regularly required to operate within or near active railway tracks, placing them at risk of being struck by trains or other railway vehicles. These risks are especially heightened in areas with limited visibility, during night shifts, or under adverse weather conditions, where detection and reaction time are reduced.

3.3.1.1 Magnitude

The magnitude of risks related to collisions and accidents involving railway vehicles during the operation phase is assessed as **very severe**. This judgment is informed by professional evaluations and incident data from railway operations. Workers maintaining tracks, inspecting systems, or performing repairs are exposed to live rail environments where trains operate at high speeds. The consequences of accidents can be life-threatening, including fatalities or severe injuries, particularly when adequate safety protocols, visibility measures, or signalling systems are not in place. These risks are further heightened during emergency interventions or unscheduled maintenance, where time pressure and complex coordination exacerbate potential hazards.

3.3.1.2 Spatiotemporal Impacts

Based on the grading system, the spatiotemporal impacts are rated as **regional** and **permanent**.

- Spatial Extent: the impact spreads beyond the project boundaries, potentially affecting external workers, or adjacent worksites, or the broader workforce operating in the region.

- Duration: the impacts are long-term, persisting throughout the entire operation phase, which extends over the lifetime of the railway infrastructure. Regular maintenance, inspections, and upgrades of railway signalling systems require continuous engagement with live rail environments.

3.3.1.3 Sensitivity

Sensitivity to these risks is rated as **very high**. Railway workers operate directly in hazardous environments where their physical safety depends on the effectiveness of safety measures, such as warning systems, personal protective equipment (PPE), and training. Workers performing duties in proximity to trains are particularly vulnerable, as any misstep or failure in situational awareness can lead to catastrophic consequences. Sensitivity is further elevated during nighttime operations, poor weather conditions, or in areas with complex track layouts or tunnels.

3.3.1.4 Likelihood

The likelihood of collisions and accidents involving railway workers during the operation phase is assessed as **possible**. This evaluation reflects the routine presence of workers in operational rail environments, coupled with potential gaps in safety systems or protocols. Incidents may occur due to human error, communication failures, or technical malfunctions, particularly in high-traffic areas or during unscheduled activities.

Table 18-18. Significance of the Risk of Collisions and Accidents Involving Railway Workers

Magnitude	Spatiotemporal scale	Sensitivity	Likelihood	Overall significance
4	3	4	2	Very high (14)

3.3.2 Electrical Hazards from Overhead Catenary Systems

The railway operates on a high-voltage power supply, exposing workers to electrocution risks when maintaining electrical components, handling live wires, or working near power lines. Inadequate lockout-tagout (LOTO) procedures and failure to follow electrical safety protocols could result in severe injuries or fatalities.

3.3.2.1 Magnitude

The magnitude of risks associated with overhead catenary systems during the operation phase is assessed as **very severe**. This evaluation is based on professional judgment and industry experience. Overhead catenary systems are 25 kV, 50 Hz installations critical to powering trains. Accidental contact with live wires or associated infrastructure can lead to fatal electrocution, severe electrical burns, or secondary injuries caused by resulting fires or falls. Maintenance workers and operational staff are particularly at risk when performing inspections, repairs, or emergency interventions. The continuous presence of energized catenary systems heightens the severity of these hazards.

3.3.2.2 Spatiotemporal Impacts

Using the grading system, the spatiotemporal impacts are categorized as **project-wide** and **permanent**.

- Spatial Extent: the risks span across the entire operational railway network, as overhead catenary systems are present throughout. Any section of the track where maintenance or operational activities are conducted exposes workers to potential electrical hazards.
- Duration: these impacts are Permanent, persisting for the entire operation phase of the railway system. The risks remain constant as long as the catenary systems are live and in use to support railway operations.

3.3.2.3 Sensitivity

Sensitivity to electrical hazards from overhead catenary systems is rated as **very high**. Workers performing maintenance, inspections, or emergency interventions on or near energized systems are highly vulnerable. Proximity to live wires and the reliance on safety protocols and equipment amplify their sensitivity. Even minor lapses in safety measures or equipment malfunctions can result in significant harm, making careful management and training critical to mitigate this risk.

3.3.2.4 Likelihood

The likelihood of electrical hazards occurring during the operation phase is assessed as **possible**. This rating reflects the continuous presence of high-voltage systems, and the routine maintenance and operational activities required to keep the railway network functional. Human error, equipment failure, or adverse weather conditions—such as storms causing wire damage—can increase the probability of incidents if proactive measures are not implemented.

Table 18-19. Significance of the Electrical Hazards from Overhead Catenary Systems

Magnitude	Spatiotemporal scale	Sensitivity	Likelihood	Overall significance
4	3	4	2	High (13)

3.3.3 Track and Infrastructure Maintenance Risks

Ongoing track repairs, inspections, bridge and tunnel maintenance involve risks such as: falls from elevated structures (e.g., bridges, overpasses, embankments), manual handling injuries due to lifting heavy railway components, noise and vibration exposure from rail grinding and track tamping operations.

3.3.3.1 Magnitude

The magnitude of risks related to track and infrastructure maintenance during the operation phase is assessed as **very severe**. Railway maintenance involves tasks such as track realignment, bridge inspections, tunnel maintenance, and ballast cleaning, which expose workers to various hazards. These include risks of injury from moving trains, heavy machinery, and tools, as well as environmental risks like extreme weather conditions, low visibility, or unstable ground conditions. Without strict safety protocols and well-maintained equipment, such tasks can result in serious injuries or fatalities.

3.3.3.2 Spatiotemporal Impacts

Based on the grading system, the spatiotemporal impacts are categorized as **project-wide** and **permanent**.

- Spatial Extent: risks are present across the railway network, including tracks, bridges, tunnels, and other infrastructure. Maintenance activities occur at multiple locations within the operational footprint.
- Duration: these impacts can be permanent, resulting in irreversible consequences to workers health and safety. Maintenance is a continuous requirement to ensure safe operations, and the associated risks remain as long as maintenance activities are conducted.

3.3.3.3 Sensitivity

Sensitivity to track and infrastructure maintenance risks is rated as **high**. Workers are directly exposed to hazardous environments, often operating near live tracks and heavy equipment. The complex nature of maintenance tasks, which require precision and coordination, heightens their vulnerability. Factors like fatigue, inadequate training, or faulty equipment increase the sensitivity of workers to these risks.

3.3.3.4 Likelihood

The likelihood of maintenance-related risks is assessed as **possible**. Maintenance tasks are routine and unavoidable during the operation phase, and the dynamic railway environment introduces constant potential for incidents. Historical data from similar operations supports the probability of recurring risks, especially in the absence of robust safety management systems.

Table 18-20. Significance of the Track and Infrastructure Maintenance Risks

Magnitude	Spatiotemporal scale	Sensitivity	Likelihood	Overall significance
4	2	3	2	High (12)

3.3.4 Exposure to Harmful Substances

Maintenance and operations staff may be exposed to diesel fumes, lubricants, solvents, and chemicals used in rail maintenance, leading to respiratory diseases, skin irritation, or long-term health effects if adequate ventilation and protective measures are not in place.

3.3.4.1 Magnitude

The magnitude of exposure to harmful substances during the operation phase can be assessed as **moderate**, depending on the nature of the substance and level of exposure. Railway operation involves interaction with substances such as lubricants, fuels, cleaning chemicals, and emissions from trains. Prolonged or accidental exposure to these substances may result in health issues, including respiratory problems, skin irritation, and long-term illnesses, such as organ damage from toxic chemicals. Workers engaged in maintenance or cleaning are particularly vulnerable, as they are frequently in direct contact with these substances. Without effective safety protocols and protective measures, the potential severity of harm is significant.

3.3.4.2 Spatiotemporal Impacts

Using the grading system, the spatiotemporal impacts are categorized as **project-wide** and **long-term**.

- Spatial Extent: the risks span the operational footprint, affecting various areas such as maintenance yards, fuel storage zones, and onboard train environments. Harmful substances may also spread into adjacent areas due to leaks, spills, or inadequate containment.
- Duration: these impacts are long-term, persisting throughout the lifetime of railway operations. Regular handling and use of hazardous substances ensure continuous exposure risks unless stringent control measures are implemented.

3.3.4.3 Sensitivity

Sensitivity to exposure to harmful substances is rated as **moderate** for workers who directly handle these materials or work in environments where they are present. Sensitivity is elevated among individuals with pre-existing health conditions or inadequate access to protective equipment. Poor ventilation in enclosed spaces and improper storage or disposal of substances amplify the vulnerability of workers.

3.3.4.4 Likelihood

The likelihood of exposure to harmful substances during the operation phase is assessed as **possible**. This rating reflects the routine use of hazardous materials and substances in railway operations. Accidents, spills, or improper handling further increase the probability of incidents, making consistent safety measures essential to reduce this risk.

Table 18-21. Significance of the risks of Exposure to Harmful Substances

Magnitude	Spatiotemporal scale	Sensitivity	Likelihood	Overall significance
2	2	2	2	Moderate (8)

3.3.5 Fire and Explosion Risks

The presence of flammable materials in train engines, electrical substations, and fuel storage facilities poses a fire and explosion risk, particularly in maintenance depots and train stations. Malfunctions in electrical systems or overheating components could lead to fire incidents, endangering railway workers.

3.3.5.1 Magnitude

The magnitude of fire and explosion risks during the operation phase is assessed as **very severe.** This evaluation is based on potential hazards arising from fuel storage, electrical systems, and onboard train components, such as engines and battery packs. Mismanagement of flammable materials, malfunctioning electrical equipment, or overheating can result in significant incidents with catastrophic consequences, including severe injuries, fatalities, property damage, and service disruptions. The continuous operation of trains and supporting infrastructure creates ongoing risks if safety measures are not strictly observed.

3.3.5.2 Spatiotemporal Impacts

Using the grading system, spatiotemporal impacts are classified as **localized** and **permanent**.

- Spatial Extent: fire and explosion risks are restricted to specific facilities or areas within the operational railway system—such as individual stations, maintenance depots, train compartments, or storage rooms for hazardous materials. These incidents typically affect a limited number of workers or assets and occur within a controlled environment, making the spatial scale localized.
- Duration: the risk of fire and explosion carries the potential for irreversible consequences, including fatalities, permanent injuries, or long-term health damage due to burns, smoke inhalation, or structural collapse. Even though the incidents themselves may be rare or of short duration, their outcomes are permanent for affected individuals, justifying the permanent classification for duration.

3.3.5.3 Sensitivity

Sensitivity to fire and explosion risks is rated as **moderate**, especially for railway workers and personnel stationed at maintenance facilities. Workers who handle fuels or operate in areas with high electrical loads are particularly vulnerable to incidents caused by equipment malfunction or mismanagement. Sensitivity is heightened in enclosed spaces, such as train cabins or underground stations, where fires or explosions can spread rapidly.

3.3.5.4 Likelihood

The likelihood of fire and explosion risks occurring during the operation phase is assessed as **possible,** depending on factors such as adherence to safety protocols, the condition of equipment, and the implementation of preventive measures. Historical data from railway operations highlights recurring risks, particularly in instances of equipment failure, improper storage, or human error.

Table 18-22. Significance of the Fire and Explosion Risks

Magnitude	Spatiotemporal scale	Sensitivity	Likelihood	Overall significance
4	3	2	2	High (11)

3.3.6 Risk of Slips, Trips, and Falls in Stations and Work Areas

Wet or uneven surfaces in stations, depots, and rail yards increase the likelihood of slips, trips, and falls, which are among the most common causes of workplace injuries in railway operations.

3.3.6.1 Magnitude

The magnitude of the risks of slips, trips, and falls in stations and work areas during the operation phase is assessed as **moderate**. This evaluation considers the potential for injuries resulting from wet floors, uneven surfaces, poorly maintained flooring, or obstructed walkways in high-traffic areas. Such incidents can lead to minor injuries, such as bruises or sprains, as well as more severe outcomes, including fractures or head injuries. The continuous use of stations and work areas, coupled with varying weather conditions and the presence of operational equipment, heightens the potential for these incidents.

3.3.6.2 Spatiotemporal Impacts

Using the provided grading system, spatiotemporal impacts are categorized as **project-wide** and **medium-term**.

- Spatial Extent: the risks are present throughout the operational footprint, including passenger stations, platforms, stairways, and maintenance facilities. Both public and staff-accessible areas are susceptible to slip, trip, and fall hazards.
- Duration: persists for weeks to months but remains reversible. Workers may require medical attention or temporary work restrictions, but the effects are not permanent.

3.3.6.3 Sensitivity

Sensitivity to these risks is rated as **moderate**, as railway workers are directly exposed to hazards in stations and work areas. Workers are vulnerable to slips or falls on wet or uneven surfaces. Workers in maintenance and operational roles face additional challenges, such as cluttered workspaces and restricted visibility, which further elevate their sensitivity to these hazards.

3.3.6.4 Likelihood

The likelihood of slips, trips, and falls occurring during the operation phase is assessed as **likely.** This judgment reflects the routine nature of risks in busy stations and work areas. Factors such as high foot traffic, weather conditions (e.g., rain or snow), and delays in hazard identification or remediation contribute to the recurring probability of incidents.

Table 18-23. Significance of the Risk of Slips, Trips, and Falls in Stations and Work Areas

Magnitude	Spatiotemporal scale	Sensitivity	Likelihood	Overall significance
2	1	2	3	Moderate (8)

3.3.7 Psychological and Ergonomic Risks for Railway Personnel

Railway personnel working long shifts may face:

- Fatigue and stress-related issues due to extended working hours and high concentration requirements.
- Ergonomic challenges from prolonged sitting and repetitive tasks, leading to musculoskeletal strain.

The repetitive nature of tasks and the sustained pressure of ensuring safe and efficient train operations contribute to the enduring presence of these risks

3.3.7.1 Magnitude

The magnitude of psychological and ergonomic risks for railway personnel during the operation phase is assessed as **moderate**. The staff are frequently subjected to long working hours, shift rotations, and high-pressure environments, leading to stress, fatigue, and burnout. Additionally, prolonged sitting, repetitive movements, and poorly designed workspaces can result in musculoskeletal disorders, chronic pain, and reduced productivity. These combined risks highlight the significant impact on both mental and physical well-being if preventative measures are not taken.

3.3.7.2 Spatiotemporal Impacts

Based on the grading system, the spatiotemporal impacts are categorized as **project-wide** and **medium-term**.

- Spatial Extent: Psychological and ergonomic risks affect the railway personnel across the operational footprint, including control centres, and station workspaces. These risks are not confined to specific locations but are prevalent throughout the railway system.
- Duration: these impacts are medium-term, persists for weeks to months but remains reversible.

3.3.7.3 Sensitivity

Sensitivity to these risks is rated as **high**, as the railway personnel is directly exposed to the stressors of their roles and the ergonomic challenges of their work environments. Personnel working in poorly adjusted workstations or using outdated equipment are particularly vulnerable to physical discomfort and long-term injuries. Psychological sensitivity is elevated by the responsibility of ensuring passenger safety, adhering to strict schedules, and managing emergency situations, which can exacerbate stress and fatigue.

3.3.7.4 Likelihood

The likelihood of psychological and ergonomic impacts materializing during the operation phase is assessed as **likely**. The continuous demands of train operations, coupled with the potential for poorly designed workstations and insufficient mental health support, result in a recurring probability of these risks affecting the railway personnel.

Table 18-24. Significance of the Psychological and Ergonomic Risks for Train Operators and Staff

Magnitude	Spatiotemporal scale	Sensitivity	Likelihood	Overall significance
2	1	3	3	9

3.3.8 Emergency Response and Crisis Management Risks

Railway workers need to be prepared for derailments, system failures, extreme weather events, and hazardous material spills. Inadequate emergency preparedness, insufficient training, and lack of coordination among emergency teams could result in increased casualties and injuries during accidents.

3.3.8.1 Magnitude

The magnitude of emergency response and crisis management risks during the operation phase is assessed as **very severe.** Railways operate in complex environments where emergencies, such as accidents, derailments, fires, or medical crises, can escalate rapidly if not managed effectively. Delays in response, poor communication, or lack of preparedness may exacerbate the impacts, potentially leading to significant loss of life, injuries, and operational disruptions. The critical nature of these emergencies underlines the need for robust crisis management systems and protocols to minimize harm.

3.3.8.2 Spatiotemporal Impacts

Based on the grading system, the spatiotemporal impacts are categorized as **project-wide** and **permanent**.

- Spatial Extent: Emergency response and crisis management risks are present across the entire operational footprint, including tracks, stations, train interiors, maintenance depots, and control centres. These risks also extend to adjacent areas that may be affected by emergencies, such as surrounding communities during derailments or hazardous material spills.
- Duration: These risks are permanent, persisting throughout the operational lifespan of the railway system. The potential for crises remains constant due to the dynamic nature of railway operations and the ever-present risk of unforeseen events.

3.3.8.3 Sensitivity

Sensitivity to these risks is rated as **high**, as both railway staff and passengers are directly affected during emergencies. Staff members responsible for managing crises are particularly vulnerable to stress and decision-making fatigue, while passengers may be physically harmed or experience psychological distress during such events. Inadequate training, lack of experience, or insufficient resources further increase the sensitivity of all stakeholders involved.

3.3.8.4 Likelihood

The likelihood of emergency response and crisis management risks during the operation phase is assessed as **possible**, depending on the frequency of incidents, the effectiveness of existing safety measures, and the level of preparedness among railway staff. Historical data and industry experience indicate that emergencies, while not daily occurrences, are inevitable during long-term operations, particularly when unforeseen technical failures or human errors occur.

Table 18-25. Significance of the Emergency Response and Crisis Management Risks

Magnitude	Spatiotemporal scale	Sensitivity	Likelihood	Overall significance
4	3	3	2	High (12)

3.3.9 Exposure to Extreme Weather Conditions

Railway workers, particularly those in track maintenance and inspection roles, may be exposed to extreme heat, cold, heavy rain, or snowfall, increasing the risk of heat exhaustion, frostbite, and hypothermia.

3.3.9.1 Magnitude

The magnitude of risks associated with exposure to extreme weather conditions during the operation phase is assessed as **moderate**. Railway operations often face extreme weather events, such as heavy rainfall, snowstorms, high winds, and heatwaves, which can severely impact both workers and infrastructure. Workers exposed to harsh weather conditions may experience health issues such as hypothermia, heat exhaustion, or injuries from slippery or unstable surfaces. Extreme weather can also disrupt train operations, leading to safety risks and operational delays.

3.3.9.2 Spatiotemporal Impacts

Using the grading system, the spatiotemporal impacts are categorized as **project-wide** and **short-term**.

- Spatial Extent: Extreme weather risks affect the entire operational network, including outdoor work zones, stations, and areas along the railway tracks.
- Duration: These impacts are short-term, lasts for a few hours to several days and is quickly resolved with no lasting consequences for worker health and safety. Climate change is expected to amplify the frequency and intensity of extreme weather events over time.

3.3.9.3 Sensitivity

Sensitivity to extreme weather risks is rated as **moderate**. Railway workers conducting outdoor maintenance, inspections, or emergency repairs are particularly vulnerable, as they are directly exposed to harsh environmental conditions. Sensitivity is heightened for workers without access to adequate protective gear or shelter.

3.3.9.4 Likelihood

The likelihood of exposure to extreme weather conditions during the operation phase is assessed as **possible**. This assessment reflects the unpredictability of extreme weather events due to climate change. These risks are expected to occur regularly over the lifespan of the railway system.

Table 18-26. Significance of the Exposure to Extreme Weather Conditions

Magnitude	Spatiotemporal scale	Sensitivity	Likelihood	Overall significance
2	1	2	2	Low (7)

3.4 Summary of impacts

Table 18-27. Summarized OHS impacts during construction and operation phase

Phase	Impact	Positive/Negative	Overall significance before mitigation measures are implemented
Construction Phase	Risk of accidents due to heavy machinery and equipment use	Negative	***High (13)*** Major injuries or fatalities likely without strict controls and adequate training
Construction Phase	Risks related to working at heights	Negative	***High (13)*** Falls can result in life-threatening injuries; requires robust fall protection systems and training
Construction Phase	Electrical hazards from overhead lines and power supply systems	Negative	***High (12)*** High risk of electrocution or burns due to proximity to energized electrical systems
Construction Phase	Risk of rockfall and erosions	Negative	***High (12)*** Risk result from unstable geological conditions, steep slopes, inadequate slope stabilization, and changes in vegetation cover
Construction Phase	Risks related to Collision with Utilities	Negative	***High (12)*** Risk of accidents due to collisions with high voltage electrical and high-pressure magistral gas lines
Construction Phase	Noise and vibration exposure	Negative	***Moderate (8)*** Health impacts such as hearing loss or stress common without strict noise control measures
Construction Phase	Exposure to hazardous materials	Negative	***High (11)*** Long-term health issues like respiratory illnesses or chemical burns possible

Construction Phase	Risk of confined space incidents	Negative	***Moderate (10)*** Confined environments pose risks of asphyxiation and injuries without adequate precautions
Construction Phase	Fire and explosion risks	Negative	***Moderate (10)*** Flammable materials and operational activities present moderate risks
Construction Phase	Manual handling and ergonomic risks	Negative	***Moderate (10)*** Musculoskeletal injuries likely without ergonomic improvements
Construction Phase	Risks Associated with Road and Railway Traffic	Negative	***High (13)*** High probability of accidents involving workers, machinery and trains without strict traffic management
Construction Phase	Psychological and social risks	Negative	***Moderate (8)*** Stress, isolation, and interpersonal conflicts likely without support systems
Construction Phase	Exposure to extreme weather conditions	Negative	***Low (7)*** Constant exposure to extreme weather impacts safety and operations
Operation Phase	Risk of collisions and accidents involving railway vehicles	Negative	***Very High (14)*** High-speed rail environments pose significant risks of injuries and fatalities
Operation Phase	Electrical hazards from overhead catenary systems	Negative	***High (13)*** Constant exposure to live electrical systems creates life-threatening hazards
Operation Phase	Track and infrastructure maintenance risks	Negative	***High (12)*** Ongoing maintenance creates significant safety risks for workers

Operation Phase	Exposure to harmful substances	Negative	***Moderate (8)*** Continuous handling of toxic materials poses long-term health risks
Operation Phase	Fire and explosion risks	Negative	***High (11)*** Persistent risks from operational fuels, systems, and flammable materials
Operation Phase	Risk of slips, trips, and falls in stations and work areas	Negative	***Moderate (8)*** Ongoing injuries likely due to wet floors, obstructions, and uneven surfaces
Operation Phase	Psychological and ergonomic risks for train operators and staff	Negative	***Moderate (9)*** Stress and musculoskeletal injuries due to prolonged work hours and poorly designed workspaces
Operation Phase	Emergency response and crisis management risks	Negative	***High (12)*** Delays and lack of preparedness can exacerbate impacts of emergencies
Operation Phase	Exposure to extreme weather conditions	Negative	***Low (7)*** Constant exposure to extreme weather impacts safety and operations

Note: Community health, safety and security impacts are addressed in the Social Impact Assessment (Chapter 19) and the Major Accidents and Disasters Assessment (Chapter 17).

4 MITIGATION MEASURES

The Occupational Health and Safety (OHS) mitigation measures outlined in this chapter provide a framework for protecting workers, minimizing risks, and ensuring compliance with applicable safety standards during the construction and operations phases of the Project. These measures serve as the baseline requirements that must be incorporated into the OHS Management System of both the future Contractors and SRI to ensure effective hazard control, enforcement of safety protocols, and provision of adequate training and protective equipment.

The Contractor will be responsible for developing and implementing a Construction OHS Management Plan. SRI will be responsible for developing and implementing an equivalent Operational OHS Management Plan, which must detail the specific measures necessary to mitigate the identified OHS risks associated with railway operation and maintenance activities. These plans must fully reflect and expand upon the requirements outlined in this Chapter, ensuring their practical implementation in alignment with Project-specific risks and regulatory obligations.

The outlined mitigation measures are preliminary and subject to refinement as additional information becomes available during further Project planning, reconstruction and implementation phases.

4.1 Construction Phase

The OHS mitigation measures for the construction phase are designed to protect workers, minimize risks, and ensure compliance with applicable safety standards. SRI must require the incorporation of these measures by the Contractor starting from the tender preparation phase, extending through contracting and monitoring during project execution.

Table 18-28. specifies the OHS mitigation measures that must be implemented during construction.

Table 18-28. Proposed OHS Mitigation Measures during construction

Impact	Mitigation measures
Risk of accidents due to heavy machinery and equipment use	- SRI will ensure tender documents require strict implementation of machine operation protocols and operator training to be enforced by the Contractor. - SRI will require routine machinery maintenance and inspections to be specified in the Construction OHS Management Plan. - The Contractor must establish and delineate clear pathways for machinery and personnel, as monitored and verified by the Supervision Engineer. - Contracts must mandate the use of Personal Protective Equipment (PPE), such as high visibility clothing by all workers.
Risks related to working at heights	- SRI will enforce the installation of fall protection systems (e.g., guardrails, safety nets) through specific contractual obligations.

	- Worker training on working-at-height safety protocols must be included in tender requirements. - The Supervision Engineer must ensure the Contractor implements exclusion zones beneath elevated work areas.
Electrical hazards from overhead lines and power supply systems	- SRI will require the Contractor to develop its own lockout/tagout (LOTO) procedure that comply with the existing SRI LOTO procedures. The Supervision Engineer will approve and monitor its implementation. - Safety briefings and awareness programs must be included in the Contractor's obligations. - The Supervision Engineer will oversee the establishment of exclusion zones around energized areas. - SRI will require the Contractor to provide insulated personal protective equipment (PPE), including gloves and boots, as a mandatory contractual obligation.
Risk of rockfall and erosions	- SRI will require the Contractor to conduct detailed geotechnical surveys and slope stability assessments before commencing any excavation, especially tunneling or slope works in the areas prone to erosion. - Contracts must stipulate the installation of protective structures (e.g., rockfall barriers, mesh netting, retaining walls) in erosion-prone or unstable slope areas, particularly near tunnel portals. - SRI will mandate the implementation of drainage control measures to minimize water-induced erosion during and after construction. - Vegetation clearance will be limited to essential areas, and slope revegetation or stabilization must be included in the Contractor's environmental management plans, monitored by the Supervision Engineer. - Emergency protocols must be embedded in the Contractor's OHS Plan.
Risks related to Collision with Utilities	- SRI will require the Contractor to prepare a Utility Conflict Management Plan, including utility mapping, detection, and risk mitigation procedures prior to any excavation or construction near underground or above-ground utilities. - Contracts must specify mandatory coordination with utility providers, especially for areas where high-voltage lines (10 kV, 35 kV, 110 kV) and the main gas pipeline (MOP 55 bar) are present. - The Contractor must mark utility zones with visible signage and physical barriers, as verified through the Supervision Engineer's field inspections. - Tender documentation will require the Contractor to implement no-dig zones and alternative work methods near high-risk utilities. - Emergency response training for utility-related incidents (e.g., gas leaks, electrical contact) must be included in the Contractor's HSE program and reviewed by the Supervision Engineer.

Noise and vibration exposure	- The Contractor must monitor noise and vibration levels, with thresholds enforced by the Supervision Engineer during regular inspections, with special attention during tunneling works. - SRI will include PPE requirements, such as earplugs or noise-canceling headphones, in its tender special requirements. - Mandatory rest breaks and vibration-reduction measures must be enforced.
Exposure to hazardous materials	- Through its tender documents SRI will require the Contractor to conduct pre-construction site assessments, especially the mandatory asbestos assessment of buildings by experienced specialists. - SRI will enforce the preparation of mandatory Asbestos Management Plans before commencement of works on each building or structure containing the asbestos materials. - Contractor's management plans will include measures for the safe handling and disposal of hazardous materials, including the identification, collection, storage and disposal of decommissioned railway materials such as old sleepers. Where sleepers are treated with hazardous substances (e.g. creosote or asbestos), appropriate procedures aligned with national legislation and international good practice will be implemented to ensure safe handling, transport, and disposal. The contractor shall also coordinate in advance with licensed hazardous waste management facilities to ensure sufficient capacity and compliance with disposal requirements (requirement in more details described in chapter 16 Waste Materials) .. - During project oversight the Supervision Engineer will approve and monitor the implementation of containment measures stipulated in Contractors' management plans. - Contractor will provide specific PPE such as respirators and protective suits.
Risk of confined space incidents	- SRI will ensure tender requirements mandate confined space hazard assessments, entry permits, and monitoring. - The Contractor must equip workers with respirators and harnesses, as enforced by the Supervision Engineer through regular audits. - Confined space safety training and emergency response protocols must be specified in contractual obligations.
Fire and explosion risks	- SRI will require fire prevention and response training for Contractors' workers, as well as proper storage protocols for flammable materials. - Contracts must mandate fire suppression systems and regular inspections of electrical equipment. - The Supervision Engineer will verify compliance during project audits.
Manual handling and ergonomic risks	- The Contractor is required to deliver training on manual handling and ergonomics and to include a description of these topics in the training program.

	- Mechanical aids, such as lifting equipment, must be incorporated into project plans. - The Supervision Engineer will ensure workstations are optimized for ergonomic safety.
Risks Associated with Road and Railway Traffic	- SRI will require that all tender documents and contracts include a provision for contractors to develop Traffic Management Plans to address road traffic management protocols for each construction site, as well as for areas with heightened traffic risks such as tunnels, site entrances and exits, and other relevant locations.. - Contractor will be obliged for preparation of a Railway Interface Safety Management Plan, clearly outlining roles, safe access protocols, work windows, signaling coordination, and emergency procedures, time-restricted work windows, mandatory safety training, real-time communication protocol with railway traffic control - The Contractor must install signage and barriers, as overseen by the Supervision Engineer during site inspections. - Worker awareness and training programs will be monitored by the Supervision Engineer.
Psychological and social risks	- SRI will require the Contractor to provide stress management training and support programs for workers. - Rotational shifts and manageable work hours must be included in the Construction OHS Management Plan and reviewed by the Supervision Engineer. - The Supervision Engineer will conduct regular audits to ensure measures are implemented.
Exposure to extreme weather conditions	- The Contractor shall implement daily review of forecast data and real-time weather conditions relevant to the construction site. - The contractor will assign responsibility to the HSE Officer or designated Site Supervisor to track weather alerts and advise on work scheduling. - Contractor will establish predefined thresholds for suspension or adjustment of high-risk activities under adverse conditions, including lifting and hoisting operations during high winds, earthworks or excavation during heavy rainfall, electrical works during lightning or thunderstorms, extended outdoor work under heatwave or freezing conditions. - SRI will require the Contractor to provide protective measures for workers exposed to harsh weather, such as weather-resistant PPE and access to shelters. - Regular maintenance of infrastructure to withstand extreme weather impacts must be monitored.

Emergency Preparedness and Response Plan

In addition to the previously outlined requirements, the Contractor shall develop and implement a site-specific Emergency Preparedness and Response Plan (EPRP) prior to commencing construction activities. The EPRP shall be proportionate to the scale and nature of the construction operations and must comply with applicable national legal requirements and internationally recognized standards.

The EPRP shall include, at a minimum:

- Defined emergency roles and responsibilities, including the identification and training of designated emergency response personnel and first responders;
- Clear evacuation procedures for the construction site, including prominently marked escape routes, designated emergency assembly points, and protocols for evacuations from tunnels or confined spaces;
- Communication protocols, including emergency contact lists, notification procedures, and on-site alert systems such as alarms and radios;
- First aid arrangements, including trained personnel, locations of first aid kits and medical supplies, and coordination mechanisms with local medical facilities in Paraćin, Aleksinac, Niš, and surrounding areas;
- Coordination procedures with local emergency services (fire, medical, police) through formal liaison channels and established communication protocols;
- Scenario-based emergency procedures addressing incidents such as fire, explosion, electrocution, hazardous material spills, equipment failure, tunnel collapse, or worker injuries at height.

The EPRP shall be communicated to all personnel and incorporated into induction programs and ongoing safety training, tested regularly through drills, periodically reviewed and updated in line with any changes in project phases and risk assessments.

By integrating these measures into the construction phase of the Project, from tender preparation and contracting to execution monitoring, SRI should ensure the effective protection of workers and alignment with international OHS standards.

4.2 Operations Phase

The OHS mitigation measures for the operational phase are established to safeguard workers, passengers, and infrastructure, minimize risks, and ensure adherence to relevant safety standards. SRI will be responsible for the enforcement of these measures throughout all stages of the operations phase. This responsibility encompasses the integration of these measures into operational Management Plans and Procedures, as well as their implementation and monitoring during the ongoing railway operations.

SRI will ensure the development and implementation of an Operational OHS Management Plan that includes targeted measures to mitigate the identified OHS impacts during the operation phase. This plan should address all potential risks and include the measures specified in Table 18-29, which defines the proposed OHS mitigation measures for operations phase impacts.

Table 18-29. OHS Mitigation Measures during Operations

Impact	Mitigation measures

Risk of collisions and accidents involving railway vehicles	- SRI is required to ensure that the design includes advanced signaling systems and train control technologies to ensure the safety of workers in proximity to live tracks. - Strict and clearly defined safety protocols must be enforced for any work conducted near or on operational railway infrastructure. These protocols must address worker access, communication with traffic control, emergency procedures, and real-time monitoring, ensuring that safety is maintained. - SRI must enforce the use of high-visibility PPE for maintenance personnel. - Maintenance scheduling during non-operational hours must be obligatory, with compliance verified by the SRI respective services.
Electrical hazards from overhead catenary systems	- SRI will update the current lockout/tagout procedures and implement comprehensive measures for de-energizing catenary systems during maintenance activities. - Operators must provide PPE, such as insulated gloves and dielectric boots, as specified in operational plans. - Routine inspections of catenary systems must be enforced by strict protocols and audited by SRI. - Warning signage and barriers must be installed and monitored to prevent accidental contact.
Track and infrastructure maintenance risks	- SRI must ensure that design includes provisions for worker safety during maintenance, including the use of advanced monitoring technologies like automated track inspection systems. - SRI must enforce lockout/tagout procedures and train staff on safe maintenance practices. - SRI will monitor compliance through regular audits and inspections of maintenance activities.
Exposure to harmful substances	- SRI must implement protocols for safe storage, labeling, and disposal of harmful substances. - SRI must ensure strict compliance with mandatory personal protective equipment (PPE) usage for hazardous substances. - Routine and mandatory air quality monitoring in high-risk areas must be implemented.
Fire and explosion risks	- SRI will enforce the implementation of rigid fire safety protocols and fire suppression systems onboard trains, at stations, and in depots. - SRI will enforce providing mandatory training to internal and external staff in fire prevention and emergency response procedures and will implement regular semi-annual emergency drills. - Regular inspections of electrical systems and fuel storage facilities must be mandated and audited by SRI.
Risk of slips, trips, and falls in stations and work areas	- SRI is responsible for conducting routine inspections to identify potential hazards in both passenger and work areas,

	inspections must be clearly detailed in the standard operating procedures. - Design must mandate installation of non-slip surfaces, handrails, and proper lighting in high-risk zones. - SRI must implement rapid response protocols for cleaning and repairs, with compliance monitored by trained staff.
Psychological and ergonomic risks for train operators and staff	- SRI will enforce ergonomic assessments of control centers, and workspaces during operational planning. - Designs must include provisions for adjustable seating and interfaces tailored to the workers' needs. - SRI must offer mental health support programs and fatigue management systems to prevent long-term impacts.
Emergency response and crisis management risks	- SRI will develop comprehensive emergency response plans, including crisis simulations and drills. - SRI will mandate regular training for staff on emergency protocols and first aid. - SRI must equip stations and all other facilities with mobile and stationary emergency equipment and monitor its effectiveness during regular audits. - Advanced communication systems for rapid information dissemination must be implemented.
Exposure to extreme weather conditions	- SRI must enforce protective measures for workers exposed to harsh weather, such as weather-resistant PPE and access to shelters. - SRI must implement monitoring systems for real-time weather updates and alerts. - Regular maintenance of infrastructure to withstand extreme weather impacts must be monitored by SRI.

These mitigation measures should be integrated into all phases of operational management, with SRI ensuring compliance through robust oversight, monitoring, and enforcement mechanisms.

4.3 Monitoring

SRI is responsible for appointing a Supervision Engineer who will be responsible for supervising the activities of the Contractor on a day-to-day basis and for undertaking regular monitoring throughout the construction and operations phases of the Project to ensure that the legal requirements, Lenders' Policies, ESIA commitments and requirements of OHS Management Plans are being met. Furthermore, monitoring should track changes in baseline conditions to verify that mitigation measures implemented by the construction contractor or SRI to prevent or limit potentially significant negative impacts are adequate and effective. If monitoring indicates that negative impacts are occurring despite compliance with Management Plans, additional mitigation measures may be required, and the Plans revised accordingly.

The monitoring activities outlined in Table below in relation to OHS risks are proposed for the construction and operations phases. The enforcement of this monitoring is the obligation of SRI, conducted through its appointed representatives (i.e. the Supervision Engineer); however, this does not release the Contractor or other legal entities operating inside Project limits, from their responsibility to carry out all legally required monitoring activities in accordance with applicable regulations and contractual obligations.

Table 18-30. OHS Monitoring during Construction and Operation phase

Monitoring Requirement	Frequency	Location	Method
Construction Phase			
Compliance with heavy machinery and equipment protocols	Monthly	All Project worksites	- Visual inspections of machinery operation and maintenance activities. - Audits of operator training records and records on third party inspections.
Fall protection system functionality	Weekly	Elevated work zones and scaffolding sites	- Inspections of guardrails, safety nets, and harness usage. - Review of worker compliance logs.
Electrical safety measures compliance	Weekly	Areas with overhead lines and electrical systems	- Inspections of lockout/tagout protocols. - Audits of PPE usage for workers in electrical zones.
Noise and vibration levels monitoring	Monthly	High-intensity worksites (e.g. tunnels)	- Instrument-based measurements of noise and vibration levels. - Comparison to regulatory thresholds.
Rockfalls and erosions monitoring	Bi-weekly	Slope areas, tunnel portals (especially km 192+275 to	- Visual inspections of slope stability and erosion control measures (e.g., retaining walls, netting, drainage).

Monitoring Requirement	Frequency	Location	Method
		192+854), and cut sections	- Review of weather-related risk triggers (e.g., heavy rainfall). - Audits of slope stabilization and vegetation regrowth progress.
Collisions with utilities monitoring	Monthly	Areas with underground and aboveground utilities (e.g., 10/35/110 kV lines and MOP 55 bar gas pipeline)	- Inspections for visible utility markers, fencing, and signage. - Review of utility location records and updates. - Audits of Contractor's coordination with utility providers and adherence to utility conflict plans.
Hazardous materials handling and containment	Monthly	Sites with chemical storage and hazardous material activities	- Inspections of storage areas and containment measures. - Audits of hazardous material handling records.
Confined space safety protocol compliance	Monthly	Confined space worksites	- Inspections of entry permits and monitoring systems. - Audits of worker training logs for confined space safety.
Fire and explosion risk assessments	Weekly	All Project worksites	- Inspections of flammable material storage and fire suppression systems. - Safety audits of fire response training records.
Manual handling and ergonomic practices monitoring	Monthly	Workstations and manual task zones	- Observations of worker posture and equipment use. - Review of compliance with ergonomic protocols.
Traffic management plan adherence	Weekly	Worksite traffic zones	- Inspections of signage and barriers. - Audits of worker awareness training records.
Railway Interface Safety Management Plan adherence	Monthly	Worksites near operational railway track	- Observations on safe access and communication protocols, signalling coordination and work windows implementation. - Audits of emergency preparedness drills and safety training effectiveness.
Psychological and social well-being monitoring	Semi-annual	All Project worksites	- Surveys of worker well-being and stress levels. - Review of support program implementation by Contractor.
Weather resilience monitoring	Annual; Increased frequency during extreme seasons	Exposed work areas	- Review of PPE adequacy and availability for weather extremes.
Operations Phase			

Monitoring Requirement	Frequency	Location	Method
Compliance with railway worker safety protocols	Not less than quarterly	Tracks, stations, maintenance zones, and tunnels	- Unannounced safety audits of worker behaviour and PPE usage. - Review of work permits, time logs, and management records. - Evaluation of near-miss and incident reports.
Overhead catenary and electrical system integrity	Quarterly or after major maintenance events	Overhead lines, substations, switching yards	- Instrument-based checks for current leakage and grounding effectiveness. - Drone-based visual inspection of high-risk and inaccessible areas. - Review of thermal imaging data for hot spots.
Track and infrastructure maintenance safety compliance	Not less than quarterly	Track, bridges, tunnels and culverts	- Physical inspection of safety practices during maintenance. - Review of safety logs, LOTO procedures, and maintenance checklists. - Worker interviews for protocol familiarity.
Harmful substance exposure monitoring	Quarterly or after major maintenance events	Depots, cleaning facilities, storage areas	- Air and surface sampling for diesel fumes, solvents, and other hazardous substances. - Inspection of ventilation systems and containment areas. - Audits of chemical inventory and SDS documentation.
Fire and explosion prevention system effectiveness	Quarterly	Depots, stations, rolling stock, signal cabins	- Functional testing of fire alarms, detectors, and suppression systems. - Audits of fire drill records and extinguisher inspection logs. - Review of flammable material handling/storage.
Slips, trips, and falls hazard inspections	Quarterly	Platforms, public and staff walkways, rest areas	- Condition surveys for flooring, stairwells, railings, and lighting. - Verification of incident log follow-ups and signage adequacy. - Observation of housekeeping practices.
Psychological and ergonomic well-being monitoring	Quarterly	Control centers, maintenance workshops, ticket offices	- Anonymous mental health surveys and one-on-one interviews. - Ergonomic assessments of workstations and vehicle operator cabins. - Review of rotation schedules and job design.
Emergency response system and preparedness	Quarterly (drills); Monthly (readiness checks)	Stations, tunnels, control rooms, onboard trains	- Emergency drills simulating various scenarios (fire, derailment, medical).

Monitoring Requirement	Frequency	Location	Method
			- Inspection of first-aid kits, evacuation signage, and PA systems. - Training refreshers for emergency response teams.
Weather resilience monitoring	Annual; Increased frequency during extreme seasons	Exposed work areas, trackside facilities, signal boxes	- Review of PPE adequacy and availability for weather extremes. - Functional testing of heating/cooling/lighting in shelters. - Evaluation of drainage, snow/ice control systems, and heat mitigation plans.

5 RESIDUAL IMPACTS ASSESSMENT

Residual impact assessment on OHS during construction and operational phases is presented in Table 18-31.

Table 18-31. Residual OHS Impact Assessment

Phase	Impact	Negative or Positive	Overall significance before mitigation	Summary of mitigation strategy	Assessment of impacts after mitigation	Overall significance after mitigation
Construction	Risk of accidents due to heavy machinery and equipment use	Negative	*High (13)*	Enforcement of safety protocols, operator training, PPE requirements, and routine machinery inspections.	Residual risk reduced significantly; isolated incidents possible due to human error.	*M (2) + ST (1) + S (2) + L (2) = Low (7)*
Construction	Risks related to working at heights	Negative	*High (13)*	Installation of fall protection systems, worker training, and exclusion zones beneath elevated work areas.	Risk minimized with robust safety measures, though minimal risk remains.	*M (2) + ST (1) + S (2) + L (1) = Low (6)*
Construction	Electrical hazards from overhead lines and power systems	Negative	*High (13)*	Lockout/tagout procedures, insulated PPE, safety briefings, and exclusion zones.	Residual risk limited to rare equipment failures or human error.	*M (2) + ST (1) + S (2) + L (2) = Low (7)*
Construction	Risk of Rockfall and Erosions	Negative	*High (12)*	Geotechnical risk assessments, slope stabilization measures, protective barriers, warning signage and regular inspections.	Low residual risks remain in extreme weather conditions.	*M (2) + ST (2) + S (2) + L (1) = Low (7)*
Construction	Risk of Collision with Utilities	Negative	*High (12)*	Pre-construction utility surveys, utility strike prevention protocols including mapping, marking and use of detection equipment.	Risk significantly reduced through avoidance and detection measures; rare strikes may occur due to outdated utility records.	*M (2) + ST (2) + S (2) + L (1) = Low (7)*
Construction	Noise and vibration exposure	Negative	*Moderate (9)*	Monitoring, use of PPE, rest breaks, and engineering controls to reduce noise and vibrations.	Potential for minimal discomfort remains due to proximity to machinery, especialy during tunneling works.	*M (2) + ST (1) + S (2) + L (2) = Low (7)*
Construction	Exposure to hazardous materials	Negative	*High (11)*	Hazard assessment, containment measures, PPE provision, and safe handling/disposal protocols.	Rare exposure incidents may occur, but overall risks are significantly reduced.	*M (2) + ST (1) + S (2) + L (1) = Low (6)*
Construction	Risk of confined space incidents	Negative	*High (10)*	Confined space hazard assessments, strict entry permits, monitoring, PPE, and specialized training.	Incidents unlikely due to comprehensive controls; residual risks are minimal.	*M (2) + ST (1) + S (2) + L (1) = Low (6)*

Construction	Fire and explosion risks	Negative	*High (10)*	Fire prevention training, proper storage of flammable materials, installation of suppression systems, and regular inspections.	Rare fire incidents possible but manageable with robust preparedness measures.	*M (2) + ST (1) + S (2) + L (1) = Low (6)*
Construction	Manual handling and ergonomic risks	Negative	*Moderate (10)*	Training in manual handling techniques, use of mechanical aids, and ergonomic workstation adjustments.	Physical strain minimized with ergonomic solutions; occasional discomfort possible.	*M (1) + ST (1) + S (2) + L (1) = Low (5)*
Construction	Risks Associated with Road and Railway Traffic	Negative	*High (13)*	Development of traffic management plans, Railway Interface Safety Management Plans, signage, barriers, and worker awareness programs.	Collisions rare due to strict controls; minor residual risks remain due to human factors.	*M (2) + ST (2) + S (2) + L (2) = Moderate (8)*
Construction	Psychological and social risks	Negative	*Moderate (8)*	Stress management programs, rotational shifts, and monitoring of worker well-being.	Stress levels reduced significantly; occasional social challenges may arise.	*c M (1) + ST (1) + S (2) + L (1) = Low (5)*
Construction	Exposure to extreme weather conditions	Negative	*Low (7)*	Weather-resistant PPE, access to shelters, real-time weather monitoring	Impact reduced significantly; occasional disruptions possible due to extreme events.	*M (1) + ST (1) + S (1) + L (1) = (4) Low*
Operation	Risk of collisions and accidents involving railway workers	Negative	*Very High (14)*	Advanced signaling systems, PPE requirements, and maintenance scheduling during non-operational hours.	Residual risks limited to rare cases; compliance ensures minimal impact.	*M (8) + ST (2) + S (2) + L (2) = Moderate (10)*
Operation	Electrical hazards from overhead catenary systems	Negative	*High (13)*	Lockout/tagout procedures, PPE provision, routine inspections, and installation of warning signage and barriers.	Residual risks limited to isolated instances; controls significantly reduce impact.	*M (2) + ST (2) + S (2) + L (2) = (8) Low*
Operation	Track and infrastructure maintenance risks	Negative	*High (12)*	Automated track inspection systems, lockout/tagout procedures, and worker safety training.	Maintenance safety improved significantly; minor risks from technical failures remain.	*M (2) + ST (2) + S (2) + L (2) = (8) Low*
Operation	Exposure to harmful substances	Negative	*Moderate (8)*	PPE provision, air quality monitoring, containment measures, and safe storage/disposal protocols.	Harmful substance exposure reduced significantly; isolated incidents possible.	*M (1) + ST (1) + S (2) + L (2) = (6) Low*
Operation	Fire and explosion risks	Negative	*High (11)*	Fire safety training, suppression systems, proper storage of flammable materials, and regular inspections.	Rare fire incidents manageable with robust protocols; residual risks minimized.	*M (2) + ST (2) + S (2) + L (1) = (7) Low*

Operation	Risk of slips, trips, and falls in stations and work areas	Negative	*Moderate (8)*	Routine inspections, installation of non-slip surfaces, proper lighting, and rapid cleaning/repair protocols.	Physical injuries minimized; residual risks persist due to high foot traffic.	*M (1) + ST (2) + S (2) + L (1) = (7) Low*
Operation	Psychological and ergonomic risks for train operators and staf	Negative	*Moderate (9)*	Ergonomic assessments, adjustable seating/interfaces, mental health programs, and fatigue monitoring systems.	Stress and physical strain reduced significantly; residual impacts manageable.	*M (1) + ST (2) + S (2) + L (2) = (7) Low*
Operation	Emergency response and crisis management risks	Negative	*High (12)*	Comprehensive response plans, regular emergency drills, staff training, and advanced communication systems.	Rare emergencies manageable with preparedness measures; residual impacts minimized.	*M (2) + ST (2) + S (2) + L (2) = (8) Low*
Operation	Exposure to extreme weather conditions	Negative	*Low (7)*	Weather-resistant PPE, access to shelters, real-time weather monitoring, and infrastructure resilience measures.	Impact reduced significantly; occasional disruptions possible due to extreme events.	*M (1) + ST (1) + S (1) + L (1) = (4) Low*

6. CONCLUSION

The OHS Impact Assessment for the Project demonstrates the critical importance of prioritizing worker safety throughout both the construction and operations phases. As a Beneficiary, SRI holds responsibility for ensuring that the identified risks are effectively mitigated and that compliance with national legislation, international best practices, and Lenders' Policies is consistently upheld.

Through the comprehensive analysis of potential OHS risks, key impacts were identified, each of these impacts, if left unaddressed, could result in significant harm to workers.

Mitigation measures have been carefully defined to address these risks. SRI must play an active role in enforcing these measures by ensuring their integration into tender documentation, Project contracts, and management plans, as well as through rigorous oversight by the Supervision Engineer during Project construction phase.

The monitoring framework outlined for both phases provides a structured approach to verify compliance with the OHS Management Plans and ensure the effectiveness of mitigation measures. Regular inspections, audits, and continuous feedback mechanisms are essential for adapting measures where necessary and addressing emerging risks proactively.

Following the implementation of proposed mitigation, the residual impacts have been assessed as being reduced in severity, with most risks categorized as having low or moderate significance. This assessment underscores the importance of SRI's leadership and vigilance in safeguarding OHS across the project lifecycle.

In conclusion, the successful implementation of the OHS mitigation measures and monitoring program will not only ensure compliance with applicable standards, but also foster a culture of safety and responsibility.

Republic of Serbia
Ministry of European
Integration

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#ЕУ
ЗА ТЕБЕ

RAILWAY LINE BELGRADE–NIŠ, SECTION III
Paraćin–Stalać and Đunis to Trupale (Niš), Environmental and Social Impact Assessment, SOCIAL IMPACT ASSESSMENT

EU PPF
PROJECT PREPARATION FACILITY

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LIST OF ABBREVIATIONS AND ACRONYMS

AOI	Area of Influence
CCTV	Closed Circuit Television
EBRD	European Bank for Reconstruction and Development
EIA	Environmental Impact Assessment
EIB	European Investment Bank
ESIA	Environmental and Social Impact Assessment
ESMP	Environmental and Social Management Plan
E&S	Environmental and Social
EUR	Euro Currency
GBVH	Gender Based Violence and Harassment
GDP	Gross Domestic Product
IFI	International Financial Institution
ILO	International Labour Organisation
PPF	Project Preparation Facility
PRL	Plan for Renewal of the Livelihood
RAP	Resettlement Action Plan
RS	Republic of Serbia
RPF	Resettlement Policy Framework
SEP	Stakeholder Engagement Plan
SIA	Social Impact Assessment
SPSPA	Spatial Plan of the Special Purpose Area
SRI	Serbian Railways Infrastructure

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19 Social Impact Assessment

19.1 Introduction

This Social Impact Assessment (SIA) covers Section 3 of the Belgrade–Niš railway line, specifically the stretch from Paraćin to Trupale (Niš). The full section comprises three sub-sections; however, for the purposes of this SIA, only two sub-sections are included[1]:

1) **Paraćin–Stalać Sub-Section**, which runs from km 153+380 to km 174+171, with a total length of 20.4 km, with a design speed of 120 km/h (Figure 19.1), and

2) **Đunis–Trupale (Niš) Sub-Section**, which runs from km 191+937.96 to km 229+642, with a total length of 37.7 km, with a design speed of 160 km/h (Figure 19.2 and Figure 19.3).

The SIA has been conducted as a core component of the overall Environmental and Social Impact Assessment (ESIA) process. This SIA therefore forms an integral chapter within the broader ESIA study, ensuring that key social dimensions of the Project are assessed, mitigated and monitored in line with national legislation and international standards, particularly those of the EBRD and EIB. This chapter is not intended to be viewed as a standalone assessment; rather it should be read in conjunction with other ESIA chapters, especially:

- Introduction (Chapter 1) and Project Description (Chapter 2)
- Assessment of Alternatives (Chapter 4)
- Air Quality (Chapter 6)
- Surface Water (Chapter 9) and Groundwater (Chapter 10)
- Noise and Vibration (Chapter 12)
- Cultural Heritage (Chapter 15)
- Waste and Materials (Chapter 16)
- Major Accidents and Disasters (Chapter 17)
- Resettlement Policy Framework for Section 3

[1] *The Stalać-Đunis sub-section between km 174+171 and km 191+938 is not part of this SIA/ESIA.*

It should be noted that this assessment is based on the Project design information available at the time of writing. The requirements for and locations of construction facilities, such as materials laydown areas, construction compounds, workers accommodation camps, access roads and spoil disposal areas, have not yet been determined. The assessment is therefore limited to evaluating potential significant impacts related to the known Project alignment and components.

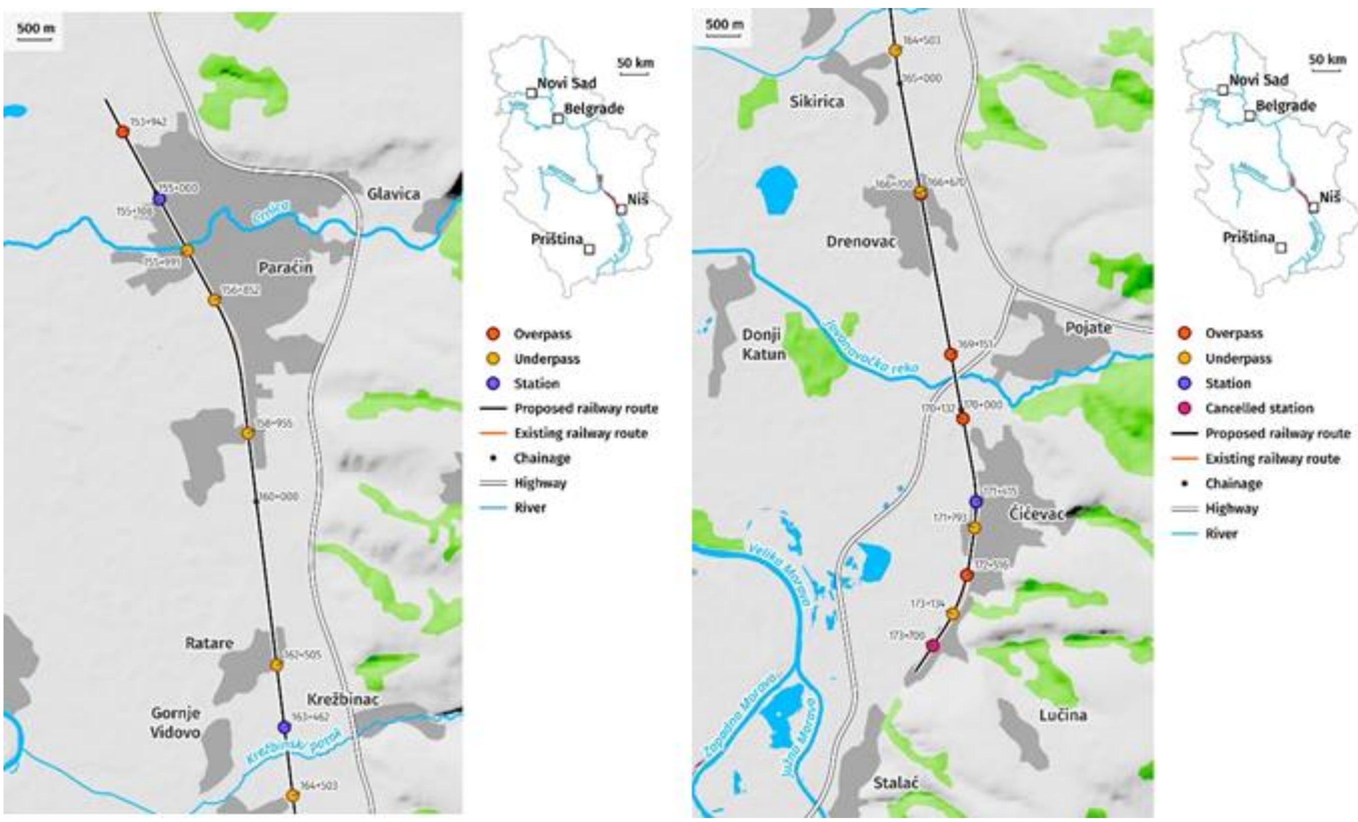

Figure 19.1 Overview of Paraćin–Stalać railway sub-section

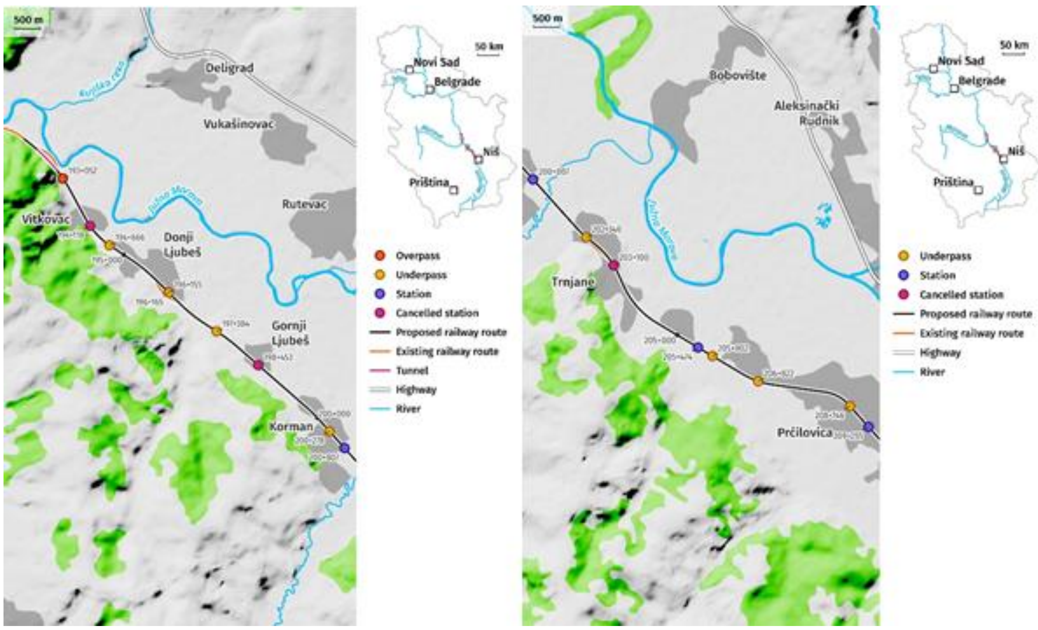

Figure 19.2 Overview of Đunis–Trupale railway sub-section (1/2)

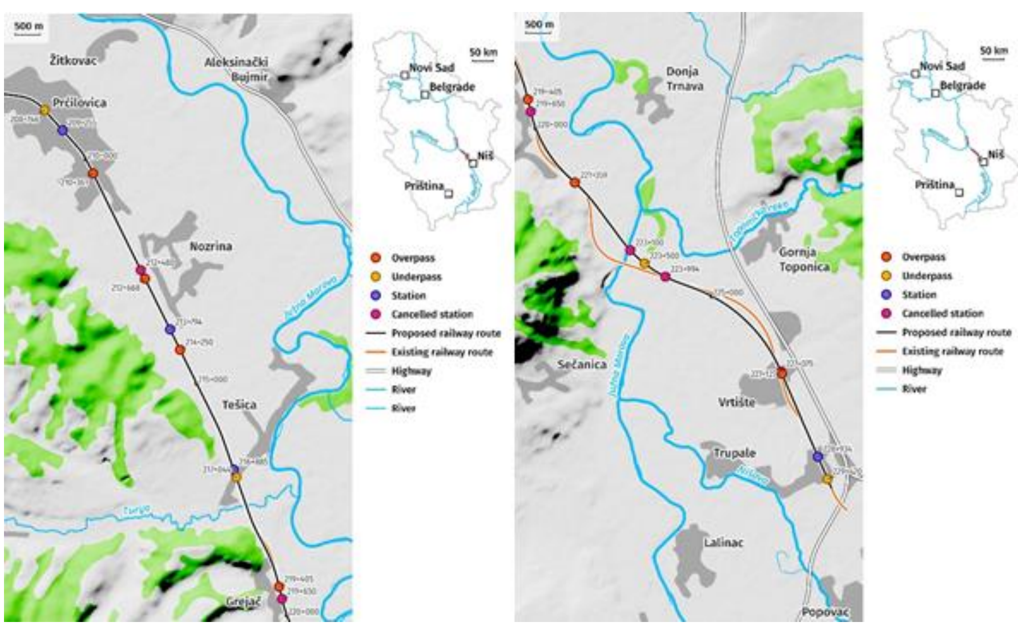

Figure 19.3 Overview of Đunis–Trupale railway sub-section (2/2)

19.2 Project Description – Section 3 of the Belgrade-Niš railway project

A brief description of the area is provided below, while more details about the baseline conditions is provided in chapter 19.5 (Social Baseline Conditions).

19.2.1 Overview of the Existing and Newly Planned Railway Route

The **Paraćin–Stalać sub-section** passes through two municipalities - Paraćin and Ćićevac. The entire sub-section generally follows the existing railway line except for short deviations required for improvement of the turn radius located at the exit from settlement Striža and exit from village of Ćićevac and runs mostly through agricultural land with the exception of the urban areas and villages. The sub-section starts around 1.8 km before the Paraćin railway station and ends 2.2 km before Stalać railway station. It passes through the town of Paraćin and the gravitating urban communities Žabari and Striža on the right-hand side. Paraćin station will be reconstructed. From Striža, which is located on the outskirts of Paraćin, to Ćićevac the railway line passes along the villages Ratare, Sikirica, Drenovac, and Pojate, which borders Ćićevac to the north. Ratare-Sikirica stop will be upgraded to a station, and Ćićevac station will be reconstructed, while Drenovac stop will be decommissioned. Finally, the railway continues from Ćićevac to the nearby village of Lučina where the sub-section Paraćin–Stalać ends at the exit of the village of Lučina. Lučina stop will be decommissioned.

The **Đunis–Trupale (Niš) sub-section** passes through three municipalities - Kruševac, Aleksinac and Niš. There are several deviations from the existing railway alignment required for improvement of the turn radius. Similar to the Paraćin–Stalać sub-section, it runs through an agricultural area with the exception of the urban areas and villages. The sub-section starts between Đunis and Vitkovac, around 2.1 km from Vitkovac station, and ends at the exit of Trupale, around 0.5 km from Trupale station. The sub-section commences with approximately 1.3 km long deviation on the right (western) side of the existing alignment, of which approximately 1.1 km is tunnel construction, and rejoins the existing railway alignment before the village of Vitkovac. From the Vitkovac stop, which will be decommissioned, the new route makes a short deviation from the existing alignment into farmland on the left side and continues with a short run along the existing line until Donji Ljubeš, where it deviates again through buildings and farmland in the village of Donji Ljubeš. Donji Ljubeš stop will be decommissioned. The railway deviation continues after Donji Ljubeš for around 1 km through farmland and houses in Srezovac, where the new alignment keeps a straight line. After rejoining the existing alignment, the railway passes through Gornji Ljubeš, which is spread on both sides of the line. Gornji Ljubeš stop will be decommissioned.

Continuing along the existing alignment, the railway runs through agricultural land to the villages of Korman and then on to nearby Trnjane. Korman station will be reconstructed, while Trnjane stop will be decommissioned. There is a short but significant deviation through properties in Trnjane. From Trnjane, the railway continues along the existing alignment through agricultural land to Donji Adrovac, located on the right side of the railway. Adrovac station located will be reconstructed.

Keeping the existing alignment, a short distance from Donji Adrovac the railway passes through the populated municipality of Aleksinac and attached settlements of Prćilovica, Žitkovac and Moravac. Aleksinac station will be reconstructed. From Moravac to the nearby villages of Stublina (left side), and Nozrina and Lužane (right side), the railway continues on the existing alignment along agricultural land. Nozrina stop will be decommissioned, Lužane station will be reconstructed.

From Lužane to Tešica (located on both sides of the railway) and Bankovac (right side) the railway continues on the existing alignment along agricultural land. After Tešica/Bankovac through to village of Grejač (located on the right side) the route deviates across agricultural land. Tešica stop will be upgraded to a station and Grejač station will be decommissioned.

After a short convergence with the existing alignment in the village of Grejač, the railway deviates again at the nearby Veliki Drenovac through farmland and forestry, then briefly touches the existing alignment at the outskirts of Veliki Drenovac, and makes a significant deviation again crossing agricultural land, forestry and Južna Morava river as it passes Supovac (located on the right side), and reaches the village of Mezgraja. Supovački Most and Mezgraja stops will be decommissioned.

At Mezgraja the new railway intersects the existing alignment and continues with a deviation through agricultural land into the village of Vrtište. Vrtište stop will be decommissioned. At Vrtište the new railway again intersects the existing alignment deviating through local farmland and buildings until the exit of the village, where it rejoins the existing alignment into nearby village of Trupale. Trupale station will be reconstructed. The sub-section Đunis–Trupale (Niš) ends at the exit of the village of Trupale.

19.2.2 Key Planned Project Features

A number of key project features are defined in the Preliminary Design such as railway stations, road crossing points, bridges, viaducts, culverts, power and communications, etc. A full description of all planned project features is provided in ESIA Chapter 2: Project Description, whereas stations and deleveled crossings are explained in detail below.

19.2.2.1 Stations

There are currently 8 railway stations and 12 stops (20 in total) which are in use on Section 3 of the Belgrade to Niš railway line. According to the Preliminary Design, 1 station will be closed and 7 will remain after reconstruction. Additionally, 2 stops will be upgraded to stations, and the remaining 10 existing stops will be closed.

In summary, there will be a total of 9 stations on this section and no stops (see Table 19.1 below). Mother and child facilities are foreseen on all stations hosting international passenger traffic. All stations will comply with legal requirements regarding accessibility for persons with mobility difficulties, such as disability ramps, escalators and elevators. Safety measures, including security cameras are also planned in all areas in and around stations.

Table 19.1 Existing and planned stations and stops (grey for closed stops or stations)

Municipality	Existing Stations and Stops	Status After Project	Linear Distance to Nearest Planned Stations	Planned traffic
Paraćin	Paraćin station	Remaining	-	International, regional
	Sikirica–Ratari stop	Remaining, upgrade to station	-	Regional
	Drenovac stop	Decommissioned	Approx. 2.5 km to the Sikirica–Ratari station	
Ćićevac	Ćićevac station	Remaining		Regional
	Lučina stop	Closed Decommissioned	Approx. 2.6 km to the Ćićevac station	
Aleksinac	Vitkovac stop	Decommissioned	Approx. 5 km Đunis station	
	Donji Ljubeš stop	Decommissioned	Approx. 5 km to Korman or Đunis station	
	Gornji Ljubeš stop	Decommissioned	Approx. 4 km to Korman or Đunis station	
	Korman station	Remaining		Regional
	Trnjane stop	Decommissioned	Approx. 2 km to Korman	
	Adrovac station	Remaining		Freight only
	Aleksinac station	Remaining		International, regional
	Nozrina stop	Decommissioned	Approx. 3 km to Aleksinac, 1.6 km to Lužane	
	Lužane station	Remaining		Regional
	Tešica stop	Remaining, upgrade to station		Regional
	Grejač station	Decommissioned	Approx. 2.6 km to Tešica	
Niš	Supovački most stop	Decommissioned	Approx. 7.5 km to Tešica	
	Mezgraja stop	Decommissioned	Approx. 7.0 km to Tešica	
	Vrtište stop	Decommissioned	Approx. 2.5 km to Trupale	
	Trupale stop	Remaining, upgrade to station		Regional

Note: There are no stations/stops in Krusevac.

19.2.2.2 Road Crossing Points

In addition to increased rail speeds, the goal of the Project is to create a modern, double-track railway with a high level of safety. The existing railway line is not fenced and most of the existing road crossings are uncontrolled level (at-grade) crossings lacking safety features such as boom gates, signalling or signage.

In accordance with the Serbian and European design standards and safety requirements, the new railway will be fully fenced and all existing level road crossings will be replaced with 30 deleveled crossings (overpasses and underpasses), at the same or at a nearest feasible location. From the total of 30 deleveled crossings along the new route, 10 will be overpasses and 20 underpasses; 12 will be constructed at new locations and 18 reconstructed at the existing locations.

Details about existing and new crossings for both sub-sections are provided in Table 19.2 and Table 19.3 respectively.

The construction of 3 underpasses to allow the passage of pedestrian and bicycle traffic is planned in the following locations:

- Paraćin in Šumadijska street at km 155+532
- Ćićevac in Moravska Street at km 173+678
- Mezgraja in Maršala Tita Street at km 224+180

All domestic and international regulations and standards for safety have been applied. Special attention has also been given to technical standards ensuring unrestricted and safe movement, as well as access for persons with disabilities, children, persons with children and babies, elderly persons. As such, the underpasses will be equipped with both elevators (designed to accommodate a cyclist with bicycle, as well as a disabled person in a wheelchair) and stairs. The height of the underpasses will be 2.6 m, and the width, 4 m.

The underpasses are designed with several specific features:

- Video Surveillance: Complete coverage of underpass and their entrances with video surveillance systems to enhance security.
- Enhanced Lighting: Increased lighting levels at underpass entrances, to ensure safety and visibility.

Table 19.2 Existing and planned crossings Paraćin-Stalać sub-section

Municipality	Crossing Name	Chainage	Existing or new location	Status After Project	Type of Traffic	Vehicle diversion / est. increase in travel time	Annual Average Daily Traffic
Paraćin	Overpass 1	153+941.53	New (IIA No. 158 to Šumadija)	Overpass	Light vehicle, pedestrian	-	-
Paraćin Žabare	Level Crossing	155+532	Existing (at Šumadijska St)	Underpass for pedestrian/cyclist	Pedestrian, cyclist	Diverted to Overpass 1 2000 m, 3 – 3.5 min increase	1495
Paraćin	Underpass 2	155+991.45	New (at Majora Gavrilovića St)	Underpass	Heavy vehicle, pedestrian, cyclist	-	-
Paraćin	Underpass 3	156+851.81	New (vicinity of Striška St)	Underpass	Heavy vehicle, pedestrian	-	-
Paraćin	Level crossing	156+860 appx	Existing (Striška St)	Closed	-	-	In existing conditions this is not level crossing and can be used only by pedestrians
Paraćin	Level crossing	157+350 appx	Existing	Closed	-	Diverted to Underpass 3 800 – 1700 m, 2 – 3.5 min increase	This level crossing is used only by few freight vehicles of nearby gravel pit
Paraćin	Culvert	158+890 appx	New	Culvert	-	-	-
Paraćin Strizha	Underpass 4	158+955.08	Existing (Kralja Petra I St)	Underpass	Heavy vehicle, pedestrian	-	-
Paraćin	Culvert	159+885 appx	New	Culvert	-	-	-
Paraćin	Culvert	160+415 appx	New	Culvert	-	-	-
Paraćin	Level crossing	162+128	Existing	Closed	-	Diverted to Underpass 5 600 – 900 m, 1 – 2 min increase	671
Paraćin Ratari	Underpass 5	162+505.32	New (Vožda Karađorđa St)	Underpass	Heavy vehicle, pedestrian	-	-
Paraćin Sikirica	Level crossing	163+810	Existing (Ravnogorska St)	Closed	-	Diverted to Overpass 5, 1600 – 3100m, 2 – 6 min increase, or diverted to overpass 6, 900 – 2900 m, 1 – 5 min increase	372
Paraćin Sikirica	Underpass 6	164+502.60	Existing (Branka Krsmanovića St)	Underpass	Heavy vehicle, pedestrian	-	-
Paraćin Drenovac	Underpass 7	166+670	Existing (Beogradska St)	Underpass	Heavy vehicle, pedestrian	-	-

Municipality	Crossing Name	Chainage	Existing or new location	Status After Project	Type of Traffic	Vehicle diversion / est. increase in travel time	Annual Average Daily Traffic
Paraćin Drenovac	Level crossing	168+180	Existing (Marka Kraljevića St)	Closed	-	Diverted to Overpass 7 1600 – 1800 m, 2 – 6 min increase	113
Ćićevac Pojate	Overpass 8	169+150.51	New (Atarski Put St)	Overpass	Agricultural vehicle	-	-
Ćićevac	Overpass 9	170+132.23	New (Zmaj Jovina St)	Underpass	Agricultural vehicle, pedestrian	-	-
Ćićevac	Underpass 10	171+793.08	Existing (Železnička St)	Underpass, single-lane	Light traffic, pedestrian	-	-
Ćićevac	Overpass 11	172+515.95	New (Radnička St)	Overpass	Heavy vehicle	-	-
Ćićevac	Underpass 12	173+134.14	New (Mirka Tomića St)	Underpass	Light traffic, pedestrian	-	-
Ćićevac	Level Crossing	173+678	Existing (Moravska St)	Underpass for pedestrian/cyclist	Pedestrian, cyclist	Diverted to Overpass 12 900 – 1160 m, 2 -5 min increase	314

Table 19.3 Existing and planned crossings Đunis–Trupale sub-section

Municipality	Crossing Name	Chainage	Existing or new location	Status After Project	Type of Traffic	Vehicle diversion / est. increase in travel time	Annual Average Daily Traffic
Aleksinac Vitkovac	Overpass 1	193+051.67	New (JNA St)	Overpass	Light vehicle	-	-
Aleksinac Vitkovac	Level Crossing	194+105	Existing	Closed	-	Diverted to Underpass 2 650 – 1300 m, 1 - 3 min increase	197
Aleksinac Vitkovac	Underpass 2	194+665.63	Existing (JNA-Save Kovačevića St)	Underpass	Light vehicle	-	-
Aleksinac Vitkovac	Level Crossing	194+975	Existing	Closed	-	Diverted to Underpass 2 230 – 500, m, 1 – 3 min min increase	553
Aleksinac Vitkovac	Level Crossing	195+600	Existing (Moravska and Slavoljuba Simonovića St)	Closed	-	Diverted to Underpass 930 – 1000 m, 3 – 3,5 min increase	This is culvert and is not monitored
Aleksinac Donji Ljubeš	Level Crossing	195+900	Existing (9 Brigade St)	Closed	-	Diverted to Underpass 500 – 900 m, 1.5 – 2 min increase	This was in very bad condition and is used only by pedestriens and

Municipality	Crossing Name	Chainage	Existing or new location	Status After Project	Type of Traffic	Vehicle diversion / est. increase in travel time	Annual Average Daily Traffic
							agricultural machines
Aleksinac Donji Ljubeš	Underpass 3	196+164.67	Existing (Jordana Pavlovića St)	Underpass	Light vehicle, pedestrian	-	-
Aleksinac Donji Ljubeš	Level Crossing	196+550	Existing (Dragomira Kostića St)	Closed	-	Diverted to Underpass 3 or 4 550 – 950 m, 1 - 3 min increase	174
Aleksinac Srezovac	Underpass 4	197+383.93	Existing	Underpass	Light vehicle, pedestrian	-	-
Aleksinac Gornji Ljubeš	Level Crossing	198+450	Existing (Dragomira Kostića St)	Closed	-	Diverted to Underpass 4 1100 – 2100 m, 1 – 3 min increase	169
Aleksinac Korman	Underpass 5	200+277.95	Existing (to Kneza Lazara St)	Underpass	Light vehicle, pedestrian	-	-
Aleksinac* Korman	Level Crossing	198+360	Existing (to Kneza Lazara St)	Closed	-	Diverted to Underpass 5. 83m, < 1 min increase	584
Aleksinac Korman	Level Crossing	201+390	Existing	Closed	-	Diverted to Underpass 5 or 6. 1300 – 2400 m, 2 – 5 min increase	238
Aleksinac Trnjane	Underpass 6	202+340.17	Existing (Omladinska St)	Underpass	Heavy vehicle, pedestrian	-	-
Aleksinac Trnjane	Level Crossing	203+158	Existing	Closed		Diverted to Underpass 6 and 7. 850 – 1000 m, 2 min increase	601
Aleksinac Donji Androvac	Underpass 7	205+802.46	Existing (Local road)	Underpass	Heavy vehicle	-	-
Aleksinac Donji Androvac	Underpass 8	206+821.81	Existing (Deligradska St)	Underpass	Agricultural vehicle	-	-
Aleksinac Prčilovica	Level Crossing	207+885	Existing (Vuka Karađića St)	Pedestrian tunnel at 207+920	Pedestrian	Diverted to Underpass 8 and 9. 950 m, 2 – 3 min increase	560
Aleksinac Žitkovac	Underpass 9	208+746.36	Existing (Milentija Popovića St)	Underpass	Light vehicle, pedestrian, cyclist	-	-
Aleksinac Moravac	Overpass 10	210+360.94	Existing (local road to IIA No. 217)	Overpass	Light vehicle, pedestrian	-	-
Aleksinac Nozrina**	Level Crossing	212+480	Existing (Local road)	Closed	-	Diverted to Underpass 11 800 m, 2 min increase	270
Aleksinac Nozrina	Overpass 11	212+668.35	Existing (Stublina-Nozrina road)	Overpass	Light vehicle, pedestrian	-	-

Municipality	Crossing Name	Chainage	Existing or new location	Status After Project	Type of Traffic	Vehicle diversion / est. increase in travel time	Annual Average Daily Traffic
Aleksinac Lužane	Level Crossing	213+756	Existing (Local road)	Closed	-	Diverted to overpass 12. 493m, 2 min increase	This is moved in 214+249
Aleksinac Lužane	Overpass 12	214+249.68	New	Overpass	Light vehicle	-	-
Aleksinac Tešica	Level Crossing	215+710	Existing (Agricultural road)	Closed	-	Diverted to crossings 12 and 13. 1400 – 2300 m, 5.5 – 6 min increase	It was hard accessible and used only by agricultural machines
Aleksinac Tešica	Underpass 13	217+044.45	Existing (National road No. 217)	Underpass	Heavy vehicle, pedestrian	-	-
Aleksinac Tešica	Level Crossing	218+270	Existing (Cara Dušina St)	Closed	-	Diverted to crossings 13 and 14. 1320 – 3000 m, 2.5 – 5 min increase	637
Aleksinac Grejač	Overpass 14	219+404.75	Existing (Local road)	Overpass	Light vehicle	-	-
Aleksinac Grejač	Level Crossing	219+863	Existing (Local road)	Closed	-	Diverted to overpass 14. 893m, > 2 min increase	29
Aleksinac Veliki Drenovac	Overpass 15	221+359.49	Existing (Agricultural road)	Overpass	Light vehicle	-	-
Aleksinac Mezgraja	Underpass 16	223+500.00	Existing (Peke Dapčevića St)	Underpass	Light vehicle	-	-
Aleksinac Mezgraja	Level Crossing	224+205	Existing (Maršala Tita St)	Pedestrian/cyclist underpass 224+180	Pedestrian, cyclist	Diverted to underpass 16. 730 – 1300 m, 1.5 – 2 min increase	590
Aleksinac Vrtište	Overpass 17	227+126.66	Existing (Beogradska St)	Overpass	Light vehicle, pedestrian, cyclist	-	-
Aleksinac Vrtište	Level Crossing	227+850	Existing (Local road)	Closed	-	Diverted to overpass 17. 1100 m, 3 min increase	39
Aleksinac Trupale	Underpass 18	229+419.58	Existing (Železnička St)	Underpass	Light vehicle, pedestrian	-	-

* Level crossing removed to new location, at the same street, less than 100 m away
** Level crossing removed to new location about 190 m away, in km 212+668

19.3 Area of Influence

For the purpose of this SIA, the Area of Influence (AoI) has been defined at two levels: narrow and wide.

- The **narrow AoI** includes all settlements and structures located within 1 km of the railway alignment, where the most direct and tangible social impacts can be expected. Within this zone, particular attention is given to areas and receptors within 500 m, which are more likely to experience higher intensity impacts. The description of baseline conditions in this narrow AoI is provided in 19.5.1 (Site-Specific Baseline – Settlements Adjacent to the Railway).
- The **wide AoI** includes broader areas where indirect or lower-intensity impacts may occur, such as changes in regional connectivity or reduced accessibility due to level crossing closures. This includes larger towns and urban zones, such as Niš, that are located outside the 1 km corridor but may still experience impacts. The description of baseline conditions in this broader AoI is provided in 19.5.2 (Baseline Conditions in the Wider Study Area).

19.4 Undertaken Activities

The SIA team reviewed the *Amendments to the Spatial Plan of the Special Purpose Area (SPSPA) of the Infrastructure Corridor of the Railway Belgrade-Niš* as well as the *Report on Performed Public Insight in the Draft Amendment and Additions to the SPSPA* (available at: https://www.mgsi.gov.rs/cir/dokumenti/javni-uvid-u-nacrt-izmena-i-dopuna-prostornog-plana-podruchja-posebne-namene-5).

As part of the SIA process, a series of consultations were also conducted to gather first-hand information on community dynamics, stakeholder concerns and potential social impacts of the Project. The timeline of key activities is provided below:

Date	Activities
2024	- Meetings with Local Community Offices Ćićevac, Paraćin, Niš and Aleksinac to discuss the Project and gather baseline information.
May 2025	- Meetings with municipality/city officials in Paraćin. Ćićevac, Aleksinac and Niš to discuss social impacts - Additional meetings with Local Community Offices

These consultations revealed a number of recurring concerns across communities. The most commonly raised issues included:

- Lack of clarity regarding the final Project design and technical solutions;
- Uncertainty about the scope of expropriation and demolition of private properties;
- Fears of community fragmentation due to closure of level crossings and installation of railway fencing, particularly affecting vulnerable groups;
- Concerns over access to critical facilities (schools, kindergartens, healthcare, farmland) located on the opposite side of the alignment;
- Concerns regarding flood-prone areas and the technical adequacy of planned solutions.

These concerns have been integrated into the relevant impact assessment sections of this SIA, reflecting the inputs collected during the public disclosure process and the follow-up consultations held at both municipal and local levels.

19.5 Social Baseline Conditions

19.5.1 Site-Specific Baseline – Settlements Adjacent to the Railway

The area along the railway alignment features a diverse range of building types and land uses. Residential structures include apartment blocks, single-family houses and traditional dwellings built from compacted earth or brick. Most homes are enclosed by fenced yards, often containing orchards, flowerbeds, vegetable gardens and auxiliary buildings such as summer kitchens, garages, workshops, and animal shelters.

A detailed overview of both subsections along with a list of key receptors identified during the development of this SIA is given below.

SUBSECTION 1: Paraćin-Stalać

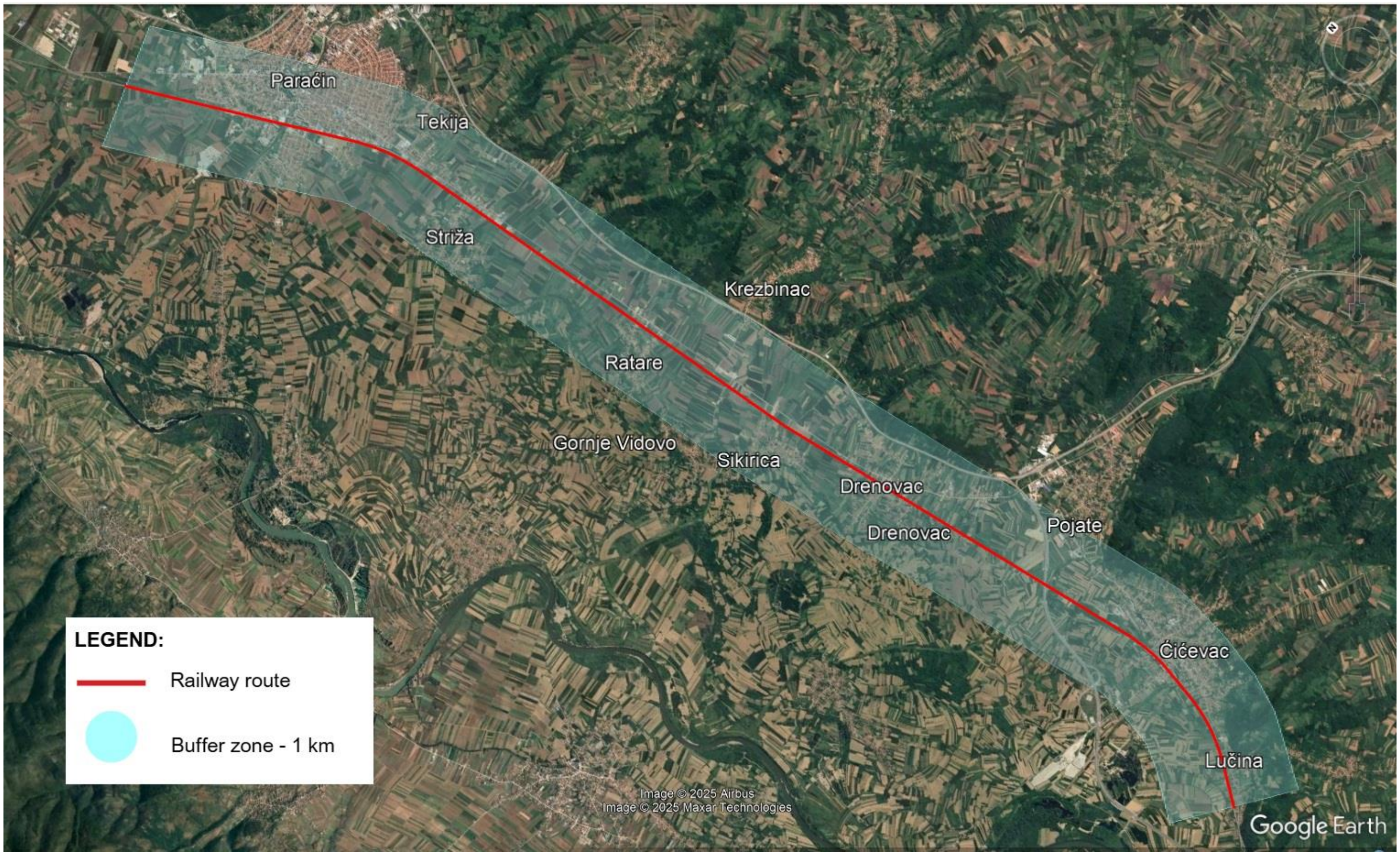

Figure 19.4 Map of the affected settlements along the Paraćin – Stalać route

This subsection of the planned railway alignment extends for 20.4 km and can be divided into three segments for the purpose of analysis, based on distinct spatial and socio-economic characteristics:

Segment 1: Paraćin Station to Striza (0–7 km): This segment alignment begins at **Paraćin station**, located in a densely populated urban area. Immediately after the station, the route passes through a large industrial zone with numerous business and manufacturing facilities, with some closer than 50 m from the railway. Paraćin has a long industrial and agricultural tradition, including glass, cement and confectionery production, as well as arable farming and livestock breeding. Notably, the confectionery company Pionir operates a major factory in this area.

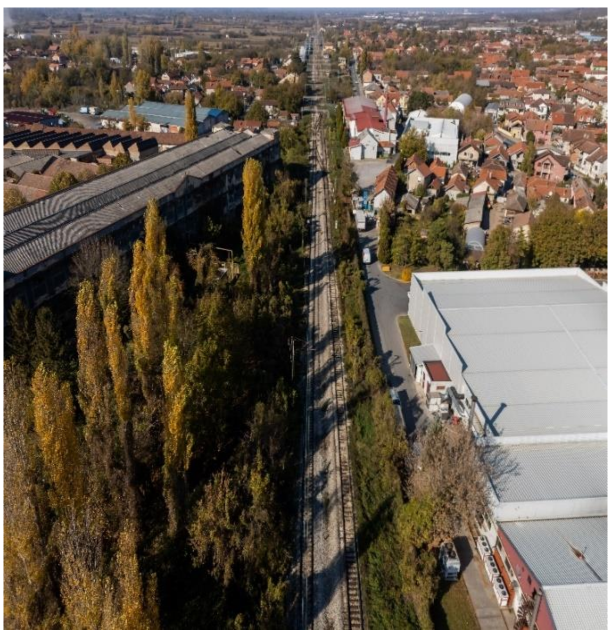

Figure 19.5 Paraćin railway route (left); Striža settlement (right)

This segment is also characterised by a high density of agricultural land, with cultivated plots extending on both sides of the alignment. The railway passes near residential neighbourhoods, with some houses located approximately 50 m from the track. The railway continues to cross through the urban structure of Paraćin, following the existing alignment that already divides these communities.

The new alignment largely follows the existing route, with two planned changes:

- Due to safety concerns and incompatibility with high-speed rail operations, the existing level crossing in Šumadijska street in Paraćin is planned for closure, with integration of a new bypass road considered for a new railway design.

- Planned deviation on the existing alignment to accommodate new alignment in Paraćin, which involves a curve correction 20 m to south, but with no residential properties affected.

As the line moves further from the urban core, settlement density decreases, giving way to linear, sporadically developed communities and more continuous farmland. The settlements of **Striza** and **Tekija** mark the end of this segment. In Striža, the railway will be reconstructed along the existing corridor, which currently passes through the settlement.

Healthcare services are located outside the immediate influence area: the General Hospital and Emergency Service in Paraćin are approx. 1,000 m east of the alignment.

Segment 2: Striza to Sikirica (7–14 km): This section traverses a flat and predominantly agricultural landscape. Cultivated land dominates the area, and the local economy is strongly agriculture-based.

The route passes through:

- **Ratare**, located 2 km from Striza, separated by large farmland areas where the alignment continues to follow the current railway that already intersects the settlement
- **Gornje Vidovo**, about 800 m from the alignment, with a local road crossing the existing railway
- **Sikirica**, the last settlement in this segment.

Although the new alignment largely follows the existing route, the Sikirica–Ratare Station has been added as part of the revised operational plan (deviation) to improve service and enhance connectivity.

Figure 19.6 Ratare aerial view (left); road leading to Sikirica (right)

These three settlements are well-connected via a dense local road network, which will help maintain connectivity even during temporary construction disruptions. The new alignment also runs between these settlements and **Krezbinac**, located approx. 1 km to the west, following the existing railway route.

Segment 3: Sikirica to Lučina (14–21 km): The final segment begins in **Sikirica** and continues through the center of **Drenovac**, a small village with mixed land use. The alignment will be reconstructed within the existing railway corridor, maintaining the current configuration. About 3 km further west lies **Pojate**, approximately 600 m from the alignment.

The alignment intersects the E761 regional road, which connects **Pojate** to **Ćićevac**. While this crossing occurs at a critical point, Ćićevac and Pojate are not expected to be disconnected due to the presence of a well-developed local road network. On the outskirts of Ćićevac, both residential zones and farmland are observed.

In **Ćićevac**, spatial separation is already present due to the current railway infrastructure. The new alignment mostly follows the existing route; however, two deviations are planned: one at the entrance to the station, involving a curve correction and a 40 m shift to the west, and another further along the line, with a 50 m shift to the west. Neither deviation will affect residential properties.

Figure 19.7 Railway route in Ćićevac

The subsection ends at the settlement of **Lučina**, a small but populated rural area with significant agricultural activity. The railway alignment through Lučina follows the existing track, which already traverses the settlement.

KEY SENSITIVE RECEPTORS IDENTIFIED ALONG SUBSECTION 1:

Sensitive receptors (e.g. schools, kindergartens, cemeteries, healthcare facilities and sports infrastructure) within the Project's zone of influence include but may not be limited to:

Receptor type	Location	Distance from railway
Kindergarten	Paraćin	290 m
Stadium	Paraćin	200 m
School	Drenovac	20 m
Cemetery	Drenovac	320 m
School	Drenovac	450 m
Football club	Ratare	120 m
Large cemetery	Between Pojate and Ćićevac	100 m
Health clinic	Ćićevac town center	130 m
Kindergarten	Ćićevac (western outskirts)	300 m

Receptor type	Location	Distance from railway
Sports stadium	Ćićevac	150 m
School	Ćićevac	160 m
Cemetery	Lučina	400 m
School	Striza	550 m

SUBSECTION 2: Đunis-Trupale (Niš)

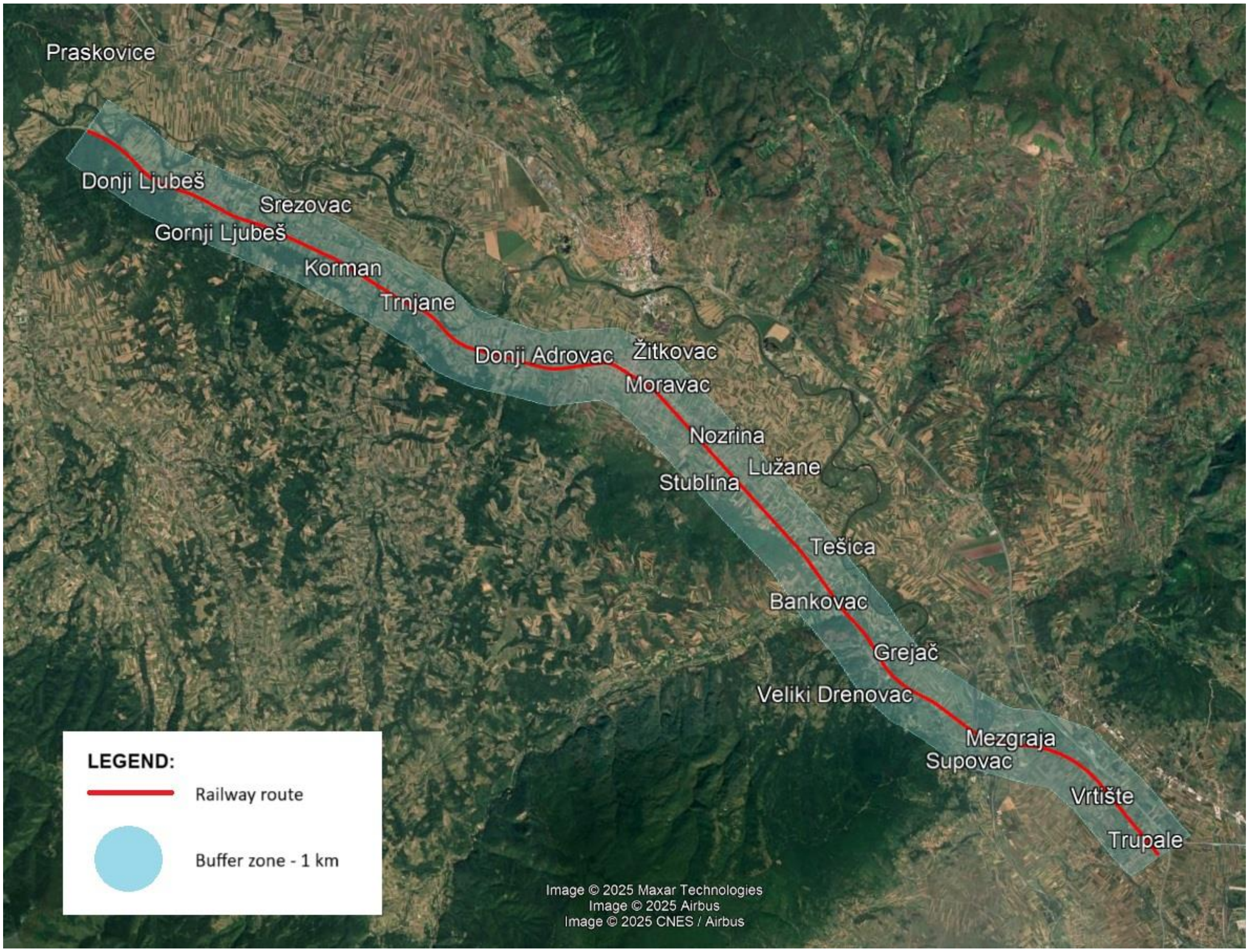

Figure 19.8 Map of the affected settlements along the Đunis - Trupale route

This subsection of the proposed railway alignment spans approximately 37.7 km, running parallel to the Južna Morava River and traversing a mix of agricultural landscapes, linear rural settlements and densely inhabited zones. As the subsection passes mostly through rural areas, the most common economic activity is small-scale farming. No larger industrial zones in the vicinity of the planned railway line have been identified. Roma people are the second largest ethnic community in this subsection and use the railway to reach larger cities (such as Nis). The closest Roma settlements to the railway corridor, located approximately 300-400 m away, are in the Prćilovica settlement, where two informal Roma communities exist, as well as in Striža. During consultations undertaken for this SIA, residents reported that some houses in Striža, which are scheduled for demolition to make way for an underpass, are inhabited by Roma families. Additionally, in Žitkovac, the local primary school has a student population where over 50% of second-grade pupils belong to the Roma community.

For analytical clarity, the alignment is described sequentially by key settlements and land uses affected.

- The section begins at the existing alignment, 2 km east of the settlement of **Praskovce**, passing through agricultural land adjacent to the South Morava River. Before entering Vitkovac, a construction of a new 580 m Đunis Tunnel is planned, with a route deviation that improves curve geometry and maintains the design speed. The alignment deviation passes mostly through forested, uninhabited areas and does not affect any residential properties.
- It then enters **Vitkovac**, and continues along the existing corridor running through the centre of the settlement, maintaining the physical separation that already exists. However, a 950 m long deviation with a curve correction is planned, involving a 40 m shift northeast from the existing line. Approx. 400 m further lies **Donji Ljubeš**, where the curve correction with a 70 m shift northeast from the existing line is planned. From here, the alignment continues to follow the existing track that already divides the settlement, though only a smaller portion of the settlement lies west of the railway.
- The route proceeds to **Srezovac** (600 m from Donji Ljubiš), passing close to cultivated land within the settlement itself. In Srezovac, two curve corrections are planned: a 30 m shift northeast at the first curve and a 50 m shift south at the second.

Figure 19.9 Aerial view of Srezovac

- **Gornji Ljubiš**, located 200 m further, is already divided by the existing railway, which the new alignment continues to follow. The village is surrounded by farmland and remains closely linked to Srezovac.
- The existing alignment continues through agricultural areas to reach **Korman**, approx. 850 m from Gornji Ljubiš, where the settlement is already physically divided by the railway corridor, a condition that will remain with the proposed alignment.
- It then enters **Trnjane**, where two deviations are planned. The first involves a curve correction with a 60 m shift northeast from the existing line. The second consists of a curve connection that retains the route through the existing station. This design was selected to minimise demolitions in the village center due to terrain constraints and the need to maintain connections to Korman and Donji Adrovac stations, though it will still affect approximately 20 buildings.
- Alignment than continues to **Donji Androvac**, located 2 km away. In Donji Androvac, all residential structures are on one side of the alignment, meaning the settlement remains spatially unified, although cultivated land lies on the opposite side.

Figure 19.10 Aerial view of Trnjane

- Just 230 m onward lies **Prcilovci** (north of the railway), where the railway route follows the established corridor passing through the centre of the settlement. There are two informal Roma settlements adjacent to the railway line here. There are also several houses in Striza (scheduled for demolition) reportedly inhabited by Roma people.

Figure 19.11 Street separating primary school in Prćilovci from the railway route

- Directly south is the settlement of **Žitkovci**, functionally merged with Prcilovci. In Zitkovci, there is a primary school in which more than 50% of students in the second school belong to the Roma population. Here, Aleksinac station is located and is planned for optimisation within the existing corridor to reduce displacement[2].
- Immediately south lies **Moravac**, which is already intersected by the existing railway alignment, and the new route continues along this path.
- Continuing 500 m further are **Nozrina** and **Lužane**, both entirely situated east of the alignment. To the west lies **Stublina** (500 m from the railway). Three local roads connecting these eastern and western communities are expected to be severed.
- Approx. 1.5 km from the previous group of settlements lies the village of **Tešica**, which extends on both sides of the existing railway. The new alignment will generally follow the current route, with a slight curve correction involving a 20-m shift to the northeast. Although formally considered separate settlements, Tešica and **Bankovac** are closely connected by a local road lined with houses on both sides, forming a continuous residential area. The new railway will cross this road diagonally, creating a physical barrier and effectively separating the two settlements.

Figure 19.12 Road to Tešica, surrounded by agricultural fields

[2] *Several options were reviewed during the assessment of alternatives for this station. The option which involves optimising the layout of the existing station was selected as the most technically, economically and socially balanced solution. This option significantly reduces physical displacement and land acquisition needs. The redesign lowers the number of affected structures from over 30 to just 5-7, representing an approximately 80% reduction compared to the original concept.*

- The alignment continues 1.2 km further to **Grejač**, which remains intact on the western side of the track, along with **Veliki Drenovac**, to which it is connected. There are numerous agricultural plots on the eastern side of the railway. However, in this area, a set of curve corrections is planned, resulting in shifts of up to 600 m from the existing alignment through Grejač, and following settlements Mezgraja and Vrtište.

Figure 19.13 Grejač settlement

- Further south, the railway separates **Supovac** (west side) from **Mezgraja** (east side), maintaining the existing spatial arrangement, with a direct crossing between the two.

Figure 19.14 Aerial view of Supovac (left) and Mezgraja (right)

- Between Mezgraja and the next village, **Vrtište** (2 km), the deviation continues through predominantly agricultural land, following a corrected set of curves designed to improve alignment geometry .
- **Trupale**, the final settlement, lies 950 m further. Most of the residential area is located west of the alignment, which follows the existing railway route.

KEY SENSITIVE RECEPTORS IDENTIFIED ALONG SUBSECTION 2:

Sensitive receptors (e.g. schools, kindergartens, cemeteries, healthcare facilities and sports infrastructure) within the Project's zone of influence include but may not be limited to:

Receptor type	Location	Distance from railway
School	Vitkovac	25 m
School	Donji Ljubiš	150 m
Cemetery	Between Gornji Ljubiš and Korman	70 m
Sports field	Korman	15 m
School	Trnjane	20 m
Cemetery	Trnjane	250 m
Cemetery	Donji Androvac	500 m
Sports club	Donji Androvac	220 m
School & kindergarten	Prcilovci	25 m
Cemetery	Prcilovci	200 m
School	Prcilovci	70 m
Kindergarten	Prcilovci	250 m
Stadium	Žitkovci	50 m
Cemetery	Žitkovci	150 m
School	Moravac	270 m
School	Nozrina	220 m
Sports field	Grejač	200 m
Stadium	Mezgraja	Adjacent
Cemetery	Mezgraja	200 m

Receptor type	Location	Distance from railway
Football field	Vrtište	Adjacent
Sports Field	Vrtište	300 m

19.5.2 Baseline Conditions in the Wider Study Area

19.5.2.1 Population

Although the railway passes directly through a number of smaller settlements (described above), it lies within a **much broader functional region of nearly 460,000 people**, including major urban centres and economically significant areas. This overall figure includes the total population of two larger towns (Paraćin and Aleksinac), one smaller town (Ćićevac) and the cities of Niš and Kruševac.

Table 19.4 Population by inhabited area (town, village) in 2011 and 2022

Municipality/city	Town / village	Population (2011 census)	Population (2022 census)	% decrease	Population % women (2022)
Republic of Serbia		7,186,862	6,647,003	-7.5%	51%
Paraćin	Paraćin	54,242	45,543	-16%	52%
	Tekija	1266	1121	-11.5%	51%
	Striža	1880	1571	-16.4%	50%
	Ratare	544	461	-15.3%	49%
	Krežbinac	452	376	-16.8%	52%
	Gornje Vidovo	781	595	-23.8%	50%
	Sikirica	921	719	-21.9%	51%
Ćićevac	Ćićevac	9,476	7,860	-17%	50%
	Pojate	846	755	-10.8%	49%
	Lučina	811	699	-13.8%	50%
Kruševac	Kruševac	128,752	113,582	-11,8%	52%
	Đunis	680	565	-14%	51%
Aleksinac	Aleksinac	51,863	43,098	-16.9%	50%

Municipality/city	Town / village	Population (2011 census)	Population (2022 census)	% decrease	Population % women (2022)
	Vitkovac	312	250	-19.9%	50%
	Donji Ljubeš	498	378	-24.1%	48%
	Srezovac	185	149	-19.5%	48%
	Gornji Ljubeš	170	136	-20%	49%
	Korman	689	554	-19.6%	50%
	Trnjane	1274	1059	-16.9%	51%
	Donja Peščanica	96	55	-42.7%	47%
	Donji Adrovac	741	635	-14.3%	46%
	Prćilovica	2362	2191	-7.2%	51%
	Žitkovac	2624	2258	-13.9%	52%
	Moravac	1744	1499	-14%	50%
	Nozrina	699	651	-6.9%	52%
	Stublina	157	134	-14.6%	48%
	Lužane	826	651	-21.2%	49%
	Tešica	1717	1441	-16.1%	48%
	Bankovac	151	124	-17.9%	44%
	Grejač	544	511	-6.1%	49%
	Veliki Drenovac	438	351	-19.9%	51%
Niš	Niš	260,237	249, 501	-4.1%	52%
	Mezgraja	541	507	-6.3%	51%
	Supovac	344	289	-16%	48%
	Vrtište	1112	1150	+3.4%	50%
	Trupale	2127	1960	-7.9%	49%

Source: Statistical Office of the RS

Most of the settlements affected by the project are characterized by significant decrease of the population, even more than typical for the population of Serbia in general. It is only the city of Nis that has a population decrease (-4.1%) smaller than Serbian average (-7.5%). The decrease is more significant in Paracin (-16%), Cicevac (-17%), Krusevac (-11.8%) and Aleksinac (-16.9%). In Donja Pescanica village, the population decrease is as big as -42.7%. The ratio of women to men is close to equal in most areas, i.e. on average, 51% of the population are women. Interestingly, though, share of women in rural settlements of Aleksinac county in 12 out of 23 villages is smaller than 50%.

In 2022, the average age of the population in nearly all municipalities exceeded the national average of 43.85 years, with the exception of Niš. Again, in the smaller settlements the average age is even higher than in the more urban locations. A consistent pattern across all locations is that women tend to be older on average—by approximately 2 to 3 years—compared to men. Furthermore, the aging index[3] of the population in 2022 was alarmingly high across all areas, with particularly concerning figures reported in the municipality of Ćićevac.

Table 19.5 Average age (town, village) in 2022

Town / village	Total average age	Men	Women	Aging index
Republic of Serbia	43.8	42.4	45.1	151
Paraćin	45.5	44.1	46.8	184
Ćićevac	46.1	44.7	47.4	195
Kruševac	45.0	43.5	46.4	169
Aleksinac	45.5	44.4	46.5	180
Niš	43.3	42.1	44.5	146

Source: Statistical Office of the RS

Table 19.6 provides more information on the characteristics of households and families in the affected areas, highlighting potential vulnerabilities within the local population. Considering the overall aging trend in these locations and other available data, it is likely that a significant portion of single-person households consists of elderly individuals living alone. While the share of single headed households in Serbia is 30%, it is a bit smaller in both larger urban (e.g. Krusevac 25%, Paracin 27%) and rural settlements (in 28 out of 33 rural settlements on the list this share is smaller than 30%).

[3] Population ageing index is the ratio between the population aged 60 and over and population aged from 0 to 19, estimated in the middle of the reference year.

Households with six or more members typically represent multigenerational families and/or those with several children. While the national average for such households is relatively low (around 4%), in many of the affected villages this figure approaches or exceeds 10%. Additionally, the proportion of families headed by single mothers is notably high at 17% overall. Although this percentage is higher in more urban areas, it remains significant even in smaller rural settlements. The percentage of families which comprise single fathers with children is overall around 5%, which is also not a negligible value. Between one fifth and one quarter of the affected population comprises single parents with children. It is only rural settlements in Niš county where this share is a bit smaller (15%-20%).

Table 19.6 Types of households and families (town, village) in 2022

Municipality	Town / village	Number of households	% of single headed households	% of households with 6 or more members	% of families - mother with children	Population % women (2022)
Republic of Serbia		2,589,344	30%	4%	17%	5%
Paraćin	Paraćin	16485	27%	7%	17%	6%
	Tekija	361	20%	9%	16%	6%
	Striža	484	19%	13%	13%	6%
	Ratare	157	36%	10%	15%	9%
	Krežbinac	123	23%	10%	21%	4%
	Gornje Vidovo	188	22%	15%	10%	9%
	Sikirica	253	28%	11%	17%	8%
	Drenovac	518	26%	12%	13%	5%
Ćićevac	Ćićevac	2816	27%	8%	13%	6%
	Pojate	260	22%	8%	12%	8%
	Lučina	227	29%	10%	9%	2%
Kruševac	Kruševac	41488	25%	6%	16%	5%
	Đunis	214	29%	4%	14%	6%
Aleksinac	Aleksinac	109	31%	2%	18%	6%
	Vitkovac	146	25%	4%	14%	11%
	Donji Ljubeš	49	20%	10%	9%	7%
	Srezovac	47	21%	11%	9%	7%

Municipality	Town / village	Number of households	% of single headed households	% of households with 6 or more members	% of families - mother with children	Population % women (2022)
	Gornji Ljubeš	215	31%	6%	13%	6%
	Korman	402	26%	5%	17%	4%
	Trnjane	21	14%	0%	6%	11%
	Donja Peščanica	109	31%	2%	18%	6%
	Donji Adrovac	216	23%	10%	11%	4%
	Prćilovica	659	20%	14%	16%	3%
	Žitkovac	791	23%	7%	17%	7%
	Moravac	514	24%	10%	16%	6%
	Nozrina	218	22%	11%	16%	5%
	Stublina	53	32%	2%	20%	9%
	Lužane	234	23%	8%	18%	6%
	Tešica	422	26%	10%	19%	7%
	Bankovac	45	22%	2%	12%	6%
	Grejač	209	34%	3%	14%	9%
	Veliki Drenovac	119	27%	13%	15%	5%
Niš	Niš	100274	29%	2%	18%	5%
	Mezgraja	178	25%	9%	12%	7%
	Supovac	124	43%	3%	8%	10%
	Vrtište	410	23%	7%	11%	4%
	Trupale	641	23%	11%	11%	5%

Source: Statistical Office of the RS

Table 19.7 presents an additional aspect of the social situation in the cities and municipalities affected by the project, namely the proportion of social welfare beneficiaries, with a particular focus on those receiving financial assistance. The information is only available at municipal level and gender disaggregated data for those receiving financial assistance is not available. Overall, the share of population registered as beneficiaries of social welfare ranges significantly – in

Ćićevac it is less than 10% (which is the national rate), while in Paraćin it exceeds 20%. Services provided by the social welfare system include a range of things in addition to financial aid, such as placement in residential institutions, foster care, home care and assistance for the elderly and ill, etc. There are differences between men and women, but of a smaller size and unclear direction.

The percentage of people receiving financial social assistance also ranges significantly. It is between 1% and 5.3% in the affected municipalities, being much higher in the municipalities with larger share of Roma population among which poverty incidence is much higher than in Serbia overall.

Table 19.7 Social welfare beneficiaries (municipalities) in 2022 and 2023

Municipality	Share of population registered as social welfare beneficiaries (2022)		Share of population receiving financial assistance (2023)
	Men	Women	Total
Republic of Serbia	10.4%	10.9%	2.5%
Paraćin	22.8%	22.4%	1%
Ćićevac	6.5%	10.0%	1.5%
Kruševac	16.3%	19.9%	2.3%
Aleksinac	8.4%	7.4%	5.3%
Niš	15.2%	15.7%	4.0%

Source: DevInfo, Vital statistics

In all affected areas, the majority of the population is of Serbian ethnicity, while the Roma represent the second largest ethnic group (Table 19.8). The share of Roma inhabitants is a bit below the national average in Paraćin, Ćićevac and Kruševac, but above the national average in Niš and especially in Aleksinac (almost double the national rate). No other minorities are present in a significant percentage in any of the municipalities, which is different than at the national level where Serbs make up only 81% of the population. The percentage of people who didn't want to declare their ethnicity is higher than any second ranked ethnicity individually. Complementary to ethnicity, the majority of the population in all areas belong to the Serbian Orthodox faith. Based on the public consultations, it was confirmed that Roma communities also live near the railway corridor, specifically in Striža—where some houses slated for demolition are inhabited by Roma families—and in informal settlements in Prćilovići. Additionally, in Žitkovac, over half of the students at the local primary school are Roma.

Table 19.8 Ethnicity (municipality) in 2022

Municipality/city	Serbs	Roma	Unknown ethnicity	TOTAL
Republic of Serbia	80.6%	1.9%	4.8%	87.4%
Paraćin	92.3%	1.8%	3.5%	97.6%
Ćićevac	94.4%	1.5%	2.4%	98.5%
Kruševac	93.5%	1.8%	3.%	98.4%
Aleksinac	88.8%	3.7%	5.3%	97.9%
Niš	90.2%	2.3%	4.3%	96.8%
TOTAL	91.9%	2.2%	3.7%	97.8%

Source: Statistical Office of the RS

19.5.2.2 Level of Development, Economic Activity, Employment and Unemployment

In Serbia there is a categorization of cities/municipalities by the level of development, made by the Ministry of Public Administration and Local Self-Government of the RS. The categorization is based on different criteria, such as GDP per capita, population trends, unemployment trends, education trends, etc. According to those criteria, the affected municipalities all belong to different categories of development. These groups range from I to IV, with Group I representing the most developed areas and Group IV the least developed.

Aleksinac belongs to the group IV with a level of development below 60% of the national average. Paraćin and Ćićevac belong to the third category municipalities, with a level of development between 60% and 80% of the national average. Kruševac is better placed, belonging to the second category municipalities with the level of development between 80% and 100% of the republic level average. Finally, Niš belongs to the group of best developed cities in Serbia, having the level of development higher than national average.

Table 19.9 Level of development of affected municipalities/cities

Municipality	Paraćin	Ćićevac	Kruševac	Aleksinac	Niš
Level of development	Group III	Group III	Group II	Group IV	Group I

Source: Regulation on determining the unified list of development levels of regions and local self-government units for 2014

The latest publicly available budgets of the municipalities in 2024 are provided in the table below.

Table 19.10 Municipality budgets in 2024

Municipality	Total in RSD	Total in EUR[4]
Paraćin	2.489.835.313	21.2 million
Ćićevac	518.525.090	4.4 million
Kruševac	7.225.094.367	61.6 million
Aleksinac	2.175.126.355	18.5 million
Niš	17.456.489.490	148.9 million

Source: 2024 Municipal Budget Decisions (available on municipality websites)

Niš is the largest city in the region and as such, an important administrative, economic, educational and cultural centre. According to DevInfo data there is 3,790 companies registered in Nis and 12,211 sole proprietors. Kruševac is the second largest economic center among the project affected cities/municipalities with 1,264 registered companies and 5,732 sole proprietors. In Aleksinac, the respective numbers are 223 and 1,665. On the other hand, in Ćićevac the number of registered companies is only 69, while the number of sole proprietors is 336. Finally, in Paraćin there is 600 companies and 2,251 sole proprietors.

In the table below, the number of persons registered as unemployed with the National Employment Service of Serbia in May 2024, is presented for each affected municipality. The percentage of women among unemployed persons is higher than men in all municipalities, this difference being the highest in Ćićevac and Kruševac. The percentage of registered unemployed persons among the estimated working age population (15 to 64) is higher than the national average in all municipalities and the highest in Aleksinac, at 15.9%.

Table 19.11 Registered unemployed persons per municipality in May 2024

Municipality	Number of registered unemployed persons (May 2024)		%
	Total	Of which % women	
Republic of Serbia	356,432	56,2%	8.4%
Paraćin	4,148	56,4%	14.9%
Ćićevac	622	60,5%	12.8%
Kruševac	6,563	60,2%	9.4%
Aleksinac	4,209	52,1%	15.9%
Niš	16,686	58,0%	10.4%

[4] *Exchange rate of 117.4 RSD per 1 EUR was used*

Source: National Employment Service of the RS

While the unemployment rate is higher in the affected municipalities than in Serbia overall, another problem is that the average net salaries in all affected cities and municipalities but the largest one (Niš) are significantly below the national average (900 EUR in February 2025), as can be seen in the table below. Nis is very close to the national average and Kruševac as a larger city is around 10% below the national average. Salaries in other three municipalities are similar, despite differences in their size and level of economic development, and they range between 706 EUR and 742 EUR. Salaries have grown in the past year in all municipalities, between 8.4% (Aleksinac) and 12.4% (Ćićevac), which is similar to the republic level growth of 10%.

Table 19.12 Average net salaries (municipality) in February 2024 and February 2025

Municipality	Average net salary (February 2024		Average net salary (February 2025)		% increase
	RSD	EUR	RSD	EUR	
Republic of Serbia	94,979	810	105,499	900	10,0%
Paraćin	77,588	662	87,016	742	10,8%
Ćićevac	72,433	618	82,697	706	12,4%
Kruševac	84,028	717	92,465	789	9,1%
Aleksinac	76,030	649	83,010	708	8,4%
Niš	91,485	781	101,137	863	9,5%

Source: Statistical Office of the RS - Average earnings by municipality

19.5.2.3 Education and Schools

The level of education among Serbian citizens has improved in the last decade, comparing the 2011 and 2022 census data. However, the share of the population with no education or incomplete primary education is still high and in the affected municipalities it is higher than the national average, everywhere except in the large administrative and university centre, the city of Niš. The percentage of women in this category is double the percentage of men in almost all municipalities, ranging from 10% to 16% (5% in Niš) and pertains to the oldest categories of the population. The percentage of men and women completing higher education is far below the national average, everywhere but in Niš, where it is above national rates. However, women are exceeding men in this regard in all affected municipalities, as well as at national level, which has been a growing trend in recent years. The share of illiterate people varies among municipalities – somewhere it is below national illiteracy rate and somewhere above it. While in Serbia this rate is 0.63% in Niš it is double less – 0.31%, but in Aleksinac it is as much as 1.82%. In Paracin it is 0.81%, in Kruševac and in Ćićevac 0.55%. In all cases, the share of illiterate persons is higher for women than men.

Table 19.13 Level of education of (municipality) in 2022

Municipality	None or incomplete elementary		Elementary		Secondary		Higher education	
	men	women	men	women	men	women	men	women
Republic of Serbia	4%	8%	16%	19%	58%	48%	21%	24%
Paraćin	6%	12%	24%	25%	56%	47%	15%	16%
Ćićevac	5%	12%	22%	28%	60%	47%	13%	13%
Kurševac	4%	10%	19%	20%	58%	48%	19%	22%
Aleksinac	8%	16%	25%	28%	55%	43%	12%	13%
Niš	1%	5%	10%	14%	59%	51%	29%	31%

Source: DevInfo, Vital statistics

According to the results of the 2022 population census, over 45% of men and women are computer literate at the national level average. The results are lower in all affected municipalities but Niš, where the share of IT literate persons is above national rate, both for men and women. Overall, one quarter to one third of the population is still computer illiterate, except in Niš where this rate is lower.

Table 19.14 Population aged 15 and over by computer literacy and sex (by municipality), 2022

Municipality	Computer illiterate		Some computer literacy		Computer literate	
	men	women	men	women	men	women
Republic of Serbia	22%	26%	32%	27%	45%	47%
Paraćin	27%	31%	37%	31%	37%	38%
Ćićevac	31%	38%	33%	28%	36%	35%
Kruševac	26%	30%	32%	26%	42%	44%
Aleksinac	33%	39%	34%	28%	32%	33%
Niš	19%	23%	24%	22%	57%	55%

Source: DevInfo, Vital statistics

19.5.2.4 Health and Health Care Services

Life expectancy at birth in 2022 is higher for women in all cities/municipalities, being at the same time a bit higher than for Serbia overall, both form men and women. The details are provided in the Table below.

Table 19.15 Life expectancy at birth (municipality) in 2021-2023

Municipality	Life expectancy at birth (2021-2023)	
	men	women
Republic of Serbia	72.3	77.49
Paraćin	72.92	76.6
Ćićevac	76.11	78.92
Kruševac	73.5	78.86
Aleksinac	73.15	78.02
Niš	73.55	78.47

Source: Statistical Office of the RS

In 2023, cardiovascular diseases were the leading cause of death across all municipalities, ranging from 38.4% in Kruševac to as high as 52.9% in Aleksinac and 51.5% in Ćićevac. Tumours represented the second most common cause of death, accounting for between 19.7% in Ćićevac and 24% in both the City of Niš and Kruševac. Respiratory diseases ranked third in most municipalities, with the exception of the City of Niš. Their share as a cause of death varied from 5.8% in Paraćin, 6.1% in Aleksinac, and 6.8% in Ćićevac to 8.3% in Kruševac. All municipalities, with the exception of Ćićevac, have a general hospital – Ćićevac has a primary health care centre.

19.5.2.5 Infrastructure

The E-75 highway serves as Serbia's principal north-south transportation artery, running parallel to the Belgrade–Niš railway, particularly near the Paraćin–Ćićevac and Đunis–Trupale sections. This alignment offers strategic advantages for construction and logistics, facilitating efficient access to various project sites. While the E-75 is the dominant route in this corridor, several regional and local roads provide supplementary access to the railway. Among these, State Road 246 plays a significant role by connecting towns and villages adjacent to the railway. However, it's important to note that State Road 246 is classified as a class IIA state road, indicating its regional significance rather than national prominence. In contrast, the E-75 is designated as a class IA motorway, reflecting its status as part of the international E-road network and its critical importance to Serbia's infrastructure.

In areas where main roads diverge from the railway—such as around Ćićevac and Aleksinac—access relies on a network of smaller local roads. These roads, while paved, vary in condition and width, especially in more remote or rural areas. They are essential for connecting villages along the railway and are typically served by daily bus services from local operators.

Kruševac has the most extensive road network, with a total of 444 kilometres, of which 396 kilometres are classified as modern roads. Ćićevac, however, stands out with a significantly lower proportion of modern roads—only 104 kilometres out of a total of 228—suggesting a need for further investment in road improvement (Table 19.16).

Table 19.16 Length of roads, 2023

Municipality	Total (km)	Modern road (km)
Paraćin	232	189
Ćićevac	228	104
Kruševac	444	396
Aleksinac	265	239
Grad Niš	339	339

Source: DevInfo, Transport and infrastructure

Access to basic utility infrastructure varies significantly across the municipalities along the Paraćin–Ćićevac i Đunis-Trupale railway section. The highest level of connection to the public water supply is recorded in the City of Niš, while lowest connection rates in Aleksinac (Table 19.17). In terms of water resource distribution, Paraćin and Kruševac are municipalities that allocate part of their water resources to neighbouring municipalities. Conversely, Ćićevac relies on water supply from other municipalities to meet local needs.

When it comes to public sewage systems, the situation is notably uneven. Paraćin has the highest sewage network coverage, with 76% of households connected, whereas in Ćićevac, only 5% of households have access to the sewage system. Surprisingly, despite its urban status, the City of Niš has a relatively low sewage coverage rate of 34% (Table 19.17).

Table 19.17 Connection to public water supply and sewage (municipality) in 2023

Municipality	% households connected to the public water supply	% of households connected to public sewage
Paraćin	90%	76%
Ćićevac	80%	5%
Kruševac	88%	60%
Aleksinac	75%	31%
Grad Niš	99%	34%

Source: Statistical Office of the RS

Electricity and telecommunications infrastructure is available and established across all local communities within the study area, ensuring stable access to essential utilities. Solid waste collection services are organized by local authorities and are typically conducted on a weekly schedule. Despite these arrangements, challenges persist with regard to waste management practices. In particular, some rural and peri-urban settlements continue to experience problems with unregulated waste disposal, as a portion of the population still resorts to using informal and unauthorized dumping sites. This issue represents an ongoing concern for environmental health and local service delivery.

19.5.2.6 Land Use and Property Ownership

Agricultural land is the dominant land use in all municipalities along the railway section, though in each case, it covers less than the national average of 70%. Nevertheless, farming remains the most widespread land use, underscoring the region's rural nature. The corridor primarily runs through small villages and open landscapes, with minimal urban development. Among the municipalities, Paraćin and Aleksinac have the highest proportion of agricultural land at 64%, while Ćićevac has the lowest at 54%. Forested areas account for a smaller portion, ranging from 27% in Niš to 36% in Paraćin (Table 19.18). This land use distribution emphasizes the corridor’s strong agricultural focus - an important factor for planning and development efforts tied to the railway modernization project.

Table 19.18 Land use (by municipality) in 2023

Municipality	Total area	Agricultural land	Forest land
Paraćin	542 km^2	64%	36%
Ćićevac	124 kms^2	54%	28%
Kruševac	854 km^2	58%	35%
Aleksinac	707 km^2	64%	29%
Niš	597 km^2	62%	27%

Source: Statistical Office of the RS

In line with the Spatial Plan, the land designated for public use in the construction of Section 3 facilities spans approximately 370 hectares. Although specific land use data for this specific area is not available, the broader framework indicates that the surrounding region is primarily agricultural, making up around 61% of total land use. This is followed by construction land (29%), forested areas (9%) and a minimal share of water surfaces (less than 1%).

Based on these proportions, it is estimated that roughly half of the designated 370 hectares - around 185 hectares - may be agricultural land. The public-purpose land includes both areas currently occupied by the existing railway corridor and additional plots that will need to be acquired to accommodate the project’s expansion. Nearly half of the total affected area lies within the territory of Aleksinac municipality. The remaining half is distributed almost equally between Paraćin and Ćićevac, with a slightly smaller share located in Niš (Table 19.19). Kruševac municipality is not included in the table, as it is estimated land expected to be acquired on the territory of Kruševac municipality is only 1.5 ha.

Table 19.19 Estimated affected area (municipality)

Municipality	Total estimated affected area
Paraćin	75 ha
Ćićevac	70 ha
Aleksinac	175 ha
Niš	50 ha
TOTAL	370 ha

A more detailed quantification of affected land is provided in the Resettlement Policy Framework (RPF) for Section 3 which includes preliminary estimates of the number and size of land that may be impacted by the Project. The RPF also identifies potentially affected households and users.

19.5.3 Gender Perspectives on Rail Transport

Women make the majority of public transport users, yet they face significant mobility and safety challenges that limit their ability to fully benefit from the transport system in access to education, healthcare, jobs, and participation in economic and public life.[5]

Women in Serbia rely more heavily on public transport than men, with 76% of female respondents using it regularly compared to 65% of men. [6] However, this is not due to preference but necessity. Forty-four percent of women reported having no other travel option, versus 32% of men, indicating that women are more likely to be “captive users” reliant on public systems due to lower car ownership and income levels.[7] Gender differences in mobility are pronounced and rooted

[5] Nato Kurshitashvili, Karla Gonzalez Carvajal, Kelly Saunders, and Laila Ait Bihi Ouali (2022). Paths toward Green Mobility: Perspectives on Women and Rail Transport in Bosnia and Herzegovina, and Serbia. World Bank; https://documents1.worldbank.org/curated/en/099855004142226786/pdf/P1741420168b9304b0aec80cdf2fadc8500.pdf

Dornier, SeConS (2018) Gender Equality in Transport in Serbia (GETS), https://secons.net/en/publikacija/gender-equality-in-transport-in-serbia/

[6] Kurshitashvili et al. 2022

[7] *Ibid.*

in broader patterns of inequality that shape access to transport modes, services, and infrastructure. Women in Serbia demonstrate higher trip frequency than men, averaging 3.9 daily trips compared to 3.6 among men, and they more often rely on walking and public transportation. This reflects both their central role in unpaid care work and their more complex mobility needs, such as combining commuting with school drop-offs, shopping, or accessing services. Despite this higher mobility demand, women are significantly less likely to use private motorized transport as drivers, with only 16% of their trips involving car driving compared to 40% among men. In contrast, they are more frequently passengers, particularly in cars driven by others.[8]

Rail transport, while not a primary mode for daily commuting, is integrated into broader gendered mobility dynamics. It is generally underutilized, particularly by women, due to limited availability, irregular schedules, and poor intermodal connectivity. The average distance to a train station is greater than to a bus stop, especially in rural areas, which affects women more given their reliance on public transport. The role of rail is further diminished by women's restricted access to first- and last-mile options, such as shared mobility services or bicycles, due to both infrastructural gaps and prevailing cultural norms.[9]

According to the World Bank study, the main barriers include inadequate first- and last-mile connectivity, safety concerns—especially at night—and insufficient station amenities, such as clean toilets or baby-changing facilities. Women reported experiencing harassment more frequently (6% vs. 2% of men), which further discourages use. Despite these issues, current rail users of both genders expressed general satisfaction with service reliability and safety during the day.

Women's mobility patterns also reflect their care responsibilities. Their trips are more complex, involving multiple modalities, in order to manage household tasks, school drop-offs, and care for dependents. This requires flexible, frequent, and accessible services, which are often lacking in the current rail network.

Although overall safety ratings were high among users, significant gender disparities were noted. In the face-to-face survey, 97% of all railway users said they feel either "very safe" (58%) or "somewhat safe" (39%) from injury due to infrastructure risks. However, fewer women than men reported feeling "very safe"—54% of women compared to 61% of men in stations, and 59% vs. 68% in trains. These differences widened significantly in perceptions of personal security,

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[8] Dornier, SeConS, 2018.

[9] *Ibid*

which includes threats like harassment and assault. Only 40% of women said they felt “very secure” in stations compared to 62% of men, and just 44% of women felt “very secure” on trains versus 63% of men.

Sexual harassment, though underreported, emerged as a pressing issue. In phone and online surveys, 6% of women reported experiencing or witnessing sexual harassment in stations or trains, compared to only 2% of men. Additionally, 21% of respondents (with younger people overrepresented) reported hearing of harassment incidents. Notably, 9% preferred not to respond, highlighting the sensitivity and possible underreporting of such experiences.

Women expressed particular discomfort during night-time travel. About 35% of users overall avoid traveling at night, but women more frequently reported completely avoiding rail stations and trains after dark, or requiring an escort. This avoidance, often referred to as a form of “mobility tax” or “pink tax,” pushes women to use more expensive travel alternatives to feel safe

Security infrastructure was found lacking. Around 50% of users said there were no visible police or guards at or around train stations. Only 25% reported seeing security personnel nearby, and another 25% noted a distant presence. Women in focus groups emphasized that lighting and CCTV were not sufficient—what made them feel safer was a visible human presence (e.g., staff or guards). Currently, the rail system lacks real-time alert tools such as panic buttons or mobile incident reporting apps. Passengers are also not informed about procedures to follow during incidents.

Women also show a greater concern for environmental sustainability, placing higher value on low-pollution transport options. Enhancing women’s rail use could therefore support Serbia’s green mobility objectives.

While municipal-level data on rail commuting is unavailable, daily commuting trends indicate that women commute less frequently for work or education compared to men (Table 19.20). It is also worth noting that residents of smaller, predominantly rural municipalities tend to commute more often than those living in larger urban areas, such as the City of Niš.

Table 19.20 Daily commuting, 2022

Municipality	Paraćin	Niš - city	Ćićevac	Aleksinac
Population size, population census 2022				
Total	**45543**	**249501**	**7860**	**43098**
Male	21942	120792	3926	21335
Female	23601	128709	3934	21763
Daily commuting of the labour force				

Municipality	Paraćin	Niš - city	Ćićevac	Aleksinac
Total	**5885**	**30149**	**1377**	**6938**
Within municipality	3798	5924	596	4205
Another municipality within same county	1136	18456	569	1948
Another county	951	5769	212	785
Total - male	**3399**	**15910**	**842**	**3859**
Within municipality	2211	3165	351	1912
Another municipality within same county	593	9369	334	1318
Another county	595	3376	157	629
Total - female	**2486**	**14239**	**535**	**3079**
Within municipality	1587	2759	245	2293
Another municipality within same county	543	9087	235	630
Another county	356	2393	55	156
Daily commuting of students				
Total	**2022**	**7633**	**409**	**2528**
Within municipality	1478	2951	171	1745
Another municipality within same county	323	4467	188	680
Another county	221	215	50	103
Total - male	**990**	**3729**	**206**	**1227**
Within municipality	748	1546	79	912
Another municipality within same county	150	2078	101	274
Another county	92	105	26	41
Total - female	**1032**	**3904**	**203**	**1301**
Within municipality	730	1405	92	833
Another municipality within same county	173	2389	87	406
Another county	129	110	24	62
Total commuting (labour force + students)				
Total	7907	37782	1786	9466
Male	4389	19639	1048	5086
Female	3518	18143	738	4380
% of commuting population				
Share of all commuting people within the total population	17.4	15.1	22.7	22,0

Municipality	Paraćin	Niš - city	Ćićevac	Aleksinac
Share of male commuting within the total male population	20.0	16.3	26.7	23,8
Share of female commuting within the total female population	14.9	14.1	18.8	20,1

Source: Statistical Office of the RS

19.5.4 Vulnerability in the Area of Influence

EBRD and EIB define vulnerable groups as those exposed to multiple risks, heightened sensitivity, or limited capacity to cope with adverse impacts. In line with the requirements of both institutions, this assessment gives special attention to how the project may affect such groups. The socio-economic baseline outlines key data on population vulnerabilities, while the impact section analyses whether the project may disproportionately affect them, how, and what mitigation measures are needed. Potential project benefits for vulnerable groups are also considered.

Vulnerable groups have been defined as presented in the table below. **It is important to note that not every individual in these categories will necessarily be deemed as vulnerable, as vulnerability is often context dependent. The inclusion of these categories is to ensure that targeted mitigation measures address specific needs, rather than to assume universal vulnerability. Also, these categories are not mutually exclusive; an individual may belong to several categories simultaneously**.

Table 19.21 Vulnerable groups and ways in which can be affected

Project impact	Vulnerable groups	Specific ways in which they can be affected
Fencing of the railway and closure of level crossings	▪ Persons with mobility impairments ▪ Elderly residents ▪ Children and single parents ▪ Women (as primary pedestrians[5]) ▪ Economically marginalised groups	The installation of fencing along the railway and the closure of existing level crossings will result in significantly longer travel distances for community members needing to reach the opposite side. This particularly affects access to key community resources such as schools, health centres, kindergartens, cemeteries and agricultural land. Elderly residents and people with chronic illnesses or disabilities often rely on public transport to reach healthcare services, which may become more difficult and costly. Students commuting to school or university may face longer, more complex journeys. Roma communities and economically vulnerable residents, less likely to own private vehicles, may face added financial strain to access the nearest operational station. Women, as primary users of public transport, are also likely to be disproportionately affected, especially those without access to private vehicles who depend on nearby rail connections for affordable and safe mobility. *See 19.6.3.2 (Community Severance During Operation) for more details.*
Closure of train stops and stations	▪ Elderly residents ▪ Roma communities ▪ Students ▪ People with chronic illnesses or disabilities ▪ Women (as primary pedestrians)	The planned closure of train stops/stations along the alignment will significantly affect residents who depend on local rail services for essential travel. Elderly residents and people with chronic illnesses or disabilities often rely on public transport to access healthcare services, which may become more difficult and expensive to reach. Students commuting to schools/universities may face longer and more complex journeys. Roma communities and economically vulnerable residents, who are less likely to own private vehicles, may face additional financial strain due to the need to arrange alternative transport to the nearest operational station. Women, as primary users of public transport, are also likely to be disproportionately impacted. Many women in the affected areas do not have regular access to private vehicles and depend on nearby rail connections for affordable and safe mobility. *See 19.6.3.1 (Closure of railways stops and stations) for more details.*
Land acquisition and physical/economic displacement	▪ Elderly or low-income households ▪ Informal or undocumented occupants	The Project will require the acquisition of land and demolition of structures, leading to both physical and economic displacement. Elderly and low-income households may lack the financial and physical capacity to secure alternative housing or restore their previous standard of living. Informal residents may face uncertainty regarding their eligibility for compensation and resettlement assistance.

	▪ Persons residing formally or informally in structures (continuously or intermittently) affected by the Project, with no other property or place of residence ▪ Roma households ▪ Farmers whose land/livelihood are affected	Roma communities, often residing in informal settlements and facing systemic discrimination, are at high risk of involuntary displacement without adequate support. Farmers, particularly those dependent on small land plots for subsistence or income, may experience a permanent loss of productive land, leading to a loss of livelihood. *See 19.6.2.1 (Land Acquisition and Resettlement) for more details.*
Temporary disruption of farmland access during construction	▪ Smallholder farmers ▪ Low-income rural households	Construction activities may temporarily block or limit access to farmland, especially plots located on opposite sides of the railway corridor. Smallholder farmers who often depend on manual labour or limited mechanisation can be particularly affected. They may face delays in planting and harvesting, increased travel distances, higher fuel or transport Low-income rural households who rely on agriculture for subsistence may also experience financial strain during this period. *See 19.6.2.2 (Temporary Disruptions of Community Mobility and Access During Construction*
Temporary disruption of crossings and paths during construction	▪ Children and parents ▪ Elderly ▪ Persons with disabilities ▪ Low-income households relying on foot access	Temporary closure of crossings before the construction of permanent underpasses or overpasses may isolate parts of communities, forcing residents to use unsafe or significantly longer routes to access schools, cemeteries or community services. Vulnerable pedestrians, such as children, elderly individuals, persons with disabilities and low-income households, may be particularly affected due to reduced mobility, safety concerns and limited alternative transport options. *See 19.6.2.2 (Temporary Disruptions of Community Mobility and Access During Construction*
Limited access to project information and consultation mechanisms	▪ Persons with low literacy ▪ Persons without internet access or ICT knowledge ▪ Physically disabled individuals ▪ Marginalized ethnic groups (e.g. Roma)	Limited access to digital platforms or written materials may prevent vulnerable individuals from understanding the project's impacts or participating meaningfully in public consultations. This can reduce their ability to raise concerns, seek clarifications or advocate for compensation and mitigation measures. Note: This is addressed in the Stakeholder Engagement Plan, which outlines specific measures to ensure inclusive access to project information and consultations.

19.6 Assessment of Impacts

19.6.1 Methodology

The general impact assessment methodology for determining the significance of impacts used by all specialists working on the development of this ESIA study is presented in Chapter 5. Due to the nature of socio-economic impacts, the overall methodology has been adapted for use in the socio-economic assessment. The focus of the assessment is on how the Project will interact with the social environment to produce impacts to human receptors. This involves the ***prediction of the magnitude*** of an impact, ***determining the sensitivity of receptors*** and crossing these two parameters to ***evaluate the significance*** of an impact.

As opposed to the general methodology used for other topics, the socio-economic impact assessment has avoided using a grading system and has relied on a more qualitative assessment of the interaction of various factors to determine the magnitude of an impact. These factors include consideration of the spatial extent of the impact (on site, local, regional, international), duration (temporary, short term, long term or permanent), scale or size, frequency and likelihood of an impact occurring.

Impact magnitude definitions which were used are as follows:

Table 19.1 Criteria for determining social impact magnitude

Category	Description (adverse impacts)
Major	A highly likely impact that would have implications beyond the Project life affecting the wellbeing of many people across a broad cross-section of the population and affecting various elements of the local communities', or workers', resilience.
Moderate	A likely impact that continues over several years throughout the Project life and affects the wellbeing of specific groups of people and affecting specific elements of the local communities', or workers', resilience.
Minor	A potential impact that occurs periodically or over the short term throughout the life of the Project affecting the wellbeing of a small number of people and with little effect on the local communities', or workers', resilience.
Negligible	A potential impact that is very short lived so that the socio-economic baseline remains largely consistent and there is no detectable effect on the wellbeing of people or the local communities', or workers', resilience.

Table 19.2 Criteria for determining sensitivity of a social receptor

Category	Description (adverse impacts)
High	An already vulnerable social receptor with very little capacity and means to absorb proposed changes or with very little access to alternative similar sites or services, and/or minimal opportunities for mitigation.
Medium	An already vulnerable social receptor with limited capacity and means to absorb proposed changes or with little access to alternative similar sites or services, and/or limited opportunities for mitigation.
Low	A non-vulnerable social receptor with some capacity and means to absorb proposed changes and with some access to alternative similar sites or services, and/or reasonable opportunities for mitigation
Negligible	A non-vulnerable social receptor with plentiful capacity and means to absorb proposed changes and with good access to alternative similar sites or services, and/or good opportunities for mitigation.

Significance has been attributed to each impact, taking into account the interaction between magnitude and sensitivity, as presented in the following impact evaluation matrix:

Table 19.3 Impact evaluation matrix

		Magnitude						
		Adverse				Beneficial		
		Major	Moderate	Minor	Negligible	Minor	Moderate	Major
Sensitivity	High	Major	Major	Moderate	Negligible	Moderate	Major	Major
	Medium	Major	Moderate	Minor	Negligible	Minor	Moderate	Major
	Low	Moderate	Minor	Negligible	Negligible	Negligible	Minor	Moderate
	Negligible	Minor	Negligible	Negligible	Negligible	Negligible	Negligible	Minor

Major and moderate impacts are considered significant, while minor and negligible impacts are considered insignificant. After assigning significance to each identified impact, the social team identified the most practical ways to mitigate the significant negative impacts and enhance positive impacts, where possible. The key objective is to reduce significant impacts to the lowest possible level.

After identifying mitigation measures, impacts were re-assessed to determine their residual impact. This involved repeating the impact assessment steps while assuming that the identified mitigation measures will be implemented, and then re-evaluating their significance.

19.6.2 Impacts in the Pre-Construction and Construction Phase

19.6.2.1 Land Acquisition and Resettlement

The Project will result in involuntary physical and economic displacement as land must be acquired through a process of expropriation. While the full scope and procedures for land acquisition, including eligibility, compensation principles and assistance measures, are detailed in the **Resettlement Policy Framework (RPF)** prepared for Section 3, a summary of the key anticipated impacts is provided below to support understanding of the social risks.

The railway alignment was defined to meet technical and operational objectives while minimising land acquisition and physical resettlement wherever possible. As part of this process, a total of 15 alignment changes were introduced, including both route deviations and infrastructure design adjustments, with the goal of improving track geometry, maintaining design speeds and reducing disruption to communities. These modifications were assessed not only from a technical and environmental perspective, but also through a social lens, with the potential impact on residential and economic structures playing a key role in the selection of preferred options. An assessment of social implications of route deviations was carried out for 11 proposed deviations. An example is also the Aleksinac Station, where several options were reviewed. The option which involves optimising the layout of the existing station was selected as the most technically, economically and socially balanced solution. This option significantly reduces physical displacement and land acquisition needs. The redesign lowers the number of affected structures from over 30 to just 5-7, representing an approximately 80% reduction compared to the original concept.

These considerations are detailed in the ESIA chapter “**Analysis of Alternatives**”.

As outlined in the Spatial Plan, Section 3 is expected to impact a total of 4,457 land plots. Of these, only a small portion of 14% or 619 plots are projected to be fully affected, while the majority - 86% or 3,838 plots will only be partially impacted. These figures are based on preliminary assessments and may be revised as planning and implementation advance.

Table 19.22 Potentially affected land plots by municipality

Municipality/city	Total estimated fully affected land plots	Total estimated partly affected land plots
Paraćin	80	684
Ćićevac	141	476
Kruševac	4	7
Aleksinac	324	2,238

Municipality/city	Total estimated fully affected land plots	Total estimated partly affected land plots
Niš	70	433
Total:	**619**	**3,838**

Table 19.23 Potentially affected structures by project component

Project component	Type of structure				
	Residential structures	Auxiliary structures	Business or other structure	Railway structure	Railway apartment[10]
Overpass or underpass, access road	73	44	4	8	2
Railway station	36	13	7	31	30
Expansion of existing alignment	15	17	1	0	1
New alignment	56	45	4	4	1
TOTAL	180	119	16	43	34

Most of the proposed deviations involve minor shifts from the existing railway (typically between 20 and 600 m) and pass through agricultural or uninhabited land, avoiding impacts on residential structures. However, in several areas, alignment changes are expected to result in physical displacement due to proximity to residential zones. These include:

- Trnjane, where two deviations are planned: a 60-m northeast shift affecting 10 residential properties, and a curve connection through the existing station area, which, despite being selected to minimise impacts, will still affect approximately 20 buildings.
- Donji Ljubeš, where a 70-m shift to the northeast will affect 4 residential structures.
- Srezovac, where two curve corrections will impact 2 residential properties.
- Vitkovac, where a 40-m northeast shift will result in the displacement of 1 household.
- Grejač, Mezgraja, and Vrtište, where a broader realignment intended to improve track curvature will shift the railway alignment by up to 600 m and affect more than 20 residential properties.

[10] *These railway apartments are currently housing 94 individuals in total. Of these, 13 apartments are occupied by active railway employees - primarily from SRI, with three tenants from Serbia Cargo and one from Serbia Voz. The remaining 21 units are occupied by third parties, including relatives of former railway workers and other individuals.*

A significant number of local residents have expressed concerns about the expropriation process. During the public disclosure of the SPSPA, residents submitted numerous questions related to expropriation, including full or partial loss of land parcels, demolition of houses and auxiliary structures, and/or inability to use the remaining portion of plots (rendering it unusable) or loss of access to their land altogether. **Such concerns were recorded in all settlements**. Specific issues raised include:

- **Local Community Offices in Praćilovica, Žitkovac, Trnjane and Vitkovac** noted the high number of elderly residents in their areas who would require targeted assistance and support throughout the resettlement process.
- **In Trnjane and Korman**, residents expressed strong opposition to the proposed deviation from the current railway alignment, which would result in extensive expropriation and demolition of residential and agricultural structures, leading to both physical and economic displacement. Communities insist that the alignment should follow the existing route to avoid unnecessary impacts. These concerns, along with the alternatives considered for this area, are discussed in more detail in Chapter 4 (subchapter 1.4.2) – Assessment of Alternatives.
- **In Trnjane**, additional concerns were raised regarding the anticipated loss of the only local sports field, located next to the school, which holds social and recreational significance for the community.
- **In Striža**, residents reported that several of the houses marked for demolition to make way for an underpass are inhabited by Roma families. This raised concerns about culturally appropriate resettlement approaches and the need to ensure vulnerable groups are adequately supported.
- **In Praćilovica and Žitkovac**, communities have called for the relocation of the planned alignment outside of the settlements.

The magnitude of displacement has been ranked as major, due to the number of people affected and the permanent character of the change. The actual sensitivity of receptors could not be determined at the time of developing this SIA, as it is unknown exactly which households will be affected and their detailed socio-economic status. For determining the overall significance of this impact, it is assumed that the average sensitivity of the receptors can be ranked as medium to high, and the impact, i.e. land acquisition further leading to involuntary physical and economic displacement, assessed as a ***major adverse*** impact, requiring mitigation.

The detailed assessment of all land acquisition related impacts is provided in the Section 3 RPF, disclosed at the same time as this SIA.

PLANNED MITIGATION MEASURES:

- SRI will prepare and implement a Resettlement Action Plan (RAP) for Section 3, in full alignment with the principles and procedures outlined in the Section 3 RPF, which forms part of the ESIA disclosure package.

- Special attention will be given to vulnerable groups, ensuring that international best practices are applied with the aim of restoring, and where possible, improving their standard of living and livelihood conditions.
- All resettlement activities will be carried out through transparent, participatory processes, and include clear grievance mechanisms to address concerns that may arise during implementation.

19.6.2.2 Temporary Disruptions of Community Mobility and Access During Construction

Agricultural land is present along almost the entire Section 3 corridor. Both subsections traverse regions with high agricultural activity, particularly flat and fertile lowlands used for crop cultivation, orchards and pasture. This includes not only privately owned farmland but also plots adjacent to settlements that are used for farming.

Communities such as **Striža, Sikirica, Drenovac, Ratare, Vitkovac, Trnjane, Prćilovci** and **Grejač** are among those especially reliant on agriculture and have cultivated land plots located on both sides of the planned railway. During construction, access to some of these plots will be temporarily restricted due to excavation works, construction machinery, fencing and safety buffers. This could create logistical challenges for landowners and users who need to cross the alignment to reach parts of their land, especially in cases where roads or footpaths are interrupted or re-routed. Where fragmentation occurs, farmers may face longer travel times, increased fuel costs or reduced ability to maintain land on the opposite side of the corridor. In addition, the temporary use of land for storage, worker facilities or machinery access routes may result in direct loss of productive land or delays in planting and harvesting cycles. These interruptions are likely to disproportionately affect smaller landowners with limited access to mechanized equipment or alternative plots.

Due to the importance of agricultural land in this region and the fact that it is heavily farmed, the magnitude of the impact has been assessed as moderate. The sensitivity of receptors, in this case farmers who are dependent on this land for livelihoods, is defined as medium. The overall evaluation is that the impact, i.e. temporarily hindered access to agricultural land further leading to loss of agricultural livelihoods, is ***moderate adverse***.

In addition, certain construction activities will occur along the railway, and it may be necessary to carry them out in locations where at grade crossings, currently in use by the local population, are located. In the longer term, at grade crossings will be replaced with overpasses and underpasses, however temporary closure of at grade crossings before underpasses and/or overpasses are available may also occur, as a temporary impact. This could cause longer walking and travel distances for community members to access the other side of the railway for common daily activities. The impact on vulnerable groups, including women, the elderly, children (and their parents, particularly single parents), as well as people with low incomes, who are most often pedestrians, will be disproportionally higher. The change is temporary, and the overall magnitude is minor, as it could occur only in some locations. These concerns were also reflected in **community feedback** gathered during the public disclosure of the SPSPA. **In several settlements including Gornji Ljubeš, Trnjane, Prćilovica and Korman, residents expressed fears over pedestrian safety** (particularly for schoolchildren) due to the closure of existing crossings without adequate alternatives, which would result in significantly longer and unsafe walking routes, sometimes up to 4–6 km. They noted that disruption of access may also be particularly problematic for elderly persons and persons with limited mobility.

Given the high reliance on agriculture in this region, as well as the presence of vulnerable groups who depend on accessible routes for daily movement, the sensitivity of receptors is assessed as medium to high. The magnitude of the impact ranges from minor to moderate, depending on the location and duration of access restrictions, particularly where construction interrupts frequently used crossings or essential agricultural access. The overall impact is assessed as ***moderate adverse***.

PLANNED MITIGATION MEASURES:

- Contractor to develop and implement a Construction Traffic Management Plan, ensuring that access to agricultural land, with agricultural machines, is available at all times. Plan for clear and visible signage in all affected settlements to direct pedestrians and vehicles to alternative routes.
- The Contractor to keep every at grade crossing open until the underpasses and overpasses intended to replace it are constructed and open for traffic. No crossing shall be closed before a functioning alternative is made available to the local population.
- Contractor to consult local communities during the development of the Construction Traffic Management Plan and to make it publicly available.

19.6.2.3 Risk of Damage to Private Property, Infrastructure and Utilities

Construction works along the Paraćin–Stalać and Đunis–Trupale subsections involve a range of high-impact activities including earthworks, excavation, piling and the movement of heavy machinery. These activities pose a risk of incidental damage to private property, local infrastructure and existing utility networks located near the railway alignment.

<u>Risk of damage to private properties near construction locations</u>: The railway section traverses densely settled zones (e.g. Paraćin, Vitkovac, Prcilovci, Žitkovci and Moravac), where residential structures, access roads and basic infrastructure are often located within 50–100 m of the construction corridor. In several cases, buildings are situated closer than 30 m, particularly in areas such as Vitkovac and Trnjane. Although only buildings within the expropriation corridor will be formally removed, adjacent properties outside the corridor remain at risk from unintended damage. The magnitude of the impact is moderate, while sensitivity is rated medium due to the significant presence of poor quality housing near project locations, making the impact, i.e. possible damages to private property, ***moderate adverse***. Note: Specific impacts of vibration on properties adjacent to construction areas are discussed in Chapter 12 of the ESIA.

Risk of damage to community utilities: Given the fact that the railway intersects with local infrastructure networks in many locations, there is also a risk of damages to community utilities used by the local population (water supply, electricity, etc.) during construction. The possibility of these impacts occurring is significant and they can occur in many locations along the construction areas, which is why the magnitude has been rated as moderate. The sensitivity of the local population is also medium, and the final impact, i.e. possible damages to infrastructure causing supply shortages, is assessed as ***moderate adverse***.

Risk of damage to local roads: A common impact which, based on experience from other projects, has the potential to create great divides with local communities, concerns damages to local roads used for construction purposes. The magnitude of the impact is assessed as being moderate, because it can occur in many locations along the construction areas and the likelihood of it occurring is high. Because of the importance of local roads for the population and the fact that many are not repaired by the municipalities as often as people would prefer, the sensitivity of local receptors is assessed as medium, making the impact, i.e. damages of local roads, ***moderate adverse***.

PLANNED MITIGATION MEASURES:

For construction related damages:

- Contractor to ensure workers have strict instructions to obey the boundaries of project right of way areas
- Contractor to organise the assessment and recording of the condition of sensitive structures near future construction sites, before the start of use of heavy machinery
- Contractor to undertake detailed pre-condition and post-condition surveys of any buildings in vibration sensitive areas as defined in Chapter 12.
- Contractor to implement a grievance mechanism to enable people to file complaints
- Contractor to provide prompt compensation for any damages at full replacement cost.

For impacts on utilities:

- Contractor to carry out the relocation of any affected infrastructure and provide advance notification to users of any disruption and full and prompt reestablishment of function.

- Contractor to carry out prompt repairs of any accidentally affected networks and provide information to local communities on how and when services will be re-established.

For damages to local roads:

- The Contractor to undertake, prior to the start of construction, a pre-condition survey of all access roads to be used. The survey will be conducted by a civil engineer experienced in roads and will use photographic, video and other supporting materials to document the road condition in survey reports. Surveys will be undertaken together with responsible entities depending on the type of road and witnessed by the local municipality representatives.
- Contractor to maintain quality of all used roads and promptly repair any damages.

19.6.2.4 Employment and Procurement Opportunities During Construction

At the time of developing this SIA, there is no detailed information on the required or planned workforce. Construction will be done in phases and not all workers will be employed all the time. The frequency at which workers will be employed and the duration of their engagement will depend on the contractors' organisation of work. Based on experience from other similar projects in Serbia, it is possible that the workforce may even reach 3,000 workers at its peak.

There will always be a need for employment of some local workers as well, particularly the unskilled workforce. This could create some opportunities for people living near the project areas. When reviewing the unemployment data for the affected municipalities, it is evident that the unemployment rate in all five affected municipalities is above the national average. In Paraćin and Aleksinac, unemployment is highest (15% and 16% respectively).

Indirect employment opportunities will be created in connection to the Project's supply chain and the procurement of goods and services. Materials needed for civil works such as concrete, sand, gravel, crushed stone, etc., will probably be procured locally, as they are available in the area. In addition, the presence of the workforce in these locations is sure to create some opportunities for small businesses such as shops, bars, restaurants. Some accommodation services may also be needed, even if worker camps are used, and this too will create benefits for local communities. All of these types of services suggest that there may be opportunities for women, which should be additionally enhanced if possible.

The magnitude of employment and procurement opportunities is assessed as being moderate, as this will be a detectible change, particularly for the small communities along the railway, and because construction could last up to three years overall. Because of the importance of employment and procurement opportunities for the local population, their sensitivity is rated as medium and the final impact, i.e. availability of employment and procurement opportunities, is evaluated as being ***moderate beneficial***.

PLANNED ENHANCEMENT MEASURES:

The Contractor will develop and implement a Construction Labour, Employment and Local Procurement Plan, with the following elements:

- cooperate with the National Employment Service to engage unemployed persons
- announce employment opportunities locally and encourage women to apply
- implement transparent and fair recruitment procedures procure goods and services locally whenever possible.

19.6.2.5 Impacts on Railway Traffic Operators

Construction works will require temporary closures of track segments, modifications to timetables or re-routing of trains. These interventions may disrupt existing rail operations and affect service continuity, punctuality and commercial performance. Such disruptions may be felt by Srbija Voz, the national passenger rail operator, which provides local, regional and intercity passenger services. In parallel, Srbija Kargo and/or other freight operators may experience temporary limitations in freight movement capacity, delays in scheduling and increased operational costs due to detours or the need for rescheduling. Given that rail freight is an important mode of cargo transport for industrial and agricultural sectors along Section 3, construction-related disruptions could also have a ripple effect on supply chains, particularly in time-sensitive logistics.

Although these impacts are temporary and largely dependent on the construction phasing and traffic management strategies to be adopted, they remain relevant to the broader socio-economic context of the project. The sensitivity of these stakeholders is considered medium, given their institutional capacity but also their reliance on uninterrupted infrastructure access. The magnitude of the impact is assessed as moderate, especially if mitigation and coordination are insufficient. The overall impact on rail operators is therefore assessed as ***moderate adverse*** for both passenger and freight services.

PLANNED MITIGATION MEASURES:

- SRI to establish formal coordination mechanisms with both Srbija Voz (passenger rail operator), Srbija Kargo and other freight operators early in the planning phase to anticipate operational disruptions and integrate their input into the construction schedule.

19.6.2.6 Labour and Working Conditions

As explained above, the details regarding the needed workforce are unknown at present, however experience suggests that it will not be small. A part of the workforce may need to be housed on site, and this means that adequate worker accommodation will need to be provided, whether in worker camps or in private accommodation, or a combination of the two.

Overall, all contractors and suppliers have to abide by the Serbian Labour Law and other relevant Serbian legislation for all workers, regardless of whether they are citizens of Serbia or foreigners. The Serbian Labour Law is mostly aligned with EBRD and EIB standards regarding working conditions (see Chapter 3 on applicable legislation and comparison to EBRD/EIB standards). Measures to bridge the few gaps that do exist are described in the mitigation section, especially the need for regular monitoring of labour and working conditions.

The magnitude of impacts on workers in relation to their working conditions, is assessed as being moderate, due to the relatively large workforce which is expected, the possibility that foreign workers will be engaged, and the importance of providing adequate working conditions for everyone. The sensitivity of workers is assessed as medium and the final impact, i.e. risks associated with labour and working conditions, as ***moderate adverse***.

PLANNED MITIGATION MEASURES:

The Contractor will:

- Develop and implement a Construction Labour and Employment Plan and a Construction Worker's Code of Conduct.
- Ensure that all non-employee workers are engaged in line with both national legislation and applicable international (ILO) standards and recommendations.
- Provide a grievance mechanism for workers available to all Project workers including subcontractors
- Develop and implement a Workers' Accommodation Management Plan in accordance with the requirements of IFIs regarding worker accommodation and international best practice standards, specifically the IFC and EBRD guidance note: Workers' accommodation: processes and standards (2009).
- The Contractor will organise training on HR issues, internal grievance mechanism and workers' code of conduct.

SRI will organise an independent labour audit after contractor mobilisation and prior to commencement of main construction and at least quarterly during construction, to ensure that all workers are engaged in line with both national legislation and applicable international (ILO) standards and recommendations.

19.6.2.7 Community Health, Safety and Security

Community health, safety and security risks during the construction phase are addressed across several chapters of the ESIA, including those related to air quality, soil contamination, waste and materials management, noise and vibration, and accident prevention. Each of these areas includes targeted mitigation measures designed to reduce potential adverse effects on local communities and ensure that residual impacts remain within acceptable regulatory and health-based thresholds. However, certain risks merit additional emphasis within this SIA due to their direct relevance to local well-being and vulnerability. These include:

Risk of accidents: The risk of accidents involving community members is a common concern on large-scale infrastructure projects, especially those that pass through or near populated areas. This is particularly relevant for Section 3, which runs through a series of rural and peri-urban settlements where pedestrian traffic is common, and awareness of large-scale construction activity is generally low. Children and young people represent a particularly vulnerable group in this context. **In settlements such as Gornji Ljubiš, Trnjane and Praćilovica, schools and kindergartens are located in close proximity to the railway corridor (within 25 to 70 m in some cases)** placing children at heightened risk of exposure to construction hazards. During **community consultations**, children were repeatedly mentioned as being at risk, particularly in settlements such as Gornji Ljubeš, Trnjani, Praćilovica and Ćićevac. Other sensitive receptors are present throughout the corridor and will require specific attention during construction planning. The development of a comprehensive Traffic Management Plan will include a detailed assessment of high-risk locations.

The magnitude of this impact is assessed as moderate and the sensitivity of the receptors is medium, making the potential risk of transport related accidents involving community members, ***moderate adverse***.

Noise during construction: Across the alignment corridor, a total of 7,507 buildings were recorded along the Paraćin–Stalać sub-section, of which 3,449 were identified as noise-sensitive receptors. In the Đunis–Trupale sub-section, there are 11,345 buildings, with 4,848 considered noise-sensitive. The overwhelming majority (over 99.5%) are residential, while the remainder include educational, commercial or public functions. These figures are based on the assessment presented in ESIA Chapter 12 (Noise and Vibration) and provide important context for understanding social exposure to construction and operational impacts.

Noise impacts during construction will most notably affect areas within 100 m of the works. The impact may be more pronounced during impact piling operations, where threshold exceedance could extend up to 500 m. Such elevated noise levels may disturb daily routines, affect sleep and increase stress levels among nearby residents, especially vulnerable groups such as the elderly, children and persons with pre-existing health conditions. To address these risks, the

Contractor will prepare a Construction Noise Management Plan, which will include practical mitigation measures. These will involve avoiding impact piling works in zones where houses are located at a distance less than 500 m or using low or non-vibratory piling methods etc. Details and assessment of noise impact significance is given and explained in Chapter 12 of the ESIA (Noise and Vibrations).

Concerns about noise during the public disclosure of the SPSPA were particularly prominent in Prćilovica, Žitkovac and Tešica, where houses are near the existing railway. In Žitkovac, residents also noted that removal of existing vegetation would increase exposure to construction noise.

Vibration during construction: Vibration, while more limited in range, can still pose significant concerns, particularly in terms of structural impacts on buildings and comfort or disturbance to residents. The strongest vibration levels (e.g., from impact piling) may exceed permissible values up to 25 m from the construction site, while other construction methods could affect receptors within 8 m.

Although structural damage is limited to very close distances, annoyance or discomfort from vibrations may be experienced up to 78 m, particularly during piling operations. As with noise, mitigation measures will be outlined in a dedicated Construction Vibration Management Plan. These measures will include avoiding impact piling works in zones where houses are located at a distance less than 78 m and using low or non-vibratory piling methods, etc. **Concerns regarding vibrations during the public disclosure of the SPSPA were noted in Prćilovica, where residents already experience noticeable ground tremors from existing train traffic and fear significant worsening during construction and high-speed rail operation.** Details and assessment of vibration impact significance is given and explained in Chapter 12 of the ESIA (Noise and Vibrations).

Interaction with workers - community safety risks: Risks can occur as a result of the interaction of workers and the local population, and this is particularly the case in areas where workers may be housed or where they spend their leisure time. In such cases, local women and girls are at more risk of gender-based harassment and violence (GBVH). On this project, having in mind the possible scale of the needed workforce and the sizes of smaller villages along the railway route (some counting only several hundred inhabitants), the magnitude of this impact is assessed as being moderate, while the sensitivity is assessed as medium, making the risk of GBVH for local women and girls, ***moderate adverse***.

PLANNED MITIGATION MEASURES:

For risk of traffic accidents involving community members:

- The Contractor will develop and implement a Construction Traffic Management Plan, to ensure all construction related transport is carried out in a safe manner, minimising traffic congestions, road safety risks and disruption to all road users and local access.
- Contractor to identify sensitive locations and agree prevention measures with the communities (e.g. slower driving near local school, awareness raising for children and parents, etc.). Measures to address traffic safety will be included in the Construction Traffic Management Plan, as presented in the ESMP.

For noise and vibrations:

- For noise and vibration mitigation measures, please refer to Chapter 12 (Noise and Vibration) of the ESIA, which outlines detailed actions to minimise impacts during construction.

For interaction with workers - community safety risks:

- Contractor will consult local communities on the location of construction camps, locating them away from sensitive receptors as defined in more detail in the ESMP.
- Contractor will engage community liaison person(s) and implement a grievance mechanism. The Contractor will organise a training on how community grievances are managed.
- Contractor will enforce a code of conduct for all workers (Construction Worker's Code of Conduct), with strict rules to prevent GBVH. The Contractor will organise training for all employed workers on GBVH issues (Training Plan) and develop specific protocols on how to handle grievances related to GBVH.
- Contractor will ensure local security forces are informed of increased risks, so they can increase monitoring in the area as needed
- The detailed measures will be included in the Construction Community Health and Safety Programme, as presented in the ESMP.

19.6.3 Impacts in the Operation Phase

19.6.3.1 Closure of railways stops and stations

There are currently 8 railway stations and 12 stops (20 in total) which are in use on Section 3. One station will be closed and 7 will remain after reconstruction. Additionally, 2 stops will be upgraded to stations, and the remaining 10 existing stops will be closed.

In summary, a total of 11 stops/stations are planned for closure along the alignment. A **table of all existing stops/stations that are planned to be closed, with an indication of the distance to the next nearest station and the daily passenger flow**[11] is provided below.

No.	Station/stop to be closed	Nearest planned station	Approx. distance	Daily passenger flow
1.	Drenovac Stop	Sikirica–Ratari Station	2.5 km	25
2.	Lučina Stop	Ćićevac Station	2.6 km	14
3.	Vitkovac Stop	Đunis Station	5 km	1
4.	Donji Ljubeš Stop	Gornji Ljubeš or Đunis Station	5 km	15
5.	Gornji Ljubeš Stop	Korman or Đunis Station	4 km	10
6.	Trnjane Stop	Korman Station	2 km	32
7.	Nozrina Stop	Lužane Station	1.6 km	50
8.	Grejač Station	Tešica Station	2.6 km	83
9.	Supovački Most Stop	Tešica Station	7.5 km	18
10.	Mezgraja Stop	Tešica Station	7 km	9
11.	Vrtište Stop	Trupale Station	2.5 km	8

[11] *Data taken from the Feasibility Study.*

Based on data presented in the table above, several of the planned closures involve locations that have recorded only minimal activity in recent years. This suggests that, for many of these sites, the overall social impact of closure is likely to be minimal. However, a few of the locations scheduled for closure have shown a more consistent pattern of use, indicating that some residents will be more directly affected. For these communities, the loss of direct access to railway services will represent a tangible disruption, especially taking into account the relatively small population of each settlement. Both residents of the immediate area and those from surrounding villages who previously used these stops will now be required to travel longer distances to reach the nearest operational station. Affected residents will now be required to travel longer distances to reach the nearest operational station.

Community concerns about the closure of stops/stations have been raised in Trnjane, Vitkovac, Drenovac, Grejač, Praćin, Žitkovac, Moravac, Prćilovac and Mezgraja. Particularly in Trnjane and Vitkovac, many people are concerned because they rely on train transport to Niš for work. Considering that Drenovac is the largest community in Paraćin municipality, the community has suggested relocating the new station planned in Sikirica-Ratari closer to Drenovac.

This change will have the most pronounced effect on pedestrians and vulnerable population groups, especially those who lack access to private transportation options. These include elderly residents, low-income households, women (who are more likely to depend on public transport in certain local contexts) and individuals with reduced mobility. For these groups, even short additional distances can pose significant barriers to accessing essential services, education and employment opportunities. Even where there are buses connecting the villages where railway stops will be closed with cities and towns where stations will continue to exist, bus schedules may not be aligned with train schedules and in some cases, bus stops are not near the stations. Therefore, the change which will occur, i.e. having to travel greater distances to access rail transport, will be significant and permanent and the magnitude is assessed as major. The sensitivity of receptors is assessed as low, moving towards medium in the case of vulnerable groups, and the overall impact, i.e. loss of access to railway transport, is therefore assessed as being ***major adverse***.

PLANNED MITIGATION MEASURES:

SRI to cooperate with local self-governments and other stakeholders to support the organisation of local road transport services in villages, coordinated with train arrivals and departures at nearest stations, by:

- At the start of construction, SRI to establish and chair a coordination group, comprising representatives of the affected local self-governments who will work on preparing local transport services adjusted to train transport.

Include representatives of Serbia Voz who will be defining future train schedules and a representative of the MCTI to provide support to the process and ensure cooperation with other relevant ministries.

- SRI to organise quarterly meetings of the coordination group during construction, to discuss what settlements need to be included in local transport services, the capacity of local self-governments to organise transport, potential cooperation between bordering self-governments to collect passengers from their territories, etc.
- SRI to ensure that draft plans for the organisation of local transport services are presented to local communities along the railway line and that their feedback is taken into account to adjust plans, to the extent possible.
- SRI to invite representatives of the MCTI and/or other ministries, as needed to provide support to local self-governments who do not have the capacity to organise local transport.
- As agreed with local self-governments, SRI to ensure that all local transport information relevant for train transport (e.g. bus schedules and how they correspond to train schedules) is available in local communities, at train stations, on the SRI and municipal websites, in local media, etc.
- SRI to establish cooperation with local self-governments and Serbia Voz on responding to grievances in connection to this topic and monitor how these grievances are being addressed.
- During operation, SRI to continue to engage with local self-governments and Serbia Voz to monitor whether transport services are adequate and raise any concerns that must be addressed to enhance services. Involve MCTI for support, as needed.

19.6.3.2 Community Severance During Operation

As part of the railway modernisation, numerous existing level crossings are planned for closure, to be replaced by a combination of underpasses and overpasses. **The new railway will be fully fenced, and all 48 existing level road crossings will be replaced with 30 deleveled crossings (overpasses and underpasses)**.

The level crossing closures will result in traffic being diverted to newly constructed or existing underpasses/overpasses. In many locations, this leads to additional travel distances up to 3 km. **Diversion distances over 1 km can generally be considered socially significant, especially for vulnerable groups such as the elderly, children going to school and persons with reduced mobility.** Such diversions can disrupt daily routines and limit access to schools and other services. Longer diversions also affect agricultural users, particularly smallholder farmers who depend on direct access to fields and equipment. In several locations, urban centres or clustered villages may be served by only one key crossing, making the closure of that access point especially disruptive to mobility. In addition, in some locations, the fencing of the railway and the closure of at grade crossings could cause longer walking and travel distances for community members to access the other side of the railway for work, school, etc. Again, the impact on vulnerable groups, including women, the elderly, children (and their parents, particularly single parents) as well as people with low incomes, who are most often pedestrians, will be disproportionally higher.

A **list of frequently used level crossings with diversions over 1 km is provided below** (the full list for both sub-sections is provided in Table 19.2 and Table 19.3 respectively).

Sub-section	Location	Diversion distance
Paraćin - Stalać	Žabare (Šumadijska St)	2,000 m
	Sikirica (Ravnogorska St)	1,600–3,100 m or 900–2,900 m
	Drenovac (Marka Kraljevića St)	1,600–1,800 m
	Ćićevac (Moravska St)	900–1,160 m
Đunis - Trupale	Vitkovac	650–1,300 m
	Vitkovac (Moravska & S. Simonovića St)	930–1,000 m
	Gornji Ljubeš (Dragomira Kostića St)	1,100–2,100 m
	Korman	1,300–2,400 m
	Trnjane	850–1,000 m
	Tešica – Diversion 1	1,400–2,300 m
	Tešica – Diversion 2	1,320–3,000 m
	Mezgraja (Maršala Tita St)	730–1,300 m
	Vrtište (Local road, km 227+850)	1,100 m

Numerous concerns regarding permanent community severance and reduced access to essential services have been raised by local communities during consultations. These concerns are particularly significant in locations where the planned railway alignment cuts through settlements, dividing them and leaving key facilities such as schools, kindergartens, health centres, cemeteries, and agricultural land on opposite sides of the track. Below is a summary of the **most critical feedback received from affected communities**:

- **Gornji Ljubeš**: Residents reported that children would be forced to walk 4–5 km to reach school due to the closure of a nearby crossing, significantly increasing exposure to traffic and road safety risks.
- **Prćilovica**: The railway alignment splits the village in two, disrupting access to schools, the local cemetery and farmland. Community members expressed particular concern for persons with disabilities, stressing the need for safe, accessible underpasses. Suitable pedestrian or vehicle crossings was seen as a critical measure to

reduce safety risks for children and elderly residents. They are particularly concerned about children accessing their schools, because all educational facilities are located close to the railway alignment.

- **Ćićevac**: Municipal officials and residents raised concerns about maintaining access to agricultural fields and roads leading to the highway. With farmland and access roads located on opposite sides of the alignment, ensuring connectivity is a great concern for them. Additional concerns focused on healthcare access, particularly for dialysis patients and users of daily medical services. Stakeholders emphasized the need to preserve functionality of the Red Cross, Health Centre and the planned geriatric service.
- **Moravac**: Community members warned that the removal of crossings without timely and adequate alternatives would increase travel distances and isolate sections of the settlement, affecting both daily life and emergency response.
- **Trnjane**: Residents are concerned that residents will have to take detours of over 2 km to reach schools, kindergartens and cemeteries. They noted that 1,400 residents would be cut off on one side of the railway, and those without private vehicles would struggle to reach medical facilities due to the loss of railway and bus services. Safety and accessibility were cited as major concerns.
- **Korman**: Residents are concerned that the closure of a local crossing would necessitate a 5 km detour via a neighboring village to access basic services such as the school, post office and shops. Lack of alternatives would significantly impact mobility.
- **Mezgraja**: The residents are concerned that the alignment will divide the village into two non-functional halves. Residents requested that an existing pedestrian underpass be upgraded to accommodate vehicles. Concerns were also raised about emergency services response times, which would be prolonged by longer detours. Disruption to public transport and pupil commutes was emphasized.
- **Pojate**: Stakeholders raised the issue of agricultural land access being disrupted due to river realignment, cutting off the only route to several farming areas.
- **Žitkovac**: Residents expressed fears that the division of their town could cause economic hardship and outmigration. Access to schools and services would become difficult, particularly for children and persons with disabilities.
- **Trupale**: Residents highlighted emergency healthcare concerns, noting that ambulance and fire response times would increase significantly due to longer rerouting caused by severance.
- **Žabare**: In addition to emergency access concerns, residents feared that the alignment would separate the school and kindergarten from the residential zone and isolate the industrial area from the rest of the settlement. Additionally, in Žabare, the residents are concerned that 14 companies might face significant operational

challenges, including a 6 km detour due to closure of level crossings, that increases transportation time and costs, as well as limited access to a landfill site.

- **Vitkovac**: Local stakeholders similarly flagged isolation of medical facilities as a direct result of the alignment.
- **Drenovac**: Municipality representatives consulted during the development of this SIA noted that the railway is dividing the community in two parts with the majority of community facilities located in one part of the settlement. Closure of the level crossings and fencing of the railway would make access to community facilities more difficult for one part of the settlement. The planned alignment would split this village of 2,600 residents, placing all public facilities (including a school serving 120 pupils) on one side and leaving large parts of the community disconnected. The stop at Drenovac is proposed to be closed.
- **Paraćin**: Residents submitted a petition against the removal of the Šumadijska Street crossing, which reportedly serves 2,000 users daily. Municipality representatives consulted during the development of this SIA are concerned that closure of this railway crossing will eliminate their only point of access to the other part of the town. Additionally, this technical solution would cause issues in provision of emergency services (ambulance, firefighters, etc.), as their response time would be much longer than it currently is. This technical solution would cause disruptions to around 300 households and 14 large companies.

***Note**: The issue has been analysed in detail in Chapter 4 - 'Assessment of Alternatives' of the ESIA. It has been concluded that construction of a grade-separated crossing at this exact location is not technically feasible due to spatial constraints and proximity to residential buildings and a state road. Instead, the proposed solution builds on the long-term traffic development plans of the city. A newly designed road connection leads to a grade-separated overpass at km 153+942, forming part of the planned bypass road (ring road) around Paraćin, based on the existing municipal transport strategies and available planning documentation. This bypass will include a future bridge over the Crnica River and connect further south to a planned underpass at km 155+991, ensuring seamless integration with Vidovdanska Street and the southern parts of the town, including the road toward Striža (see the figure below, taken from the chapter 'Assessment of Alternatives'). It would significantly reduce the severance impact by shortening travel distance from approximately 6 km to 700 m. It should also be noted that the bypass is under the responsibility of the Municipality itself. Since its execution falls outside the scope of SRI, measures for coordination have been defined (see the "Planned Measures" section below).*

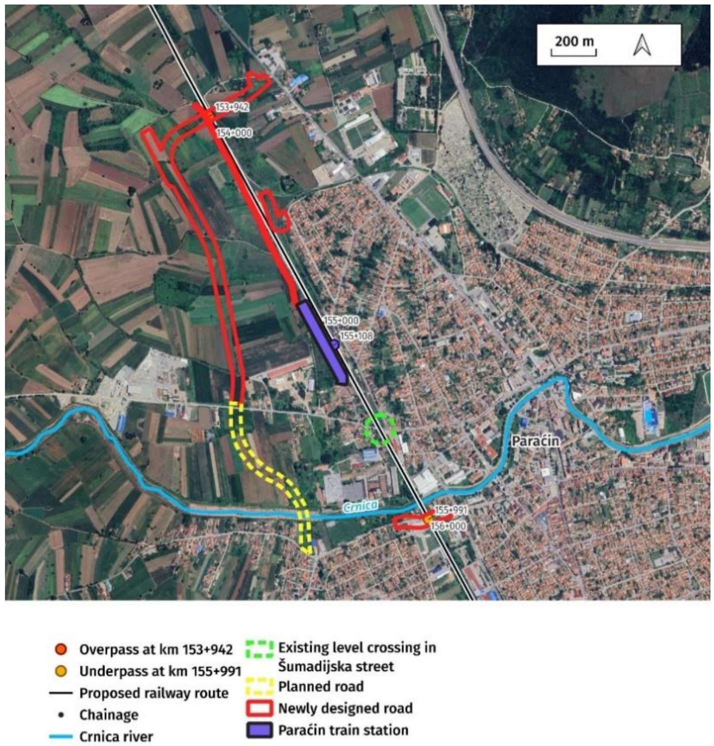

Figure 19.15 Map of the proposed alternative solution for Šumadijska street

It can be expected that the majority of negative impacts of closure of at grade crossings will be mitigated through the planned overpasses and underpasses, reducing the significance of this impact. Nevertheless, in some locations, the impact may still be significant, and further mitigation may be needed. This will be ascertained during the ESIA disclosure phase, when detailed information about these issues is presented to local communities. **Targeted meetings with all communities are planned during this period. SRI, in cooperation with the Designer/Technical Team and the Ministry of Construction, Transport and Infrastructure, will organise technical information sessions in all affected communities. These meetings will be held within the first 60 days of the disclosure phase to allow for public feedback on technical solutions.** During the disclosure phase, SRI also plans to hold public consultation meetings in each affected local municipality/city. During these meetings, SRI will present the Project solutions and discuss whether all impacts have been mitigated with the proposed overpasses and underpasses, and if any additional measures are needed (e.g. additional pedestrian crossings, etc.).

Given the permanent nature of the severance, the lack of viable alternative routes in certain locations, and the heightened exposure of vulnerable groups, the magnitude of this impact is considered high. While receptor sensitivity remains variable, it is assessed as medium to high in affected communities, leading to an overall impact rating of ***major adverse***.

PLANNED MITIGATION MEASURES:

- As detailed in the SEP, during the ESIA disclosure period, SRI to organise technical information sessions in all affected communities within the first 60 days of the disclosure phase to allow for public feedback on technical solutions. During the disclosure phase, SRI to also hold public consultation meetings in each affected local municipality/city. During all meetings, SRI to provide clear information (maps) in villages along the railway corridor, showing the locations of the future overpasses and underpasses and any other available railway crossings for vehicles and pedestrians, as well as the roads which will be closed and where traffic (vehicle and pedestrian) from the closed roads is being diverted. Depending on the outcome of consultations, SRI to ensure that additional crossings are planned wherever feasible, if needed in co-operation with the local municipalities.

- In response to stakeholder concerns regarding the closure of the Šumadijska Street level crossing, SRI to formally coordinate with the Municipality of Paraćin to ensure timely execution of the planned bypass road and associated infrastructure (including the overpass at km 153+942 and future bridge over the Crnica River), which are integral to mitigating the severance impacts at this location. To support this process, SRI (with the support of MCTI) will propose the establishment of a joint working group with the Municipality within 60 days of start of ESIA disclosure. This coordination mechanism to be formalised through a Memorandum of Understanding (MoU). This group to be tasked with assessing:
    - Possibilities to advance planning or construction of the critical bypass, together with possibilities to accelerate the design or implementation of the bypass
    - Providing the updated public information to affected residents

- SRI to ensure these changes are reflected in the final ESIA after the 120-day public disclosure period.

19.6.3.3 Loss of Access to Agricultural Land and Impacts on Agricultural Livelihoods During Operation

The permanent closure of existing at-grade railway crossings may result in longer travel distances for farmers accessing their agricultural land, particularly with machinery. Access will instead rely on the use of designated overpasses and underpasses as defined by the preliminary design. This change has the potential to adversely affect agricultural productivity and result in permanent impacts on local livelihoods.

Community consultations have revealed that access to agricultural land is a recurring concern across several settlements. For example, farmers across settlements, including Mezgraja, Prćilovica, Ćićevac, Žabare, Trnjane, Ratare and Trupale, expressed concern about losing safe, direct and practical access to land essential for their livelihoods - particularly land located on the opposite side of the railway. Across all locations, there is widespread uncertainty about how existing farm roads will be connected to new infrastructure, creating concerns over long-term access and continued agricultural productivity.

Due to the value of agricultural land in this region and the fact that it is heavily farmed, the magnitude of these impacts has been assessed as moderate, while the sensitivity of receptors is defined as medium. The overall evaluation is that the impact, i.e. more difficult access to agricultural land, further leading to negative impacts on agricultural livelihoods, is ***moderate adverse***.

It will be important to present this information in all areas along the project footprint to determine if all impacts have been mitigated with the proposed overpasses and underpasses, and if any additional measures are needed (e.g. the construction of culverts which may be used by agricultural machinery).

PLANNED MITIGATION MEASURES:

- As detailed in the SEP, during the ESIA disclosure period, SRI to organise technical information sessions in all affected communities within the first 60 days of the disclosure phase to allow for public feedback on technical solutions. During the disclosure phase, SRI to also hold public consultation meetings in each affected local municipality/city. SRI to provide clear information (maps) in villages along the railway corridor, showing the locations of the future overpasses and underpasses and any other available railway crossings, as well as the roads which will be closed and where traffic from these roads is being diverted. Information on what types and sizes of vehicles can use each crossing also need to be clearly displayed, as well as planned access and services roads which will be built as part of the project. Depending on the outcome of consultations, SRI, with assistance of MCTI, to ensure that the dimensions of the proposed separate grade crossings are adjusted to the size of the vehicles/machinery likely to use these crossings and any additional crossings and/or roads are included in the relevant designs to enable movement of agricultural machines from one side of the railway to the other (e.g. culverts with appropriate dimensions and with appropriate access roads, can also be used by agricultural machines), if needed.

19.6.3.4 Improved Railway Transport and Safety

Overall this project in the operations phase will bring significant benefits for local communities, by way of improved railway transport. Transport will be more reliable, quicker and with a higher level of services provided. For numerous reasons listed in the baseline section on how transport relates to gender issues, the project will bring important benefits particularly for women, and even more so, for women from rural communities.

The project is expected to bring significant improvements for local communities in terms of safety and security and they are all assessed as ***moderate beneficial*** impacts. These improvements include:

- Safer use of underpasses in all locations, particularly at night, to reduce the risks of attacks or accidents involving vehicles and pedestrians. This is particularly important for women and children pedestrians.
- Safer road transport and pedestrian movements, particularly in the smaller villages, resulting from termination of at grade crossings, the fencing of the railway and relocating the railway route away from some settlements.
- Safety, as well as access will be improved in and around stations and in the trains themselves, for persons with mobility difficulties (disabled people, persons with strollers, etc.). The stations will have better facilities, which will be particularly important for parents with babies, and generally all women and girls.

Other impacts, assessed as ***minor beneficial***, because the likelihood of them occurring is not as certain as of those above, are:

- Improved railway transport has the potential to foster local development, by making these parts of the country more accessible to others, and thereby creating the conditions for tourism development. This too could be an opportunity for local women, particularly those wishing to engage in rural tourism which is growing in Serbia.
- As presented earlier, there will be a need for organised transport to and from stations, which will also be a mitigation measure to address longer walking and travel distances to stations. This is seen as an opportunity for local transport providers (mini buses, taxis, etc.), who can provide these types of services.
- The removal of existing railway tracks in some of the locations where the railway will depart from its current route, also has the potential for freeing up some land for new community amenities, such as green areas or for

new roads. This potential benefit falls outside the scope of the Project and any decisions and implementation will rest with the respective local self-governments.

PLANNED ENHANCEMENT MEASURES:

- During detailed design, the Contractor shall define gender-responsive and inclusive design solutions, building on those already included in the preliminary design. The Contractor shall include experienced gender and inclusion specialist as part of the design team to ensure it considers adequately gender-responsive and inclusive solutions, control and mitigation measures.
- To further enhance this positive impact, SRI will develop and implement a Gender Plan, based on consultations with women living in local communities along the railway, who use the train. Their feedback will be taken into account to define concrete measures that will be implemented to increase safety even further.

19.6.3.5 Community Health, Safety and Security During Operation

Community health, safety and security aspects during the operational phase are addressed across multiple chapters of the ESIA, including those focused on air quality, soil contamination, noise and vibrations, water management, waste and material management and accident risks. In each case, targeted mitigation measures have been identified to ensure that potential adverse impacts on local communities are minimised and remain within acceptable thresholds.

However, one of the concerns raised by communities along the railway corridor during the preparation of this SIA relates to **noise and vibration during operation**, as well as **drainage and flooding**. Given this, a summary is provided here to highlight the social relevance of these impacts and risks.

As elaborated in Chapter 12, **railway noise** can have a direct effect on community health, particularly for people living or working close to the track. Common impacts include annoyance, sleep disturbance and general reductions in quality of life. Children are especially vulnerable, with documented impacts on concentration and academic performance when schools are located near busy rail lines. The social consequences of operational noise may also include decreased property values and increased healthcare needs or costs, particularly for vulnerable populations such as the elderly, low-income households and those without adequate soundproofing. Based on acoustic modelling and analysis presented in Chapter 12:

- Along the Paraćin–Stalać section, 12 zones have been identified where residents of 2,871 properties are expected to be exposed to noise levels above allowable thresholds by 2045, increasing to 3,068 properties by 2060.

- Along the Đunis–Trupale section, 25 zones have been identified where 4,530 properties are expected to exceed limits in 2045, increasing to 4,644 properties by 2060.

To address this, an Operational Noise Management Plan will be developed by SRI to ensure continuous monitoring and adaptive management of operational noise levels. Noise protection measures will be applied to houses and noise-sensitive receptors such as schools, kindergartens, healthcare facilities and cultural sites. Key actions include the construction of noise barriers, alignment optimisation, train schedule adjustments and maintenance of low-noise rail infrastructure.

Vibration generated by railway operations can affect those living or working near the railway line. Although less frequently perceived than noise, vibration can lead to annoyance, physical discomfort and concerns about structural damage, even in cases where actual damage is unlikely. Chronic or repeated exposure may result in heightened stress and disruption of daily routines, especially during night hours or in sensitive environments such as homes, hospitals and educational institutions. The extent of vibration impact depends on multiple variables, including train type, speed, track condition, soil composition and receptor building sensitivity.

Vibration modelling conducted for the Paraćin–Trupale railway section identified 69 buildings as potentially affected by vibration and ground-borne noise. These receptors will be prioritised for mitigation to prevent impacts during operations. SRI will develop an Operational Vibration Management Plan, incorporating all necessary technical and procedural measures to control vibration and ground-borne noise during railway use.

During the public disclosure of the amended Spatial Plan, **residents from several settlements (most notably Prćilovica, Žitkovac, Tešica and Moravac) expressed concerns about increased noise and ground vibrations during railway operations. In Prćilovica, it was specifically noted that vibrations are already strongly felt with current train speeds, and residents fear worsening conditions with high-speed rail. In Žitkovac and Tešica, concerns focused on the proximity of houses to the tracks and the removal of vegetation, which previously acted as a natural noise barrier. In Moravac, general concerns were raised about deteriorating living conditions due to noise in densely populated areas**.

Drainage and flood-related hazards: **During community consultations, it was noted that in Ćićevac, poor maintenance of railway drainage infrastructure and adjacent infiltration fields causes repeated flooding and stagnant water near residential areas, creating breeding grounds for mosquitoes and associated health risks**. This includes the infiltration field near the station, which residents claim is poorly located and endangers nearby homes.

Furthermore, the lack of proper drainage culverts behind commercial areas increases flood risk. Use of electric pumps in underpasses was also deemed financially and operationally unsustainable by the municipality. During meetings with LCOs, **Ćićevac, Drenovac, Mezgraja, Trnjane and Vitkovac requested proper culverts along the entire route, flood-safe underpass designs with adequate protection systems**, connections between underpasses and overpasses for flooding events, information about planned drainage infrastructure including soak pits, and solutions to address high groundwater levels that compromise underpass functionality during winter months and frequent flood events documented in 2010 and 2016.

PLANNED MEASURES:

- For noise and vibration mitigation measures, please refer to Chapter 12 (Noise and Vibration) of the ESIA.
- For drainage and flooding related measures, please refer to Chapter 9: Surface Water.

19.6.3.6 Employment Impacts

SRI is struggling with a high outflow of employees, mainly as a result of retirement (the average age of SRI employees is 50 years) and there is a constant need for employing new individuals, with preference given to younger people. This is particularly important having in mind the significant number of planned infrastructure investments, which will require even more employees, with higher skills. Due to the current structure and age of employees, the company is also aware of the need of investing into trainings and requalification programmes and has developed and is implementing the SRI Employee Education Plan. Such an Employee Education Plan is prepared annually as part of the SRI Business Plan, which is submitted for approval to the Government of Serbia, together with the needed budget. It can be expected that some employees of the Belgrade to Niš railway may need to be requalified and some may need to be re-assigned to other posts, which will be supported by measures in the Employee Education Plan. The magnitude of this impact is assessed as minor and receptor sensitivity even for the most vulnerable employees (older, lower skills) can be characterised as low, making the final impact, i.e. risk of SRI employees being laid off in the operations phase, ***negligible***.

19.7 Mitigation and Enhancement Measures

The following table provides mitigation measures for all adverse impacts that have been assessed as significant (major or moderate) and enhancement measures for positive impacts, which could contribute to increasing their significance.

Table 19.24 Measures for mitigation of adverse impacts and enhancement of beneficial impacts

Phase	Summary of impact	Mitigation / enhancement measures
Pre-construction	Physical and economic displacement caused by land acquisition	▪ SRI will prepare and implement a Resettlement Action Plan (RAP) for Section 3, in full alignment with the principles and procedures outlined in the Section 3 RPF, which forms part of the ESIA disclosure package. ▪ Special attention will be given to vulnerable groups, ensuring that international best practices are applied with the aim of restoring, and where possible, improving their standard of living and livelihood conditions. ▪ All resettlement activities will be carried out through transparent, participatory processes, and include clear grievance mechanisms to address concerns that may arise during implementation.
During construction	Temporary disruptions of community mobility and access during construction	▪ Contractor to develop and implement a Construction Traffic Management Plan, ensuring that access to agricultural land, with agricultural machines, is available at all times. Plan for clear and visible signage in all affected settlements to direct pedestrians and vehicles to alternative routes. ▪ The Contractor to keep every at grade crossing open until the underpasses and overpasses intended to replace it are constructed and open for traffic. No crossing shall be closed before a functioning alternative is made available to the local population. ▪ Contractor to consult local communities during the development of the Construction Traffic Management Plan and to make it publicly available.
During construction	Damages to private properties near construction locations	▪ Contractor to ensure workers have strict instructions to obey the boundaries of project right of way areas ▪ Contractor to organise the assessment and recording of the condition of sensitive structures near future construction sites, before the start of use of heavy machinery ▪ Contractor to undertake detailed pre-condition and post-condition surveys of any buildings in vibration sensitive areas as defined in Chapter 12. ▪ Contractor to implement a grievance mechanism to enable people to file complaints ▪ Contractor to provide prompt compensation for any damages at full replacement cost.
During construction	Damages to community utilities during construction	▪ Contractor to carry out the relocation of any affected infrastructure and provide advance notification to users of any disruption and full and prompt reestablishment of function. ▪ Contractor to carry out prompt repairs of any accidentally affected networks and provide information to local communities on how and when services will be re-established.

Phase	Summary of impact	Mitigation / enhancement measures
During construction	Damages to local roads caused by construction machines and equipment	▪ The Contractor to undertake, prior to the start of construction, a pre-condition survey of all access roads to be used. The survey will be conducted by a civil engineer experienced in roads and will use photographic, video and other supporting materials to document the road condition in survey reports. Surveys will be undertaken together with responsible entities depending on the type of road and witnessed by the local municipality representatives. ▪ Contractor to maintain quality of all used roads and promptly repair any damages.
During construction	Employment and procurement opportunities	▪ The Contractor will develop and implement a Construction Labour, Employment and Local Procurement Plan, with the following elements: o cooperate with the National Employment Service to engage unemployed persons o announce employment opportunities locally and encourage women to apply o implement transparent and fair recruitment procedures procure goods and services locally whenever possible.
During construction	Impacts on railway traffic operators	▪ SRI to establish formal coordination mechanisms with both Srbija Voz (passenger rail operator), Srbija Kargo and other freight operators early in the planning phase to anticipate operational disruptions and integrate their input into the construction schedule.
During construction	Labour and working conditions	▪ The Contractor will: o Develop and implement a Construction Labour and Employment Plan and a Construction Worker's Code of Conduct. o Ensure that all non-employee workers are engaged in line with both national legislation and applicable international (ILO) standards and recommendations. o Provide a grievance mechanism for workers available to all Project workers including subcontractors o Develop and implement a Workers' Accommodation Management Plan in accordance with the requirements of IFIs regarding worker accommodation and international best practice standards, specifically the IFC and EBRD guidance note: Workers' accommodation: processes and standards (2009). o Organise training on HR issues, internal grievance mechanism and workers' code of conduct. ▪ SRI will organise an independent labour audit after contractor mobilisation and prior to commencement of main construction and at least quarterly during construction, to ensure that all workers are engaged in line with both national legislation and applicable international (ILO) standards and recommendations.

Phase	Summary of impact	Mitigation / enhancement measures
During construction	Risk of traffic accidents involving community members	▪ The Contractor will develop and implement a Construction Traffic Management Plan, to ensure all construction related transport is carried out in a safe manner, minimising traffic congestions, road safety risks and disruption to all road users and local access. ▪ Contractor to identify sensitive locations and agree prevention measures with the communities (e.g. slower driving near local school, awareness raising for children and parents, etc.). Measures to address traffic safety will be included in the Construction Traffic Management Plan, as presented in the ESMP.
During construction	Interaction with workers - community safety risks	▪ Contractor will consult local communities on the location of construction camps, locating them away from sensitive receptors as defined in more detail in the ESMP. ▪ Contractor will engage community liaison person(s) and implement a grievance mechanism. The Contractor will organise a training on how community grievances are managed. ▪ Contractor will enforce a code of conduct for all workers (Construction Worker's Code of Conduct), with strict rules to prevent GBVH. The Contractor will organise training for all employed workers on GBVH issues (Training Plan) and develop specific protocols on how to handle grievances related to GBVH. ▪ Contractor will ensure local security forces are informed of increased risks, so they can increase monitoring in the area as needed ▪ The detailed measures will be included in the Construction Community Health and Safety Programme, as presented in the ESMP.
During construction	Noise and vibrations	▪ Refer to Chapter 12 (Noise and Vibration) of the ESIA, which outlines detailed actions to minimise impacts during construction.
During operation	Closure of railways stops and stations	▪ SRI to cooperate with local self governments and other stakeholders to support the organisation of local road transport services in villages, coordinated with train arrivals and departures at nearest stations, by: ○ At the start of construction, SRI to establish and chair a coordination group, comprising representatives of the affected local self-governments who will work on preparing local transport services adjusted to train transport. Include representatives of Serbia Voz who will be defining future train schedules and a representative of the MCTI to provide support to the process and ensure cooperation with other relevant ministries. ○ SRI to organise quarterly meetings of the coordination group during construction, to discuss what settlements need to be included in local transport services, the capacity of local self-governments to organise transport, potential cooperation between bordering self-governments to collect passengers from their territories, etc.

Phase	Summary of impact	Mitigation / enhancement measures
		◦ SRI to ensure that draft plans for the organisation of local transport services are presented to local communities along the railway line and that their feedback is taken into account to adjust plans, to the extent possible. ◦ SRI to invite representatives of the MCTI and/or other ministries, as needed to provide support to local self-governments who do not have the capacity to organise local transport. ◦ As agreed with local self-governments, SRI to ensure that all local transport information relevant for train transport (e.g. bus schedules and how they correspond to train schedules) is available in local communities, at train stations, on the SRI and municipal websites, in local media, etc. ◦ SRI to establish cooperation with local self-governments and Serbia Voz on responding to grievances in connection to this topic and monitor how these grievances are being addressed. ◦ During operation, SRI to continue to engage with local self-governments and Serbia Voz to monitor whether transport services are adequate and raise any concerns that must be addressed to enhance services. Involve MCTI for support, as needed.
During operation	Community severance - longer walking and travel distances for community members to access the other side of the railway	▪ As detailed in the SEP, during the ESIA disclosure period, SRI to organise technical information sessions in all affected communities within the first 60 days of the disclosure phase to allow for public feedback on technical solutions. During the disclosure phase, SRI to also hold public consultation meetings in each affected local municipality/city. During all meetings, SRI to provide clear information (maps) in villages along the railway corridor, showing the locations of the future overpasses and underpasses and any other available railway crossings for vehicles and pedestrians, as well as the roads which will be closed and where traffic (vehicle and pedestrian) from the closed roads is being diverted. Depending on the outcome of consultations, SRI to ensure that additional crossings are planned wherever feasible, if needed in co-operation with the local municipalities. ▪ In response to stakeholder concerns regarding the closure of the Šumadijska Street level crossing, SRI to formally coordinate with the Municipality of Paraćin to ensure timely execution of the planned bypass road and associated infrastructure (including the overpass at km 153+942 and future bridge over the Crnica River), which are integral to mitigating the severance impacts at this location. To support this process, SRI (with the support of MCTI) will propose the establishment of a joint working group with the Municipality within 60 days of start of ESIA disclosure. This coordination mechanism to be formalised through a Memorandum of Understanding (MoU). This group to be tasked with assessing:

Phase	Summary of impact	Mitigation / enhancement measures
		○ Possibilities to advance planning or construction of the critical bypass, together with possibilities to accelerate the design or implementation of the bypass ○ Providing the updated public information to affected residents ▪ SRI to ensure these changes are reflected in the final ESIA after the 120-day public disclosure period.
During operation	As a result of closed at grade crossings, the need to travel longer distances with agricultural machines to access agricultural land on the other side of the railway, possibly leading to losses for people engaging in agriculture and longer term impacts on their livelihoods.	▪ As detailed in the SEP, during the ESIA disclosure period, SRI to organise technical information sessions in all affected communities within the first 60 days of the disclosure phase to allow for public feedback on technical solutions. During the disclosure phase, SRI to also hold public consultation meetings in each affected local municipality/city. During all meetings, SRI to provide clear information (maps) in villages along the railway corridor, showing the locations of the future overpasses and underpasses and any other available railway crossings for vehicles and pedestrians, as well as the roads which will be closed and where traffic (vehicle and pedestrian) from the closed roads is being diverted. Depending on the outcome of consultations, SRI to ensure that additional crossings are planned wherever feasible, if needed in co-operation with the local municipalities. ▪ In response to stakeholder concerns regarding the closure of the Šumadijska Street level crossing, SRI to formally coordinate with the Municipality of Paraćin to ensure timely execution of the planned bypass road and associated infrastructure (including the overpass at km 153+942 and future bridge over the Crnica River), which are integral to mitigating the severance impacts at this location. To support this process, SRI (with the support of MCTI) will propose the establishment of a joint working group with the Municipality within 60 days of start of ESIA disclosure. This coordination mechanism to be formalised through a Memorandum of Understanding (MoU). This group to be tasked with assessing: ○ Possibilities to advance planning or construction of the critical bypass, together with possibilities to accelerate the design or implementation of the bypass ○ Providing the updated public information to affected residents ▪ SRI to ensure these changes are reflected in the final ESIA after the 120-day public disclosure period.
During operation	Loss of access to agricultural land and impacts on agricultural livelihoods during operation	▪ As detailed in the SEP, during the ESIA disclosure period, SRI to organise technical information sessions in all affected communities within the first 60 days of the disclosure phase to allow for public feedback on technical solutions. During the disclosure phase, SRI to also hold public consultation meetings in each affected local municipality/city. SRI to provide clear information (maps) in villages along the railway corridor, showing the locations of the future overpasses and underpasses and any other available railway crossings, as well as the roads which will be closed and where traffic from these roads is being diverted. Information on what types and sizes of vehicles can use each crossing also need

Phase	Summary of impact	Mitigation / enhancement measures
		to be clearly displayed, as well as planned access and services roads which will be built as part of the project. Depending on the outcome of consultations, SRI, with assistance of MCTI, to ensure that the dimensions of the proposed separate grade crossings are adjusted to the size of the vehicles/machinery likely to use these crossings and any additional crossings and / or roads are included in the relevant designs to enable movement of agricultural machines from one side of the railway to the other (e.g. culverts with appropriate dimensions and with appropriate access roads, can also be used by agricultural machines), if needed.
Operation	Improved railway transport and safety	▪ During detailed design, the Contractor shall define gender-responsive and inclusive design solutions, building on those already included in the preliminary design. The Contractor shall include experienced gender and inclusion specialist as part of the design team to ensure it considers adequately gender-responsive and inclusive solutions, control and mitigation measures ▪ To further enhance this positive impact, SRI will develop and implement a Gender Plan, based on consultations with women living in local communities along the railway, who use the train. Their feedback will be taken into account to define concrete measures that will be implemented to increase safety even further.
Operation	Community health, safety and security during operation	▪ Refer to specialist chapters covering community health, safety and security aspects during the operational phase (air quality, soil contamination, noise and vibrations, water management, waste and material management and accident risks)

19.8 Residual Impacts Assessment

The following table presents the outcome of the impact assessment on the assumption that the proposed mitigation and enhancement measures have been implemented and the final impact significance (residual impact). *Note: Impacts/risks defined in other specialist chapters are not listed here.*

Table 19.4 Assessment of residual impacts

Phase	Identified impact	Impact evaluation / significance before mitigation	Impact evaluation / significance after mitigation
Pre construction	Physical and economic displacement	Major / Significant	Minor / Not significant
Construction	Temporary disruptions of community mobility and access during construction	Moderate / Significant	Negligible / Not significant
Construction	Damage to private properties near construction locations	Moderate / Significant	Negligible / Not significant
Construction	Damages to community utilities during construction	Moderate / Significant	Negligible / Not significant
Construction	Damages to local roads caused by construction machines and equipment	Moderate / Significant	Negligible / Not significant
Construction	Employment and procurement opportunities for the local population	Moderate / Significant	Moderate / Significant
Construction	Impacts on railway traffic operators	Moderate / Significant	Minor / Not significant
Construction	Labour and working conditions	Moderate / Significant	Negligible / Not significant
Construction	Increased risks of accidents involving community members on local roads	Moderate / Significant	Negligible / Not significant
Construction	Risks for the local population in areas (smaller villages) due to interactions with workers	Moderate / Significant	Negligible / Not significant

Phase	Identified impact	Impact evaluation / significance before mitigation	Impact evaluation / significance after mitigation
Operation	Closure of railway stops and stations	Major / Significant	Minor / Not significant
Operation	Community severance in certain locations - longer walking and travel distances for community members to access the other side of the railway for every day activities	Major / Significant	Minor / Not significant
Operation	Loss of access to agricultural land and impacts on agricultural livelihoods during operation	Moderate / Significant	Minor / Not significant
Operation	Improved railway transport and safety	Moderate / Significant	Moderate / Significant

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RAILWAY LINE BELGRADE–NIŠ, SECTION III PARAĆIN–NIŠ,
Environmental and Social Impact Assessment,
20. CUMULATIVE IMPACTS ASSESSMENT

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LIST OF ABBREVIATIONS AND ACRONYMS

AoI	Area of Influence
CH	Critical Habitat
EBRD	European Bank for Reconstruction and Development
EIB	European Investment Bank
ESIA	Environmental and Social Impact Assessment
IFC	International Finance Corporation
km	kilometre
PBF	Priority Biodiversity Features

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1. CUMULATIVE IMPACT ASSESSMENT

1.1. Introduction

Cumulative impacts are impacts that may individually be limited in scope, but when combined with the effects of other past, present, or reasonably foreseeable developments, may become more significant. This chapter presents the cumulative impact assessment of the Belgrade–Niš Railway Project (Section 3), in accordance with good international practice and EBRD and IFC guidance. The assessment focuses on **in-combination effects** — cumulative environmental and social impacts that may arise when the Project interacts spatially and temporally with other planned or ongoing developments in the wider area.

The analysis is based on a review of national and local planning documentation, consultations with stakeholders, site visits, and relevant technical assessments conducted as part of this ESIA. It considers how combined impacts may influence common environmental and social receptors, particularly where/when spatial and temporal overlaps are expected.

Where necessary, mitigation measures have been proposed, including coordination with other project developers to reduce overlapping impacts and ensure that cumulative environmental and social effects remain within acceptable thresholds throughout implementation.

1.2. Methodology

In identifying relevant developments, the following sources were used:

- National-level planning documents, including the Spatial Plan of the Republic of Serbia (2021–2035) and the Changes and Additions to the Spatial Plan for the Special Purpose Area of the Infrastructure Corridor of the Belgrade–Niš Railway (October 2024);
- Site visits and consultations with local self-governments, where multiple meetings were held during the data collection and spatial planning phases. These consultations provided insight into planned infrastructure, upcoming development initiatives, and potential overlaps with the railway corridor;
- Publicly available local-level sources, such as municipal development strategies and action plans, as well as news portals and regional television reports. These sources offered timely updates on projects not always captured in national planning documentation.

Projects have been selected for inclusion in the following table based on the following criteria:

- Geographic proximity to the Project;
- Temporal overlap with the construction or operational phases of the Project;
- Thematic relevance, particularly regarding shared environmental or community impacts;
- Strategic or infrastructure importance, as reflected in official planning documents or stakeholder input.

Table 1-1. Planned developments in the observed area

Project (P)	Category	Time Schedule	Status	Relevance	Zone of Spatial Overlap (Indicative)
P1 - Modernisation of the Belgrade-Niš Railway Line, Section 2 (Velika Plana-Paraćin)	Infrastructure – Railway	2024–2030	Design Phase	Direct spatial and temporal overlap	Connection point with section 2 in Paraćin at km153; works aligned with Section 3.
P2 - Modernisation of Belgrade-Niš Railway Line, Section Stalać-Đunis	Infrastructure – Railway	2024–2030	Under Construction	Direct spatial and temporal overlap	Connection points in Stalać (km 174), Đunis (km 192)
P3 - Implementation of the project "Clean Serbia"	Municipal Infrastructure – Waste and Sanitation	2020–2025	Implementation phase	Potential indirect interaction (traffic, dust)	Paraćin, Ćićevac Aleksinac (urban areas)
P4 - Development of regional water supply systems	Municipal Infrastructure – Water	2021-2035 (Strategic)	Phased implementation	Potential indirect overlap – shared corridor	Paraćin (km 153–156), Stalać (km 174), Žitkovac–Moravac (km 208–213),
P5 – Niš Railway Bypass Project	Infrastructure – Railway	2024-2028	Under Construction	Potential indirect overlap – cumulative waste generation	Southern edge of Section 3, Aleksinac and Niš area

Developments that are still in the early planni-ng stages, are dependent on future funding or permitting decisions, or represent long-term strategic initiatives without confirmed implementation timelines or defined spatial footprints have not been included in this assessment.

Note: The Resnik–Velika Plana section (Section 1 of the Belgrade–Niš railway) has not been included in this cumulative impact assessment, as its nearest point lies approximately 80 km from Section 3. Due to this considerable distance and the absence of any shared receptors or overlapping environmental or social impacts, no in combination impacts are anticipated with this Section of the railway corridor.

1.3. Common Sensitive Receptors

Based on the review of environmental and social topics addressed in the ESIA, the common sensitive receptors outlined in Table 1-2 have been identified as potentially being affected by in combination impacts from other developments during the construction and/or operation phases of the Project.

While the primary focus of this chapter is on in-combination effects, receptor sensitivity has also been considered in relation to overlapping Project-generated impacts (see Section 1.6).

Table 1-2. Common Sensitive Receptors

Receptors	Relevant Environmental and Social Topics
Local communities and residential properties	Noise and vibration, air quality, visual impacts, land acquisition, access, social well-being, economy and businesses
Agricultural land and land users	Water quality, soil contamination, access disruption
Biodiversity	Habitat fragmentation, noise disturbance, light pollution, barrier effects
Surface water bodies	Water pollution, sedimentation, hydrological alteration
Construction and maintenance workers	Occupational health and safety, exposure to dust, noise, and hazardous materials
Road users and public transport passengers	Traffic disruption, noise, air emissions, visual impacts

At the time of this assessment, and based on the currently available project documentation and official timelines, it is expected that only the developments listed in Table 1-1 as P1 and P2 (the modernisation of Section 2 of the Belgrade–Niš Railway and the Stalać–Đunis Section) will occur simultaneously with the Project. These two developments are scheduled to be implemented in parallel with the Project and have confirmed physical and temporal overlaps at the connection points along the railway route in Paraćin, Stalać, and Đunis. However, there is the potential that impacts resulting from the Project combined with those from the other relevant developments (P3 and P4 in Table 1-1), could result in cumulative impacts, particularly where spatial and temporal overlaps exist. These may result in more intense environmental and social pressures — such as increased dust generation, elevated noise levels, or compounded disruptions to local traffic networks. Such impacts would be especially relevant in locations where construction traffic from multiple developments share local road infrastructure, or where different infrastructure corridors are situated in close physical proximity. These have therefore, also been included in the assessment.

1.4. Area of Influence

The Area of Influence (AoI) defines the spatial boundary within which potential impacts may occur. This Area is defined by the nature of the environmental and social parameters considered, and the expected extent of potential impacts based on professional judgement and available data.

Table 1-3 defines the AoI's that have been used for the assessment of impacts for relevant individual topics (as covered in other ESIA Chapters).

Table 1-3. Project Area of Influence

Parameter	Area of Influence
Geology	500 m on both sides of the railway corridor.
Soil	500 m buffer on each side of the planned railway.
Biodiversity	500 m on both sides of the railway corridor. EAAA applied for Priority Biodiversity Features (PBFs)/Critical Habitats (CH) where identified; a 5 km buffer on each side of the railway is considered for features requiring extended ecological assessment.
Groundwaters	1,000 m on both sides of the railway (2 km total corridor).
Surface waters	Area around river crossings, including 500 m upstream and downstream from bridges.
Landscape	Up to 5 km on each side of the railway route.
Noise and vibrations	500 m corridor on both sides of the railway section.
Resources and waste	500 m on each side of the railway route.
Air quality	500 on each side of the railway corridor.

1.5. Impact Assessment Scale

A structured scale has been defined to support the evaluation of cumulative impacts. It considers three main dimensions: **likelihood**, **magnitude** (intensity and duration), and **spatial extent** of the impact. These parameters are combined to determine the **overall cumulative impact level**, which reflects the combined extent and relevance of each effect.

The classification is applied consistently across all environmental and social topics assessed in this ESIA. Spatial terms are aligned with the defined Areas of Influence (Table 1-3). For example, “localized” impacts typically occur within 500 m of the railway, while “regional” effects may extend up to 5 km.

Table 1-4 below presents the cumulative impact levels used in this assessment.

Table 1-4. Scale for assessment of cumulative impacts

Cumulative Impact Level	Description (Likelihood, Magnitude)	Spatial Extent
Major Negative Cumulative Impact	High likelihood; impacts of high magnitude affecting a large number of receptors. Long-term and potentially difficult to restore or requiring long-term recovery effects.	Regional extent (up to 5 km), affecting multiple communities, ecosystems, or strategic environmental assets and clusters of receptors
Moderate Negative Cumulative Impact	Moderate to high likelihood; moderate magnitude; may affect several receptors. Medium-term and partially reversible effects. Likely significant unless mitigated. Receptors may include local communities, land users, public transport passengers, and users of shared access roads.	Project area and its surroundings (up to 1 km), affecting clusters of receptors.

Cumulative Impact Level	Description (Likelihood, Magnitude)	Spatial Extent
Minor Negative Cumulative Impact	Likely but low magnitude; typically affects a limited number of localized receptors (e.g., isolated residents, farm plots, or transit users). Short-term and reversible effects. Not considered significant.	Localized impacts within Project area or at isolated points (e.g. one stream crossing, small community).
Negligible / No Cumulative Impact	Unlikely and very low magnitude; effects are minimal and not expected to cause measurable impact on any receptor. Not significant.	Very localized or contained within the immediate Project footprint.
Positive Cumulative Impact	High or moderate likelihood of beneficial outcomes (e.g., improved infrastructure, ecosystem restoration), affecting multiple receptors or regions. Significance is context-dependent.	Can be local (e.g. access improvement) or regional (e.g. long-term modal shift benefits)

1.6. Matrix of Effect Interactions

This section presents a matrix of cumulative impacts identified during the construction and operational phases of the Project. The assessment focuses on potential cumulative effects resulting from the Project's interaction with other developments (P1–P4), in locations where spatial and temporal overlaps are expected.

The analysis is based on baseline conditions and impact predictions presented in the ESIA, and considers combined effects on shared receptors — such as communities, land users, public transport passengers, and environmental features — caused by overlapping activities (e.g. traffic, dust, noise, or resource pressure).

Each identified impact is evaluated using the cumulative impact levels defined in Table 1-4. These levels reflect the **likelihood**, **magnitude**, and **spatial extent** of each combined impact. The terminology used in the "Impact Assessment" column of Table 1-5 is aligned with this evaluation framework.

This matrix also provides the basis for identifying where targeted mitigation measures are required.This assessment has been developed using a conservative approach, assuming a potential worst-case scenario regarding spatial and temporal overlaps, in order to ensure that all plausible cumulative effects are adequately captured and addressed.

Table 1-5. Matrix of Effect Interactions

Issue	Project Phase	Type of Cumulative Overlap	Description of Cumulative Impact	Key Receptors	Impact Assessment
Environmental Issues					
Air Quality	Construction	Spatial + Temporal	Increased emissions from simultaneous construction activities under Projects P1, P2, P3, and P4 in overlap zones such as Paraćin (km 153–156), Stalać (km 174), Žitkovac–Moravac (km 208–213), and urban areas along the corridor.	Communities, workers, flora and fauna, agricultural land	Moderate Negative Cumulative Impact

Issue	Project Phase	Type of Cumulative Overlap	Description of Cumulative Impact	Key Receptors	Impact Assessment
Air Quality	Operation	Spatial + Temporal	Minor emissions during maintenance near shared infrastructure areas Paraćin (km 153–156), Stalać (km 174), Žitkovac–Moravac (km 208–213), potentially overlapping with operations under P4.	Communities, regional environment	Negligible / No Cumulative Impact
Water Quality	Construction	Spatial + Temporal	Risk of water pollution from runoff and accidental spills during overlapping construction works of Section 3 and P1, P2, P4, especially near Paraćin and Stalać.	Surface waters, groundwater, aquatic fauna/flora, local population	Moderate Negative Cumulative Impact –
Water Quality	Operation	Spatial + Temporal	Contamination from spills or leaks during maintenance in shared areas with P1 and P4 (Paraćin (km 153–156), Stalać (km 174), Žitkovac–Moravac (km 208–213),).	Surface waters, agricultural land, groundwater, local communities	Moderate Negative Cumulative Impact
Biodiversity and Nature	Construction	Spatial + Temporal	Habitat fragmentation and disturbance within biodiversity-sensitive corridors in areas near Stalać (P2) and Žitkovac–Moravac (P4), within 5 km AoI.	Local wildlife, ecosystems	Moderate Negative Cumulative Impact
Biodiversity and Nature	Operation	Spatial + Temporal	Barrier effects on animal movement in fenced operational sections overlapping with infrastructure works in P2 and P4.	Fauna, wildlife corridors	Moderate Negative Cumulative Impact
Noise and Vibration	Construction	Spatial + Temporal	Cumulative construction noise and vibration from overlapping activities in Paraćin (km 153–156), Stalać (km 174), Žitkovac–Moravac (km 208–213), and urban settlements involving Projects P1–P4. This includes temporary noise impacts near public transport access points (e.g. stations, stops), potentially affecting public transport passengers during boarding, waiting, or transfer activities.	Local communities, workers, wildlife, public transport passengers	Moderate Negative Cumulative Impact
Noise and Vibration	Operation	Spatial + Temporal	Noise and vibration from concurrent railway operation in overlapping segments near Paraćin km153 and Stalać km 174.	Local residents, fauna, public transport passengers	Minor Negative Cumulative Impact
Waste and Materials	Construction	Spatial + Temporal	Combined construction and demolition waste from Projects P1–P5 including dismantling of old tracks, ballast, and excavation debris, stressing local waste systems (Paraćin (km 153–156), Stalać (km 174), Žitkovac–Moravac (km 208–213) and Niš area.	Municipalities, landfill operators, contractors	Moderate Negative Cumulative Impact –

Issue	Project Phase	Type of Cumulative Overlap	Description of Cumulative Impact	Key Receptors	Impact Assessment
Waste and Materials	Operation	Spatial + Temporal	Waste from maintenance activities combined with municipal and infrastructure waste from surrounding settlements/business zones. Volumes manageable but cumulative effect noted.	Local municipalities, service operators	Negligible / No Cumulative Impact
Social Issues					
Economy	Construction	Spatial + Temporal	Increase in demand for workforce and business services – creates positive impacts on individuals and businesses due to increased demand	Local communities and businesses	Positive Cumulative Impact
Livelihood	Construction	Spatial + Temporal	Potential restrictions on local population movement in cases where multiple projects are implemented simultaneously	Local population and businesses	Moderate Negative Cumulative Impact
Community health and safety and security	Construction	Spatial + Temporal	Increased risk to local populations from construction-related traffic and transport incidents	Local population	Moderate Negative Cumulative Impact

Note: The impact ratings presented in Table 1-5 follow the cumulative impact scale defined in Table 1-2. The spatial reference corresponds to the topic-specific Areas of Influence presented in Table 1-3. For example, noise and air quality are typically assessed within a 500 m buffer, while biodiversity and landscape effects may extend up to 5 km.

1.7. Mitigation Measures

Table 1-6 highlights selected mitigation measures from the relevant Environmental and Social Management Plans that are particularly relevant for addressing identified cumulative impacts. Whilst these measures are not additional, they are emphasized here due to their significance in the context of in-combination impacts — particularly in areas such as Paraćin, Stalać, or Žitkovac–Moravac where overlapping activities may intensify dust, noise, traffic, or habitat disturbance. These measures require targeted application, spatial coordination, and, where necessary, reinforced implementation to ensure that residual cumulative impacts remain within acceptable thresholds.

Effective inter-project communication between developers and contractors will be key to managing cumulative impacts arising from overlapping construction activities.

Mitigation measures are only reiterated for issues assessed in Table 1-5 as having Minor, Moderate, or Major cumulative impact. Mitigation measures for impacts assessed as Negligible are not repeated below, but the measures already included in Management Plans, representing standard good practice, are considered sufficient.

Table 1-6. Mitigations/recommendations

Issue	Project Phase	Cumulative Impact	Impact Assessment	Mitigation Measures	Impact After Mitigation
Air Quality	Construction	Increased emissions from simultaneous construction activities under Projects P1–P4 in zones such as Paraćin (km 153–156), Stalać (km 174), Žitkovac–Moravac (km 208–213), and urban areas.	Moderate Negative Cumulative Impact	Apply strict dust suppression protocols, enforce vehicle emission standards, restrict construction hours, and coordinate construction schedules where possible (particularly with P1–P2), and engage in consultation with relevant stakeholders (e.g. P3–P4) to identify opportunities for shared environmental monitoring and schedule alignment to reduce cumulative air emissions.to reduce concurrent construction activities that generate air emissions.	Negligible / No Cumulative Impact
Water Quality	Construction	Risk of water pollution from runoff and spills during overlapping works of Section 3 with P1, P2, and P4, especially near Paraćin and Stalać within 1 km Area of Influence	Moderate Negative Cumulative Impact	Install spill containment systems, ensure proper waste disposal, and use adequate/effective water treatment measures, consult with developers of adjacent projects to align emergency response and site management practices where feasible, and incorporate shared monitoring of water quality at sensitive overlap points (e.g. Paraćin, Stalać).	Minor Negative Cumulative Impact
Biodiversity	Construction	Habitat fragmentation in biodiversity-sensitive corridors near Stalać (P2) and Žitkovac–Moravac (P4), within 5 km Area of Influence.	Moderate Negative Cumulative Impact	Engage with developers of nearby projects (particularly P2 and P4) to explore possibilities for aligned construction timing and shared mitigation (e.g. wildlife corridors), while incorporating these considerations into the biodiversity management plan for Section 3., implement wildlife corridors and crossings, avoid critical habitat zones during breeding periods, and enforce habitat restoration requirements.	Minor Negative Cumulative Impact
Noise and Vibrations	Construction	Increased noise and vibration in overlap zones such as Paraćin, Stalać and Žitkovac-Moravac due to concurrent construction with P1 - P4.	Moderate Negative Cumulative Impact	Install temporary noise barriers in residential zones, coordinate timing of concurrent noisy activities, restrict construction activities during sensitive periods, and monitor compliance with project-specific noise limits.	Minor Negative Cumulative Impact

Issue	Project Phase	Cumulative Impact	Impact Assessment	Mitigation Measures	Impact After Mitigation
Waste and Materials	Construction	Combined waste generation from parallel excavation and decommissioning works (e.g., rail removal, sleeper disposal), especially in overlap areas (e.g., Paraćin, Aleksinac) from projects P1 – P5, may exceed local disposal and recycling capacity.	Moderate Negative Cumulative Impact	Coordinate internally and consult with relevant authorities and nearby infrastructure projects (e.g. P1–P5) to anticipate peak waste volumes and plan appropriate disposal and recycling logistics. Include these aspects in site-specific waste management plans. Coordinate construction timelines to avoid peak waste generation, implement on-site waste segregation, and liaise with licensed waste operators for the proper recycling or disposal of track materials (rails, sleepers, ballast), ensure separation at source and secure interim storage zones if needed, including early identification of peak waste volumes from track removal (e.g. steel rails, wooden/concrete sleepers) to ensure advance logistical coordination.	Minor Negative Cumulative Impact
Noise and Vibration	Operation	Long-term noise and vibration effects from overlapping railway operations near Paraćin and Stalać, affecting local communities, wildlife, and public transport passengers.	Minor Negative Cumulative Impact	Ensure operational compliance with national noise standards; monitor noise levels near sensitive receptors; inform public transport users of expected operational noise in station areas; coordinate with P2/P4 on future upgrades.	Negligible / No Cumulative Impact
Biodiversity	Operation	Barrier effects on animal movement due to fenced railway and overlap with P2 and P4	Moderate Negative Cumulative Impact	Incorporate fauna passages in fencing design; monitor key wildlife crossings; consult with P2 and P4 developers to avoid fencing barriers near ecological corridors.	Minor Negative Cumulative Impact
Water Quality	Operation	Risk of minor contamination from leaks or spills during maintenance works in overlap areas with P1 and P4 (e.g., Paraćin, Stalać, Žitkovac–Moravac)	Moderate Negative Cumulative Impact	Include spill prevention protocols in O&M procedures; establish emergency response plans for shared maintenance zones; consult with operators of adjacent infrastructure (e.g. P4) to align procedures.	Minor Negative Cumulative Impact
Livelihood	Construction	Potential restrictions on local population movement in cases where multiple projects are implemented simultaneously	Moderate Negative Cumulative Impact	Timely planning and coordination of construction activities between projects.	Minor Negative Cumulative Impact

Issue	Project Phase	Cumulative Impact	Impact Assessment	Mitigation Measures	Impact After Mitigation
Community health and safety and security	Construction	Increased risk to local populations from construction-related traffic and transport incidents	Moderate Negative Cumulative Impact	Implementation of traffic management plans and coordination between projects. Engagement of local municipalities in planning and implementation of measures to mitigate risks.	Minor Negative Cumulative Impact

The in-combination assessment confirms that cumulative effects are most relevant during the construction phase, particularly in specific locations where the Project overlaps with other infrastructure developments (P1–P5). These locations include Paraćin (km 153), Stalać (km 174), Đunis (km 192), and the urban zones of Aleksinac and Žitkovac–Moravac (km 208–213) and Niš area. Key issues include increased noise and dust, habitat fragmentation, construction-related water pollution and waste generation.

Mitigation measures defined in Section 1.7 will be implemented accordingly in these overlapping zones to reduce risks. Residual effects are expected to remain within acceptable thresholds under effective mitigation and will be monitored during Project implementation.

1.8. CONCLUSION

The cumulative impact assessment for the Belgrade–Niš Railway Project (Section 3: Paraćin–Trupale) has been carried out in accordance with international good practice and the environmental and social requirements of the EBRD and EIB. The analysis considered both spatial and temporal overlaps with other ongoing or planned developments within the Project's area of influence, as outlined in Table 1-1.

Potential cumulative risks and environmental and social interactions were first assessed using a combined matrix, addressing both construction and operation phases. Where relevant, targeted mitigation measures have been proposed, including dust suppression, spill containment, noise barriers, traffic management measures, and ecological corridors.

The assessment of in-combination effects confirmed that cumulative impacts are primarily concentrated during the construction phase, especially in locations with spatial and temporal overlaps such as Paraćin (km 153), Stalać (km 174), Đunis (km 192), and Aleksinac–Žitkovac–Moravac (km 208–213). The majority of these effects are expected to be minor to moderate, with residual impacts deemed acceptable provided mitigation is implemented effectively.

All proposed mitigation measures will be integrated into the Project's Environmental and Social Management Plan (ESMP) and implemented with a focus on the identified overlap zones. Cumulative risks will be addressed through proactive coordination with other projects and continuous environmental and social monitoring.