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Western Balkans Investment Framework

Infrastructure Project Facility

Technical Assistance 4 (IPF 4)

TA2012054 R0 WBF

Preliminary Design and Feasibility Study with EIA for construction of Highway E-80 in Serbia (SEETO Route 7): from Kosovo* (administrative crossing Merdare) to Niš via Prokuplje bypass, section Niš-Pločnik

WB13-SER-TRA-01

PRELIMINARY DESIGN

Environmental and Social Impact Assessment Study (ESIA)

July 2018

COWI | IPF

European Western Balkans Joint Fund (EWBJF)

Western Balkans Investment Framework (WBIF)

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The technical assistance operation is financed under the Western Balkans Investment Framework (WBIF) which is a joint initiative of the EU, International Financial institutions, bilateral donors and the governments of the Western Balkans which supports socio-economic development and EU accession across the Western Balkans through the provision of finance and technical assistance for strategic investments, particularly in infrastructure, energy efficiency and private sector development.

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Prepared Andrijana Mladenovic, Snezana Boskovic, Ivana Bjedov, Nina Valcic, Ljubomir Životić, Mirjam Vujadinović Mandić, Marija Ostojić

Checked Slavica Askovic, Merih Kerestecioglu, Iro Dimitriadou

Approved Yannis Papapanagiotou

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List of Abbreviations

AADT	Annual average daily traffic
ACM	Asbestos-containing materials
BOD	Biochemical oxygen demand
CEC	Cation exchange capacity
CIE	International commission on illumination
CM	Cadastral municipalities
COD	Chemical oxygen demand
CTMP	Construction traffic Management Plan
CWMP	Construction Waste Management Plan
DALI	Digital addressable lighting interface
DTM	Digital terrain model
EBRD	European Bank for Reconstruction and Development
EEC	European Economic Community
EIA	Environmental Impact Assessment
EIB	European Investment Bank
EPM	Erosion potential model
ESAP	Environmental and Social Action Plan
ESIA	Environmental Social Impact Assessment
EU	European Union
Frag (A)	Fragile habitat due to functional instability and sensitivity to degradation
Frag (B)	Fragile habitat due to poor and slow reproducibility
FRY	Federal Republic of Yugoslavia
HMSS	Hydro meteorological service of Serbia
IFI	International finance institutions
ILO	International Labour Organization
INCS	Institute for Nature Conservation of Serbia
IPA	Important Plant Area
ITS	Intelligent transportation systems
IPF	Infrastructure projects facility
IUSS	International union of soil sciences
KSDOO	Corridors of Serbia (Koridori Srbije d.o.o.)
LED	Light emitting diode
MCTI	Ministry of Construction, Transportation and Infrastructure
MEP	Ministry of Environmental Protection
NATM	New Austrian Tunneling Method
NTS	Non-Technical Summary
PD	Preliminary Design
PERS	Public Enterprise Roads of Serbia
PR	Performance Requirements
RAP	Resettlement Action Plan
REACH	Registration, evaluation, authorisation and restriction of chemicals
Ret	Rare habitat in Serbia
RPF	Resettlement Policy Framework
RS	Republic of Serbia
SEP	Stakeholder Engagement Plan
SEETO	South East Europe Transport Observatory
SIA	Social Impact Assessment Study
SP	Spatial Plan
TEM	Trans-European Motorway network
TETRA	Terrestrial trunked ratio
UPS	Uninterruptible power supply
VMS	Variable message signs
WBIF	West Balkans Investment Framework
WRB	World reference base for soil resources

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Non-Technical Summary

(in separate file)

1 Introduction

Project Title:	Preliminary Design and Feasibility Study with EIA for construction of Highway E-80 (SEETO Route 7) in Serbia
Project Number:	WB13-SER-TRA-01
Contractor:	COWI-IPF Consortium
Beneficiary:	Public Enterprise "Roads of Serbia" and Ministry of Construction, Transport and Infrastructure
Location:	Serbia
Project start date:	11/01/2016
Project Duration:	18 months (32 months, revised work plan)
Anticipated completion:	9/2018

1.1 The Project Stakeholders

For the purposes of this Report and according to the EBRD Performance Requirements (PR 10, point 8) and EIB Environmental and Social Standards stakeholders are individuals or groups that are affected or likely to be affected (both directly and indirectly) by the project ("affected parties") or that may have an interest in the project ("other interested parties"). In the context of this WBIF/ IPF4 sub-project the key stakeholders are:

- *Municipality Merosina and Prokuplje, with the local citizens either directly affected through impacts from land acquisition and resettlement or future construction activities or have interest in the project.*
- External Stakeholders influencing the project design, alignment and construction,
- Affected population and enterprises,
- Vulnerable groups,

Other external Stakeholders with high interest in the Project are:

- National Government and line ministries,
- Regional and Local Governments, in the project area and along the road corridor have been identified and considered throughout all the phases of the ESIA. A detailed analysis, identification and engagement programme has been developed as a stand-alone document and it is the Stakeholder Engagement Plan for this project as appended in Annex 1.

These stakeholders are followed by other important stakeholders listed below:

- Koridori Srbije d.o.o. (KSDOO) – as the final beneficiary- Investor:
- PE Roads of Serbia (PERS): former end beneficiary – investor (till May 2018)
- Ministry of Construction, Transport and Infrastructure (MCTI): promoter
- European Investment Bank (EIB): potential lender

- European Union / Directorate-General for Neighbourhood and Enlargement Negotiations (DG-NEAR), Directorate-General for Mobility and Transport (DG-MOVE), EU Delegation in Serbia
- Serbian European Integration Office (SEIO), acting also as NIPAC
- JASPERS – Joint Assistance to Member States and Candidate Countries provided by EC/EIB/EBRD

The exhaustive list of Stakeholders, their mapping by level of interest and their power to be exerted over the Project, as well as the Consultation and disclosure programme is presented in details in the SEP.

1.2 The Team of Experts

The team of experts for the design and study comprises 9 senior and 7 junior NKEs, led by a Senior Project Manager.

All experts are recruited from COWI IPF Consortium partners and more specifically from CeS COWI, TRADEMCO and WYG.

All local experts possess relevant to their discipline licenses, as required by the Serbian legislation.

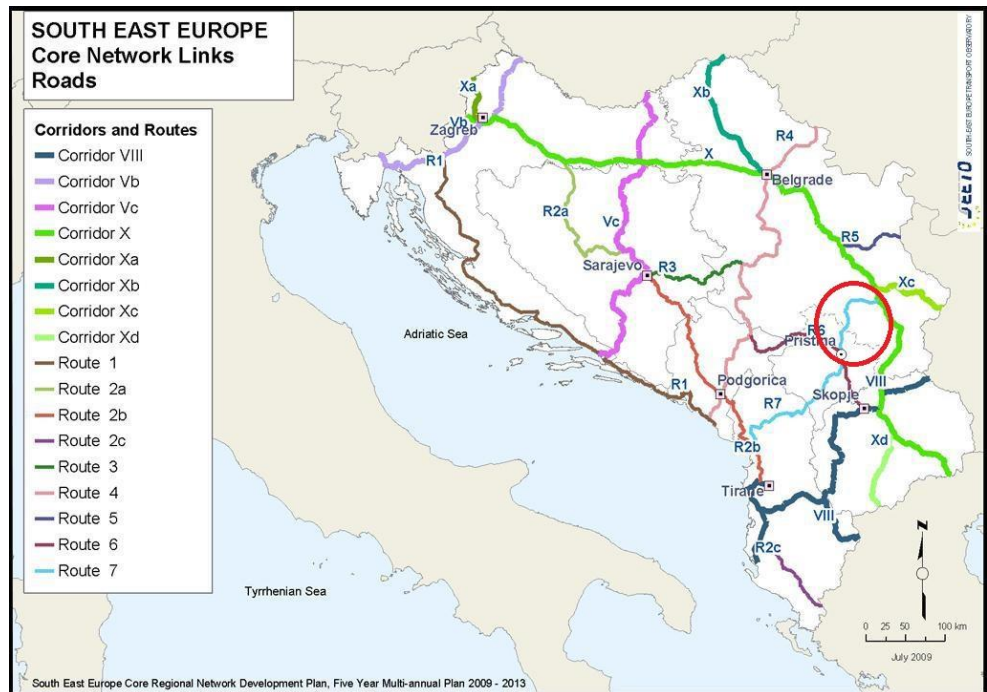
The overall responsibility of the subproject is upon the IPF4 TA Transport Sector Key Expert (Yanni Papapanagiotou) who together with the Senior Project Manager (Iro Dimitriadou) supervises the execution of the activities and coordinate their execution by the team of experts.

1.3 Project Significance

Improving Highway E-80 (section Nis-Merdare) is without any doubt considered of great significance. This highway forms part of a wider axis (Route 7) that links Bulgaria with Adriatic Sea via Serbia, Kosovo* and Albania.

This Route is part of the SEETO core network, a priority highway according to strategic documentation of Republic of Serbia and recently adopted by the EC as priority project. As high priority project in view of the Berlin Process it was discussed and reconfirmed in the meeting of WB6 Prime Ministers in Vienna (27-8-2015).

Figure 1 Map of SEETO Core Road Network in Western Balkans (source SEETO MAP)



The construction of a new highway between Nis and Pristina through the administrative crossing point Merdare is expected to reduce significantly travel times, increase level of service and road safety and enhance regional transport activities, both passenger and freight.

Route 7, in addition to Corridor Xc (Nis-Piot-Dimitrovgrad- Bulgarian border E-80/M-1.12), is part of European road E-80, as classified in the European Agreement on Main International Traffic Arteries and state road IB class no.35. Niš-Merošina-Prokuplje-Kuršumlija-Podujevo-Priština and state road IIA class no. 216 Prokuplje-Žitorađa-Doljevac, connection with the state road A1, as classified within the Serbian network.

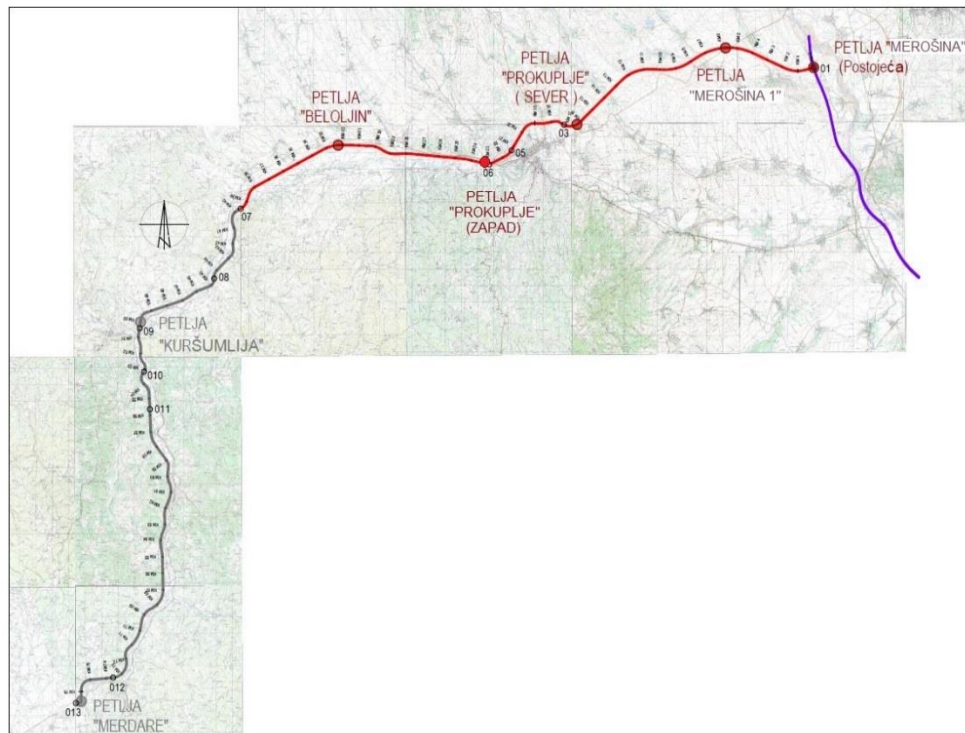
Route 7 is one of the main east-west road corridors through Serbia and as such, it connects not only Nis and Pristina, but also represents the main connection with Corridor IV (which mainly crosses Bulgaria and Romania) and Corridor X with Route 6 (Skopje-Pristina) and Route 2b (Sarajevo-Podgorica-Vlora). This motorway section of E-80 belongs to Trans-European Motorway network (TEM) and is also a part of TEN-T Corridor X (branch Xc).

Route 7 is included in the Priority Project List of the SEETO Five Year Multi Annual Plan 2014-2018 as part of the South-East Europe Core Regional Transport Network Development Plan, together with the link from Pristina to Merdare which was also proposed for financing from WBIF from Kosovo* (subproject WB11-KOS-TRA-02).

“Preliminary Design and Feasibility Study with EIA for construction of Highway E-80 in Serbia (SEETO Route 7): from Kosovo* (administrative crossing Merdare) to Nis via Prokuplje bypass” has been reduced to a part of the highway (40km out of 77km initially approved). More specifically the assignment is undertaken for the

section Nis (point 01 of PFS preferred alignment) to Pločnik (point 07 of PFS preferred alignment) in a length of approximately 40 km (out of 77 km in total).

Figure 2 Highway alignment under study-design in current T.A (nodes 01-07, red line)



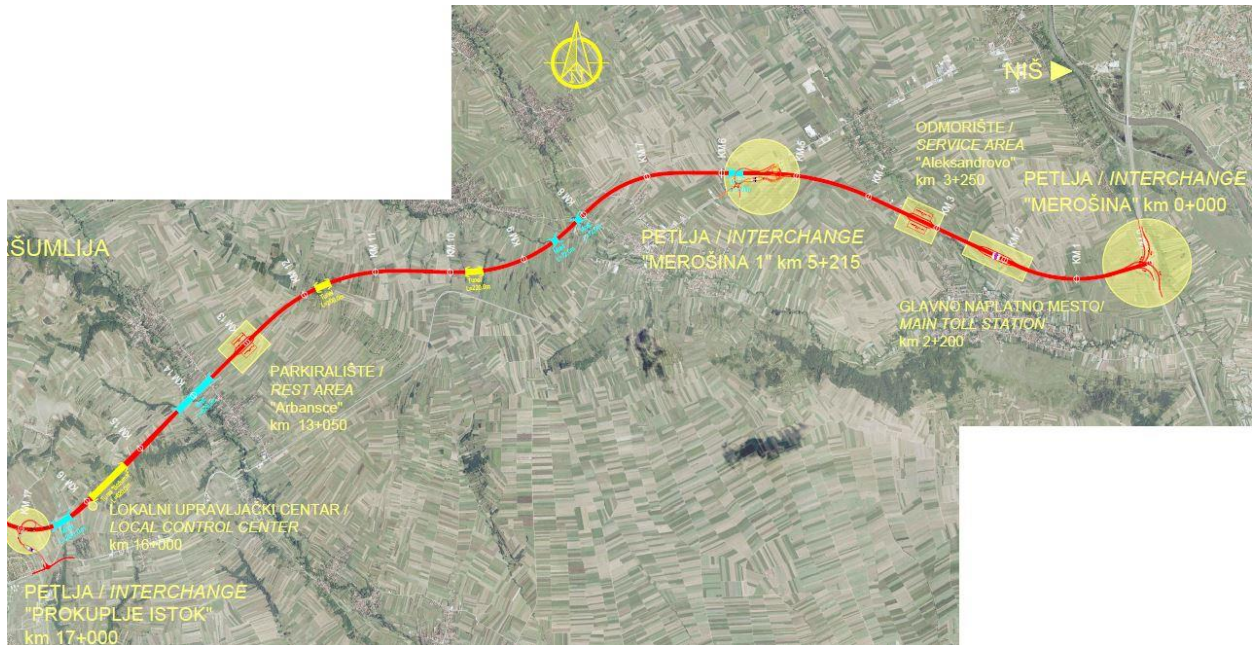
With respect to different landscape characteristics, the new highway corridor can be divided into three main sections:

- Merošina – Prokuplje
- Prokuplje bypass
- Prokuplje – Pločnik

Section: Merošina – Prokuplje

Figure 3

Section Merosina-Prokuplje



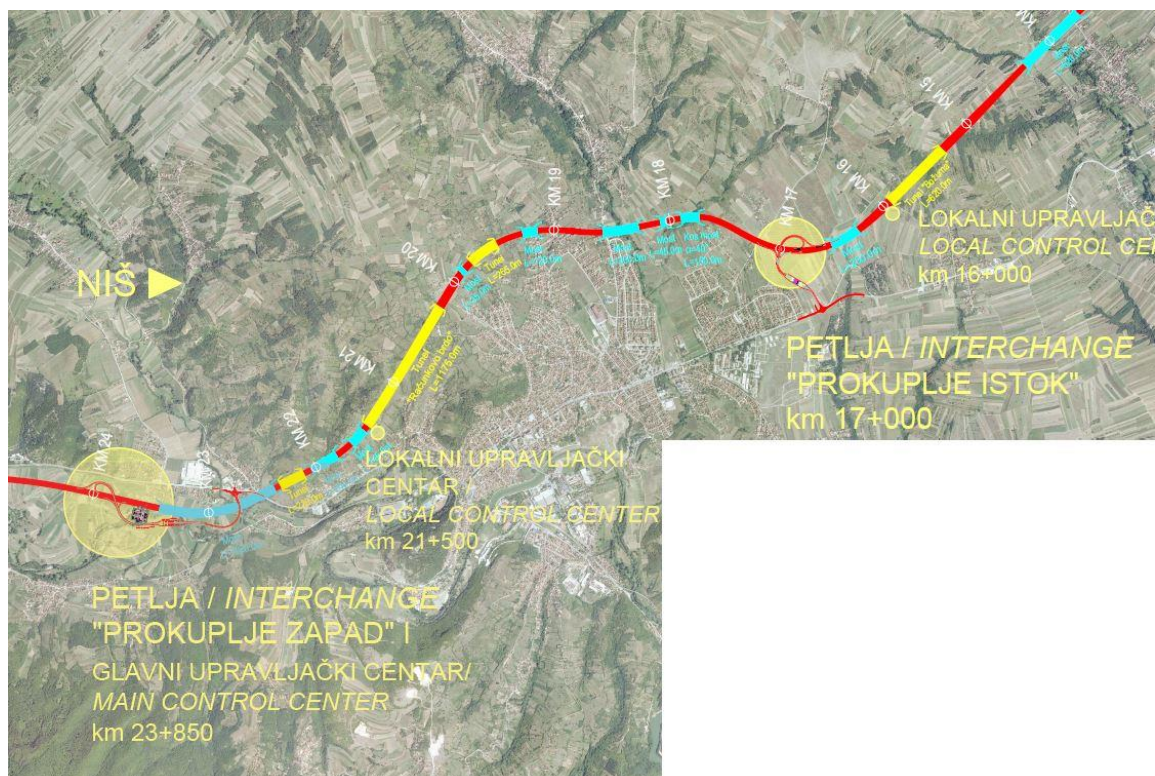
The starting point is the existing interchange “Merošina”, connection to Highway E-75, south of Niš. The alignment passes through the valleys of rivers and streams in plain and hilly terrain conditions. Villages are mostly located along the road and along water courses. The land is fertile arable land, usually with annual plantings and to a lesser extent orchards and vineyards.

From the existing junction “Merošina” E75/E80 up to approximately km 5+500 the designed highway alignment is using the geometry and corridor of the existing state road IB-35. On that particular section, the existing road cross section will be used as one highway lane (with rehabilitation of existing pavement and additional widening) and a second lane will be fully constructed.

Highway route will be mostly on embankments or cuttings with bridges over existing watercourses (one 12 m, two 70 m long and one 130 m long), three underpasses, five overpasses, three viaducts (210, 500 and 250 m long) and three tunnels, two shorter, 220 and 225 m and one longer, 620 m long.

Section: Prokuplje Bypass

Figure 4 Section Prokuplje Bypass



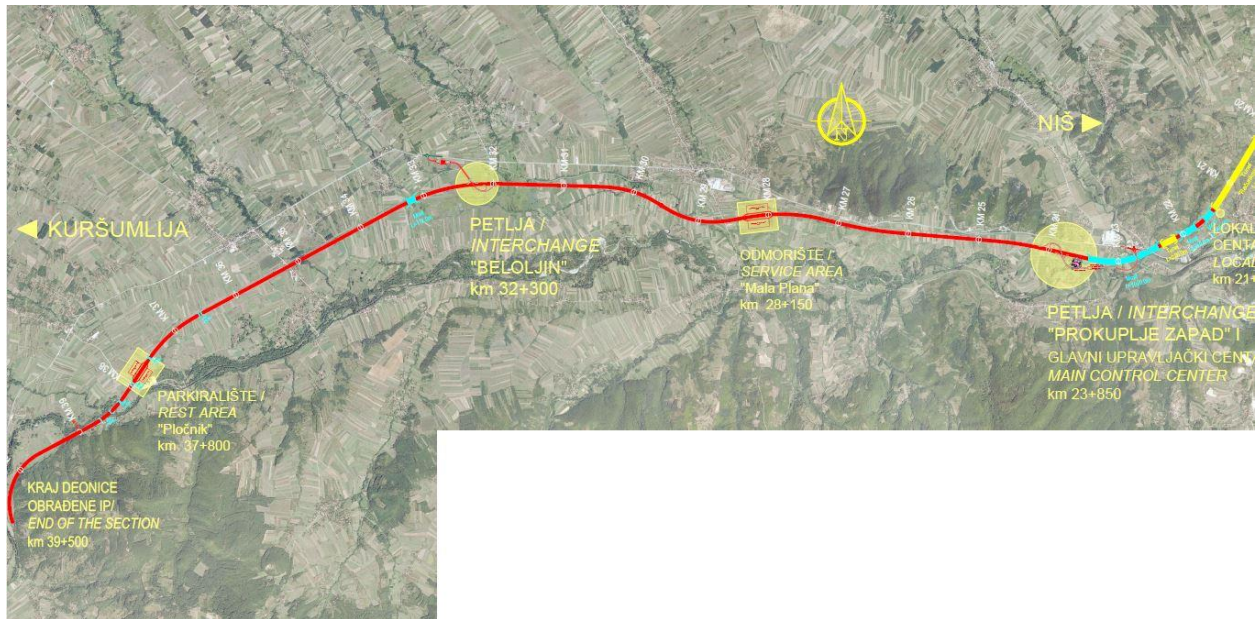
The Prokuplje Bypass is placed on the north side of Prokuplje on a terrain that is characterized as hilly to mountainous with settlements along the roads that pass through the valley between the hills.

Slopes of the terrain is very steep and hard to pass. The route of the highway is placed on high embankments, which turns deep cuts to the structures, bridges and tunnels. There are two bridges, one 130 m and other 315 m long. There are two underpasses and four viaducts, respectively 140 m, 150 m, 250 m and 975 m long. There is one overpass and three tunnels, two of which up to 300 m and one over 1100 m.

The northern part of the Prokuplje bypass is located in favorable terrain conditions with scattered settlements.

Section: Prokuplje – Pločnik

Figure 5 Section Prokuplje-Pločnik



This area extends along the Toplica River Valley. The first part of the valley up to Beloljin is much wider and provides opportunities for alternative routes within a flattened area. The slopes of the surrounding hills are not so steep and not too complicated to build a highway route. There is one overpass and seven underpasses on the route, three bridges 35 m long, three bridges 15 m long, one bridge of 50 m and one of 140 m.

In total the motorway will be mainly on embankments or cuttings, sometimes with structures such as bridges over water courses and tunnels, and can be considered as a route through mountainous terrain.

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Preliminary Design and Feasibility Study with ESIA for construction of Highway E-80 in Serbia (SEETO Route 7)
PRELIMINARY DESIGN - Environmental and Social Impact Assessment Study (ESIA)

2 Project Description and Project Alternatives

2.1 Technical Description of the Project

2.1.1 Design speed

By current and prospective traffic load, topography and created conditions, the highway alignment route is divided into the following sections:

Table 1 Sections of the highway alignment

Section	Chainage	Lenght [km]	Terrain	Speed	
				Basic Vo [km/h]	Design Vr [km/h]
Merošina (E-75)– Merošina 1	0+000,00– 5+500,00	5.500	Lowlands	100	130
Merošina1 - Prokuplje (Istok)	5+500,00– 14+283,84	8.783	Mountainous	100	130
Prokuplje (Istok)- Prokuplje (Zapad)	14+283,84– 27+096.32	12.812	Highland, mountain	80	100
Prokuplje (Zapad)- Beloljin	27+096.32– 32+650.00	5.553	Lowlands	100	130
Beloljin - Pločnik	32+650.00– 39+419.45	6.769	Lowlands	100	130

2.1.2 Functional and geometric characteristics

Table 2 Geometrical cross-section - full profile

Cross section:			Vr =130km/h	Vr=100km/h
lane width for continuous drive	ts	[m]	3.75	3.50
width of emergency lane	tz	[m]	2,50	2,50
width of the edge strips:		[m]		
a) between the lane and the median	tiv	[m]	1,00	0,50
b) between the driving and emergency lanes	tiz	[m]	0,50	0,50
shoulder width:		[m]		
a) along the emergency lane	tbz	[m]	1,50	1.50

Table 3 Geometrical cross-section - half profile – possible I phase

Cross section:			Vr =100km/h	Vr=80km/h
lane width for continuous drive	ts	[m]	3.50	3.25
width of emergency lane	tz	[m]	1.75	1.65
width of the edge strips:		[m]		
a) between the lane and the median	tiv	[m]	0.50	0,35
shoulder width:		[m]		
a) along the emergency lane	tbz	[m]	1.50	1.50

Table 4 Design elements of the plan and profile - full profile

Layout plan:			Vr=130km/h	Vr=100km/h
the minimum radius of horizontal curve	minR	m	800	450
the maximum radius of horizontal curve	maxR	m	5000	3000
minimum length of transition curve	minL	m	112,50 (A=300)	84,50 (A=195)
Longitudinal profile:				
the maximum longitudinal grade	max i	%	4.0	5.0
maximum slope of twisting ramps	max ir	%	0.9	0.9
minimum slope of twisting ramps	min ir	%	0.4	0.4
the minimum radius of convex curvature	minRv \cap	m	22500	8000
the minimum radius of concave curvature	minRv \cup	m	11250	4250
Cross section				
minimum cross grade	min ipk	%	2.5	2.5
maximum cross grade	max ip	%	7.0	7.0
Visibility:				
minimum length of stopping sight	minPz	m	300	180
maximum width zone visibility	bp	m	14,00	9.20

Table 5 Design elements of the plan and profile - half profile – (possible I phase)

Layout plan:			Vr=100km/h	Vr=80km/h
the minimum radius of horizontal curve	minR	m	800	450
the maximum radius of horizontal curve	maxR	m	5000	3000
minimum length of transition curve	minL	m	112,50 (A=300)	84,50 (A=195)
Longitudinal profile:				
the maximum longitudinal grade	max i	%	4.0	5.0
maximum slope of twisting ramps	max ir	%	0.9	0.9
minimum slope of twisting ramps	min ir	%	0.4	0.4
the minimum radius of convex curvature	minRv \cap	m	22500	8000
the minimum radius of concave curvature	minRv \cup	m	11250	4250
Cross section				
minimum cross grade	min ipk	%	2.5	2.5
maximum cross grade	max ip	%	7.0	7.0
Visibility:				
minimum length of stopping sight	minPz	m	300	180
minimum length of overtaking visibility	minPp	m	480	600
maximum width zone visibility	bp	m	14,00	9,00

2.1.3 Junctions and toll-stations

Connections of the new highway with the existing and planned road network will be realized through junctions/interchanges. The decision about the location of junctions resulted from the position of the designed alignment route in relation to the existing road network, in order to reduce transport work and taking into account the “rhythm” of the intersections along new alignment.

The design of the intersections is a result of secondary road ranking. Junctions are designed with full connections. Orientation of direct and semi-direct ramp is such

that corresponds to the distribution of traffic load on the crossing directions. The dimensions of the layout elements correspond to existing spatial constraints.

All junctions are designed according to closed toll fee payment system and include control access to motorway through the toll platforms.

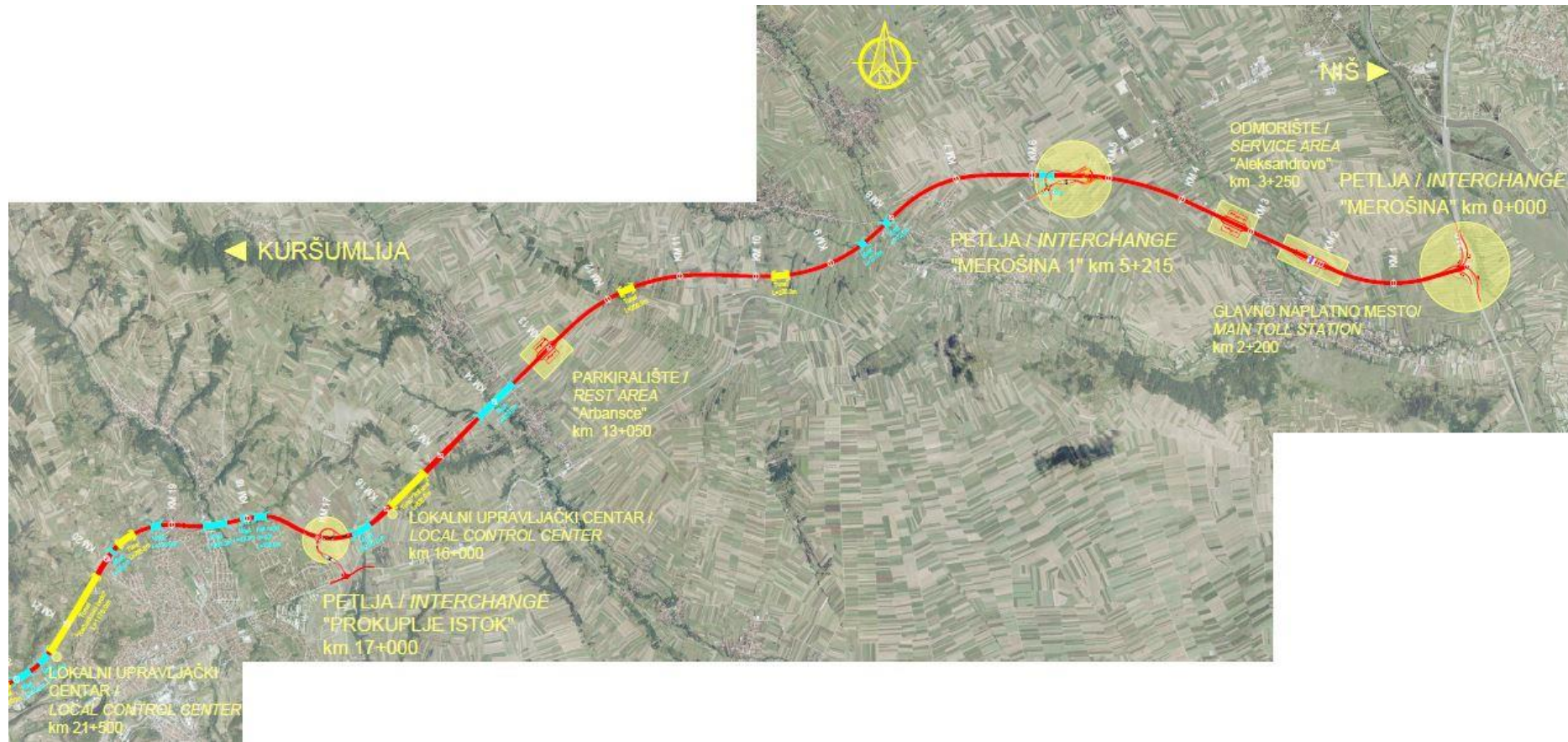
Location, concepts and functional level of designed interchanges are shown in the following table.

Table 6 Location, concepts and functional level of designed interchanges

Interchange	Interchange station	Connection road	Interchange type	Functional level	Booths	Type
Merošina	0+000	E-75 (motorway)	„triangle“	A	16	Main toll
Merošina 1	5+215	IB-35 (state road)	„trumpet“	C	7	Side toll
Prokuplje (east)	17+000	IB-35 (state road)	„trumpet“	C	7	Side toll
Prokuplje (west)	23+848	IB-35 (state road)	„trumpet“	C	7	Side toll
Beloljin	32+278	IB-35 (state road)	„trumpet“	C	7	Side toll

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Figure 6 Alignment layout and position of main features



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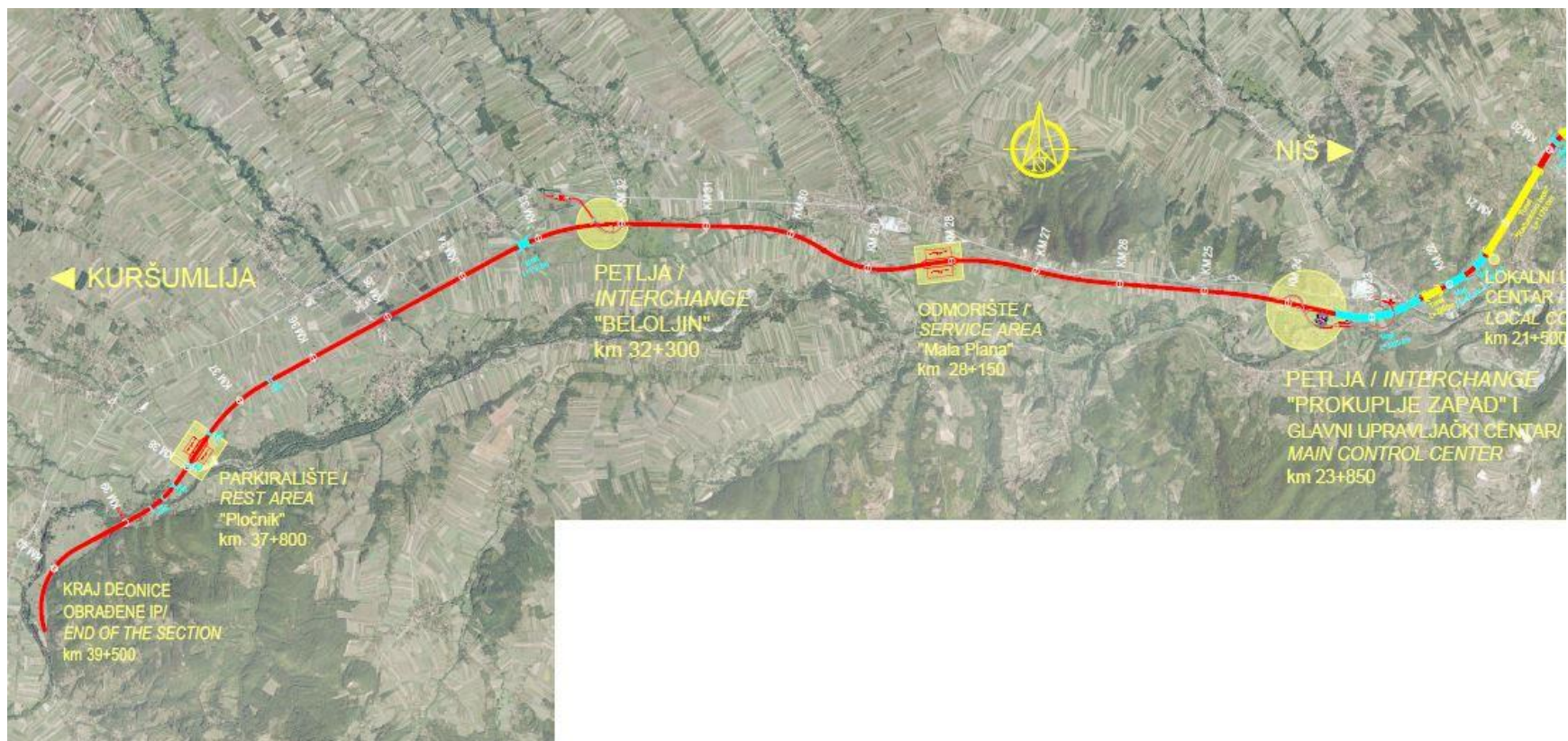
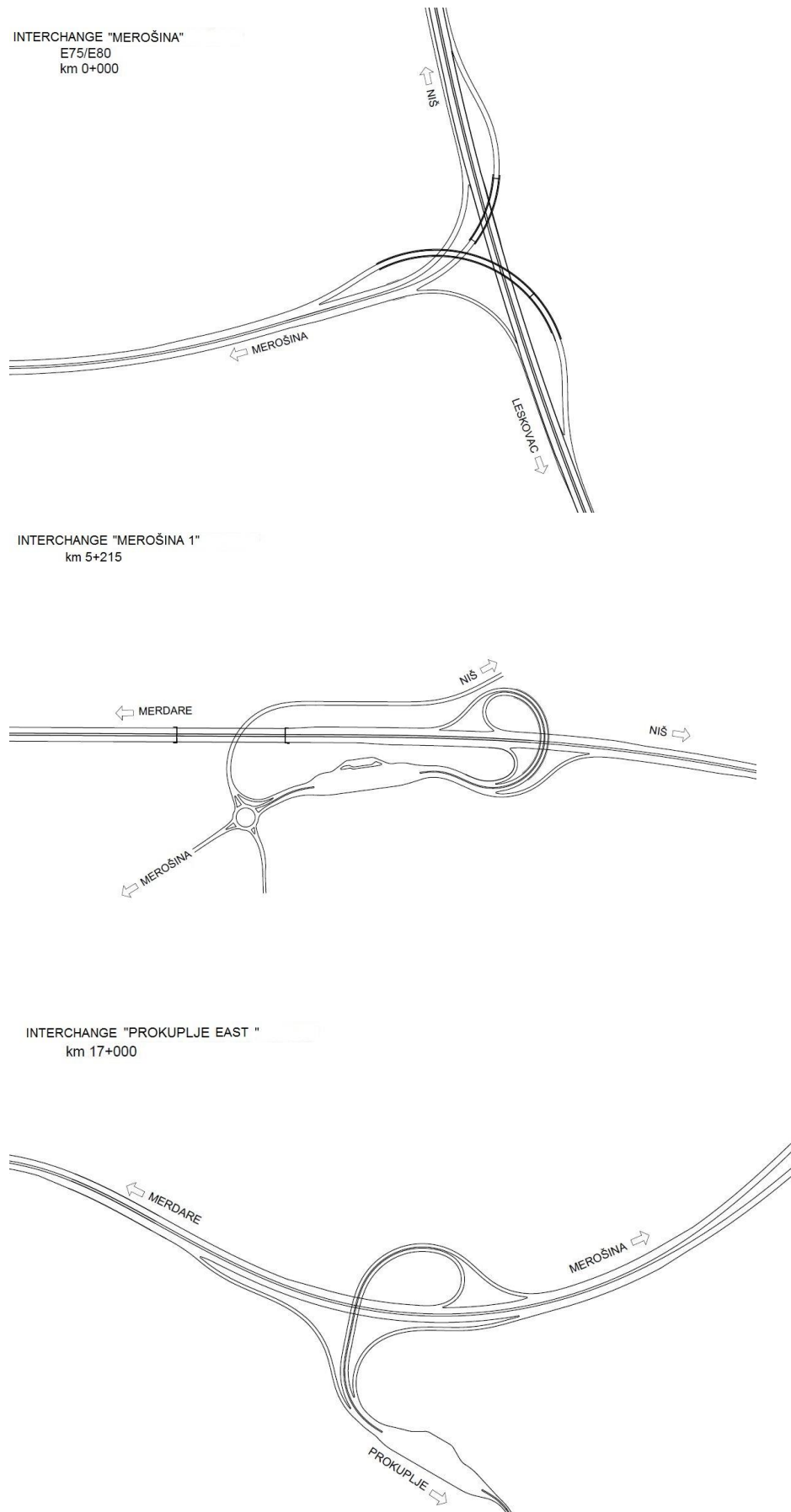
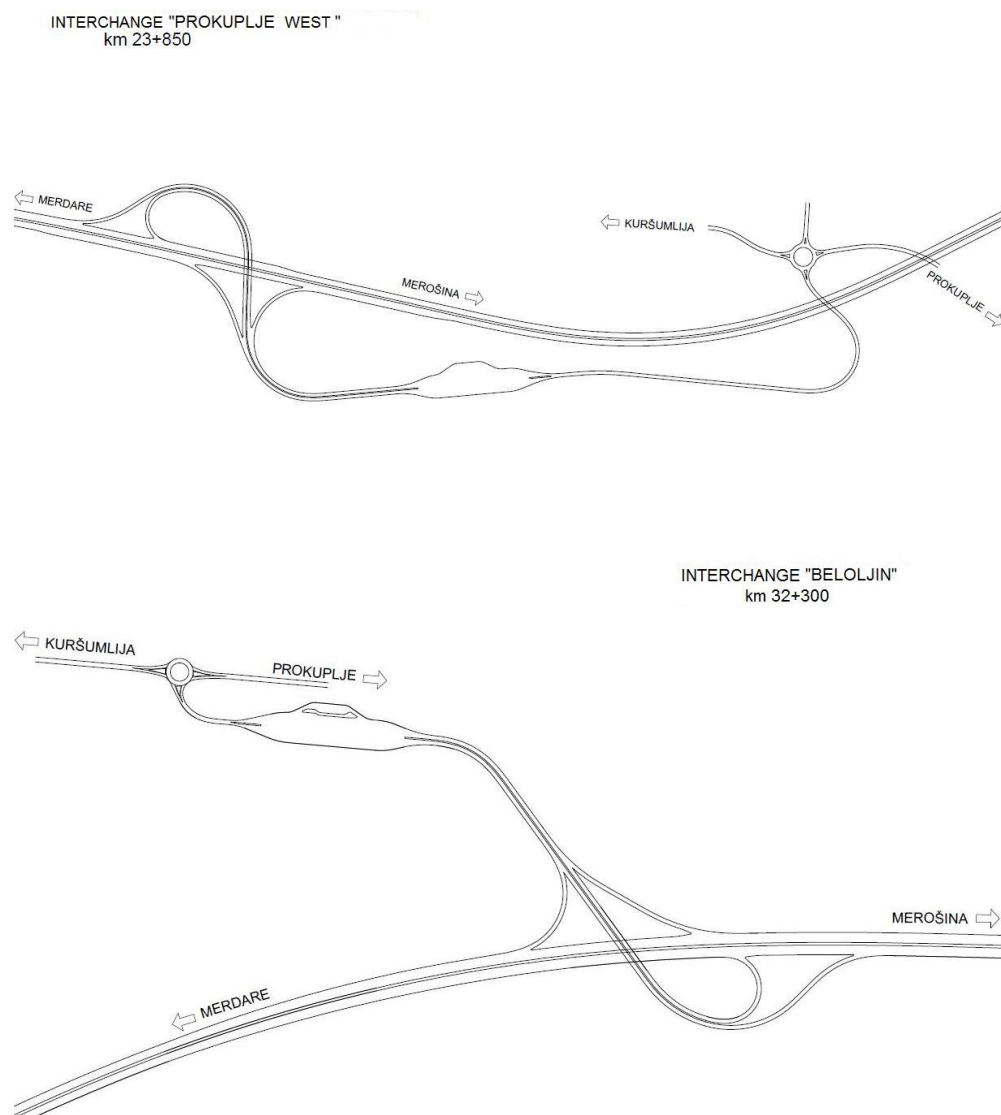


Figure 7 *Layout and position of junctions*





After consultation with PERS about state strategy regarding toll stations, it is concluded that up to date, State and PERS have a strategy to keep the existing toll payment system on every existing and new motorway section.

That is to say, toll payment collection will be performed by paying directly to toll staff at booths or by toll card (electronic pre-paid payment system).

2.1.4 Drainage concept

General concept

Drainage design propose such a solution that all storm water from pavement surface are efficiently collected and taken for the treatment and continue to the recipient. Rainwater from cut and fill slopes are collected with trenches and concrete channels along the right of way fence.

Such a concept implies that drainage of rainwater from pavement surface will be carried out to the gutters at the edge of the pavement. At certain distances along the gutters manholes with drain covers will be installed. Atmospheric water goes into a closed pipe system and from there to the separators for the treatment of storm water. After passing through the separator for oil products, purified water is drained by pipeline to the recipient, where the water is discharged.

Closed drainage pipe system collects water from the bridges and the tunnels along the route. There are bridge drains with drain covers on the bridges, which are connected to the outlet piping.

The tunnels have drainage systems and fire hydrant network in case of fire fighting.

Hydrant system in the tunnels

Fire pipeline passes through the tunnel tube and continues to ring pipeline for the second tunnel tube. Branches in the pipeline which connect the two tunnel tubes are designed. There are branches from the main pipeline to the each hydrant which are placed above the ground in niches.

Supply of water network is provided from the reservoir for fire fighting purposes. The required pressure at any hydrant is achieved by pumping station located within the reservoir. It is enabled filling and emptying of the reservoir and ventilation by vents.

The tunnels are equipped with a system for the evacuation of runoff water from the pavement and a drainage system.

Water drainage system in tunnels

Tunnels are equipped with a drainage system for the collection of spillage from the pavement in case of the incidents. This system consists of linear channels (slotted gutter type), that are connected to main collector (underneath the pavement) through siphons. This solution is designed to maintain and prevent fire and flammable and toxic fluids from spreading inside and between tubes.

Main collector is connected to treatment/storage facility at tunnel portal. In case of spillage or fire event in the tunnel, regulatory valve (controlled by emergency control system) routes drained liquid towards a dedicated underground tank which will be unloaded by specialized vehicles, operated by relevant authorities. During the normal operation of the tunnel, regulatory valve bypasses the reservoir, and routes the collected water towards the treatment objects (sedimentation tank and oil separator), before the outfall to the recipient.

Second part of tunnel drainage system consists of perforated drainage pipes for the collection of groundwater from the rock. While in short tunnels rock drainage have a free outfall into the recipient at tunnel portals, in longer tunnels, these pipes are connected to the second main collector (which is parallel to the collector for pavement drainage) at required distances.

Climate change adaptation and resilience

Highway drainage system design is done based on several studies. Most important, Hydrology study which is updated and prepared for the Preliminary design preparation and to serve as an input for further technical documentation and design. Hydrology study took into consideration Climate Change assessment findings (provide as an Annex to FS) as further design inputs, mostly changing, i.e. increasing, maximum daily precipitation data on several stations (Niš, Prokuplje and Kuršumljaja). All respective following calculations, on which design is based, had these data as an input i.e. flood levels, maximum flows, etc,

2.1.5 Pavement

Rehabilitation and widening of existing road pavement

State road order IB no.35 (road M-25 by the old categorization) is road Niš-Priština, which begins in the junction "Merosina" on highway E-75, in the southern exit of the town of Nis. From the existing junction "Merošina" E75/E80 up to approximately km 5+500 the designed highway alignment is using the geometry and corridor of the existing state road IB-35. On that particular section, the existing road cross section will be used as one highway lane (with rehabilitation of existing pavement and additional widening) and a second lane will be fully constructed.

The structure of existing pavement and layer thicknesses are determined by drilling exploration cores (along the pavement edge), deep enough to reach the natural ground. The works were carried out in April 2016. Back then, 6 exploration cores were drilled.

Design solution

- (a) *Section: Junction Merošina - Junction Merošina 1*
Chainage: km 0+000 - km 5+297

Existing pavement reconstruction

- Preliminary works
 - › Removal (by milling) existing asphalt layer, d = 13 cm
- Construction of new pavement layer
 - › Laying down thermostable mesh
 - › Bituminous base course BNS 22 sA, d = 7+7 cm
 - › Stone mastics asphalt wearing course SMA11s, d = 4 cm

New pavement construction on widening

- Preliminary works
 - › Removal of topsoil
 - › Construction of stone aggregate subgrade

- Construction of new pavement layer
 - › Crushed stone aggregate layer 0/63 mm, d=25 cm
 - › Crushed stone aggregate layer 0/31 mm, d=20 cm
 - › Bituminous base course BNS 22 sA, d = 7+7 cm
 - › Stone mastics asphalt wearing course SMA11s, d = 4 cm

New pavement construction on stopping lane

- Preliminary works
 - › Removal of topsoil
 - › Construction of stone aggregate subgrade
- Construction of new pavement layer
 - › Crushed stone aggregate layer 0/63 mm, d=25 cm
 - › Crushed stone aggregate layer 0/31 mm, d=20 cm
 - › Bituminous base course BNS 22 sA, d = 7 cm
 - › Stone mastics asphalt wearing course SMA11s, d = 4 cm

New pavement of main road route

The design of pavement of main road route (driving and overtaking lane), according to the Terms of Reference, analysed two alternative solutions, through a strategy of preventive maintenance of high mechanical characteristics of supporting layers of pavement. Two types of new pavement for the main road have been examined in accordance with the traffic volumes:

- OPTION 1: Flexible new pavement. New pavement construction with surfacing of asphalt-concrete and subbase layer of crushed stone aggregates.
- OPTION 2: Semi-rigid new pavement. New pavement construction with surfacing of asphalt-concrete and subbase layer of cement stabilized crushed stone aggregates.

Economic analysis of alternative solutions includes calculation the cost of construction and maintenance costs according to the given scenario. Economic analysis of investment costs is based on - Life Cycle Cost Analysis (LCCA). The Economic evaluation of alternative solutions for driving showed that OPTION 1 presents higher NPV and Economic uniform annual cost, than OPTION 2.

Therefore, based on the economic analysis of the pavement the designer proposes for the main road route OPTION 1 to be adopted i.e. flexible pavement structure. The designer opinion is that the application of cement stabilized layer despite the lower cost of construction, would not be rational, taking into account the limited number of construction companies in Serbia who would be able to perform in good quality (making-initiation of cracks, etc.).

Bearing in mind that, proposed solution is to design flexible new pavement on all new pavement surfaces, except in two longer tunnels ("Božurna" and "Računkovo

brdo”) where, according to the safety regulations and firefighting measures, rigid (concrete) pavement is designed.

Selected option is presented (flexible pavement) in following, by sections and by pavement structure layers.

Design solution of main road route

(b) *Section: Junction Merošina - Junction Merošina 1 - Junction Prokuplje East*

chainage: km 0+000 - km 5+297 - km 16+233

New pavement construction – driving and fast lane

- Preliminary works
 - › Removal of topsoil
 - › Construction of stone aggregate subgrade
- Construction of new pavement layer
 - › Crushed stone aggregate layer 0/63 mm, d=25 cm
 - › Crushed stone aggregate layer 0/31 mm, d=20 cm
 - › Bituminous base course BNS 22 sA, d = 7+7 cm
 - › Stone mastics asphalt wearing course SMA11s, d = 4 cm

New pavement construction – stopping lane

- Preliminary works
 - › Removal of topsoil
 - › Construction of stone aggregate subgrade
- Construction of new pavement layer
 - › Crushed stone aggregate layer 0/63 mm, d=25 cm
 - › Crushed stone aggregate layer 0/31 mm, d=27 cm
 - › Bituminous base course BNS 22 sA, d = 7 cm
 - › Stone mastics asphalt wearing course SMA11s, d = 4 cm

(c) *Section: Junction Prokuplje East - Junction Prokuplje West*
chainage: km 16+233 - km 22+809

New pavement construction – driving and fast lane

- Preliminary works
 - › Removal of topsoil
 - › Construction of stone aggregate subgrade
- Construction of new pavement layer

- › Crushed stone aggregate layer 0/63 mm, d=25 cm
- › Crushed stone aggregate layer 0/31 mm, d=20 cm
- › Bituminous base course BNS 22 sA, d = 7+6 cm
- › Stone mastics asphalt wearing course SMA11s, d = 4 cm

New pavement construction – stopping lane

- Preliminary works
 - › Removal of topsoil
 - › Construction of stone aggregate subgrade
 - Construction of new pavement layer
 - › Crushed stone aggregate layer 0/63 mm, d=25 cm
 - › Crushed stone aggregate layer 0/31 mm, d=27 cm
 - › Bituminous base course BNS 22 sA, d = 6 cm
 - › Stone mastics asphalt wearing course SMA11s, d = 4 cm
- (d) *Section: Junction Prokuplje West - Junction Beljolin - Pločnik*
chainage: km 22+809 - km 32+331 - km 42+545

New pavement construction – driving and fast lane

- Preliminary works
 - › Removal of topsoil
 - › Construction of stone aggregate subgrade
- Construction of new pavement layer
 - › Crushed stone aggregate layer 0/63 mm, d=25 cm
 - › Crushed stone aggregate layer 0/31 mm, d=20 cm
 - › Bituminous base course BNS 22 sA, d = 7+7 cm
 - › Stone mastics asphalt wearing course SMA11s, d = 4 cm

New pavement construction – stopping lane

- Preliminary works
 - › Removal of topsoil
 - › Construction of stone aggregate subgrade
- Construction of new pavement layer
 - › Crushed stone aggregate layer 0/63 mm, d=25 cm
 - › Crushed stone aggregate layer 0/31 mm, d=27 cm
 - › Bituminous base course BNS 22 sA, d = 7 cm
 - › Stone mastics asphalt wearing course SMA11s, d = 4 cm

New pavement of main route in tunnels

Following contemporary practice in this area and in EU countries, in addition to the active measures for the prevention of fires in tunnels (ventilation, extraction and smoke detectors) the application of passive measures, such as the use of completely non-combustible materials like cement-concrete is a key issue. Also, some European countries (Austria, Slovakia, Slovenia, Spain) recommended in its regulations the application of rigid pavement in tunnels longer than 500 m.

Design solution

Design solution of the new pavement of main route in tunnels is as follows:

New pavement construction – tunnels "Debelo Brdo" and "Lalinac"

- Preliminary works
 - › Construction of stone aggregate subgrade
- Construction of new pavement layer
 - › Crushed stone aggregate layer 0/63 mm, d=25 cm
 - › Crushed stone aggregate layer 0/31 mm, d=20 cm
 - › Bituminous base course BNS 22 sA, d = 7+7 cm
 - › Stone mastics asphalt wearing course SMA11s, d = 4 cm

New pavement construction – tunnels "Plehane kuće" and "Vrsnik"

- Preliminary works
 - › Construction of stone aggregate subgrade
- Construction of new pavement layer
 - › Crushed stone aggregate layer 0/63 mm, d=25 cm
 - › Crushed stone aggregate layer 0/31 mm, d=20 cm
 - › Bituminous base course BNS 22 sA, d = 7+6 cm
 - › Stone mastics asphalt wearing course SMA11s, d = 4 cm

New pavement construction – tunnels "Božurna" and "Racunkovo brdo"

- Preliminary works
 - › Construction of stone aggregate subgrade
- Construction of new pavement layer
 - › Crushed stone aggregate layer 0/63 mm, d=25 cm
 - › Crushed stone aggregate layer 0/31 mm, d=20 cm
 - › Bituminous base course BNS 22 sA, d = 6 cm
 - › Cement concrete slab (class C 35/45 with dowels), d = 22 cm

New pavement on junctions

New pavement construction – Junction Merošina

- Preliminary works
 - › Construction of subgrade
- Construction of new pavement layer
 - › Crushed stone aggregate layer 0/63 mm, d=30 cm
 - › Crushed stone aggregate layer 0/31 mm, d=20 cm
 - › Bituminous base course BNS 22 sA, d = 7+6 cm
 - › Stone mastics asphalt wearing course SMA11s, d = 4 cm

New pavement construction – Junction Merošina 1/Prokuplje East/

Prokuplje West/Beloljin

- Preliminary works
 - › Construction of subgrade
- Construction of new pavement layer
 - › Crushed stone aggregate layer 0/63 mm, d=30 cm
 - › Crushed stone aggregate layer 0/31 mm, d=20 cm
 - › Bituminous base course BNS 22 sA, d = 10 cm
 - › Stone mastics asphalt wearing course SMA11s, d = 4 cm

Other pavement surfaces

Preliminary design provide us design solution for pavements as follows:

- › New pavement for service and local roads
- › Pavement on bridge structure

Design solution

Service and local roads

- Preliminary works
 - › Construction of subgrade
- Construction of new pavement layer
 - › Crushed stone aggregate layer 0/63 mm, d=30 cm
 - › Crushed stone aggregate layer 0/31 mm, d=20 cm
 - › Bituminous base course BNS 22 sA, d = 10 cm
 - › Asphalt concrete wearing course AB 11s, d = 4 cm

Pavement on bridge structure

- Preliminary works

- › Construction of hydroisloation, $d = 1 \text{ cm}$
- Construction of new pavement layer
 - › Asphalt concrete wearing course AB 11s, $d = 5 \text{ cm}$
 - › Stone mastics asphalt wearing course SMA11s, $d = 4 \text{ cm}$

2.1.6 The key engineering structures

Structure types which are designed on highway are adopted based on several factors:

- data from highway design (vertical alignment, longitudinal and cross sections)
- terrain characteristics (layout and levelling position of structures)
- soil type and geotechnical characteristics (deep or shallow foundation)
- obstacle characteristics (overhead clearance of state/local/dirt roads, railway line, river bed width and peak flood level) have influenced the selection of type and height of main girder and therefore the spans of structures.

During designing attention was paid to adopt as smaller number of structure type, as possible, in order to uniform technology, and thus to speed up the works.

Solution with two separate structures for each direction is accepted. On sections where design speed is $V_r=130\text{km/h}$ (I, II, IV and V section) width of each structure is $b=15,40\text{m}$, and where design speed is $V_r=100\text{km/h}$ (III section) width is $b=14,40\text{m}$.

Foundation type is accepted according to Geotechnical Survey which is prepared for Preliminary Design. Foundation type should be checked in next phase of design based on detail geotechnical investigations. On several structures, where embankment is high, reinforced earth behind the abutments was adopted.

Guardrails on the structures are provided (according to Preliminary Design for traffic equipment), space for installation conduct over structures and placement of lighting poles (interchange area). Also, revision paths on outer cantilevers of structures are provided.

In the tables bellow, there are lists of structures: bridges, overpasses, underpasses and viaducts with overview of spans, lengths, obstacles and foundation types:

Table 7 *Bridges, viaducts, underpasses*

	No	Chainage	Object type	Obstacle	Spans	Construction type	Type of foundation
Section I	1	0+209.27	Underpass	Local road	$L=15\text{m}$	RC slab	Shallow
	2	2+990.50	Bridge	Dirt road and stream Aleksandrovacki potok	$L=12\text{m}$	RC slab	Shallow
	3	3+512.79	Underpass	Local road	$L=15\text{m}$	RC slab	Shallow
Section II	4	5+825.00	Viaduct	Interchange Merosina 1	$L=6 \times 35=210\text{m}$	Precast prestressed girder	Deep
	5	8+095.00	Bridge	Local road and stream Krajkovacka River	$L=15+20+20+15=70\text{m}$	RC slab	Deep
	6	8+512.99	Bridge	Lepajski Stream	$L=15+20+20+15=70\text{m}$	RC slab	Deep
	7	13+733.12	Underpass	Local road	$L=12\text{m}$	RC slab	Shallow

	No	Chainage	Object type	Obstacle	Spans	Construction type	Type of foundation
Section III	8	14+030.00	Viaduct	Country road, Jugbogdanovacka river and ravine	L=10x50=500m	Box girder	Deep
	9	116+425.43 r16+420.50	Viaduct	Ravine	L=5x50=250m	Box girder	Shallow
	10	L17+829.99 r17+810.02	Bridge	Ravine Ciganski stream	L=30+35+35+30=130m	Beam(Homberg's) girder	Shallow
	11	18+051.33	Underpass	Local road	L=10+15+10=35m	RC slab	Shallow
	12	L18+413.18 r18+412.32	Bridge	Country road, Strzavska River and state road II order no. 216	L=6x50+15=315m	Box girder	Deep
	13	L19+193.64 r19+208.29	Viaduct	Dirt road	L=4x35=140m	Precast prestressed girder	Deep and shallow
	14	L19+854.04 r19+877.94	Underpass	Local road	L=10+15+10=35m	RC slab	Shallow
	15	L21+556.07 r21+553.29	Viaduct	Dirt road	l L=30+3x35+30=165m r L=30+35+35+30=130m	Beam(Homberg's) girder	Shallow
	16	L21+908.08 r21+919.75	Viaduct	Country roads	L=5x50=250m	Box girder	Shallow
Section IV	17	L22+885.84 r22+880.95	Viaduct	State road II order Trnavska River, railroad, dirt road	l L=35+40+18x50=975m r L=18x50+35+40=975m	Box girder	Deep and shallow
	18	25+399.60	Underpass	Country dirt road	L=10+15+10=35m	RC slab	Shallow
	19	L26+463.80 r26+464.47	Bridge	Country dirt road	L=10+15+10=35m	RC slab	Shallow
	20	28+631.10	Underpass	Local road	L=10+15+10=35m	RC slab	Shallow
	21	L29+801.45 r29+797.73	Underpass	Country dirt road	L=10+15+10=35m	RC slab	Shallow
	22	30+070.10	Bridge	Stream	L=15m	RC slab	Shallow
	23	31+790.58	Bridge	Dirt road and stream (Zdravinska River)	L=10+15+10=35m	RC slab	Deep
	24	33+135.77	Bridge	Kondzeljska River and two dirt roads	L=10+15+15+10=50m	RC slab	Deep
	25	33+617.50	Underpass	Country dirt road	L=10+15+10=35m	RC slab	Shallow
Section V	26	34+925.00	Bridge	Draguska River	L=35m	Precast prestressed girder	Shallow
	27	35+157.52	Underpass	State road IIA order	L=10+15+10=35m	RC slab	Shallow
	28	36+578.73	Underpass	Country dirt road	L=10+15+10=35	RC slab	Shallow
	29	37+534.18	Bridge	Channel	L=15m	RC slab	Shallow
	30	37+970.89	Underpass	Local road	L=10+15+10=35m	RC slab	Shallow
	31	38+278.07	Bridge	Stream	L=15m	RC slab	Shallow
	32	l 38+566.58 d 38+576.48	Bridge	Toplica River and channel	L30+40+40+30=140m	Box girder	Deep

Table 8 Overpasses

Section	No	Chainage	Object type	Obstacle	Spans	Construction type	Type of foundation
I	1	1+713.84	Overpass	Highway E80	L=2x30=60	Beam (Homberg's) girder	Deep
II	2	7+600.87	Overpass	Highway E80	L=112+152=264m	RC slab	Deep
II	3	10+567.81	Overpass	Highway E80	L=2x25=50	Beam (Homberg's) girder	Deep
II	4	12+149.26	Overpass	Highway E80	L=2x25=50	Beam (Homberg's) girder	Shallow
III	5	17+185.75	Overpass	Highway E80	L=16+18+20+12=66	RC slab	Shallow
III	6	18+985.65	Overpass	Highway E80	L=2x30=60	Beam (Homberg's) girder	Shallow
III	7	20+149.55	Overpass	Highway E80	L=2x30=60	Beam (Homberg's) girder	Deep

Table 9 Structures in interchanges

No	Interchange	Chainage	Object type	Obstacle	Spans	Construction type	Type of foundation
1	Merošina	0+000	Ramp R1	Highway E75	L=24,12+27,135+28,14+25,125+25=129,52;	Beam (Homberg's) girder	Deep
		0+000	Ramp R3	Highway E75, Ramp 1 and Ramp 4	L=2x24,12+27,635+32,665+4x35,17+33,15+30,12=312,49	Beam (Homberg's) girder	Deep
2	Merošina 1	5+214.94	Overpass (ramp bifurcation M-01 and M-02)	Highway E80	L= 7x30=210m	Beam (Homberg's) girder	Deep
3	Prokuplje east	17+000.00	Overpass (Ramp R-AB)	Highway E80	L= 2x25=50m	Beam (Homberg's) girder	Shallow
4	Prokuplje west	23+847.62	Overpass	Highway E80	L=16+8x20+16=192	RC slab	Shallow
5	Beloljin	32+278.00	Overpass	Highway E80	L=(5+6)x30=330	Beam (Homberg's) girder	Deep
	Approach road to Prokuplje west interchange	-	Viaduct	Railway line	L=16+5x20+16+16+6x20+16=284m	RC slab	Shallow

2.1.7 Tunnels

On highway Niš – Merdare, section Niš – Pločnik (km0+000 to km39+500) construction of a total of 6 tunnels is planned.

Table 10 Review of tunnels per section

Tunnel	Beginning of tunnel	End of tunnel	Length
Debelo brdo	9+570.00	9+790.00	220 m
Lalinac	11+625.00	11+850.00	225 m
Božurna	15+300.00	15+920.00	620 m
Vršnik	19+550.00	19+750.00	200 m
Računkovo brdo	20+250.00	21+425.00	1175 m
Plehane kuće	22+120.00	22+340.00	220 m

Tunnel 1 – “Debelo brdo”

The construction of the tunnel "Debelo brdo" consists of two connected tunnel tubes. The entrance portal of tunnel construction is located at km 9 + 570, and the exit portal at km 9 + 790. Length of the tunnel tube is 220 m. Standard cross section elements of the tunnel are designed for highway alignment design speed of 130 km/h, as per rulebooks, but maximum speed in tunnel will be reduced according to traffic signalization and safety regulation. The roadway is in one-sided longitudinal slope of 4.0% toward the entrance portal. Tunnel "Debelo brdo" is less

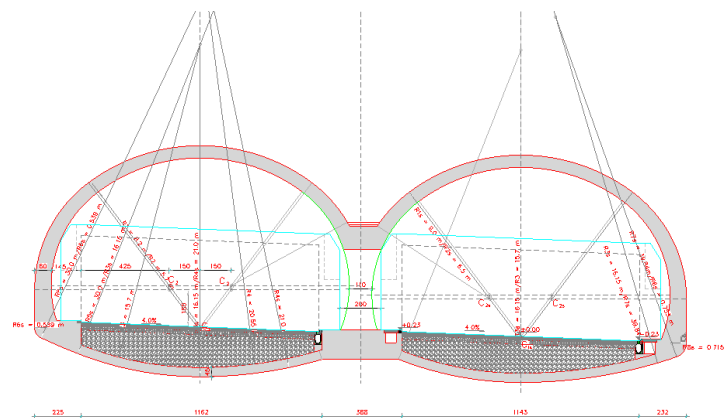
than 300 m long, therefore in accordance with the standards for the design and construction of tunnels on highways, special security measures are not designed, so pedestrian paths are used as evacuation path.

Construction method

The contour of the clearance gauge is defined by the circles of radius $R1 = 8.20$ m and $R2 = 5.70$ m, and the area of clearance gauge of a single tube is 98.54 m². The structural character of the tunnel construction is such that it involves construction in phases and the application of modern tunnel building technology - the concept of the New Austrian Tunnelling Method – “NATM”.

Singular type of structure along the entire length of the tunnel is adopted. The construction process is carried out mainly in the marl and marly clays. The primary lining consists of shotcrete layer and lattice girders. Secondary lining is made of concrete C25/30, and is reinforced with calculated rebar. Geotextile and geomembrane is placed between primary and secondary lining as hydroinsulation.

Figure 8 Tunnel 1 construction



Source: Consultant's design

Tunnel 2 – “Lalinac”

Tunnel "Lalinac" is planned to be built using "cut and cover" method for minimizing earthworks. The tunnel consists of two connected tubes formed from piles and beams with slab. The entrance portal of tunnel construction of both tubes is located at chainage km 11 + 625, while the exit portal at chainage km 11 + 850. The length of the tunnel is 225 m. Standard cross section elements of the tunnel are designed for highway alignment design speed of 130 km/h, as per rulebooks, but maximum speed in tunnel will be reduced according to traffic signalization and safety regulation. The roadway is in one-sided longitudinal slope of 3.5% toward the exit portal. Tunnel "Lalinac" is shorter than 300.00 m, so in accordance with the standards for the design and construction of tunnels on the highways, there are no specially designed security measures, so pedestrian paths are used as paths of evacuation.

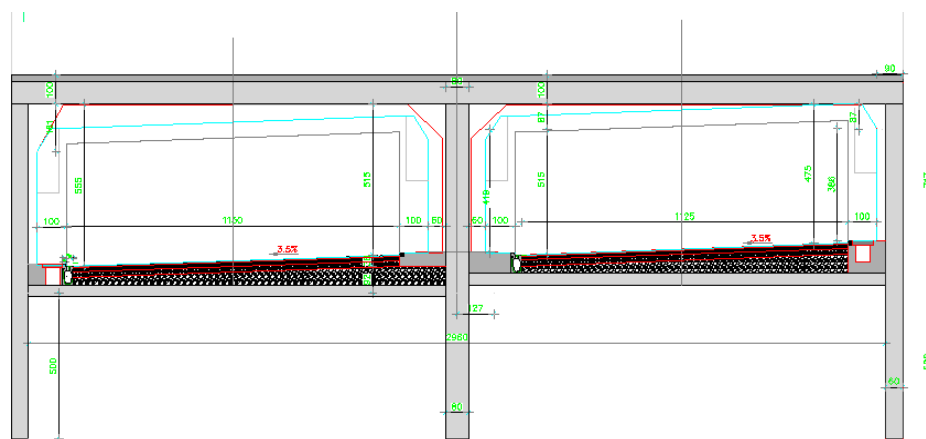
Tunnel construction

Tunnel "Lalinac" is built in the open excavation, with "cut and cover" method, by placing three rows of piles, connected with the concrete beams that are

monolithically linked with the concrete slab. After that, backfill and tunnel excavation are done. The concrete slab is raised on the higher level than traffic profile dictates, for the purpose of reducing load of overburden on the construction. Area of clearance gauge of the left tube is 73.18 m², while on the right tube it is 68,32m².

Geological conditions are such that singular construction type can be adopted along the entire length of the tunnel. The construction is carried out mainly in the silty ground and marly clay.

Figure 9 Tunnel 2 construction



Source: Consultant's design

Tunnel 3 – “Božurna”

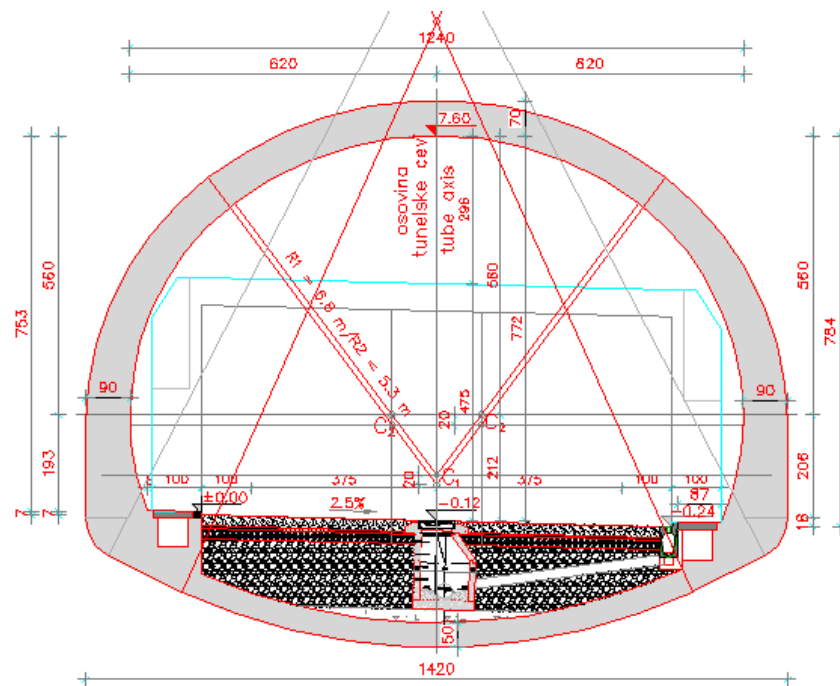
Tunnel “Božurna” consists of two tubes. The distance in between the two tunnel bores is sufficient in order to avoid any loading/vibration/deformation impact arising from the excavation of one bore to the other.. The entrance portal for both tubes is at chainage km 15 + 300, while the exit portal is at chainage km 15 + 920. The total length of the tunnel tube is 620 m. Standard cross section elements of the tunnel are designed for highway alignment design speed of 130 km/h, as per rulebooks, but maximum speed in tunnel will be reduced according to traffic signalization and safety regulation. Vertical alignment is changing from 4% uphill to 4% downhill, thus tunnel is in vertical curve. Bearing that in mind maximum longitudinal grade in tunnel is cca 1.50% on entrance, and cca 1.20% on exit of the tunnel. Tunnel “Božurna” is longer than 500 m, therefore in accordance with the standards for the design and construction of tunnels on highways, total of 14 SOS niches and 10 hydrant niches are placed in the two tubes. Two escape cross passages between the tubes for evacuation of pedestrians are also designed.

Tunnel construction

The contour of the clearance gauge is defined by the circles of radius R1 = 6.80 m and R2 = 5.30 m, while the area of clearance gauge of a single tube is 80.70 m². Tunnel construction is designed in such way that it involves construction in phases and the application of modern tunnel building technology - the concept of the New Austrian Tunnelling Method - “NATM”.

In accordance with the geotechnical conditions along the tunnel, a single type of structure is adopted along the entire length of the tunnel. The construction is carried out in marly environment, with layers of marly clay and gravel in the overlay. At a preliminary level of design, the primary lining consists of shotcrete and lattice girders. Secondary lining is made of concrete C25/30, and is reinforced with calculated rebar. Geotextile and geomembrane is placed between primary and secondary lining as hydroinsulation.

Figure 10 Tunnel 3 construction



Source: Consultant's design

Tunnel 4 – “Vršnik”

Tunnel "Vršnik" consists of two tubes. The distance in between the two tunnel bores is sufficient in order to avoid any loading/vibration/deformation impact arising from the excavation of one bore to the other. The entrance portal of right tunnel tube is at km 19+550.00, and exit portal is at km 19+750.00. The entrance portal of the left tunnel tube is at km 19+535.00, while exit portal is at km 19 + 755.00. The length of both left and right tunnel tubes is 200.00 m. Standard cross section elements of the tunnel are designed for highway alignment design speed of 100 km/h, as per rulebooks, but maximum speed in tunnel will be reduced according to traffic signalization and safety regulation. The roadway is in one-sided longitudinal slope of 5.0% towards the entrance portal. As the tunnel "Vršnik" is less than 300.00 m, in accordance with the standards for the design and construction of tunnels on the highways, there are no specially designed security measures; so pedestrian paths are used as paths of evacuation.

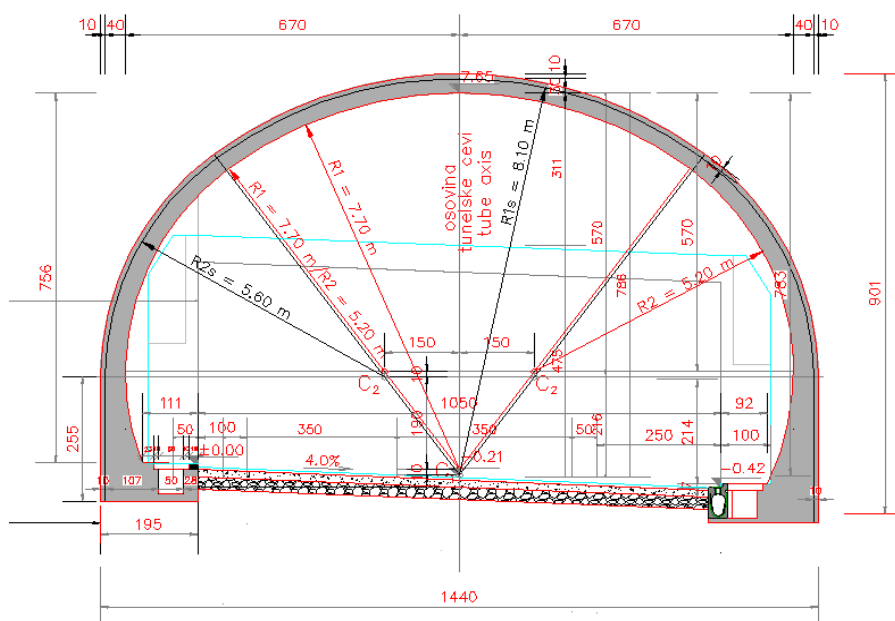
Tunnel construction

The contour of the clearance gauge is defined by circles of radius $R1 = 7.70$ m and $R2 = 5.60$ m, and the area of clearance gauge of a single tube is 87.35 m². The

structural character of the tunnel construction is such that it involves construction in phases and the application of modern tunnel building technology - the concept of the New Austrian Tunnelling Method – “NATM”.

Singular type of structure along the entire length of the tunnel is adopted. The construction process is carried out mainly gneiss and degraded gneisses. The primary lining consists of shotcrete layer. Secondary lining is made from concrete C25/30, and is reinforced with rebar. Geotextile and geomembrane is placed between primary and secondary lining as hydroinsulation.

Figure 11 Tunnel 4 construction



Source: Consultant's design

Tunnel 5 – “Računkovo brdo”

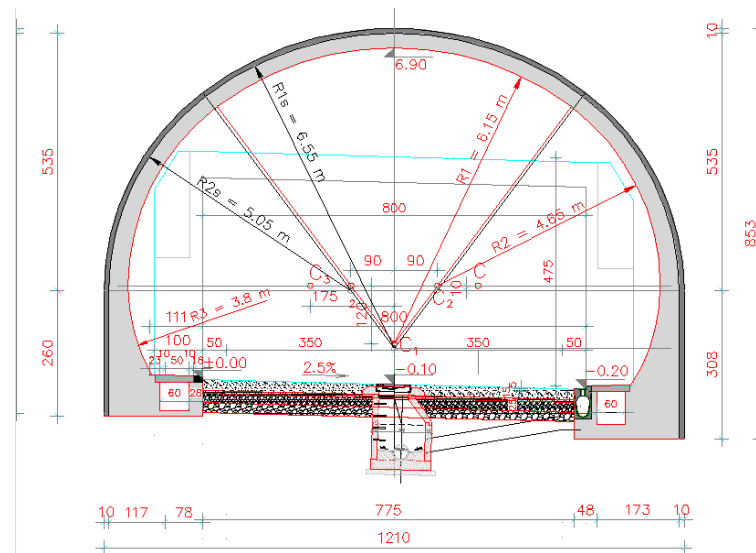
Tunnel "Računkovo brdo" consists of two separated tubes. The distance in between the two tunnel bores is sufficient in order to avoid any loading/vibration/deformation impact arising from the excavation of one bore to the other.. The entrance portal of the right tunnel tube is at km 20+250.00, and the exit portal is at km 21+425.00. The entrance portal of the left tunnel tube is at km 20+200.00, and the exit portal is at km 21+425.00. The length of the right tunnel tube is 1,175.00 m, while the length of the left tube is 1,225.00 m. Standard cross section elements of the tunnel are designed for highway alignment design speed of 100 km/h, as per rulebooks, but maximum speed in tunnel will be reduced according to traffic signalization and safety regulation. Vertical alignment is changing from 4% uphill to 5% downhill, thus tunnel is in vertical curve. Bearing that in mind maximum longitudinal grade in tunnel is cca 1.1% on entrance, and cca 2.80% on exit of the tunnel. As tunnel “Računkovo brdo” has length of about 1,200 m, inside the tunnel, in accordance with the standards for the design and construction of tunnels on the highways, in both tubes 17 SOS niches and 14 hydrant niches are placed. Also, two passages for pedestrian evacuation and one for vehicle evacuation are designed.

Tunnel construction

The contour of the clearance gauge is defined by the circles of radius $R1 = 6.15$ m, $R2 = 4.65$ m, and $R3 = 3.80$ m. Area of clearance gauge of a single tube is 65.11 m². The structural character of the tunnel construction is such that it involves construction in phases and the application of modern tunnel building technology - the concept of the New Austrian Tunnelling Method – “NATM”.

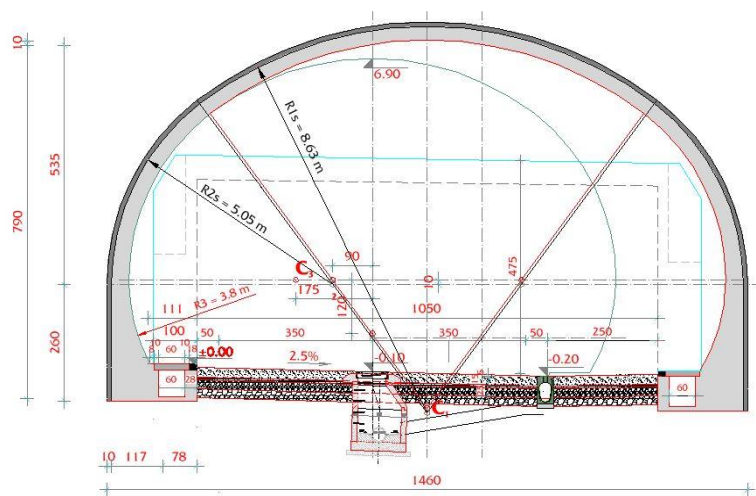
Singular type of structure along the entire length of the tunnel is adopted. The construction will be built in gneiss environment. At a preliminary level of design, the primary lining consists of shotcrete layer. Secondary lining is made from concrete C25/30, and is reinforced with rebar. Geotextile and geomembrane is placed between primary and secondary lining as hydroinsulation.

Figure 12 Tunnel 5 construction



Source: Consultant's design

Figure 13 Tunnel 5 lay-by construction



Source: Consultant's design

Tunnel 6 – “Plehane kuće”

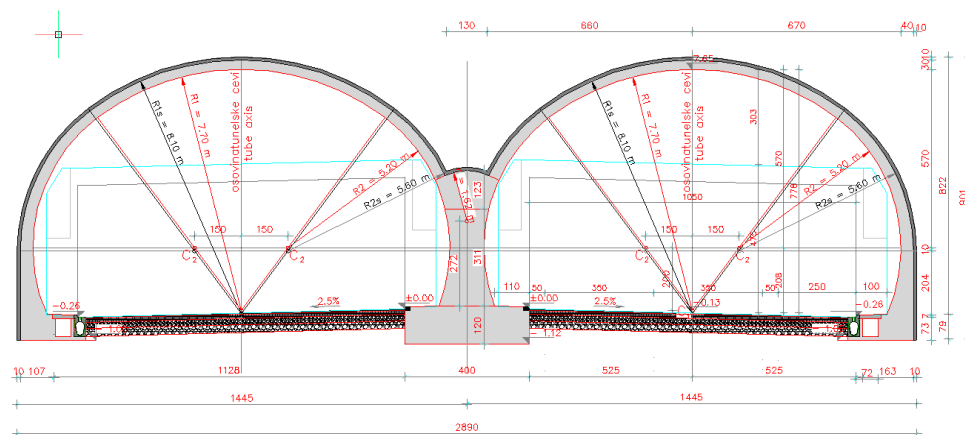
The construction of the tunnel "Plehane kuće" consists of two connected tunnel tubes. The entrance portal of the tunnel is located at km22+120, and the exit portal at km22+340. The length of tunnel tube is 220m. Standard cross section elements of the tunnel are designed for highway alignment design speed of 100 km/h, as per rulebooks, but maximum speed in tunnel will be reduced according to traffic signalization and safety regulation. The roadway is in one-sided longitudinal slope of 4.0% toward the exit portal. Tunnel "Plehane kuće" is less than 300.00 m long, therefore in accordance with the standards for the design and construction of tunnels on highways, special security measures are not designed, so pedestrian paths are used as evacuation path.

Tunnel construction

The contour of the clearance gauge is defined by the circles of radius $R1 = 7.70$ m and $R2 = 5.20$ m, while the area of clearance gauge of a single tube is 87.35 m². The structural character of the tunnel construction is such that it involves construction in phases and the application of modern tunnel building technology - the concept of the New Austrian Tunnelling Method – “NATM”.

Accordingly with geotechnical conditions along the tunnel a singular type of structure is adopted along the entire length of the tunnel. The construction will be built in gneiss environment. The primary lining consists of shotcrete layer. Secondary lining is made from concrete C25/30, and is reinforced with rebar. Geotextile and geomembrane is placed between primary and secondary lining as hydroinsulation.

Figure 14 Tunnel 6 construction



Source: Consultant's design

Safety measures for long tunnels

Overall standards

Safety measures for “long” tunnels ($L > 500$ m) along the alignment are defined according to the domestic and international standards for such a design. There are

two such long tunnels on the new route: Tunnel 3 “Božurna” and Tunnel 5 “Računkovo brdo”.

List of adopted regulations and standards:

- DIRECTIVE 2004/54/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 29 April 2004 on minimum safety requirements for tunnels in the trans-European road network
- Guidelines for designing of roads in Republic of Serbia, Chapter 11-Designing of tunnels, 2012
- Regulations for the equipment and operation of road tunnels RABT 2006
- RVS 09.02.31 Tunnels Tunnel Equipment Ventilation Basic principles – chapter 9

RVS 09.02.22 (9.282) Tunnels, Tunnel equipment Tunnel power supply

For tunnel power supply two technical centres shall be constructed: technical centre 1 and technical centre 2. Technical centre 1 shall be constructed in the vicinity of right tunnel tube portal, at the right side of the road. Technical centre 1 contains transformer substation, back-up power supply (UPS and diesel-generator), switch board room and local control centre (auxiliary) for control and monitoring of all tunnel equipment. Technical centre 2 shall be constructed in the vicinity of the left tunnel tube portal, at the right side of the road. Technical centre 2 contains transformer substation, switch board room and back-up power supply (UPS and diesel-generator). Transformer substations will provide primary power supply. Uninterruptible power supply devices will provide continuous power supply for all necessary consumers (overpressure fans in cross-connections, safety lighting, automation systems and traffic related devices). Back-up power source for main ventilation system of tunnel tubes shall be provided by diesel-generators. Power supply for transformer substations shall be provided via 10 kV cables according to conditions from local electrical utility company. Transformer substations shall be interconnected.

Lighting

General and emergency lighting is planned. General lighting is divided into zones: access zone, threshold zone, transition zone, interior zone and exit zone based on safe stopping distance, L20 calculations and other elements of tunnel construction. Symmetrical system of lighting with LED light sources is adopted based on concrete road surface in the tunnel. Lighting shall be controllable by DALI system which will provide continuous follow of luminance decrease along tunnel tube (CIE-curve). Every second luminaire of base lighting row shall be supplied by UPS, thus forming safety lighting (average illuminance of road of 10Lx shall be achieved). Lighting of cross-connections shall be provided supplied by UPS. Emergency lighting shall be positioned at the tunnel wall at height not exceeding 1m and at regular intervals of less than 25m. Emergency lighting shall be supplied by UPS.

Power distribution

Consumers shall be supplied via distribution boards located in emergency (SOS) niches and switch boards located in technical centres. All cables used in tunnel

space shall be of halogen free type. Cables for safety systems shall be of FE180/E90 type.

Heat cables shall be provided for fire water pipes.

Protection against indirect contact shall be TN-S.

Earthing, equipotential bonding and lightning protection

Equipotential bonding of all metal parts shall be provided. In every emergency (SOS) niche equipotential bonding bar shall be provided as well as in technical centres. These bars shall be connected to foundation earthing. Foundation earthings of technical centres and foundation earthing of tunnel tubes shall be connected, thus forming one linked complex earthing.

Technical centres shall be provided with complete lightning protection system (external and internal). Coordinated surge protection shall be used.

Automation

Automation system will be implemented via distribution boards located in emergency (SOS) niches and technical centres. Automation boards will be equipped with controllers (with algorithms according to different scenarios) linked together via tunnel optical cable. All tunnel system will be monitored and controlled. All data will be transferred to main control centre with a connection to local control centre (redundant).

Fire detection system

Fire detection system is intended for timely fire detection in the tunnel tubes, emergency (SOS) niches, evacuation corridors, operating and transformer stations, as well as for alarming and undertaking protective measures against possible damages and consequences. For fire detection in emergency (SOS) niches, operating and transformer stations and evacuation corridors, addressable signalization system is designed comprised of a fire control unit, automatic detectors, manual call points, input modules and installation cables.

For fire detection in tunnel tubes, Fibro Laser linear heat detection system is provided. The detector is a fibre optic sensing cable laid on the ceiling of each tunnel tube.

Sound system

Audio sound system is intended for informing and warning of tunnel users. The design envisages digital central device with amplifiers for connecting loudspeaker sets, and has the ability of connecting microphone combination either for direct informing of traffic participants in the tunnel or for recording of new messages which would be emitted as required.

Audio communication system

SOS intercom is used for communication of tunnel users with the nearest control room and communication of officers and service personnel among themselves and

with remote control centre. A call to the control centre from the tunnel is made in case of help needed, incidents, fire, traffic accidents or breakdowns, as well as for official and service needs for communication among personnel. Personnel on duty can efficiently undertake all required measures and, if needed, forward the call to any emergency service. Dialling device (SOS phone) is proposed in each emergency (SOS) niche and at entrances into evacuation corridors.

Intrusion detection system'

Intrusion Detection System is used for detection of unauthorized access to facilities and detection of occupancy and use of emergency (SOS) niches. Intrusion detection is performed by:

- Magnetic contacts for door monitoring
- Alarm siren.

Magnetic contacts on the doors of emergency (SOS) niches are used for detection of their use. If so, signal generates, via controller, and this moment is forwarded to the video surveillance system to zoom in the zone where the alarm was generated.

Air control system

The air control system is intended for air quality monitoring in the tunnel, and in case of a disturbance, it alarms the monitoring and control centre. The system consists of:

- Air visibility monitoring set
- Unit for control of CO concentration in the air
- Air stream speed and direction control set.

Traffic control and signalization system

The traffic controller supports all functions specified in TLS specification and provides interfaces needed for diverse input-output devices, such as:

- Inductive detector
- LED VMS with pre-defined signs
- LCD displays
- freely programmable displays
- barrier gates

Video surveillance system

The video surveillance system is intended for surveillance of the tunnel system and documenting of events by recording on an appropriate device. The video surveillance system consists of:

- Fixed colour cameras
- Mobile colour cameras

The cameras allow for contents analysis, follow-up of incidental situations, vehicle crossing over to the opposite lane, forbidden overtake. The design envisages

recording of events, storage, date and time recording and content viewing and printing.

Radio communication system

Radio system devices and installation have to enable radio communication in the tunnel with police department, fire department, ambulance and maintenance services. Radio system installation has to support digital TETRA functional system. The system basically consists of a receiving antenna system for signals present at the technical centre location, base station located in the technical centre, repeaters in the tunnel itself, fibre optic communication infrastructure and radiating cables.

Central system – fibre optic ring

The Central Monitoring and Control System is located in a rack in the technical centre and is used for monitoring and control of all systems in the tunnel, evaluation of collected data, deciding on actions and visualization of the system. This design envisages a fibre optic ring which runs along the route of telecommunication channels on the right side viewed in the driving direction through both tunnel tubes.

Ventilation system – “Racunkovo brdo”

Tunnel “Racunkovo brdo” will be ventilated using longitudinal ventilation system. The longitudinal ventilation system consists of 16 jet fans per one tunnel tube. Fans are arranged in groups of two (pairs). Distance between fan groups is 100 m. The distance of the first group of fans from the entrance into the right tube and exits from the left tube is 120 meters. The distance of the first group of fans from the exit of the right tube is 100 meters from the entrance to the left tube 75 meters. Nominal electrical power fan is 18.33 kW with a achieved flow of 16 m³ / sec. All fans are reversible and have the ability to achieve full capacity of ventilation in both directions. During normal operation (free traffic flow without obstruction at speeds of 20-80 km / h) ventilation system provides air movement speed 1-1.5 m / s in the direction of the vehicle. In normal operation mode required ventilation can be achieved in the case of exclusion 4 fans per one tube. During the work in the event of an emergency or fire, the ventilation system works in the maximum operating mode in which achieved a critical air velocity > 2.8 m / sec. The fans are arranged that can be operated at an elevated temperature (400 0 C) for 2 hours.

Ventilation system – “Bozurna”

Tunnel “Bozurna” will be ventilated using longitudinal ventilation system. The longitudinal ventilation system consists of 8 jet fan at one tunnel tube. Fans are arranged in groups of two (pairs). Distance between fan groups is 100 meters. The distance of the first group of fans from the entrance into the right tube and exits from the left tube is 120 meters. The distance of the first group of fans from the exit of the right tube and the entrance into the left tube is 100 meters. Nominal output fan is 25.7 kW achieved with a flow rate of 25.6 m³ / sec. All fans are reversible and have the ability to exercise of the full capacity of ventilation in both directions. During normal operation (free traffic flow without obstruction at speeds of 20-100 km / h) ventilation system provides air movement speed 1-1.5 m / s in the direction of the vehicle. In normal operation mode required ventilation can be achieved in the case of switching off the fan 2 per one tube. In the event of an emergency or

fire, the ventilation system works in the maximum operating mode in which achieved a critical air velocity $> 2.58 \text{ m / sec}$. The fans are arranged that can be operated at an elevated temperature ($400 \text{ }^{\circ}\text{C}$) for 2 hours.

System for Pressurization of cross-connections

The system for pressurization of cross-connections for emergency evacuation should provide the necessary overpressure in the corridor to avoid the penetration of flames and smoke from the fire zone in the evacuation zone. Pressurization is done using a pair of axial fans and overpressure dampers. Complete maintenance system overpressure is designed to work and spare fan. Overpressure inside evacuation corridor may not cause the force to the door of more than 133 N.

HVAC system in technical centres

Technical centres are fully equipped with an air conditioning system to maintain the environmental conditions for the work of the staff. Rooms for the diesel-generator are equipped with a ventilation system.

ITS Installations

In order to provide efficient and safe movement of all road user on future highway, Intelligent Transportation Systems (ITS) equipment have been designed. ITS equipment will provide efficient management of traffic flows on the highway as well as fast reactions in case of the emergencies on the road.

As traffic conditions in tunnels are different from other parts of the highway and risk of accident is higher, higher concentration of ITS installations is provided in them, which will reduce risk of an accident through better traffic management. Some of the major ITS systems that will be provided are Variable Message Signs (VMS), info panels, SOS phones, data collection systems, traffic lights etc.

At the entrance portals of tunnels, it is planned to install info panels, which will inform users about certain condition within the tunnel.

In order to provide efficient and safe movement inside the tunnel tubes, by managing traffic flow, it is planned to use variable message signs, which will be placed at the distance of about 250 meters along the tunnel. Also, traffic lights for lane management are planned to be provided. Variable message signs will inform users about the hazards, speed limit and other valuable information about traffic conditions inside tunnels.

Right before evacuation cross-connections which are planned for redirection of vehicles in case of an emergency, it is planned to install traffic lights which will regulate the flow of oncoming traffic.

To increase the visual guidance, it is proposed to install LED markers on the edge lines. The typical distance between the LED markers is 25 m in the inner zone of tunnel and 15m in the zones close to the tunnel portal.

Inductive loops are planned to be installed at entry and exit portals of the tunnel. They will collect data on traffic flow that enters and exit tunnel including traffic counts, categories of vehicles, speed, direction etc.

Monitoring and traffic management inside tunnels is planned from Remote control centre. Auxiliary control centres (part of technical centres) will be provided in the vicinity of tunnel tubes. Connection of all tunnel equipment with control centre will be provided via optical cables.

2.1.8 Other structures

Engineering structures and slope protection

Diverse designed (technical) solutions were adopted considering engineering structures and slope protection of the highway E 80 on the subject section. Significant diversity of technical solutions was required considering terrain morphology, road alignment, clearance gauge of motorway, insight into Basic geological map, geological characteristics of the ground etc. Deep cuts – notches, embankment backfilling, quite a few structures along road alignment, retaining and breast (lining) concrete wall were foreseen.

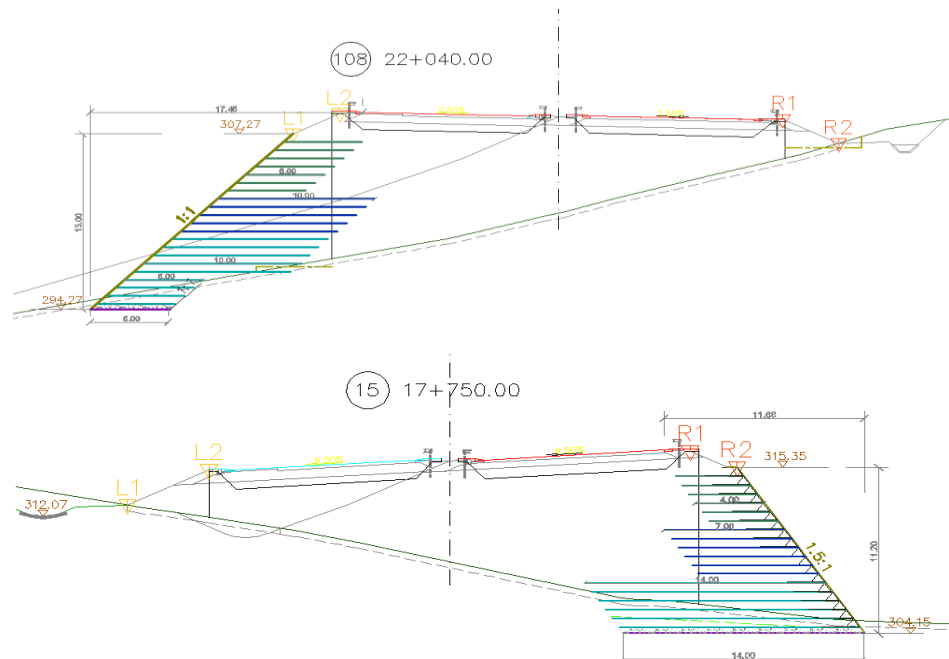
The basic structure of the designed - technical solutions is as follows:

- Slope shortening of the highway trunk embankment by adopting reinforced soil slopes with plastic geo-grids.
- Stabilization of the slope cut in cohesive (weakly bonded) ground (marlstones), by adopting a discontinuous retaining structure made of bored piles
- Shallow - to medium deep slope rock cuts without stabilization measures
- Stabilization of deep rock cuts, by adopting regular anchoring, placing of steel wire mesh, and plastic or bi-degradable mats, and construction of the breast (lining) wall in the toe of the rock cut

Slope shortening of the highway trunk embankment by adopting reinforced soil slopes with plastic geo-grids

On some sections, slope shortenings of the highway trunk embankment were designed in order to adopt steeper embankment slopes of (v: h) 1: 1.5 or 1: 1 instead if typical embankment slopes of (v: h) 1: 3, 1: 2.5 and 1: 2, and to additionally strengthen the embankment. The embankment strengthening is secured by designing Reinforced soil (earth) slopes. Reinforced earth - embankment slopes are designed to be made of plastic - flexible geogrids and backfilled by material from borrow pits along road alignment, or in the special case of very high reinforced soil slopes, from coarse and highly permeable soil material – widespread and well graded sandy and gravel soil.

Figure 15 View of the typical reinforced earth structures, with the slope inclination of (v:h) 1:1 & 1.5:1

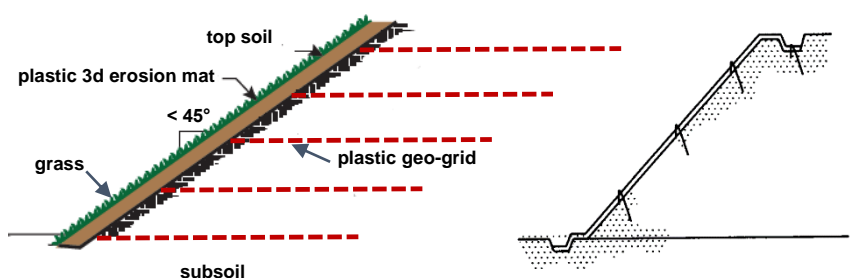


Source: Consultant's design

Specific care was rewarded to the slope protection of reinforced soil structures against erosion. Depending on the face inclination of the reinforced soil, slope protection is carried out at the following two methods:

- 1 In the case of the inclination of the slope reinforced earth (v: h) 1: 1, plastic 3D geo-grids are foreseen, as well as slope protection by placing vegetative layer – top soil (Figure 15).
- 2 In the case of reinforced soil slope with the face inclination of (v: h) 1.5: 1, placing of temporary panels, formwork” (green Terramesh), is foreseen. Panels are made of a double-twisted hexagonal steel wire mesh 8 × 10 cm, with supports and struts. The wire mesh is galvanized, by zinc alloy and aluminium (5%) - galvanized or hot galvanized, in both cases coated with thin polymer layer (PVC coating). In order that vegetation and grass can grow and develop, it's required to install vegetation “compartments” in the front, i.e., humus layer (20 cm) mixed with grass seed. The humus layer works as the first layer of the embankment, right next to the slope and is detached from the panel elements by bio - degradable jute mat or plastic mat.

Figure 16 Schematic illustration reinforced soil slope protection with inclination (v: h) 1:1



Source: Consultant's design

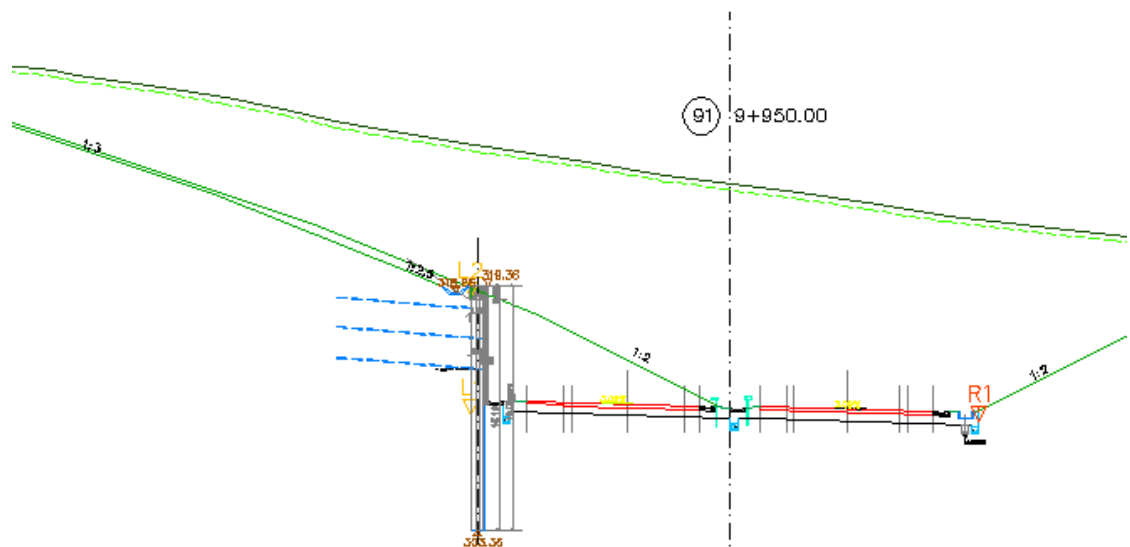
Stabilization of the slope cut in cohesive (weakly bonded) ground (marlstones), by adopting a discontinuous retaining structure made of bored piles

On the section before and after the tunnel "Debelo brdo" from Ch. 9 + 350 to Ch. 9 + 570 (start of the tunnel) from Ch. 9 + 790 (end of the tunnel) to Ch. 10 + 250 is designed to shorten slope on the left, hill side of the road, by construction of a discontinuous support structure made of the large diameter bored piles. The total length of the pile structure is $L = 94.00$ m. Support structure is made of reinforced - concrete bored pile with the diameter of $\varnothing 900$ mm and with the axial spacing of $r = 2.25$ m. Pile are length of 15.1 m. The piles are connected by reinforced - concrete beam, with the dimensions of 120x 90 cm. Between the piles, a reinforced - concrete slab is foreseen, 20 cm thick. On the slab, drainage holes "weep holes" are designed, with the length of 10m.

In the arrears of the piles, reinforced - concrete channel, with the dimensions of $b / h = 0.60 / 0.50$ m and concrete quality C 25/30 are designed.

Slopes above the piles are designed at an inclination of (v: h) 1:2.5 and 1:3.

Figure 17 Typical view of the slope cut stabilization measures by bored piles



Source: Consultant's design

Shallow – to moderate deep slope rock cuts, without stabilization measures

On the sections with shallow – to moderate deep rock cuts, in the complexes of crystalline schists: mainly gneiss and amphibole -gneiss, mica schist, amphibolic schist, pegmatite, aplite, quartz and marble (Gn), extensive slope stabilization measures are not provided. Rock slopes excavation (cuttings) are designed in the inclination of (v: h) 1: 1. The maximum depth of a rock cut section is $h = 6$ m. After each cut section, protective 7 berms, with the width of $b = 3.0$ m, are designed, in order for proper construction, drainage and maintenance of slopes. In the middle of the berm, drainage ditch is designed, and inclined berm sides of 4%, to the ditch.

All rock slope surface, irrespective of the applied method of stabilization, are designed to be processed by hydro seeding. By applying hydro seeding procedure, vegetation is growing faster, from 5 to 7 days, and also grass roots are bonded better to the ground. If the procedure is performed properly and timely, uniform and lush vegetation of ground surface is obtained in a very short period of time. Ultimate is vegetation coverage of 50% is expected to develop eventually.

Figure 19 Typical view of deep rock cuts stabilization measures, by applying regular anchoring, placing of steel wire mesh, and plastic or bi-degradable mats, and construction of the breast (lining) wall in the toe of the rock cut

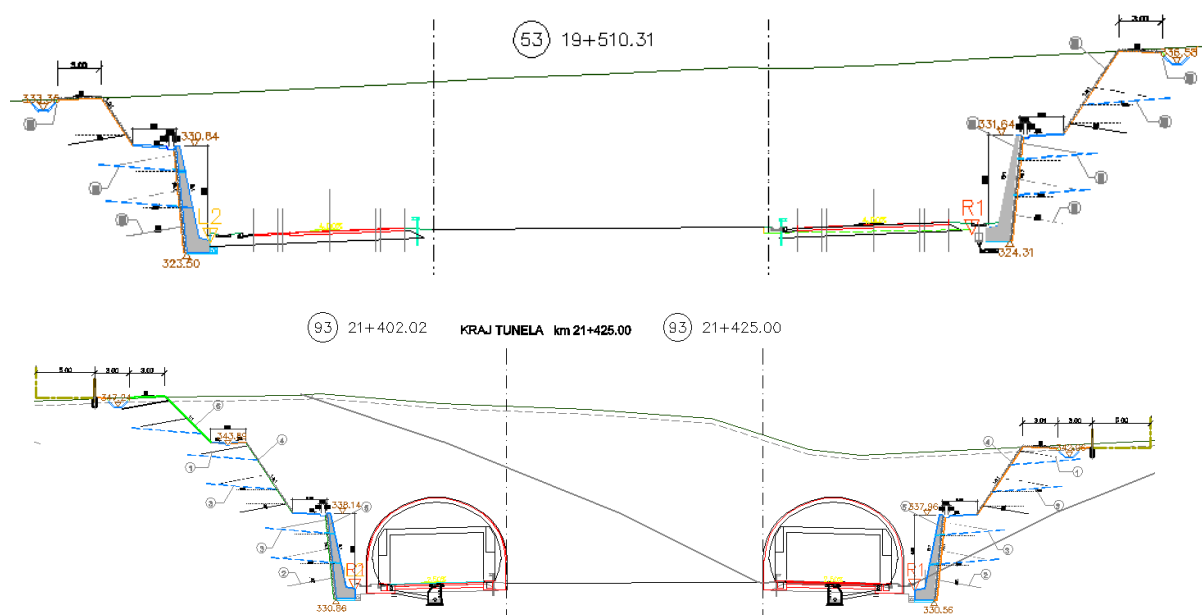


Figure 20 View of principal rock cut stabilization measure by applying regular anchoring, placing of steel wire mesh, and geo-mats



Noise barrier structures

The noise caused by traffic flow is discontinuous, of variable intensity, with intermittent pulses. It has a negative impact on the quality of life of the surrounding population and its health. Since a large number of facilities is located in the immediate vicinity of the observed section, it is necessary to implement appropriate protection measures against negative impact of the traffic noise.

Design of noise barriers envisages the construction of structures for noise protection, which would eliminate its negative impact.

Acoustic zoning was not conducted during the development of the preliminary design for subject area, and therefore permissible noise levels are not defined. Selection of the permissible noise levels was done in accordance with the Regulation on noise indicators, disturbance and harmful effects of noise in the environment (Official Gazette of RS, No. 75/2010). Since the newly designed road belongs to the category of highway, the highest values of the permissible noise levels are selected regarding the category of the observed roads, and use of the area directly to the road. The designer has selected the values of permissible noise levels for residential areas which amount to 65 dB (A) for the daytime period and to 55 dB (A) for the night-time period. In preparation of the Final Design, it is necessary to determine whether the acoustic zoning has defined permissible levels, which deviate from the adopted ones for the preparation of the Preliminary Design, and accordingly determine the need for protection measures.

The project envisaged placing of noise protection walls. The height and length of noise protection walls is determined based on the noise level analysis, using the CadnaA software. Required length and height of the walls are obtained as the result of the analysis.

Height of the walls is defined so that it provides a reduction of the traffic noise levels below the permissible level in settlements along the planned road. Several types of solutions were taken into consideration and the proposed solution meet the following criteria:

- Resistance to weather conditions
- Rational constructions
- Visual effects
- Possibility of pre-fabricated construction
- Possibility of superstructure
- Spatial coherence
- Easy maintenance

Noise barriers are provided on the left or right side, as observed in the chainage growth direction, in the area of objects which are exposed to the negative impact of the forecast traffic, at the total length of about 228 m. The height of the walls varies from 2 meters to a maximum of 2.5 meters.

2.1.9 Road side facilities

The basic road side facility concept includes facilities which are related to the function of a highway (functional facility) and facilities which are designed to meet the needs of road users (facility for user needs).

Functional facilities

Functional accompanying facilities include all the services and facilities whose primary purpose is the maintenance and minor repairs of road structures and

elements, as well as supporting service equipment. This group includes supporting facilities and services and / or facilities needed to control and manage the traffic on the road.

For the E-80 highway the **linear spatial distribution** base for maintenance and facilities management and control traffic was adopted, in principle. This solution takes into account the relationships of standards and the required level of maintenance.

The following functional accompanying facilities are provided along the highway:

Road maintenance facility are complexes of buildings used to accommodate all services and equipment for winter and summer road maintenance;

The position of the facility is within the typical junction („double trumpet“, „indirect trumpet“).

Maintenance facility is the basic facility that covers the so-called “Highway unit section” with a length of approx. 40km, according to adopted linear maintenance system.

Road control and management facility, in accordance with the basic principles (find out→ inform→undertake) which contains:

- Systems to provide timely information
- Notification system

The maintenance and control base is located near junction “Prokuplje (West)” km 23+600

Toll collection includes services and facilities intended for the collection, processing and control of collection. Toll collection facilities, includes:

- Main toll station (GNM): After Merošina junction at km 2+150.00 and
- Side toll station (SNM): The position of SNM is defined by location of the junctions. Every junction has one side toll station.

Facilities for the road user needs

Several facilities for road user needs are proposed along the highway alignment:

Rest areas that are used for shorter staying and relaxation (15-30 min.) Parking for cars is separated from the parking for trucks and buses that are parked in the same area. In future, if there is a need, these areas can be equipped with an internal telephone, sanitary facilities, drinking water, billboards with tourist information etc.

Service areas involve longer staying (30-90 min.), and have a separate area for parking of passenger cars, buses, trucks and, if need be, tourist vehicles. They contain parking, public phone, lighting, restaurants, shops, cafes etc. There may be gas stations and repair facilities for minor service and repair.

Location of facilities for users' needs

The main goal in locating the facilities areas is to match the needs of users with functional safety requirements and spatial possibilities and limitations, with consideration of the following parameters:

- traffic-technical conditions;
- "external overview" of facility;
- position relative to the junction;
- limiting elements of the plan and profile;
- spatial limitations;
- natural and historical conditions of micro-location;
- utility infrastructure;
- environmental protections.

Table 11 Location of facilities for users' needs

Station	Type of facility	Type	Name
3+250	Service area	Both sides	"ALEKSANDROVO"
13+100	Rest area	Both sides	"ARBANASCE"
28+150	Service area	Both sides	"MALA PLANA"
37+800	Rest area	Both sides	"PLOČNIK"

2.2 Road Safety

2.2.1 Traffic and Road Safety implementation

The main aim of the Traffic and Road safety implementation in motorway is to increase traffic safety and to ensure safe traffic conditions in terms of proposed Level of Service. By its implementation greater efficiency can be achieved and traffic safety can be increased on each section of proposed motorway.

Nis-Plocnik motorway Preliminary Design contains several integral parts where traffic and road safety is implemented. As a part of PD, ITS implementation is proposed (both on open route and in tunnels), electrical and mechanical installation are also proposed along the route and in tunnels, traffic signalization and equipment is proposed for alignment and side facilities. Finally, Road safety audit is performed for whole Nis-Plocnik proposed alignment.

Highway alignment and all its side facilities are planned and designed according to local laws, rulebooks and guidelines:

- Law on Public Roads (Official Gazette RS no. 101/05 and 123/2007, 101/11, 93/12 and 104/13)
- Law on Road Traffic Safety (Official Gazette of RS No. 41/09, 53/10, 101/11 and 32/13-CC)
- Rulebook on the Conditions which Have to be Fulfilled by Road Structures and Other Elements of Public Road from the Aspect of Traffic Safety (Official Gazette of RS No. 50/11), and others,

and also according to international guidelines and best practise (EU and German standards and guidelines) such as:

- Richtlinien für die Anlage von Landstraßen, RAL, Germany.

2.2.2 ITS equipment on the route of the highway E80

The implementation of intelligent transport systems (ITS) includes measures and technology that combine information and telecommunication technology which can increase the level of traffic safety, efficient traffic flow and therefore a lower level of environmental pollution.

The aims of applying the ITS systems are:

- Informing drivers about traffic conditions, restrictions, warnings and other required information which have variable character
- Traffic control in terms of traffic management
- Management of traffic flow in case of the incident in order to reduce the consequences and negative impacts on other vehicles in the traffic flow

Positioning and implementation of equipment and system along the highway provides certain features and limitations in the exploitation of the highway. For this reason, in moment of defining location of the equipment it was necessary to ensure, as far as possible, flexibility and sustainability of the proposed system. Systems that provide this are as follows:

- Fully programmable information (graphic) display on the portal with the ability to display text in the central part and displaying standard traffic signs – Info tables
- Variable message signs (VMS) with the ability to display predefined traffic signs
- Elements to control the height of vehicles that access highway
- The system for collecting data on traffic flow in the form of inductive loops that are positioned into the pavement
- The system for collecting data on weather conditions along the route of the highway – Meteo stations
- Weight In Motion System (WIM)
- The system for detecting the transport of dangerous goods

All ITS equipment is proposed and designed according to:

- Law on Road Traffic Safety (Official Gazette of RS No. 41/09, 53/10, 101/11, 32/13-CC, 55/2014, 96/2015 - other law and 9/2016 - CC)
- Rulebook on Traffic Signage (Official Gazette of RS No. 134/14 and 85/17)
- Manual for Roads Designing - SRDM 6-6 ITS equipment
- Best local and international practice

2.2.3 ITS equipment in the tunnels of the highway E80

Along the route of the highway E80 project envisages the construction of 6 tunnels. Length of the tunnels ranges from 220m to 1225m. Tunnels Računkovo brdo and Božurna are two major tunnels with lengths of 1225m and 620m respectively, while other smaller tunnels having length of to 300m. In these two tunnels adequate traffic equipment is provided which will ensure safe traffic in the tunnel tubes and traffic management in the event of unforeseen circumstances or needs for closing a tunnel tube for traffic.

At the entrance to the tunnel Računkovo brdo, access control with barriers is designed. Barriers are designed for individual tunnel tubes so one tube can be closed in the case of an incident or closing tube for maintaining. At the entrances to the tunnel Božurna there are no ramps provided but access control is done by the traffic light system.

The following elements of ITS equipment have been implemented in these tunnels:

- The system for collecting data on traffic flow in the form of inductive loops that are positioned into the carriageway
- Fully programmable information (graphic) display on the portal with the ability to display text in the central part and displaying traffic signs according to the current regulations on traffic signalisation – Info tables
- Variable message signs (VMS) with the ability to display predefined traffic signs
- Access control with barriers (Računkovo brdo)
- Led markers on the carriageway

VMS signalization placed inside the tunnel is planned so that it can provide information to users, in both directions. This makes possible, if necessary, two-way traffic in each tunnel tube.

All ITS equipment is proposed and designed according to:

- DIRECTIVE 2004/54/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 29 April 2004, on minimum safety requirements for tunnels in the Trans-European Road Network
- Rulebook on the Main Conditions which a Tunnel on a Public Road Has to Fulfil from the Aspect of Traffic Safety and Suitability of the Road for Traffic (Official Gazette of RS No.121/2012)
- Manual for Roads Designing - SRDM 6-6 ITS equipment
- Manual for Roads Designing - SRDM 11-5 Tunnel Equipment
- Law on Road Traffic Safety (Official Gazette of RS No. 41/09, 53/10, 101/11, 32/13-CC, 55/2014, 96/2015 - other law and 9/2016 - CC)
- Rulebook on Traffic Signage (Official Gazette of RS No. 134/14 and 85/17)

2.2.4 Electrical and safety installations in tunnels

In order to provide efficient and safe movement of all road users on future highway a number of electrical and mechanical installations have been designed primarily in

road tunnels. Electrical and mechanical installation will provide safe environment for all tunnel users. They consist of:

- Power installations
- Telecommunication installations
- Ventilation

Power installations comprise transformer substations, back-up power supply (UPS and diesel generator), power distribution via cabinets, lighting (general and emergency) and automation as a specific part.

Telecommunication installations comprise fire detection, video surveillance, radio re-broadcast, emergency telephones and sound information system as well as gas detection and air movement measurement.

Ventilation system consists of reversible jet fans in pairs at certain distance in entrance part of the tunnel as well as overpressure fans for cross connections.

All systems are monitored and controlled via SCADA with manual override option.

Tunnels „Božurna“ and „Računkovo brdo“ (longer than 500m) are equipped with Safety installations for long tunnels as per EU regulations, RABT, RVS and Local regulation and guidelines.

2.2.5 Traffic equipment and signalization

Interchanges and road sections are marked with standard traffic signalisation and equipment. Road markings are used to divide traffic lines and mark areas that vehicles should use. Traffic signs will inform users about priorities, speed limits as well as give them information about destinations in the zones of the intersections. As main element of passive road safety guiderails are designed along the section in order to reduce consequences of potential traffic accidents.

All Traffic equipment and signalization equipment is proposed and designed according to:

- Law on Road Traffic Safety (Official Gazette of RS No. 41/09, 53/10, 101/11, 32/13-CC, 55/2014, 96/2015 - other law and 9/2016 - CC)
- Rulebook on Traffic Signage (Official Gazette of RS No. 134/14 and 85/17)
- Technical guidelines for the implementation of the system for retention of vehicles on public roads in the Republic of Serbia

2.2.6 Road Safety Audit

As a part of Ministry of Construction and PERS road safety audit strategy, along with some other projects, Preliminary Design for Nis-Pločnik motorway was a subject of extensive Road Safety Audit (RSA).

RSA Workshop took place in Belgrade, PERS premises, from 28-30. November 2017. RSA was performed through:

TA to Connectivity in the Western Balkans

Sub-Project Code: CONNECTA-TRA-CRM-REG-01

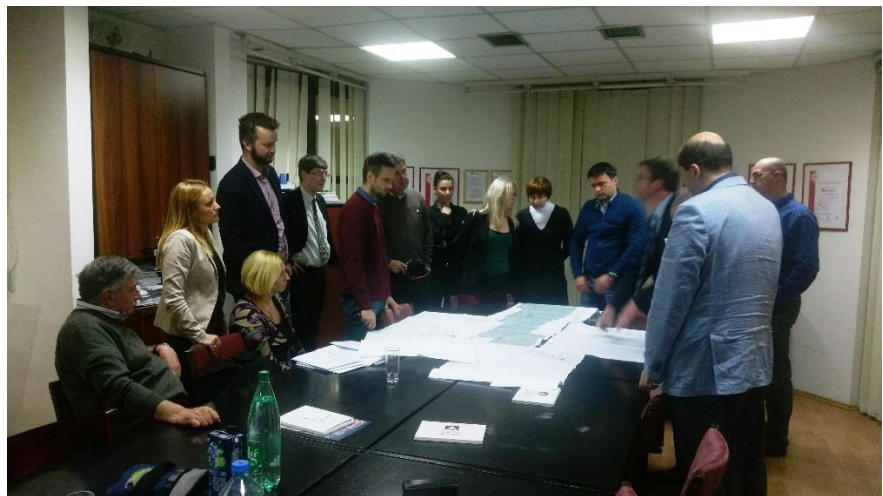
Area: Connectivity Transport Reform Measures

Preparation of Road Safety Inspection and Audit Plans for core/comprehensive road network in Western Balkans (WB6) and Pilots

Stage One Road Safety Audit, E80 Niš-Pločnik, Serbia

On Day 1 Design team presented the project background and also technical, environmental and social part of the design. After the presentation RSA team and Consultant discuss further about some aspects of the highway alignment and other part of the design.

Figure 21 RSA Workshop and discussion



On Day 2, RSA team performed a Site visit, together with Consultant, in order to become more familiar with the existing state road (which is close to proposed highway) and also to see proposed places for major highway objects (interchanges, tunnels, bridges etc.).

Figure 22 Site visit and design review "in situ"



On Day 3, RSA team, together with Beneficiary, performed a meeting and agreed further steps in audit.

The Consultant received comments from RSA team, in a form of report which was prepared on 20 December 2017. After reviewing this report the design was improved taking into consideration the RSA recommendations. Then a report was prepared describing what is implemented and some of the design solutions were also further explained. That Report was sent to PERS and to the Ministry on 13 February 2018.

2.3 Transport of the excavated material

For the purposes of the elaboration of the Feasibility Study, rough estimates of the earthworks have been carried out. Approximate quantities of earthworks were obtained from the projected cross-section profiles. The mass balance of earthworks will be attached as an integral part of the highway route project.

The highway section from Niš to Pločnik is physically divided into 5 (sub-) sections (defined among interchanges), however, insight into the layout of the mass, imposes the following logical unit: Section I and Section II to represent Lot 1 (Merosina – Prokuplje), Section III - Lot 2 (Prokuplje Bypass), Section 4 and Section 5 - Lot 3 (Prokuplje – Pločnik). Nevertheless, it must be noted that this is an indicative separation and that the final elaboration and definition of construction Lots will be performed during the Detail Design of the project.

Table 12 Review of indicative separation in Lots and sections

Lot 1		Lot 2	Lot 3	
I Section	II Section	III Section	IV Section	V Section
0+000-5+500	5+500-14+280	14+280-27+096	27+096-32+650	32+650-39+419

It has been assumed that the excavation will be carried out by the excavator "CATERPILLAR 365C L", and transport by truck "MERCEDES 4144-K ACTROS".

Based on the practical effects of the above mentioned, the traffic will be carried out as follows:

- For a transport distance of 1km excavation, carry one excavator and 5 trucks.
- For a transport distance of 3km excavation, carry one excavator and 8 trucks
- For a transport distance of 8km excavation, carry one excavator and transport 15 trucks
- For transport distance of 10km excavation, one excavator and transport of 17 trucks

Transportation in the construction site is done by a different set of machines bulldozer and grader.

Transport will be carried out by state road IB-35, local roads for the needs of the approach, temporary construction roads for access to the construction site.

“Lot 1” Merosina - Prokuplje:

Section I, length 5,5 km - one team of workers will work in the site (21049 m³) for 46 days, the other team will transport the material (37119 m³) from the borrow pit 17 truck -17 days;

Section II, length 8,78 km - divided into two parts and with two workers transport teams will transport excavated material (776034 m³) - 262 days, transport of materials (98167 m³) at a distance of 8 km 15 trucks - 44 days, transport of excavated materijal (117527 m³) in to Section I - 17 Trucks for 52 days, transport of excavated materials (68096 m³) to the landfill for 30 days.

“Lot 2” Prokuplje bypass:

Section III, length 12,816 km - will be divided into three sections.

- Three sets of machines will work in site (273135 m³) for 124 days.
- Three sets of machines (15 trucks) will handle the transport of materials (1360 m³) at the transport length of up to 1 km - 1 day
- Three sets of machines (24 trucks) will carry the transport of materials (26612 m³) at the transport length up to 3 km - 4 days
- Three sets of machines (33 trucks) will carry the transport of materials (423820 m³) at a transport length of up to 8 km - 62 days
- Three sets of machines (51 trucks) will handle the transport of materials (325485 m³) at a transport length of up to 10 km in a landfill-48 days.

“Lot 3” Prokuplje - Plocnik:

Section IV, length 5,554 km.

Required quantity of material (775398 m³) will be delivered from a borrow pit with 17 trucks in 341 days.

Section V length 6,769 km.

One set of machines will be transported in site (30362 m³) for 66 days.

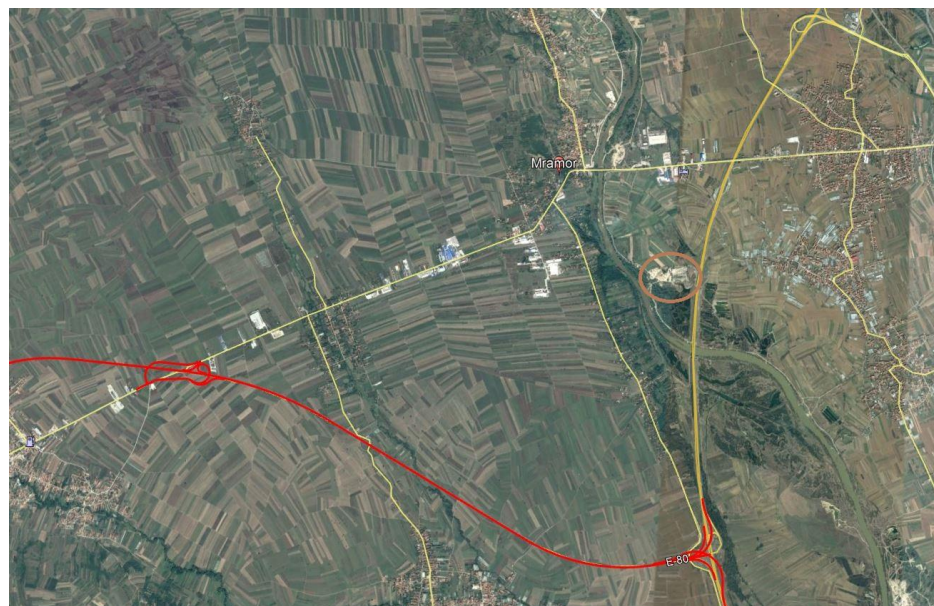
Required quantity of material (1188982 m³) will be delivered from a borrow pit with 17 trucks in 522 days.

Top soil (up to 0.4 m thick) and agricultural subsoil will be stripped and temporarily stockpiled in dedicated areas for later use (restoration, landscaping, etc.).

Potential borrow pits for gravel, in relative vicinity of the highway, are:

- Batušinac (south of Merosina I/C)
- Čokot, near village Mramor, 11 km from Niš
- Doljevac, 20 km on south of Niš, near village Doljevac
- Krušče, near existing road Niš-Prokuplje, 13 km from Niš, on the right side of the road, near village Krušče
- Pločnik, on the left side from the road Prokuplje-Kuršumljija, 23km from Prokuplje.

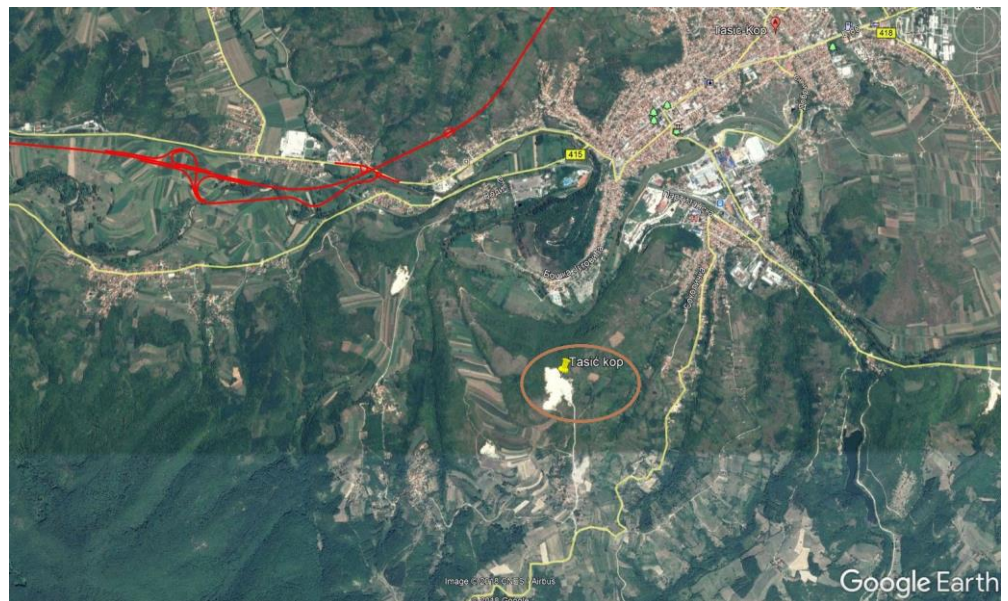
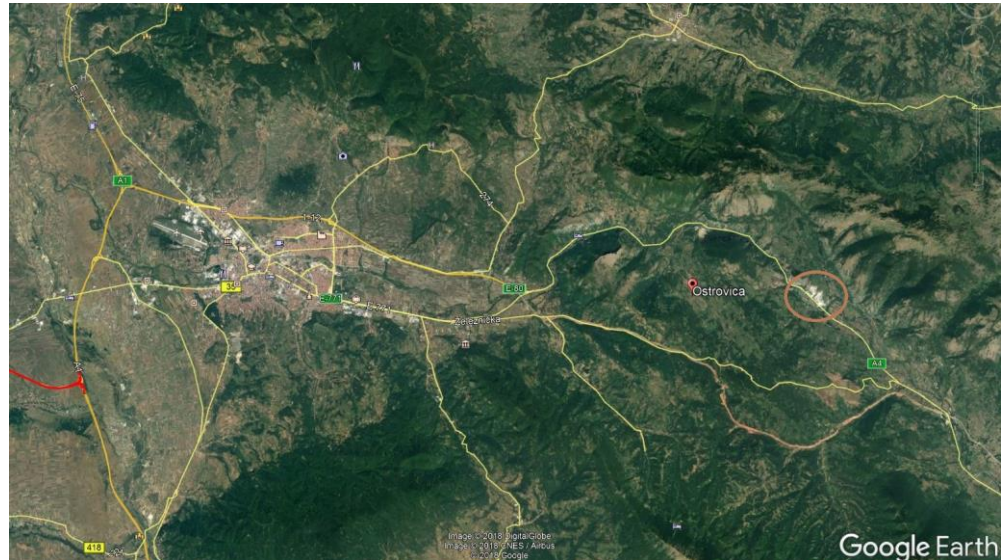
Figure 23 Potential borrow pits for gravel close to Merosina I/C



Potential borrow pits for crushed stone (limestone):

- Ostrovica, on the right side of Niš-Pirot road, 23km from Niš (dolomite)
- Tasić kop, near Prokuplje

Figure 24 Potential borrow pits for crushed stone



The above mentioned locations constitute potential sources of material, but quarries and borrow pits are not defined in the present stage of the project (Preliminary Design). This will be initially investigated during the Detail Design phase, when the final decision regarding the construction lots will be taken, thus the needs for materials and disposal will be performed. At the Detail Design stage a closer comparison of environmental and social impacts will be undertaken by the updated ESIA. These impacts (among others) will include visual intrusion, noise, sedimentation and transport of materials.

2.4 Display of emissions

This chapter provides an overview of the types and quantities of gases, liquid and solid matter emitted by motor vehicles, including discharges into surface and groundwater, landfill and noise, vibration, heat and ionizing and non-ionizing radiation.

Pollution effects of the Construction phase can be considered as minor compared to the operation phase, and they are elaborated in section 5.1. The movement of motor vehicles is dominating cause of degradation of the present ecological potentials. Other possible causes of degradation are inorganic leached from the material storage, wastewater of workers and other anthropogenic emissions. Due to the adopted immission modeling methodologies, it is appropriate to divide the emissions from the motor vehicles into three groups:

- Gaseous substances,
- Solid and liquid phase,
- Noise.

From the aspect of the time character of broadcasting, pollution in the wider sense can be permanent, seasonal and accidental.

Continuous (systematic) pollution is primarily related to the volume, structure and characteristics of the traffic flow, the characteristics of the road and the climatic conditions. As a result of traffic flow, permanent emissions of harmful substances into the atmosphere, are formed.

Seasonal pollution is related to a certain annual period. A typical example of this type of pollution is the use of salt to maintain the road in the winter months. This type of pollution is characteristic of the fact that in a very short period of time, large concentrations of sodium and calcium chloride occur.

Accidental harmful pollution is most often due to the transport of hazardous materials: oil and its derivatives, although it is not rare very dangerous chemical products, either liquid or easily volatile. Special problem in this case is the fact that these are almost instantaneous very high concentrations that can not be foreseen temporarily or spatially. Consequently, very wide belts, most commonly water areas, but not rarely and superficial waters of high category, are often protected from the point of view of protection, as the most risky places on the freeways in the mentioned sense.

Display of the type and amount of emitted substances is a starting step to approximate quantification of the effects of traffic on environmental resources.

The significant negative impact of transport in terms of environmental protection is air pollution. Each liter of combusted fossil fuel produces approximately 100g of carbon monoxide, 20 grams of volatile organic compounds, 30g of nitrogen oxides, 2.5g of carbon dioxide and many other noxious and toxic substances such as sulfur compounds and particulates. All these compound result in air pollution to a

certain extent, either by direct effect on the health or globally, causing the greenhouse effect.

For the determination of the quantity of emitted gaseous pollutants, which come from the road, the software tool Copert 4 was used. Its development was funded by the European Environment Agency - EEA in the framework of the activities of the European Thematic Center on Air and Climate Change.

Gaseous substances

The measurement results obtained by Copert methodology were used for this research study. Quantities of six dominant components of exhaust emissions in grams per kilometer are given in Table 12.

Table 13 Specific emission for road vehicles [g/kg fuel]

Category	Fuel	CO	NO _x	NM-VOC	CH ₄	PM ₁₀	CO ₂
Passenger car	Gasoline	221,70	28,39	34,41	1,99	0,00	2720
	Diesel	12,66	11,68	3,73	0,12	4,95	3090
Light truck	Gasoline	305,63	26,58	32,61	1,51	0,00	2590
	Diesel	15,94	20,06	1,08	0,08	4,67	3090
Heavy duty vehicle	Diesel	11,54	38,34	6,05	0,34	2,64	3090
BUS	Diesel	10,61	42,02	5,75	0,44	2,24	3090

Source: Consultants's calculations

Table 14 Daily emissions (according to AADT forecasts per section for year 2035)

	Merošina-Merošina 1		Merošina1-Prokuplje Istok		Prokuplje Istok-Prokuplje Zapad		Prokuplje Zapad-Prokuplje Beloljin		Prokuplje Beloljin-Interchange Kuršumljija	
	length =5.5 km		length=8.78 km		length=12.81km		length=5.55 km		length=6.77 km	
	AADT=16348		AADT=15989		AADT=13131		AADT=13742		AADT=11589	
	Overall emissions per km (kg/km)	Overall emissions per section (kg)	Overall emissions per km (kg/km)	Overall emissions per section (kg)	Overall emissions per km (kg/km)	Overall emissions per section (kg)	Overall emissions per km (kg/km)	Overall emissions per section (kg)	Overall emissions per km (kg/km)	Overall emissions per section (kg)
CO	131.43	722.865	128.75	1130.42	106.67	1366.44	110.55	613.55	92.18	624.06
Nox	30.75	169.125	29.97	263.14	23.59	302.19	26.84	148.96	23.08	156.25
NM-VOC	22.04	121.22	21.56	189.30	17.69	226.61	18.84	104.56	15.66	106.02
CH ₄	1.24	6.82	1.21	10.62	0.99	12.69	1.04	5.77	0.88	5.96
PM10	2.91	16.005	2.84	24.93	2.27	29.08	2.51	13.93	2.13	14.42
CO ₂	3685.6	20270.8	3597.4	31585.2	2883	36931.23	3169.2	17589.1	2701.3	18287.8

Source: Consultants's calculations

Liquid and solid substances

In highway operation it can be expected that liquid and solid emissions are results of following processes:

- leakage of fuel, oil and lubricants,
- deposition of exhaust gases,
- tire wear,
- pavement wear,
- leakage or spilling loads
- rejection of organic and inorganic waste.

The chemical composition of these materials are primarily fuel components such as hydrocarbons, organic and inorganic carbon, nitrogen compounds (nitrate, nitrite, ammonia). A special group of elements are heavy metals such as cadmium, copper, zinc, mercury, iron and nickel. A significant part is made of solid matter of different structures and characteristics that occur in the form of precipitated, suspended or dissolved particles. It is possible to register the substances that are the result of use of specific materials for corrosion protection. Another group of carcinogenic materials are polyaromatic hydrocarbons (benzopyrene) which are the product of incomplete combustion of fuel and used engine oil.

For the estimation of quantities, it was assumed that all solid and liquid substances are deposited in the first time on a pavement, and then, through spraying, rinsing and other processes coming to the ground, surface and ground waters, etc. In accordance with this, and based on the foreign experience derived from 20 years of research, an estimate of emissions of pollutants retained on pavement surfaces was carried out. The substances quantities that motor vehicles emit during one year per hectare of pavement surface for the reference traffic load and the forecasted traffic, as well as the total amount of pollutants on the highway route at an annual level are given in the following tables.

Table 15 Emissions of solid and liquid substances at annual level for section I, year 2035

Section I: Merošina-Merošina 1	Reference AADT-8700 vehicles	Quantities emitted per unit area for AADT =16348	Total emitted quantities per section
	kg/ha/year	kg/ha/year	kg/year
Suspended particles	145.00	272.47	3,446.7033
Biochemical oxygen demand (BOD ₅)	6.50	12.21	154.5074
Chemical oxygen demand (COD)	49.00	92.07	1,164.7480
Total organic carbon (TOC)	25.00	46.98	594.2592
Nitrates	0.98	1.84	23.2950
Total phosphorus	0.13	0.24	3.0901
Oils and lubricants	2.25	4.23	53.4833
Copper	0.01	0.02	0.2377
Iron	2.50	4.69	59.3546
Lead	0.04	0.08	0.9984
Zinc	0.08	0.15	1.8779

Source: Consultants's calculations

Table 16 Emissions of solid and liquid substances at annual level for section II, year 2035

Section II: Merošina 1-Prokuplje East	referent AADT-8700 vehicles	Quantities emitted per unit area for AADT =15989	Total emitted quantities per section
	kg/ha/year	kg/ha/year	kg/year
Suspended particles	145.00	266.48	5,382.9633
Biochemical oxygen demand (BOD ₅)	6.50	11.95	241.3053
Chemical oxygen demand (COD)	49.00	90.05	1,819.0704
Total organic carbon (TOC)	25.00	45.95	928.0971
Nitrates	0.98	1.80	36.3814
Total phosphorus	0.13	0.24	4.8261
Oils and lubricants	2.25	4.14	83.5287
Copper	0.01	0.02	0.3712
Iron	2.50	4.59	92.6983
Lead	0.04	0.08	1.5592
Zinc	0.08	0.15	2.9328

Source: Consultants's calculations

Table 17 Emissions of solid and liquid substances at annual level for section III, year 2035

Section III: Prokuplje East-Prokuplje West	referent AADT-8700 vehicles	Quantities emitted per unit area for AADT =13131	Total emitted quantities per section
	kg/ha/year	kg/ha/year	kg/year
Suspended particles	145.00	218.85	5,889.2535
Biochemical oxygen demand (BOD ₅)	6.50	9.81	264.0010
Chemical oxygen demand (COD)	49.00	73.96	1,990.1615
Total organic carbon (TOC)	25.00	37.73	1,015.3885
Nitrates	0.98	1.48	39.8032
Total phosphorus	0.13	0.20	5.2800
Oils and lubricants	2.25	3.40	91.3850
Copper	0.01	0.02	0.4062
Iron	2.50	3.77	101.4170
Lead	0.04	0.06	1.7059
Zinc	0.08	0.12	3.2086

Source: Consultants's calculations

Table 18 Emissions of solid and liquid substances at annual level for section IV, year 2035

Section IV: Prokuplje West-Beloljin	referent AADT-8700 vehicles	Quantities emitted per unit area for AADT =13741	Total emitted quantities per section
	kg/ha/year	kg/ha/year	kg/year
Suspended particles	145.00	229.02	2,924.5428
Biochemical oxygen demand (BOD ₅)	6.50	10.27	131.1002
Chemical oxygen demand (COD)	49.00	77.39	988.2938
Total organic carbon (TOC)	25.00	39.49	504.2315
Nitrates	0.98	1.55	19.7659
Total phosphorus	0.13	0.21	2.6220
Oils and lubricants	2.25	3.55	45.3808
Copper	0.01	0.02	0.2017
Iron	2.50	3.94	50.3626
Lead	0.04	0.07	0.8471
Zinc	0.08	0.12	1.5934

Source: Consultants's calculations

Table 19 Emissions of solid and liquid substances at annual level for section V, year 2035

Section V:Beloljin-Pločnik	referent AADT-8700 vehicles	Quantities emitted per unit area for AADT =11589	Total emitted quantities per section
	kg/ha/god	kg/ha/god	kg/god
Suspended particles	145.00	193.15	3,007.3455
Biochemical oxygen demand (BOD ₅)	6.50	8.66	134.8120
Chemical oxygen demand (COD)	49.00	65.27	1,016.2754
Total organic carbon (TOC)	25.00	33.30	518.5078
Nitrates	0.98	1.31	20.3255
Total phosphorus	0.13	0.17	2.6962
Oils and lubricants	2.25	3.00	46.6657
Copper	0.01	0.01	0.2074
Iron	2.50	3.33	51.7886
Lead	0.04	0.06	0.8711
Zinc	0.08	0.11	1.6385

Source: Consultants's calculations

2.5 Demonstration of the treatment technology for all types of waste materials

Generation of waste during the construction and operation of the road is one of the causes of pollution. At the construction site there is waste that is found as a result of the campsite's existence (municipal waste) and waste found by discarding or discharging liquid or solid materials. All waste are systematically collected and tethered, especially in the presence of toxic substances or substances that can significantly jeopardize the environment.

Table 20 Generating waste on site

Operation	Generated waste
Earth works	Solid waste and excess material
Current repairs and maintenance	Used oil, rubber and metal parts
Construction camp	Waste, paper, packaging

The waste generated in the construction site usually has no toxic properties and consists of paper, plastic packaging, glass, organic waste. According to statistical data, about 0.3 kg / day is generated per person per day. Hazardous waste will also occur and its eventual occurrence in the environment is not predictable and depends exclusively on the management of the site and the construction phase, or potential accidents.

When the construction of the highway is completed, before it is put into operation, the quantities of waste asphalt, waste material from excavation and embankments, and construction waste are usually left.

Waste materials resulting from the regular operation of the highway include:

- Waste oils and sediment from the separator for collection of atmospheric waters swept from the pavement surfaces, Liquid municipal waste from sanitary facilities
- Solid municipal waste within the accompanying contents,
- Solid municipal waste from uncontrolled emissions of participants in traffic on the slopes of the road (wild landfills),
- Waste generated due to regular and periodic road maintenance.

Waste oils and sludges belong to hazardous waste and they are collected and transported by special tanks and deposited at the designated sites. The dynamics of cleaning the separator and precipitator depends on the rate of accumulation (amount of precipitation). The organization responsible for road maintenance is obliged to regularly monitor the condition of the water treatment equipment and timely organize the discharge.

Liquid municipal waste is treated depending on the vicinity of the sewerage network. In the case of the existence of a sewerage network, a connection is built and the sanitary unit enters the sewage system. Otherwise, wastewater accumulates in a septic tank, which requires regular maintenance and discharge, which falls within the competence of the local community organization on the territory where the sanitary unit is located.

The collection and transport of solid municipal waste from catering and other facilities within the road belt is performed by a municipal organization in charge of the area in which the facility is located. The road company is obliged to maintain the cleanliness of the road belt and collect all solid waste that has been discarded by road users.

Technological wastewater is purified, and the facility in whose possession the purification equipment is concerned is responsible for the disposal of waste oil and sludge. For the removal of waste, caused by the regular and periodic maintenance of the road structure, the road company is in charge.

2.6 Design Alternatives

The alignment of the project and the technical solutions were selected among several options examined during the General Design and the Preliminary Design.

2.6.1 Highway alternatives analyzed in the General Design

Alternative solutions were obtained by a combination of options:

- Location of the loop on the E-75 highway, options: (Nis)Merošina-N or Doljevac-D
- Variant of the Prokuplje bypass, options: north-a, south-b
- Variant of route Prokuplje-Pločnik, options: north-1, medium-2, south-3

The evaluation of alternative solutions and the selection of the preferred one was performed using Multi-Criteria Analysis (Annex 5). The MCA included the following criteria:

- Engineering requirements expressed through construction and maintenance costs,
- Exploitation costs,
- Safety of traffic,
- Spatial consequences,
- Environmental and social consequences

In particular environmental and social consequences included Social Environment (expropriation of agricultural land and resettlement of inhabitants), Nature Protection (nature protected zones, impact on water), Cultural heritage, and Climate Change Adaptation (risk of flooding and risk of landslides). Preliminary assessment of suitability has been made for all variants of the General Design taking into account all above mentioned criteria.

The first rank grouping of criterios is between **Costs and Impacts** with a relative weight 30% - 70% respectively. Then five groups of Impacts were set, namely:

Environment (20% weight)

Socio-Economic (15% weight)

Safety (15% weight)

Climate Change Adaptation (10% weight)

Strategic Relevance (10% weight)

All examined variants (18 of them, formed as all possible combinations of sections) were estimated approximately similar from the ecological point of view.

The above mentioned criteria were taken into consideration along with financial, economical and planning criteria.

As presented in the tables below, the initial estimations for expropriation needs vary between from 233 Ha to 271 Ha, and from 32 to 63 buildings.

Alternative Na2 being

- one of the most economic ones,
- presenting highest scores in vehicle operating cost and travel time savings,
- having the minimum need for acquisition of agricultural land and
- one on the less needs for buildings expropriations as well as
- total accordance with spatial plan and local planning

scored higher and **has being selected**.

This alignment has been further elaborated in the Preliminary Desing.

Comparing the alternatives with respect to agricultural land and expropriation needs, the following should be noted:

- “N” to “D”:

N - the selected alignment does not influence the most productive land. Care was taken to avoid large vineyards, either as part of the vinery itself or as fruit bearing complexes. It requires less expropriation of buildings and agricultural land. Moreover the planned highway is on the path of the existing road.

- “a” to “b” to “b + a’ ”:

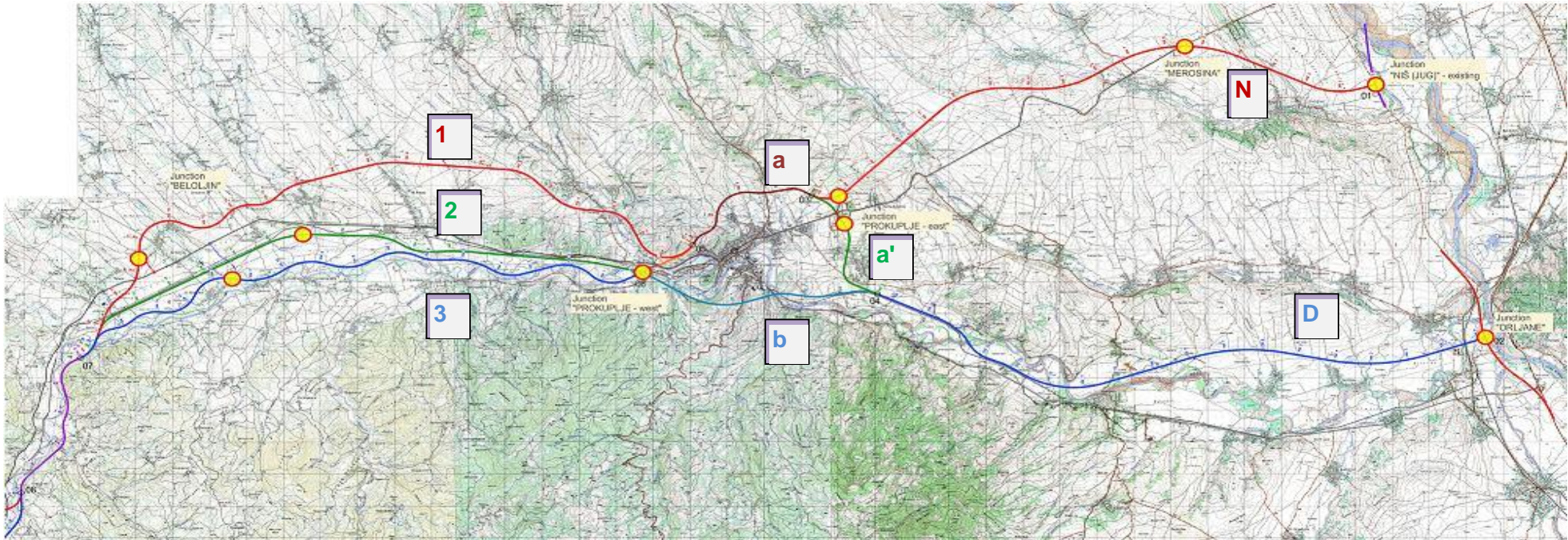
“a” - slightly higher need for expropriation, in relation to “b”, present alternative options “a” and “b+a’ ” as a consequence of proximity to the suburban zone of Prokuplje. In this zone there are at least 200 residential buildings, so the maximum care was taken in order to minimise expropriation needs. Expropriation of houses, as well as quality agricultural land is reduced by designing a long viaduct on exit from tunnel 5, which drastically reduces the project footprint (in relation to the variant of the high embankment in this area). The northern variant for the bypass was not in accordance with the spatial plans and the existing project documentation.

- “1” to “2” to “3”

“2” - selected as the most favorable because it is sufficiently distant from the alluvial Toplica (compared to variant 3), and drastically economically more profitable and ecologically more justified than variant 1, because it passes through an already built and anthropogenically modified area.

In total, the selected alignment option, in the General Design stage, does not influence the most productive land which is spread mainly on the alluvial plains, river terraces and moderately steep and sunny slopes of Jastrebac Mountain away from the physical footprint of the Project.

Figure 25 Variants of the highway route processed in the General Design



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Table 21 Comparison of variants examined during General design (E & S impact)

Section	Code	Nature protection	Cultural heritage	Climate changes	Social environment
Autoput E-75 -Prokuplje	Niš – Prokuplje (N)	Passes in length 650m through the IPA area "Lalinačke slatine". If relocate highway outside the physical boundaries of IPA, there will still be a negative impact (it cuts the connection between the parts of IPA) and will require some measures of protection.	At the beginning passes Mramor, locality Crkvište (17), remains of the medieval church and necropolis dating from the thirteenth and fourteenth century (variant semi motorway (S) is finished, and wouldn't have influence on archeological site).	According to Spatial plan, 3.5km in erosion area.	920m total length of planned noise barriers. 95 ha of agricultural land and 17 buildings for expropriation
	Doljevac – Prokuplje (D)	No limitations	Passes near Lukomir, remains of Roman buildings and graves in agricultural land on the banks of Toplica river (7).	According to Spatial plan, 7.5km in erosion area, and 7.45km in potentially floodplain area.	600m total length of planned noise barriers. 103 ha of agricultural land and 21 buildings for expropriation
Prokuplje bypass	(a to 1)	No limitations	No limitations	No limitations	24 ha of agricultural land and 15 buildings for expropriation
	(a to 2/3)	No limitations	No limitations	No limitations	24 ha of agricultural land and 15 buildings for expropriation
		No limitations	No limitations	No limitations	9 ha of agricultural land and 1 building for expropriation
	(a')	No limitations	No limitations	No limitations	20 ha of agricultural land and 12 buildings for expropriation
	(b)	No limitations	No limitations	No limitations	520m total length of planned noise barriers. 32.5 ha of agricultural land and 7 buildings for expropriation
Prokuplje - Pločnik	North 1	No limitations	No limitations	According to Spatial plan, 3.6km in erosion area.	780m total length of planned noise barriers. 123 ha of agricultural land and 15 buildings for expropriation
	Middle 2	In Toplica valley over the entire length. 3 passages for amphibians and reptiles under the road will be necessary, because the whole route is on the embankment.	No limitations.	According to Spatial plan, 9km in potentially floodplain area.	500m total length of planned noise barriers. 105 ha of agricultural land and 12 buildings for expropriation

Section	Code	Nature protection	Cultural heritage	Climate changes	Social environment
	South 3	On the section between Kuršumlja and Prokuplje is desirable to set the route away from the left bank of Toplica River. This requirement of the Institute for Nature Protection is not met. The alignment goes through the valley of Toplica River, on average 500m distance, and several times passes from one to the other side of the river.	No limitations.	According to Spatial plan, 10.55km in potentially floodplain area.	540m total length of planned noise barriers. 115.5 ha of agricultural land and 4 buildings for expropriation

Table 22 Summary of main parameters examined during General design for section Nis - Pločnik

Code	Nature protection	Cultural heritage	Climate change	Social environment	Construction Cost (million €)	Operation Savings/benefits	Policy and Planning
Da'a1	No limitations	Passes near Lukomir, remains of Roman buildings and graves	According to Spatial plan, 11.1km in erosion area, and 7.45km in potentially floodplain area.	1380m total length of planned noise barriers. 270 ha of agricultural land and 63 buildings for expropriation	393 full motorway 259 half motorway	Low benefits	Partly in accordance
Da'a2	3 passages for amphibians, reptiles and small mammals under the road will be necessary, because the whole route is on the embankment	Passes near Lukomir, remains of Roman buildings and graves	According to Spatial plan, 7.5km in erosion area, and 16.45km in potentially floodplain area.	1100m total length of planned noise barriers. 261ha of agricultural land and 61 buildings for expropriation	270 full motorway 186 half motorway	Low benefits	Partly in accordance
Da'a3	Does not meet the requirement of the Institute for Nature Protection	Passes near Lukomir, remains of Roman buildings and graves	According to Spatial plan, 7.5km in erosion area, and 18km in potentially floodplain area.	1140m total length of planned noise barriers. 271ha of agricultural land and 53 buildings for expropriation	333 full motorway 246 half motorway	Low benefits	Partly in accordance

Code	Nature protection	Cultural heritage	Climate change	Social environment	Construction Cost (million €)	Operation Savings/benefits	Policy and Planning
Db1	No limitations	Passes near Lukomir, remains of Roman buildings and graves	According to Spatial plan, 11.1km in erosion area, and 7.45km in potentially floodplain area.	1800m total length of planed noise barriers. 258.5 ha of agricultural land and 43 buildings for expropriation	431 full motorway 283 half motorway	High benefits	Not in accordance
Db2	3 passages for amphibians, reptiles and small mammals under the road will be necessary.	Passes near Lukomir, remains of Roman buildings and graves	According to Spatial plan, 7.5km in erosion area, and 16.45km in potentially floodplain area.	1620m total length of planed noise barriers. 240.5 ha of agricultural land and 40 buildings for expropriation	265 full motorway 185 half motorway	High benefits	Not in accordance
Db3	Does not meet the requirement of the Institute for Nature Protection	Passes near Lukomir, remains of Roman buildings and graves	According to Spatial plan, 7.5km in erosion area, and 17.95km in potentially floodplain area.	1660m total length of planed noise barriers. 251 ha of agricultural land and 32 buildings for expropriation.	328 full motorway 245 half motorway	High benefits	Not in accordance
Na1	Passes in length 650m through the IPA area "Lalinačke slatine"	No influence on arceological site	According to Spatial plan, 3.5km in erosion area and 3.6km in erosion area.	1700m total length of planed noise barriers. 242 ha of agricultural land and 47 buildings for expropriation	405 full motorway 267 half motorway	High benefits	Full accordance
Na2	Passes in length 650m through the IPA area "Lalinačke slatine". 3 passages for amphibians, reptiles and small mammals under the road will be necessary.	No influence on arceological site	According to Spatial plan, 3.5km in erosion area and 9km in potentially floodplain area.	1420m total length of planed noise barriers. 233 ha of agricultural land and 45 buildings for expropriation	282 full motorway 195 half motorway	High benefits	Full accordance
Na3	Passes in length 650m through the IPA area "Lalinačke slatine". Does not meet the requirement of the Institute for Nature Protection	No influence on arceological site	According to Spatial plan, 3.5km in erosion area and 10.55km in potentially floodplain area.	1460m total length of planed noise barriers. 243.5 ha of agricultural land and 37 buildings for expropriation	345 full motorway 254 half motorway	High benefits	Full accordance

2.6.2 Re-alignment and alternative options analysis at Preliminary Design level

During the Preliminary design phase small scale variants of the alignment and of technical solutions were examined, in order to avoid specific areas and to decrease impacts to the environment, expropriations etc. Also, the designer was careful to maximize bypassing populated areas and existing facilities. The assessment of choosen variant identified 72 physical structures occupying a total area of 1,37 Ha: 60 residential buildings, 10 ancillary structures such as barns, 10 storage houses, pig stys, outdoor WC, 1 local football stadium and 1 swimming pool are impacted.

The following option analysis were performed:

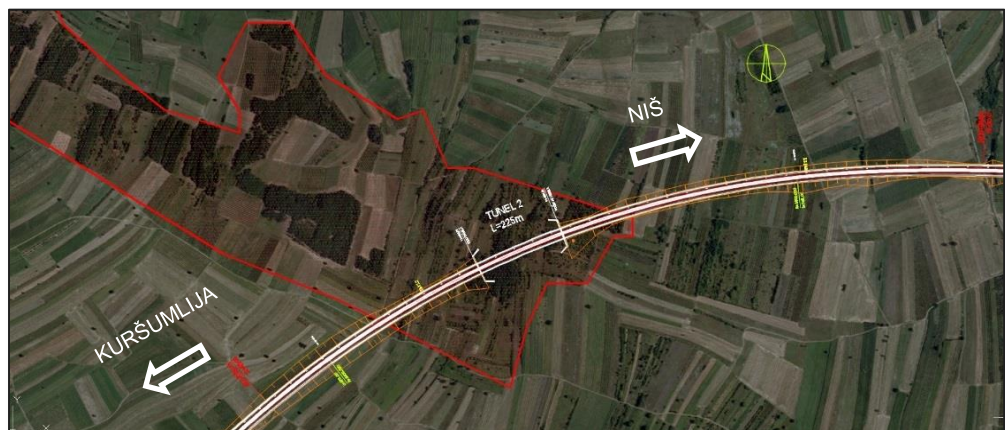
- Lalinacke slatine area
- Plocnik archaeological site area
- Short tunnels versus open cuts
- Inclusion of additional interchanges

Lalinačke slatine

For the purpose of preparation of the Spatial Plan the Spatial Plan Consultant and the Preliminary Design Consultant received technical conditions, No. 020-892/2 from 01.06.2016 issued by the Institute for Nature conservation of Serbia. In this document, it is marked that part of the ecologically important area “Lalinačke slatine” is within the SP scope border.

Highway alignment is passing through the IPA area “Lalinačke slatine” in the total length of cca 600m, from km 11+500 up to km 12+100.

Figure 26 Highway alignment in relation to IPA area (marked red)



Bearing in mind that one part of the alignment goes through that area, the Consultant initiated a meeting with Institute which was held in Institute premises. Also the Consultant send to the Institute a request for opinion, presenting the exact position of highway alignment related to the protected area. The Consultant presented two alternative options for this area, a “cut and cover” tunnel of 225 m

length, or a deep cut, which would go through the protected area. If these solutions were not considered by the Institute of Nature conservation as adequate, alternative alignment options would be examined.

After this meeting the Consultant received the opinion from the Institute for nature conservation No. 020-1429/2 08.10.2016 regarding the fact that the highway route intersects the periphery of IPA "Lalinačke slatine".

IPA region "Lalinačke slatine" implies a dozen separate units in the area of Lalinac and Mramor to Prokuplje. This area encompasses salt marsh and steppe habitats that are rare as such on the territory of Serbia. Key parts of the area are located around Lalinac, then around Merosina (habitat type salt marsh) and about Balinovac where steppe habitat fragments are registered. **After site visit the Institute concluded that the plant species on the concerned section have a wide distribution in Serbia, and that planned activities will have no impact on the conservation status of characteristic plant species.** On the periphery of IPA site, uncultivated habitats are dominant with very small fragments of steppes. Both of proposed technical solutions (deep cut or tunnel 225 m long, which would have to do "cut and cover" method, due to the thin overlay) are feasible regarding protection of natural values.

Based on all of this conclusion the Consultant adopted the "cut and cover" tunnel option for a total length of 225 m, from km 11+625 to km 11+850, and performed a screening in order to evaluate if Appropriate Assessment is necessary for this case (Annex 10).

As per the results of the screening process, the project does not affect qualifying elements of the site - in this case the salt steppe habitat - and it is no likely that a significant effect will be raised on integrity, possible key values, conservation objectives and/or biodiversity importance of the area. Therefore, it is concluded that the site can be screened out as no likely significant effect will be raised on the key values or integrity of the IPA "Lalinačke slatine".

Based on preliminary geotechnical data received up to date, the overlay of the tunnel consist of silty sands and sands with layers of marly clay, marl, sandstone and conglomerate. The lower part of the tunnel is located in marl and marly clay with layers of sand and sandstone. Longitudinal profile with geological data represented in the figure below.

Figure 27 Longitudinal section of tunnel "Lalinac" along with geological data

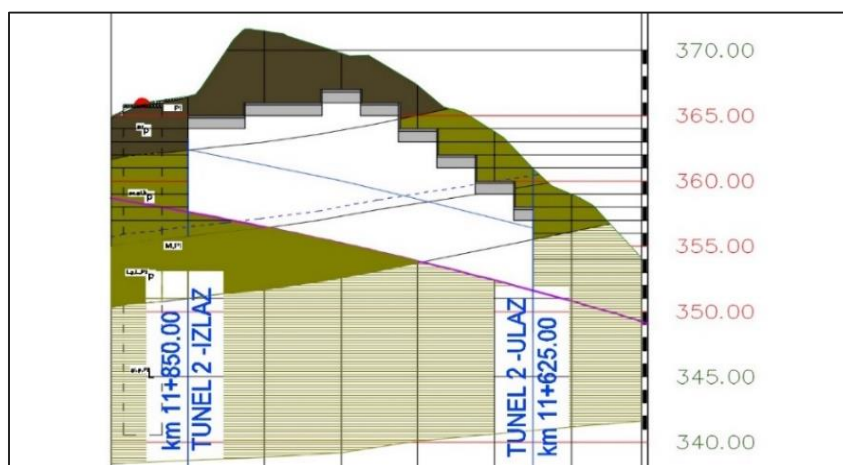


Figure 28 3D model of a highway alignment with "cut and cover" tunnel position

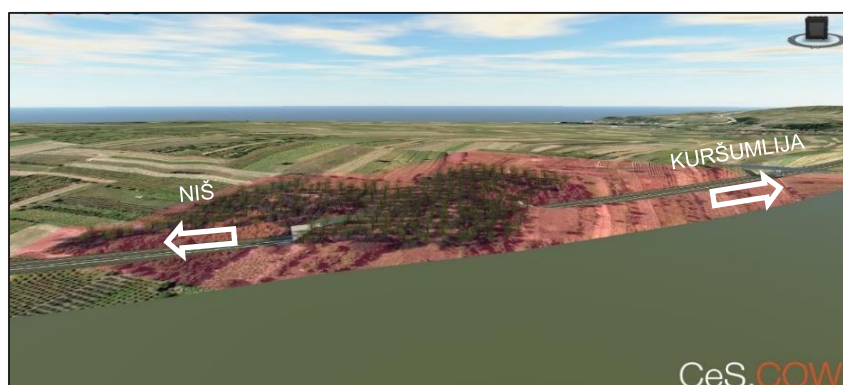
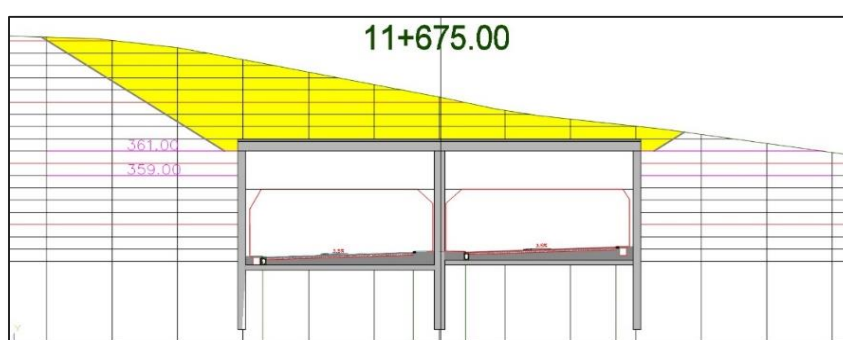


Figure 29 Cross section of a tunnel "Lalinac" on km 11+675.00



Archaeological site Pločnik realignment solutions

For the purpose of preparation of the Spatial Plan the Spatial Plan Consultant and the Preliminary Design Consultant received a document "Elaborate of cultural heritage protection zones, along with the E80 Niš-Pločnik highway", No. 256/8 from 24.05.2016 issued by the Institute for Cultural Heritage Protection of Serbia. In this document, several significant cultural heritage zones are marked, along with the designed highway alignment. These zones are divided according to their priority

and level of protection. One of them in particular is highlighted as a high level protection zone, Pločnik settlement, near Kuršumlja town.

Figure 30 Site in Pločnik, where houses from the Neolithic period were built

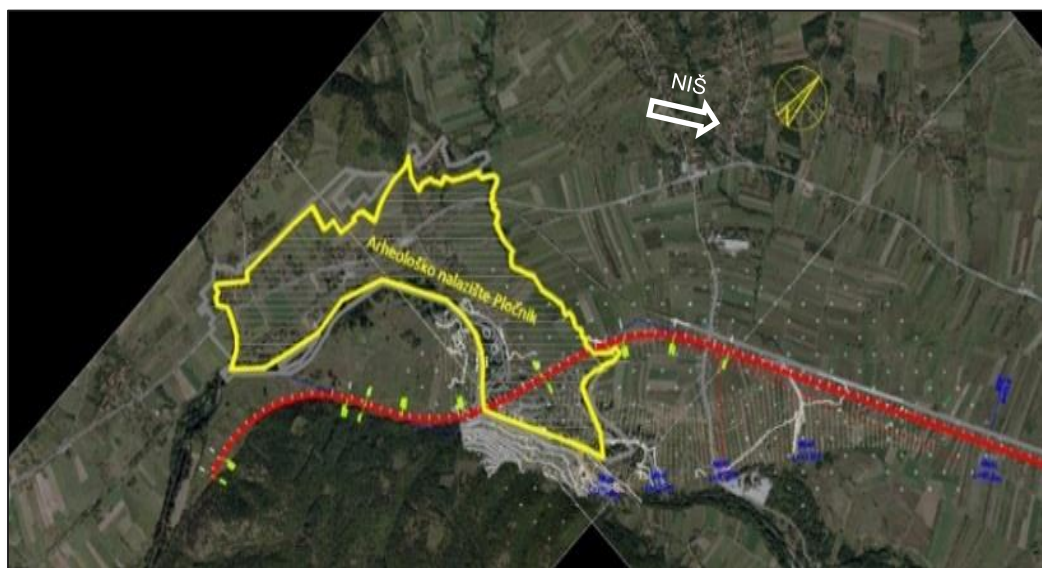


Pločnik is an archaeological site in the village of the same name in Toplica District, Serbia. A 120 hectare site belonging to the Neolithic Vinča culture existed from 5500 BCE until a fire destroyed it in 4700 BCE. The site was first discovered during railway construction in 1927, but was investigated only sporadically until excavations carried out by the Prokuplje Museum the National Museum of Serbia began in 1996. The preliminary dating of a Pločnik metal workshop with a furnace and copper tools to 5,500 BCE, if correct, indicates the Copper Age could have started in Europe 500 years or earlier than previously thought. ¹

After the graphical representation of protected archaeological area (parcel lots) and after it is overlain with initial highway alignment, Consultant realized that one section of the proposed centreline is in collision with the protected area.

¹ Source <https://en.wikipedia.org>

Figure 31 "Pločnik" area archaeological site (yellow) and initial alignment (red)



A meeting with the Institute was initiated and held in their premises, on which it was agreed that the Consultant will submit an additional request with further explanation of alignment geometry and its influence on Pločnik site. According to that, the opinion of the Institute was received, (No. 3/1419 from 26.07.2016.), which confirmed the before mentioned archaeological research in this area. After the completion of the research, and if there are no findings that must be kept in situ, the Institute approves the proposed motorway route.

Bearing that in mind the Consultant decided to change the route in this part to fully avoid any potential collision with the archaeological site and protected area.

The realignment was send to geodetic and geotechnical experts in order to prepare an additional survey. After additional geodetic survey results were received, the Consultant prepared minor redesign of alignment and of vertical alignment.

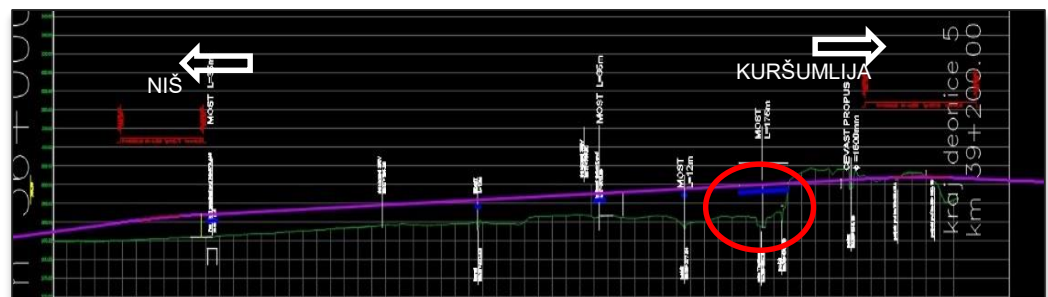
Figure 32 Realignment according to the Pločnik site protected zone.



As presented on the figure above, the realignment was done from km 36+400 to km 39+400 (“white” alignment) in order to avoid crossing the “yellow” protected zone. The total length of realignment is cca 3 km.

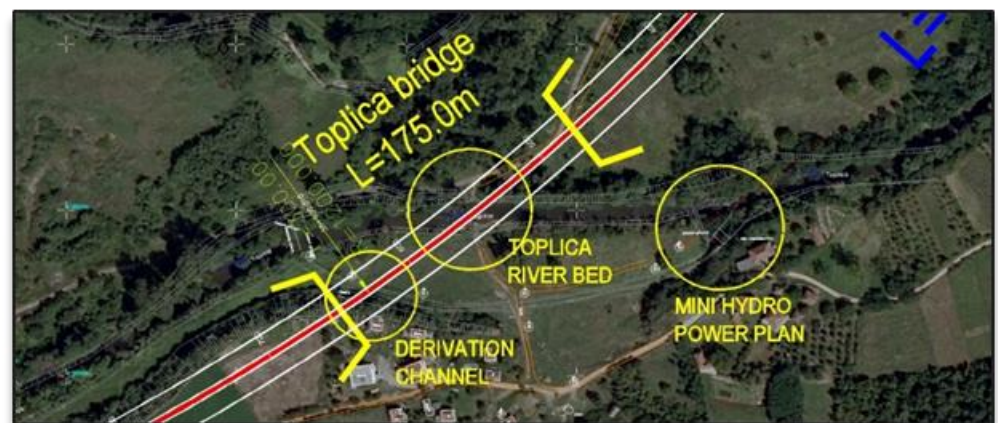
After the draft design of vertical alignment, the positions of several structures were defined. There are two bridges with span $L=35$ m, two with span $L=12$ m, all of them crossing local roads and streams, and one bridge with a total length of cca $L=140$ m, crossing the Toplica River (marked on the figure below).

Figure 33 Longitudinal profile of Pločnik area highway realignment



The bridge over Toplica River is extended because of a small hydro power plant which is in near area, and its derivation channel with inflow in Toplica River bed. The bridge will cross over both Toplica and derivation channel river bed.

Figure 34 Micro location of a new bridge over Toplica River



Testing short tunnel alternatives: tunnel vs open cut

This option analysis is performed in order to compare the constructing of open cuts instead of constructing three short ($L<300$ m) bored tunnels. It is based on the Preliminary Design drawings, i.e. draft layout and draft longitudinal profile, internal discussion and analysis among the design team experts (highway, tunnelling, and geotechnical expert), preliminary geotechnical data received and site visit held on the 8th of June 2016.

There are three such tunnels along the alignment:

- Tunnel 1 at km 9+700 ($L=220$ m),

- Tunnel 4 at km 19+650 (L=265m) and
- Tunnel 6 at km 22+250 (L=220m).

Further examination of the proposed centreline and vertical alignment, as well as preliminary geotechnical results, brought up another alternative solution apart from tunnelling. Deep reinforced cuttings, with slopes and berms according to the preliminary geotechnical results, were also examined.

The selection of the preferred variant was performed according to the following criteria:

- Expropriation needs
- Technical difficulties
- Financial cost
- Environmental impact
- Operation and maintenance needs, protection against Climate Change effects

The table that follows includes the main results of the comparison of the alternatives examined. Full Option Analysis is presented in Annex 5.

As a result of this option analysis, tunnelling is selected as the most acceptable solution. With this solution additional land acquisition, negative environmental impact and impact on agricultural land, as well as additional resources for maintenance and safe operation, especially in winter months, will be avoided.

Figure 35 Tunnel 1 “Debelo drbo” proposed layout

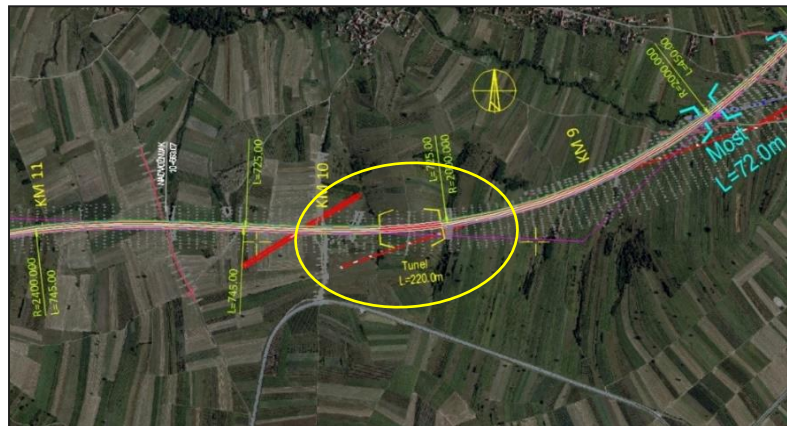


Figure 36 Tunnel 4 “Vrsnik” proposed layout

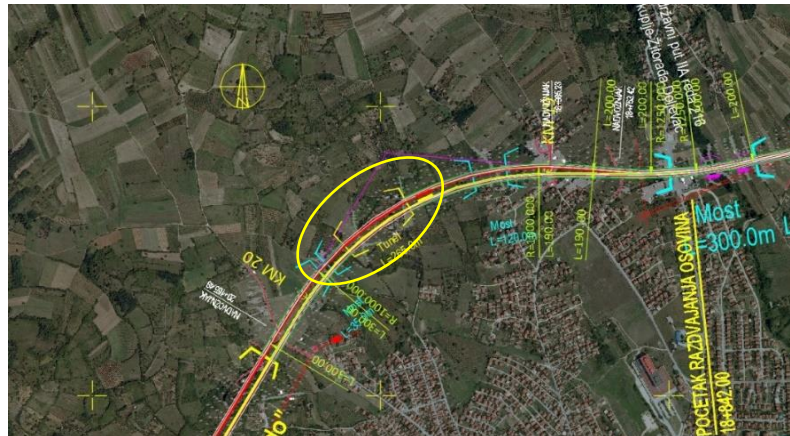


Figure 37 Tunnel 6 “Plehane kuće” proposed layout

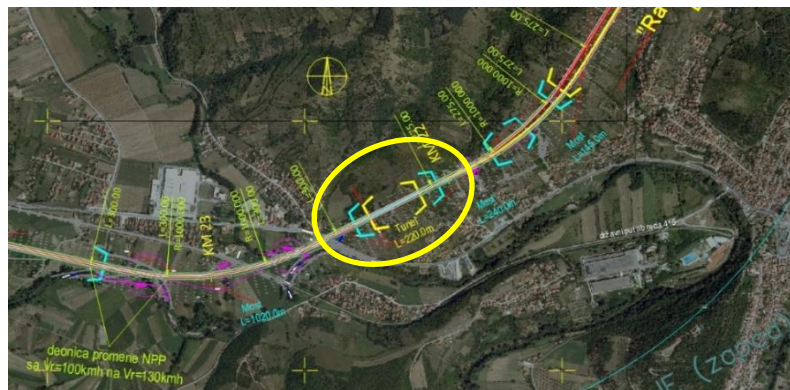
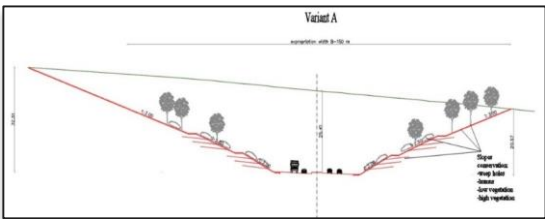
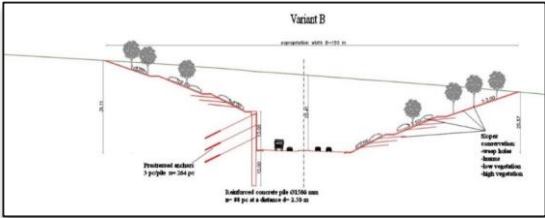
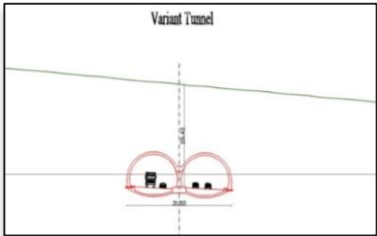
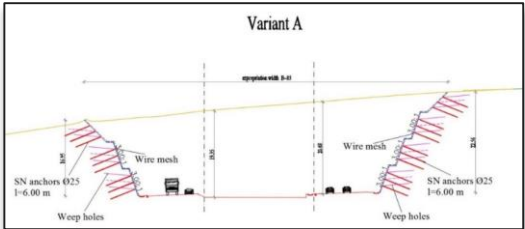
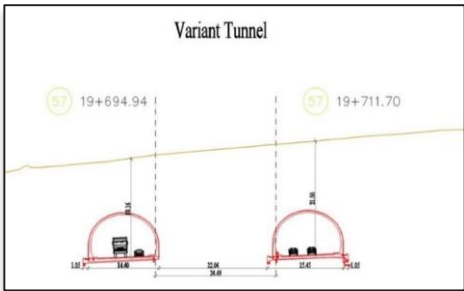
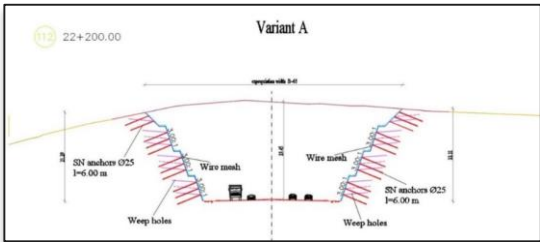
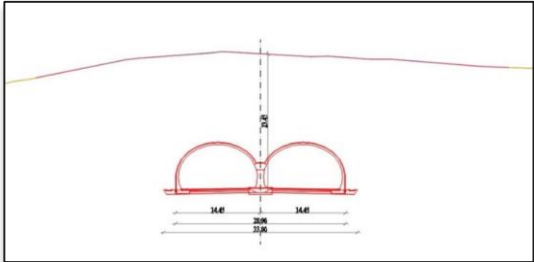


Table 23 Comparison of alternative solutions short tunnels vs open cut

Tunnel	Variants	Cost (m €)	Length (m)	Advantages	Disadvantages
Tunnel 1 "Debelo brdo"	A-OPEN CUT 	5.3	220	Lower construction cost	<p>Significant occupancy of fertile land (about 1.8 ha of which 0.4 ha is cultivated), due to excavation and large space requirements for landfills. This issue will yield strong negative environmental, social and economic impacts.</p> <p>Significant probability of slope instability, during execution of excavation and throughout exploitation time</p> <p>Increased maintenance costs, especially because of drifting in the winter months.</p>
	B-OPEN CUT WITH RETAINING STRUCTURE 	5.2	220	Lower construction cost	<p>Significant occupancy of fertile land, due to excavation and large space requirements for landfills. This issue will yield negative social and economic impacts.</p> <p>Increased maintenance costs due to monitoring requirements for pre-stressed permanent anchors</p> <p>Increased maintenance costs, especially because of drifting in the winter months</p> <p>Untypical height of the structure will have a negative impact on drivers.</p>
	C-TUNNEL 	6.6	220	<p>Preserving orchards and the existing road that cross the highway on the site of the tunnel</p> <p>Preserving the existing road (state road 1b 35 Niš-Merošina-Prokuplje-Kuršumlija) from the impact of construction and operation of the motorway</p> <p>Reducing the impact on agricultural land in the tunnel zone (less expropriations and impact due to noise and emissions)</p>	<p>More expensive construction</p> <p>High operation and maintenance cost</p>

Tunnel	Variants	Cost (m €)	Length (m)	Advantages	Disadvantages
Tunnel 4 „Vrsnik“	A-OPEN CUT 	4.4	265	Not been identified	Significant occupancy of fertile land (about 2.1 ha, of which 1.5 ha are cultivated), due to excavation and large space requirements for landfills. This issue will yield strong negative environmental, social and economic impacts. Increased maintenance costs due to periodic inspection requirements and repairs of mesh, anchors, etc. Increased maintenance costs, especially because of drifting in the winter months
	B-TUNNEL 	3.2	265	Preserving the household and orchards on the site of the tunnel Preserving the existing two roads that cross the highway in the zone of the tunnel Protection of houses near the tunnel (about 250m) from the motorway noise and air pollution Reducing the impact on agricultural land in the tunnel zone.	High operation and maintenance cost
Tunnel 6 „Plehanje kuce“	A-OPEN CUT 	3.3	220	Not been identified	Occupancy of land, due to excavation (occupancy of about 1.1 ha) and large space requirements for landfills. This issue may yield negative environmental, and social impacts. Increased maintenance costs due to periodic inspection requirements and repairs of mesh, anchors, etc. Increased maintenance costs, especially because of drifting in the winter months

Tunnel	Variants	Cost (m €)	Length (m)	Advantages	Disadvantages
	<p>B-TUNNEL</p> 	3.4	220	<p>Protection of houses near the tunnel (nearest at about 160m) from the motorway noise and air pollution</p> <p>Conservation of agricultural land and natural habitats at the site of the tunnel</p>	High operation and maintenance costs

80 Infrastructure Project Facility – Technical Assistance 4 (IPF4) - TA2012054 R0 WBF
Preliminary Design and Feasibility Study with ESIA for construction of Highway E-80 in Serbia (SEETO Route 7)
PRELIMINARY DESIGN - Environmental and Social Impact Assessment Study (ESIA)

Prokuplje West and Merosina 1 junctions

In the General Design, which serves as input for the Preliminary Design preparation, an interchange at Prokuplje West area was not foreseen. Nevertheless, the design team, having in mind the very sensitive highway section of Prokuplje bypass, started to analyse and plan two junctions, one eastern and one western of the City of Prokuplje, in order to have one highway section which will fully operate as a city bypass.

Consultation with PE “Roads of Serbia” has started and the study team received an official Letter from PERS, which, among other issues, gave opinion on two issues concerning interchanges (Letter No. 953-15024/16-1 from 30.08.2016):

- There is a need of design and planning the main toll station immediately after the existing interchange “Merošina”.
- A potential additional junction at Prokuplje West should be justified through traffic forecast and analysis in subject area.

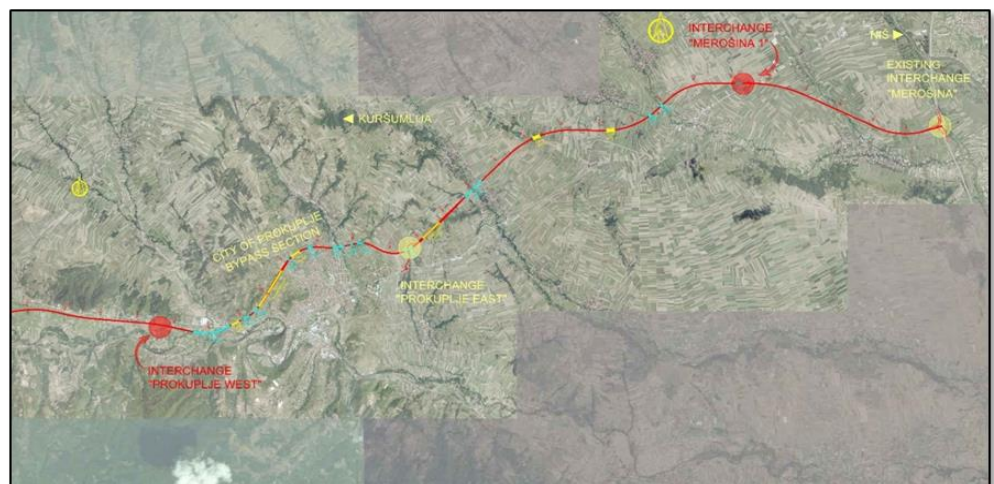
Traffic assessment

The first issue raises the question of necessity of a potential “Merošina 1” interchange, as it is close to existing junction and also close to the main toll station, and the second the issue of a potential Prokuplje West junction.

As a result a traffic analysis and presentation of possible alternative solution regarding the two proposed junctions: „Merošina 1“ at km 5+500 and „Prokuplje West“ at a km 26+000 of highway alignment was performed. Options without“(option A) and „with“ (option B) junctions were analysed and presented through traffic forecasts and the overall benefits were estimated.

In all examined cases the Niš-Merdare highway is assumed to be tolled and integrated to the national tolling system (in full motorway scenario) and that the existence of junction “Merošina 1” will, among others, provide a controlled entrance/exit to the tolled facility.

Figure 38 Position of junctions „ Merošina 1“and„ Prokuplje West



For the purpose of the analysis the „VISUM“ transport model was used in order to analyse the following 3 options (options A):

- 1 Highway from Niš to Merdare without junction „Prokuplje West“
- 2 Highway from Niš to Merdare without junction „Merošina 1“
- 3 Highway from Niš to Merdare without junction „Prokuplje West“ and „Merošina 1“

and to compare with the “with” junctions option (option B).

All analyses were performed for time horizon 2045, for the “with” project scenario and implementation of toll is assumed for the whole highway. As resulted from the analysis traffic flows decrease in cases without one or both analysed junctions. The drop of traffic ranges from 1% to 28% depending on option and section, and the highest drop is on Prokuplje bypass (28%) in the option when both junctions won't be built.

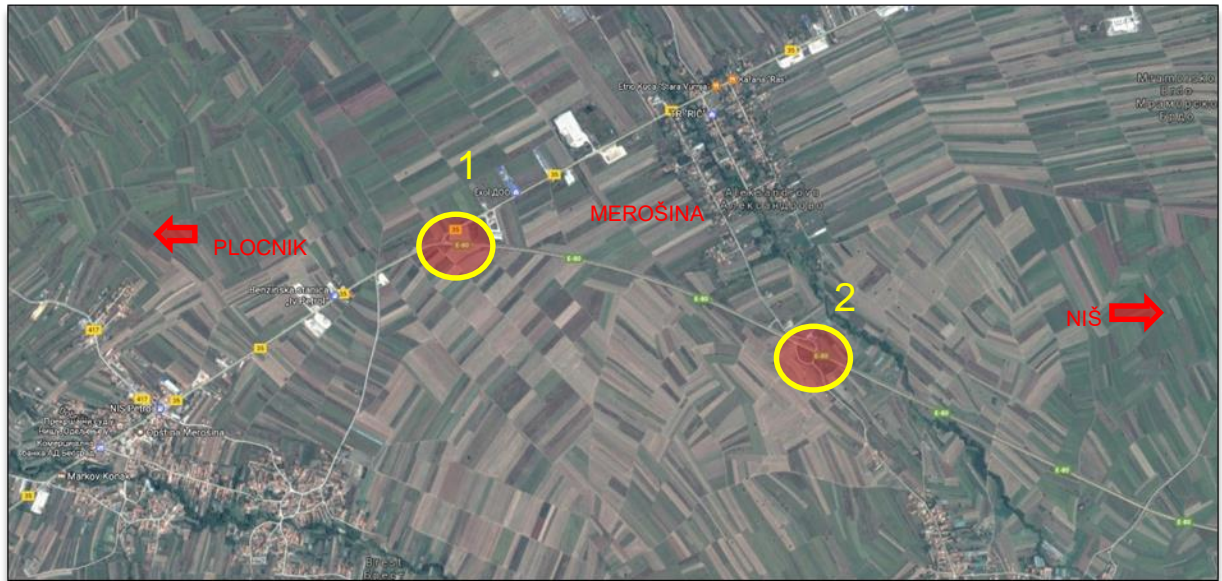
Decrease in traffic on all sections, in the options without the aforementioned junctions, practically implies a change in operational indicators on the entire network, because the vehicles chose other routes. The results show lower values of vehicle-kilometres and vehicle-hours on new highway in comparison with options where both junctions will be built. Traffic “escaping” from the highway, because of reduced number of access points, seems to take longer and slower routes making in total more vehicle-kilometres and vehicle-hours.

Non-implementation of the aforesaid junctions will result in increase of veh-km and veh-hours on the network and will proportionally reduce the socioeconomic benefits (comparing to base scenario with both junctions) by about 9% in case “without Prokuplje West” and by 12% in case “without Merosina 1”.

Taking into account the results of the PFS stage, were socioeconomic benefits were estimated around 900 mil Euro (NPV), the “loss” of 9% and 12% would amount to around 80 mil Euro and 100 mil Euro less benefits, respectively. In contrast the cost of constructing the junctions is approximately 1.0 mil € for “Merošina 1” and 2.0 mil € for „Prokuplje West“.

In addition, since the bypass of Prokuplje has been planned and prepared according to one of the previous Preliminary designs as a highway there is a need to provide a highway section to serve as a city bypass. With junction „Prokuplje West“, the bypass will be really able to operate effectively, even in case that due to financing limitations the construction of the whole highway will be made in several stages, first priority being the bypass. This will not be the case if the next to „Prokuplje East“, junction, will be „Beloljin“, further away to the south-west.

Figure 39 Position of existing junctions at Merosina



“Merosina 1” junction will serve as a connection to the local network. According to the traffic study, with this junction traffic volumes will increase which will also increase toll revenues.

Interchanges layout and expropriation needs

On the other hand, there is a potential negative social impact, because of additional land expropriation due to interchange layout and influence zone. Heaving that in mind, when designing the interchange layout, the designers team tried to minimize those impacts, by defining such functional and layout solutions which would reserve the minimum land and avoid demilotion of buildings. The layout of the junction was adopted to serve all these space limits, which resulted in a unique geometry of interchange.

Figure 40 Position of additional I/C Merosina 1

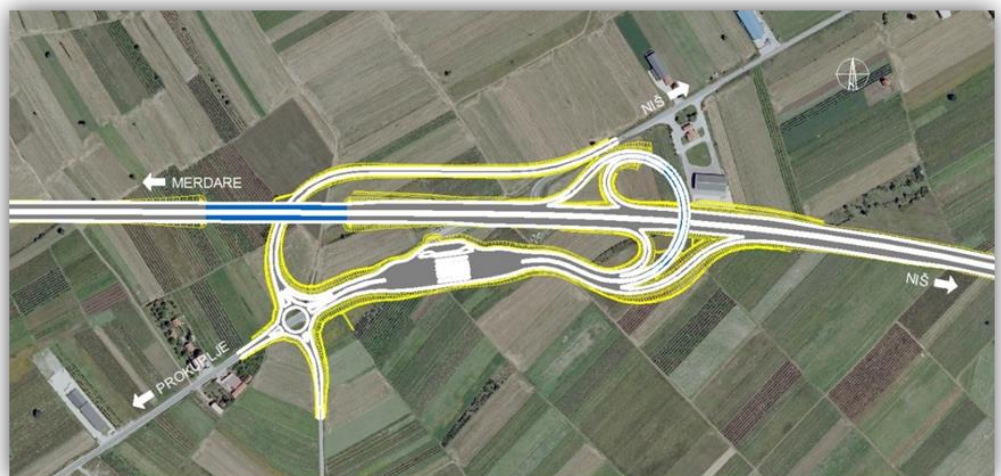
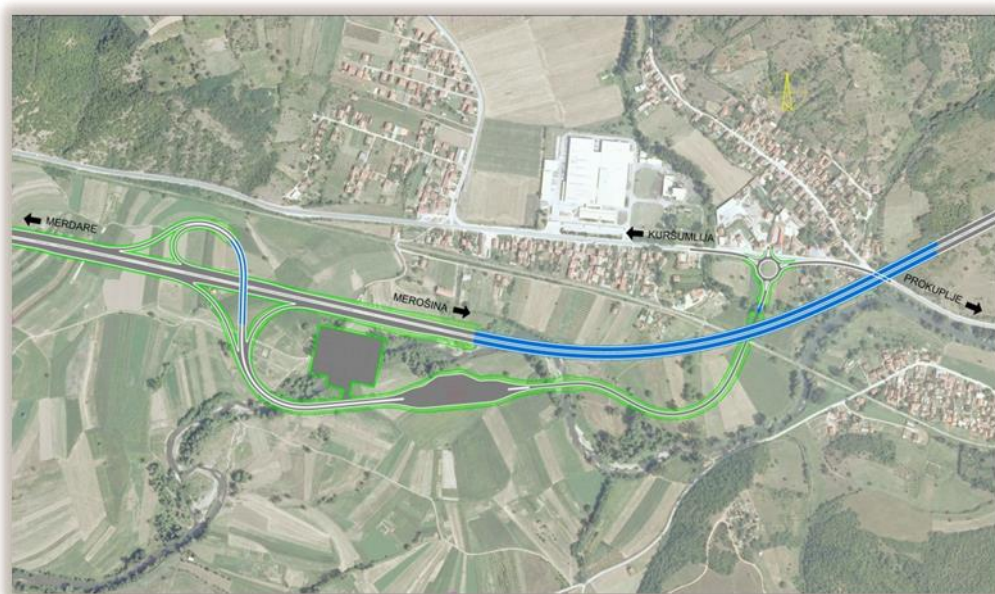


Figure 41 Position of additional I/C Prokuplje west



3 Basis for Impact Assessment

3.1 National Environmental Legal and Policy Framework

The environmental regulations applicable to this project are numerous and diverse. Therefore only the key requirements associated with the project have been chosen to be presented in this section. However, a full and detailed list of legislation associated with the project will be developed as part of the project management systems for construction and operation.

Serbia has largely transposed the EU regulatory requirements related to **environmental impact assessment** into national legislation, including the EIA Directive (Directive 92/11/EC, as amended).

The preparation of plans and technical documentation in the field of the road sector as well as of their Environmental Impact Assessment is regulated by numerous regulations of the Republic of Serbia, which can be classified into two groups.

The first group refers to regulations on the development of planning and technical documentation. The key law for the preparation of planning and technical documentation is the Law on Planning and Construction ("O.G. of the RS" No. 72/09, 81/09-ex., 64/10, 24/11, 121/12, 42/13, 50/13, 98/13, 132/14 and 145/14), which, inter alia, regulates both the scope and the content of spatial, urban plans and technical documentation. Strategic Environmental Impact Assessment is an integral part of the spatial plan of the special purpose area.

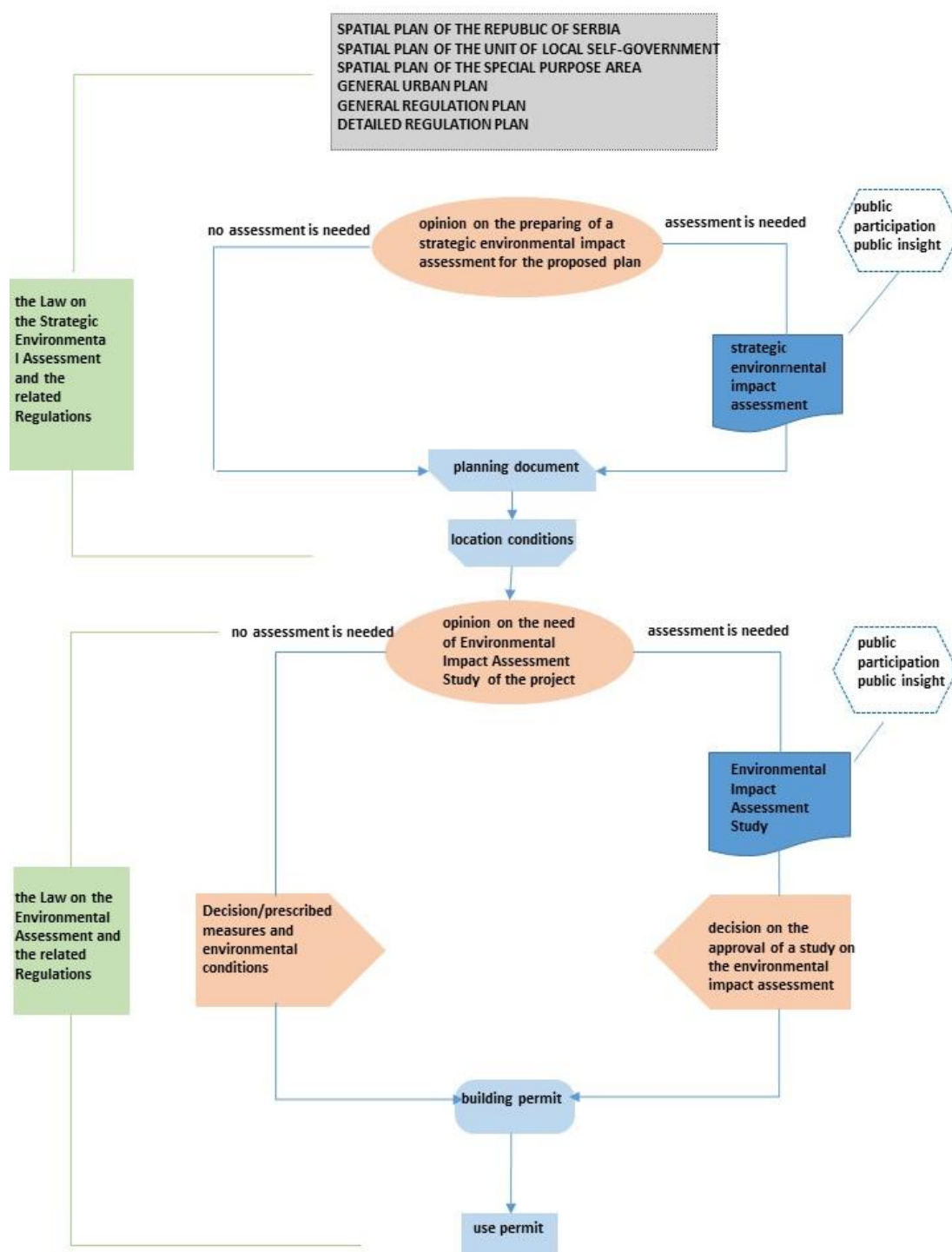
The second group of regulations is legal regulation in the field of environmental protection. The preparation of environmental impact assessment of spatial and urban plans is regulated by the Law on Strategic Impact Assessment ("O.G. of the RS", No. 135/04 and 88/10), and the preparing technical documentation by the Law on Environmental Impact Assessment ("O.G. of the RS" ", No. 135/04 and 36/09).

The Law on Strategic Impact Assessment ("O.G. of the RS ", No. 135/04 and 88/10) regulates the conditions, manner and procedure for assessing the impact of certain plans and programs, on the environment.

The Law on the Environmental Impact Assessment ("O.G. of the RS ", No. 135/04 and 36/09) regulates:

- The process of Environmental Impact Assessment,
- The content of the Environmental Impact Assessment Study,
- The participation of interested authorities and organizations and of the public,
- Cross-border notification for projects that can have significant impacts on the environment of another state,
- Supervision, and other issues of importance for environmental impact assessment.

Figure 42 Procedure from Project planning to construction and operation according to Serbian legislation



An EIA is required during the Preliminary design stage of a project. The opinion on the need for an EIA is initiated by a formal screening study in order to identify the categorization of the project. But in cases where the project categorization is obviously high due to its nature and scale and the clear requirement under international standards and national legislation the screening may be omitted.

The fulfilment of environmental impact assessment requirements is a prerequisite for the construction permit. The national EIA procedure comprises the phases of screening, scoping, impact assessment and public consultation.

The obligation to do an EIA is regulated by the Decree on the List of projects for which the EIA is mandatory and the List of projects for which the EIA may be required (Off. Gazette of RS, No. 114/2008). The "List 1" sets the facilities for which an EIA is mandatory, and among others, it includes the "construction of main highways and roads with four or more lanes".

The authority in charge for EIA approval of the "List 1" facilities is the Ministry of Agriculture and Environment.

Nature conservation is primarily regulated by the: Law on Nature Conservation (Off. Gazette of RS, No. 36/2009, 88/2010 and 91/2010) which is harmonized with the EU Habitats Directive and the Birds Directive. Specific aspects of nature conservation are regulated by various by-laws. The Decree on Ecological Network (Off. Gazette of RS, No. 102/2010) identifies ecological network areas in Serbia and sets the management, financing, monitoring and protection requirements.

Protection of habitats and species is regulated by the:

- 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 („Off. Gazette of RS“ No. 35/2010),
- Regulation on cross-border trade and trade in protected species ("Official Gazette of the Republic of Serbia", No. 99/2009, 6/2014)
- Regulation on special technical and technological solutions that enable undisturbed and safe communication of wild animals („Off. Gazette of RS“, No. 72/10).
- Regulation on control of use and trade of wild flora and fauna ("Off. Gazette of RS", No.31/2005, 45/2005-corr., 22/2007, 38/2008, 9/2010 and 69/2011)
- Rulebook on cross-border trade and trade in protected species ("Official Gazette of the Republic of Serbia", No. 99/2009, 6/2014)
- Regulation on the proclamation and protection of strictly protected and protected wild species of plants, animals and fungi („Off. Gazette of RS“, No. 5/2010, 47/2011, 32/2016 and 98/2016), which contains lists of strictly protected and protected wild species and protection measures. **Strictly protected species** according Regulation are:
 - species extinct in the Republic of Serbia and reintroduced through a reintroduction programme;
 - extremely endangered wild species;
 - endangered wild species;
 - relict species;
 - local endemite;
 - stenoendemite;
 - internationally significant and protected wild species;
 - species requiring strict protection for other reasons.

The following wild species are **protected species** according to the Regulation:

- vulnerable wild species;
- endemic species;
- indicator, key and umbrella species;
- relict species;
- internationally significant and protected wild species;
- species that are not endangered, but can easily be confused with an endangered species, due to appearance.

Standards for **surface water quality, groundwater and sediment** are regulated by the Decree on limit values of polluting substances discharged into surface water, groundwater and sediment and deadlines for compliance (Off. Gazette of RS, No. 50/2012) setting the limit values of polluting substances and defining five classes of the ecological status: high, good, moderate, poor and bad. Limit values of parameters related to general water conditions, oxygen regime, nutrients, salinity, metals, organic matter, and microbiology are defined by the Regulation on parameters of the ecological and chemical status of surface water and parameters of the chemical and quantitative status of groundwater (Off. Gazette of RS, No.74/2011). Limit values for priority and priority hazardous substances are set by the Decree on limit values of priority and priority hazardous substances polluting surface waters and deadlines for compliance (Off. Gazette of RS, No.35/2011).

Standards for **contaminated soil and groundwater** are stipulated by the Regulation on the program for systematic monitoring of soil quality, indicators for evaluation of soil degradation and methodology for preparation of remediation program (Off. Gazette of RS, No.88/10).

Environmental noise is regulated by the Law on Environmental Noise (Off. Gazette of RS, No. 36/2009, 88/2010) as the main legislative document. The permitted noise levels are defined by the Decree on environmental noise indicators, limits values, assessment methods of the noise indicators, the nuisance and the harmful effects (Off. Gazette of RS No. 75/2010). This Decree stipulates the noise levels (Table 24), 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. However, it is not stated what the appropriate noise limit is in the case of a new development, where the prevailing noise levels already exceed the stated values.

Table 24 Noise levels in open spaces (limits as defined in Serbian legislation)

Zone	Purpose of the area	Noise Level [dB(A)]	
		Daytime and evening	Night-time
1	Recreation areas, health institution areas, cultural and historical sites, large parks	50	40
2	Tourist areas, schools, camps	50	45
3	Residential areas	55	45
4	Commercial and residential areas, children playgrounds	60	50
5	City centre, workshop area, commercial area, administrative area with apartments, zones along highway, regional roads and city streets	65	55
6	Industrial areas, warehouse, and service areas, transport terminals with no residential buildings	Noise level at the boundary of this zone shall not exceed the limit value defined for the zone it borders	

The main legislative document in Serbia regulating the **waste management** is the Law on Waste Management (Off. Gazette of RS, No. 36/2009, 88/2010). The Law is supplemented by 29 by-law documents regulating specific waste management aspects. In 2015 the Law was revised and amended to more precisely transpose certain requirements of the Waste Framework Directive and its adoption is expected shortly. **Hazardous waste** is primarily regulated by the Law on Waste Management (Off. Gazette of RS, No. 36/2009, 88/2010) and the Regulation on Categories, Testing and Classification of Waste (Off. Gazette of RS, No 56/2010).

The Ministry of Agriculture and Environment is in charge of the country's environmental management. Cities and local municipalities are in charge of local environmental planning and issuing of local approvals and permits.

The competent authorities and organizations which will issue their conditions and approvals for the purpose of the Spatial Plan of special purpose infrastructure corridor highway E -80, section Niš-Merdare and the Preliminary design are the following:

- Ministry of Construction, Transport and Infrastructure
- Ministry of Agriculture and Environmental Protection
- Ministry of Health
- Ministry of Labour, Employment, Social and Veterans Affairs
- Ministry of Mining and Energy
- Municipality of Merošina
- Municipality of Prokuplje
- Municipal departments for Urban planning (both Municipalities)
- Niš City Administration for economy, sustainable development, and the environment
- Demining centre
- PE Broadcasting Equipment and Communications
- PE EMS

- PE Železnice infrastruktura
- PUC “Hammeum” Prokuplje
- PUC “Naisus” Niš
- PE Directorate for construction of Municipality
- PE for urban and spatial planning Prokuplje
- PE Post
- PE Roads of Serbia
- PE Hydro meteorological Institute
- PE Seismological Institute
- Republic Institute for Protection of Cultural Monuments
- Statistical Office of the Republic of Serbia.

3.2 National Social Legal and Policy Framework

3.2.1 Public consultation and information disclosure framework

Serbian legislation guarantees to its citizens the right to information, i.e. that everyone shall have the right to be informed accurately, fully and timely about issues of public importance. These provisions are included in the Constitution of the Republic of Serbia: (Official Gazette of the RS, No. 98/2006), as well as in the Law on Free Access to Information of Public Importance (Official Gazette of the RS, No. 120/04, 54/07, 104/09, 36/2010).

The Law on Planning and Construction (Off. Gazette of RS, No. 72/2009, 81/2009, 64/2010, 24/2011, 121/2012, 42/2013, 50/2013, 98/2013, 132/2014 and 145/2014) regulates the development and adoption of spatial and urban plans in Serbia, which are all subject to a public disclosure and consultation process.

Serbia ratified the Aarhus Convention in 2009. Provisions of the Aarhus Convention were incorporated into the environmental regulation, including the Law on Environmental Impact Assessment and the Law on Strategic Environmental Impact Assessment.

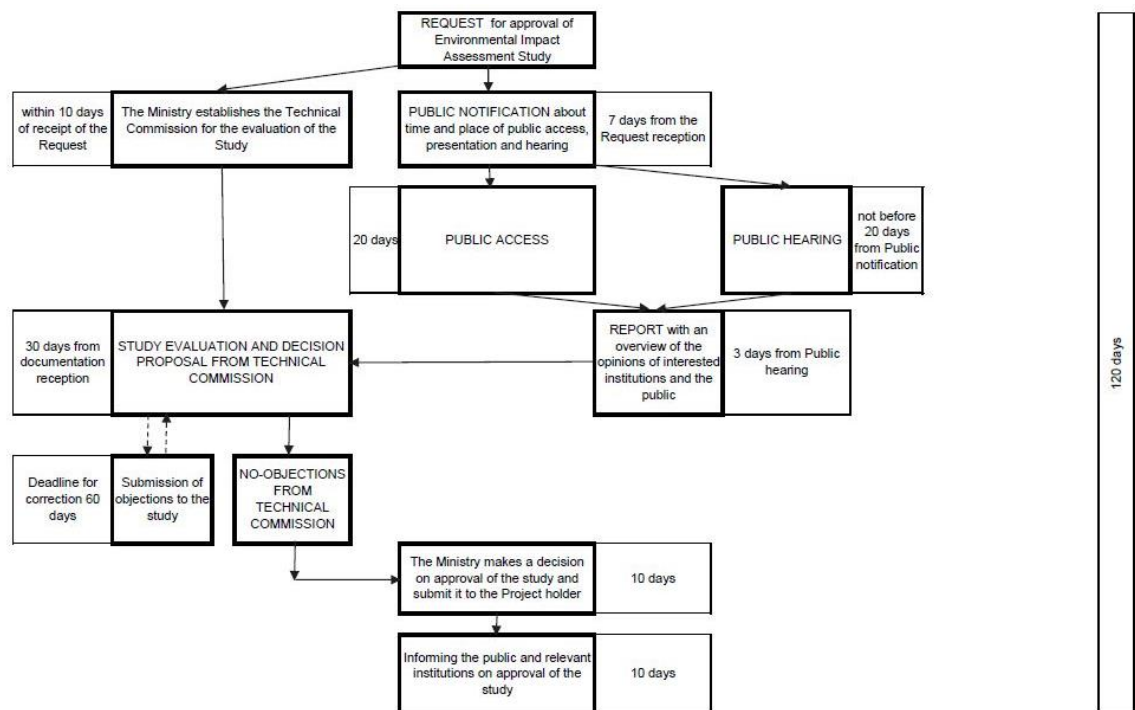
The disclosure of environmental impact assessment documents is regulated by the respective Law and applies to all three stages (Screening, Scoping, EIA) of the process. The competent authority is obliged to publicly disclose the documents and to organise the public consultation in respect to the Environmental Impact Assessment Study.

It should be noted that the first publication and public consultation activities start from the Scoping phase of the project. During the Scoping phase of the EIA, the publication of the announcement of the Application for a decision on the scope and content of the EIA Study, in the local newspaper, takes place and the Application with all enclosed documents are available to the public for 15 days. The authorities, organisations and the public concerned may submit their opinions on the

application with regards to the application within 15 days from the date of announcement.

Thereafter the competent authority makes a decision on the scope and content of the EIA Study, taking into account the opinions of the authorities, organisations and the public concerned.

Figure 43 Procedure from EIA submission to approval



3.2.2 Land acquisition

Land in Serbia is legally categorised as construction land or agricultural land. According to the Law on Planning and Construction (Off. Gazette of RS, No. 72/2009, 81/2009, 64/2010, 24/2011, 121/2012, 42/2013, 50/2013, 98/2013, 132/2014 and 145/2014) agricultural land can be changed into construction land through the adoption of relevant spatial plans. In the case of traffic infrastructure (railway) development, the Spatial Plan of the Special Purpose Area needs to be adopted by the relevant state authority. i.e. the Ministry of Construction, Traffic, and Infrastructure.

Land needed for construction of the public (state-funded) projects is typically acquired through expropriation, regulated by the Law on Expropriation (Off. Gazette of RS, No. 53/95, 16/2001, 20/2009, and 55/2013). The Law enables government institutions to acquire private property for projects that are deemed to be of national and/or local interest, while protecting the interests of all project-affected persons with the legal title (ownership), whose assets are to be

expropriated. The Law also enshrines the principle of fair compensation. The public interested is declared by the Government through the adoption of the specific law or decision.

The additional laws regulating certain aspects of land acquisition and property transaction issues are the following:

- Law on Fundamentals of Property Relations (adopted in 1980, amended 1990, 1996 and 2005);
- Law of Planning and Construction (adopted and corrected in 2009, and amended in 2011);
- Law of Agricultural Land (adopted in 2006, amended in 2009);
- Law on State Cadastre (adopted in 2009, amended in 2010).

3.2.3 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 72 ILO International Labour Standards (Conventions), including the eight fundamental Conventions.

Labour and human resource management in Serbia are primarily addressed through the Law on Labour Off. Gazette of RS, No. 24/2005, 61/2005, 54/2009, 32/2013, 75/2014). Compliance with labour laws is monitored by the Labour Inspectorate of the Ministry of Labour and Social Policy of the Republic of Serbia.

Other applicable laws include:

- Law on Amicable Resolution of Labour Disputes (Official Gazette of the RS No. 125/04, 104/09);
- Law on Strikes (Official Gazette of the FRY No. 29/96);
- Law on Mobbing (Official Gazette of the RS No. 36/10);
- Anti-Discrimination Law (Official Gazette of the RS No. 22/09);
- Law on Preventing Discrimination Against Persons with Disabilities (Official Gazette of the RS No.33/06);
- Law on Vocational Rehabilitation and Employment of Disabled Persons (Official Gazette of the RS No. 36/2009);
- Pension and Disability Insurance Law (Official Gazette of the RS No. 34/03, 64/04, 84/04, 85/05, 101/05, 63/06, 05/09, 107/09, 101/10).

3.2.4 Occupational health and safety framework

The Law on Occupational Health and Safety (Off. Gazette of RS, No. 101/2005) is the main legislative document regulating Occupational Health and Safety issues in Serbia. The Law was enforced in 2005 and incorporated the principles of the EU Workplace Health and Safety Directive (89/391/EEC).

The Law is based on general principles of prevention and requires: (1) avoiding risks, (2) evaluating the risks, (3) combating the risks at source, (4) adapting the work to the individual, (5) replacing the dangerous by the non-dangerous or the

less dangerous, (6) prioritizing collective protective measures (over individual protective measures) and (7) giving appropriate instructions to the workers.

Enforcement of the Law is provided by the implementation of the set of by-laws (regulations and decrees) which stipulate specific requirements related to the general principles defined by the Law.

The Regulation on manner and procedure of risk assessment at workplace and working environment (Off. Gazette of RS, No. 72/06, 84/06) is the main legislative document related to the assessment of health and safety risks at the workplace.

Occupational health and safety are under the responsibility of the Ministry of Labour and Social Policy. Particularly, the Directorate for Occupational Health and Safety is in charge of legislation preparation and the Labour Inspectorate is competent for supervision of the legislation enforcement.

3.3 EIB and EBRD Environmental and Social Policy

Currently EIB and EBRD are considered as potential financiers for the implementation of the Project. Therefore their Environmental and Social Policy is presented herebelow.

The EIB Statement on Environmental and Social Principles and Standards, sets the policy context for the protection of the environment and human well-being. This framework promotes the EU approach to environmental and social issues, and is in line with international best practice.

This is reflected in its environmental and social safeguards, through the EIB Statement on Environmental and Social Principles and Standards. Such procedures, principles and standards are translated into the routine practices of the EIB in the Environmental and Social Practices Handbook (http://www.eib.org/attachments/strategies/environmental_and_social_practices_handbook_en.pdf), which is subject to regular review and revision.

EIB environmental and social standards are listed below:

1. Assessment and Management of Environmental and Social Impacts and Risks

This Standard applies to all operations likely to have significant and material environmental and social impacts and risks. These impacts and risks need to be taken into account at the earliest possible stage in all the technical planning and decision-making processes.

2. Pollution prevention and abatement

The Standard applies during the environmental and social impacts and risks identification process. The implementation of the actions necessary to meet the requirements contained in this Standard is managed by the promoter's overall environmental and social management plan, the elements of which are outlined in Standard 1.

3. EIB standards on biodiversity and ecosystems

The EIB Biodiversity Ecosystems Standard (2013) is based on the following principles:

- Maintenance of the integrity of areas of important biodiversity as well as the natural functions and processes of ecosystems and their resilience through the application of the mitigation hierarchy.
- Internalisation (when possible) of biodiversity and ecosystems values into the cost benefit analysis and design of the project;
- Compliance with all relevant EU environmental legislation for projects in the EU, Candidate and potential Candidate countries and especially the Directives 2011/92/EU (EIA), 2001/42/EC (SEA), 2009/147/EC (Birds) and 92/43/EC (Habitats).
- Respect of international conventions and consistency with relevant provisions and standards contained in the international agreements and conventions, especially the Convention on Biological Diversity, the Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention) as well as the CITES Convention, the Ramsar Convention and the UNESCO World Heritage Convention.
- Ecosystems and land/seascape approach:
- Ensuring the appropriate participation of local communities and Indigenous communities in the decision-making process, especially where impacts on ecosystems services adversely impact the livelihood of indigenous communities.
- Implement adaptive management measures so as to efficiently protect biodiversity and ecosystems; and,
- Efficient monitoring and reporting to track the promoter's overall impact

For all projects financed by the EIB, the client/promoter must demonstrate that a range of alternatives and their impacts on biodiversity has been analyzed. The promoter is also required to apply the mitigation hierarchy, i.e. to take appropriate measures to avoid, minimize or rehabilitate/mitigate impacts that may damage biological diversity, regardless of area's protection status. In areas of natural habitat, mitigation measures must be designed to achieve no net loss of biodiversity where feasible. Where residual adverse impacts on biodiversity remain, the promoter may propose biodiversity offsets, where appropriate. The EIB supports the ongoing work to make operational the selective application of biodiversity offsets, while recognizing that certain impacts - such as loss of critical habitat - cannot be offset.

4. EIB Climate-Related Standards

The Standard requires that financing as a whole is aligned with EU climate policy. Climate change considerations should be taken into account at all stages of the project cycle.

5. Cultural Heritage

The objective of this Standard is to outline the promoter's responsibilities in terms of cultural heritage management, involving the actions taken to identify, assess, decide and enact decisions regarding the impact on cultural heritage associated with operations supported by the EIB.

6. Involuntary Resettlement

This Standard applies to all components of operations financed by the EIB, including associated facilities, which result in involuntary resettlement. It may further apply to activities resulting in involuntary resettlement that in the EIB's judgment are (a) directly and significantly related to the EIB-supported project; (b) necessary to achieve its objectives as set forth in the project documents.

7. Rights and Interests of Vulnerable Groups

Standard 7 sets out to avoid or minimise, or otherwise mitigate and remedy, potential harmful effects of EIB operations to vulnerable individuals and groups whilst seeking that these populations duly benefit from such operations.

8. Labour Standards

This Standard applies in full to all workers directly engaged by the promoter throughout the project life cycle. With regard to workers engaged through third parties, the promoter will determine that such third parties are legitimate, reputable and that their workers are protected consistently with these standards.

9. Occupational and Public Health, Safety and Security

Based upon international best practice and the EIB's recommendations, the promoter will agree with the EIB on (i) the level of comprehensiveness of the assessment of the health, safety and security risks and (ii) how occupational and public health and safety requirements will be best addressed and managed as part of the promoter's overall environmental and social management plan (ESMP). The ESMP should be supported by internationally recognized environmental and quality management systems (ISO 9001, ISO 14001).

10. Stakeholder engagement

As a public institution, the EIB actively promotes the right to access to information, as well as public consultation and participation; the right to access to remedy, including through grievance resolution, is equally acknowledged and actively promoted by the EIB. Standard 10 affirms the EIB's expectation that promoters uphold an open, transparent and accountable dialogue with all relevant stakeholders at the local level targeted by its EIB operations. This Standard stresses the value of public participation in the decision-making process throughout the preparation, implementation and monitoring phases of a project.

The Environmental and Social Policy of the EBRD (<https://www.ebrd.com/what-we-do/strategies-and-policies/approval-of-new-governance-policies.html#a1>), as approved by the Board of Directors at its Meeting on 7th May 2014, outlines how the Bank will address the environmental and social impacts of its projects by:

- defining the respective roles and responsibilities of both EBRD and its clients in designing, implementing and operating projects in line with this Policy and the Performance Requirements
- setting a strategic goal to promote projects with high environmental and social benefits
- mainstreaming environmental and social sustainability considerations into all its activities

To help clients and/or their projects achieve to environmental and social sustainability, the Bank has defined specific PRs for key areas of environmental and social sustainability as listed below:

PR1. Assessment and Management of Environmental and Social Impacts and Issues

This Performance Requirement outlines the client's responsibilities in the process of appraising, managing and monitoring environmental and social issues associated with projects proposed for EBRD financing. These include the following:

- identifying and assessing the environmental and social impacts and issues, both adverse and beneficial, associated with the project;
- adopting measures to avoid, or where avoidance is not possible, minimize, mitigate, or offset/compensate for adverse impacts on workers, affected communities, and the environment;
- identifying and, where feasible, adopting opportunities to improve environmental and social performance;
- promoting improved environmental and social performance through a dynamic process of performance monitoring and evaluation.

PR2. Labour and Working Conditions

This PR sets out the client's responsibilities with regards to labour and working conditions, including, among other things, the abolition and elimination of child and forced labour. The provisions of this document are based on the conventions adopted by the International Labour Organisation (ILO) and are very similar to the requirements of the Serbian labour legislation. The main difference relates to the requirement for the Bank's client to ensure that contractors involved in the project meet EBRD standards.

PR3. Resource Efficiency, Pollution Prevention, and Control

This PR requires from the client to identify project-related opportunities for energy, water and resource efficiency improvements and waste minimisation, to adopt the mitigation hierarchy approach to addressing adverse impacts on human health and the environment arising from the resource and to promote the reduction of project-related greenhouse gas emissions.

PR4. Health and Safety

This PR requires the Bank clients to identify and assess community health and safety risks associated with the project and take appropriate preventive measures. These measures will favour the prevention or avoidance of risks and impacts over minimisation and reduction.

PR5. Land Acquisition, Involuntary Resettlement, and Economic Displacement

This PR outlines requirements to be met for the projects involving involuntary resettlement and economic displacement. Involuntary resettlement refers both to physical displacement (relocation or loss of shelter) and economic displacement (loss of assets or resources, and/or loss of access to assets or resources that leads to loss of income sources or means of livelihood) as a result of project-related land acquisition and/or restrictions on land use.

PR6. Biodiversity Conservation and Sustainable Management of Living Natural Resources

This PR outlines the client's responsibilities with regards to the conservation of biological and landscape diversity in the project area. The client is required to assess the state of biodiversity, identify sensitive areas and habitats and develop appropriate mitigation measures designed to avoid/minimize the impact on flora and fauna. The client needs to adopt the mitigation hierarchy approach, with the aim of achieving no net loss for priority biodiversity features, and where appropriate, especially critical habitats, a net gain of biodiversity.

PR7. Indigenous peoples (not applicable to this project)

PR8. Cultural Heritage

This PR sets out the client's responsibilities with regards to the conservation and protection of cultural heritage, both tangible and intangible (including traditional skills, knowledge, beliefs and/or minor dialects and languages). The presence and potential for the presence of any cultural heritage assets, both tangible and intangible, in the Project area will be addressed in the ESIA.

PR9. Financial intermediaries (not applicable to this project)

PR10. Information Disclosure and Stakeholder Engagement

In particular, the EBRD requires the clients to carry out a comprehensive and systemic identification of stakeholders to identify those parties that are affected or likely to be affected by the project impacts (affected parties) and those groups that may have an interest in the project (other interested parties). Also, EBRD considers stakeholder engagement as a continuous and ongoing process that starts at a very early stage of the project and continues/evolves throughout the entire project lifecycle. The Stakeholder Engagement Plan should be developed and maintained for the Category "A" projects².

² Given the length of the motorway (40km) and that this project involves the construction of new road, the project is categorised as a Category A.

3.4 Comparison between International ESIA and Serbian EIA Processes

The two 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. For example, issues associated with local grievances arising from land purchase for the project are managed locally by local regulatory authorities. In the ESIA process, these local issues must also be encompassed in the integrated impact assessment. The Table below summarises the similarities and differences between the ESIA and Serbian EIA process.

Table 25 Relation with the local EIA procedure

Activity	ESIA	EIA	Comments
Screening Study	✓	✓	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	✓	✓	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	✓		A formal stakeholder engagement plan is not required under national legislation. However, stakeholder consultation is part of the EIA process.
Scoping Study	✓	✓	Due to the requirements of the ToR, an International Scoping Study was not produced for this project. The local Scoping Study was submitted to the local regulatory authorities. The EIA Scoping Application and Decision are presented in Annex 4.
Consideration of alternatives	✓	✓	Both the impact assessment process for investment and national regulatory requirements, require the consideration of other feasible approaches, including alternatives locations, technologies, scales and ‘no project’ options.
Environmental Impact Assessment	✓	✓	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	✓	✓	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.
Socio-Economic Impact Assessment	✓	Limit ed	The impact assessment for investment requirements requires an integrated approach including full deliberation of the socio-economic effects. The national regulatory requirements for impact assessment are primarily focused on environmental requirements with other requirements encompassed in other regulatory (e.g. ‘planning’) mechanisms. 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.
Environmental and Social Management Plan (ESMP)	✓		ESMP is not typically included as a requirement according to local legislation. It is required for Category A projects according to EBRD requirements. 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

Activity	ESIA	EIA	Comments
Non-Technical Summary (NTS)	✓	✓	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 and a summary of the residual impacts.
Public Consultation & Disclosure	✓	✓	The public consultation process for both investment and national regulatory purposes is required. Given the length of the motorway (40km) and that this project involves the construction of new road, the project is categorised in Category A, requiring the full ESIA disclosure package to be publicly disclosed for a minimum of 120 days.
Management of Grievances and Objections	✓		A Grievance Mechanism is not a formal requirement under the national regulatory requirements. However, grievances are reported under the consultation process and are encompassed under other regulatory mechanisms (e.g. the local 'planning' process).

4 Environmental and Social Baseline

4.1 Environmental Baseline

4.1.1 Topography and relief

Niš - Pločnik highway route passes through valley lowlands and hilly region. Highway route elevation range is from 210 (join to Belgrade – Niš highway) to 420 m a.s.l (bypass of Prokuplje, “Računkovo hill” tunnel).

Structural basin bottom is the lowest part of Toplica River course and is significantly wider on the northern side. It is very uniform and cultivated field crops are the most important source of income for the rural population. Space from structural basin foot toward mountain zone could be called hilly chain zone, where mild forms of relief are dominant.

The altitudinal range within basin indicates that there are more levels of fluvio-denudation processes appearing in vertical succession and these forms are dominating in the landscape. These fluvio-denudation forms are modified by fluvial erosion, so their forms are not well saved. Fluvio-denudation levels have mild slopes and eastern orientation which is also the direction of all larger water courses. Drainage network has different density and form. The main water courses in the area are Južna Morava, with its largest tributary Toplica River, and a large number of tributaries of the lower range. Considering former volcano activity which occurred in Toplica region in far geological past, this area is rich in various minerals like mica and feldspar, and iron ores.

Toplica-Kosanica structural basin is located between Mali and Veliki Jastrebac Mountains on the north, Kopaonik and Požar Mountains on the west, Prolom Mountain, Sokolovica, Arbanaška Mountains, Vidojevica and Pasjača Mountains on the southwest and south. Toplica valley has complex morphology, and it consists of more expansions and gorges. It consists of four morphologically different parts: 1) Gorge from its source to Vlahinje village, west from town Kuršumlja, 2) Toplicko-kosanicki gorge (middle Toplica gorge) from Vlahinje to Gubetina village, 3) short gorge between village Gubetina and Prokuplje, and 4) valley of lower Toplica, formed in lacustrine sediments of Dobrič. Toplica is not homogenous, neither by geological structure nor by terrain configuration. There are two distinguishable structural basins in Toplica County: Toplički and Kosanički basin, as well as smaller expansions and gorges within the valleys of Toplica River tributaries. The base of Toplica structural basin is made of lacustrine sediments, which have been changed by denudation processes.

Exogenous relief

Types of relief and relief process are determined by highway route position which passes through lowlands and hilly zones. Both, erosional and accumulative types of relief have been developed within the corridor. Accumulation processes are especially expressed in the lower part of the Toplica River course, on confluence with Južna Morava River.

Eluvial relief – eluvial processes occur on the whole area except on terrains where accumulation predominates, although with various effects. The results of these processes are various deposits of mainly small thickness. The higher thickness of eluvial material can be found in Miocene formation areas, as well as in other places, mostly on curved areas between watersheds, on mildly flattened ridges and similar positions.

Deluvial-proluvial relief - Deluvial-proluvial processes and relief almost dominate on the highway route. This relief is especially expressed on the part from Pločnik to Prokuplje on the right bank of Toplica River. It is less present in terrains made of carbonates. According to the intensity of deluvial-proluvial processes, it can be concluded that the area is characterized with mild to strong process intensity. Mild process intensity is present in the eastern parts of the region, between Prokuplje and Niš, while higher intensity is present in the central part of the route from Prokuplje to Pločnik, on both sides of Toplica River. These terrains are characterized by numerous permanent and occasional water courses and a dense network of gullies. This especially refers to terrains formed from semi- metamorphic Paleozoic rocks and from Miocene sedimentary rocks.

Main forms of accumulation formed by deluvial-proluvial processes are wide deluvial-proluvial curtains on almost all bigger valley sides of permanent water flows and on position with higher altitudinal gradients and deluvial covers on mild slopes.

Alluvial relief - Alluvial relief is mainly presented with accumulative and some slighter erodible forms, in the lower part of Toplica River and more erodible forms in the middle and upper stream of Toplica River and its tributaries. Water courses valleys are commonly mild and shallow cut in and have U-profiles. There are following accumulative forms of alluvial relief present in the study area: alluvial plains, river terraces, and inundated cones. In principle, these formations have broad distribution and small thickness. In the profile of alluvial sediments dominating formations of riverbeds are mainly coarse-grained deposits (gravel and sand). Less common are finer material formations like aleurolithes, sub-clays, and sub-sands, which usually have a small thickness. Most of the hilly water courses have small and narrow alluvial plains formed of blocky-gravel material. River terraces as parts of former alluvial plains are present mostly in the lower and middle part of Toplica River, where they appear as narrow floors (bottoms) formed by same or nearly same materials as alluvial plains. Inundated fans (proluvial cones) are formed in many places in the corridor area primarily on confluences of smaller water courses and Toplica River. Bigger inundated cones are found on the left side of Toplica River from Tulare to Mala Plana.

Colluvial relief – forms of colluvial relief in the corridor are rare or practically missing. There are mostly small landslides and rare escarpments along Prokuplje – Mala Plana direction.

Anthropogenic relief – this type of relief is a consequence of human activity. It is represented by forms of anthropogenic origin (large settlements, landfills, artificial reservoirs, etc.).

Endogenous relief

Individually, the phenomena of endogenous relief on the highway route are present. These characteristics could have great number of faults, especially on the part of the road from Prokuplje to Pločnik. This kind of relief disposal is consequence of the neogene-quaternary vertical tectonic mobility and destructive erosion processes.

4.1.2 Geomorphology

Highway loop Niš-south (existing) is positioned nearby location Crkvište. It is found on the old river terrace without risk of flooding, approximately 1.5 km far from Južna Morava River, on approximately 20 m higher elevation. E80 highway route follows an old road to Merošina in west – northwest direction passing over Golema padina and Mala padina toponyms. Terrain elevation is from 200 to 220 m a.s.l up to the third km of the road, and on following 670 m of the route it rises for additional 15 m, so the elevation is 235 m a.s.l. Terraced relief has 1-3% slope during first two kilometres of road, and until km 4+120 slope is increasing to 3-5%. From this point, until km 5+740, route spreads over Taljanka toponym which is located south and southwest from Aleksandrovo village. Elevation on this part of the terrain is 235-255 m a.s.l. In this part of highway route dominate slope from 1-5% and southern and south-eastern aspects.

Figure 44 Morphology of the first section



On approximately km 5+500 km highway leaves the old road to Merošina. Terraced relief with a slope of 1-3% is found north from Merošina (km 5+740 – km 7+820). In this part of highway route, terrain descends from 255 to 250 m a.s.l. in a southeast direction.

Figure 45 Morphology of the second section



On Zmijarnik toponym, from km 7+820 – km 8+320, the route descends on lower terrain and rises in front of Drenjak toponym on higher terrain. A bridge is planned bellow Zmijarnik toponym. In this part of the route, the highway passes over Lepajski spring eastern from Baličevac village and the terrain becomes slightly steeper with slopes from 5-8%.

The terrain elevation from 9+090 - km 10+590 of the road is from 265-370 m a.s.l.. This altitudinal increase varies in aspect and slope is from 6-12%, but in continuation of the road it is even lower than 5% (km 11+630 - km 12+500). A tunnel 200 m long is planned on km 11+620. The highway crosses over Zavati toponym and terrain above Konjarnik toponym, and it starts to descend on Altambara toponym. The terrain has southeastern aspect here.

On a road section from km 13+490 - km 13+890 route passes over Devičanska River, among Jugbogdanovac and Arbanasce villages. On this part of road route the construction of a bridge 620 m long is planned.

Figure 46 Position of the bridge km 13+700



In route continuation, km 13+890 - km 15+410, highway passes through an area eastern from Djurovac village. Terrain elevation is from 310-370 m a.s.l., and slopes are up to approximately 6%, and from km 15+000 higher than 10%.

From km 15+410 - km 16+100 of the highway, slopes are slightly greater than 10%, which is avoided by the construction of tunnel Božurna 620 m long bellow Babine uši area. Altitude on this part of the ground is from 350-395 m a.s.l.

Afterwards the road descends from km 16+100 - km 18+180 from a hill northwest of Nova Božurna village. Terrain has slopes up to 15% and the road is descending over Slanište area at an elevation of 310 m a.s.l. At the beginning of this part of route a 250 m long bridge is planned at 18+000km, and three shorter bridges are planned at 18+000 km, before, and after it. Also, highway loop Prokuplje is located at km 16+450 of the highway.

Highway route after descends into a depression on approximately 200 m south of Donja Stražava village (km 18+180 - km 18+380) near Stražavska River.

In part of the route from km 18+380 - km 20+500, terrain height is from 280 m up to around 350 m a.s.l. Slopes in some parts of this route are around 9%. Two bridges are planned (L=325 m and L=140 m) on this location, and one tunnel (L=265).

Hereafter highway route (km 20+500 – 22+270 km) passes north from Prokuplje and Računkovo hill, located next to Prokuplje vineyards, at altitudes up to 420 m a.s.l. In this part of the route, slopes are greater than 15-19%, and therefore tunnel called “Računkovo hill”, 1175 m long, is planned. Construction of two bridges and one tunnel which leads to lower terrain (303 m a.s.l.) is planned in this part of the highway route.

Figure 47 Prokuplje bypass, picture and 3D model – tunnel-bridge-tunnel



From km 22+270 to km 22+900 route overpasses ground by bridge 1025 m long (up to km 23+400).

E80 highway route continues from km 23+400 to the end of route (40+000 km) across plain terrain from 250-300 m a.s.l., with uniform slope lower than 1%.

Figure 48 Morphology of the last section



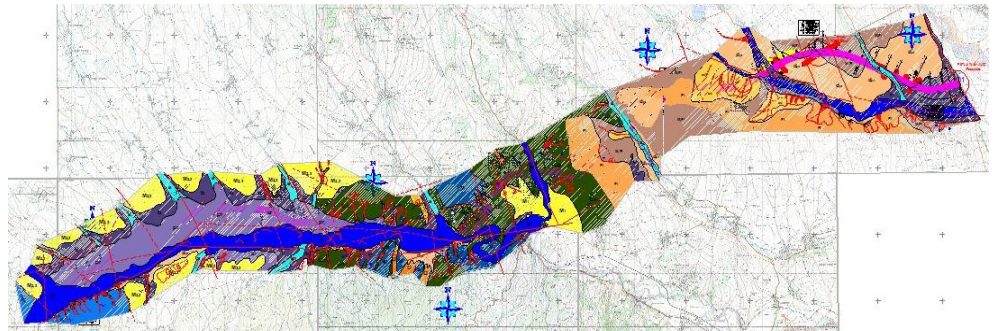
4.1.3 Geology

The route of the future highway passes through a geologically very heterogeneous terrain of Prokuplje vicinity, made of fine grained gneisses Proterozoic age and Neogene sediments of foothills i.e. Quaternary sediments in the Toplica Valley and its smaller river tributaries. On the part of the route around Prokuplje, the solid rock mass mainly dominates. This solid rock mass is variable quality i.e. tectonic damaged, with variable thickness of surface weathered zone. Besides, in one part of the route between Merosina and Prokuplje, in the wider area between 9 and 12 km, potential or conditional instabilities were identified. So, in the case of large earth excavations, landslides may be activated that would endanger the designed highway route. Based on this, the zones in which characteristic geological units dominate were extracted and presented in Table 26 represented geological units along the highway route are also presented on the engineering geological map (Figure 49).

Table 26 Engineering geological zones with extracted geological units

Section	Approximate length	Represented geological units
Interchange Nis south – to approximately km: 17+000	km: 0+000 to km: 17+000	Alluvial and river-terraced plateaus (al, t ₁ , t ₂ , pr) Neogene hilly terrains (dpr, ed, Pl, M-Pl)
Interchange Nis south – to approximately km: 23+000	km: 17+000 to km: 21+000 km: 21+000 to km: 23+000	Alluvial and river-terraced plateaus (al, t ₁) Crystalline schists complex (Gn, M, Q)
Prokuplje – Plocnik	km: 23+000 to km: 39+300	Alluvial and river-terraced plateaus (al, t ₁ , t ₂) Neogene hilly terrains (dpr, dl, pr, ed, Pl, M-Pl, M) Crystalline schists complex (Gn, M, Q)

Figure 49 Engineering geological map along the highway route



Alluvial and river-terraced plateaus (al, t1, t2, pr)

Most part of the highway route intersects alluvial plateaus of Toplica tributaries and river terraces of smaller distribution. On this section, proluvial-deluvial formations are present, which are occurred by diffuse superficial erosion, transport of periodical water and gravity. Alluvial area of Toplica is made of sands and gravels in the riverbed facies, with sandy clays and clayey sands and in the roof flood plain facies with higher content of silty and clayey fractions is developed. River terraces have a similar geological structure in the vertical profile. Certain terraced forms, such as terraced forms south from Mramor, originated in a specific way, by the action of large delapsion movement. They are presented by silty clays, silty sands, loess clays, etc. Spacious inundated cones, upstream from Prokuplje, are under the influence of smaller torrent flows which gravitate from the surrounding terrain. These alluvial and river-terraced plateaus, beyond the influence of Toplica River flow and its tributaries, are mostly stable. Potential instabilities are present in the zone of unregulated riverbed coasts. These instabilities may have importance in the design and construction of the bridges mostly over the Toplica River and less in the zone of planned bridges over its tributaries. Regardless of the extreme heterogeneity, both in composition and physical-mechanical characteristics, these areas have good to medium resistance deformable characteristics, favourable to conditionally favourable physical-mechanical characteristics for the structure construction.

Neogene hilly terrains (dpr, dl, pr, ed, PI, M-PI, M)

These terrains are situated around the perimeter of middle and lower Toplica Valley, where we have two different parts (different in age and composition): younger Neogene complex downstream from Prokuplje (km: 0+000 to km:17+000) and older Neogene complex upstream from Prokuplje over which highway route construction was not planned. They are separated by the crystalline metamorphic complex of Prokuplje vicinity. They are of a very heterogeneous lithological composition and are characterized by frequent facial changes. The main lithological representatives are poorly bonded sandstones, gravels, sands, and clays with numerous transitional varieties. Younger Neogene complex corresponds to the upper Miocene and lower Pliocene. There are two horizons: the lower – in which sediments of fine grain composition dominate (clays and silts containing fine grain sands, coal clays locally, etc.) and the upper – made primarily of sands with rare layers of sandy clays and gravel lenses. These terrains are mostly covered

with complex of deluvial, deluvial-proluvial sediments and surface weathered zone thickness of over 10 m. Also, on the slopes of Debelo Brdo (Balicevac village), conditional instability in the weathered zone of Neogene sediments is identified. Also, the appearance of minor instabilities is determined in Pliocene sands and gravels near Nova Božurna, north-east from Prokuplje. Regarding terms of physical-mechanical properties, this sediment unit is medium to good characteristics. Conditions for the construction in these sediments range from conditionally favourable to very favourable.

Crystalline schists complex (Gn, Ga, M, Q)

In the structure of this metamorphic complex fine-grained gneisses and liptinites dominate, and occurrence of amphibole gneisses and amphibole-pyroxene schists are identified. Within the gneisses, the appearance of marbles and quartz are registered. In this complex denudation processes are expressed with linear erosion in some places, only on steep slopes, and products of these processes are deposited at the bottom of the slopes and on the flattened parts of the terrain. Slope creations are often mixed with torrential deposit, and thicker layers of contemporary deluvial-proluvial deposit are formed in the bays. Rock mass of this complex has in general favourable to conditionally favourable properties. Rocks, which are the part of this complex composition, have uneven physical-mechanical properties and decomposition degree. Products of mechanical decomposition are different thicknesses which are in the range of 0.5 m to over 5.0 m. The stronger parties of metamorphic complex, such as quartz, marbles and better-preserved gneisses and amphibolites have thinner or do not have weathered zone and which make morphologically prominent parts of the terrain.

4.1.4 Hydrogeology

Based on the research it was found that the terrain in the entire area is basically built from rocks that are watertight. The largest part of the surface water drains by gravity down the slopes to the local erosion basis - local stream ravines and river valleys. In addition, due to the steep slope of the terrain, water intensive transported decomposed material and formed gullies in the middle, and ravines in the lower parts of the slopes.

The research was carried out in the dry season. That means the accumulation of groundwater in stronger degraded zones of rock masses and the deluvial layer during hydrological peaks are possible. Aquifers formed this way are localized, very small yield, but their discharge is manifested in the form of wetting and low leakage in the contacts with the rock. Larger accumulations of groundwater are found in alluvial deposits of Stražavačka River, Toplica River and Trnavska River.

Deluvial, silty - sandy clay with fine-grained debris (dgp, dr) have a maximum surface distribution. They are characterized by an integrated and subordinated cracked porosity, uneven and inconsistent water-permeable, and can be seasonal local water saturated.

Deluvial deposits have the general function of the hydrogeological collector conductors. Locally, due to the increased content of fine-grained components, is

unevenly permeable to water, seasonally may be wet, less frequent water saturated.

Alluvial silty-clayey (alg, p, alp, pr) and gravel-sandy-clayey (alp, g, š, alp, š) deposition of Stražavačka, Trnavska and Toplica River generally have super capillary porosity and accumulate slightly larger amounts of free groundwater comes only in gravel deeper part. However, higher dust parts of the area are full of water most of the year. Water permeability of this material is generally poor, which is especially true in the area just below the surface.

The groundwater level was determined at the tunnel excavation sites, where the groundwater regime could be damaged during the construction of the highway.

1. Tunnel "Debelo Brdo" – near the zone of that tunnel there is a water supply system for the wells of the village of Baličevac. During geotechnical investigations the groundwater level in the tunnel zone was not registered. Additional research is recommended in the phase of the Main Design.
2. Tunnel Lalinac - the appearance of underground waters is below the excavation zone of the bottom of the tunnel, so this digging does not disturb the regime of underground waters.
3. Tunnel Nova Božurna – the entrance portal zone will most likely be in the zone of groundwater influence. But, in this part of the route, the population is supplied with water from the city water supply system (Prokuplje area), so that possible blurring of groundwater during the lowering of their level for tunnel excavation needs will not have a significant impact.
4. Tunnel Računkovo brdo - no groundwater occurrence has been recorded in the tunnel excavation zone.
5. Tunnel Vrsnik - The appearance of groundwater is registered at a depth below the level of the tunnel excavation
6. Tunnel Plekane kuće - no groundwater occurrence has been recorded in the tunnel excavation zone.

Note: Along the whole section, presence of karst rocks is not registered.

Water supply

Prokuplje water supply is now performed from underground sources (40%) and from accumulation (water source „Bresnica“) (60%). There is a deficit in the amount of water for water supply.

Solving the problem of water supply of the city of Prokuplje started with the construction of a dam and reservoir on the river Bresnička in 1975. Raw water from the reservoir is transported to treatment plants by gravity pipeline, from where is transported by pipeline to the city. The capacity is 70 - 80 l/s. In 1992, from the spring "Hisar" four wells, depth of 120 - 150 m, ground water is delivered by

pressure waterpipe L=1.5 km to the pump station Draganja. Further is distributed directly to the city network, while excess water goes into the tank on the hill Hisar. The capacity of the spring is 60 l/s.

Figure 50 Water supply system „Hisar“



PS-Pump station "Draganja", wells B1, B3, B4 and B5-reservoir "Hisar"

The source "Bumburek" has a capacity of 25 l/s and wells and a pumping station have made so far to put the available amount of water straight into the distribution network. It is necessary to do pressure waterpipe with a length of 4.5 km.

Municipality Prokuplje water supply will be solved permanently when building a water supply system "Selova" is completed. Then the town and villages in the municipality will receive around 400 l/s of drinking water.

Figure 51 Dam "Selova"



A bottled water from this area was mineral water "Milan Toplica" from the wells near Viča. This mineral water factory is not active now, but it will be open soon. The project of reconstruction of the pipeline is in the phase of adoption.

4.1.5 Climate settings

Climate characterization of a wider area of the highway section Niš-Pločnik is preformed using measurements from two synoptic (Niš and Kuršumlja) and one climatological (Prokuplje) station, all owned by the Hydro meteorological Service of Serbia (HMSS). Observations are obtained from the HMSS's Yearbooks of Climatological Data available at: http://www.hidmet.gov.rs/podaci/meteo_godisnjaci. Geographical coordinates of meteorological stations and their elevation are given in Table 25. Normal annual and monthly values climatological parameters relevant for climate characterization and its possible impacts on the highway are calculated for the period 1981-2010.

Table 27 Meteorological stations and their location

Station	Latitude	longitude	Elevation (m)
Niš	43°20' N	21°54' E	204
Prokuplje	43°14' N	21°36' E	266
Kuršumlja	43°08' N	21°16' E	383

The climate of the wider area of the highway section Niš-Pločnik is a temperate continental; with moderately warm summers and moderately cold winters. At altitudes above 1000 m it changes towards a mountain climate, with short and fresh summers and longer, colder and snowy winters. It is mainly influenced by orography, with the Kopaonik Mountains on the west and the Toplica River valley along the highway route.

According the Köppen climate classification³ the region has a temperate humid climate with warm summers (Cfa).

Climate conditions are described through the analysis of normal monthly and annual values of relevant parameters (minimum, maximum and mean air temperature, precipitation, humidity and winds) in the period 1981-2010, observed at meteorological stations Niš, Prokuplje and Kuršumljia.

Mean annual air temperature in the period 1981-2010 measured at the three meteorological stations is between 10.3 and 11.9°C. The warmest month is July and the coldest is January. Autumns are warmer than springs due to a mild influence of the Mediterranean Sea. The temperature gradually rises from west to east as elevation decreases.

Mean annual precipitation for the same period is about 600 mm, with slightly more precipitation on the west and less on the east. Precipitation is uniform and it has a continental regime, with a maximum in summer and minimum in winter.

Temperature

Normal mean annual air temperature in the period 1981-2010 is 11.9°C at Niš, 11°C at Prokuplje and 10.3°C at Kuršumljia station. Annual and monthly temperatures gradually rise from west to east (from Kuršumljia towards Niš) as elevation decreases. The difference is most pronounced in summer and lesser in winter. The warmest month is July (20.1°C Kuršumljia, 21.4°C Prokuplje and 22.5°C Niš) and the coldest is January (0°C Kuršumljia and Prokuplje and 0.6°C Niš). Normal seasonal and annual temperature is presented in Table 27.

Table 28 Normal seasonal and annual temperatures (°C) for the period 1981-2010 at the meteorological stations in the region

Station	Winter	Spring	Summer	Autumn	Annual
Niš	1.7	12.1	21.7	12.0	11.9
Prokuplje	1.2	11.1	20.4	11.3	11.0
Kuršumljia	0.9	10.4	19.4	10.5	10.3

The annual flow of normal maximum and minimum monthly temperatures generally follows normal mean temperature, with an exception of the highest maximum monthly temperature that is recorded in August. Normal mean, minimum and maximum temperatures are presented in Figure 52, Figure 53 and Figure 54.

³ <https://www.britannica.com/science/Koppen-climate-classification>

Figure 52 Normal monthly maximum, minimum and mean temperatures for the period 1981-2010 at Niš meteorological station

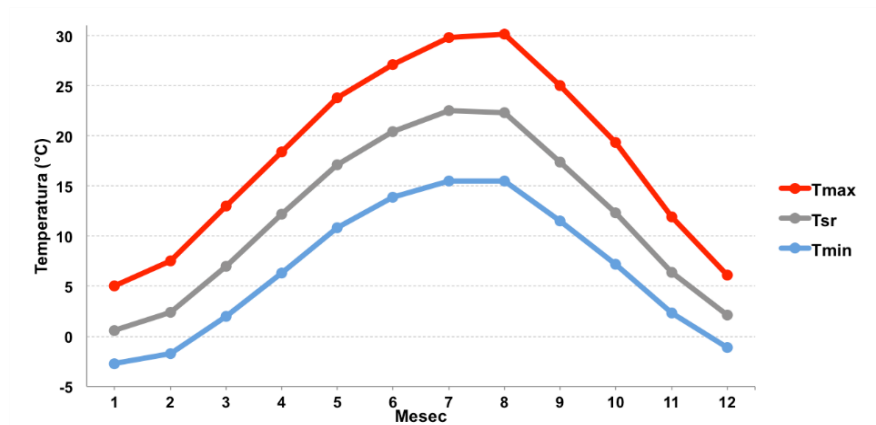


Figure 53 Normal monthly maximum, minimum and mean temperatures for the period 1981-2010 at Prokuplje meteorological station

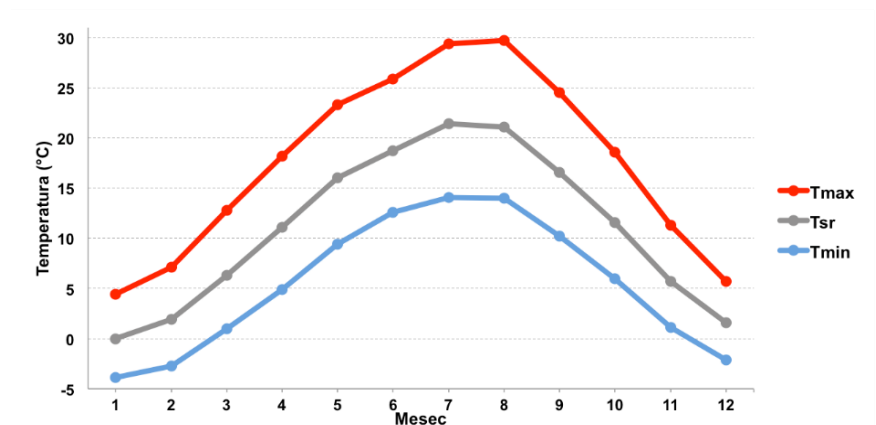
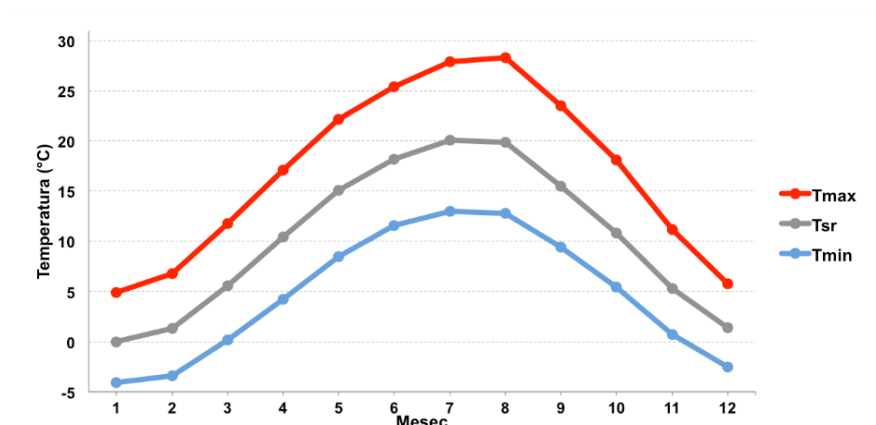


Figure 54 Normal monthly maximum, minimum and mean temperatures for the period 1981-2010 at Kuršumlija meteorological station



Frost days (days with minimum temperature below 0°C) are recorded at all three stations from October to April. In average, there is 103.3 frost days at Kuršumlija station, 92.2 at Prokuplje and 79.8 at Niš. Icing days (days with maximum temperature below 0°C) are noted from November to March; in average 17.6 at

Kuršumlja, 14.4 at Prokuplje and 14.7 at Niš. The largest number of frost and icing days is in January.

Average number of summer days (days with maximum temperature above 25°C) ranges from 88.9 at Kuršumlja station to 109.2 at Niš. Days with tropical nights (days with minimum temperature above 20°C) are not often recorded at the stations at Kuršumlja (0.1 day) and Prokuplje (0.5 day), while there are 4.1 annually in average at Niš.

Table 29 Average monthly and annual number of frost days, icing days, summer days and days with tropical nights for the period 1981-2010 at the meteorological stations in the region

Station	MONTH												Annual
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	
	Average number of frost days (Tmin<0°C)												
Niš	22.3	17.8	9.5	1.5	0	0	0	0	0	1.9	8.8	17.9	79.8
Prokuplje	23.3	19.4	12.3	2.7	0.1	0	0	0	0	3.0	11.6	19.8	92.2
Kuršumlja	24.6	21.1	15.1	3.9	0.2	0	0	0	0	3.7	13.5	21.1	103.3
	Average number of icing days (Tmax<0°C)												
Niš	6	3.4	0.5	0	0	0	0	0	0	0	0.4	4.3	14.7
Prokuplje	5.9	2.9	0.4	0	0	0	0	0	0	0	0.4	4.7	14.4
Kuršumlja	6.9	4.2	0.8	0	0	0	0	0	0	0	0.6	5.1	17.6
	Average number of summer days (Tmax>25°C)												
Niš	0	0	0.5	2.7	12.9	20	25.9	26.5	16	4.5	0.3	0	109.2
Prokuplje	0	0	0.5	2.6	11.6	18.1	25.1	25.8	14.4	3.2	0.2	0	101.5
Kuršumlja	0	0	0.2	1.7	9.1	16.4	22.6	23.9	12.0	2.9	0.1	0	88.9
	Average number days with tropical nights (Tmin>20°C)												
Niš	0	0	0	0	0	0.7	1.5	1.8	0.2	0	0	0	4.1
Prokuplje	0	0	0	0	0	0.1	0.2	0.3	0	0	0	0	0.5
Kuršumlja	0	0	0	0	0	0	0	0.1	0	0	0	0	0.1

Precipitation

Normal annual precipitation amount for the period 1981-2010 in the highway region varies from 580.5mm at Niš, 550.2mm at Prokuplje to 642mm at Kuršumlja station. Maximum of monthly precipitation normally occurs during spring or beginning of summer (May and June) at Niš and Prokuplje and in July at Kuršumlja, as presented in histogram in Figure 40. The lowest precipitation is recorded in January (at Kuršumlja) or February (at Niš and Prokuplje). Normal seasonal and annual precipitation is presented in Table 30.

Figure 55 Normal monthly precipitation for the period 1981-2010 at the meteorological stations in the region

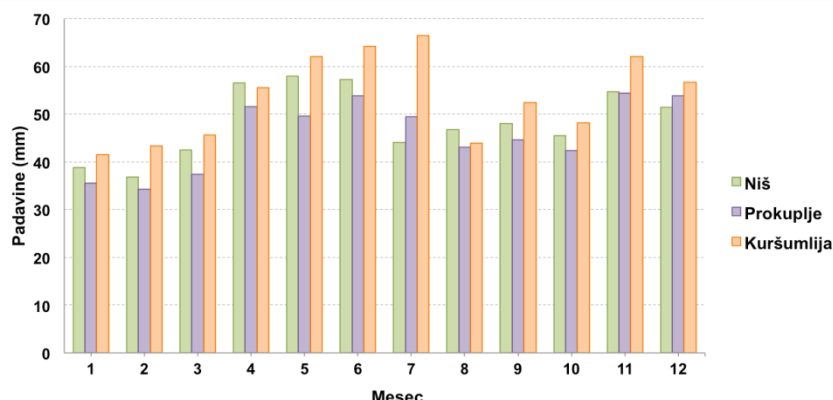


Table 30 Normal seasonal and annual precipitation (mm) for the period 1981-2010 at the meteorological stations in the region

Station	Winter	Spring	Summer	Autumn	Annual
Niš	127.1	157.1	148.0	148.3	580.5
Prokuplje	123.7	138.6	146.4	141.4	550.2
Kuršumljia	141.6	163.2	174.5	162.7	642.0

Average annual number of days with precipitation (days with precipitation larger than or equal to 0.1mm) is the largest at Niš, 134.3, at Kuršumljia is 123.5 and 98 at Prokuplje. Average annual number of days with heavy precipitation (days with precipitation larger than or equal to 10mm) at Niš and Prokuplje is 17, while it is somewhat higher at Kuršumljia (20.3). Heavy precipitation is mainly recorded in May at Niš and during summer or in November at Prokuplje and Kuršumljia (Table 30). Days with very heavy precipitation (days with precipitation larger than or equal to 20mm) occur in average 4.4 times per year at Niš and Prokuplje and 5.9 times at Kuršumljia.

Table 31 Average monthly and annual number of days with precipitation, heavy precipitation and very heavy precipitation and mean precipitation intensity for the period 1981-2010 at the meteorological stations in the region

Station	MONTH												Annual
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	
	Average number of days with precipitation (RR≥0.1mm)												
Niš	12.9	12.7	12.0	12.9	12.4	11.1	8.7	7.6	9.4	9.5	11.2	14.0	134.3
Prokuplje	7.7	8.4	8.2	9.6	9.5	8.6	6.3	5.9	7.3	7.5	8.4	10.5	98.0
Kuršumljia	11.3	11.3	10.9	11.5	11.8	10.5	8.6	7.3	8.8	8.9	9.8	12.8	123.5
	Average number of days with heavy precipitation (RR≥10mm)												
Niš	1.0	0.7	1.2	1.7	1.8	1.7	1.4	1.6	1.4	1.6	1.7	1.4	17.0
Prokuplje	0.8	0.9	1.0	1.7	1.3	1.8	1.8	1.2	1.4	1.5	2.0	1.5	16.9
Kuršumljia	1.2	1.2	1.3	1.8	1.9	2.1	2.2	1.6	1.8	1.7	2.1	1.5	20.3
	Average number of days with very heavy precipitation (RR≥20mm)												
Niš	0.1	0.0	0.2	0.4	0.5	0.5	0.4	0.5	0.5	0.4	0.6	0.2	4.4
Prokuplje	0.2	0.1	0.1	0.3	0.3	0.5	0.5	0.5	0.4	0.4	0.4	0.5	4.4
Kuršumljia	0.2	0.3	0.4	0.5	0.4	0.8	0.9	0.4	0.7	0.5	0.7	0.3	5.9
	Average precipitation intensity (mm/dan)												
Niš	3.0	2.9	3.5	4.4	4.7	5.1	5.1	6.1	5.1	4.8	4.9	3.7	4.3
Kuršumljia	3.7	3.9	4.2	4.8	5.3	6.1	7.8	6.0	6.0	5.4	6.4	4.4	5.2

Measurements show that larger precipitation amount at Kuršumljia station falls over less number of days. Of the total number of precipitation days at this location, 16.5% are days with heavy and 4.8% days with very heavy precipitation. As a consequence average annual precipitation intensity at Kuršumljia is 5.2 mm/day and it is larger than at Niš (4.3 mm/day).

Snow cover normally forms in the colder half of the year, from October to April. In average, there is from 36 (Niš) to 43 (Kuršumljia) days with snow cover during a year. The largest number of days with snow cover and largest heights are observed in January and December (Table 31) and at higher elevations. Normal annual number of days with snow cover above 5cm is between 20.7 and 24.6, days with snow cover above 10 cm from 10.5 to 15.4 and days with snow cover above 20 cm between 2.3 and 8.7.

Table 32 Average monthly snow cover height, number of days with snow cover, snow cover above 5cm, 10cm and 20cm for the period 1981-2010 at the meteorological stations in the region

Station	MONTH												Annual
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	
	Average snow cover height (cm)												
Niš	6.7	6.1	3.1	0.5	0.0	0.0	0.0	0.0	0.0	0.0	2.9	5.8	
Prokuplje	7.2	5.8	3.2	1.3	0.0	0.0	0.0	0.0	0.0	0.2	4.8	8.5	
Kuršumljia	7.7	6.5	4.8	1.7	0.0	0.0	0.0	0.0	0.0	0.2	4.1	8.0	
	Average number of days with snow cover												
Niš	11.7	8.8	3.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	2.9	9.0	35.9
Prokuplje	11.6	8.9	3.7	0.3	0.0	0.0	0.0	0.0	0.0	0.0	2.8	8.9	37.3
Kuršumljia	13.8	10.3	3.7	0.3	0.0	0.0	0.0	0.0	0.0	0.1	3.9	11.2	43.2
	Average number of days with snow cover above 5 cm												
Niš	7.5	5.6	1.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.6	4.6	20.7
Prokuplje	6.5	5.7	1.9	0.1	0.0	0.0	0.0	0.0	0.0	0.0	1.6	5.0	22.0
Kuršumljia	7.9	5.8	1.9	0.2	0.0	0.0	0.0	0.0	0.0	0.0	2.2	6.6	24.6
	Average number of days with snow cover above 10 cm												
Niš	4.0	3.2	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	2.0	10.5
Prokuplje	4.4	4.5	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1	2.9	15.4
Kuršumljia	4.6	3.5	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2	3.4	13.7
	Average number of days with snow cover above 20 cm												
Niš	1.3	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.3	2.3
Prokuplje	2.1	3.0	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	1.0	8.7
Kuršumljia	1.9	1.1	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	1.3	5.0

Humidity

Normal annual relative humidity for the period 1981-2010 observed at the stations is 69.6% at Niš, 76.2% at Prokuplje and 77.3% at Kuršumljia. It rises from east to west, along with precipitation and elevation increase and temperature decrease. Normal monthly values vary from 60 to 85%, the largest are in winter and the smallest in summer, as presented in Table 33.

Table 33 Normal monthly and annual relative humidity (%) for the period 1981-2010 at the meteorological stations in the region

Station	MONTH												Annual
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	
Niš	79.9	73.9	66.1	63.5	64.8	65.0	61.2	61.3	68.5	73.2	77.4	80.6	69.6
Prokuplje	74.6	74.6	73.3	72.8	70.4	71.0	75.6	78.4	80.5	82.3	82.7	78.4	76.2
Kuršumljija	83.1	79.5	73.9	71.8	74.3	75.2	72.3	72.6	77.6	80.9	82.3	84.0	77.3

Fog

Normal annual number of days with fog is 11 at Niš and 9.5 at Kuršumljija. Foggy days are usually observed in the colder half of the year, from October to February.

Table 34 Normal monthly and annual number of days with fog for the period 1981-2010 at the meteorological stations in the region

Station	MONTH												Annual
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	
Niš	2.6	1.0	0.2	0.1	0.3	0.0	0.1	0.0	0.3	1.4	1.9	3.1	11.0
Kuršumljija	1.0	0.8	0.3	0.4	0.3	0.4	0.3	0.3	0.9	2.3	1.4	1.2	9.5

Wind

Normal annual wind direction frequencies and mean velocity for the period 1981-2010 at stations Niš and Kuršumljija are shown on Figure 41 and Figure 42 respectively.

Common wind directions at Niš are north-northwest and east-northeast due to the shape of the orography that is open to the northwest through the South Morava Valley and to the east along the Nišava River Valley. Winds from other directions are rare since mountains shelter the location. The largest mean velocity is for winds from the northwest and east.

Common wind directions at Kuršumljija are south to southeast, as well as north and northeast. Similarly to Niš, orography streams air masses along the Toplica (northeast) and Kosanica (east) River valleys. The largest mean velocity is for winds from the south-southeast and north-northwest.

Figure 56 Wind rose at Niš station for the period 1981-2010. Left panel: normal annual relative direction frequencies (%). Right panel: normal annual velocity (m/s)

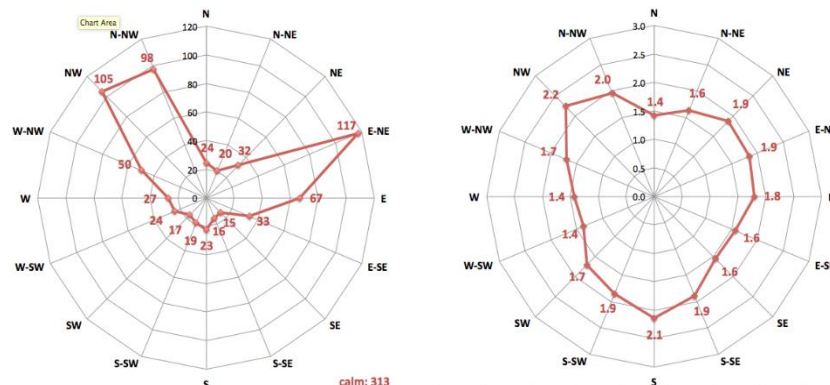
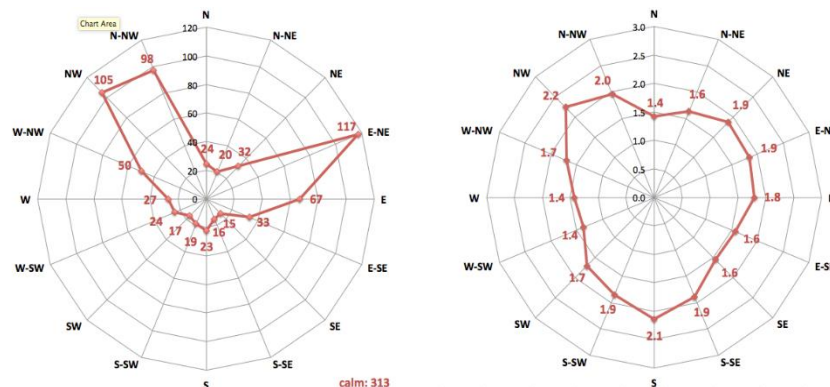


Figure 57 Wind rose at Kuršumlija station for the period 1981-2010. Left panel: normal annual relative direction frequencies (%). Right panel: normal annual velocity (m/s)



4.1.6 Surface water

Surface waters from this area are drained by streams that belong to the basin of the Toplica River. Tributaries are generally torrential flows.

At the time of high water some parts of the field are flooded, it is especially the case in alluvial area of the Toplica River.

List of all watercourses which crosses the route is presented in the following Table 35

Table 35 List of all watercourses on the route

No.	Name of watercourse	Station	Permanent watercourse	Crossing method	Piers in river bed	Length of river regulation (crushed stone)
		(km)	(Yes/No)	L/diameter (m)	Yes/No	(m)
1	Aleksandrovački Stream	2+988	N	Bridge, L=12m	N	97
2	Golema Padina Stream (occasional watercourse)	5+825	N	Viaduct, L=210m	N	

No.	Name of watercourse	Station	Permanent watercourse	Crossing method	Piers in river bed	Length of river regulation (crushed stone)
		(km)	(Yes/No)	L/diameter (m)	Yes/No	(m)
3	Mala Padina Stream (occasional watercourse)	7+420	N	Pipe culvert, diameter 1,6m	-	
4	Krajковаčka River	8+105	Y	Bridge, L=70m	N	75
5	Lepajski Stream	8+514	N	Bridge, L=70m	N	280
6	Jugbogdanovačka River	14+062	Y	Viaduct, L=500m	N	113
7	Suvi Stream	14+235	N		N	302
8	Ciganski Stream	17+785.4	N	Bridge, L=130m	N	170
9	Stržavska River	18+433	N	Bridge, L=315m	N	103
10	Bezimeni Stream	19+184	N	Viaduct, L=140m	N	
11	Trnavska River	22+679.4	N	Viaduct, L=975m	N	135
12	Randelov Stream	25+550	N	Bridge, L=35m	N	
13	Planska River	27+538	N	Bridge, L=18m	N	408
14	Drenovački Stream	29+019	N	Box culvert, L=5m	-	345
15	Zdravinska River	30+108	N	Bridge, L=15m	N	115
		31+791	N	Bridge, L=35m	N	80
16	Kondželjska River	33+131	N	Bridge L=50m	N	
17	Draguška River	34+928	Y	Bridge, L=35m	N	
18	Tisin Stream	36+578	N	Bridge, L=35m	N	
19	Suvodolski Stream	37+533	N	Bridge, L=15m	N	
20	Backa River	38+278	N	Bridge, L=15m	N	
21	Toplica River	38+550	Y	Bridge, L=140m	N	

Recent data about surface water quality, as well as physico-chemical, chemical, microbiological parameters of the river network including Toplica River, from hydro meteorological stations, are available from the “Survey results of surface and groundwater quality for 2013”, Environmental Protection Agency Belgrade, 2014. Therefore, additional quality measurement wasn’t conducted during the project. Nevertheless, it should be noted that additional sampling will be necessary before the start of construction, since these data may be outdated by that time and among the obligations of the contractor is to test the quality of the water upstream from the bridges before the start of construction work on the bridge.

The results of the performed physical-chemical, chemical and microbiological analyzes of surface water samples (watercourses), ie the relevant parameters for the annual period, are compared with the limit values of the quality classes prescribed by the Decree on the Limit Values of Pollutants in Surface and Groundwater and Sediment and Deadlines for their reaching (Official Gazette RS No. 50/2012). The values of the priority and priority hazardous substances are compared with the values of the environmental quality standards, ie the average annual concentration (AAC) and the maximum permissible concentration (MPC) prescribed by the Decree on limit values of priority and priority hazardous substances that pollute surface waters and deadlines for their reach (Official Gazette of RS No. 24/2014).

For the needs of this study, the data for Toplica River was isolated from the above mentioned assessment. For the parameters defined in the Regulation (Official Gazette of RS, No. 50/2012), the corresponding classes of quality are displayed with Roman numerals and color (I class - blue, II class - green, III class - yellow, IV class - orange and V class-red color). For the purpose of better transparency, the table is divided into seven sub-groups, by groups of parameters as defined in the Regulation (Official Gazette of RS, No. 50/2012).

Table 36 Assessment of the status of Toplica River water quality in 2013

		Toplica
Watercourse type		Type 3
General	Ph	I-IV
	Dissolved solids	I-II
Oxygen regime	Dissolved oxygen	V
	Oxygen saturation	III
	BOD	II
	COD(dichromate method)	II
	COD (permanganate method)	II
	Total organic carbon (TOC)	III
Nutrients	Total nitrogen	III
	Nitrates	II
	Nitrites	III
	Ammonium jon	IV
	Ammonia	
	Total phosphorus	II
	Orthophosphates	III
Salinity	Chlorides	I
	Total residual chlorine	-
	Sulphate	I
	Total mineralization	I
	Electrical conductivity at 200°C	I
Metals	Arsenic	II
	Boron	I
	Copper	-
	Zinc	I
	Chromium (total)	I
	Iron (total)	III
	Manganese (total)	II
Organic substances	Phenolic compounds (such as C ₂ H ₅ OH)	II
	Petroleum hydrocarbons	I
	Surface active substances (such as lauryl sulphate)	I
	AOH (adsorbent organic halogen)	-
Macrobiological parameters	Fecal coliforms	IV
	Total coliforms	III
	Intestinal Enterococcus	-
	Number of aerobic heterotrophs (Kohl method)	-

4.1.7 Natural hazards

To investigate resilient of the highway to current and future climate conditions the first step is to determine climate variables and climate related hazards that may damage or influence the assets. The list of the climate effects is given in Table 37, where a level of the highway sensitivity (no, medium or high) is assigned to each threat.

Climate-related hazards rated with high sensitivity are floods, landslides and soil erosion, all caused by the intense rainfall. Heavy showers may cause soil erosion, landslide or rock fall, increase ground subsidence and endanger embankments. Excess water on the highway may impact the traffic safety. Floods and river currents may damage bridges or other parts of road's infrastructure. Since the climate change simulations show a likely increase of the heavy precipitation events, both in frequency and intensity, the risk of such threats will be even higher in the future.

Another hazard marked as highly sensitive is the increase in extreme temperature during summer. It is almost certain that annual and seasonal mean temperatures will continue to grow by the end of the century, as well as the intensity and frequency of days with high maximum temperatures. This may cause an asphalt melt and rutting, as well as thermal expansion of bridge joints, thus increasing the maintenance costs.

Table 37 Project sensitivity to climate-related hazards (N=no, M=medium, H=high)

	Air temperature increase	Extreme temperature	Precipitation change	Extreme precipitation	Wind	Humidity	Floods	Landslides	Soil erosion
On-site assets and processes	M	H	M	H	M	N	H	H	H
Inputs (maintenance)	M	H	M	H	N	N	H	H	H
Outputs (users and tolls)	N	H	N	H	N	N	H	H	H

The vulnerability of the project to climate-related hazards is defined as a product of a sensitivity of the highway and exposure in current and future climate conditions, as in Table. It is classified as high if both, sensitivity and exposure, or at least one of them are classified as high. Vulnerability assessment in Table 38 is done only for threats that are rated with high sensitivity.

Table 38 Vulnerability assessment matrix for the present (blue) and future (red) climate

	EXPOSURE			
		No	Medium	High
SENSIVITY	No			
	Medium			
	High	Extreme temp.	Floods; Landslides; Soil erosion; Extreme precipitation Extreme temp.	Floods; Landslides; Soil erosion; Extreme precipitation

The high vulnerability is found for extreme precipitation, floods, landslides and soil erosion, both in the present and future climate conditions. For extreme temperatures the vulnerability in the present climate is medium, while in the future climate it is expected to be high. It may be a threat to the surface asphalt layer that has a relatively short lifespan and this issue may be addressed later through the highway maintenance.

Risk assessment

Climate-related hazards risks are assessed through rating the probability and severity of the impacts related to the threats and evaluating the significance of the risks to the project realization. Risks associated with the high vulnerabilities are identified as follows:

1. Heavy precipitation increase may cause excess water on the highway
2. Heavy precipitation increase may cause slopes instability and more frequent landslides
3. More frequent flood events may damage piers on bridges
4. More frequent flood events may endanger road infrastructure
5. Rise of flood levels with 100 years return period at the Toplica River may jeopardize road infrastructure
6. Warmer summers with prolonged and more intense heat waves could cause asphalt melt and rutting

After the identification each risk is evaluated according to the magnitude of consequence it can have to the assets and likelihood of occurrence in the risk matrix in Table 39. Risks 2,3,4 and 5 are recognized as extreme, while 1 and 6 are considered to be high.

Table 39 Risk matrix: severity and likelihood rating of the identified risks

		Magnitude of consequence				
		Insignificant	Minor	Moderate	Major	Catastrophic
Likelihood (probability)	Almost certain (95%)		6			
	Likely (80%)			1	2	
	Moderate (50%)				3, 4, 5	
	Unlikely (20%)					
	Rare (5%)					

4.1.8 Soil settings

Soil cover on the highway route

Agricultural production is the main activity of the population on the whole route. Soils have medium productivity potential (classes from 2 to 4), and are suitable for agriculture, horticulture and viticulture. In the wider area of Toplica District on higher altitudes soils have lower quality and are used mainly for animal husbandry, fruit growing and cultivation of cereals, while the great part of the district is covered by forests. In the area around Toplica River dominates semi-intensive and intensive fruit growing, field crops cultivation and vegetable production.

Soil cover on the E80 highway route description is based on the interpretation of soil maps 1:50,000 scales (Antonović et al, 1979) for this part of Serbia. Soil cover is very diverse and E80 highway passes through seven different types of soil according to national classification system: vertisol, fluvisol, cambisol, colluvium, humofluvisol, sirozem and rigosol. According to World Reference Base for soil resources these soil types could roughly correspond to following reference soil groups, respectively: Vertisols, Fluvisols, Cambisols, Regosols, Phaeozems and Anthrosols, and maybe some other. More different subtypes of these soil types are found in the zone of E80 highway route, as presented in the Table 40, as well as on the soil map in

Figure 58, Figure 59 and Figure 60.

Figure 58 Tentative soil map, first and second highway section



Figure 59 Tentative soil map, third and fourth highway section

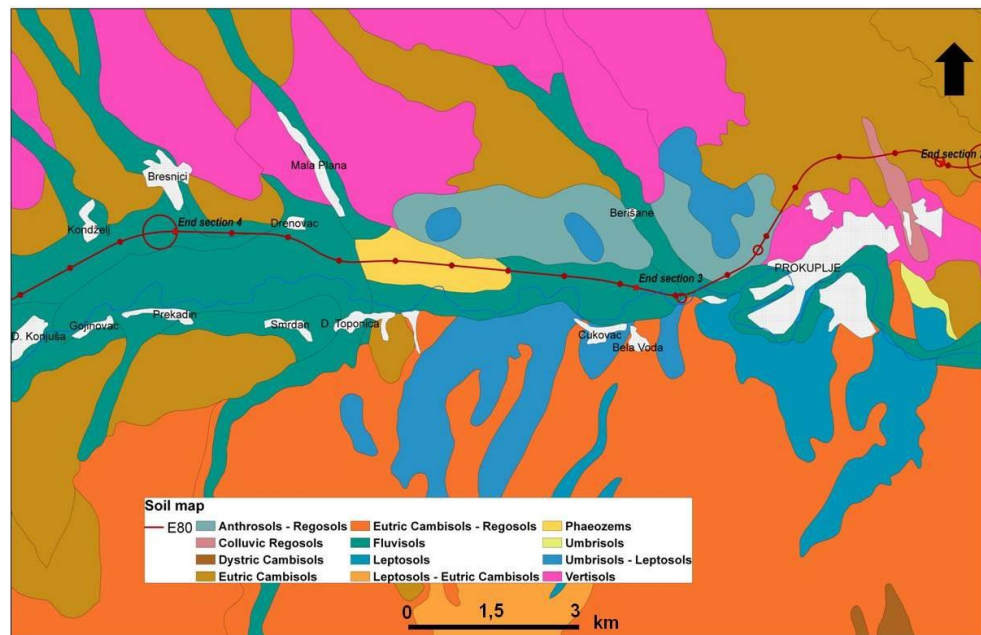


Figure 60 Tentative soil map, fifth highway section

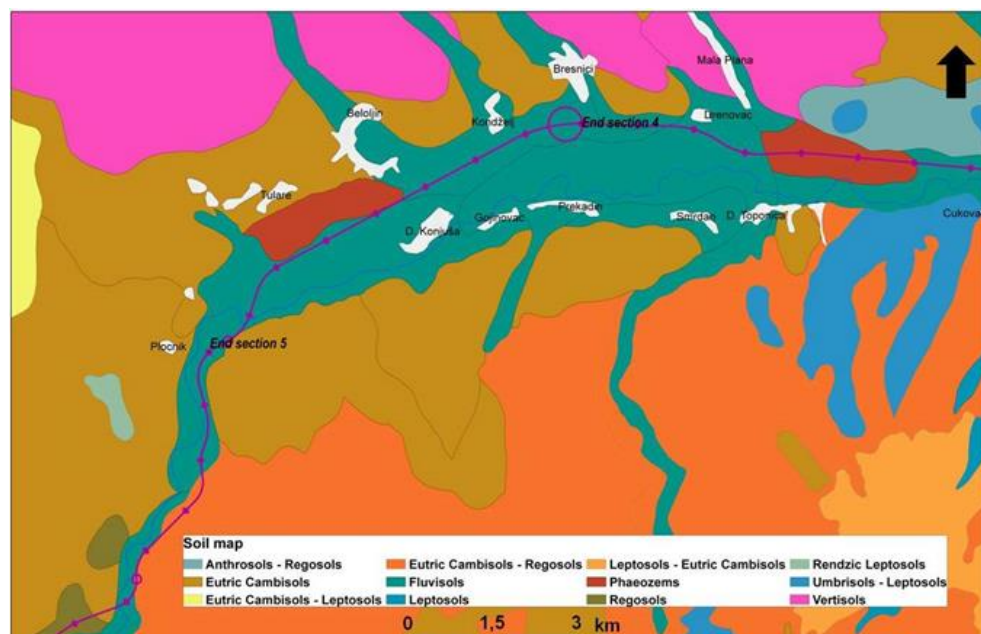


Table 40 *Overview of soil mapping units according to national classification and possible WRB interpretation at highway sections*

Section	Chainage (from-to, km)	Route length (km)	Soil unit (national classification system)	Possible Reference soil group (WRB)
1	0+000-4+120	4.12	Brownized vertisol and vertisol formed on neogene sediments, non carbonated, in ratio 90:10	Vertisols
1,2	4.12-5.74	1.62	Vertisol formed on neogene sediments, non carbonated	Vertisols
2	5.74-7.82	2.08	Brownized vertisol and vertisol formed on neogene sediments, non carbonated, in ratio 90:10	Vertisols
2	7.82-8.32	0.50	Carbonated fluvisol	Calcaric Fluvisols
2	8.32-9.09	0.77	Brownized vertisol and vertisol formed on neogene sediments, non carbonated	Vertisols
2	9.09-12.54	3.45	Vertisol formed on neogene sediments, non carbonated	Vertisols
2	12.54-13.49	0.95	Vertic eutric cambisol formed on lacustrine sediments	Cambisols
2	13.49-13.73	0.24	Vertisol formed on neogene sediments, non carbonated	Vertisols
2	13.73-13.89	0.16	Fluvisol, non carbonated	Fluvisols
2	13.89-15.41	1.52	Vertisol formed on neogene sediments, non carbonated	Vertisols
2	15.41-16.10	0.69	Eutric cambisol, formed on neogene sediments	Cambisols
2,3	16.10-18.18	2.08	Eutric cambisol formed on Gneiss	Cambisols
3	18.18-18.38	0.20	Colluvial soils	Regosols
3	18.38-20.50	2.12	Eutric cambisol formed on Gneiss	Cambisols
3	20.50-22.27	1.77	Anthrosol and eutric regosol formed on Gneiss, in ratio 70:30	Anthrosols – Regosols, Leptosols
3	22.27-22.90	0.63	Fluvisol, carbonated	Calcaric Fluvisols
3,4	22.90-25.97	3.07	Fluvisol, non carbonated	Fluvisols
4	25.97-28.64	2.67	Humofluvisol - meadow alluvial gleyic soil	Phaeozems
4	28.64-30.58	1.94	Fluvisol, non carbonated	Fluvisols
4	30.58-31.60	1.02	Humofluvisol - meadow alluvial gleyic soil	Phaeozems
4,5	31.60-40.00	8.40	Fluvisol, non carbonated	Fluvisols

Heavy metals in soil

The presence of dangerous and harmful substances in agricultural land in the zone of the E75 highway was investigated in 2011. The research was performed by Soil Institute, Belgrade. Interpretation of maximum allowed concentrations was

conducted using Regulations on allowed quantities of dangerous and harmful substances in soil ("Official Gazette RS", No 23/94) and the Regulations on methods of organic crop production ("Official Gazette SRJ", No 51/02). The total content of arsenic, cadmium, cobalt, chromium, copper, nickel and lead was investigated. Nowhere around Niš area, near joint of E-80 and E-75 highways, were found higher concentrations in mentioned elements. Only at one location nickel amount ranged between 35 and 100 mg/100 g, and one lead sample was between 85 and 100 mg/100 g. Nevertheless, these increased concentrations can be assigned to natural (geochemical, background) origin of these elements in alluvial soils, meaning they were brought here with erosion process from the terrain where rocks and soils are rich in these elements. Lead content exceeded maximum allowed concentration only in 5.6% of samples.

4.1.9 Ambient air quality

At the area of highway E-80 there is no official data provided by continuous measurements of air quality, except for Nis.

However, state road IB-35 and state road IIA-216, as well as the single-track non-electrified railway line no. 71 could be air pollution sources in the vicinity of the highway. Also, during the winter period house heating is a source of significant pollution in the towns of Prokuplje and Kursumlija.

Taking into consideration that new highway will generate additional traffic in the subject area, cumulative impacts on air quality could occur on the highway sections that are close to the existing main roads and railway line. Therefore, additional air pollution would result in the areas of the section from Prokuplje to Pločnik which passes near the railway line, and near state road IB-35.

Taking into consideration that traffic potentially contributes a big share in the total emissions of certain pollutants; the following air composition is expected:

Table 41 The share of motor vehicles in the total emissions of certain pollutants

Pollutant	The share of motor vehicles in total emission (%)
Carbon monoxide	60
Hydrocarbons	45
Nitrogen oxides	34
Sulfur dioxide	5.9
Solid particles	6.8

Air pollution impacts are considered to be minor because AADT is significantly below high levels and will be generated from the traffic which is using state roads at the moment and that there is no other significant source of the pollution.

Recorded traffic in 2015 and forecasted traffic for 2020 are presented in the following tables.

Table 42 Recorded AADT on the M25 / Ib35 road sections for the base year 2015

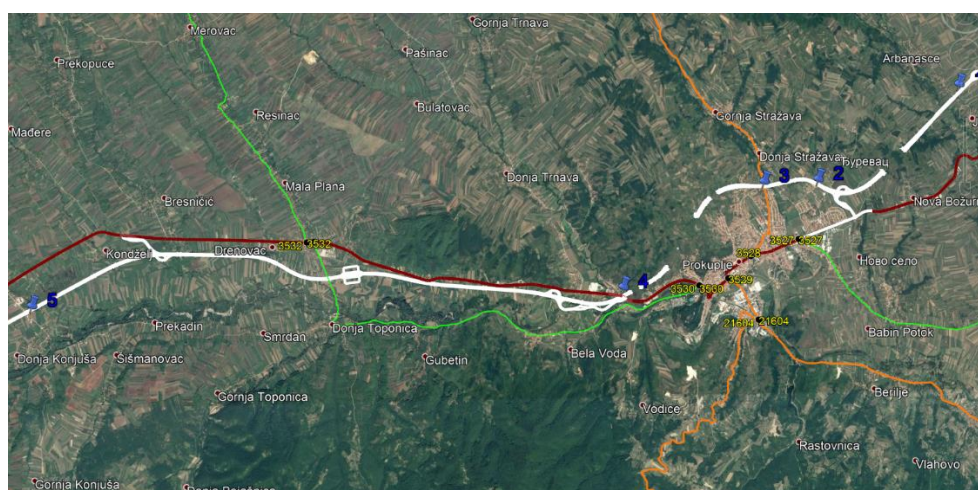
From	To	AADT 2015	PC
Merosina	Merošina 1	6,539	6,152
Merošina	Prokuplje (Orljane)	5,718	5,221
Prokuplje (Djukovac)	Potocic (D. Topanica)	5,044	4,545
Potocic (M. Plana)	Beloljin	3,896	3,449
Beloljin	Pločnik	2,454	1,924

Table 43 Forecasted traffic for the scenario with the investment in 2020 [vehicles/day] – the semi-motorway in operation

From	To	Total	PC
Interchange Nis 3 (Prokuplje)	Interchange Merosina (Merosina 1)	8,592	8,057
Interchange Merosina (Merosina 1)	Interchange Prokuplje sever	8,115	7,594
Interchange Prokuplje sever	Interchange Prokuplje zapad	7,599	7,204
Interchange Prokuplje zapad	Interchange Beloljin	7,785	7,285
Interchange Beloljin	Pločnik	6,701	6,382

Because of the project setting, a comprehensive air quality baseline was not seemed necessary; however air quality measurements at locations near the highway route have been carried out during March 2018, a time period where emissions from house heating were present. Five locations were selected in populated areas where the highway could affect air quality. The same locations were selected for noise measurements.

Figure 61 Measurement sites for the ambient air quality



Quality of the ambient air by determining the concentration of sulfur dioxide, nitrogen dioxide, carbon monoxide, Particulate matter PM10, and black smoke index on the spot along Highway E80, Niš-Pločnik section according to legal and technical regulations in Serbia.

Table 44 Air quality measurement results

Results						
Measuring point MM1						
Date	ID number	Parameter (µg/m ³)				
		SO ₂	NO ₂	CO	PM10	Black smoke
13.03.2018.	1803164001	22,2	3,8	< 1000	12,5	26,6
Limit value		125	85	5000	50	50
Measuring point MM2						
Date	ID number	Parameter (µg/m ³)				
		SO ₂	NO ₂	CO	PM10	Black smoke
13.03.2018.	1803164002	< 20,0	4,1	< 1000	15,7	28,1
Limit value		125	85	5000	50	50
Measuring point MM3						
Date	ID number	Parameter (µg/m ³)				
		SO ₂	NO ₂	CO	PM10	Black smoke
13.03.2018.	1803164003	24,4	3,7	< 1000	29,7	61,5
Limit value		125	85	5000	50	50
Measuring point MM4						
Date	ID number	Parameter (µg/m ³)				
		SO ₂	NO ₂	CO	PM10	Black smoke
14.03.2018.	1803164004	20,5	4,3	< 1000	18,3	29,8
Limit value		125	85	5000	50	50
Measuring point MM5						
Date	ID number	Parameter (µg/m ³)				
		SO ₂	NO ₂	CO	PM10	Black smoke
14.03.2018.	1803164005	< 20,0	4,0	< 1000	6,6	12,7
Limit value		125	85	5000	50	50

The values prescribed by the Regulation on the Conditions for Monitoring and Air Quality Requirements (Official Gazette of RS, No. 11/10 and 75/10, Amend 63/13) are not exceeded at all measuring points. Only at one measuring point, number 3, the concentration of soot is exceeded the value in the Regulation. It is a measuring site located near the state road IIA-216.

Report Quality of the ambient air quality on the spot along Highway Route E80 section Niš-Pločnik is given as Annex 9 of the Study.

4.1.10 Noise and vibration

The noise sensitive area along the route is the zone with residential receptors In Prokuplje, Jugbogdanovac, Arbanasce, Mala Plana, Merošina and Beloljin. The area comprises mainly residential houses and some commercial properties. No

schools, hospitals, kindergartens or similar receptors have been identified near the route.

For the purposes of this study in March 2018, noise measurements were made at 5 measuring points in Prokuplje and its surroundings. Measurements were made in the open space.

Measuring point 1

The first point is located at the chainage 13+600, on the right side of the new highway, just before the bridge in km 13+780 (underpass for the local road in km 13+733). It is a group of residential buildings that are quite close to the route, and belong to the settlement Arbanasce. There is also a local road that connects settlements Jug Bogdanovac and Arbanasce.

Figure 62 Respective position of measuring point 1



Measuring point 2

The second point is located at the chainage 17+400, on the left side of the new highway, after the Prokuplje Istok junction. It is a group of residential buildings that are close to the route, and belong to the suburban area of Prokuplje.

Figure 63 Respective position of measuring point 2



Measuring point 3

The third point is located at the chainage 18+600 km, on the left side of the new highway, near the end of the bridge, and near the state road category IIA no. 216. It is a group of residential houses that are close to the route, and belong to the suburban section of Prokuplje, near the local road to the village Donja Stražava.

Figure 64 Respective position of measuring point 3



Measuring point 4

The fourth point is located at the chainage 22+550 km, on the right side of the new highway, near the bridge where the state road category IB no. 35 passes, before the Prokuplje West junction. It is located on the road towards the village Donja Trnava. It is a settlement near the route, which is in vicinity of the “Hisar” factory (about 500m).

Figure 65 Respective position of measuring point 4



Measuring point 5

The fifth point is located at the chainage 35+130 km, on the right side of the new highway, near the bridge under which the state road category IIA passes, connecting the villages of Donja Konjuša and Beloljin, and near Beloljin railway station. It's a group of residential houses, but there is a small production facility.

Figure 66 Respective position of measuring point 5



At the time of measurement and reporting, there were no data on acoustic zoning for the area where the measurement was performed, according to the Law on Protection against Noise in the Environment (Official Gazette of the Republic of Serbia No. 36/2009 and 88/2010).

Due to the position of the measuring points, measuring points 1 and 2 belong to zone 3 (residential areas), while measuring points 3, 4 and 5 belong to zone 5 (City centre, workshop area, commercial area, administrative area with apartments, zones along highway, regional roads and city streets).

Table 45 Levels of measured outdoor environmental noise

Locations	Measurement interval		
	Day	Evening	Night
Location 1	40	36	34
Location 2	34	35	32
Location 3	49	47	46
Location 4	54	54	52
Location 5	46	38	33

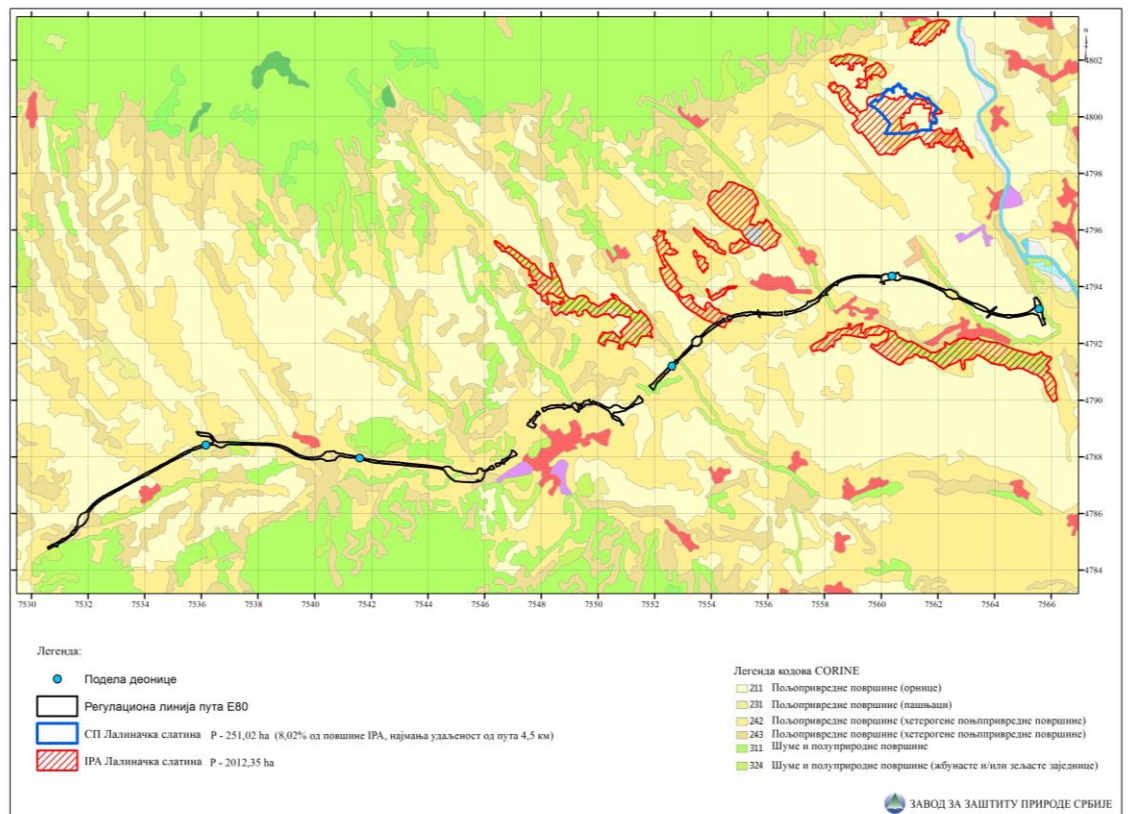
On the basis of the performed measurements, it can be concluded that the relevant noise levels do not exceed the noise values of the noise indicators for the daily, evening and night periods at all measuring points

The Noise Measurement Report is in Annex 9 of the Study.

4.1.11 Ecology and nature conservation

Land cover according to CORINE Land Cover

Figure 67 Land cover in highway zone according CORINE Land Cover



Information about land cover, the method and changes in use in period 1990-2006 on the territory of Europe are monitored through "CORINE Land Cover" program ("CO (o) R (dination of) IN (on the formation) E (environment) Habitats Codes "). According to the current classification of CORINE habitats and accompanying national cartographic background, the following 8 types of third-level classification were recorded at the concerned section of the highway area:

1. Artificial surface

1.1 Urban fabric

1.1.2 Discontinuous urban fabric

1.2 Industrial, commercial and transport units

1.2.1 Industrial or commercial units

2. Agricultural areas

2.1 Arable land

2.1.1 Non-irrigated arable land

2.2 Permanent crops

2.2.2 Fruit trees and berry plantations

2.4 Heterogeneous agricultural areas

2.4.2 Complex cultivation patterns

2.4.3 Land principally occupied by agriculture, with significant areas of natural vegetations

3. Forests and semi-natural areas

3.1 Forests

3.1.1 Broad-leaved forests

3.2 Shrub and/or herbaceous vegetation association

3.2.1 Transitional woodland – shrub

There are other land cover types existing within the concerned section of the highway (eg. small inland wetlands and water bodies or grasslands patches) which are nevertheless not mapped within national CORINE Land Cover. In general as we can see the most part of the highway crosses arable land, of which the orchards and vineyards make up about 7%, the remaining arable land is 61%, then the meadows 3%, the forests 3%, the construction land about 2% and the unused land about 24% (untreated arable land, small orchards).

Protected areas

In the area of the proposed highway neither officially designated natural protected areas nor areas for which the protection procedure has been initiated are found. The only officially designated protected area near the route is the Natural monument „Lalinačka Slatina“. It is located about 5 km away from the route of the highway.

On the other hand, the proposed route crossed the edge of one part of the IPA "Lalinačke slatine" (Opinion of Environment Protection Institute of Serbia (No. 020-3092/2 of 03.03.2015),

Figure 68 IPA region "Lalinačke slatine" and highway route



The IPA was designed during 2003 and 2005, (Niketić, M., 1995; Randelović, V., Amidžić, L., Ilić, N., 2000; Milosavljević, V., Randelović, V., Zlatković, B., 2002; Stevanović, V., 2005; Zlatković, B., Randelović, V., Amidžić, L., 2003, 2005a, 2005b). The IPA area of "Lalinačke Slatine" consists of 11 smaller unconnected parts of a total area of 2012.35 ha. In Lalinačka, Oblačinska and Lepajska there are salt marshes.

The delineation of the different sites of the IPA "Lalinačke Slatine" was based more on the presence of natural/semi-natural vegetation and the assumption of salt soils and less on the actual and observed presence of salt marsh and salt steppe habitats. Among the units that make up parts of IPA area are wheat fields, abandoned fields, vineyards, orchards, weed community, row crops and the like. Only in one of the eleven parts of the IPA there is actually a salt marsh. On the other hand, the vegetation of the part of the IPA area (the locality of Jug Bogdanovac) that will be affected by the highway works consists of old abandoned orchards, vineyards, fields and similar agricultural areas.

After the field research conducted from 30.5 until 3.06.2016 the experts from the Institute for Nature Conservation of Serbia concluded that the plant species present in the section where the highway route intersects the periphery of IPA "Lalinačke slatine", are not characteristic of salt marsh or salt steppe habitats but species with a wide distribution in Serbia. Species present are typical representatives of grass formations and steppes (*Chrysopogon gryllus*, *Andropogon ischaemum*, *Achillea millefolium*, *Asperula cynanchica*, *Astragalus onobrychis*, *Carduus acanthoides*, *Coronilla varia*, *Dactylis glomerata*, *Eryngium campestre*, *Euphorbia cyparissias*, *Lotus corniculatus*, *Medicago falcate*, *Salvia nemorosa*, *Scabiosa ochroleuca* etc.) as well as dog rose (*Rosa canina*), abandoned fruit trees, vineyards, orchards. Therefore locality of the Jug Bogdanovac cannot be considered as a priority biodiversity feature or a critical habitat and the planned activities will have no impact on the conservation status of the IPA characteristic plant species and no significant impact on the integrity, conservation objectives and/or biodiversity importance of the IPA "Lalinačke Slatine". This was also stated in the Opinion No. 020-1429/2 08.10.2016. The absence of significant habitat types was again verified during a field visit on 03.04.2018. There are many settlements along the route in the corridor. Arable land is dominated by fruit crops, mainly cherry, crop and vegetable crops mixed

with groups of trees, hedges. There is an organic agricultural production in the wider area of the left bank of the Toplica River in the area of Prokuplje to Pločnik. Over 150 households - subcontractors are associated.

Vegetation and flora

The transect method in targeted habitats of interest was used in order to survey flora and vegetation. Data obtained mainly refer to the different species presence. This includes the identification, enumeration, photographing of certain specimens, collection and storing, in order to further detailed determination. Field research were carried out during 19.-20.06.2012 and 30.5-3.06.2016 in the area from Mramor to Pločnik, and resulted in a minimum of 160 plant species.

Determination of plant species and lower systematic units (taxa) was based on classic determination keys for vascular plants, such as: „Flora SR Srbije“ I-IX (Josifović, 1970–1977) i X (Sarić, 1986), „Flora Europaea“ I-V (Tutin, 1964-1980) and „Iconographia Florae Partis Austro-Orientalis Europae Centralis“ (Jávorka, Csapody, 1975). Invasive species were determined according with “Preliminary list of invasive species” (Lazarević *et al.*, 2012).

Protected and endangered plant species

Given that the prevailing vegetation is highly anthropogenic (agricultural areas, settlements and associated infrastructure), the whole area is characterized by ruderal and segetal plants (species that are most often encountered growing within human settlements on habitats that are occasionally or permanently under the influence of various forms of human activity: road embankments, moist and nitrified banks of the river, abandoned grasslands of arable land, paths, fences, courtyards, exploitation of raw materials, forest fissures, etc.). At places where fragmented natural and semi-natural habitats are observed (forest and grassland ecosystems, end-point and wetland vegetation, rare stones and dry meadows, etc.), the vegetation consists of typical species for these types of habitats in Serbia.

Twenty-six nationally protected flora species were recorded in the area of the investigated highway route under direct and indirect influence (Rulebook on the proclamation and protection of strictly protected and protected wild species of plants, animals and fungi ("Official Gazette of the Republic of Serbia" No. 05/2010, 47/2011, 32/2016 and 98/2016)). 21 of these are also protected by the Regulation on placing control of the use and circulation of wild flora and fauna (Table 46)

Table 46 *Protected plant species (Rulebooks-P; Regulation-U) in the area of Nis-Plocnik highway route and their national and international protection status*

Latin name	Serbian name	English name	P	U	HD	IUCN	ECL
<i>Achillea millefolium</i>	hajdučka trava	Yarrow / Nose-bleed / Thousand Leaf	*	*		LC	
<i>Acorus calamus</i>	idirot	Sweet-flag	*	*		LC	
<i>Agrostis stolonifera</i>	rosulja vrežovita	Creeping Bent				LC	LC
<i>Allium ursinum</i>	sremuš	Ramsons / Broad-leaved-garlic	*	*			LC
<i>Alopecurus pratensis</i>	visoka kunica	Meadow Foxtail				LC	LC
<i>Althaea officinalis</i>	beli slez	Marsh Mallow	*	*			
<i>Arctium lappa</i>	čičak	Greater Burdock / Great Clot-bur	*	*			
<i>Asarum europaeum</i>	kopitnjak	Asarabacca	*	*			
<i>Colchicum autumnale</i>	mrazovac, kačun	Meadow Saffron	*			LC	
<i>Fragaria vesca</i>	šumska jagoda	Wild Strawberry	*	*			LC
<i>Galium odoratum</i>	lazarkinja	Sweetscented Bedstraw	*				
<i>Geranium macrorrhizum</i>	zdravac	Italian Cranisbill	*				
<i>Herniaria glabra</i>	sipanica	Smooth Rupturewort	*	*			
<i>Hypericum perforatum</i>	kantarion	Perforate St John's-wort / Hard-hay	*	*			
<i>Hypericum rumeliacum</i>	rumelijski kantarion		*	*			
<i>Inula helenium</i>	oman	Elecampane / Horseheal	*	*			
<i>Iris pseudacorus</i>	vodena perunika	Yellow Iris	*	*		LC	LC
<i>Lamium album</i>	mrtva kopriva	White Dead-nettle	*	*			
<i>Lilium martagon</i>	zlatan, šumski ljiljan	Turk's Cap Lilly	*				
<i>Origanum vulgare</i>	vranilova trava	Wild Majoram	*	*			
<i>Pholiurus pannonicus</i>			*				
<i>Potentilla erecta</i>	srčenjak	Tormentil	*	*			
<i>Pulmonaria officinalis</i>	plućnjak, međunika	Lungwort	*	*		LC	
<i>Rosa canina</i>	šipak	Dog-rose	*	*			

Latin name	Serbian name	English name	P	U	HD	IUCN	ECL
<i>Symphytum officinale</i>	gavez	Common Comfrey / Consoud	*	*			
<i>Teucrium chamaedrys</i>	dubačac, podubica	Wall Germander	*	*			
<i>Teucrium montanum</i>	trava iva, mali dubačac	Mountain Germander	*	*			
<i>Thymus serpyllum</i>	majčina dušica	Breckland Thyme / Creeping thyme / Mother of thyme	*	*			
LC – Least Concern							

Sources: IUCN - The IUCN Red List of Threatened Species. Version 2018-1. <www.iucnredlist.org>.

Downloaded on 06 July 2018., HD - Habitats Directive - Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora. ECL – European Red List

No plant species recorded within the affected area are included within the Red Book of Flora of Serbia 1 (Stevanović, 1999), or in the Annexes of International Conventions (i.e. the Bern Convention, CITES).

The planned activities of constructing the highway with their scope and character do not represent a threat to the status, survival or preservation of the state of natural populations of these protected species in the Republic of Serbia. All of these plant species are marginal in the investigated area, with few populations or scattered individual specimens. As such they are not vulnerable and or irreplaceable and they cannot be considered as Priority Biodiversity Features following EBRD PR6.

However, one should highlight the presence of four plant taxa that are not located on the highway route, but in the wider area. These are described in the Red Book of the Flora of Serbia 1 as extremely vulnerable taxa in Serbia. All are strictly protected according to the “Rulebook on the designation and protection of strictly protected and protected wild species of plants, animals and fungi”. It is estimated that these taxa are not directly endangered by the highway route, but given that the the habitat types mentioned below may be found in the wider surroundings of the route, their presence must be taken into account in the planning of possible accompanying activities, in the wider area of the the intended highway.

Table 47 *Four strictly protected plant taxa located in the wider vicinity of the highway route, outside the zone of direct and indirect impact.*

Latin name	Serbian/English name	Habitat	Distribution in Serbia
<i>Allium guttatum</i> Stevan subsp. <i>dalmaticum</i> (A.Kerner ex Janchen) Stearn	Spotted Onion	salt marsh	Little Lalinac, Lalinačka slatina
<i>Allium cyrilli</i> Ten.	Cirilijev luk/ cyrillic garlic	On neglected land and along the periphery of arable land	Niš (surrounding), Donja Vrežina, Gornji Komren
<i>Aster oleifolius</i> (Lam.) Wagenitz.	Maslinolisni zvezdan	On dry, sunny and bare peaks of hills on the edge of the plateau above the Lalinačke slatine. It occurs in a distinctly steppes community and borders with surrounding pasture and ruderal parts.	Mramorski plato, Little Lalinac
<i>Lamiaceae Stachys milani</i> (Petrov.)	Čistac Kralja Milana	Slightly swollen fertile soil in the flood meadows	Mramor, Little Lalinac

For the field of **forestry** and composition of forest ecosystems, different data sources were used and their triangulation. One was field research done in the period from 01 to 05.02.2015 and from 30.05.-03.06.2016, when the whole proposed route of highway was surveyed. An additional important data source for the forest ecosystems were the forest management plans (FMP) for the forest management units (FMU) crossed by the Project. According to the *Bylaw on the content of the FMPs and programs of forest management, the annual operational plan and the temporal annual management plan for private forests*, FMPs among others contain chapters related to bio-ecological basis of forest management, information about state of forest, forest habitats and stands, maps with stand composition by tree species and mixture, established forest functions, maps with basic purpose of forests with purpose units and sites of protected areas, rare species of flora and fauna and infrastructural equipment, and overview maps of management classes which contain layout of stands by management classes. FMPs are developed every ten years and are approved by the Ministry of Agriculture, Forestry and Water Management

Data received from the Public Enterprise „Srbijašume“, that is responsible for management of State forests in Serbia show that the proposed route passes through the FMU „Sagonjska Crna Čuka“, the FMU „Kravare“ and the FMU „Vidojevica“ managed as follows:

- FMP „Sagonjska Crna Čuka“, for the period 2015-2024, PE „Srbijašume“
- FMP „Kravare“, for the period 2016-2025, PE „Srbijašume“
- FMP „Vidojevica“, for the period 2008-2018, PE „Srbijašume“

Finally, additional scientific literature was used for obtaining additional information about forest trees and forest habitats.

Natural/Semi-natural vegetation

According to the map of the potential climatogenic vegetation of Yugoslavia (Stevanovic, 1995), the area provided for the construction of the highway is in the zone of Hungarian oak-Turkey oak forest *Quercion frainetto*. The original

vegetation of the entire area has changed to a large extent towards anthropogenic vegetation through the development of agricultural land, settlements and related infrastructure. The area, once rich in oak-pedunculate oak and ash tree forests is today converted into arable land, orchards, raspberry or run-down areas with various ruderal vegetation while forests are fragmented and natural stands occur sporadically, mainly along the Toplica River and other smaller watercourses as wetlands, wet meadows and small forested areas. The anthropogenic activities have also resulted in the creation of artificial water bodies (in abandoned borrow pits and sand pits) and wet areas with characteristic vegetation. According to data recorded so far (Stevanović, V., 2005; Zlatković, B., Randelović, V., Amidžić, L., 2003, 2005a, 2005b; Niketić, M., 1995; Randelović, V., Amidžić, L., Ilić, N., 2000; Milosavljević, V., Randelović, V., Zlatković, B., 2002.), within the Toplica River watercourse are fragments of gallery forest ecosystems that may be included in the following vegetation:

- Purple willow forests - *Salicetalia purpureae* Moo 1958, with the dominance of plant communities
 - *Salicetum purpureae* Wend.-Zel. 1952 (Forests of Purple willow)
 - *Salicetum elaeagni* Moor 1958 em. Obred. (Forests of Grey willow)
- Silverleaf poplar wood - *Populetales albae* Soo 1940
 - *Populeto-Salicetum Rajev. 1950 s.l. (Forests of poplar and willow)*
- Ecotonous communities of class *Trifolio-Geranietea* Muller 1961 are adjacent to fragments of forest ecosystems (heliophilous and semi-xerothermous communities of forest edges).
- Climatogenic community for this area is a community of Hungarian oak and Turkey oak, which by plant community classification belongs to the order:
 - *Hungarian oak forests - Quercion frainetto* Ht. 1954.
 - *Quercetum frainetto – cerris* Rudski 1946. (Hungarian oak and Turkey oak forests)
- Fragments of hydro-mesophilic meadow communities and hay meadows that are under anthropogenic influence are represented by class
 - *Molinio-Arrhenatheretea* Tx. 1937. Such habitats are covered with more than 30% of the vegetation cover. Dominating vegetation of low to medium-high herbaceous plants, especially grasses (*Poaceae*, *Juncaceae* and *Cyperaceae*), but also bryophytes and lichens. The characteristic species are: *Arrhenatherum elatius*, *Salvia pratensis*, *Luzula campestris*, *Pimpinella saxifraga*, *Lotus corniculatus* etc.
- Among dry vegetation meadow fragments from a class-*Festuco Brometea* Br.Bl. et Tx. 1943 (xerophyl and semixerophyl meadow communities) were recorded.
- Aquatic (pond) and marsh vegetation is represented by class *Phragmitetea communis* Tx. et Prsg. 1942. Typical species recorded here are: *Festuca valesiaca*, *Bromus erectus*, *Koeleria gracilis*, *Leontodon hispidus*.

Agricultural and ruderal ecosystems / vegetation

Agricultural areas dominate along the proposed highway. They are represented by different types of cultivated crops of orchards and vegetable gardens (apples, plums, cherries, raspberries, wheat, corn, etc.), and abandoned agriculture areas:

- Intensely and extensively cultivated open fields (without, with scarce or abundant weed flora). Annual plants are dominant. These are mainly species of the genera: *Bromus*, *Aegilops*, *Avena* etc. or species from the Brassicaceae and Fabaceae families (Figure 61).
- Orchards and vineyards of different ages (Figure 62). Orchards on meadows are the most common.
- Abandoned fields and orchards (neglected land where, depending on age, i.e. the time when the area was abandoned, herbaceous, shrub or woody weed vegetation can dominate, Figure 63).
- Plantaginetea majoris Tx. ex Prsg. 1950. Community class and communities of type Polygonatum avicularis Gams 1927. Type with edificator *Polygonum vulgare* (knotgrass) appear on the sunny, dry and warm habitats, intensively cultivated areas and on/near the local transportation infrastructure. From the representatives of ruderal vegetation class *Artemisietea vulgaris* (ruderal vegetation of permanent, extremely nitrophilous community) fragments of communities with *Agropyrum repens*, *Tanacetum vulgare*, and *Calamagrostis epigaeus* are recorded.

Figure 69 Corn field (left) and wheat field (right)



Figure 70 Young orchard (left) and the old orchard (right)



Figure 71 Abandoned orchards in the meadows which may be dry or moist



Figure 72 Hedges between agricultural crops



All habitat types encountered along the proposed highway are listed here, according to the Rulebook. The ones that, according to this Rulebook, are assessed as important "for protection of priority habitat types" are marked with bold.

A FORESTS

A1.1 Forest of White Willow (*Salix alba*) and Poplars (*Populus* spp.)

A1.12 White poplar forest (*Salix alba*) and poplar (*Populus* spp.)

A1.14 Forests of black poplar (*Populus nigrae*)

A1.2 Forest of Alder (*Alnus* spp.) and Narrow-leaved Ash (*Fraxinus angustifolia*)

A1.21 Black alder forest (*Alnus glutinosa*)

A1.23 Narrow-leaved ash forest (*Fraxinus angustifolia*)

A2.1 Forest of Hungarian Oak (*Quercus frainetto*) and Turkey Oak (*Quercus cerris*)

A2.11 Hungarian oak (*Quercus frainetto*) and Turkey oak (*Quercus cerris*) forest

A2.6 Forest of Sessile Oak (*Quercus petraea*) and Hornbeam (*Carpinus betulus*)

A2.61 Sessile oak (*Quercus petraea*) and common hornbeam (*Carpinus betulus*) forest

AA Groves, Lines of trees and individual trees

AA.12E Groves of Black Locust (*Robinia pseudoaccacia*)

B SHRUBS

B1.1 Shrub and/or herbaceous vegetation associations of Willow (*Salix* spp.)

B1.14 Purpleosier willow shrubberies (*Salix purpurea*)

B1.141 Shrub and/or herbaceous vegetation associations of Purple Willow (*Salix purpurea*)

B1.16 Bitter willow shrubberies (*Salix eleagnos*)

B1.161 Shrub and/or herbaceous vegetation associations of Elaeagnus willow (*Salix eleagnos*)

There are also areas of natural vegetation inside agriculture land in habitats such as small scale market croplands, bare tilled, fallow or recently abandoned arable land as well as weed communities of abandoned areas. A very important feature in this region is the presence of bordering hedges (G2 Hedgerows, Figure 64). These can be dense or fragmented. They are markedly ecological belts of vegetation along the roads and through fields and orchards. They provide shelter for species and their preservation is of great importance for the ecological role of the area.

There is no officially defined list of invasive species of plants, animals, and fungi with regulation measures of control and suppression at the national level. The preliminary list of invasive plant species of Serbia (Lazarević *et al.*, 2012) was used as the starting point for the identification of invasive species. Given that habitats in this area are under anthropogenic influence, the presence of 14 alien, adventive species, and/or invasive taxa (foreign species that have the extraordinary ability to conquer "empty space") has been recorded. Among them the: *Ailanthus altissima* (Tree of Heaven), *Ambrosia artemisiifolia* (Roman Wormwood/Hogweed), *Helianthus tuberosus* (Jerusalem Artichoke), *Robinia pseudacacia* (False Acacia / Locust-tree).

Natural Habitat types

Near the examined area of the highway corridor with its surroundings, the following important habitat types (and their fragments) were observed. Classification follows the national classification of habitats as presented in the *Regulations on the criteria for the separation of habitat types, the types of habitat, vulnerable, endangered, rare and habitat types of priority for protection and protection measures for their preservation* ("Official Gazette of RS", no. 35/10). They are marked as "priority habitats for protection"

Table 48 National and international priority habitat types on the road section and near the highway corridor

National code	Habitat type	Natura 2000	Emerald	National	Affected by project (Y/N)
A1.12	White poplar forest (<i>Salix alba</i>) and poplar (<i>Populus spp.</i>)	*91E0	!44.1	Frag(A)	N
A1.14	Black poplar forest (<i>Populus nigrae</i>)	*91E0		Frag(A)	N
A1.21	Black alder forest (<i>Alnus glutinosa</i>)	*91E0	!44.914	Frag(A)	N
A1.23	Narrow-leaved ash forest (<i>Fraxinus angustifolia</i>)	*91E0	!44.43	Frag(A)	N
A2.11	Hungarian oak (<i>Quercus frainetto</i>) and Turkey oak (<i>Quercus cerris</i>) forest	91M0	!41.7	Frag(B)/Ret	N
A2.61	Sessile oak (<i>Quercus petraea</i>) and common hornbeam (<i>Carpinus betulus</i>) forest	9160, 91L0, 91Y0	!41.2	Frag(B)	N
B1.14	Purpleosier willow shrubberies (<i>Salix purpurea</i>)		!44.1	Frag(A)	N
B1.16	Bitter willow shrubberies (<i>Salix eleagnos</i>)	3240	!44.1	Frag(A)	N
E4.11	Land reedbeds			Frag(A)	N
E4.12	Land Cattails bulrush (<i>Typha spp.</i>)			Frag(A)	N
Abbreviations: HD – Annex I NATURA 2000 habitat type based on EU Directive 92/43/EEC as described in the 2013 Interpretation manual of European Union Habitats, EU28, DG Environment, Nature ENV B.3. EMERALD - selected EMERALD habitat type Ret - a rare habitat in Serbia Frag (A) - fragile habitat due to functional instability and sensitivity to degradation Frag (B) - fragile habitat due to poor and slow reproducibility					

However, in this area these habita types are not important and/or representative (small areas, already fragmented and discnected stands, a certain degree of human influence, etc.), compared to other parts of Serbia, in order to be protected according to the provisions of the Rulebook. As such they cannot be considered as natural habitats, based on the EIB description, or of significant biodiversity value so as to trigger the status of critical habitats beased on EBRD 6.

In environmental terms, the remains of natural and semi-natural surfaces or existing forest and meadow area are the most important for the protection and preservation, together with the maximum preservation of the integrity of the existing water courses with their accompanying vegetation and secondary incurred wet surfaces with accompanying hydrology. Special care must be taken when

planning the rehabilitation and reconstruction of disturbed areas regarding preventing the spread of invasive species and vegetation (afforestation and grassing of indigenous flora).

4.1.12 Fauna

Overall, the field surveys and the available literature indicates that within the Project area there are no "hotspots" for taxa of conservational interest for fauna (fishes, amphibians and reptiles, birds and mammals) with regards to species richness or abundance. However, protected species are present which inhabit mostly the natural and semi-natural habitats along the route. All encountered protected species (strictly protected and protected), are common and widespread in Serbia and/or have wide preferences adapted to the mainly anthropogenic environment along the proposed route. In addition, some of the mammal species e.g. Roe deer, Wild boar, Red fox, Badger, and the Hare as well as some bird species (partridge, common quail) are also common game species, with broad home range in Serbia. On the other hand, strictly protected species like the Otter and the Lesser mole-rat are not directly affected by the proposed highway route, since their main habitats are out of the impact zone.

More detailed description of the baseline status of the different groups is presented in the following paragraphs but eventually no species can be considered as a priority biodiversity feature and does not trigger the status of critical habitats based on the EBRD guidelines. Also no habitats along the proposed route are essential for the maintenance of the species conservation status in Serbia. No endemic species have been recorded in the area.

Mammal fauna

The "Toplica and Jablanica" geographical region where the proposed highway is located, mainly includes the river basin of Toplica. In relevant analyses of mammalian biodiversity in Serbia, this region is generally considered of being of being characterised by relatively low (poor) diversity (Savić *et al.*, 1995). Based on available data, the mammalian fauna in the whole region consists of 33 species, of the nearly 100 mammal species that have been recorded so far in Serbia.

For the baseline study of the mammalian fauna, field trips were realized from 30.5 until 3.06.2016. The researchers used the transect method along the proposed route with a strip of 200-500 m right and left (depending on terrain), in order to obtain additional data and to check/confirm existing ones. Alive and also dead animals were recorded along the transects as well as additional data indicative of species presence such as traces, dens, holes, burrows, and excrements. The field data mostly confirmed the information from literature available in either comprehensive studies about mammalian biodiversity in Serbia (Petrov, 1992; Savić *et al.*, 1995; Savić *et al.*, 1997) or relevant species-specific papers (Paunović & Milenković, 1996; Milenković, Paunović & Griffiths 2000). Finally, as some of the protected mammal species in the affected area are also game species, data from management plans from the local hunting societies of Merosina, Prokuplje and Kursumlija (their hunting grounds include the area on and around the Project) were also used. These hunting management plans are regularly updated every 10 years

and officially approved by the Ministry of Agriculture, Forestry and Water Management. They include, *inter alia*, the assessment of population number 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.

The species list eventually considered for the analysis of the impact of the highway includes the species that based on habitat requirements, field data and other available data are expected along the proposed route and its surrounding corridor, as well as species whose daily-night and seasonal corridors of movement cross the route and the corridor of the highway. Also, some species whose presence is still not documented, but for which there is a certain realistic assumption that they inhabit the corridor of the subject line, have been considered. Based on this conceptual approach, a mammal fauna with a total of 38 species is considered (Table 49).

Table 49 List of mammal species likely to occur in the area of the planned Niš-Pločnik highway

Order	Family	Scientific name	Common English name	National legislation	IUCN	EU Habitats Directive	Bern Convention
<i>Insectivora</i>	<i>Erinaceidae</i>	<i>Erinaceus roumanicus</i>	Hedgehog	P	LC		
	<i>Soricidae</i>	<i>Sorex minutus</i> ?	Pygmy shrew	P	LC		III
		<i>Sorex araneus</i>	Common shrew	P	LC		III
		<i>Neomys fodiens</i>	Water shrew	SP	LC		III
		<i>Neomys anomalus</i> ?	Mediterranean water shrew	P	LC		III
		<i>Crocidura suaveolens</i>	Lesser shrew	P	LC		III
		<i>Crocidura leucodon</i> ?	Bicolored shrew	P	LC		III
	<i>Talpidae</i>	<i>Talpa europaea</i>	European mole	P	LC		III
<i>Chiroptera</i>	<i>Rhinolophidae</i>	<i>Rhinolophus hipposideros</i>	Lesser horseshoe bat	SP	LC	II, IV	II
<i>Chiroptera</i>	<i>Vespertilionidae</i>	<i>Myotis daubentonii</i>	Daubenton's bat	SP	LC	IV	II
		<i>Plecotus austriacus</i>	Grey long-eared bat	SP	LC	IV	II
<i>Lagomorpha</i>	<i>Leporidae</i>	<i>Lepus europaeus</i>	European hare	P	LC		III
<i>Rodentia</i>	<i>Sciuridae</i>	<i>Sciurus vulgaris</i>	Red squirrel	P	LC		III
	<i>Muridae</i>	<i>Spalax leucodon</i>	Lesser mole-rat	SP	DD		

Order	Family	Scientific name	Common English name	National legislation	IUCN	EU Habitats Directive	Bern Convention
		<i>Myodes glareolus</i>	Bank vole		LC		
		<i>Arvicola amphibius</i>	European water vole	P	LC		
		<i>Microtus subterraneus</i>	European pine vole		LC		
		<i>Microtus arvalis</i>	Common vole		LC		
		<i>Apodemus flavicollis</i>	Yellow-necked mouse		LC		
		<i>Apodemus sylvaticus</i>	Wood mouse		LC		
		<i>Apodemus agrarius ?</i>	Striped field mouse		LC		
		<i>Rattus rattus</i>	Black rat		LC		
		<i>Rattus norvegicus</i>	Brown rat		LC		
		<i>Mus musculus</i>	House mouse		LC		
	Gliridae	<i>Glis glis</i>	Edible dormouse	P	LC		III
Carnivora	Canidae	<i>Canis aureus ?</i>	Golden jackal	P	LC	V	
		<i>Vulpes vulpes</i>	Red fox	P	LC		
	Mustelidae	<i>Mustela nivalis</i>	Least weasel	P	LC		III
		<i>Mustela putorius</i>	European polecat	P	LC	V	III
		<i>Vormela peregusna</i>	marbled polecat	SP	VU		II
		<i>Martes martes ?</i>	European pine marten	P	LC	V	III
		<i>Martes foina</i>	Beech marten	P	LC		III
		<i>Meles meles</i>	European badger	P	LC		III
		<i>Lutra lutra</i>	Eurasian otter	SP	NT	II, IV	II
	Felidae	<i>Felis silvestris</i>	Wildcat	P	LC	IV	II
Artiodactyla	Suidae	<i>Sus scrofa</i>	Wild boar	P	LC		
	Cervidae	<i>Capreolus capreolus</i>	European roe deer	P	LC		III

P – Protected wild species; SP – Strictly protected wild species.
VU-Vulnerable, NT – NearThreatened, DD-Data Deficient, LC- Least Concern species based on IUCN Red List categories
Species marked with “?” mean most probable, but still not verified presence.

The largest group are rodents - *Rodentia* (13 species). They inhabit a wide ecological spectrum of different habitat types, from forest and steppe to significantly anthropogenically modified. Only four species are protected according to national legislation. The Lesser mole rat is a „strictly protected wild species“, while the red squirrel, the water vole and the edible dormouse are „protected wild

species". The lesser mole-rat (*Spalax leucodon*), prefers dry habitats and can be found on a hilly area around the route between Prokuplje and Merošina and further towards Nis, but not around the section through the Toplica valley, from Prokuplje towards Pločnik, where the soil is much more humid. The water vole (*Arvicola amphibius*) inhabits very humid and aquatic habitats along the banks of larger and smaller watercourses, swamped parts of the forest and the periphery of the drainage channels. The water vole inhabits suitable habitats along the Toplica River and its alluvion, and most probably the larger and smaller left tributaries of Toplica River. The red squirrel (*Sciurus vulgaris*) and the edible dormouse (*Glis glis*) are forest species. However, they show considerable flexibility in terms of habitat selection, so the squirrel can be found in forests, urban and rural parks, and the edible dormouse on the attics of houses, stables and barns.

The second group by the presence are Carnivores (*Carnivora*) with 10 recorded species. All carnivore species are protected under the national legislation. The Eurasian otter (*Lutra lutra*) and the Marbled polecat (*Vormela peregusna*) are "strictly protected species" and the rest are "protected wild species".

The Eurasian otter is the only species specifically related to aquatic habitats. It is widespread along the Toplica River, and probably settles, occasionally or permanently, in some of its larger tributaries. The marbled polecat in the subject area is uncertain. There is an earlier finding from the area east of Merošina, where warm and dry habitats, the preferred habitat of the species, are present. However, it is a relatively adaptable species, and it is possible that it spreads to the west, along the Toplica River valley.

Regarding the rest of protected species, some (the Golden jackal - *Canis aureus*, the Red fox - *Vulpes vulpes*, the European badger - *Meles meles*, the European polecat - *Mustela putorius*, and the Beech marten - *Martes foina*) have a broader distribution and can be found in different types of habitats, so their presence is routinely expected along the entire route (the badger especially in the parts of contact of the route and a forest). The Least weasel - *Mustela nivalis* is a characteristic inhabitant of the steppe-type habitat and open vegetation complex, and is expected in a wide area of present agroecosystems.

On the other hand, the European pine marten - *Martes martes* and the wildcat - *Felis silvestris* are species more strongly related to the forest habitat, and their presence can be primarily expected in the alluvial forests along the Toplica River and the peripheral forests of the mountain Vidojevica that are nevertheless not in the highway corridor, as well as mountain forests along the right bank of the Toplica in the area of the Pločnik village and the forest Umac, between the villages Donja Trnava and Potočić, located in the corridor coverage.

Given the general ecological and trophic status of *Carnivora* of the second and higher ranks, large populations of most of these species are not expected along the proposed route. This applies in particular to the typical forest species such as the European pine marten and the Wildcat, or to the Otter, species strictly related to appropriate aquatic habitats. On the other hand, in recent years there has been a significant increase of some species, more adaptable to changes in the

environment. Such species are the Red Fox, the European Badger, and especially the Golden Jackal.

Insectivores (*Insectivora*) are represented by 8 species. There are still no documented findings for three species (Pygmy shrew - *Sorex minutus*, Mediterranean water shrew - *Neomys anomalus* and Bicolored shrew - *Crocidura leucodon*), but based on their range in Serbia and the existence of suitable habitats, it is likely to be presumed that they inhabit corridor of concerned route. All of them are protected and the Water shrew is a strictly protected species.

There are species that inhabit forest (small and common shrew - *Sorex araneus*, European mole - *Talpa europaea*), and habitats of ecotonic character (Hedgehog - *Erinaceus roumanicus*, Lesser shrew - *Crocidura suaveolens*), as well as aquatic or highly humid habitats - Water shrew - *Neomys fodiens* and Mediterranean water shrew - *Neomys anomalus*). Insectivores are generally a group of species which shows ecological plasticity and the ability to adapt to changes in environmental conditions. All of them are relatively common and widespread in the country.

The even-toed ungulates (*Artiodactyla*) includes species that are characteristic for almost the entire territory of Serbia (Roe deer - *Capreolus capreolus* and Wild boar - *Sus scrofa*). These are species of relatively wide ecological niches in terms of the habitat selection and food preferences, so present in the wider area of the projected route. The wild boar is more related to forest habitats, so its appearance along the route can be expected mainly in contact with forests. Both are also significant game species and as such they are also under a special „hunting“ regime. Every year hunting quotas are issued by the Ministry for agriculture, forestry and water management and Ministry for nature/environment protection, based on approved hunting management plans.

The European hare (*Lepus europaeus*) is the only representative of *Lagomorpha* in Serbia and spreads almost all over the country. Although it can often be found in the forests, the hare is, however, a typical resident of the open terrain of the steppe type, with predominantly grassland vegetation. Therefore, it can be found everywhere along the projected highway route. It is a protected wild species, and also a hunting game species.

Bats (*Chiroptera*) are a very heterogeneous and numerous mammal order. About 30 species have been recorded in Serbia so far. It is possible that the bat fauna is much more diverse and more numerous than the available data indicate. Research on bats is methodologically complex, so many areas are still poorly explored. However, bats represent a very important component of the living world and when assessing the impact of the construction of infrastructure and other facilities should be subject to further detailed analysis.

In the geographical region of Toplica there is evidence of the existence of only three species. Two of them – the Lesser horseshoe bat (*Rhinolophus hipposideros*) and the Grey long-eared bat (*Plecotus austriacus*) are species primarily related to cave habitat types, but along the route they also inhabit residential areas in settlements, mainly as a roost places. The third species – Daubenton's bat (*Myotis daubentonii*) is associated with aquatic habitats, and

inhabits the area of the Toplica River and nearby watercourses. All Chiroptera in Serbia are under strict protection.

Bird fauna

Regarding bird fauna, field studies took place from 01- 05.02.2015 and from 30.05.-03.06.2016 in order to obtain additional data and verify literature references. The team followed the transect method along the proposed route with a monitoring strip 200-500 m right and left, depending on terrain. In addition the team used personal research data (2014-2017) as well as data collected for the needs of the analysis of the bird fauna of nesting areas in the south-eastern Serbia, and for the needs of the production of regional lists of species bird nesting and formation of nesting birds atlases. Finally, literature sources used the most important studies for the protection and distribution of birds in Serbia (Puzović, S., et al. 2003; Puzović, S., et al. 2009; Puzović, S., et al. 2015; Šćiban M. et al, 2015; Matvejev, 1950). The use of these studies was important in order to confirm the presence of some bird species, as well as their national trends, which was significant for determining the species to which the route of the highway will have the most impact and how to set measures for their mitigation.

About 120 species of birds are present in the area along the highway route.

Table 50 Bird species in the area of Nis-Pločnik highway route and their national and international protection status

No.	Scientific name	English name	National legislation	IUCN Red List status	2009/14 7/EC Annex I	Bern Convention Annex II	Bonn Convention
1.	<i>Anas platyrhynchos</i>	Mallard	P	LC			+
2.	<i>Anas crecca</i>	Eurasian Teal	P	LC			+
3.	<i>Perdix perdix</i>	Grey Partridge	P	LC			
4.	<i>Coturnix coturnix</i>	Common Quail	P	LC			+
5.	<i>Phasianus colchicus</i>	Common Pheasant	P	LC			
6.	<i>Tachybaptus ruficollis</i>	Little Grebe	SP	LC		+	
7.	<i>Phalacrocorax carbo</i>	Great Cormorant	P	LC			
8.	<i>Egretta alba</i>	Great Egret	SP	LC		+	+
9.	<i>Ardea cinerea</i>	Grey Heron	P	LC			
10.	<i>Ciconia ciconia</i>	White Stork	SP	LC	+	+	+
11.	<i>Ciconia nigra</i>	Black Stork	SP	LC	+	+	+
12.	<i>Circus aeruginosus</i>	Western Marsh-harrier	SP	LC	+		+
13.	<i>Circus cyaneus</i>	Northern Harrier	SP	LC	+	+	+
14.	<i>Buteo buteo</i>	Common Buzzard	SP	LC		+	+
15.	<i>Accipiter nisus</i>	Eurasian Sparrowhawk	SP	LC		+	+
16.	<i>Accipiter gentilis</i>	Northern Goshawk	P	LC		+	+
17.	<i>Falco tinnunculus</i>	Common Kestrel	SP	LC		+	+

No.	Scientific name	English name	National legislation	IUCN Red List status	2009/14 7/EC Annex I	Bern Convention Annex II	Bonn Convention
18.	<i>Falco subbuteo</i>	Eurasian Hobby	SP	LC		+	+
19.	<i>Gallinula chloropus</i>	Common Moorhen	P	LC			
20.	<i>Fulica atra</i>	Common Coot	P	LC			
21.	<i>Vanellus vanellus</i>	Northern Lapwing	SP	LC			
22.	<i>Tringa ochropus</i>	Green Sandpiper	SP	LC			
23.	<i>Scolopax rusticola</i>	Eurasian Woodcock	P	LC			+
24.	<i>Gallinago gallinago</i>	Common Snipe	SP	LC			
25.	<i>Columba livia f. domestica</i>	Feral Pigeon		-			
26.	<i>Columba palumbus</i>	Common Wood-pigeon	P	LC			
27.	<i>Streptopelia decaocto</i>	Eurasian Collared-dove	P	LC			
28.	<i>Streptopelia turtur</i>	European Turtle-dove	P	VU			+
29.	<i>Cuculus canorus</i>	Common Cuckoo	SP	LC			
30.	<i>Asio otus</i>	Long-eared Owl	SP	LC		+	
31.	<i>Strix aluco</i>	Tawny Owl	SP	LC		+	
32.	<i>Athene noctua</i>	Little Owl	SP	LC		+	
33.	<i>Otus scops</i>	Common Scops-owl	SP	LC		+	
34.	<i>Caprimulgus europaeus</i>	Eurasian Nightjar	SP	LC	+	+	
35.	<i>Upupa epops</i>	Eurasian Hoopoe	SP	LC		+	
36.	<i>Alcedo atthis</i>	Common Kingfisher	SP	LC	+	+	
37.	<i>Merops apiaster</i>	European Bee-eater	SP	LC		+	+
38.	<i>Dryocopus martius</i>	Black Woodpecker	SP	LC	+	+	
39.	<i>Picus viridis</i>	Eurasian Green Woodpecker	SP	LC		+	
40.	<i>Dendrocopos major</i>	Great Spotted Woodpecker	SP	LC		+	
41.	<i>Dendrocopos syriacus</i>	Syrian Woodpecker	SP	LC	+	+	
42.	<i>Dendrocopos medius</i>	Middle Spotted Woodpecker	SP	LC	+	+	
43.	<i>Dendrocopos minor</i>	Lesser Spotted Woodpecker	SP	LC		+	
44.	<i>Jynx torquilla</i>	Eurasian Wryneck	SP	LC		+	
45.	<i>Alauda arvensis</i>	Eurasian Skylark	SP	LC			
46.	<i>Galerida cristata</i>	Crested Lark	SP	LC			
47.	<i>Lullula arborea</i>	Wood Lark	SP	LC	+		
48.	<i>Riparia riparia</i>	Sand Martin	SP	LC		+	
49.	<i>Hirundo rustica</i>	Barn Swallow	SP	LC		+	
50.	<i>Delichon urbicum</i>	House Martin	SP	LC		+	

No.	Scientific name	English name	National legislation	IUCN Red List status	2009/14 7/EC Annex I	Bern Convention Annex II	Bonn Convention
51.	<i>Anthus pratensis</i>	Meadow Pipit	SP	NT		+	
52.	<i>Anthus trivialis</i>	Tree Pipit	SP	LC		+	
53.	<i>Motacilla alba</i>	White Wagtail	SP	LC		+	
54.	<i>Motacilla flava</i>	Yellow Wagtail	SP	LC		+	
55.	<i>Prunella modularis</i>	Hedge Accentor	SP	LC		+	
56.	<i>Erithacus rubecula</i>	European Robin	SP	LC		+	+
57.	<i>Luscinia megarhynchos</i>	Common Nightingale	SP	LC		+	+
58.	<i>Phoenicurus phoenicurus</i>	Common Redstart	SP	LC		+	+
59.	<i>Phoenicurus ochruros</i>	Black Redstart	SP	LC		+	+
60.	<i>Saxicola rubetra</i>	Whinchat	SP	LC		+	+
61.	<i>Saxicola torquatus</i>	Common Stonechat	SP	LC		+	+
62.	<i>Turdus philomelos</i>	Song Thrush	SP	LC			+
63.	<i>Turdus viscivorus</i>	Mistle Thrush	SP	LC			+
64.	<i>Turdus pilaris</i>	Fieldfare	SP	LC			+
65.	<i>Turdus merula</i>	Eurasian Blackbird	SP	LC			+
66.	<i>Sylvia borin</i>	Garden Warbler	SP	LC		+	+
67.	<i>Sylvia atricapilla</i>	Blackcap	SP	LC		+	+
68.	<i>Sylvia communis</i>	Common Whitethroat	SP	LC		+	+
69.	<i>Sylvia curruca</i>	Lesser Whitethroat	SP	LC		+	+
70.	<i>Acrocephalus schoenobaenus</i>	Sedge Warbler	SP	LC		+	+
71.	<i>Locustella luscinioides</i>	Savi's Warbler	SP	LC		+	+
72.	<i>Cettia cetti</i>	Cetti's Warbler	SP	LC		+	+
73.	<i>Acrocephalus scirpaceus</i>	Eurasian Reed-warbler	SP	LC		+	+
74.	<i>Acrocephalus palustris</i>	Marsh Warbler	SP	LC		+	+
75.	<i>Hippolais icterina</i>	Icterine Warbler	SP	LC		+	+
76.	<i>Hippolais pallida</i>	Olivaceous Warbler	SP	LC		+	+
77.	<i>Phylloscopus trochilus</i>	Willow Warbler	SP	LC		+	+
78.	<i>Phylloscopus sibilatrix</i>	Wood Warbler	SP	LC		+	+
79.	<i>Phylloscopus collybita</i>	Common Chiffchaff	SP	LC		+	+
80.	<i>Regulus regulus</i>	Goldcrest	SP	LC		+	+
81.	<i>Troglodytes troglodytes</i>	Wren	SP	LC			
82.	<i>Muscicapa striata</i>	Spotted Flycatcher	SP	LC		+	+
83.	<i>Ficedula hypoleuca</i>	European Pied Flycatcher	SP	LC		+	+

No.	Scientific name	English name	National legislation	IUCN Red List status	2009/14 7/EC Annex I	Bern Convention Annex II	Bonn Convention
84.	<i>Ficedula albicollis</i>	Collared Flycatcher	SP	LC	+	+	+
85.	<i>Parus major</i>	Great Tit	SP	LC		+	
86.	<i>Parus ater</i>	Coal Tit	SP	LC		+	
87.	<i>Parus caeruleus</i>	Blue Tit	SP	LC		+	
88.	<i>Parus palustris</i>	Marsh Tit	SP	LC		+	
89.	<i>Parus lugubris</i>	Sombre Tit	SP	LC		+	
90.	<i>Aegithalos caudatus</i>	Long-tailed Tit	SP	LC		+	
91.	<i>Sitta europaea</i>	Wood Nuthatch	SP	LC		+	
92.	<i>Certhia brachydactyla</i>	Short-toed Tree-creeper	SP	LC		+	
93.	<i>Lanius excubitor</i>	Northern Grey Shrike	SP	LC		+	
94.	<i>Lanius minor</i>	Lesser Grey Shrike	SP	LC	+	+	
95.	<i>Lanius collurio</i>	Red-backed Shrike	SP	LC	+	+	
96.	<i>Pica pica</i>	Black-billed Magpie	P	LC			
97.	<i>Garrulus glandarius</i>	Eurasian Jay	P	LC			
98.	<i>Corvus monedula</i>	Eurasian Jackdaw	P	LC			
99.	<i>Corvus frugilegus</i>	Rook	P	LC			
100.	<i>Corvus cornix</i>	Carrion Crow	P	LC			
101.	<i>Corvus corax</i>	Common Raven	P	LC			
102.	<i>Sturnus vulgaris</i>	Common Starling	P	LC			
103.	<i>Oriolus oriolus</i>	Eurasian Golden-oriole	SP	LC		+	
104.	<i>Passer domesticus</i>	House Sparrow	P	LC			
105.	<i>Passer montanus</i>	Eurasian Tree Sparrow	P	LC			
106.	<i>Passer hispaniolensis</i>	Spanish sparrow	SP	LC			
107.	<i>Fringilla coelebs</i>	Chaffinch	SP	LC			
108.	<i>Fringilla montifringilla</i>	Brambling	SP	LC			
109.	<i>Carduelis cannabina</i>	Eurasian Linnet	SP	LC		+	
110.	<i>Carduelis carduelis</i>	European Goldfinch	SP	LC		+	
111.	<i>Carduelis chloris</i>	European Greenfinch	SP	LC		+	
112.	<i>Carduelis spinus</i>	Eurasian Siskin	SP	LC		+	
113.	<i>Serinus serinus</i>	European Serin	SP	LC		+	
114.	<i>Pyrrhula pyrrhula</i>	Eurasian Bullfinch	SP	LC			
115.	<i>Coccothraustes coccothraustes</i>	Hawfinch	SP	LC		+	
116.	<i>Emberiza schoeniclus</i>	Reed Bunting	SP	LC		+	
117.	<i>Emberiza hortulana</i>	Ortolan Bunting	SP	LC	+		

No.	Scientific name	English name	National legislation	IUCN Red List status	2009/14 7/EC Annex I	Bern Convention Annex II	Bonn Convention
118.	<i>Emberiza citrinella</i>	Yellowhammer	SP	LC		+	
119.	<i>Emberiza cirius</i>	Cirl Bunting	SP	LC		+	
120.	<i>Emberiza melanocephala</i>	Black-headed Bunting	SP	LC		+	
121.	<i>Emberiza calandra</i>	Corn Bunting	SP	LC			
P-protected species, SP-strictly protected species LC- Least Concern, VU- Vulnerable, NT-Near Threatened species based on IUCN Red List categories.							

Significant species of nesting birds in the area from Pločnik to the Prokuplje bypass are: Lesser Grey Shrike - *Lanius minor* and Red-backed Shrike - *Lanius collurio*, the Corn Bunting - *Emberiza calandra*, Eurasian Skylark - *Alauda arvensis*, while during the winter the Great Grey Shrike - *Lanius excubitor* is also recorded. During the field surveys, no nests of strictly protected species were recorded along the proposed highway route. Since the route is positioned mainly through the agricultural landscape, eventual nests of species of conservational significance are placed out from either direct or indirect impact.

The affected area hosts particularly dense populations of hunting bird species, such as the Grey Partridge - *Perdix perdix* and the Common Quail - *Coturnix coturnix*.

These species are strictly protected in Serbia, and some of them are also listed in the Appendix I of the EU Birds Directive. Grey Partridge and Common Quail are hunting species and the area is one of the most important in Serbia, especially for partridges. There is no methodological monitoring and long term data series of these species which, in addition to hunting, suffer from other types of pressures affecting their number. In that sense, it is necessary to prescribe measures for the preservation of each local population of these species.

In the section from the Prokuplje bypass, via Merošina to the existing E75 motorway, it is important to mention the presence of species such as the Spanish Sparrow - *Passer hispaniolensis*, Black-headed Bunting - *Emberiza melanocephala*, Yellow Wagtail - *Motacilla flava*, Lesser Grey Shrike - *Lanius minor*, Woodchat Shrike - *L. senator* and Cetti's Warbler - *Cettia cetti*. Just like the first section, in this part of the particularly dense population there are hunting bird species, such as the Grey Partridge - *Perdix perdix* and Common Quail - *Coturnix coturnix*. This area is also one of the most important for these two species in Serbia.

Fauna of amphibians and reptiles

Concerning the fauna of **amphibians and reptiles**, extensive researches in the Project affected area was carried out during the springs of 2013, 2014 and 2015. Sites of interest were again visited once a year since. In addition field data (personal communication) collected for the preparation of the Red Data Book of Fauna of Amphibians and Reptiles of Serbia were used.

Judging by the species composition, the herpetofauna (amphibians and reptiles) of this region is similar to that of other regions in Serbia. Analysis of diversity centers shows that the herpetofauna of this region is moderate in the number of species. There are no endemic species or species of restricted distribution. The fauna of amphibians and reptiles on the subject section of the highway is shown in Table 51.

Table 51 Fauna of amphibians and reptiles in the area of the highway

Latin name		English name	Red List status	92/43/EEC (Annexes II, IV, V)	Bern Convention	National legislation
AMPHIBIANS						
Caudata (salamanders and newts)	<i>Salamandra salamandra</i>	Fire salamander	LC		III	SP
	<i>Lissotriton vulgaris</i>	Smooth newt	LC		III	SP
Anura (frogs and toads)	<i>Hyla arborea</i>	European tree frog	LC	IV	II	SP
	<i>Bombina variegata</i>	Yellow-bellied toad	LC	II, IV	III	SP
	<i>Bufo bufo</i>	Common toad	LC		III	SP
	<i>Bufo viridis</i>	European green toad	LC	IV	III	SP
	<i>Pelophylax ridibundus</i>	Marsh frog	LC	IV	III	P
	<i>Rana dalmatina</i>	Agile frog	LC	IV	III	SP
REPTILES						
Testudines (turtles)	<i>Emys orbicularis</i>	European pond turtle	LC	II, IV	II	SP
	<i>Testudo hermanni</i>	Hermann's tortoise	VU	II, IV	II	P
Lacertilia (lizards)	<i>Anguis fragilis</i>	Slowworm	LC		III	Not protected
	<i>Darevskia praticola</i>	Meadow lizard	NT		III	SP
	<i>Lacerta viridis</i>	European green lizard	LC	IV	II	Not protected
	<i>Podarcis muralis</i>	Common wall lizard	LC	IV	II	Not protected
	<i>Dolichophis caspius</i>	Caspian whipsnake	LC	IV	III	SP
Serpentes (snakes)	<i>Natrix natrix</i>	Grass snake	LC		III	SP
	<i>Natrix tessellata</i>	Dice snake	LC	IV	II	SP
	<i>Zamenis longissimus</i>	Aesculapian snake	LC	IV	II	SP
	<i>Vipera ammodytes</i>	Nose horned viper	LC	II, IV	II	SP
P – Protected species; SP – Strictly protected species; LC – Least Concerned; VU – Vulnerable; NT – Near Threatened species based on IUCN Red List categories						

The species belonging to the so-called green frog complex (*Rana (Pelophylax), esculenta* complex), the Hermann's tortoise (*Testudo hermanni*) and the horned viper (*Vipera ammodytes*) are protected based on the *Decree on controlling the use and traffic of wild flora and fauna*, for their commercial value. There are no precise data regarding population status and trends of these species but they are

considered common in the affected area. This applies also to the species listed on the Annex II of the Habitats Directive. As a result the herpetofauna species present in the area are not vulnerable or significant or of restricted range and cannot be considered as Priority Biodiversity Features.

Watercourses that flow into the Toplica River represent important corridors for amphibians and reptiles. Since the construction of the highway will not cut off these natural corridors with barriers, the highway itself does not pose a direct threat. Also, parts of the watercourses over which the highway passes does not represent reproductive centers for amphibians, because they run dry for most of the season.

Ichthyofauna

Toplica River is the largest right tributary of South Morava, the length of the stream is over 130 km and its river basin covers about 2000 km². Length of the river affected by project is relatively too small to be shown in percentage. It springs on Kopaonik and is formed of several streams and smaller rivers. The length of the whole stream is fed by the waters of many tributaries from Kopaonik Mt., Jastrebac Mt. and Pasjače Mt., which are rich in interesting fish resorts. In the upper flow the river has a width of 8 to 10 m, with frequent torrential rapids and vortex, clear and cold water. In the middle and lower flow the width of the trough is over 15 m. The water depth is 0.5m and up to several meters in the vortex. The Toplica River is a typical river with salmonid and cyprinid regions. In the upper stream it is shaded with shrubby vegetation and trees, while the middle flow is characterized by woody vegetation on the banks. The proposed highway is in middle part of the river.

In Toplica and its tributaries 18 species of fish and one species of Lamprey were recorded, representatives of 7 families (*Cyprinidae*, *Cobitidae*, *Balitoridae*, *Centrarchidae*, *Percidae*, *Salmonidae*, *Siluridae* and Lampreys - *Petromyzontidae*). The composition of ichthyofauna along certain streams is shown in the following tables.

To establish baseline conditions data were obtained during surveys conducted by the team during June and August 2016. Samples were collected by using the electro-fishing equipment for scientific purposes.

The composition of ichthyofauna along certain streams is shown in the following tables. The tables refer only for permanent watercourses. The others are occasional ones, so they were not included in the survey and results. The main permanent watercourses that will be somehow affected by project are:

- Krajковаčka river (km 8+105) (bridge L=70m and river regulation in area of bridge),
- Jugbogdanovačka river (km 14+062) (viaduct L= 500m),
- Draguška river (km 34+928) (bridge L=35 m) and
- Toplica river (km 38+550) (bridge L=140 m).

The remaining crossings refer to temporary and mostly dry watercourses, except in cases of heavy rains and snow melting.

Table 52 Composition of the ichthyofauna in the Toplica River basin

Species	English name	Toplica River	Krajковаčka river	Jugbogdanovačka river	Bejašnička river	Bresnička river	Arbanaška river	Dragaška river	Jošanička river
<i>Alburnus alburnus</i>	common bleak	*							
<i>Alburnoides bipunctatus</i>	schneider	*	*	*	*	*	*	*	*
<i>Barbus barbus</i>	common barbel	*							
<i>Barbus balcanicus</i>	Danube barbel	*	*	*	*	*	*	*	*
<i>Carassius gibelio</i>	Prussian carp	*							
<i>Chondrostoma nasus</i>	common nase	*							
<i>Gobio gobio</i>	gudgeon	*	*	*	*			*	
<i>Gobio kessleri</i>	Kessler's gudgeon	*				*			
<i>Phoxinus phoxinus</i>	common minnow	*					*	*	*
<i>Rhodeus amarus</i>	European bitterling	*							
<i>Rutilus rutilus</i>	common roach								
<i>Squalius cephalus</i>	chub	*	*	*	*		*	*	
<i>Salmo trutta</i>	brown trout								*
<i>Lepomis gibbosus</i>	pumpkinseed								
<i>Perca fluviatilis</i>	perch								
<i>Silurus glanis</i>	wels catfish								
<i>Cobitis elongata</i>	Balkan Loach			*					
<i>Barbatula barbatula</i>	stone loach		*	*	*		*	*	*
<i>Eudontomyzon vladkovi</i>	Vladykov's lamprey						*	*	

Toplica River and its tributaries have a mosaic qualitative and quantitative distribution of fish. The composition of their communities is (in addition to the general abiotic conditions of the environment (water temperature, hydrological regime, water velocity, oxygen quantity)) largely determined by the diversity of habitat types along the river stream, and more recently by restocking (artificial insertion of young fish to increase the existing population in a certain environment). All mentioned habitat types are typical for Toplica River, common in this watershed and spread in Serbia. Along the entire course of the Toplica River alternate communities of fish type upper ritrona (salmonid-type) with the communities of the medium and the lower ritrona. The composition of ichthyofauna is conditioned by spawning, developmental, nutritional and seasonal migratory-interdromatic features of most fish species. The spawning migrations are particularly important, when the fish migrate into tributaries that include natural hatcheries of certain species of fish. Seasonal migrations are also important in order to find the right food or place for wintering. Spawning and seasonal migration will not be affected by project because planned works are spatial and time restricted and project must follow guidelines given by Srbijavode (consider water protection) and Instiute for nature Conservation (nature, ecosystems and species protection).

Protecting water as resources and habitats of the species and their communities as well as integral protection and preservation of autochthonous, original fish diversity are also contained in international conventions, directives and other documents that are applied at both national and local levels. Among these international documents, the Convention on the Conservation of European Wildlife and Fauna and Natural Habitats - Berne Convention ("Official Gazette of the Republic of Serbia - International Agreements", No. 102/07) and the Directive on the Protection of Natural Habitats and Wild Fauna and Flora (Council Directive 92/43 / EEC of 1992). The status of protection of recorded fish species in the subject area of the river basin of Toplica are shown in the following table. There are no fish assessed within a threat category in the IUCN red list.

Table 53 Ichthyofauna in the area of the highway

Species	English name	National legislation	IUCN status	EU Habitats directive	Bern convention
<i>Alburnus alburnus</i>	common bleak	-	LC	-	-
<i>Alburnoides bipunctatus</i>	schneider	P	LR		III
<i>Barbus barbus</i>	common barbel	P	LC	V	-
<i>Barbus balcanicus</i>	Danube barbel	P	LC	V	-
<i>Carassius gibelio</i>	Prussian carp	-	NE	-	-
<i>Chondrostoma nasus</i>	common nase	P	LC	-	III
<i>Gobio gobio</i>	gudgeon	P	LC	-	-

Species	English name	National legislation	IUCN status	EU Habitats directive	Bern convention
<i>Gobio kessleri</i>	Kessler's gudgeon	SP	LC	II	III
<i>Phoxinus phoxinus</i>	common minnow	-	LC	-	-
<i>Rhodeus amarus</i>	European bitterling	-	LC	II	III
<i>Rutilus rutilus</i>	common roach	-	LC	-	-
<i>Squalius cephalus</i>	chub	P	LC	-	-
<i>Salmo trutta</i>	brown trout		LC	-	-
<i>Lepomis gibbosus</i>	pumpkinseed	-	LC	-	-
<i>Perca fluviatilis</i>	perch	P	LC	-	-
<i>Silurus glanis</i>	wels catfish	P	LC	-	III
<i>Cobitis elongata</i>	Balkan Loach	SP	LC		III
<i>Barbatula barbatula</i>	stone loach	-	LC	-	-
<i>Eudontomyzon vladykovi</i>	Vladykov's lamprey	SP	LC	II	III,
P – Protected species; SP – Strictly protected species; LC – Least Concerned, NE- Not evaluated species IUCN category					

With the exception of *Eudontomyzon vladykovi* the other two fish species included in the Annex II of the EU Habitats Directive are widespread in Serbia and common in the Project area. The Vladykov's lamprey (*Eudontomyzon vladykovi*) is a migratory species. Its main spawning areas are the upper parts of Arbanaška river and some times Dragaška river, all outside the possible impact of the proposed highway. During migration, large number of lamprey go upstream of Toplica river to reach these spawning areas. If there are some barriers this species is able to avoid them and continue upstream via the river banks. Therefore these three species even though protected also in the EU level are not vulnerable or ecologically significant and are not further assessed as Priority Biodiversity Features. In any case, the impact of Project on Vladykov's lamprey as well as in the other fish species is minor.

Table 54 Qualifying interests: species listed on Annex II of Council directive 92/43/EEC

NAME	Recorded during the field study	POPULATION		Habitat	Status within Serbia	Expected Status within the Project Area	Impact
		Resident	Migratory				
European bitterling (<i>Rhodeus amarus</i>)	yes	yes		Medium to large rivers and lakes.	Wide spread	common	Low

NAME	Recorded during the field study	POPULATION		Habitat	Status within Serbia	Expected Status within the Project Area	Impact
		Resident	Migratory				
Balkan Loach (<i>Cobitis elongata</i>)	yes	yes		Small to medium rivers	common	common	Low
Vladykov's lamprey (<i>Eudontomyzon vladykovi</i>)	yes	no	spawning migratory	Small to medium rivers	rare	unknown	Low

4.1.13 Landscape and visual settings

Landscape basic elements in the analysed area are:

- Human elements resulting operation (agricultural land, settlements and infrastructure) and
- The natural and semi-natural elements (lawn vegetation and forests)

The most landscape element is agricultural land. Represented are mainly fruit and fields culture (Figure 66, Figure 67 and Figure 68). In this part of the present and the land that is unused, untreated arable land and orchards to which the present grass vegetation and indigenous weed species that sub-spontaneous beyond.

Figure 73 Agrarian landscape –orchard



Figure 74 Agrarian landscape - crops



Figure 75 Abandoned arable land



Planned sections peripheral tangential Prokuplje, as well as some smaller villages: Merošina, Zlokućane, Jugbogdanovac, Potočić, Kondželj ... Since anthropogenic elements, there is a railway, road network that connects the agricultural area with settlements and related infrastructure. At the end of the analysed sections of the causeway Neolithic settlement Pločnik and the remains of Roman thermae.

Figure 76 *Neolithic settlement at Pločnik*



Figure 77 *Roman thermae*



From the viewpoint of visual perception, the landscape is very dynamic with developed relief forms (from the river valley, across the lowland to hilly and mountainous areas).

Figure 78 *The morphology of the terrain*



Forests as natural elements of the landscape are fragmented and occur sporadically, mostly along watercourses. Grove, hedges and single trees are scattered throughout the landscape.

Figure 79 Grove



It is necessary to point out that a part of the landscape is degraded by anthropogenic influence in terms of visual perception of space, with the existing infrastructure, roads and their use (Figure 80).

Figure 80 Anthropogenic degradation of landscapes



4.2 Social Baseline

This section briefly describes some of the Social Baseline Land use and Property and Cultural Heritage and Archaeology. Social Impact Assessment Study (SIA), together with Resettlement Policy Framework (RPF), Stakeholder Engagement Plan (SEP) and Environmental and Social Action Plan (ESAP) are attached to this ESIA as part of annex 1.

4.2.1 Demographics

Population and Settlements

As of January 2016, population of Serbia was estimated to be 7.076.372, which continues the trend of population decrease of around half percent every year. This trend can be corroborated while observing the table below. Low birth rate, aging population and emigration are the trendsetting factors.

Table 55 Population trends in Serbia

	2011	2012	2013	2014	2015
	Population	Population	Population	Population	Population
Serbia population					
Total:	7236519	7201497	7166552	7131787	7095383
Population decrease:	-	0.48%	0.49%	0.49%	0.51%

When analysing population density, Serbia is one of the countries in Europe with lower population density at an average of 91 inhabitants per sq. kilometre⁴ (but one of the highest in the region - higher population density have only Slovenia and Albania). Population density of municipality Prokuplje reaches 56.1 inhabitants per sq. kilometre and 69, 6 inhabitants per sq. kilometre in municipality of Merošina. Municipality of Prokuplje is one of the least inhabited municipalities in Serbia comparing to its surface area. The district of Niš is the third most populated district of Serbia with a population of 373.404 , which represents 5.1% of total Serbian population.

Table 56: Population of Merošina and Prokuplje, with a list of larger settlements⁵

	Population				Population		
	Total	Male	Female		Total	Male	Female
Merošina				Prokuplje			
Population	13968	7174	6794	Population	44419	22056	22363
City areas				City areas	27333	13442	13891
Rural areas	13968	7174	6794	Rural areas	17086	8614	8472
Merošina settlements above 200 inhabitants				Prokuplje settlements above 200 inhabitants			
Azbresnica	726	378	348	Prokuplje (city area)	27333	13442	13891
Aleksandrovo	409	211	198	Babin Potok	618	323	295
Arbanasce	513	263	250	Babotinac	242	121	121
Balajnac	1254	645	609	Bace	228	111	117
Baličevac	1141	587	554	Bela Voda	259	125	134

⁴ Source: National statistical office; for 2016 population data

⁵ Source - National statistical office of Serbia - <http://webzrzs.stat.gov.rs/WebSite/Default.aspx>

	Population				Population		
	Total	Male	Female		Total	Male	Female
Merošina				Prokuplje			
Batušinac	792	410	382	Beloljin	485	223	262
Biljeg	498	260	238	Berilje	738	371	367
Brest	547	288	259	Bresničić	237	111	126
Bučić	489	240	249	Velika Plana	506	235	271
Gornja Rasovača	218	117	101	Gornja Stražava	676	352	324
Gradište	559	280	279	Gornja Trnava	314	162	152
Devča	385	201	184	Donja Konjuša	246	119	127
Dešilovo	366	194	172	Donja Rečica	357	188	169
Donja Rasovača	536	286	250	Donja Stražava	799	422	377
Dudulajce	309	152	157	Donja Toponica	299	134	165
Jovanovac	492	273	219	Donja Trnava	1383	707	676
Jug Bogdanovac	493	258	235	Žitni Potok	484	242	242
Kovanluk	226	115	111	Klisurica	202	101	101
Kostadinovac	254	123	131	Mađere	261	145	116
Krajkovac	509	267	242	Mala Plana	558	286	272
Lepaja	600	303	297	Mikulovac	317	160	157
Merošina	905	451	454	Nova Božurna	227	118	109
Oblačina	447	210	237	Novo Selo	390	200	190
Padina	335	171	164	Petrovac	302	164	138
Rožina	692	353	339	Pločnik	120	57	63
Mramorsko Brdo	189	96	93	Potočić	420	220	200
				Reljinac	532	267	265
				Tulare	262	136	126
				Čučkovac	278	148	130
				Džigolj	222	113	109

The table above shows that municipality of Merošina doesn't have urban settlements; all settlements in Merošina are considered to be mostly rural. Prokuplje city is the only urban settlement in municipality of Prokuplje, representing more than 60% of the municipality population.

Merošina with its population of 13.968 inhabitants belongs to a group of smaller municipalities, representing 0.19% of overall population. Prokuplje with population of 44.419 inhabitants (0.62% of total population) is the seventh largest municipality in Serbia without status of a city. Population analysis reveals that, according to present trend, in year 2041. Merošina will have 11.972 inhabitants (6.149 female and 5.823 males) suffering decrease of nearly 15% comparing to 2011, while

Prokuplje will have 34.883 inhabitants (17.460 female and 17.423 male) with a decrease of nearly 22%⁶.

The municipality administration centre of Merošina municipality is located in the Merosina village, but it is not the largest settlements - villages Baličevac and Balajnac are the two most populated villages.

The Table does not include tens of smaller settlements in municipality of Prokuplje with population below 100 inhabitants, even some villages of population below 10 inhabitants.

There are 2.487.886 households in Serbia, 61% living in urban areas, and 39% living in rural and "other"⁷ areas.

Age

The population of Serbia is significantly aging. In 1971 the average person in Serbia had 32.4 years, and now the median age of Serbian population is almost 43 years, but that average is similar to the European median age. Life expectancy is 72 years for male, and 77 for female population.⁸ Since 2011, every year, population in Serbia is in average getting older for 0.17 years, with a similar rate for female and male population. The graph below shows female and male age groups in Serbia and their rate in total Serbian population.

Figure 81 Age group distribution

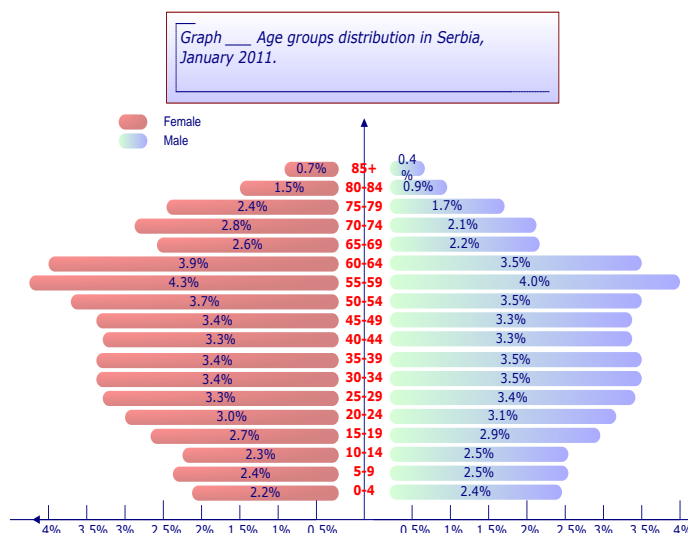


Table below shows that municipality of Merošina has a significantly older population, while municipality of Prokuplje a slightly older population than the national level. The main reason for this has been explained before: emigration of younger people to larger cities (Belgrade, Niš) and to other countries. The difference of ratio of working

⁶ Projection by Statistical office of Serbia

⁷ Statistical office applied so-called administrative-legal criteria. Urban settlements are determined by acts of local self-governments, rest is defined as "other".

⁸ Source - National statistical office of Serbia - <http://webzrs.stat.gov.rs/WebSite/Default.aspx>

age population group (age 20 to 64) in total population of more than 6% between municipality of Merošina and the national level seems to be the most alarming statistical data, as well as the ratio of older age group population (65+).

Table 57: Major age group comparison

Major age groups		0-14	20-64	65+
Serbia		14.27%	62.74%	17.40%
Merošina		14.17%	56.61%	23.15%
Prokuplje		15.06%	59.90%	18.72%

Age - views from field survey

The Association of Pensioners of Prokuplje was reported to have 8500 members, which makes them a single most numerous social group and organization. During stakeholders meeting it was clearly explained that they are considered to be one of the most influential local citizen organizations. During the meeting, no concerns were expressed regarding the Highway construction process providing that all local roads are kept operational. It has been stressed that all primary health protection is available on a weekly basis (once or twice a week) in every village in addition to the health care provided in the hospital. Overall economy long-term effect of the Highway was deemed to be negative.

(See: Economy and livelihoods issues - views from field survey –in section0 of the Main SIA in Annex 1).

Gender and gender equality

Out of the total population of Serbia, 51.3% are female and 48.7% are male inhabitants.

The Constitution of the Serbia proclaims principles of gender equality (Art. 15), all internationally recognized human right (Art. 18), and prohibition of any form of discrimination (Art. 21), gender equality in marriage (Art. 62):

- Article 15 - The State shall guarantee the equality of women and men and develop equal opportunities policy.
- Article 18 The Constitution shall guarantee, and as such, directly implement human and minority rights guaranteed by the generally accepted rules of international law, ratified international treaties and laws. The law may prescribe manner of exercising these rights only if explicitly stipulated in the Constitution or necessary to exercise a constitute project specific right owing to its nature, whereby the law may not under any circumstances influence the substance of the relevant guaranteed right.
- Article 21 - All direct or indirect discrimination based on any grounds, particularly on race, sex, national origin, social origin, birth, religion, political or other opinion, property status, culture, language, age, mental or physical disability shall be prohibited.

- Article 62 - Marriage shall be entered into based on the free consent of man and woman before the state body. Contracting, duration or dissolution of marriage shall be based on the equality of man and woman.

Although the Constitution fails to mention gender pay equality, articles of The Labour Law⁹ treats rights of men and women equally, including right of equal pay. Additionally, according to provisions of this Law, a working woman has the right of absence from work due to pregnancy and childbirth, maternity leave, and absence from work for child care, for a total of 365 days. This length of maternity leave is usually used in full, making it one of the most lengthy in the world. The right of employment is also proclaimed equal, but because of maternity leave provisions young women in certain cases will be discriminated in employment possibility, although it is illegal to ask questions about maternity plans during job interviews. This particularly applies to employment in small and moderate private enterprises.

Despite principles however, many women in Serbia face challenges combining paid work and child care responsibilities. This could be an additional cause for Serbia's low fertility rate, which is one of the lowest in European countries, and average in the region at 1.46 percent in 2014.

The employment rate of women in Serbia (38.3%) is significantly lower than the EU-27 average (58.5%)¹⁰. Gender gap in employment rates stood at an average of -15 percentage points during the analysed period (October 2008-October 2011). The observed gender gap in employment is mainly caused by higher inactivity of women, which is above men's by 16.7 percentage points. Unemployment is also higher among women than among men, but to a far lesser extent – gender unemployment gap stood at an average of 2.5 percentage points during the period of analysis. Between October 2008 and October 2011, all the main labour market indicators worsened for both men and women. However, the worsening of employment and unemployment rates was less pronounced for women than for men, which led to reductions in gender employment and unemployment gaps. The worsening of all labour market indicators in Serbia is a reflection of the strong impact of the global economic crisis on the Serbian labour market. However, female employment, although at lower levels, was more resistant to the crisis. This is because women in Serbia are more often employed in the public sector, which did not adapt to the crisis by cutting down employment to the same extent as the private sector. Furthermore, the fact that women who work are on average better educated and more skilled than men who work may have contributed to this trend, because low-skilled workers are more likely to lose jobs during the crisis than high-skilled ones¹¹.

⁹ "Official gazette of RS" 24/2005, 61/2005, 54/2009, 32/2013 i 75/2014

¹⁰ The current situation of gender equality in Serbia – Country Profile - study that was financed by, and prepared for the use of the European Commission, Directorate-General Justice, Unit D2 "Gender Equality" in the framework of the service contract managed by Roland Berger Strategy Consultants GmbH in partnership with ergo Unternehmenskommunikation GmbH & Co. KG.

¹¹ study of FREN – Foundation for the Advancement of Economics published in Belgrade "Gender Pay Gap in the Western Balkan Countries: Evidence From Serbia, Montenegro and Macedonia"

Lower employment ratio of women is one of the causes of the fact that the unadjusted wage gap in Serbia is 3.3%¹² which is one of the smallest gap in Europe, but this statistic needs to be looked at more closely in order to understand it in full. At the lowest part of the distribution (lowest 20% of the wages) female wages are on average even 1.6% higher than male wage. The gap grows to 5.6% and 5.5% in the 2nd and 3rd quintile (40% and 60% of the wages height) of the wage distribution. The gap then starts dropping again and becomes statistically insignificant at the top of the wage distribution.

4.2.2 Economy and Livelihoods

National Level Overview

Serbia is considered to be an emerging market economy. Serbian nominal GDP in 2015 was officially estimated at \$36.56 billion or \$5,102 per capita.¹³ The economy is dominated by services, like trade and tourism, which accounts for 60.3% of GDP, followed by industry with 31.8% of GDP, and agriculture at 7.9% of GDP.¹⁴ The official currency of Serbia is Serbian dinar, and the central bank is National Bank of Serbia. The Belgrade Stock Exchange is the only stock exchange in the country.

The economy has been affected by the global economic crisis. After eight years of economic growth (average of 4.45% per year - but following strong economy recession during the 1990's), Serbia again entered the economic depression in 2009 with negative growth of -3%, and in 2012 with -1.5%. The public debt has doubled in 5 years, from 2009 to 2014: from pre-crisis level of 29.2% to 63.8% of GDP.¹⁵ In recent years it is showing some signs of recovery.

Livelihoods in the Study Municipalities

The Table below shows consistent results to those that were already shown in different statistical information. Around one third of all households depend on retirement pensions for livelihood (31% in Merošina and 35% in Prokuplje). As average pension keeps falling behind the average pay in Serbia (52.2% in 2015 compared to 66.6% in 2002), that the average monthly pension is around 200 EUR (this is a country average - we can consider that this average is much lower for study municipalities, more so as the average agricultural pension is by far the lowest).

The data shown on the left reveals a surprisingly low percentage of families living out of agriculture. But this data is misleading. As a rule most of agricultural households have mixed sources of income - from agriculture but also from other sources - income from paid non-agricultural work, pensions etc. Further study will

¹² Ibid.

¹³ "Report for Selected Countries and Subjects". International Monetary Fund. Retrieved 10/10/2016

¹⁴ Source: <https://www.cia.gov/library/publications/the-world-factbook/geos/ri.html> last accessed on 10/10/2016

¹⁵ Source: <http://www.mfin.gov.rs/pages/article.php?id=7161> last accessed on 10/10/2016

show economic structure and indicators in the study municipalities for further comparison.

Table 58. Household income in Merošina and Prokuplje¹⁶

Household livelihoods key income	Total
Merošina	
Total households	4046
Agricultural based income	147
Non-agricultural based income	476
Retirement pension	1260
Social help	120
Other income	169
Mixed income	1788
No income	86
Prokuplje	
Total households	15119
Agricultural based income	239
Non-agricultural based income	3767
Retirement pension	5283
Social help	546
Other income	692
Mixed income	4235
No income	357

In Merošina municipality 30.12% of all economically active population is reported to live from activities related to the agriculture, compared to 9.3% in Prokuplje. In Prokuplje, 20% of all population are employed in industry (see: <https://www.leoni.com/en/company/locations/>), and near 19% in Merošina.

Nearly 8.5% of Merošina active population are employed in commerce, compared to 12.88% in Prokuplje, but only 1,69% (Merošina) and 2.02% (Prokuplje) are working in services related to tourism¹⁷. Construction related activities employ 6.5% in Merošina, and 3% in Prokuplje.

Compared to these economically related activities, state and municipality administration employs 8,75% of all employed persons in Merošina, and significant 17,13% in Prokuplje, 3,9% working population works in schools in Merošina (three times more women than men), and 7,71% in Prokuplje. In Merošina 4,45% works in health and social care institutions (five times more women than men) and 10,92% in Prokuplje.

Economy in the Study Municipalities

Economies of Municipality Prokuplje and Merošina encounters similar problems in economic development that are typical for all regions in Serbia, including less developed road, water management, and utility infrastructures, poor use of land in agriculture, poor use of natural resources, water, forest and other, as well as

¹⁶ Source - National statistical office of Serbia - <http://webzrzs.stat.gov.rs/WebSite/Default.aspx>, 2011
National census

¹⁷ This includes restaurants, local bars etc.

uncontrolled industrialization, economic problems inherited from the previous period, emigration of younger, working-age population to the major economic centres in Serbia, and abroad.

In the municipality of Prokuplje, there are close to 200 small and Moderate enterprises (number of enterprises continuously changes, but for last ten years it varies around this number). Nearly 8.5% of Merošina active population and 12,88% in Prokuplje are employed in commerce. Usually, these are retail businesses and smaller shops satisfying local needs for general goods. One third of all small businesses in Prokuplje and Merošina are active in the field of commerce. There are only four large companies in the municipality of Prokuplje, and none in the municipality of Merošina (this does not include public utility companies). Most of them are engaged in commerce (32.99%), small-scale industrial production (25.77%), and only a small fraction (7.22%) in agricultural production despite the fact that agriculture is the single most important economic sector in both municipalities. In providing tourist services (including restaurants and bars) deal only 2.06% of all company. The situation is very similar in the municipality of Merošina.

At the same time, in the municipality of Prokuplje operates around 1,000 shops, more than 55% are working in commerce activities, around 10% are restaurants and bars, 7% are providing personal services, only about 6% are in craftsmanship and 9% in t Therefore, there are only several larger industry companies still operating: Hissar (after 2006. operates within a large company group "PIONIR", production of chocolate and confectionery products, fruit and vegetables processing and natural fruit juice production - employs 158); Milan Toplica (production of mineral water and non-alcoholic beverages, based on river Toplica in the village of Tulare), Prokupac (renowned production of alcoholic beverages, fruit brandy, 70 employees), two construction material production etc.

A single most important industry enterprise in Prokuplje is a company LEONI Wiring Systems Southeast d.o.o, founded in 2009 by foreign investment of a German mother company LEONI AG, a renowned global wiring systems and cable technology production. LEONI Wiring Systems Prokuplje employs 2000 workers, out of which 85% are from Prokuplje municipality, making LEONI a largest employer in the municipality of Prokuplje by far. Their influence on population and families' livelihood is major. If we compare 2000 employed by this company to other data in social baseline, we will notice that around 5% of all population or nearly 11% of all active Prokuplje population are employed by Leoni. The influence of LEONI d.o.o. seems to be even more significant to study municipalities, but also to the entire region, as LEONI has two more factories in the region - one in Niš and another in village of Malošište, municipality of Doljevac. LEONI d.o.o. is planning expansion of production capacities and employment of additional 500 people in 2017. Leoni, Prokuplje produces goods for known buyers in automotive and commercial vehicles industry and for the healthcare sector, communications and infrastructure, household and electrical appliances, wires and strand. All production of LEONI is exported to foreign purchasers provided by the mother company and transported by Niš-Belgrade Highway to Hungary, Croatia and further.

4.2.3 Land use and property

Land use in Merošina and Prokuplje

Serbia is located on a total area of 8,840,000 hectares. Agricultural land covers 5,734,000 hectares (0.56 ha per capita), of which 4,867,000 hectares of this surface area is arable land (0.46 ha per capita). About 70 percent of Serbia's territory is agricultural land, while 30 percent is covered by forests¹⁸. The total area of utilized agricultural land on the territory of the Republic of Serbia amounts to 3,355,859 ha (37% of total area). Average family farm uses 4.5 ha of agricultural land, has one two-axle tractor and grown: one head of cattle, four pigs, three sheep, 26 cattle throat and one bee colony. However, most of them are farms that use less than 2 ha of agricultural land¹⁹. In the total agricultural area in 2011, fields and gardens account for 64.6%, orchards 4.7%, vineyards from 1.1% meadows and 12.2% pastures 16.6%. In the structure of sown arable land and garden cereals accounted for 58.0%, industrial crops with 13.0%, vegetable crops with 8.3%, forage crops 13.8%.

There has been an on-going trend in Serbia of transforming agricultural to construction land for building industrial, logistic, commercial or similar complex, mostly closer to large urban settlements like Belgrade, Novi Sad and Niš, but also some smaller cities.

The municipality of Prokuplje covers an area of 75,896 ha. Agricultural land occupies 45,083 ha, or 60%, forest 26,895 ha or 35% and arid land 3,918 ha or 5% of surface area. Construction land covers around 15% of municipality area. Used arable land amounts to 81.6% of all agricultural land which is considerably higher than the average on the national level. The arable land area is divided into 210,000 plots, which means that 1 ha of arable land is divided into 4.3 parcels. Such fragmented landholdings endanger the exploitation of the land and its environmental protection²⁰. The used agricultural land area is 98% privately owned, while the rest is owned by the state, unlike forest lands that are usually state owned. Private properties are managed by 16,585 agricultural households, so one household uses about 2.8 ha of land, which is significantly below the national level average, but consistent to the regional (largest agricultural land masses are in Vojvodina, Šumadija and around Belgrade which significantly influences the national average). Land at its quality value ranges from the first to the eighth class. On cultivated land areas 89% amounts to farming crops (cereal cultures), only 4.6% on vegetable farming, 9% to orchards (two times more than national level average) and 2% for vineyards. Pastures occupy 24.8% of total agricultural land.

The municipality of Merošina covers a total area of 19,325 hectares, out of which 13,841 ha or 71.6% is considered to be arable land, forests cover 3,310 ha or 17.1%, construction land covers 2,059 ha or 10.7%. The agricultural land on the territory of Merošina municipality occupies 14,700 ha out of which 10,800 ha is being cultivated, or around 71%. Farming crops occupy 7,079 ha or 65.5%,

¹⁸ Source: web site of the Government of Serbia: <http://www.arhiva.srbija.gov.rs/cms/view.php?id=1024>

¹⁹ Source: Statistical yearbook for 2012 published by National Statistical office

²⁰ Source: Regional spatial plan for Nišavski, Toplički and Pirotski district, 2011.

vegetable cultures occupy 1,318 ha or 12.2% (i.e. beans, potatoes), and under forage crops (clover and alfalfa) occupies additional 1,251 ha or 11.5% of arable land. Orchards occupy 1,469 ha or 13.6% and the most important fruit crop is certainly the "Oblačinska" sour cherry. Vineyards occupy 445 ha or 4.1% and are mainly located in warm and semi hot exposures which favours production of high quality grapes. The share of meadows and pastures in relation to the total agricultural area is 1,904 ha or 12.9% of agricultural land. Pasture parcels are fragmented and scattered throughout the territory. The biggest meadow and pasture complexes are spread over the higher parts of the cadastral municipalities that stretch along the slopes of the mountain Mali Jastrebac and along alluvial plains of river. Agricultural land is 99% privately owned, cultivated by 3441 agricultural households and only 6 companies, which means that an average household cultivates 2,6 ha of land.

Future highway route passes predominantly over arable land, from which orchards and vineyards make approximately 7%, and other arable land 61%. Furthermore, meadows cover 3%, forests 3%, settlements and possible settlements approximately 2%, and unused land approximately 24% (mostly uncultivated arable land, smaller parts are orchards) of route length.

Based on the preliminary design and geodetic survey conducted, complemented by field verification and confirmation from the cadastre, the Project execution will require permanent acquisition of land by using eminent domain power and expropriation in a total area of approximately 398.4ha of different types of land, represented in 3440 land parcels and 72 physical structures in both municipalities Merošina and Prokuplje as the direct area of influence. The land record in Serbia is kept by cadastral municipalities (CM) and the impacts of land acquisition are spread over 28 CM while resettlement is occurring in 14 CM. The inventory of CM per type of impact is presented in the table below.

Table 59 Overview of impacted Cadastral Municipalities due to physical relocation and impacts on non-residential structures

MUNICIPALITY MEROŠINA	MUNICIPALITY PROKUPLJE
CM Gradište	CM Nova Božurna
CM Brest	CM Djurovac
CM Merošina	CM Donja Stražava
CM Balićevac	CM Prokuplje Grad
CM Arbanasce	CM Prokuplje
CM Jug Bogdanovac	CM Gubetin
	CM Potočić
	CM Donja Konjuša

Table 60 Overview of impacted Cadastral Municipalities impacted by land acquisition

Municipality	Cadastral Municipality	Number of parcels per municipality	Total
Merošina	Balajnac	206	
Merošina	Gradište	182	
Merošina	Brest	93	
Merošina	Merošina	21	
Merošina	Balićevac	611	

Municipality	Cadastral Municipality	Number of parcels per municipality	Total
Merošina	Lepaja	4	Total I 1379
Merošina	Jug Bogdanovac	41	
Merošina	Arbanasce	221	
Prokuplje	Nova Božurna	66	Total II 2041
Prokuplje	Pojate	36	
Prokuplje	Djurovac	28	
Prokuplje	Donja Stražava	114	
Prokuplje	Prokuplje grad	78	
Prokuplje	Prokuplje	311	
Prokuplje	Bela voda	103	
Prokuplje	Djukovac	180	
Prokuplje	Gubetin	109	
Prokuplje	Potočić	176	
Prokuplje	Donja Toponica	20	
Prokuplje	Mala Plana	58	
Prokuplje	Drenovac	120	
Prokuplje	Prekadin	16	
Prokuplje	Bresničić	221	
Prokuplje	Kondželj	128	
Prokuplje	Donja Konjuša	67	
Prokuplje	Viča	71	
Prokuplje	Tulare	139	
Kuršumlija	Donje Točane	20	Total III 20
Grand Total Number of land parcels TTL1+TTL2+TTL3			3440

The alignment does not influence the most productive land which is spread mainly on the alluvial plains, river terraces and moderately steep and sunny slopes of Jastrebac Mountain away from the physical footprint of the Project. Large vineyards, either as part of the vinery itself or as fruit bearing complexes are not impacted.

The patterns of use indicate that 77% of arable land comprises plough land and gardens, 5% of land is under grain cultivation, and the remaining land is under vegetable production. This area has not been subject to the agricultural reform and process of merging small land parcels (in Serbian legislation known as "komasacija" - land consolidation). This explains the large number of small individual land parcels impacted which is not entirely commensurate with the physical footprint of the project. For example in other recent comparable infrastructure Projects the number of parcels was 30% lower for an alignment 6 times longer.

The assessment of impact in terms of the area of land needed is indicative and approximate since the exact area is dependent on the completion of the design for expropriation when the exact amount of land will be known. However, the impact shall be smaller than the one approximated in this chapter since the detailed design for expropriation will prepare the land plan schedule and identify the extent to which each parcel is needed for the Project by identifying the exact area. Notwithstanding, the mitigation measures described further in this chapter shall equally apply and cover all impacts regardless of the area of land acquired and loss of assets attached to it.

The assessment identified 72 physical structures occupying a total area of 13679 m2 to be impacted by the development. By disaggregation per actual use of structures it has been identified that 60 residential structures for dwelling, 10 ancillary structures such as barns, 10 storage houses, pig stays, outdoor WC, 1 local football stadium, 1 swimming pool are impacted.

4.2.4 Cultural heritage and archaeology

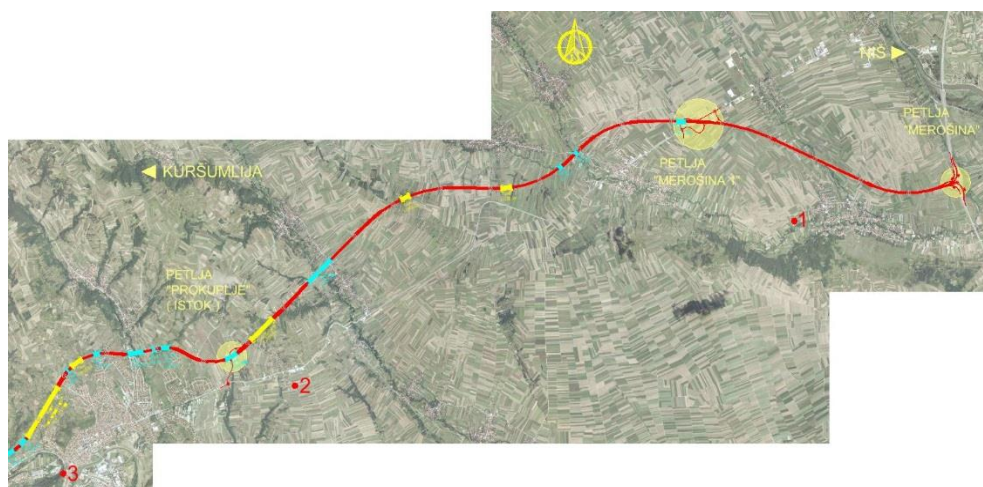
The Republic Institute for Protection of Cultural Monuments in Belgrade in cooperation with the National Museum of Toplica in Prokuplje, at the request of the Ministry of Construction, Transport and Infrastructure of the Republic of Serbia, based on the Law on Cultural Property ("Official Gazette of RS" 71/94) and the Decision on Spatial plan of special purpose infrastructure corridor highway E -80, section Niš-Merdare, prepared the report "Protection zones, protective measures and conditions of storage and use of cultural heritage and historical landscape for development of the Spatial Plan of special purpose infrastructure corridor highway E-80 Nis-Merdare" (Annexes 4 and 6). This study was based on findings in the ground and on desktop data. A field visit was carried out at the beginning of 2016.

Within the scope of the project is the identified as immovable cultural heritage archaeological site of Pločnik ("Official Gazette of SRS" no. 50/12), as well as the Viča and locality Veliki Breg prehistoric settlement characterized as "goods" under the above mentioned protection status. .

Within the corridor of the planned highway, but outside its borders, there is a number determined immovable cultural goods, and goods under protection:

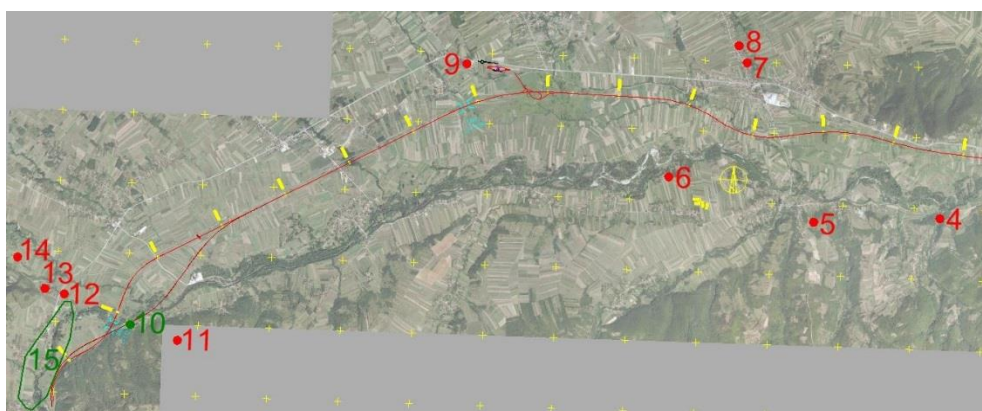
- 1 Beside the Kulina - Balajnac, identified immovable cultural heritage/archaeological site of great importance for the Republic of Serbia (Decision of the Republic Institute for Protection of Cultural Monuments no. 218/64, "Official Gazette of SRS" no. 28/83);
- 2 Nova Božurna (prehistoric jewellery storage)
- 3 Prokuplje

Figure 82 ICP beside the planned highway corridor, Nis - Prokuplje



- 4 Gubetin (modern church on the foundations of the old one)
- 5 Donja Toponica (prehistoric tumulus and medieval graveyard)
- 6 Smrdan (ancient settlement)
- 7 Mala Plana (archaeological site)
- 8 Mala Plana (modern church on the foundations of the old one)
- 9 Kondželj (Church of St. Archangel Gabriel), established immovable cultural heritage/cultural monument (Decision of the Institute for Protection of Cultural Monuments in Niš no. 1017/1 from 23.08.1976.)
- 10 Viča, locality Veliki Breg (prehistoric settlement)
- 11 Viča, fortress on the hill Duvari
- 12 Bace (Roman baths and ancient settlement) established immovable cultural heritage/archaeological site (Decision the Institute for Protection of Cultural Monuments in Niš no. 15 of 22.02.1968.)
- 13 Bace, site Lukići (church foundations)
- 14 Bace (church)
- 15 Pločnik (Vincha settlement)

Figure 83 ICP beside the planned highway corridor, Prokuplje - Pločnik



On the section from the Merošina to the confluence of Trnavska River to Toplica River (after Prokuplje bypass), the existence of remnants of older cultures indicates, the categorized archaeological site Kulina-Balajnac, located about 300m west of the village Gradište Balajnac, about 1.3 km from the highway route. It is a plateau on the dominant hill with the remnants of fortifications from the Byzantine

VI century. Archaeological excavations in 1969 partly revealed the remains of a basilica and a large tank.

Figure 84 Archaeological site Kulina-Balajnac



From the confluence of Trnavska River to Toplica River to the end of the route there is a large number of sites from all periods of human history, the scope of which is not established. Therefore the constant presence of an archaeologist during excavation work is necessary.

The Republic Institute for Protection of Cultural Monuments initially recommended an archaeological research to take place at the sites that area in the highway corridor zone, namely:

- Viča, locality Veliki Breg (prehistoric settlement) - number 10 on the map
- Pločnik (Vinča village) - 15 - partially excavated Neolithic settlement in the territory of the village Pločnik and Bace, along the left bank of the Toplica River (on an area of 120 ha along the river Toplica and Backa River). It was discovered in 1926, and since then several archaeological campaigns has carried out: in 1927, 1960 to 1978 and from 1996 to today. Many findings of the Vinča culture were discovered, as bases of houses, furnaces and hearths, pits, utility room with copper and stone tools, fragments of ceramic pots, figural sculptures. Pločnik belongs to the Late Neolithic period, i.e. the later phase of Vinča culture, in science known as Vinča-phase Pločnik. Life in the village lasted from 5400 to 4600 B.C., as determined by absolute dates C-14 method. Four leave with copper objects are the basis for the typology and chronology of the first metal includes the prehistory of the Balkans and Southeast Europe.

Figure 85 Pločnik (Vinča village)



Based on the Decision on establishing the site Pločnik near Prokuplje for archaeological site ("Off. Gazette of RS", no. 50/2012), the designer of the study defined the boundaries of the archaeological site and the boundaries of the protected area of archaeological site, and found that the highway route passes through the eastern part of the protection zone of Pločnik archaeological site. After a meeting with the Republic Institute for Protection of Cultural Monuments – Belgrade, the designer received their opinion (No. 3/1419 from 26.07.2016.), which confirmed the recommendation for archaeological research in this area, before the construction works. In this decision it is mentioned that after the research in this area is completed, and if there are no findings that must be kept in situ, the Institute approves the proposed highway route.

The designer, however, decided to change the route in this section to avoid collision with the protected zone of the archaeological sites.

In the Location conditions, the final decision of the Institute for the Protection of Cultural Monuments of Niš is that the supervision by archaeologists during earthworks is necessary on the entire route.

5 Environmental and Social Impact Assessment

5.1 Methodology

During the impact assessment phase, the ways in which the Project will interact with the physical, biological, cultural and social environments to produce impacts to resources/receptors were assessed.

5.1.1 Prediction of Magnitude

The magnitude of each impact was estimated as falling into one of the following designations: negligible, small, medium or large. The 'magnitude' encompasses various possible dimensions of the predicted impact, such as:

- extent (ie local, regional or international);
- duration (ie temporary, short-term, long-term or permanent);
- scale or size (no fixed designations);
- frequency (no fixed designations); and
- likelihood, for unplanned events only (ie unlikely, possible, likely).

Each ESIA topic area (eg noise, biodiversity, social, etc) adopted a methodology for defining the magnitude of change as appropriate to the discipline; however, the designations used were consistent. For example, for readily quantifiable impacts, such as noise, numerical values were used to define its size, whilst for other topics, eg social impacts, a more qualitative classification was necessary.

In the case of positive impacts, no magnitude was assigned.

5.1.2 Sensitivity of Resources and Receptors

The sensitivity (or vulnerability / importance) of the impacted resource or receptor was also defined using one of the followings designations: low, medium or high. As per the magnitude rating, the definition for each designation varied on a resource/receptor basis. Where the resource is physical (for example, a water body) its quality, sensitivity to change and importance (on a local, national and international scale) are considered.

Where the resource/receptor is biological or cultural (for example, the IPA area Lalinačke Slatine), its importance (for example, its local, regional, national or international importance) and its sensitivity to the specific type of impact are considered.

Where the receptor is human, the vulnerability of the individual, community or wider societal group is considered. The sensitivity definition for each resource / receptor is defined in more detail in the individual topic assessment chapters.

5.1.3 Evaluation of Significance

Once the magnitude of the impact and sensitivity of the resource/receptor has been characterised, the impact significance is assigned using the significance matrix presented in Figure 86.

Figure 86 Impact Significance Matrix

		Sensitivity/Vulnerability/Importance of Resource/Receptor		
		Low	Medium	High
Magnitude of Impact	Negligible	Negligible	Negligible	Negligible
	Small	Negligible	Minor	Moderate
	Medium	Minor	Moderate	Major
	Large	Moderate	Major	Major

Table 61 Context of Impact Significance

Significance Designation	Significance Context
Negligible	A resource/receptor (including people) will not be affected in any way by a particular activity or the predicted effect is deemed to be 'imperceptible' or is indistinguishable from natural background variations.
Minor	A resource/receptor will experience a noticeable effect, but the impact magnitude is sufficiently small (without mitigation) and/or the resource/receptor is of low sensitivity/ vulnerability/ importance. In either case, the magnitude should be in accordance with applicable standards.
Moderate	It has the magnitude of the impact within the applicable standards, but it falls somewhere below the minor impact, to a level slightly below the legal limit.
Major	An accepted limit or standard may be exceeded, or large magnitude impacts occur to highly valued/sensitive resource/receptors.
Positive	There will be a beneficial impact to a resource/receptor. (note: no magnitude is assigned for positive impacts).

5.2 Environmental Impacts during Construction

The following sub-chapters provide an assessment of the potential impacts of the project activities during the construction phase. The assessment has been done based on expert knowledge and expert judgment. Where specific approaches to identify impacts have been adopted, these are described in the sections introductions.

5.2.1 Air quality impact

Construction activities with potential to directly affect the ambient air quality by generating fugitive dust, fine particulate matter (PM_{2.5}, PM₁₀) and exhaust emissions (NO₂) from machinery are the following: (1) demolition of buildings situated along the proposed route, (2) earthworks (including land clearing, excavation, levelling, tunnelling), (3) transport and disposal of excavated and surplus filling material and storage of filling and backfill material, (4) construction plant and delivery of concrete (premix), (5) movement of construction mechanisation and transport vehicles. Also, there may be changes in concentrations of NO₂ and particulate matter due to changes in road traffic during the construction of the proposed project.

Re-suspension of dust through construction activities or the wind can cause a nuisance and affect vegetation. Dust particles are larger than PM₁₀ and deposit very rapidly. Therefore the health concern is not significant. Favorable conditions for dust generation are dry weather combined with high winds. The possible impacts may be expected along the route, near to dust sources, at a distance of up to 100 meters.

Impact of demolition works

The planned demolition of around 70 buildings in highway corridor will involve crushing works in an area where residential receptors are present in the radius of 100 m. The demolition activities will be carried out on less than 10 m above ground level is given that the houses have up to 2 stories. The houses appear to be made of brick and/or concrete. The demolition risk category of the area in respect to the presence of residential receptors is medium. The scope of demolition works is estimated to be small and with a medium dust emission. The overall demolition effect will be direct, short-term moderate adverse and will require implementation of mitigation measures.

Impact of earthworks and associated activities

Earthworks will involve excavations, levelling, drilling, blasting, material haulage, and stockpiling.

In the winter months, due to individual heating, primarily on wood and coal, the baseline PM₁₀ concentrations in the area may be expected to be close to the Serbian air quality standard with periodical exceedance. The magnitude of air emissions during earthworks is considered to be low. The impact will be temporary with significance assessed as minor adverse.

Settlements Merošina and Prokuplje will be affected by air pollution, so that negative impacts of emissions from the exhaust system of construction machinery and dust during construction can be expected.

Substantial quantities of hydrocarbons are emitted into the atmosphere as a result making pavement based asphalt mixes. Emissions from the pavement surface completely reduced after one year. For projects such as the respective section of the highway E-80 during the first day of paving will be broadcast around 0,145 kg/m² pollutants (primarily organic compounds, especially hydrocarbons) and after

a few months of emissions will be reduced to 0,027 kg/m². The impact is short-term and temporary, and it's estimated as negligible.

5.2.2 Soil impact

Road construction period is characterized by transport of great amounts of construction material and with the opening of borrow pits or new landfills. Second important factor in this phase is unavoidable requirement to cut topsoil horizons from large areas. During road construction, heavy machinery movement could lead to soil compaction which changes soil water and physical characteristics, first of all, water permeability, the ratio of micro and macro pores, soil structure, etc.

Impact on agricultural land during highway construction

Highway construction includes activities that affect agricultural land. Impacts are mostly expressed in zone of highway construction, where construction works are carried out. They have temporary character, bring to an end with final works and are assessed as negligible adverse.

The first problem is the physical loss of land through expropriation, as well as removal of topsoil and its permanent loss. The permanent loss is limited within the narrow area of the expropriation zone and is considered as a minor impact to soil.

Large amounts of construction material will be transported during highway construction. New borrow pits and landfills may be opened. These activities can cause land degradation or permanent soil loss. Land degradation due to landfills and borrow pits formation, and the excavation of construction material cannot be quantified during this phase of project documentation development, since their locations and volumes were not determined.

Soil pollution and degradation during highway construction can be caused by improper handling of oil and its derivatives that are used for machinery. Pollution can also be caused by vehicles and machinery washing outside planned locations, inadequately regulated construction sites, and other activities that are not carried out under recommendations of technical measures of protection during construction works. Without mitigation, the magnitude of this impact can be considered as small, while sensitivity of the receptor is assessed as medium, therefore, significance of the impact can be considered as minor.

Soil degradation

The most important land degradation types that occur during construction and operation of highways are landslides and escarpments, soil water erosion, changes in soil water permeability and deterioration of soil characteristics in a wider zone.

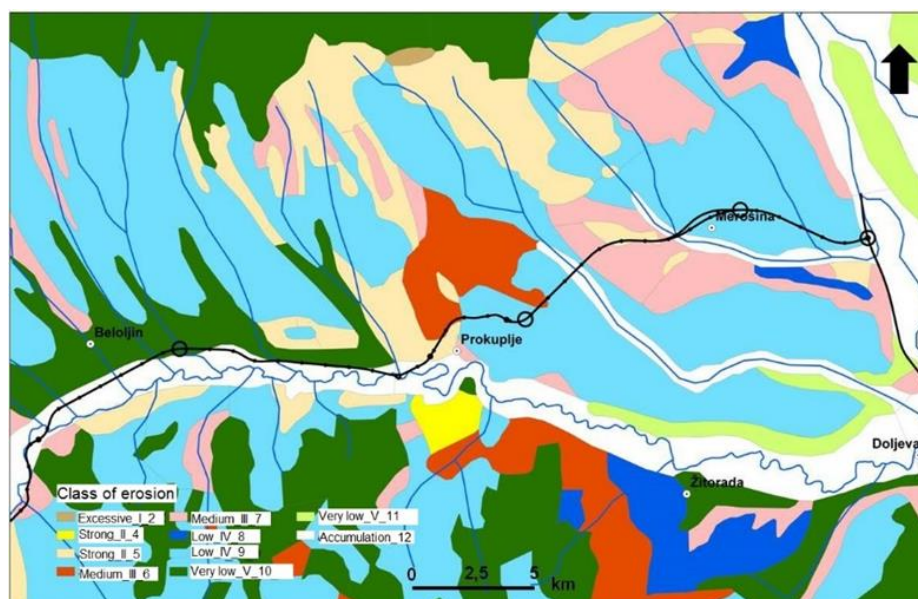
Engineering-geological research indicated that stable and conditionally stable terrain dominates within highway route. In this phase, it is not possible to perform a detailed quantification regarding negative environmental impact. Geological and hydrogeological characteristics, as well as planned earth works on specific positions could create conditions for the appearance of road subsidence, which can in certain circumstances affect the soil water permeability. However,

regardless the possible soil subsidence, and regarding local hydrogeological characteristics and consolidation time span, negative effects are considered as negligible.

Intensity of erosion processes in a study area

Soil degradation by erosion can be increased by deforestation and loss of natural vegetation, overgrazing, inadequate agricultural management without application of conservative measures, excessive vegetation use for domestic purposes and bio-industrial activity. Soil erosion is defined by forms of erosion, erosion intensity, and surface area affected. The most common are, above all, water and wind erosion. Data on erosion within the study area were obtained from soil erosion map of Serbia, scale 1:500,000 (Lazarević, 1983). Erosion assessment was carried out by potential erosion Model (EPM), widely used in Serbia. E80 highway route passes over lowlands and the wavy (hilly) landscape, rarely steep. The initial part of the section from Highway loop Niš up to Krajковаčka River is characterized with IV-8 erosion category, described as weak erosion, with erosion coefficient Z in the range 0.31-0.40. The amount of deposits for this erosion category is 400-800 m³/km²/year. This is the area of vertisol soil type. Highway route afterward passes over the bridge on Krajковаčka River, which presents an area of material accumulation. From the Krajковаčka River to Jugbogdanovačka River, terrain is characterised with moderate erosion category, III-6, with Z ranging from 0.56-0.70 and less often with strong erosion, category II-5, with Z ranging from 0.71-0.85. This is an area of vertisols and eutric cambisols. From the Jugbogdanovačka River to Prokuplje, highway route is passing through the area of weak, moderate and, less often, strong erosion category. All parts of terrain with greater slopes on the highway route are planned to be regulated with bridges or tunnels. Part of route north and west from Prokuplje passes over area highly affected by erosion, II-5 category. Hence, in this area, there is a plan to construct tunnel "Računkovo hill". The lower terrain around Toplica River on the section from Prokuplje, all the way to Pločnik are characterised among all with an accumulation of deposits. Hence, the category of endangerment of soil by erosion at highway route ranges from the weakest up to highly endangered. Provided data should be treated with reserve due to large map scale and age of the map.

Figure 87 Class of erosion



Surface erosion is present in the entire watershed of Toplica River with various intensities. High surface erosion intensity is present in the upper parts of watershed near the source of Toplica River. Landslides occur in a small scale. Lower parts of corridor route along Toplica River present sediment deposition basin. This is the area from 23-40 km of route, which is about 43% of highway length. Other parts of E80 highway passes through the mild wavy relief. Slopes higher than 10% are mainly solved with infrastructure objects such as tunnels and bridges. Erosion coefficient ranges from 0.31-0.40 (IV – 8 category, weak erosion) on almost 17-18 km length of highway. The highway passes over terrain with moderate erosion (category III-6, $Z=0.56-0.70$) and rarely high erosion (category II-5, Z from 0.71-0.85) on remaining 5-6 km of route length. Attention should be paid on 10-13 km of the route where the highway passes over terrain characterized with colluvial processes. In the zone before Prokuplje bypass and in the bypass zone, the impact on soil erosion is considered moderate. In all other zones it is considered as minor.

5.2.3 Surface and groundwater impact

The risk for contamination of surface and groundwater represent the:

- Construction work (deep excavation, demolition, and removal of the natural cover layer, etc.). By removing the top layer and the creation of new catchment areas blurred or otherwise contaminated water quickly drains underground. In cases of possible turbidity of surface waters in the inundation zone, which represents the most likely to impact phenomena, this phenomenon is not permanent and after termination of works is being reduced and will eventually disappear completely. During the works, there will be some turbidity especially of the Toplica, Trnavska, Draguška and Backa Rivers, and by erosion during the construction of the foundations and pillars of the new bridges. There are no pillars inside the river flows and several among them are seasonal watercourses (see chapter 4.1.6). Impact on surface waters from blurring is short-term, and sensitivity of rivers and streams is medium (all are

Toplica tributaries, and crossing is at least 80 m from confluence).
Significance of impact is considered minor.

The intensity of the impact of contamination of waters depends on the amount of rainfall that will occur during this period and surface site from which these substances are washed. This impact can occur from:

- Construction machinery – the potential danger of spillages or accidental releases of oil and petroleum products, discharge of motor oil or similar waste.
- Uncontrolled disposal of excavated material.
- Uncontrolled drainage of the sanitary waters in places of accommodation of workers, as well as smaller (local) pollution from the process of food preparation.

This impact is possible, but temporary and with small magnitude, and its significance is considered as negligible.

The impact on the Milan Toplica mineral water factory pipeline during the construction of bridge pillars without the implementation of protection measures could be moderate.

5.2.4 Impact on ecology and nature conservation

The assessment of impacts was based on the sensitivity of the affected resource/receptor and the magnitude of the potential impact/risk, prior to the implementation of any mitigation measure. The impacts assessed are the ones that could not be avoided or mitigated further through route refinement and which require complementary mitigation measures. It should be clarified that the route refinement is an on-going process based on available constraints and data. The presented base case route, in the current ESIA, will be further refined and finalized in the next stages of the project.

Negative impact on biodiversity during the construction of the road will be manifested primarily due to the preparation of the working area (topsoil removal, earthworks, opening quarries, vegetation clearance); movement of vehicles, possible upgrade of existing roads for access, backfilling and reinstatement of temporarily disturbed land from construction, river crossings, exploitation of construction materials, waste disposal, accidental spills of hazardous and other pollutants, energy consumption, etc.

The impact on flora in the construction phase

In the construction phase in relation to the flora and vegetation the expected direct impact is the disruption of natural and semi-natural habitats. Disruption of natural and semi-natural habitats leads to the possible loss of some habitat area and the development of different types of habitats.

Another possible negative impact of the proposed highway to the flora is the possibility of the establishment and spread of alien and invasive flora species due

to either increased traffic or also introduction for reinstatement and restoration purposes.

The impact on vegetation and habitats in the construction phase

Impacts during Construction works on the section of the highway E-80 from Nis to Pločnik, which can have consequences on the vegetation and different habitats of the area, could be:

- Loss and fragmentation of natural and semi-natural habitats due to various works such as soil removal, preparation of corridor, excavations, possible mining and drilling on the route of the highway;
- Loss and degradation of habitats due to the removing of pedological layer, as well as the possible consequent increased water runoff and erosion processes on the steep slopes,;
- Decreased resistance of plants and the extinction of certain species (dry forest) due to the crosscutting of natural watercourses and drainage fields with increased levels of water and different hydro-technical objects as part of road;
- Dust and harmful gasses created during the construction works of the highway, with a negative impact on flora and fauna;
- Careless handling of equipment, any spillage of oil and fuel from construction machinery, as well as their passing outside trails designated for passage, could lead to the degradation, and destruction of habitat and individual plants.

The magnitude of the impact on habitat loss, degradation before any mitigation is expected to be moderate/minor. The predominant vegetation along the route of the highway and the corridor around is pure agro ecosystems and semi-natural ecosystems and not natural ones and there are no flora species of conservation interest, or natural habitats of conservation interest. In addition the natural vegetation in the area, already consists of fragments of their original extent.

Nevertheless, the following locations refers to river regulation locations and to crossings over watercourses which imposes river regulations therefore should be carefully treated during the execution of works:

- Bridge over Aleksandrovački Stream, km 2+988
- Krajковаčka River regulation, km 8+105
- Lepajski Stream regulation, km 8+514
- Pipe culvert, km 10+538
- Jugbogdanovačka River regulation, km 14+062
- Suvi Stream regulation, km 14+235
- Ciganski Stream regulation, km 17+785
- Stržavska River regulation, km 18+433
- Riverbed regulation, km 22+700
- Junction Prokuplje West, the maintenance and control base, km 23+600
- Drenovački Stream regulation, km 29+019
- Zdravinjska River regulation, km 30+108
- Zdravinjska River regulation, km 31+791
- Bridge, km 34+928
- Suvodolski Stream regulation, 37+533

- Bridge in km 38+278
- Toplica River regulation, km 38+550

Impacts on terrestrial fauna in the construction phase

For the analysis of potential impacts of certain activities and actions during the construction of roads to the mammal fauna, the potential impact of individual factors (compromising) that can be expected for this type of intervention in nature, are grouped into three groups. These groups of factors are defined as:

- Modification of the normal regime of the areas by changing the physical characteristics of the space: the removal of land cover, changes of the hydrological regime of watercourses, concreting, increased noise and vibration. The effects on fauna are the physical destruction of the habitat of species in the direct intervention of the highway.
- Transformation of land and temporary disturbance by the construction and preparation of the terrain: this group of works includes construction works on the access roads, auxiliary facilities for workers, construction machinery and material storage. These activities will degrade or lead to habitat loss and fragmentation.
- Pollution: waste-disposal dumps and landfills, chemical pollution or air pollution. The main impact of these activities, will be contamination of aquatic habitats. Air pollution is an almost negligible impact, but due to increased noise and the presence of humans most animals will, at least temporarily leave the area.

Impacts on mammal fauna

The overall impact of the proposed highway to the mammal fauna of the area is expected to be minor. There might be a noticeable effect on the species during construction and operation but the species in question are of low sensitivity and vulnerability and the impact magnitude is expected to be sufficiently small (with or even without mitigation).

Impacts on bird fauna

The anticipated impacts on bird fauna during construction stem from the physical destruction of the species habitats in the direct intervention of the highway, especially wetlands and river banks and also all types of vegetation.

- Fragmentation and possible loss of bird habitats during the construction phase of the highway
- Disruption of activities due to the increased noise level along the highway during both the construction phase and the post-construction period.
- A potential breeding failure if road construction activities are implemented during the breeding period is. This can be translated as hatching failure, due to scaring of the parents or failure of proper fledging and training of nestlings. In some cases abandonment of the territory could also be caused.
- The removal of vegetation, especially individual trees and forest fragments, is a significant endangering factor, especially for colonial species like Herons.

Most of the species identified as being affected by the project are common and as most of the route crosses agriculture land and agro-systems there are no nesting birds of conservation importance. The dense populations of hunting bird species, such as the Grey Partridge and the Common Quail are a natural resource that should be considered. Consequently and assuming that no mitigation measures are applied or embedded into the design of the project, the significance of the impact should be assessed as being minor.

Impacts on herpetofauna

During the construction period, direct mortality of reptile and amphibian populations is expected to occur during excavations and clearing of vegetation. Increased vehicular traffic is also expected to cause a rise in losses of tortoises and snakes due to collisions. Snakes are often persecuted, but usually not to an extent that will cause a conservation problem.

All of the species present in the highway area are dispersed in a larger scale; therefore the magnitude of the species likely to be affected is low. They are also common species nationwide, protected species included, thus any construction work will not have a negative impact on their populations nor on other species recorded in that area.

Assuming that no mitigation measures are applied or embedded into the design of the project, the significance of the impact on reptiles and amphibians should be assessed as being negligible.

Impacts on ichthyofauna

Regarding impact on water quality, this will be minor especially as the watercourses along the highway route are already subject to pollution from urban waste water which is discharged untreated into the river, as well as from pesticides and fertilizers run-off from the surrounding agricultural lands.

Possible additional impacts to the ichthyofauna caused by the construction of the road can be expected through the following phenomena:

- Temporary diversion of river beds during construction.
- Destruction/removal of riparian/alluvial vegetation;
- Temporarily increased blurring of the surface waters during the execution of hydraulic works;
- The inappropriate disposal of excavated material along the route of the highway;
- The inappropriate disposal of waste, including the packaging of building materials and equipments (bags, nylon, plastic and metal cans and other containers, glass bottles, pallets, polystyrene, etc.) and sanitary waste;
- Accidental spills of toxic and hazardous materials during the construction.
- The building of bridges and the subsequent regulation of rivers and other watercourses will have negligible to minor impact on fish population and their habitats. The planned construction works will be spatial and time limited, restricted to relatively small parts of fish habitats and cannot disturb present fish population. The main permanent watercourses that will be somehow

affected by the project are: Krajčovačka river (km 8+105) (bridge L=70m and river regulation in area of bridge), Jugbogdanovačka river (km 14+062) (viaduct L= 500m), Dragučka river (km 34+928) (bridge L=35 m) and Toplica river (km 38+550) (bridge L=140 m). The remaining watercourse crossings on the highway route are temporary ones and remain dry most of the year, except in cases of heavy rains and snow melting. The application of guidelines given by Institute for Nature Conservation of Serbia will further minimize impacts of highway construction on water habitats and fish population.

Spawning and seasonal migration will not be affected by the Project because the planned works are spatial and time restricted. In any case the Project construction and the Project must follow guidelines given by Srbijavode (water protection) and Institute for nature Conservation (nature, ecosystems and species protection).

5.2.5 Excavated material and waste impacts

Assessment of excavated material and waste quantity

Demolition waste

Demolition waste will result from the necessary demolition of buildings (about 70). It will comprise utilities, residential property, industrial and commercial property and may include non-contaminated soil, rubble, bricks, cement, timber, pallets, scrap metals, plastics, glues, and wires..

Excavated material

Table 62 Distribution of excavated material

	I Section	II Section	III Section	IV Section	V Section	Total
	0+000-5+500	5+500-14+280	14+280-27+096	27+096-32+650	32+650-39+419	0+000-39+419
Length	5.5	8.78	12.816	5.554	6.769	39.419
Fill	175,695	874,201	724,927	775,398	1,219,344	3,769,565
Cut	21,049	1,059,824	1,050,412	0	30,362	2,161,647
Transport at the site	21,049	776,034	273,135		30,362	1,100,580
Transport up to 1km			1,360			1,360
Transport up to 3km			26,612			26,612
Transport up to 5km			423,820			423,820
Transport up to 8km		98,167				98,167
Transport from the borrow pit	37,119			775,398	1,188,982	2,001,499
Transport from the neighboring section	117,527					117,527
Transport into the embankment of the neighboring sections		117,527				117,527
Transport to the landfill		68,096	325,485			393,581

The mass distribution diagram shows that 21 049 m³ will be dug in the first section, and that this quantity of material will be installed on the same section. 37 119 m³ will be taken from the borrow pit up to 10km away. The required amount of embankments for the first section is 175 695 m³, so that the remaining 117 527 m³ will be taken from the neighboring section II.

Section II requires for embankment 874 201 m³, and from the excavation we have 1 059 824 m³. It is planned that 776 034 m³ will be used in place, 98,167 m³ will be transported up to 8km away, 117 527 m³ will be transported to section I, and 68 096 m³ to the landfill up to 10km away.

On Section III the product of the excavation is 1050412 m³, and for the embankment it is necessary 724 927 m³. It is envisaged that the excavated material will be used in the embankment, and that 325 485 m³ will be transported to a landfill up to 10 km away.

As Section IV is fully on embankment, it will be necessary to obtain 775 398 m³ from the borrow pit up to 10 km away.

For the embankment in section V 1 219 344 m³ is required. Excavation has 30 362 m³ and this material will be installed in place, and the remaining quantity of 1 188 982 m³ will be transported from the borrow pit up to 10 km away.

Construction work site waste

Construction work site waste will primarily comprise general worker waste and will be similar to household waste (food, packaging, office waste, sanitary waste). The average daily generation of household waste in Serbia is 0.87 kg/person and based on that the waste generation per worker per month (based on an average working week of five days) is estimated to be around 17.4 kg/worker.

Assessment of excavated material and waste impact

The proposed construction works will generate a significant volume of non-hazardous and inert waste whose inadequate management could result in the major adverse environmental impact. If all proposed waste management measures are implemented, the potential adverse effects will be reduced to a low magnitude resulting in impacts of a minor adverse significance.

5.2.6 Landscape and visual impact

The impact on the landscape characteristics in the construction period should be taken into consideration, especially as the landscape itself will change its identity. Along the planned corridor, the rural natural landscape is dominated by the influence of anthropogenic activities, so the construction of the highway will affect the landscape, to a lesser extent.

Construction phase includes construction activity during which the temporary facilities set up, therefore, the landscape will be temporarily changed. In addition to the landscape along the corridor, a large impact on the landscape have areas that are located in the immediate surroundings. While setting up a construction site,

construction area will, although temporarily, lose its values in the form of floral cover, quality characteristics of the soil, as well as the character of the landscape.

Modification of the landscape will affect the areas where will be built bridges, loops, viaducts and tunnels. Also, the environment used during construction will be temporarily modified due to the disposal of materials and machines, as well as borrow pits, which affects the landscape.

Degradation of the landscape is reflected primarily in the construction work, which adversely affects the landscape, through the creation of the site and its accompanying elements such as containers, camps for construction workers, machines, which have a significant impact on the landscape changing its character and aesthetic value, and adverse impacts that are inevitable during construction, such as:

- changes in land use from agricultural to building
- partially endangering visual aspects, change of colours

Temporary impacts could damage the landscape, disrupting the identity of the area (the image of the landscape and visual continuity).

The impacts above can be mitigated if when organizing the site and setting up facilities ensures that these facilities are concentrated mainly in places where planned bridges, viaducts and tunnels along the route are.

Degradation as the impact of construction work is temporary. After completion of the work, the obligation of the contractor is to bring the site to the state before the work started, except of the loop Prokuplje (West), where is the planned base for maintenance for the motorway during operation.

The impact on the landscape is temporary, with medium magnitude. Sensitivity of the receptor is assessed as low, since it is mostly anthropologically disturbed landscape. Therefore, the significance of impact is consider minor.

5.3 Social Impacts during Construction

Social impacts during construction are explored in more depth in Annex 1: SIA. Herebelow an outline of the main topics covered in Annex 1: SIA is presented.

5.3.1 Summary of key social impacts

Community perception and support

The communities in the pre-construction phase have shown very little ambivalence, and are in general pro project oriented. There is large community support and expectations of the upcoming activities. Even investments are made in this early stage to capture the momentum to benefit from opportunities to arise during the construction period.

During the pre-construction phase of the project, there will be no direct impacts on the provision of services such as water supply, sewage system, electrical energy and telecommunications. These services will be provided as per standards identified in the baseline conditions

Land acquisition and resettlement

The major social impact from development of the Project is identified as loss of :

Land;

- Physical Residential Structures;
- Physical Commercial structures;
- Ancillary structures and utility connections;
- Attachments to the land (crops, trees, vineyards and other tangibles)
- Livelihoods.

Based on the preliminary design and geodetic survey conducted, complemented by field verification and confirmation from the cadastre, the Project execution will require permanent acquisition of land by using eminent domain power and expropriation in the total are of approximately 398.4 ha of different types of land, represented in 3440 land parcels and 72 physical structures in both municipalities Merošina and Prokuplje as the direct area of influence. The land record in Serbia is kept by cadastral municipalities (CM) and the impacts of land acquisition are spread over 28 CM whilst resettlement is occurring in 14 CM.\

Temporary worker influx and population change

The influx of workers and subsequently followers is not expected to be large and is not expected to have adverse social impacts on the two local communities. Many of the impacts associated with influx are broadly identified but will become fully known once a Contractor has been appointed and decides on sourcing the necessary labour force.

Gender differentiated impact

The general impact as identified through the gender lens is the disruption of the women's travel patterns, typically influenced by the multiple tasks they are committed to for their household and the households of their parents and/or in-laws. Therefore, mitigation measures should be designed to allow unhindered and timely performance of their activities. This includes traveling for work, childcare, school drop-off, and visits to health facilities both in Prokuplje, Merošina and Nis and daily shopping. Women have daily mobility patterns that are more complex than men, owing to their gender roles, which combine domestic and care giving tasks with paid employment, income-earning activities, and community and social obligations. It has been identified that women are primary family caregivers.

Education and Skill

It is expected that there will be greater opportunities for on-the-job training and learning for the workforce on civil works during the construction of the Project. But in general, given the short timeframe for the construction phase there will be limited possibility for unskilled workers to develop other, new skills on the job.

Employment and Economy

The construction activities of the Project are likely to give the opportunity for new employment. However the announced new employment opportunities, and creation of 500 new positions, from one of the local business (Leoni Wiring system), already employing 2000 persons (11 % of the universe of unemployed in the impact area) might limit the positive impact on employment under this Project. Since the local business, with a sustainable orientation, employs in most of the cases under open-ended contracts, people already qualified or qualifying for this particular employment might hesitate in accepting employment for the construction works of the Project. The majority of new created jobs will be Project dependent. It is likely that, backstopping staff and skilled, semi-skilled and unskilled labour workers will be in demand. Practice shows that not all will be part of the contractors team initially (key staff excluded) but will be employed amongst the local population. The temporary employment opportunities will be mostly at the local level.

Infrastructure

Concerns regarding disruption to transportation routes were raised mainly in Merošina and communities where people rely heavily on poor quality roads for livelihood and access to services (e.g. emergencies, selling of produce, daily migration.). This makes it important for traffic of civilians but also for emergency transport of patients from Merošina and Prokuplje to the Clinical Centre in Niš. The traffic management plan during construction will have to take into account alternative for the 5 km section, to allow unhindered traffic flow during all times of the day, reduce traffic speed, limiting the working hours of works that could pose substantial impact on road users and the public, minimizing disruption during peak traffic periods, public holiday weekends and school holidays by limiting the extent of traffic management undertaken during these times, maintaining public access to affected properties.

Access to health services

Influx of workers by itself could induce potential impact in increased demand for health services. The influx, as explained will be minor, and will not impose pressure to the health services. The capacity of existing health facilities are able to absorb without major disruption any potential demand for care and attendance to acute conditions of the influx workers (in case of curative or emergency cases). The Clinical Centre in Nis, 30 km away, as the second largest medical centre in Serbia, is complementing the capacity of the two receptor communities.

Access to education

The Baseline has shown that the educational network comprises not only of mainstream facilities in the heart of the administrative centres of the two main impact receptors community. Focus group discussions and key informant interviews has provided evidence that unless effectively mitigated the impact the construction works might have on access to education and undisturbed school curriculum and attendance in general might be major. The education network in Prokuplje is composed of several elementary and high schools in the heart of the settlement and 10 schools in remote settlements and villages around. The situation is alike in Merošina where one elementary school is in the settlement centre, while 10 remote school facilities are scattered from 0,5 to 7 or even 8 km away. Given

that the impacted municipalities consist of remote villages the school system is organized through external small group in educational facilities. There are no exclusive transportation agencies through which the transportation of children by school busses to and from the schools is organized. However, schools are providing transportation under contract agreements with the local Public transport operator “Niš Express” and for more remote facilities outside the main network through minivan transportation provided by private transport entrepreneurs. Not all routes could be impacted but the construction works will have to harmonize or at least synchronize with the timetable of those individual lines adversely impacted by closure of roads and diversion of existing traffic especially during the peak hours and school year.

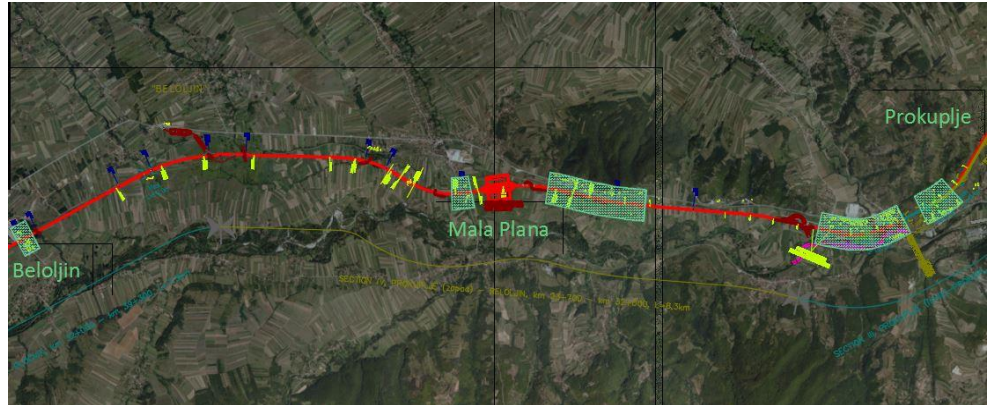
5.3.2 Noise and vibration impact

The majority of the proposed route passes through rural area with noise sensitive receptors present in Prokuplje and few settlements along the route: Merošina, Jugbogdanovac, Arbanasce, Mala Plana and Beloljin.

Figure 88 Zones of noise sensitive receptors in Merošina, Jugbogdanovac and Prokuplje (green)



Figure 89 Zones of noise sensitive receptors in Prokuplje, Mala Plana and Beloljin (green)



Residential receptors are considered to be of high sensitivity when noise and vibration are concerned.

Guidance on acceptable levels of noise from construction activities is given in British Standard BS 5228:2009. Part 1 of this standard indicates that for long term and large scale activities involving earth movements, noise from daytime construction activities would not be significant if below 55 dB LAeq. For smaller schemes, noise from daytime construction activities would not be significant if below 65 dB LAeq.

The existing daytime ambient noise levels near the residential receptors in Prokuplje are such that construction activities at 55dB LAeq are likely to be audible at the nearest noise sensitive locations. The nearest noise sensitive receptors to the worksites are approximately 30 m away. Given that the noise levels of the construction activities are about 90dB (A) at 10m, then 55dB LAeq is likely to be temporarily exceeded at the closest receptors.

The Table below presents a sample of construction working operations and a typical range of associated sound pressure levels at 10m (obtained from BS 5228-1:2009).

Table 63 Sample of construction activities and associated typical sound pressure level data at 10m (BS 5228-1:2009), Free-field dB (A)

Plant / Operation	Sound Pressure Level ($L_{Aeq,T}$ / L_{AFmax} at 10m) from BS 5228 – L_{AFmax} level denoted by
Tracked Excavator – Trenching	71 – 77
Tracked Excavator – Earthworks	68 – 80
Tracked Excavator - Dumping / Spreading Load / Compacting	78 – 86
Driven Piling Rig	61 – 101
Auger Bore Piling Rig	73 – 83
Dumper Truck – Distribution	56 – 92
Dumper Truck - Tipping / Load	74 – 86
Lorry - Pass-by / Movement of Materials	76 – 88
Mixing Concrete – Truck discharging / idling/mixing	71 – 80
Wheeled Crane	70 – 78

There will be noise generated from the concrete batch plants and vehicle movements. Location of the concrete batch plants has not been determined at this stage. The plants will be the focal point for the delivery of aggregates and cement as well as the movement of mixer trucks. Properties near the roads which will be used for construction traffic (including rotating mixer trucks) have the greatest potential for increases in noise due to construction traffic. Properties within a few metres of a road with increased traffic flows may also be affected by an increase in ground-borne vibration, particularly from heavy vehicles when there are irregularities in the road surface.

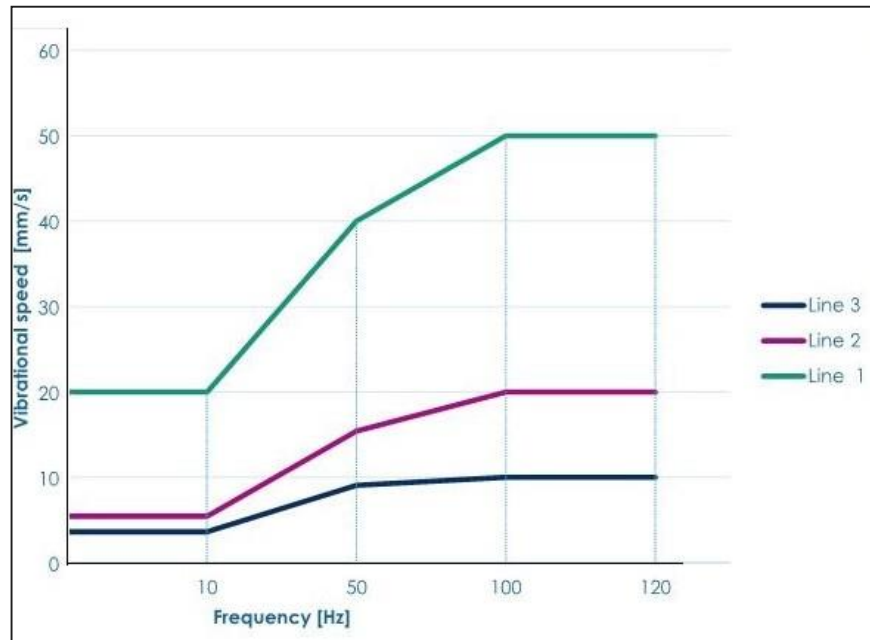
Construction of the access roads for construction traffic is planned away from the settlements and such works will be localised and short-term, and would not be expected to generate significant impacts.

Where construction noise levels are anticipated to be above 55dB $L_{Aeq,T}$ during the day, significant noise impacts are expected to be registered. Such impacts are classified as moderate to high, depending upon the levels of anticipated exceedance. Where construction noise levels are below 55dB $L_{Aeq,T}$ during the day, insignificant noise impacts are expected. Such impacts are classified as low, depending upon the levels of anticipated exceedance. For a receptor sensitivity of high, which is the case in Prokuplje, Jugbogdanovac and Beloljin the adverse impact significance will be moderate. These impacts will be local, short-term and temporary in nature.

Allowed vibration speed and vibration impact on the tunnelling zone

The level of movement required to damage the structure depends on its construction. Data are provided on standard permissible vibration rates which does not cause any damage to buildings in accordance with the German standard DIN 4150. Interval line 1 is valid for monumental and specially protected objects, interval line 2 for residential and interval line 3 for industrial and Special facilities.

Figure 90 A graphic display of the allowed vibration speed that does not cause any damages to the buildings in accordance with the German standard DIN 4150



Vibrations caused by blasting and the effects of such vibrations can become dangerous if the tunnel passes through the populated area or close to buildings or structures.

- Tunnel “Debelo brdo” is outside the populated area.
- Tunnel “Lalinac” is performed in open cut, and there is no danger of exposure to vibrations.
- Tunnels “Bozurna” is performed each tube in particular, in loose material with a high overburden and there is no danger of exposure to vibrations.
- Tunnel “Racunkovo brdo” is performed each tube in particular, in homogeneous sedimentary and magmatic rocks with a high overburden.
- Tunnel “Vrsnik” is performed in homogeneous sedimentary and magmatic rocks. Nearest houses are 250m away from the route.
- Tunnel “Plehane kuce” is performed in homogeneous sedimentary and magmatic rocks. Nearest houses are at 160m from tunnel route.

For tunnels “Vrsnik” and “Plehane kuce” the significance of impact can be consider as minor. It is recommended to perform in-situ measurements of vibration during the construction works for these two tunnels. These measurements can be used to improve the system of blasting and excavation.

5.3.3 Community health, safety and security impacts

The principal potential effects on the community during the construction will be related to: (1) road traffic disruption and safety, (2) presence of temporary workers in the local area, (3) safety risks due to unauthorised access to construction compounds and work sites.

Construction transport and increased traffic can lead to more possibilities for accidents for the local population as well as to a reduced quality of life. The construction phase will involve a large number of transport movements involving slow vehicles carrying aggregates and other materials. The works will also involve temporary closures and diversions of roads. This may increase the risk of traffic accidents in the area, especially to vulnerable road users (e.g. pedestrians, tractors, bicycles). The general public is a high-sensitive receptor. The effect magnitude is expected to be major in the area of Merošina and Prokuplje, which is most populated on the route and will primarily be affected by proposed road realignments. The initial significance of this impact (if not controlled) is major adverse. A Construction Traffic Management Plan should be developed and implemented. The plan should be prepared in cooperation with the relevant local traffic authorities, especially where transport is moving through or near settlements or areas with vulnerable road users. If the Plan is implemented and the set of other mitigation measures enforced, the significance of the residual impact would be minor adverse.

Potential influx of temporary workers to the area is expected to be limited, given that it is very likely that local workforce (Prokuplje and Merošina region) will be employed during the construction. Also, worksites along the major part of the route will be distanced from the settlements. The presence of workers may cause some disturbances in the project area. However, these are expected to be minor, and as a result, the impact on local communities about social pathologies and conflicts is assessed as minor adverse.

In case that members of the public access the construction site without authorisation, they will potentially be putting themselves at risk. To prevent this, appropriate security features will be implemented, including fencing, sign posting and potentially security personnel. It is therefore expected that the health and safety risk to the general public will be negligible.

5.3.4 Impact on cultural heritage and archaeology

On the section from Merošina to the confluence of Trnavska River to Toplica River (after Prokuplje bypass), sensitivity remnants of old civilisation can be considered high, and magnitude of impact is small, therefore significance of the impact can be considered as moderate. But, having verified - after the archaeological reconnaissance - that on the highway route there isn't any cultural heritage and archaeology remnants, taking the measure of constant presence of archaeologist during earthworks, the magnitude of impact on cultural heritage can be considered as negligible, and the significance of the impact can be considered as negligible.

As already mentioned the design team decided to change the route in this section to avoid collision with the protected zone of the archaeological site Pločnik. In the meeting of 09/06/2017 in the Republic Institute for Protection of Cultural Monuments, Belgrade, the opinion of the Institute was that the continuous presence of archaeologists during the execution of earthworks on the route from km 38+300 to km 39+200 (which includes Viča also, at km 38+800) instead of previous archaeological research, will be satisfactory.

On that part of the highway route (confluence of Trnavska River to Toplica River (km 22+680) to the end of the route (km 39+200) sensitivity can be considered high, and magnitude of impact is small, therefore significance of the impact can be considered as moderate. The measure of continuous presence of an archaeologist during the execution of earthworks, which will contribute to the implementation of protection in case of archaeological findings, is foreseen in order to turn the impact negligible.

5.3.5 Occupational health and safety impacts

The construction of large infrastructure projects carries several key health and safety risks to the workers employed in the project. Key issues for consideration associated with the proposed project are the following: (1) work at heights, (2) slips and falls, (3) moving machinery, (4) struck by objects, (5) dust and asbestos fibres dust, (6) confined spaces and excavations, (7) biological hazards (poisonous snakes).

Some of the construction activities may be classified as high risk with a significant potential for incident. However, incidents are preventable through the implementation of appropriate management systems and the following of its requirements by the workforce. It is important to ensure that the contractors will employ workers are fully trained, have an appropriate awareness of the hazards of working at construction sites and are trained to use and use the appropriate equipment to undertake their tasks in a safe manner. All workers associated with the project, and in particular the site management, will need to be familiar with appropriate safety measures for this type of construction works, starting with undertaking appropriate hazard and risk assessments for all activities. This should be followed by appropriate training, that personnel undertaking hazardous tasks are certified to do so and implementation of specific international requirements for working at height and working in enclosed spaces. A particularly vulnerable group of workers may be associated with the section of the workforce sourced from the local communities who may not have previous experience of working on large-scale construction projects.

An overview of the health and safety management and mitigation requirements for the construction phase of the project is presented in Chapter 6.2. If the appropriate measures are implemented, the health and safety risk of the project during construction to be low.

5.4 Environmental Impacts during Operation

The following sections provide an assessment of the potential impacts of the project activities during the operational phase.

5.4.1 Air quality impacts

Air pollution caused by traffic, it is possible to be quantified only if we take into account all parameters which essentially define this phenomenon (meteorological, topographical, traffic, construction, etc.).

Existing analyses of waste gasses which are formed as a product operation of automobile engines have shown that there are several hundreds of harmful organic and inorganic components. Such a large number of indicators cannot, and there is no special sense, to analyse. Therefore, as the authoritative components of air pollution are analysed: carbon monoxide (CO), nitric oxide (NO), nitrogen dioxide (NO₂), sulphur dioxide (SO₂), hydrocarbons (C_xH_y), lead (Pb) and solid particles.

- Carbon monoxide (CO)

CO affects humans as well as all fauna species. Thus it binds to hemoglobin and thereby displaces oxygen. The concentration of CO in hemoglobin of 2% can be regarded as negligible, and the concentration of over 2.5% is critical. The consequences are disturbances in balance, eye disorders, weakening of concentration, difficulty breathing and headaches. The effect of carbon monoxide on the plants can be considered insignificant.

- Nitric oxides (NO, NO₂)

The effect of nitric oxide on humans is similar to the effects of carbon monoxide. Displaces oxygen from the blood, which threatened the supply of tissues. High concentration of nitric oxide in the blood causing death. Nitric oxide as air pollutants is essential for the creation of nitrogen dioxide (NO₂), which is toxic and particularly harmful to the respiratory system. Its harmful effect on the plants is reflected in the appearance of wax leaf necrosis and premature decline. Given these influences in the world, today considers that all species of plants are protected from the influence of nitrogen oxides on the long-term concentration of 0.03 mg/m³.

- Hydrocarbons (C_xH_y)

The hydrocarbons that influence to human health is related to five groups: paraffins, naphthenes, olefins and alkynes, aromatics, oxidized hydrocarbons. Polycyclic aromatic hydrocarbons have carcinogenic effects - cancerous lung disease. The fact of hydrocarbons in the plant is quite complex and is reflected at large number of faults. High concentrations cause necrosis of flowers and leaves and lower leaves falling and difficulty in flowering. Very sensitive plants react at very low concentrations of hydrocarbons. The impact of hydrocarbons on building materials is not reliably proven.

- Sulfur dioxide (SO₂)

Sulfur dioxide combined with fine dust particles has harmful effect on mucous membranes (eyes) and airways. Effect of sulphur dioxide on plant life in the degradation of chlorophyll and the withering away of certain tissues. Sensitive species of evergreen forests have the damage already at concentrations of 0.05 mg/m³. Of all the air pollutants sulphur dioxide has the most pronounced effect on structures.

Sulfur dioxide in combination with the moisture acts as a sulfuric acid, and so destroys organic compounds. This is particularly important for the historical and artistic value of the objects. Any damage caused in this way increases with temperature, humidity and light intensity.

- Lead and its compounds

The man entered everyday larger amounts of lead and its compounds through food than they received over the respiratory organs, from the atmosphere. Permanent exposure to pollution from lead poisoning leads to chronic, which is primarily manifested in the form of loss of appetite, stomach problems, fatigue, dizziness, kidney damage and unconsciousness. Other, however, is still the dilemma of acceptable limits of concentrations of lead in the atmosphere. The toxicity of lead in relation to the vegetation is small. Concentrations of lead in plants are highly correlated with the content of lead in the soil. Otherwise the presence of lead in plants reduces their ability to grow and enzyme activity.

Taking into consideration that the new highway will generate additional traffic in the subject area, cumulative impacts on air quality could occur on the highway sections that are close to the existing main roads and railway line. Therefore, additional air pollution would result in the areas of the section from Prokuplje to Pločnik which passes near the railway line, and partly in the vicinity of the state road IB-35. At the same time, traffic within Prokuplje will be reduced, and traffic congestion eliminate, which will result in better air quality in Prokuplje.

Taking into consideration that traffic is potentially big share in the total emissions of certain pollutants; the following air composition is expected:

Table 64 The share of motor vehicles in the total emissions of certain pollutants

Pollutant	The share of motor vehicles in total emission (%)
Carbon monoxide	60
Hydrocarbons	45
Nitrogen oxides	34
Sulfur dioxide	5.9
Solid particles	6.8

In the first implementation phase, semi-motorway profile (SM) is to be constructed (2020 to 2030) and later upgrade to be made to the full motorway profile (M) 2035. The motorway (M) will have two carriage ways (proposed by the Preliminary design on the new route sections):

- 1 Flat/hilly terrain: Free-flow speed of 120 km/h, dual - 4 lanes (plus emergency lanes) carriageway, with lane width of 3.75 m
- 2 Very hilly/mountainous terrain: Free-flow speed of 100 km/h, dual - 4 lanes (plus emergency lanes) carriageway, with lane width of 3.5 m

The implementation option of SM (semi-motorway) construction in the first phase is done under the following assumption: Free-flow speed of 80 km/h, single 2 lane carriageway, with lane width of 3.75/3.5 m.

Table 65 Traffic volumes on the SM (semi-motorway) construction

From	To	Lenght [km]	2045 M [vpd]	2040 M [vpd]	2030 SM [vpd]	2020 SM [vpd]
NETWORK WITH INVESTMENT (phased implementation with semi-motorway in 2020 and 2030 and full motorway in 2040 and 2045)						
Interchange Nis 3 (Prokuplje)	Interchange Merosina (Merosina 1)	5.297	21,418	19,164	13,406	8,561
Interchange Merosina (Merosina 1)	Interchange Prokuplje sever	10.936	21,318	19,107	12,747	8,087
Interchange Prokuplje sever	Interchange Prokuplje zapad	6.576	16,078	14,982	11,184	7,573
Interchange Prokuplje zapad	Interchange Beloljin	9.522	17,344	15,788	11,597	7,758
Interchange Beloljin	Interchange Kursumlija	17.984	14,950	13,868	9,107	6,824
Interchange Kursumlija	Interchange Merdare	26.548	9,667	5,367	3,480	2,456

Air pollution impact magnitude is considered to be negligible since during the first implementation phase (SM) AADT is significantly below high levels and will be mainly diverted from the traffic which is using the existing state road at the moment and because there is no other significant source of pollution in the area.

As the receptors (populated area near the highway) can be considered as of medium sensitivity, then the significance of the impact can be also considered as negligible.

Even in full motorway profile phase, traffic volumes are expected significantly below thresholds²¹. The estimated Relative emissions is negative i.e. the impact of the new highway reduces GHG emmissions on average by 1.700 tonnes CO₂e per year, while the Absolute value of GHG emissions of the highway remains below the threshold of 100.000 tonnes CO₂e/yr till year 2044.

Therefore, for the full morotway profile phase (M), after 2045, monitoring of air pollutants concentration is recommended.

5.4.2 Soil and groundwater impacts

Types of pollutants and their form

In soils surrounding roads, as well as on wider distances, are sometimes present harmful substances in concentrations which can cause certain effects on human and animal health. This is primarily related to the components of fuel, heavy metals

²¹ According to the traffic study results and taking into consideration the Transport Emissions Factors of table A 2.7 of report "Methodologies for the Assessment of Project GHG Emissions and Emission Variations", Version 10.1, EIB

and various organic and inorganic substances. Fuel components include hydrocarbons, organic and inorganic carbon and nitrogen compounds (nitrates, nitrites, ammonia). Among them, particularly important are polycyclic aromatic hydrocarbons (PAH). Group of chemical elements named heavy metals includes lead (in decrease due to the utilization of unleaded gasoline), cadmium, copper, zinc, mercury, iron, and nickel. These elements can be found in soil in natural (inherited, background) content and could have an anthropogenic origin. Their contents could be found at greater distances from the road, and this could rise problems from the aspect of environmental pollution. Various organic and inorganic substances are a form of pollution which is a consequence of traffic participants consumables throw out, and are also found on considerable distances from road fence.

Quantification of pollutants

Pollutants are quantified through ranges of the threshold, dangerous and remediation values. Soil pollution along roads depends on the drainage system, traffic volume and structure of traffic, the configuration of surrounding terrain and tree cover around it, spraying and disposal from transport and atmospheric deposition.

Soil pollution by heavy metals has been the most investigated type of pollution. This fact is primarily underpinned with heavy metals adsorption in soil and their possibility to be absorbed by plants and therefore entering into food chains. Various studies indicated negative impacts of roads on physical and chemical characteristics of water and soil (Winston et al., 2012; MacKay et al., 2011; Rijkenberger et al., 2010; Piguet et al., 2008). Along with industry and agriculture, main environment pollution by heavy metals is transport infrastructure, i.e. roads, bridges, and overpasses. Main sources of heavy metals near roads are tire and brake wear, emitants, asphalt abrasion and saltation in the winter period (Gunawardana et al., 2012, Shaw et al., 2012). These substances arrive into soil and groundwater mainly by runoff from roads and through the dust. In table 1 are given threshold and remediation values of dangerous and harmful substances concentrations. Table is part of "Regulation on systematic soil monitoring program, indicators for the assessment of soil degradation and methodology for the development of remediation programs" ("Off. Gazette of RS", No. 88/2010) and refers to non-agricultural land, while for agricultural land is used "Regulation on allowed amounts of dangerous and harmful substances in soil and water for irrigation and methods for their testing" ("Off. Gazette of RS", No. 23/94).

Table 66 *Threshold and remediation values of dangerous and harmful substances in soils and values that can point out to significant contamination of soil*

Soil (mg/kg of absolute dry matter)		
Heavy metals	Threshold value	Remediation value
Cadmium (Cd)	0.8	12
Chromium (Cr)	100	380
Copper (Cu)	36	190
Nickel (Ni)	35	210
Lead (Pb)	85	530
Zinc (Zn)	140	720
Mercury (Hg)	0.3	10
Arsenic (As)	29	55
Barium (Ba)	160	625
Cobalt (Co)	9	240
Molybdenum (Mo)	3	200
Antimony (Sb)	3	15

The impact of various pollutants is the highest on 10 m distance from roadway edge, while from 10 m to 100 m, the influence of atmospheric deposition is prevailing. Concentrations of lead on distances 100 m and far from the highway are not required to determine. Soils near highways can have cadmium concentration up to 3 mg/kg.

Soil pollution

In the phase of highway operation, soil pollution is more expressed in a narrow zone around the road. It is usually a consequence of following processes: (1) pollution due to surface water coming from the roadway, (2) deposition of emitted gasses (atmospheric deposition, wind deposition, scattering due to vehicle movement), (3) disposal of organic and inorganic waste and (4) spillage of cargo.

Nevertheless, in conditions of closed drainage system, soil pollution due to water flow from the roadway is minimized, since protection from this type of pollution is planned. Side (lateral, shoulder) channels receive water from the pavement, and they are covered with a concrete coating. On outpour, bodies having precipitator and separator or purator are constructed. Drainage pipes are directed on separators or on slab-sided concrete channels, which gravitate to separators or purators, so all water from pavement is treated before transferring into recipients. Drainage of rainfall water from bridges is designed by pipes on 30 m distance. Applying project planned technical measures, the impact of polluted water from the pavement on the soil and groundwater can be considered negligible.

Soil pollution appears due to deposition of emitted pollutants along the highway. Emitted gasses are mainly deposited adjacent to the highway on the nearby distances on both sides. Pollution intensity is directly connected to traffic volume. According to low traffic volumes, soil pollution impact can be considered as negligible.

Soil pollution can be permanent, seasonal and accidental according to temporal scale. Permanent or systematic pollutions are a consequence of highway operation. Seasonal pollutions are related to the specific season. Pollution

appearing from road salting during frozen period, or pollution from mismanagement of pesticides during vegetation period are seasonal pollutions. Accidental pollution is usually a consequence of smaller or bigger accidents of vehicles that transport risk materials. It is most often a case of petroleum and its derivatives, although the accidents of vehicles that transport dangerous chemical materials are not rare. The greatest problem, in this case, is the fact that the only way of soil rehabilitation is to remove contaminated soil and transport it and store in safe places where endangering of environment will be minimized.

Impact on agricultural land during highway operation

Highway operation has long term character. It depends on traffic volume, quality of highway construction and other transportation objects, technical characteristics of vehicles, type and quality of petrol and roadway characteristics.

Highway operation can cause many negative effects on agricultural land such as (1) increased emission of air pollutants and their deposition in soils around the highway, (2) runoff from pavement and water spraying by transport of vehicles, as well as (3) changes in land use (parcels area decrease, difficult access to parcels).

Intensive traffic increases the amount of particles and gas pollutants in the air, which together with dust, soot, parts of asphalt, microscopically tiny particles of elemental lead, etc. carried by air flow are blown on surrounding surfaces, and in this case, on agro systems along the highway.

For sustainable and healthy agricultural production it is important that around the highway there is an absence of pollutants such as petrol components, hydrocarbons, organic and inorganic carbon, nitrogen compounds (nitrates, nitrites, and ammonia), or heavy metals such as lead, cadmium, copper, zinc, mercury and nickel. The strongest negative impact of these pollutants is in the first impact zone that includes a road belt from the highway edge to 10 m far from the highway. The second impact zone is up to 100 m from the roadway edge from the both sides of the highway. Distribution of these substances depends on the microclimate of particular locations.

Lead and cadmium are the most significant pollutants among heavy metals in soils around highways. Cadmium is present in motor oil and tires, which explains its presence in soil near the road. Lead is also used in the car industry, in batteries production, and in the past, it was used as a petrol additive, which increased its concentrations along roads in the past. A significant level of soil pollution with these two elements is noticed in zones from 5 to 10 m far from roads. Their impact on higher distances is present due to atmospheric deposition. The presence of increased concentration of heavy metals in soils is a consequence of long-term deposition of smaller amounts of these elements accumulating in surface horizon and increasing in time up to threshold level or higher. Lead and cadmium ions are absorbed by cultivated plants, and through food chain deposited in the bodies of animals and humans. Lead, and cadmium characteristic is that they are hardly or almost never extracted from the body but rather accumulated. It is well known that salad well accumulates lead and therefore it is recommended not to be grown near

roads. Corn has a higher percentage of lead in green biomass than in grains. Therefore, corn cultivated near roads should not be used for animal nutrition silage.

Impact on agricultural land from heavy metals is local (in a narrow belt) and permanent impact, with small magnitude. Sensitivity of the receptor depends of soil type in vicinity of the highway, and types of crops that are grown. If the recommendations given in the protection measures for agricultural production near the highway are observed, the significance of the impact on the soil and groundwater will be negligible.

During accidents in construction and operation stage, many of the above negative effects may occur as acute effects.

5.4.3 Surface water impacts

During the operation and maintenance of the highway, constant pollution sources which may negatively affect the quality of water are present:

- Pollution of water that falls on the road.
- Sudden pollution caused by accidental situations. Accidental situations leading to spillage of harmful and hazardous materials, the most common accidents in which there is a spillage of petroleum products with a high capacity of diffusion into the groundwater and surface water.

Significant impacts on water from the carriageway occur for AADT of the level of 30000. When these volumes are recorded they result in significant increase of hydrocarbon substances based on nitrogen and sulphur, considering that such traffic load emits larger amounts of gasses. The concentration of pollutants in AADT of 15,000 to 30,000 vehicles/day significantly different from the time of the year. Individual analysis led to the conclusion that there is a significant difference in the amount of heavy metals originating from the bodywork tires, brakes and other parts of the car (Cr, Cu, Fe, Al, etc.) if the traffic intensifies during the rain. If a simplified model EMEP/CORINAIR emission calculation for dust emission is implemented, emission calculation for dust emission is obtained from about 3.0 - 4,5 kg per day for the whole observed section. For a dry period of 18 days 55-80 kg solid particles from the highway will be deposited to the recipient.

According to the above, it is clear that the concentrations of pollutants in the water could be expected in significant quantities, and that it is necessary to apply technical protection measures for the surrounding water bodies from polluted water from the carriageway. According to the legislation, atmospheric water that is discharged into the watercourse must be purified at least to the quality that corresponds to stream water recipient.

The designed solution foresees all storm water that fall on the asphalt surface is efficiently collected and taken to controlled devices for treatment and only then continue to the end recipient.

Atmospheric water drains in the trenches of embankments or cuttings. The concept implies that highway drainage of rainwater, which has entered the road, to be carried out by gravity to the gutters at the edge of the highway. At certain distances along the gutters manholes with drain covers will be installed.

By drain covers atmospheric water goes into a closed pipe system, and from there to the separators for the treatment of rain water. After passing through the separator for oil products, purified water is drained by pipeline to the recipient, where the water is discharged.

Drainage system covers all accompanying facilities (rest areas, ramps, loops and other operational areas) and all structures (viaducts, bridges, tunnels) along the route.

The impact on surface water bodies from polluted water discharged from the highway is minimized by applying the above mentioned technical protection measures. Magnitude of this impact can be considered as insignificant, and sensitivity of receptor is considered high. Significance of the impact is considered negligible.

5.4.4 Impact on ecology and nature conservation

During the operation period, the negative environmental impacts of the highway will be manifested during normal use and in the case of accidents.

Impacts on habitats in the operation phase

The cleared land strip along the motorway will be permanently occupied by the carriageway and the associated structures. This will cause permanent habitat loss as well as fragmentation of habitats, this is, their division into a number of discrete parts. In theory and over time, the populations become divided into a number of subpopulations, and if they are too small they may be prone to local extinction.

The magnitude of this impact has been evaluated in a qualitative manner, taking into account the types and sensitivities of the habitats that will be separated by the motorway, as well as the species that will have to cross the motorway. Thus, the effects of fragmentation would be generally more important in those areas where medium and/or high sensitivity habitats are predominant at both sides of the motorway alignment.

In the actual case of the proposed highway, and given the already significant impact of the existing main road as well as of the numerous and almost uninterrupted rural settlements along the existing main road, the expected additional impact will be minor regarding habitat loss and degradation and negligible on the magnitude of the impact on habitat fragmentation. This is minor because the natural habitats in the area are already just fragments of their original extent and already fragmented.

The impact on flora in the operation phase

During the exploitation phase of the road, part of the negative effects anticipated during the construction phase will keep their effect. Removal of surface soil layer and set the asphalt surface will lead to the permanent loss of habitats from the route to the highway safety fence.

Another impact on the flora and habitat types during the exploitation phase will be pollution created by the highway. At this stage it can be fixed, seasonal and accidental. Permanent pollution is related primarily to the scope, structure, and characteristics of the traffic flow. The result of the traffic is the deposition of pollutants on the surface of the pavement, which is washed away by precipitation. It is primarily about the deposition of harmful substances from exhaust gasses, oils, and lubricants, tire wear and pavement, etc. Seasonal pollution is linked to a specific year period. A typical example of this type of pollution is the use of salt for road maintenance during the winter months. This type of pollution is characterized by the fact that in a very short period, causes high concentrations of sodium chloride. Accidental pollution usually occurs due to the transport of hazardous materials. Usually, there is oil and its derivatives, although it is not uncommon to consider accidents with vehicles which transport highly hazardous chemicals. What in this case represents a special problem is the fact that it is almost immediate, very high concentrations, which are not time-spatial and it cannot be predicted. The waters flowing from pavement surfaces present a set of harmful substances in concentrations that are often above the maximum allowable for discharges into waterways. Pollutants in this case include fuel components such as hydrocarbons, organic and inorganic carbon, nitrogen compounds; heavy metals, ie: cadmium, copper, zinc, mercury, iron and nickel; substances resulting from the use of materials for corrosion protection. A specific group of very carcinogenic materials represented as polyaromatic hydrocarbons (benzo-a-pyrene, fluoranthene) which are products of incomplete combustion of fuel, and used motor oil.

The impact on mammal fauna in the operation phase

During the operation phase of the road, part of the negative effects will keep their effect. Removal of surface soil layer and set the asphalt surface will lead to the permanent loss of habitats from the route to the highway safety fence. Because of maintenance of the highway, some species that live on the edges of forests and fields, bushes, and shrubs will be favored. This is the most numerous mammal fauna in the area concerned. On the other hand, forest vegetation along the highway will be replaced by herbaceous because of safety. This will favour the settlements of rodents, for which such conditions are especially good.

This as the domino effect may favour the secondary increased presence of some species like the carnivorous mammals (European polecat, Marbled polecat, weasel and beech marten) jackal, fox, which prey on rodents. Effects of these activities will be limited almost exclusively to the line of the highway and the area of the safety fence. The effects of noise and vibration will also remain a constant, although with periodic occurrence and intensity (depending on the day-night and seasonal dynamics of traffic). In the corridor along the highway, these effects would be substantially reduced or eliminated.

During operation, pollution from low-degradable chemical substances and agents, products of decomposition of organic waste, etc., may have a permanent or at least long-term (negative) impact on ecosystems and habitats in which they are due. The relevant impact is described in the section about surface waters. Sources of artificial light can be jeopardizing factors, especially for nocturnal species and especially –bats, because it functions as a sort of "light traps", but also stress acting on the species in the vicinity of the motorway.

After having analysed the overall situation of construction of the highway and its impact on the mammal fauna, it can be concluded that no significant impact is anticipated for any mammal species. Mammalian fauna along the respective route consists of species and communities integrated with similar ecological predispositions and characteristics in ecogeographical space. Small mammals show high ecological plasticity to shocks of this kind and high capacity of population response, which significantly reduces the effects of certain fundamental factors of influence. The habitat of strictly protected species such as lesser mole-rat is not directly impacted by the project. The otter habitats occupy a very wide area, and possible negative impacts on parts of the area on waterways along the route do not pose any serious threat for its survival and conservation status. A larger local impact is possible for some of the larger mammals with significant dispersion due to cutting of traditional migratory routes and the disruption of their ecological corridors network. However, given the already significant existing impact of the numerous and almost uninterrupted rural settlements along the existing main road and the main road itself, the expected additional impact will be negligible. The current scope and character of human activity have shaped and conditioned the scope and direction of migratory movements of many species of mammals. Extensive movement is expected in the east-west direction, longitudinal, more or less parallel to the axis of the highway route than the north-south direction, perpendicular to the route.

The impact on bird fauna

With respect to the maintenance of the highway in the operation phase, one of the indirect negative impacts is the use of salt during the winter months. Specifically, it has been found that many animal species, especially bird species (mostly songbirds) use salt as a source of food. Therefore, the use of salt greatly attracts individuals of different species in the immediate area of the highway route significantly increasing the risk of collision accidents and road mortality.

Based on studies and confirmed observations in the area, some species are actually attracted to road surfaces, increasing the risk of road killing. The Grey Partridge *Perdix perdix* is among them

The noise in the post-constructive period will in particular have a negative impact on species that nest along the highway route.

The artificial lights of the highway (if any) may cause additional impacts due to the deterioration of foraging habitats for nocturnal birds of prey and disorientation in nocturnal migrants.

The overall impact to bird fauna during the operation of the road is expected to be minor as the species found in the area are already species used to human presence and traffic, given the existing main road and the extensive agriculture activity in the area.

The impact on amphibians and reptiles fauna

The route of the proposed road section intersects the already fragmented mosaic habitats which are mainly agricultural ecosystems. During operation the impact is expected to be negligible, especially as some reptiles will probably benefit from the open spaces created in the highway corridor. For amphibians the impact prior to mitigation will be minor mostly due to the fact that the road acts as a physical barrier for the movement of these species.

The impact on ichthyofauna

During the operation phase of the proposed highway it is logical to expect that water pollution and impact to ichthyofauna will be primarily due to:

- deposition of exhaust gasses;
- tire wear;
- destruction of coachwork or the cargo leachate;
- load spillage and dump of organic and inorganic waste;
- deposition from the atmosphere;

The designed solutions for the collection and treatment of the water from the highway will be sufficient for the avoidance of these impacts to freshwater fish. Therefore the impact will be low and no additional mitigation measures are required.

5.4.5 Waste impacts

Waste that will be generated during the highway operation will be primarily food, paper, and packaging waste, coming from passengers that would use the parking along the highway.

The magnitude of this effect is considered low. As an appropriate number of waste bins and containers will be provided at the parking and cooperation with local public utility companies for waste disposal continued, the significance of this impact is assessed as negligible.

5.5 Social Impacts during Operation

Social impacts during operation are explored in more depth in Annex 1: SIA. Herebelow an outline of the main topics covered in Annex 1: SIA is presented.

5.5.1 Noise impacts

In general the noise caused by traffic flow is discontinuous, of variable intensity, with intermittent pulses. It has a negative impact on the quality of life of the

surrounding population and its health. Since a large number of facilities is located in the immediate vicinity of the observed section, it is necessary to implement appropriate protection measures against potential negative impact of the traffic noise.

The design of noise barriers envisages the construction of structures for noise protection, which would eliminate its negative impact.

Acoustic zoning was not available during the development of the preliminary design for the subject area, and therefore selection of the permissible noise levels was done in accordance with the Regulation on noise indicators, disturbance and harmful effects of noise in the environment (Official Gazette of RS, No. 75/2010). Since the newly designed road belongs to the category of the highway, the highest values of the permissible noise levels are selected regarding the category of the observed roads, and use of the area directly to the road. The designer has selected the values of permissible noise levels for residential areas which amount to 65 dB (A) for the daytime period and to 55 dB (A) for the night-time period.

The project envisaged placing of noise protection walls. The height and length of noise protection walls are determined based on the noise level analysis, using the CadnaA software.

The height of the walls is defined so that it provides a reduction of the traffic noise levels below the permissible level in settlements along the planned road. Several types of solutions were taken into consideration and the proposed solution, which should meet the following criteria:

- Resistance to weather conditions
- Rational constructions
- Visual effects
- Possibility of pre-fabricated construction
- Possibility of superstructure
- Spatial coherence
- Easy maintenance

During the preparation of the Preliminary design for the project, a detailed noise modelling was developed and the Noise Study determined the required parameters of the noise barriers for the operation of a full motorway profile highway. Because of low traffic volumes in the first phase of the highway operation, the significance of noise impact can be considered as negligible.

In the preparation of the Final Design, it is necessary to determine whether the acoustic zoning has defined permissible levels, which deviate from the adopted ones for the preparation of the Preliminary Design, and accordingly determine the need for protection measures.

In case that noise modelling indicates the expected noise level to exceed the legal limit, noise insulation of windows will be offered for the affected receptors.

According to the analysis performed during the Preliminary design, noise barriers will be provided on the left or right side, in the area of objects which are exposed to the negative impact of the forecast traffic, at the total length of about 226 m. The height of the walls varies from 2 meters to a maximum of 2.50 meters. In the first phase of construction of the highway is not envisaged setting up noise barriers as it is not expected the level of noise that has a negative impact on the quality of life of the surrounding population and its health. Design solution planned as a part of Design of noise barriers is given a basis on predicted effects of the forecasted traffic on the road that will have a full profile of the highway.

Upon implementation of the foreseen noise barriers, the impact of noise and vibration is assessed as negligible.

5.5.2 Community health, safety and security impacts

The principal public health, safety, and security issues during the operation are related to (1) general operational safety of the highway, (2) level crossings safety and (3) transport of dangerous goods.

General operational safety of the highway could affect passengers by the threat of injury or potential loss of life due to vehicle collisions, or vehicle overturns or other operational causes. To prevent the risk, the set of precautionary measures should be implemented, including road operational safety procedures, regular inspection, and maintenance of the highway and implementation of a safety management program equivalent to internationally recognised (EU) highway safety programs. If appropriate measures are implemented, the risk of vehicle collisions or vehicle overturns should be low.

The proposed project envisions only grade separated road crossings (underpasses and overpasses) thus eliminating the safety risks. No impact is expected with respect to this issue. The proposed project will contribute to the improvement of the traffic safety conditions in the area.

KS provide transport of hazardous goods for third-parties along the proposed highway and do not have a full control over the risks involved given that tank vehicle and their condition is most often a third-party responsibility. The proposed project will contribute to the improvement of the hazardous materials transport safety conditions in the area.

Transport of dangerous goods represents a potential environmental risk in the event of accidents, through leakage, safety valve releases, in pressurised and general service tank vehicles, or other hazardous material containers. The magnitude of this potential effect can be in the range from low to major, depending on the specific accident. The initial significance of the potential impact is assessed as major adverse. However, the set of preventive measures will be proposed, including the proper screening acceptance procedure, development of the Emergency Preparedness and Response Plan (including Spillage Response Plan), timing of transport, limiting speeds to minimise the risks, etc. If appropriate

measures are implemented the risk of chemical accident to affect the local community health should be low.

5.5.3 Employment

It is likely although the exact impact cannot be assessed in details at this stage. National Highways in Serbia are under tolling. The National highways and this one as well is designed with a commercial purpose, and besides adding value to transport, should bring investment returns from the collection of toll. Based on the economic indicators on previous experience on similar Projects, and the preliminary design, during operations it is expected that 20-40 permanent employees will be required for the tolling station and toll collection. The exact staffing numbers and organizational needs will be made available following the completion Project. In addition the facilities will require maintenance and potential security subject to later planning by the National Highway operator.

The primary economic impact on a National level during the operation phase will be the income from toll collection. In addition it will be income generating for the National Highway Operator.

The investment is only half way to sustainability and the road shall be subject to regular maintenance as well as winter and summer maintenance which will give procurement opportunities to local and national contractors. This will further induce employment opportunities and increase of livelihood of families of employees.

The Spatial plan and Preliminary design have envisaged at least two large gas stations to be located alongside the Highway. On one hand this may decrease the number of occasional transit visitors on one hand and the impact to the economy. Each gas station will employ at least 20 employees under terms and conditions subject to the employment policy of the specific company.

Other induced impacts are assessed to be mostly in the service sector such as: vulcanize services (tire repair), on-the-road-assistance, auto mechanics, etc.

5.6 Cumulative Impacts

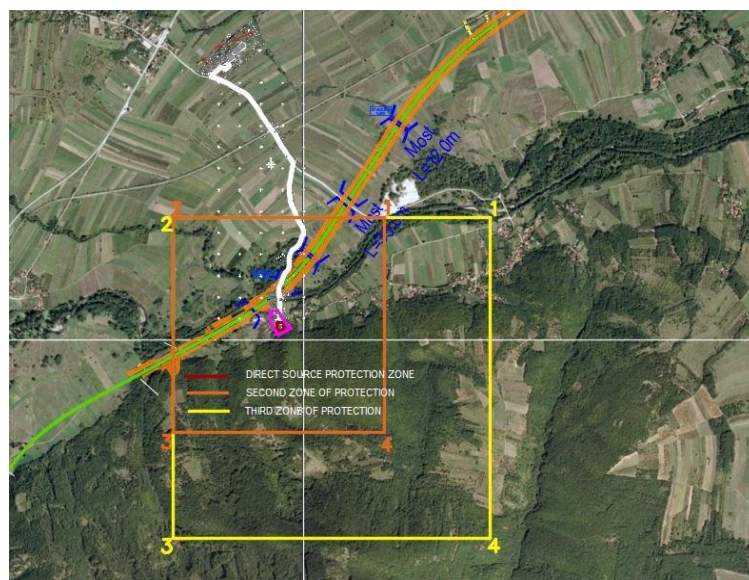
Cumulative effects are those that result from a combination of some individual effects. They can be either temporary or permanent and can arise from the following:

- the accumulation of individual effects (e.g. noise, dust and traffic) on a type of receptor (e.g. an ecological species) which when summed in a regional context or across the proposed route, are likely to result in an effect of greater significance than the sum of the individual effects; and
- the effects from other developments in the vicinity of the proposed route (during their construction or operation), which when combined with the effects of the proposed highway are likely to have an incrementally significant effect on the receptors that experience both effects.

Information about the major infrastructure or related developments currently proposed in the region have been obtained from the relevant spatial planning documents, namely: the Spatial Plan of Prokuplje Municipality (2009-2024) and the Spatial Plan of Merošina municipality. The proposed project is currently the only infrastructure project planned in the project area. The area is not located close to any national road corridors planned for upgrade or development. The developments planned in the area are related to the rehabilitation of the State Road IIA - 216 and State Road IA - 35 and construction of Selova dam and reservoir on the Toplica River, which is designed for long-term water supply solution Prokuplje, Kursumlija, Blace, Žitорађа, Merosina Doljevac, Niš (part), but no time frame has been provided for these developments.

During Spatial Plan development the Company for production of mineral water “Milan Toplica” gave an objection. The pipeline reconstruction project for the water factory has been done and obtaining approval for construction is in progress. From the Plan is evident that the pipeline and highway intersect.

Figure 91 Water source, pipeline and mineral water plant “Milan Toplica”, Tulare



At a meeting with the pipeline designer is agreed to consider all necessary protection measures in the conceptual design of pipeline, and to pay special attention to the water spring protection in the further development of the highway project documentation.

During the public consultations for the Spatial Plan, representatives of a big company called “ERGOMADE” from Merošina municipality objected that the protected zone of the planned interchange “Merošina 1” is located on the land owned by “Ergomade” at which envisages the construction of business and production facility. After Spatial Plan public consultations “Ergomade” representatives made a comment on plan, which results in agreement between PD and Spatial Plan Consultant. It was decided to minimize highway protection zones in that area (not to change the design) since highway is not physically in collision with future facility. This results in further development of “Ergomade” investment works and also in further design and spatial plan development.

Figure 92 “Ergomade” property and planned interchange “Merošina 1”

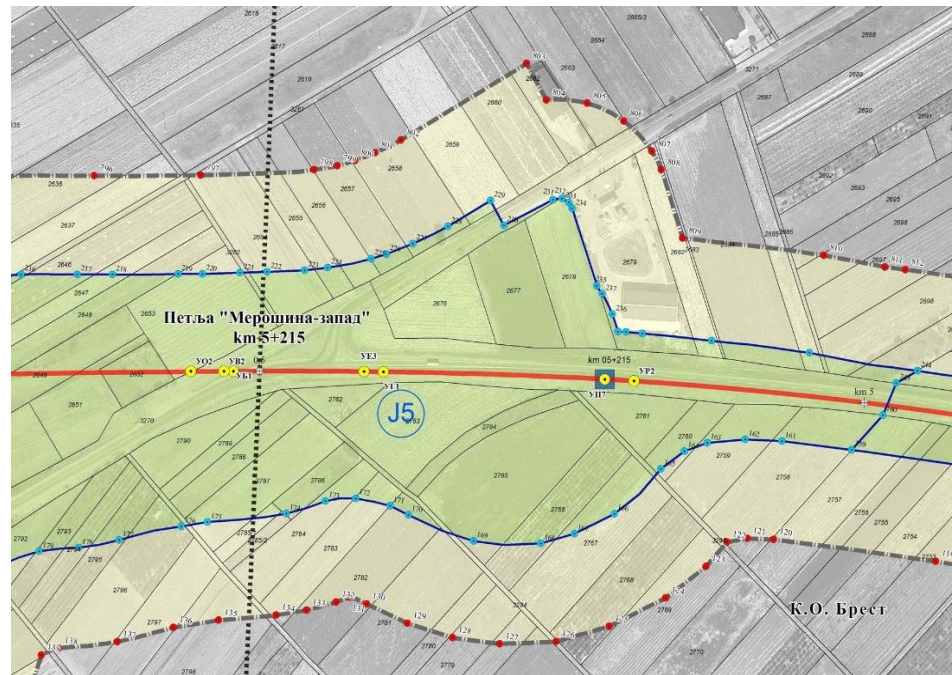
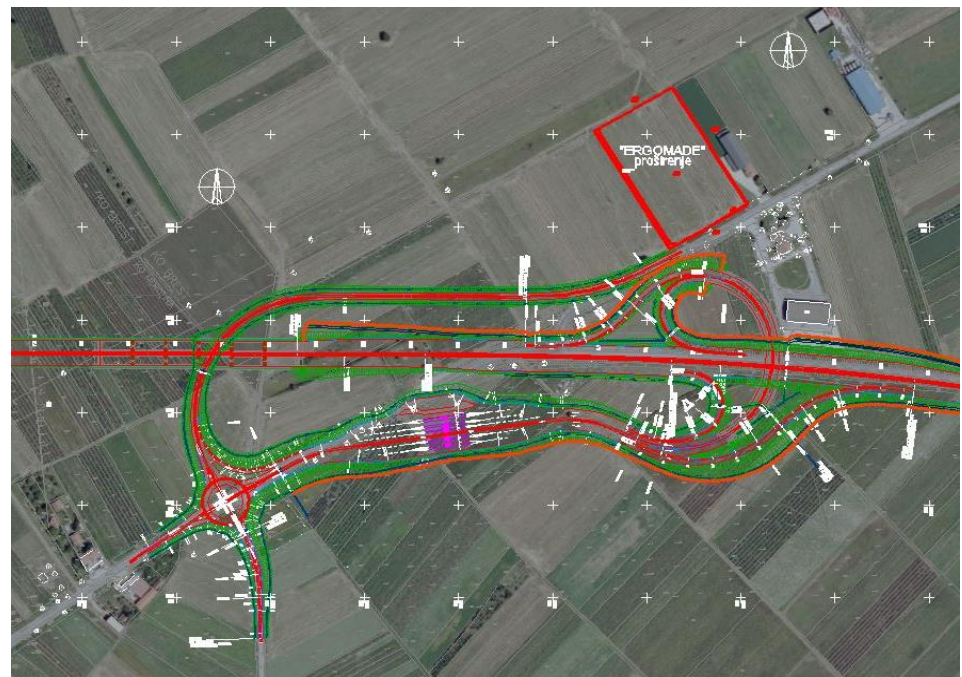


Figure 93 Planned interchange “Merošina 1”



6 Management and Mitigation

6.1 Assessment of residual Impact

Following the identification of mitigation measures, impacts are re-assessed to determine their residual impact. This is essentially a repeat of the impact assessment steps discussed in chapter 5.1, albeit with a consideration of the assumed implementation of the mitigation measures.

6.2 Environmental mitigation measures during construction

6.2.1 Ambient air quality

During the construction works it is necessary to implement a series of measures to reduce negative impacts on air quality to a minimum:

- To prevent uncontrolled spreading of construction material transport means it is necessary to implement the cleaning of vehicles before leaving the public areas as well as the obligatory covering or wetting the material to be transported to avoid its scattering;
- When weather is dry and windy, regularly wetting the surface that could lead to scattering of dust;
- Provide technical validity of machinery, regular (if necessary emergency) technical controls of norms emissions.

If appropriate dust suppression measures are implemented, the residual impact is assessed to be minor adverse.

Table 67 Air quality impact and mitigation measures during construction

Impact description	Impact assessment for the area of the interest	Mitigation measures	Residual impact
Spreading of construction material and dust in the air can be caused by: (1) demolition of buildings situated along the proposed route, (2) earthworks (including land clearing, excavation, levelling, tunnelling),	Moderate impact from building demolition in the vicinity of residential receptors	Cleaning of vehicles before leaving the public areas Obligatory covering or wetting the material to be transported to avoid its scattering When weather is dry and windy, regularly	Negligible

Impact description	Impact assessment for the area of the interest	Mitigation measures	Residual impact
(3) transport and disposal of excavated and surplus filling material and storage of filling and backfill material, (4) movement of construction mechanisation and transport vehicles.	Minor impact from air emissions during earthworks on dust soiling	wetting the surface that could lead to scattering of dust Provide technical validity of machinery, regular (if necessary emergency) technical controls of norms emissions	

6.2.2 Soil and erosion

Erosion protection measures

Properly designed slope protection and stabilization have to include two components: a vegetation-biological and a mechanical-structural component. Maximum effect is obtained when both components are integrally planned before road construction. The best protection is properly designed and planted forest cover or another vegetative cover. Forest reclamation measures include all types of afforestation; forest protective belts planting, erosion protection belts, and other measures within watersheds.

Technical (mechanical-structural) erosion protection measures include levelling, terracing (bench and sloping terraces), design of graded ditches, level ditches, transversal objects (belts, bunds and barriers) from wattle, gabions, stones, concrete and other materials, dams, pans, longitudinal objects, embankments and regulations made of wattle, gabions, stone, concrete and other material, walls and palisades, dams and micro-accumulations. Integrated application of these measures is the most effective. Technical erosion protective works aim to control energy and transport of deposit (debris flow) during erosion process, while forest (vegetative-biological) reclamation measures have active and direct protective role on soil resistance to intensified erosion.

Table 68 Soil erosion impact and mitigation measures during construction

Impact description	Impact assessment for the area of the interest	Mitigation measures	Residual impact
(1) From the Krajковаčka River to Jugbogdanovačka River, terrain is characterised with moderate erosion category, III-6, with Z ranging from 0.56-0.70 and less often with strong erosion, category II-5, with Z ranging from 0.71-0.85. This is an area of vertisols and eutric cambisols. Attention should be paid on 10-13 km of the route where	(1) Possible launching of erosive processes and landslides during the construction of a section of the highway between Krajковаčka River and Jugbogdanovačka river (km 8+100 to km 14+100) (2) Possible launching of erosive processes and landslides during the construction of the highway section Prokuplje Bypass (km 17+000 to km 22+000)	All parts of terrain with greater slopes on the highway route are planned to be regulated with bridges or tunnels. In area (2) the tunnel "Računkovo hill" is planned to be constructed. In area (1), before and after tunnel	Minor

Impact description	Impact assessment for the area of the interest	Mitigation measures	Residual impact
the highway passes over terrain characterized with colluvial processes. (2) Part of route north and west from Prokuplje passes over area highly affected by erosion, II-5 category.		Debelo brdo, slope cut stabilisation with bore piles is planned. In the area before tunnel Vrsnik (km 19+500), and after tunnel Računkovo brdo (km 21+400) a rock cut stabilization measure is provided by applying regular anchoring, placing of steel wire mesh, and geo-mats	
Erosion coefficient ranges from 0.31-0.40 (IV – 8 category, weak erosion) on almost 17-18 km length of highway.	During construction phase erosion process could occur on locations with temporarily built engineering structures.	It is necessary to design a plan for remediation and rehabilitation of the affected soil by erosion.	Negligible

Soil mitigation measures during construction

Soil conservation measures during the phase of highway construction should be conducted in accordance with established measures and terms of environmental protection specified by authorities. It includes the following measures:

- Complete topsoil material which will be removed during highway construction should be used for highway side slopes. It would be the best to embed the humus material without previous storage. If the storage is necessary, it must be provided on regulated dumps and based upon principles of humus material conservation;
- To avoid effects of soil compaction it is necessary to rationalize all vehicles movement. This particularly refers to soils having groundwater level, as in costal zones of Toplica River and its tributaries. Excavation in this type of soil should be performed under optimal conditions of soil moisture. Removal of the humus material should be done in as a single action to avoid soil subsurface horizons compaction;
- On humus material dump sites, groundwater level should not have effect on additional watering of topsoil;
- It is very important to protect all parts of terrain around the zone of direct operations. Strict protection of these parts of terrain implies that they cannot be used as permanent or temporally dump sites, borrow pits, or plateau for parking and reparation of machines, or machine washing zones.

In terms of obligations to agricultural producers during highway construction, and in accordance with determined measures and terms of environmental protection, and in accordance with Law on Environmental Protection (Official Gazette of RS ", no.

135 / 04,36 / 09, 72/09, 43/11, and 14/16) pedo-sequences protection measures include following measures and required works:

- Formation of auxiliary agricultural roads should be avoided using existing road network. If it is necessary to construct auxiliary roads or access roads, it is necessary to start with removing fertile humus layer and foresees revitalization and reclamation of arable soil after highway construction.
- It is necessary to provide access to agricultural machinery to parcels, which can be solved through the construction of temporally access roads, and it is necessary to revitalize and restore soil over which access roads are constructed after highway construction.
- Expropriation study should determine soil value and provide funds for compensation, and propose replacement locations to perform agricultural activities even during the construction phase, with no loss of the agricultural season.
- It is necessary to forbid opening of access roads around the construction site.
- During construction works, construction sites should be marked with fence and nearby soil protected from compaction. It is important to avoid soil susceptible to compaction as an operating zone for heavy machinery.
- After construction works, fertile soil should be embedded on side slopes of newly built embankment. This way of reuse of excavated soil is useful for fast vegetation development, which prevents erosion and lowers potential maintenance costs.
- Coating of embankment with humus material is possible only on slopes that provide starting conditions for protection from erosion;
- All petroleum and its derivatives manipulations during construction works, like machine supply, are necessary to perform on defined place with maximum precautions to avoid spilling. It is the same for oil packaging and other oil derivate, which must be collected and taken on controlled contractor made landfills from where should be taken away by authorized utility company;
- Machines must be parked on regulated places. These parking's should be protected from soil pollution by oil, oil derivate, naphtha and naphtha derivate. If it comes to soil pollution due to oil spilling or in some other way, polluted soil should be removed and taken away on permanent landfill.
- To avoid spreading of solid waste, which is usually found during construction and operation at construction sites (food packaging, other solid waste), its collection and deposition on regulated landfills, must be done.
- It is necessary to forbid machine and vehicle washing in a construction zone as well as concrete mixer washing and uncontrolled removal of the remaining parts of concrete mass on any surface outside road area.
- Reclamation projects must be designed for all borrow pits and landfills in order to avoid degradation of larger areas.
- Smooth mining should be conducted down the slope.

- Take into consideration maximum slope degree on which vegetation can be naturally maintained during the covering of side slopes and embankments. Under the steeper slopes soil should be firmed with wire mesh and grasses and autochthonous bushes should be grown below it.
- Sand and borrow pits can be opened and reclaimed only in accordance with the terms of Institute for Nature Conservation. Protected habitats, fertile, arable and similar areas should not be used as a landfill locations.
- Borrow pits cannot be opened deeper than maximum level of groundwater, to avoid the occurrence of open phreatic level.
- After tunnel construction, all mechanization, construction material and containers should be taken away, and soil should be cultivated by planting appropriate vegetation that corresponds to micro-location and edaphic characteristics.

Table 69 Soil impact and mitigation measures during construction

Impact description	Impact assessment for the area of the interest	Mitigation measures	Residual impact
Removing of topsoil material for the construction of the highway	(1) Physical loss of land through expropriation, as well as removal of topsoil horizon and its permanent loss. Permanent loss within the narrow area is considered as minor significance	Complete topsoil material which will be removed during highway construction should be used for highway side slopes. It would be the best to embed the humus material without previous storage. If the storage is necessary, it must be provided on regulated dumps and based upon principles of humus material conservation; After construction works, fertile soil should be embedded on side slopes of newly built embankment. This way of reuse of excavated soil is useful for fast vegetation development, which prevents erosion and lowers potential maintenance costs.	Minor
(2) Soil compaction during construction	(2) moving machinery at and around the site during construction causes compaction, considered as negligible impact	During construction works, construction sites should be marked with fence and nearby soil protected from compaction.	Negligible
(3) Improper handling of oil and its derivatives that are used for machinery	(3) soil pollution from oil and derivatives considered as minor significance	All petroleum and its derivatives manipulations during construction works, like machine supply, are necessary to perform on defined place with maximum precautions to avoid spilling. It is the same for oil packaging and other oil derivate, which must be collected and taken on controlled contractor made landfills from where should be taken away by authorized utility company;	

6.2.3 Surface water and groundwater

Temporary diversion of river beds during construction should not disrupt the flow regime and sediment in terms of flooding and erosion. These works also must not degrade the surrounding soil in hydrogeological terms.

Protective temporary constructions must be in accordance with the probability risks in terms of duration of the work.

Protection measures include all the procedures necessary for bringing quantified adverse impacts in the allowable limits and procedures to minimize the impact during the construction phase:

- Excavation and preparation of foundations for the abutments, retaining walls and other objects that are on/near surface water bodies, execute in the period of low water levels (July - September) to minimize negative impacts on rivers and their banks.
- Insure pillars from deep and lateral erosion in the coastal zone
- Make bridges with as few pillars as possible in the trough, so that the axis of the bridge is perpendicular to the river flow, and the axis of the pillars of the bridge in the direction of the stream
- Perform the necessary regulatory work to stabilize and protect the the ruinous shores near the highway. Existing and new buildings must be interconnected, and existing buildings must not be removed or damaged during the execution of works on the highway and other facilities in its corridor.
- On positions where the highway route is parallel to the river, it is obligatory to carry out the lining to the river , in order to protect the hull derivated from the fill material
- At the crossroads of the highways and bridge with river, tehcnical solutions for the construction must be in tune with plans for protection from floods and ice. Provide an unobstructed access to services and machinery for flood protection to protected wather facilities. The height between the lower edge of the bridge structure and the embankment crown should be minimum 3,0 m.
- Perform the necessary analyzes regarding the possible selection of borrowing material, impacts on groundwater and the manner of closing and recultivating the borrower after the construction of the facilities. The choice of site location, dynamics and method of exploitation of materials must be such that it does not adversely affect the quality and quantity of underground and surface waters. It is necessary to implement the activities related to the planning of the extraction of river deposits in accordance with the Plan for extraction of river deposits on the territory of the Republic of Serbia and in cooperation with the PE "Srbijavode". If it is planned to use material from the river bed, it is necessary to ask for special water conditions, to make technical documentation and obtain water consent on the same.

- The water quality of all watercourses must not be compromised, an unobstructed regime must be allowed and the defense against erosion and floods must not be disabled
- As part of geotechnical investigations, define the groundwater regime and provide a solution for the rehabilitation of the terrain at the site of a possible landslide;
- During the execution of works, the pipes of the public drinking water supply system must not be endangered, damaged or broken, nor contaminated water can be discharged into underground or surface water, nor damage other water bodies (hydroelectricity channel, dams with accumulation, regulated watercourses, plants for sewage, etc.);
- Spillage of any hazardous substances near the river must be avoided. The Contractor should be required to use biodegradable lubricants for their machines and biodegradable oils for transmissions, to minimize pollution during the works.
- Maintenance, refuelling and cleaning of construction machines execute at locations that are distant from watercourses and which will be defined before the start of works.
- River banks in the exploration area should be protected by fences during the construction phase, to prevent negative impact that may be caused by driving and unloading of materials nearby.
- Avoid driving machines inside rivers, streams, or on their banks, except where this is unavoidable due to the construction of a facility or structure. Also avoid discharge wastewaters originating from the workers into rivers and streams.
- Provide technology documentation for the construction of a bridge that does not interfere with the flow regime. It is also necessary to anticipate that there are no scaffolds and other obstacles in the watercourse, nor the deposit of materials in the watercourse;

Measures to protect the future pipeline for mineral water factory Milan Toplica's waterworks from the influence of the construction of the highway:

- Provide protection of the pipeline before starting the construction of the highway on this section (km 38+495);
- Mandatory presence of representatives of mineral water producers during construction of pillars of the bridge over the Toplica River.

Table 70 Impact to surface and groundwater and mitigation measures during construction

Impact description	Impact assessment for the area of the interest	Mitigation measures	Residual impact
Impact of contamination from the waters washed from the construction sites	Water from construction machinery, uncontrolled disposal of excavated material, uncontrolled drainage of the sanitary waters in places of accommodation of workers, as well as smaller	<ul style="list-style-type: none"> • Spillage of any hazardous substances near the river must be avoided. The Contractor should be required to use biodegradable lubricants for their machines and biodegradable oils for transmissions, to minimize pollution during the works. • Maintenance, refuelling and cleaning of construction machines execute at 	No impact

Impact description	Impact assessment for the area of the interest	Mitigation measures	Residual impact
	(local) pollution from the process of food preparation.	<p>locations that are distant from watercourses and which will be defined before the start of works.</p> <ul style="list-style-type: none"> • River banks in the exploration area should be protected by fences during the construction phase, to prevent negative impact that may be caused by driving and unloading of materials nearby. • Avoid driving machines inside rivers, streams, or on their banks, except where this is unavoidable due to the construction of a facility or structure. Also avoid discharge wastewaters originating from the workers into rivers and streams. 	
Possible turbidity of surface waters in the inundation zone,	During the works, there will be some turbidity especially of the Toplica, and Draguška Rivers and Trnavska and Backa streams, and by erosion during the construction of the foundations and pillars of the new bridges. There are no pillars inside the river flows.	<ul style="list-style-type: none"> • Excavation and preparation of foundations for the abutments, retaining walls and other objects that are on/near surface water bodies, execute in the period of low water levels (July - September) to minimize negative impacts on rivers and their banks. • It is obligation of the contractor is to test the quality of the water upstream from the bridge site before the start of construction work on the bridge • Setting thresholds suspended particulate powder/ turbidity is required and any overruns will cause stop work 	Negligible
The impact on the Milan Toplica mineral water factory pipeline during the construction of bridge pillars	Moderate	<p>Provide protection of the pipeline before starting the construction of the highway on this section (km 38+495);</p> <p>Mandatory presence of representatives of mineral water producers during construction of pillars of the bridge over the Toplica River.</p>	Negligible

6.2.4 Ecology and nature conservation

On section II from "Merošina 1" to "Prokuplje East", the route in a length of 600 m (km 11+475 - km 12+125) is passing through the IPA area "Lalinačka slatina". Two technical solutions have been examined for this section; deep excavation, which is a financially advantageous option, or a tunnel in a length of 200 m, which due to the thin overburden had to be "cut and cover". Both technical solutions envisage soil excavation on the route, but the proposed tunnel solution involves restoring excavated soil on the roof of the tunnel and levelling with the level of the surrounding area.

As mentioned above, the existing water courses and vegetation near the river and the existing forests, which are more or less in patches along the route, are the remains of natural and seminatural habitats, so they are essential for the protected

and strictly protected species of fish, amphibians, reptiles, birds and mammals, as well as the habitat of specific complexes of flora and vegetation.

The following locations refers to river regulations and crossings over watercourses which imposes river regulations therefore should be carefully treated during the execution of works

- Bridge over Aleksandrovački Stream, km 2+988
- Krajковаčka River regulation, km 8+105
- Lepajski Stream regulation, km 8+514
- Pipe culvert, km 10+538
- Jugbogdanovačka River regulation, km 14+062
- Suvi Stream regulation, km 14+235
- Ciganski Stream regulation, km 17+785
- Stržavska River regulation, km 18+433
- Riverbed regulation, Trnavska River, km 22+680
- Junction Prokuplje West, the maintenance and control base, km 23+600
- Drenovački Stream regulation, km 29+019
- Zdravinjska River regulation, km 30+108
- Zdravinjska River regulation, km 31+791
- Bridge at Draguska River, km 34+928
- Suvodolski Stream regulation, 37+533
- Bridge at Backa River in km 38+278
- Toplica River regulation, km 38+550

Regarding technical measures for the protection of flora and fauna should be envisaged the following activities:

- Measures of technical and biological noise protection are required, in accordance with the conditions for silent zones and other acoustic zones. In this regard, envisage the construction of protective fences along the settlements, especially in the zone of low vegetation along the route, as a protection belt from the noise, but also overflow of birds and bats and the starvation of them on the highway route;
- Existing smaller or larger fragments of aquatic and wetland habitats are valuable biotopes of many species and have to be preserved. On the other hand it is also important to not form similar areas during construction near the route, because they will attract many of these species, thus potentially increasing the risk of causing deaths of these species in the operation phase.
- Construction facilities to be sited on unused land of no particular ecological value. This is especially important for and should be beyond the alluvial zone of the Toplica River and outside areas with high vegetation.

- Opt for maximum use and upgrade of the existing network of roads and avoid construction of new temporary ones to minimize loss and fragmentation of vegetation and natural semi-natural habitats, especially in Toplica River alluvion and the forest areas of the Vidojevica mountain.
- No construction materials will be taken from the surrounding environment unless approved by the competent authority;
- Restore sites to their baseline condition where possible upon completion of construction (retaining as much of the original vegetation as possible for reinstatement); Species selection should be harmonized with the surrounding area and its purpose. In forested areas, the construction corridor will be reinstated in cooperation with the competent authorities.
- Establish a pre and post construction biodiversity baseline from which all mitigation, restoration, and loss / degradation can be measured;
- Establish a Reinstatement Plan prior any construction work beginning. The reinstatement plan will be approved by the competent authority;
- Develop appropriate measures against the spread of invasive species during reinstatement and /or landscaping of terrain. Pay attention that alien and especially invasive species are not used for greening
- Design and construct fauna crossing points (i.e. culverts) along the highway. This will facilitate movements and reduce the impact of fragmentation. Preserving the mobility through ecological corridors is a priority for the preservation of the already deteriorating diversity of fauna of amphibians and reptiles in this area. A study before construction should identify both suitable points, type of crossing and technical provisions (inclination, type of substrate, etc). Indicatively
 - Riverbed profile within passages should have an inclination of less than 45° (optimally 30°);
 - The river dikes sides of watercourses within the passages need to be coarsely rough (e.g. making horizontal ribs) to prevent slipping of animals in the water, and facilitate their easier access from the water;
 - The space in front of and behind the passage should be covered with an identical type of land in a given locality, and the natural vegetation of the environment
- Strictly adhere to planned route of the highway and its associated construction corridor. Limit the movement of heavy machinery to existing roads, in particular in the forest areas of the Vidojevica mountain
- Prepare and implement a River Crossings Plan as part of the ESMP.
- Vegetation clearance works will avoid affecting the riparian vegetation, whenever possible, since it provides areas for spawning and sheltering of many aquatic organisms such as fish, macroinvertebrates, amphibians and reptiles (freshwater turtles),
- No temporary facilities to be constructed in the River Toplica alluvion zone.

- During the regulation and landscaping of the riverbed of waterways and their banks, avoid concreting waterbeds (use stone and similar materials).
- In forming the new river bed and banks, preserve as much as possible, their original and authentic look and purpose. In the case of cutting riverbed, it is necessary to ensure some culverts for the smooth flow of water and the movement/migration of aquatic organisms, including fish. All the above should be implemented especially to the following points of proximity to surface permanent water features: Krajčovačka river (8+105), Toplica river (38+550), Jugbogdanovačka river (14+062), and Dragaška river (34+928). These are permanent watercourses which are permanent and where the presence of fishes, amphibians and mammals species may be significant.
- Excavation and preparation of foundations for the abutments, retaining walls and other objects that are on/near surface water bodies, should be done exclusively in either the dry period (for temporary water streams) or the period of low water levels (July - September) to minimize negative impacts on rivers and their banks.
- Delimite areas to be cleared before the beginning of the construction activities, in order to limit as much as possible the surface of vegetation to be cleared.
- Limit the traffic of heavy machinery to existing main roads (including forest ones) to the extent that is possible;
- Speed of vehicles should be limited, in order to limit emission of noise and dust in non-paved accessed roads and in order to limit the risk of accidents with fauna.
- Aim for gradual vegetation clearance in order to retain passage for species as long as possible across the corridor
- Avoid dawn-dusk and night-time works, when activity of nocturnal animals such as carnivore species and bats is increased;
- Conduct a pre-construction inspection of the areas to be cleared in order to manually transfer and remove observed tortoises to nearby locations. This is expected to reduce direct mortality.
- In order to avoid any disturbance to species during the breeding season and subsequent breeding failure, vegetation clearance works should start if possible before the breeding season (spring).
- Develop and implement a Biodiversity Action Plan (BAP) as part of the ESMP.
- In the unlikely case that nests of species of conservational interest (eg Ciconia ciconia) should be located, their relocation could be investigated, under the special conditions of the Institute for Nature Conservation of Serbia;
- Wastes created during construction will be managed under an Environmental Management Plan, to limit the disturbance to fauna as a result of presence of wastes and spills.
- When planning installation of lighting in the corridor around the highway, bridges, overpasses, loop, access roads, etc., applied appropriate technical solutions (focus light sources "down", minimum illumination without using the "decorative" light sources).

- On the highway is advisable to use non shadowing screen for protection against the dispersion of light.
- Prepare a Waste Management Plan as part of the ESMP. This Plan should include among its other objectives the avoidance of any spill affecting to the freshwater ecosystems.
- Wastes as well as any other product containing hazardous chemical substances (i.e. fuel) will not be discharged in the surface waters and will not be stored in the proximity of freshwater features.
- Excavated materials will not be dumped into freshwater features, nor will they be stored in their proximity, to avoid additional increase of the turbidity levels.
- Maintenance, refuelling and cleaning of construction machines must be scheduled in locations distant from watercourses and which will be defined before the start of works.
- Avoid driving machines inside rivers, streams, or on their banks, except where this is unavoidable due to the construction of a facility or structure

A large proportion of habitat in the areas crossed by the highway route is highly modified, fragmented and disturbed. These sections should be easy to restore after the temporary construction work activities. Losses of natural and semi-natural vegetation will be mitigated by habitat restoration or replacement, i.e. replanting the temporary affected footprints with regional plant species and seeds. These measures will be detailed in the Site Reinstatement Plan.

Table 71 Impact to biodiversity and mitigation measures during construction

Type of Impact/ Impact Description	Impact Assessment	Mitigation Measures	Residual Impact
HABITAT CHANGE			
Habitat loss and degradation A number of activities during the construction can result in the damage and loss of habitats: Vegetation clearance, soil removal, rock excavations, borrow pits and quarries modification of landscape.	Moderate - Since the predominant vegetation along the route of the highway and the corridor around is not natural, but semi-natural or pure agro ecosystems, there are no flora species of conservation interest, or natural habitats of conservation interest. Animal societies in such habitats consist predominantly of species with considerable ecological plasticity and resilience, common and with widespread home ranges in Serbia, so their conservation status would not be affected significantly by the mentioned impact.	<ul style="list-style-type: none"> • Construction facilities to be sited on unused land of no particular ecological value. This is especially important for and should be beyond the alluvial zone of the Toplica River and outside areas with high vegetation. • Opt for maximum use and upgrade of the existing network of roads and avoid construction of new temporary ones to minimize loss and fragmentation of vegetation and natural semi-natural habitats. • No construction materials will be taken from the surrounding environment unless approved by the competent authority; • Restoration of sites to their baseline condition where possible upon completion of construction (retaining as much of the original vegetation as possible for reinstatement); Species selection should be harmonized with the surrounding area and its purpose. 	Minor

Type of Impact/ Impact Description	Impact Assessment	Mitigation Measures	Residual Impact
		<ul style="list-style-type: none"> • In forested areas, the construction corridor will be reinstated in cooperation with the competent authorities. • Establish a pre and post construction biodiversity baseline from which all mitigation, restoration, and loss / degradation can be measured; • Establish a Reinstatement Plan prior any construction work beginning. The reinstatement plan will be approved by the competent authority; • Restore as soon as possible after completion of works all surfaces that are in any way degraded with construction and other work; • Develop appropriate measures against the spread of invasive species during reinstatement and /or landscaping of terrain. Pay attention that alien and especially invasive species are not used for greening. 	
Habitat Fragmentation Linear infrastructures, such as highways, contribute significantly towards the habitat fragmentation. Building of a closed highway will cause fragmentation and separation of habitats. In addition, this may cause the interruption of daily or seasonal movements for some terrestrial animal species (i.e. reptiles and mammals), disturbing the usual behaviour patterns of certain species.	Minor. The proposed route mostly crosses agricultural land with a few semi-natural habitats. So there will be no fragmentation of critical habitats or natural habitats of conservation importance. Some close to -natural habitats in the vicinity are not affected by the route of the highway	<ul style="list-style-type: none"> • Design and construct fauna crossing points (i.e. culverts) along the highway. This will facilitate movements and reduce the impact of fragmentation. A study before construction should identify both suitable points, type of crossing and technical provisions (inclination, type of substrate, etc). • Opt for maximum use and upgrade of the existing network of roads and avoid construction of new temporary ones to minimize loss and fragmentation of vegetation and natural semi-natural habitats, especially in Toplica River alluvion and the forest areas of the Vidojevica Mountain. • Strictly adhere to planned route of the highway and its associated construction corridor. Limit the movement of heavy machinery to existing roads, in particular in the forest areas of the Vidojevica Mountain. 	Minor
Degradation of riparian zone due to regulation of watercourses. The regulation and construction of river crossings could significantly affect the ecological characteristics of	Minor - The existing permanent watercourses are not significant for the spawning and seasonal migration of fish, amphibians, reptiles and/or mammals. Planned works are spatially and time restricted. Regulation is planned on the limited and minor part of watercourses. So, communication will be	<ul style="list-style-type: none"> • Prepare and implement a River Crossings Plan as part of the ESMP. • Vegetation clearance works will avoid affecting the riparian vegetation, whenever possible, since it provides areas for spawning and sheltering of many aquatic organisms such as fish, macroinvertebrates, amphibians and reptiles (freshwater turtles), 	Minor

Type of Impact/ Impact Description	Impact Assessment	Mitigation Measures	Residual Impact
rivers and water streams (river banks, riparian vegetation), the riparian flora and vegetation and subsequently the fauna (esp freshwater fish, amphibians, freshwater terrapins) and some mammal species as well, esp. the otter.	enhanced again, after the construction period.	<ul style="list-style-type: none"> • No temporary facilities to be constructed in the River Toplica alluvion zone. • During the regulation and landscaping of the riverbed of waterways and their banks, avoid concreting waterbeds (use stone and similar materials). • In forming the new river bed and banks, preserve as much as possible, their original and authentic look and purpose. In the case of cutting riverbed, it is necessary to ensure some culverts for the smooth flow of water and the movement/migration of aquatic organisms, including fish. • Strictly adhere to planned route of the highway and its associated construction corridor. Limit the movement of heavy machinery to existing roads, in particular the Toplica River alluvion. • All the above should be implemented especially to the following points of proximity to surface permanent water features: Krajčovačka river (8+105), Toplica river (38+550), Jugbogdanovačka river (14+062), and Dragaška river (34+928). These are watercourses which are permanent and where the presence of fish, amphibians and mammals species may be significant. • Excavation and preparation of foundations for the abutments, retaining walls and other objects that are on/near surface water bodies, should be done exclusively in either the dry period (for temporary water streams) or the period of low water levels (July - September) to minimize negative impacts on rivers and their banks. 	
Degradation of freshwater quality There are a number of activities during construction that can result in damage to the freshwater ecosystems. These include soil and rock excavations, borrow pits and quarries, the construction of culverts, bridges and viaducts and	Minor - Permanent watercourses that the highway crossing over are not important spawning places either for fish species or other ones (amphibians, reptiles and mammals). Although high levels of turbidity can affect fish populations, in most of the cases they are temporal events.	<ul style="list-style-type: none"> • Prepare a Waste Management Plan as part of the ESMP. This Plan should include among its other objectives the avoidance of any spill affecting to the freshwater ecosystems. • Wastes as well as any other product containing hazardous chemical substances (i.e. fuel) will not be discharged in the surface waters and will not be stored in the proximity of freshwater features. • Excavated materials will not be dumped into freshwater features, nor will they be stored in their proximity, to 	Minor

Type of Impact/ Impact Description	Impact Assessment	Mitigation Measures	Residual Impact
increased turbidity during construction activities within the water streams. Impacts are related to both deterioration of water quality (accidental spills of fuel or hazardous wastes are another possible threat)		avoid additional increase of the turbidity levels. <ul style="list-style-type: none"> Maintenance, refuelling and cleaning of construction machines must be scheduled in locations distant from watercourses and which will be defined before the start of works. Avoid driving machines inside rivers, streams, or on their banks, except where this is unavoidable due to the construction of a facility or structure. 	
SPECIES LOSS, DISTURBANCE AND DISPLACEMENT			
Loss of flora Flora species will be directly affected from the road construction through vegetation removal. Accidental loss of fauna Direct mortality may affect small mammals and reptiles (e.g. tortoise) and amphibian individuals by vegetation clearance, construction activities along the road or traffic on the access routes and machinery movement. Species disturbance Construction activities can directly and indirectly cause disturbance to fauna species, mostly due to the presence and activity of the machinery.	Minor - There are no species whose conservation status would be affected and threatened by the occasional accidents on the highway. In addition, due to the temporary nature of the activities, no threats to populations are anticipated Regarding flora, it is unlikely that any particular mitigation measures will be a necessity regarding the recovery of protected plant taxa along the proposed route. No nesting of important bird species is expected in the area,	<ul style="list-style-type: none"> Delimitation of areas to be cleared before the beginning of the construction activities, in order to limit as much as possible the surface of vegetation to be cleared. Limit the traffic of heavy machinery to existing main roads (including forest ones) to the extent that is possible; Speed of vehicles should be limited, in order to limit emission of noise and dust in non-paved accessed roads and in order to limit the risk of accidents with fauna. Aim for gradual vegetation clearance in order to retain passage for species as long as possible across the corridor Avoid dawn-dusk and night-time works, when activity of nocturnal animals such as carnivore species and bats is increased; Conduct a pre-construction inspection of the areas to be cleared in order to manually transfer and remove observed tortoises to nearby locations. This is expected to reduce direct mortality. In order to avoid any disturbance to species during the breeding season and subsequent breeding failure, vegetation clearance works should start if possible before the breeding season (spring). Develop and implement a Biodiversity Action Plan (BAP) as part of the ESMP. In the unlikely case that nests of species of conservational interest (eg <i>Ciconia ciconia</i>) should be located, their relocation could be investigated, under the special conditions of the Institute for Nature Conservation of Serbia; 	Minor

Type of Impact/ Impact Description	Impact Assessment	Mitigation Measures	Residual Impact
		<ul style="list-style-type: none"> Wastes created during construction will be managed under an Environmental Management Plan, to limit the disturbance to fauna as a result of presence of wastes and spills. 	
Light - Sources of artificial light can be jeopardizing factors, especially for nocturnal species and especially –bats, because they function as "light traps", and also increase stress acting on the species in the vicinity of the motorway.	Minor - The species of bats and nocturnal birds of prey that are present in the area are common and widespread in Serbia, and there are no expectations about the substantially threatening of their conservation status.	<ul style="list-style-type: none"> When planning installation of lighting in the corridor around the highway, bridges, overpasses, loop, access roads, etc., applied appropriate technical solutions (focus light sources "down", minimum illumination without using the "decorative" light sources). On the highway is advisable to use non shadowing screen for protection against the dispersion of light. 	Minor

6.2.5 Excavated materials and waste management

The contractors have to minimise the waste generated from their construction activities where practicable. Waste management measures will be enforced 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).

- Exact position of landfills will be determined in later phases, by examining locations "in situ".
- In case new borrow pits are determined they should be subject to review for environmental impacts before use. Protected habitats, watercourses, fertile, arable and similar areas should not be used as a landfill locations.
- Construction Waste Management Plan (CWMP) will be prepared and maintained by the Contractor of works. The Plan will identify the specific types and quantities of waste likely to arise during the construction process, including: excavated materials, construction, demolition and excavation waste;
- The majority of excavated material that will be generated will be reused, if suitable, either as engineering fill material or in the environmental mitigation earthworks of the project;
- Where generated, waste will be classified in accordance with the Serbian regulatory requirements on inert, non-hazardous and hazardous waste;
- Mixing of inert, hazardous and non-hazardous waste, either during collection or storage will not be permitted;
- Waste will be segregated and stored in containers (skips) and other storage vessels, clearly labelled, sheeted or closed when waste is not disposed in them;

- Plastic sheeting will be used to prevent leaching from waste soils and aggregates where these are not contained within skips or other storage vessels;
- Liquid wastes will be stored on hard-surfaced areas with secondary containment to prevent spillages;
- 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;
- A pre-demolition asbestos survey will be undertaken on all buildings to be demolished or refurbished to identify the presence of any asbestos-containing materials (ACM) that may be present. Where identified, ACM will be removed by licensed asbestos removal contractor and managed in accordance with the Serbian regulatory requirements on asbestos-containing waste.
- Maintenance of the construction machinery will not be provided in construction worksites. The machinery and equipment will be transferred to the agreed service centres in the closest towns. Therefore, such types of waste (waste lubricants, oils, oil filters from equipment and machinery, waste fuels, tyres, absorbable pads and oily rags, etc.) are not expected to be generated at worksites. In the case of incidental repairs, leakage of fuel or oil, the polluted soil will be removed and taken to a landfill.

Table 72 Excavated material and waste impact to and mitigation measures during construction

Impact description	Impact assessment for the area of the interest	Mitigation measures	Residual impact
The proposed construction works will generate a significant volume of non-hazardous and inert waste whose inadequate management could result in the major adverse environmental impact.	Major	<ul style="list-style-type: none"> • Construction Waste Management Plan (CWMP) will be prepared and maintained by the Contractor of works. The Plan will identify the specific types and quantities of waste likely to arise during the construction process, including: excavated materials, construction, demolition and excavation waste; • The majority of excavated material that will be generated will be reused, if suitable, either as engineering fill material or in the environmental mitigation earthworks of the project; • Exact position of landfills will be determined in later phases, by examining locations "in situ". • In case new borrow pits are determined they should be subject to review for environmental impacts before use. Protected habitats, watercourses, fertile, arable and similar areas should not be used as a landfill locations • A pre-demolition asbestos survey will be undertaken on all buildings to be demolished or refurbished to identify the presence of any asbestos-containing materials (ACM) that may be 	Minor

		present. Where identified, ACM will be removed by licensed asbestos removal contractor and managed in accordance with the Serbian regulatory requirements on asbestos-containing waste.	
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6.2.6 Landscape and visual

To protect the landscape in the planned corridor are necessary the following measures of protection:

- From the visual aspect, the land is an essential element in the landscape, because land degradation affects the conversion of land from agricultural to anthropogenically altered and degraded land. The impacts on the landscape can be mitigated by ensuring when organizing the site and setting up facilities that these facilities are concentrated mainly in places where planned bridges, viaducts and tunnels along the route are.
- All open cuts should be planted right after finishing to prevent soil erosion. This should include as less degradation and fragmentation, how the landscape would not lose its character.
- All degraded areas should be rehabilitated with new elements of greenery, so that land, and with it the landscape, returned to its original state.

Table 73 Landscape and visual impact to and mitigation measures during construction

Impact description	Impact assessment for the area of the interest	Mitigation measures	Residual impact
Temporary impacts could damage the landscape, disrupting the identity of the area (the image of the landscape and visual continuity).	Minor	<ul style="list-style-type: none"> After completion of the work, the obligation of the contractor is to bring the site to the state before the work started, except of the junction Prokuplje (West), where is the planned base for maintenance for the motorway during operation. Organize the site and setting up facilities concentrated mainly in places where planned bridges, viaducts and tunnels along the route are. All open cuts should be planted right after finishing to prevent soil erosion. This should include as less degradation and fragmentation, how the landscape would not lose its character. All degraded areas should be rehabilitated with new elements of greenery, so that land, and with it the landscape, returned to its original state. 	Negligible

6.3 Social Mitigation Measures during Construction

The mitigation measures to be taken during construction are elaborated in more depth in Annex 1: SIA. Herebelow an outline of the main topics is presented.

6.3.1 Summary of Key Social Measures

Community perception and support

The expectations of benefits related to the Project from local community and business might have a negative, moderate impact if not managed adequately. Expectation shall be managed by applying maximum transparency and implementing the Stakeholder engagement Plan.

Land acquisition and resettlement

KS will ensure that effects of physical and economic displacement are minimised and that people affected by the project will be compensated in accordance with the principles set in the Resettlement Compensation Framework:

- A detailed socio-economic assessment will be undertaken to identify impacts on people affected by the project, including land acquisition impacts and restriction to land use;
- A census will be carried out to determine: persons to be displaced by the project, persons that are eligible for compensation and assistance, inventory of affected land and property;
- A Resettlement Action Plan (RAP) will be prepared, based on the Expropriation Study, the socio-economic assessment and the census. It will detail the impacts of the project on land ownership, land use, property and livelihoods. The RAP will set out the resettlement-specific stakeholders and the consultations that are required, and will set out the measures needed to address gaps between national laws and EBRD requirements, including how those will be addressed in practice;
- The amount of land occupied/disrupted during construction will be minimised;
- Users of land will be timely informed when construction is planned to begin and how lost crops and damages will be compensated;
- All users of land whose crops are lost or affected by any other damage during construction will be compensated at full replacement value, in accordance with the Serbian legislation and the EBRD Policy;
- Any business losses will be compensated at full replacement value, in accordance with the Serbian legislation and the EBRD Policy;
- Grievance mechanism will be established;
- Temporary affected land will be reinstated/restored to its pre-construction condition.
- If compensation alone is not sufficient to restore livelihoods, implement livelihood restoration measures in accordance with IFI policies.

Temporary worker influx and population change

The influx of workers to be avoided by tapping into the local pool of workforce. The Screening of capacity of locally available pool of workforce will assess and manage labour influx. Incorporate social mitigation measures into the civil works contracts. Contractor will be required to hire workers through recruitment offices and avoid hiring “at the gate” to discourage spontaneous influx of job seekers. Local government to address this additional influx of the “followers” to ensure that no illegal and unsafe settlements develop. Ensure supervision engineer’s responsibilities regarding oversight of, and reporting on, labour influx and workers’ camps (if any). KS will make the Contractor to liaison with local services to keep track of changes in capacity of local services in respect to anticipated influx. A contingency plan for temporary rise in demand for utilities and public services shall be in place.

Gender differentiated impact

Temporary direct and indirect employment opportunities will occur. During assessment of available experts and workers in the local pool identify the positions suitable for women and those equally suitable for both sexes in order to identify

possible available workforce. The employment Plan could set a quota of women to be hired under the Project.

Education and Skills

In employment opportunities employment programs shall be designed to upgrade existing or add new. Opportunities for sub-contractor's smaller companies to gain references shall be enhanced during assessment of available workforce in the local pool announce the tentative services, works subject to possible sub-contracting so small companies can cooperate in order to maximize the opportunity. Temporary employment and on-the-job training of vulnerable groups shall be enhanced by inclusion of requirement that the Contractor shall explicitly include Roma community leaders in the advertisement effort for job openings and reflect this in his Employment Plan in collaboration with the Roma Association from Merošina and Prokuplje. Prior to that Roma community should be included during the in-depth assessment of available workforce.

Employment and economy

Local employment should be maximized by establishing fair, transparent and equal opportunities for employment. This will be facilitated by a mandatory Employment plan to be prepared by the Contractor. In order to enhance opportunities for local suppliers and subcontractors Advance information on tendering opportunities will be provided to local businesses through trade and industry chambers and local business organisations and transparent and competitive engagement policies

Infrastructure

Temporary loss of, or access to, infrastructure or services shall be avoided by providing alternative routes and roads, Inform local communities of program and sequence of works. The mitigation measures shall be designed through a Traffic Management plan Infrastructure and Utilities Management Plan; Emergency Response plan in respect to supply of water and electricity all mandatory documents to be prepared by the Contractor. Disruption of mobile providers or TV network, internet services due to collision with uncharted utilities shall be mitigated by conducting a reconnaissance survey to identify possible location of uncharted utility and liaison with the Service providers to identify the location of uncharted utilities

Labour and working conditions

The employment, although project dependent, has been assessed as moderately positive. The Project is required to comply, at a minimum, with national labour, social security and occupational health and safety laws, and the fundamental principles and standards embodied in the ILO conventions. The Contracts for construction work will specify such minimum principles and standards and regular Labour and working condition audits shall be performed.

Access to health services

Influx of workers by itself could induce potential impact in increased demand for health services. The influx, as explained will be minor, and will not impose pressure

to the health services. The capacity of existing health facilities are able to absorb without major disruption any potential demand for care and attendance to acute conditions of the influx workers (in case of curative or emergency cases. The impact shall be mitigated by maintaining current capacity of medical staff and equipment.

Acces to education

The Baseline has shown that the educational network comprises not only of mainstream facilities in the heart of the administrative centres of the two main impact receptors community Possible disruption of transportation routes of school and pre-school children from and to remote school facilities in both receptor communities with emphasis on Villages Devča, Dešilovo, Aleksandrovo, Arbanasce and Kostadinovac. Possible disruption of transportation routes

Possible disruption of transportation routes of school children from Tulare to Donja Draguša, Končić to Bresnić and Gornja Stražava to Donja Stražava. These impacts shall be mitigated Prepare a traffic management plan.

Exchange with school representatives timetable of all transportation routes for both Municipalities. To the extent feasible harmonize disruption and complete stand still of traffic with school timetable

6.3.2 Noise and vibration

KS will require the contractors to minimise noise and vibration at neighbouring residential properties and other sensitive receptors (including ecological receptors, local businesses, etc.) arising from construction activities. The following measures will be implemented:

- Noise and vibration affected residential or business receptors will be timely informed of the construction activity through appropriate communication channels;
- All staff will be briefed on the requirement to minimise nuisance from construction activities;
- Where appropriate, haul routes for construction material will avoid additional nuisance in residential areas or at sensitive sites;
- Construction operations will have agreed and limited site working hours for “normal” construction activities; works that require working outside of normal working hours will be minimized;
- Best Practicable Means will be used during construction work;
- Where appropriate, silenced / enclosed construction equipment / machinery will be utilised;
- All plants, vehicles and machinery used during construction will be regularly maintained and turned-off when not in use;
- During taking significantly noisy or vibration-causing operations near to sensitive locations (e.g. tunnelling), agreed criteria for works would be established.

Table 74 Noise impact and mitigation measures during construction

Impact description	Impact assessment for the area of the interest	Mitigation measures	Residual impact
<p>(1) There will be noise generated from the concrete batch plants and vehicle movements.</p> <p>Where construction noise levels are anticipated to be above 55dB LAeq,T during the day, significant noise impacts are expected to be registered. Such impacts are classified as moderate to high. Where construction noise levels are below 55dB LAeq,T during the day, insignificant noise impacts are expected, classified as low</p>	<p>(1) Properties near the roads which will be used for construction traffic (including rotating mixer trucks) have the greatest potential for increases in noise due to construction traffic.</p> <p>(2) For a receptor sensitivity of high, which is the case in Prokuplje, Jugbogdanovac and Beloljin the adverse impact significance will be moderate.</p>	<ul style="list-style-type: none"> • Noise and vibration affected residential or business receptors will be timely informed of the construction activity through appropriate communication channels; • All staff will be briefed on the requirement to minimise nuisance from construction activities; • Where appropriate, haul routes for construction material will avoid additional nuisance in residential areas or at sensitive sites; • Construction operations will have agreed and limited site working hours for "normal" construction activities; works that require working outside of normal working hours will be minimized; • Best Practicable Means will be used during construction work; • Where appropriate, silenced / enclosed construction equipment / machinery will be utilised; • All plants, vehicles and machinery used during construction will be regularly maintained and turned-off when not in use; 	Negligible
<p>Vibrations caused by blasting and the effects of such vibrations can become dangerous if the tunnel passes through the populated area or close to buildings or structures.</p>	<p>For tunnels "Vrsnik" and "Plehane kuće" the significance of impact can be consider as minor.</p>	<ul style="list-style-type: none"> • During taking significantly noisy or vibration-causing operations near to sensitive locations (e.g. tunnelling), agreed criteria for works would be established. • It is recommended to perform in-situ measurements of vibration during the construction works. These measurements can be used to improve the system of blasting and excavation. 	Negligible

6.3.3 Cultural heritage

After all contacts with the competent institutes for the protection of cultural monuments (from Belgrade and Nis), the conclusion is that the implementation of the prescribed measures during the execution of works on the highway will ensure the preservation of cultural assets:

- The beneficiary is obliged to provide all the conditions and enable smooth and constant monitoring of works, during the entire duration of the earthworks, by the archaeological team - archaeological supervision;
- If during the performance of the works the contractor encounters at archaeological and/or historical sites or archaeological objects or objects from the past, he shall immediately suspend the works and notify the competent Institute for the Protection of Cultural Monuments from Niš without delay, and take measures to the finding does not destroy and not damage and is preserved in place and in the position in which it is discovered, as well as to provide conditions for protective archaeological research;
- The investor of the facility is obliged to provide funds for research, protection, keeping, publishing and exhibiting goods that are discovered during the construction of the investment facility, until the transfer of the goods to the authorized institution.

Table 75 Impact to cultural heritage and mitigation measures during construction

Impact description	Impact assessment for the area of the interest	Mitigation measures	Residual impact
Within the corridor of the planned highway, but outside its borders, there is a number determined immovable cultural goods, and goods under protection.	Moderate	<ul style="list-style-type: none"> • “Corridors of Serbia” (KSDOO) is obliged to provide all the conditions and enable smooth and constant monitoring of works, during the entire duration of the earthworks, by the archaeological team - archaeological supervision; • If during the performance of the works the contractor encounters at archaeological and/or historical sites or archaeological objects or objects from the past, he shall immediately suspend the works and notify the competent Institute for the Protection of Cultural Monuments from Niš without delay, and take measures to the finding does not destroy and not damage and is preserved in place and in the position in which it is discovered, as well as to provide conditions for protective archaeological research; • The investor of the facility is obliged to provide funds for research, protection, keeping, publishing and exhibiting goods that are discovered during the construction of the investment facility, until the transfer of the goods to the authorized institution. 	Negligible

6.3.4 Community health and safety and security

KSDOO and their contractors will ensure that health, safety and security of the local community members will not be affected during the construction works and any unavoidable temporary effects will be mitigated. This will include mitigation of impacts from construction traffic and maintenance the public access wherever practicable:

A Construction Traffic Management Plan (CTMP) will be prepared and implemented; The Plan will include hauling routes, access to the construction site, traffic diversions, exceptional loads, speed limit controls on and off-site, and driver training. The Plan will cover the transport of all types of construction materials to be brought or removed from the site. This plan will be shared with public and other drivers by mass media and by traffic signalization during the works.

- Local community will be timely informed of temporary and permanent closures of roads;
- Affected roads will be cleared and cleaned from mud and other debris once the work affecting them is completed;
- A detailed programme of works related to the intersection points of the existing and the proposed highway will be developed and implemented. The programme will involve planning of works in the limited period, traffic safety measures during works, etc.
- Contractors will be encouraged to hire workforce from local communities;
- Workers Code of Conduct will be enforced, including guidelines on safe driving;
- Properties with restricted access will be provided with temporary access and where necessary, appropriate drainage to minimize nuisance for residents or business owners;
- Local community will be timely informed on temporary restrictions in their activities such as hunting, harvesting of forest food, or recreation;
- Construction compounds, work sites and other contractors' offices will be marked, fenced and secured from an unauthorised access.

Table 76 Community H&S and security impact and mitigation measures during construction

Impact description	Impact assessment for the area of the interest	Mitigation measures	Residual impact
(1) road traffic disruption and safety	The construction phase will involve a large number of transport movements involving slow vehicles carrying aggregates and other materials. The works will also involve temporary closures and diversions of roads. In the area of Merošina and Prokuplje, which is most populated on the route and will primarily be affected by proposed road realignments.	A Construction Traffic Management Plan should be developed and implemented. The plan should be prepared in cooperation with the relevant local traffic authorities, especially where transport is moving through or near settlements or areas with vulnerable road users.	Minor
(2) presence of temporary workers in the local area	Probably the local workforce (Prokuplje and Merošina region) will be employed during the construction. Also, worksites along the major part of the route will be distanced from the settlements.		Minor
(3) safety risks due to unauthorised access to construction compounds and work sites	In case that members of the public access the construction site without authorisation, they will potentially be putting themselves at risk.	Appropriate security features will be implemented, including fencing, sign posting and potentially security personnel.	Negligible

6.3.5 Occupational health and safety

KSDOO will ensure that the contractor will establish a Health and Safety Construction Plan with special focus on (but not limited to): movement of vehicles and traffic management, working at heights, working in confined spaces, working with hazardous material (e.g. explosives), management of electrical hazards, prevention of unintended ground movements and collapse. Contractual conditions will ensure that all sub-contractors follow the H&S Construction Plan.

There will be a set of general site rules that must be followed by all construction workers. Examples of these are below:

- Individuals must register upon arrival and sign out when departing from site;
- Individuals must be site inducted before commencing work;
- Alcoholic beverages and prohibited drugs are strictly forbidden. Operatives taking prescribed drugs are required to notify the site manager/H&S officer;

- The wearing of safety helmets, safety glasses, gloves, high visibility coats/vests and safety boots which provide ankle support will be mandatory while on site. Ear defenders must be carried at all times. Additional PPE shall be worn as deemed appropriate by risk assessment. Suitable work wear must be worn at all times;
- All accidents, incidents, injuries and near misses must be reported to the HSE officer. All injuries (however small) must receive medical treatment from a qualified first aider;
- The instruction or command depicted on safety signs must be complied with at all times;
- Individuals may only carry out tasks for which they are competent and authorised to do. Individuals may only operate and use plant or equipment for which they are trained and authorised. Copies of all operators certificates will be retained;
- Smoking will only be allowed in the designated smoking areas. Smoking inside the site establishment cabins will be strictly forbidden;
- Weapons and explosives will be strictly forbidden;
- Fighting, gambling, horseplay, and practical jokes will be strictly forbidden;
- Any query from the general public must be politely referred to the site manager/H&S officer.
- No food is to be consumed at the work area. Welfare facilities are to be provided on site for the consumption of food and personal hygiene. These will be kept clean and hygienic;
- No person under the age of 18 years will be engaged in work activities on site without the prior approval of the site manager;
- Defective or suspect plant will be tagged and withdrawn from use and not used until repaired or replaced; and
- Waste and debris will be cleared up as work progresses.
- Specific precautionary measures will include, but not limited to the following:
- Construction plant and equipment used on the project will be inspected by the contractor for condition and suitability and be subject to verification of maintenance certificates or records, statutory or otherwise, before being put to use. All equipment will carry a suitable and valid examination certificate. Operations using heavy plant and equipment will be undertaken and supervised by a suitably competent person;
- Site-specific factors which may contribute to excavation slope instability will be controlled (including the use of excavation dewatering, side-walls support, and slope gradient adjustments that eliminate or minimize the risk of collapse, entrapment, or drowning);
- During blasting operations, work areas will be evacuated, and blast mats or other means of deflection will be used to minimise fly rock or ejection of demolition debris (if work is conducted in proximity to people or structures);

- During tunnelling fresh air will be supplied to all underground work areas in sufficient amounts to prevent any dangerous or harmful accumulation of dust, fumes, mists, vapours, or gasses;
- Safe means of access and egress from excavations will be provided, such as graded slopes, graded access route, or stairs and ladders;
- Workers undertaking hazardous tasks will be certified to do so;
- Slips and falls will be avoided where possible through good housekeeping, spill prevention and clean-up, avoiding uncontrolled use of ropes and cords, proper storage of construction materials and the use of slip resistant footwear;
- The use of hazardous substances will be in compliance with various EU Directives, including 80/1107/EEC on protection of workers from the risks related to exposure to chemical, physical and biological agents at work, and Directive 1907/2006 on the registration, evaluation, authorisation and restriction of chemicals (REACH). Appropriate health and safety assessments will be undertaken, including handling, storage, transfer and use. A register and site inventory of hazardous materials will be kept;
- Emergency contact numbers will be made available at the work sites. This will include the fire and rescue service and the environmental inspection. A 24-hour spill response contract will also be in place.

Table 77 Occupational H&S impact and mitigation measures during construction

Impact description	Impact assessment for the area of the interest	Mitigation measures	Residual impact
(1) work at heights, (2) slips and falls, (3) moving machinery, (4) struck by objects, (5) dust and asbestos fibres dust, (6) confined spaces and excavations, (7) biological hazards (poisonous snakes).	Moderate	<p>The contractors will employ workers are fully trained, have an appropriate awareness of the hazards of working at construction sites and are trained to use and use the appropriate equipment to undertake their tasks in a safe manner.</p> <p>All workers associated with the project, and in particular the site management, will need to be familiar with appropriate safety measures for this type of construction works, starting with undertaking appropriate hazard and risk assessments for all activities. This should be followed by appropriate training, that personnel undertaking hazardous tasks are certified to do so and implementation of specific international requirements for working at height and working in enclosed spaces.</p>	Negligible

6.4 Environmental Mitigation Measures during Operation

6.4.1 Soil and groundwater

All soil used for cultivation is necessary to be fully protected. Therefore, overpasses on the route will be built and environment will be protected with windbreaks in order to collect emitted pollutants within a narrow zone along the highway, inside the fenced area, and to prevent their further spreading into agroecosystem.

High protection should include soils with favourable physical and chemical properties, fertile, as well as soils on limited, smaller areas, having constraints that could be solved with ameliorations. These soils are used as arable land, abandoned arable land or meadows, or as pastures. There is a possibility to use them for intensive field crops and vegetables production, or for animal breeding.

Selective soil protection refers to barren land, or shallow gravelly soils on steep slopes exposed to water erosion. Selective protection measures of soil from water erosion are necessary in this case, especially seeding of grasses and growth of appropriate vegetation cover. Forest soils also belong to this category of protection. Where the route passes these areas, it is necessary to be aware during constructing phase, and carefully perform unavoidable soil disturbance. This suggests that stabilization measures must be employed during and immediately following construction. The methods chosen must provide rapid benefits in order to avoid erosion spreading on larger areas.

As a measure of soil protection around highway, closed drainage system is foreseen in the PD. Drained surface water and drained subsurface water will be first treated and then released to water courses.

Regarding terms of obligations to agricultural producers during highway operation, and in accordance to Law on agricultural soil and Law on Environmental Protection pedosequences protection measures include following measures and required works:

- The soil inside the road fence needs to be seeded with grasses and arranged to prevent wind erosion, as well as the dispersion of dust to wider areas, and by this manner to prevent soil pollution. Only native species should be used and not alien ones.
- Areas planned for grasses seeding should be seeded with reclamation grasses from families of Brassicaceae, Euphorbiaceae, Asteraceae and Lamiaceae, since these species behave as hyper accumulators of pollutants. They have increased the ability of accumulation of pollutants, which decreases their concentration in soil and water.
- All areas of road belt arranged by reclamation measures should be maintained seasonally by mowing, pruning, or treated with plant protection products, etc.

Green mass obtain by mowing and pruning must not be used as a cattle feed or as a composting material (fertilizer).

- Recommended protective measures should be applied to provide land use around highway for agricultural purposes on the distance of 30 m from the edge of the road. Areas closer to the highway, located in the narrow zone, should be planted with trees or some other industrial plants. Only native species shall be used to avoid the dispersal of alien and invasive species and secure better adaptation to local conditions.
- Application of regulations related to the technical validity of vehicles, utilisation of engines with catalytic converters, and others, will significantly reduce pollution caused by traffic, and thus diminish negative impact on soil.
- Application of good agricultural practices in areas along the highway should maintain condition and quality of soil on the appropriate level.

The following measures are in the domain of erosion protection measures:

- Measures on extensive afforestation and revegetation of barren and bare land, as well as on rehabilitation of devastated and degraded forests and grasslands in the upper parts of watersheds with torrential genesis.
- Measures on designing hydraulic engineering structures for torrential flow regulations, that have depositional and consolidation character, from concrete and stone in cement mortar, in river beds and basins of small torrential streams.
- Application of contour ploughing.
- Measures on applying for erosion protection work through the implementation of agricultural and forest reclamation measures.
- Conservation measures, i.e., grass seeding, trees planting, reclamation of pastures and meadows (to establish the ecological balance). Only native species shall be used to avoid the dispersal of alien and invasive species.

Conservation measures on highways are measures against soil water erosion applied with a view to stop the process of further surface erosion development and mass movement and reduce erosion intensity to the so-called, acceptable level of geological erosion.

Recommendations for agricultural land use

Possible soil pollution around highways could be expected up to 100 m from the highway edge of the both sides of the highway. Therefore, it is:

- Recommended to organise field crops production on the parcels along Highway: small grains, corn, sugar beet, potato.
- Recommended to mount plastic or glass greenhouse as well known convenient way of agricultural production near roads.
- Recommended tree planting, especially fruit trees: walnut, chestnut, almond, cherry, hazel and others, which are grown and also raised to produce high quality and valued timber.

- Forbidden to produce medicinal herbs and sensitive crops, or crops that accumulate pollutants in the edible part, such as lettuce, spinach, cabbage, chard, berries.
- Forbidden to produce organic food.

Not recommended to grow plum, pear, nectarine, apricot, cherry and soar cherry because they are sensitive to atmospheric deposition caused by traffic.

Table 78 Impact to soil and groundwater and mitigation measures during operation

Impact description	Impact assessment for the area of the interest	Mitigation measures	Residual impact
(1) pollution due to surface water coming from the roadway,	Moderate	Due to planned drainage system, soil pollution from water flow from the roadway is eliminated, since protection from this type of pollution is foreseen.	Negligible
(2) deposition of emitted gasses (atmospheric deposition, wind deposition, scattering due to vehicle movement),	Minor	According to low traffic volumes, soil pollution impact can be considered as negligible.	Negligible
(3) Spillage of cargo.	Major	The only way for soil rehabilitation is to remove contaminated soil and transport it and store in safe places where endangering of environment will be minimized.	Negligible

6.4.2 Surface water

The concentrations of pollutants in the water can be expected in significant quantities, and it is necessary to apply the foreseen technical protection measures for the surrounding water bodies to prevent to be polluted from the carriageway.

According to the legislation, atmospheric water that is discharged into the watercourse must be purified at least to the quality that corresponds to stream water recipient.

According to the designed solution all rain water is efficiently collected and taken for treatment before being disposed to the recipient.

The concept implies rainwater to be drained by gravity to the gutters at the edge of the highway. At certain distances along the gutters installed manholes with drain covers will be foreseen. This way atmospheric water goes into a closed pipe system, and from there to the separators for treatment. After passing through the separator for oil products, purified water is drained by pipeline to the recipient, where the water is discharged.

Tunnels have separate drainage system to collect water in case of firefighting. All accompanying facilities (rest areas, ramps, interchanges and other operational areas) and all structures (bridges, viaducts) on the route have closed drainage system.

Table 79 Impact to surface water and mitigation measures during operation

Impact description	Impact assessment for the area of the interest	Mitigation measures	Residual impact
(1) pollution due to surface water coming from the roadway,	Moderate	According to the planned drainage system, soil pollution due to water flow from the roadway is eliminated, since protection from this type of pollution is planned. This also applies to tunnels, bridges and all associated facilities	Negligible

6.4.3 Ecology and nature conservation

Technical measures during the operation include all activities related to the maintenance of the section and include:

- Develop and implement during the operation phase a Monitoring Plan of terrestrial flora and fauna in order to timely recognise negative impacts and trends related to the highway operation and define additional and appropriate mitigation measures.
- Pay attention that alien and especially invasive species are not used for the maintenance of corridor.
- For the control of weeds in the green areas do not use herbicide, road belt should be maintained by haymaking.
- All sites and surfaces affected by the construction works should be reinstated with the same type of vegetation.
- Regularly maintain in a good and functional status the fauna crossing points constructed. Consider changes to these passages based on the results of the Monitoring Plan.
- Maintain the constructed fauna crossing points (i.e. culverts, passages) clear from obstacles (debris, vegetation) and functional. This will increase the permeability of the motorway and will reduce the barrier effect.
- Develop and implement a Biodiversity Action Plan
- Noise mitigation measures (see paragraph ...)
- Construct and maintain an impenetrable and resistant fence along the highway that will prevent access of animals (esp. medium and large

mammals) to the highway and will reduce the possibility of collisions and road mortality.

- Predict and maintain barriers for birds in corridors, especially for some game birds (Grey Partridge *Perdix perdix*) and for nocturnal birds of prey. These barriers will mitigate the risk of collision since normally these species are attracted to roads.
- Avoid the creation of habitats by the road that would attract fauna and lead to increased road mortality. Respect the physiognomic characteristics of natural vegetation landscapes;
- Plan for the timely removal of excess salt after winter in order to reduce the risk of collision accidents and road mortality.
- in order to track possible impacts and define eventual additional measures to mitigate and reduce the harmful effects, develop and implement a Monitoring Plan as part of the ESMP that will address terrestrial fauna and flora, road mortality and freshwater ecology (especially fish, amphibians, overall aqua-ecosystem – invertebrate species composition, production etc. as well as water quality).
- Develop and implement an Accident Response Plan to determine the optimal location and type of emergency response equipment and the required capacities for handling liquid spills. Spill Response Kits should be available and personnel will be trained in their use.

Table 80 Impact biodiversity and mitigation measures during operation

Impact Description	Impact Assessment	Mitigation Measures	Residual Impact
Habitat loss and degradation During operation along the highway corridor forest or tall vegetation will be replaced with vegetation of mainly grass species. Thus, habitat conditions for many animal species (especially reptiles, birds and mammals) will be substantially altered.	Minor – The habitat lost during construction will not be fully reinstated. Nevertheless, since the predominant vegetation along the route of the highway and the corridor around consists of semi-natural habitats or pure agro ecosystems, there are no flora species of conservation the impact after post-construction reinstatement will be minor. Animal societies in such habitats (along the route and corridor) consist predominantly of species with considerable ecological plasticity and resilience, common and with widespread home ranges in Serbia, so their conservation status would not be affected significantly by the mentioned impact. Reptiles and small mammals may be favoured by the creation of openings along the highway corridor.	<ul style="list-style-type: none"> • Develop and implement during the operation phase a Monitoring Plan of terrestrial flora and fauna in order to timely recognise negative impacts and trends related to the highway operation and define additional and appropriate mitigation measures. • Pay attention that alien and especially invasive species are not used for the maintenance of corridor. 	Minor -
Habitat fragmentation Linear infrastructures, such as highway projects, contribute	Given the already significant impact of the existing main road as well as of the numerous and almost uninterrupted rural settlements along the existing	<ul style="list-style-type: none"> • All sites and surfaces affected by the construction works should be reinstated 	Negligible-

Impact Description	Impact Assessment	Mitigation Measures	Residual Impact
significantly towards the habitat fragmentation. Building of a fenced highway will cause fragmentation and separation of habitats. In addition, this may cause the interruption of daily or seasonal movements for some terrestrial animal species (i.e. reptiles and mammals), disturbing the usual behavior patterns of certain species.	main road, the expected additional impact will be negligible.	with the same type of vegetation. <ul style="list-style-type: none"> Regularly maintain in a good and functional status the fauna crossing points constructed. Consider changes to these passages based on the results of the Monitoring Plan. 	
“Barrier effect” created by linear infrastructures can affect the dispersion and movement capacity of fauna (fish, amphibians, reptiles and mammals). This affects indirectly their capacity for searching food, shelter or other individuals of their same species during the breeding season. These factors are linked with the species population dynamics.	Minor - Habitats in both side of the proposed highway are quite similar or even the same (agricultural land), so the negative effects concerning capacity for searching food or shelter will be minor. The planned culverts and passages as well as the high bridges and tunnels will further minimise the “Barrier effect” for the existing fauna. In addition, human activity has already shaped and conditioned the scope and direction of migratory movements of many species. Extensive movement is expected in the east-west direction, longitudinal, more or less parallel to the axis of the highway route than the north-south direction, perpendicular to the route On the other side, the highway could prevent to some extent the expansion of species that are harmful to agriculture, such as the Wild Boar.	<ul style="list-style-type: none"> Develop and implement during the operation phase a Monitoring Plan of terrestrial flora and fauna in order to timely recognise negative impacts and trends related to the highway operation and define additional and appropriate mitigation measures (e.g. additional or different fauna crossing points).. Maintain the constructed fauna crossing points (i.e. culverts) clear from obstacles (debris, vegetation) and functional. This will increase the permeability of the motorway and will reduce the barrier effect. 	Negligible -
Species loss, disturbance and displacement During the operation phase of the highway some species such as rodents and reptiles are attracted by the new habitats and environmental conditions created after the road construction. This as the domino effect may favour the secondary increased presence of carnivore mammals which prey on these small mammals	Minor –Approximation to the highway make species vulnerable to collisions and road killing. The impact is considered minor taking into consideration the low vulnerability and conservation importance of the species in question).	<ul style="list-style-type: none"> Develop and implement a Biodiversity Action Plan Implement Noise mitigation measures Construct and maintain an impenetrable and resistant fence along the highway will prevent access of animals (esp. medium and large mammals) to the highway and will reduce the possibility of collisions and road mortality. Predict barriers for birds in corridors, especially for some game birds (Grey Partridge <i>Perdix perdix</i>) and for nocturnal birds of prey. 	Negligible

Impact Description	Impact Assessment	Mitigation Measures	Residual Impact
and reptiles. Impacts include mainly road mortality. Another negative impact stems from the use of salt during winter months that greatly attracts individuals of different bird species (mostly songbirds) in the immediate area of the highway route, significantly increasing the risk of collision accidents and road mortality		<p>These barriers will mitigate the risk of collision since normally these species are attracted to roads.</p> <ul style="list-style-type: none"> • Avoid the creation of habitats by the road that would attract fauna and lead to increased road mortality. Respect the physiognomic characteristics of natural vegetation landscapes; • Maintain the multifunctional passages for small and large animals clear of vegetation and debris, in a functional status. • Plan for the timely removal of excess salt after winter in order to reduce the risk of collision accidents and road mortality. • Develop and implement a Monitoring Plan as part of the ESMP that will also monitor road mortality. 	
Freshwater ecology	<p>Minor – if proper techniques and the proposed mitigation measures have been implemented during construction there will be no additional impact to freshwater ecology (riparian vegetation and water quality) during operation. The proposed technical solutions for the collection and treatment of the water from the highway, esp surrounding water bodies, will be sufficient for the avoidance of impacts to freshwater species. Therefore no additional mitigation measures are required.</p> <p>Major - A possible major negative impact will be the result of an accidental spill within all road sections close to surface water bodies such as stream crossings.</p>	<ul style="list-style-type: none"> • Develop and implement a Monitoring Plan as part of the ESMP also for freshwater ecology (especially fish, amphibians and overall aqua-ecosystem – invertebrate species composition, production etc.) in order to track possible impacts and define eventual additional mitigation measures to mitigate and reduce the harmful effects. • Monitoring of water quality is recommended as well. • Develop and implement an Accident Response Plan to determine the optimal location and type of emergency response equipment and the required capacities for handling liquid spills. Spill Response Kits should be available and personnel will be trained in their use. 	Negligible – provided that all proper mitigation measures have been adopted.

6.4.4 Landscape and visual

The task during the operation is to create the impression that the planned corridor has always been part of the landscape.

The obligation of completed construction work involves an obligation to establish plant cover on all affected places, using indigenous species with a similar combination, to harmonize with the surrounding area and purpose so that landscape can go back to its original state. It is necessary to arrange embankment horticulturally prevent erosion. In the places where the highway is monotony, it is necessary to refresh it by planting decorative species that don't require maintenance.

With the operation of the road it is necessary to ensure a minimum protective zone where greenery does not require maintenance. The morphology of the area shows a special sensitivity to the presence of highway objects such as bridges and viaducts. Interventions for landscape integration are directed at creating green curtain along the cut and embankment. The interventions are also necessary at the entrance to the tunnels, to mitigate the changes on a green blanket of the slopes.

The proposed measures are:

- Arranging community trees and shrubs along the highway
- Planting Interchanges' areas and the areas between cuttings and embankments
- Arranging bushes area
- Re-giving natural-looking to the landscape

Directions for greening land strip include:

- Selection of vegetation which is well adapted to the new conditions of the soil.
- Planting of large infrastructure facilities typically represents a major project and it requires vegetative material (seedlings) pre-order (often commissioned to production).
- Distance planting depends on the objectives and conditions of the land. Planting vegetation in a row, to ease maintenance of work, and deploy them to a triangular to achieve higher density.
- It is recommended that the distance between the shrub seedlings are from 1 to 1.5 m, and between the tree seedlings 3 m. On the inside of the curvature planting in the larger distance.
- Grasslands seeded with a mixture of seeds of various grass species, which is recommended to add seeds of legumes and herbaceous plants (enrich the flora and thereby accelerating succession). The recommendation of German experts in the landscape is to collect seeds from the surrounding areas (herbaceous plants and grasses) and then to plant the denuded areas (or at least added purchasing seeds).

- Selection of grass species must be carried out carefully. Using seeds quickly and high growing species offers faster greening, but these species may later cause problems in maintaining due to large weight of swaths.
- For extreme soil is recommended to use herbaceous plants with high ecological valence. Particularly important are herbaceous plants that tolerate drought better, do not spend a lot of nitrogen and much better than the grass bind the soil. Suitable are types with strong and deep roots.
- High grass is not suitable for young trees. Due to strong growth they are his competition for the available water, light and nutritious elements. So it is better to choose low grass species and some legumes.
- Soil lawn does not need to improve, but the selection of species adapts to ground conditions

In extremely poor soil (excavation, embankments with extreme slopes and exposure) is recommended meadow grasslands (priority - a year is sufficient, only one mowing).

Landscape

It is necessary to carry out engineering and biological measures to minimize adverse impacts and increase the quality of region images. With engineering measures create a way to land a belt to support the natural morphology of the terrain and the best way to wash the landscape characteristics of the terrain.

It necessary to respect all the guidelines, recommendations and requirements from the „Manual for design of roads in the Republic of Serbia“(JP Roads Serbia, Belgrade, 2012):

When designing the soil zone should be provided:

- traffic safety (transparency, stability, land, soil zone)
- pleasant ride (optical guiding the driver, viewpoint)
- functionality (maintenance of land strip)
- the least possible damage to the environment (preventing harmful effects on the environment roads)

In the integral design of green areas of road land, rounded design and finished a whole must do:

- Planning of relief,
- Planted and,
- Engineering and architectural design of road structures and facilities in the soil zone

In the areas of individual types of landscapes, or design editing space along the roads must be adapted to the characteristics of their landscape structure. For this it is necessary to take into account some basic principles, such as:

- proper economy and life in space, and ensuring a "healthy" landscape,

- use of local forms of vegetation that has created an interweaving of the natural and spontaneous process,
- respect for space (space identity), and
- Monitoring forms of cultural landscapes

Recommendations for the design of relief

The relief decoration soil zone necessary addition to ensuring the stability of soil to meet and landscape-design aspect. Designing relief landscape area should therefore be as much as possible to monitor the characteristics of the existing relief. For this it is necessary to take into account the characteristics of the geological structure and geo-mechanical characteristics of the stem wall to a single area. Accordingly it is necessary to create the appropriate gradient slopes.

General starting points for the creation of relief:

- the creation of new slopes should be in harmony with the natural relief forms,
- the need to form a soft pass from newly formed slopes to the existing terrain (at the base and at the top of the slope),
- the need to form soft switches and between the slopes of different inclination

The starting point for the design of the relief in respect of morphology and purpose soil:

- For hilly areas:

In these areas it is necessary to avoid geometrically correct and align the slope. Slope lines should be as much as possible to follow the configuration of an existing field or remote lines like ridges of the surrounding hills and the like. and, as they provide a perspective of the way. The upper edges of slopes should be rounded (manual or detailed machining) with smooth transitions into the existing terrain.

- For lowland areas

In the lowland areas is markedly the most desirable route to grade level more equal with the existing terrain, or that the embankment and cuttings which flatter, with very mild and gradual change in the existing flat terrain.

- For agricultural area (arable land, meadows, pastures, orchards, etc.)

In those areas, the creation of slopes should follow the basic characteristics of tillage nearby. This means that if you are in this area are cultivated terraces, the slope of the recess should be a buffer with the zone, which cannot be to provide a fully vertical nor have any geometric shape.

- For the forest area

Slopes in the area of forests must be designed primarily about the geomorphological structure of the soil and thus to be stable after the presentation that is not subject to the effects of erosion. Designing slopes in harmony with

nature offer greater possibility of establishing a successful vegetation and surface water drainage planning.

The edge of the forest is necessary to develop naturally and establish new plantations, where it is essential the correct choice of species and plants.

- For areas of the terminal connections

In the area is recommended spreading the slopes throughout the space available to the road and edged coast or to other elements in the land zone. Smaller gaps - interstices that occur between connecting ramps and times you need to shut up and the more settled. The embankment is done at a constant incline, or should not be the geometrically regular shape.

- For the area of the interchanges

Providing good transparency on the interchange areas and visibility of vertical traffic signalization must be taken primarily.

- For the area of regulation of water flow

Relief formation of new slopes should assume the characteristics of the natural morphology of riverbeds and coastal hills. In the case of rehabilitation and regular maintenance of natural water flows, should be made only locally limited intervention in riverbeds using indigenous materials (vegetation slope protection, stone, wood) or in accordance with the terms of the steering waterways.

Recommendations editing watercourses transitions

Between the existing, unregulated and regulated labour work should be as inconspicuous. New regulation of the water flow should be more in harmony with nature (planted slopes watercourses indigenous coastal vegetation).

Recommendations for performing out engineering-biotechnical measures

Aim engineering-biotechnical measures are to establish the soil, to the extent that natural processes cannot threaten the stability of the road area and buildings on it. Primarily it is necessary to prevent adverse flushing soil and prevent the development of severe forms of erosion. Engineering and biological measures that try to create more appropriate conditions for the development of vegetation. Regarding the type of the material used they can be divided into technical and biotechnical works.

When performing the technical work to stabilize the soil, such as a dispersion of surface water drainage, surface binding of the soil, protection from slipping and landslides, snow and other supporting construction and the blocking object, it is shaped taking into account the primary characteristics of the surrounding area, for example, structural characteristics of the surrounding terrain (forest, planted correct, etc.). The aim of greening, in addition to providing soil stability, and faster restoration of the vegetation and the landscape looks fulfilment of the functional and landscape-design requirement. Due to the intervention of various forms of

construction plants are often exposed to new conditions of growth. In such cases it is necessary to remediate these forms of vegetation, for example planting forest edge belt, trimming damaged hedges, coastal vegetation, tree rows etc.. The design aspect is important when performing biotechnical works or soil stabilization vegetation.

Recommendations for developing a plan of planting vegetation

For deployment should respect the existing typical planting matrix. Types and quantities of new plants should follow the existing vegetation. For the deployment of vegetation, especially high, we must bear in mind that the time travellers and optical lead and block the view. In dividing strips vegetation should be selected and arranged in such a way that the driver is protected against glare headlights of vehicles coming from the opposite direction. In the selection of species of trees and shrubs start from the fact that the species should be as far as possible adjusted to the conditions of growth. If possible, choose the more self-sown vegetation, respecting others, also important criteria for example. Suiting special conditions (salt, exhaust fumes, windiness), microclimate, soil conditions, etc.. In these cases, the choice of self-sown vegetation very limited. It is recommended to use different types of vegetation. Species diversity is particularly important when planting specific areas such as the restoration of the edge of the forest belt. Such a composition is better aligned with the given parameters of climate and soil characteristics, it is more stable, faster, inhabited by animal species, accelerating the succession and development of seedlings, etc.. As a rule, it is not necessary to plant more than 10% of the tree species. The urban environment is allowed to use foreign varieties of trees and shrubs in the case that the selection is resulting from the immediate environment. We choose among species that are resistant to polluted air and are proving a bit and their aesthetic appeal (the colour of flowers, leaves, trunks). The appropriate plant should be realized overlap of large concrete surfaces, to hide bad vistas of the surrounding residential, commercial and other facilities and the like. For greening grass surfaces, the use of legumes from nearby, worse maintained lawns. For this purpose, it is too late to mow. The seed is not advisable to purchase abroad if the source is not known and verified. Starting points for planting about individual types of landscapes.

When planning biological recultivation, exclude self-cultivation of surfaces (except for water bodies), since a spontaneous spread of foreign and invasive species has been observed in the wider area. Force the planting of indigenous (local) species Serbia, with planting materials of indigenous origin. It is also possible to foresee the use of various ornamental plant species and varieties which are not on the list of invasive species.

Forest areas

When the road passes through forests and forest ecosystems, it is necessary to provide plants of a new forest zone (protective zone). It is necessary to select species according to the characteristics of forest edges. The forest edge must be a soft line, which is achieved by placing organic seedlings.

Agricultural areas

- Use of shrubs and trees is permitted only in cases when we want to either emphasize something or/and hide.
- If the space for the typical small groups of shrubs and trees, can be similar to the matrix to form belts in the soil, primarily to intersect with the waterways, or with a protective barrier against the noise.
- On denatured agricultural soil due to improve farmland and maximize arable land, editing belt of land can be an opportunity for the ecologic landscaping agricultural area.

Cultural landscape - terraces

In areas where the prevailing cultural landscape with distinctive cultivated terraces, planting matrix to be as much follows the line of slopes and berms.

Rocky area, karst

- In such an area, the possibility of a successful planting minimal. If the terrain allows it, it is recommended in that land the wall between of rock predict pockets of land with soil to plant them and stubborn, indigenous variety or just let it heal spontaneously slope.

Table 81 Impact to landscape and mitigation measures during operation

Impact description	Impact assessment for the area of the interest	Mitigation measures	Residual impact
The highway has made a big visual change in environment	Moderate	<ul style="list-style-type: none"> • To establish plant cover on all affected places, using indigenous species with a similar combination, to harmonize with the surrounding area • to arrange embankment horticulturally prevent erosion • The morphology of the area shows a special sensitivity to the presence of highway objects such as bridges and viaducts. Interventions for landscape integration are directed at creating green curtain along the cut and embankment. • The interventions are also necessary at the entrance to the tunnels, to mitigate the changes on a green blanket of the slopes. • In the places where the highway is monotony, it is necessary to refresh it by planting decorative species that don't require maintenance • In extremely poor soil (excavation, embankments with extreme slopes and exposure) is recommended meadow 	Negligible

Impact description	Impact assessment for the area of the interest	Mitigation measures	Residual impact
		grasslands (priority - a year is sufficient, only one mowing). <ul style="list-style-type: none"> Arranging community trees and shrubs along the highway for re-giving natural-looking area. 	

6.5 Social Mitigation Measures during Operation

The necessary mitigation measures for social impacts are detailed in Annex 1:SIA. Herebelow an outline of these measures is presented.

6.5.1 Noise

Design of noise protection walls envisages the construction of structures for noise protection, which would eliminate its negative impact.

Noise barriers are provided on the left or right side of the highway, in the area of objects which are exposed to the negative impact of the forecast traffic, at the total length of about 228 m. The height of the walls varies from 2 meters to a maximum of 2.50 meters. In the first phase of construction of the highway is not envisaged setting up noise barriers as it is not expected the level of noise that has a negative impact on the quality of life of the surrounding population and its health.

The walls are situated and levelled as follows:

Table 82 Noise barriers

Wall No.	Chainage at the beginning of the wall	Chainage at the end of the wall	Side	Wall length [m]	Wall height [m]
Wall 1	13+556.946	13+716.946	Right	160	2.5
Wall 2	18+576.379	18+644.379	Left	68	2

In the further stage of development of the project documentation, in preparation of the final design, it is necessary to analyse the soundness of structures to be protected and re-examine the necessity for protection measures.

If during operation indicate impacts on facilities that exceed the limit values, it is necessary to consider the implementation of measures in the facilities.

Upon implementation of proposed mitigation measures, the residual impact of noise is assessed as negligible.

Table 83 Noise impact and mitigation measures during operation

Impact description	Impact assessment for the area of the interest	Mitigation measures	Residual impact
Extreme temperatures	In the first phase of highway operation, traffic volumes are expected significantly below thresholds. Impact from traffic noise, even in populated areas of Arbanasce and Prokuplje are considered of negligible significance.	No measures	Negligible
Extreme precipitation	Populated area receptors are private houses in Arbanasce and Prokuplje. There is no sensitive receptors as schools and hospitals in the vicinity	Noise barriers are provided, in the area of objects which are exposed to the negative impact of the forecast traffic, at the total length of about 276 m In case noise level to exceed the legal limit, noise insulation of windows will be offered for the affected receptors.	Negligible

6.5.2 Community health and safety and security

Protection measures of the population are largely already covered in previous chapters (protection from noise, vibration, etc.).

The obligation of the Investor is to make the notification if it appears any negative impact on human health and the environment during the execution of the project construction and operation of the underlying highway in accordance with the provisions of the Law on Environmental Protection and the Ministry of Health RS.

Constant contact with the local population (mainly through municipal authorities and local communities), but also penalty measures to prevent discharge of municipal waste to the area along the highway and the creation of a "wild" and uncontrolled landfills. This "rejection" waste on the conditionally safe distance from the place of residence is a deception, because through the wind, through the domestic animals, etc., possible negative phenomena (infection, odour, etc.) is very easily "return" precisely to those who had thrown out the trash.

Table 84 Community H&S and security impact and mitigation measures during operation

Impact description	Impact assessment for the area of the interest	Mitigation measures	Residual impact
(1) general operational safety of the highway	(1) Operational safety of the highway could affect passengers by the threat of injury or potential loss of life due to vehicle collisions, or vehicle overturns or other operational causes.	The set of precautionary measures should be implemented, including <ul style="list-style-type: none"> • road operational safety procedures, • regular inspection, and • maintenance of the highway and • implementation of a safety management program equivalent to internationally recognised (EU) highway safety programs 	Negligible
(2) level crossings safety	The proposed project envisions only grade separated road crossings (underpasses and overpasses) thus eliminating the safety risks		Positive
(3) transport of dangerous goods	Transport of dangerous goods represents a potential environmental risk in the event of accidents, through leakage, safety valve releases, in pressurised and general service tank vehicles, or other hazardous material containers.	The set of preventive measures will be proposed, including: <ul style="list-style-type: none"> • the proper screening acceptance procedure, • development of the Emergency Preparedness and Response Plan (including Spillage Response Plan), • timing of transport, • limiting speeds to minimise the risks, etc. 	Positive project will contribute to the improvement of the hazardous materials transport safety conditions in the area

6.6 Special protection measures

Climate change adaptation measures integrated in PD

As part of this project, study which estimates the impact of climate change on the highway for a period of 50 years, was done. In order to assess the impact that climate change could have on the highway, the results several regional climate integrations of CORDEX project (www.cordex.org) are analyzed.

According to the results of these analyzes, the coefficients reserves ht, strengthening the values for the analyzed daily maximum precipitation (ratio:

projected / Historic rainfall), for meteorological station Nis is 1.02 and for a meteorological station Kursumlija 1.16.

For the runoff calculation to unexplored basins in this section, medium values like results of numerical analysis of the mean maximum daily rainfall that are shown in the following table were adopted.

Table 85 Mean maximum daily rainfall

p(%)	0.1	1	2
H(mm)	126.8	98.3	90.4

Hydrological analysis of flows in river basins that are within this section was made taking into account increased value of maximum daily precipitation.

Climate projections show an increase in annual precipitation in the period 2015-2070 compared to 1951-2005. In projections of maximum annual rainfall changes with a return period of one hundred years, precipitation was projected to increase compared to the period 1951-2005.

In relation to these results, ITP curves of hydrological studies are made showing the dependence of the intensity of rainfall as a function of the duration of the precipitation at a particular location. For the calculation of these ITP curves climate change impact is taken into account.

Water collected from the highway is transported by closed pipeline system and hydraulic calculation for chosen diameters and inclination of the pipeline was made using data from the ITP curves. Bearing this in mind, the impact of climate changes is considered in the hydraulic calculation of the drainage system, for the future period.

Other climate change adaptation and mitigation measures will be adopted as following:

- Alignment is positioned in a way that has a minimum influence on existing watercourse network. Every watercourse, which is crossed by the designed highway alignment, has its bed regulated according to the position of alignment and new bridges. For every regulation of a river bed hydraulic calculations were made according to the rulebooks and hydrology study inputs.
- The position of major structures, bridges and piers is chosen in a way to avoid riverbeds and other watercourses. In addition in a location which is on a high embankment and close to existing watercourses (km 8+500), reinforced earth is proposed, in order to reduce the width of the embankment and to avoid additional river bed regulation.

- Clearance of structures above water is designed to be resistant on a 100 year flood level, in a way that the bottom level of the structure must be minimum 1.1 m above the 100 year flood level. This clearance is even bigger on some places where it was technically possible and economically feasible. This was particularly important to be implemented in the Toplica River potential flooding area, i.e. from km 22+000 to km 39+000 (area between Prokuplje and Pločnik)
- Embankment was raised in Toplica River potential flooding area, from km 22+000 to km 39+000, also according to the 100 year flood level. Highway embankment and structures (vertical alignment elevation) are above this level in order to ensure pavement not to be flooded.
- Embankment is stabilized on that sections with a gabion mattress (wire boxes filled with a large crushed stone) in order to avoid embankment to be washed away by flood water withdrawal.
- On high cuts along the alignment, especially on Prokuplje bypass section, km 17+000 to km 22+000, slope protection and land stabilization is also proposed. Protection with a wire mesh and anchoring is proposed in order to avoid potential rock falls and landslides.

Table 86 Climate change impact and mitigation measures during operation

Impact description	Impact assessment for the area of the interest	Mitigation measures	Residual impact
Extreme temperatures	An asphalt melt and rutting, as well as thermal expansion of bridge joints, increasing the maintenance costs	Enhanced maintenance	Negligible
Extreme precipitation, floods, landslides, soil erosion	Major	<ul style="list-style-type: none"> • The impact of climate changes (increased value of maximum daily precipitation) is considered in the hydraulic calculation of the drainage system. • Alignment is positioned in a way that has a minimum influence on existing watercourse network. Every watercourse has its bed regulated according to the position of alignment and new bridges. • For every regulation of a river bed hydraulic calculations were made according to the hydrology study inputs. • The position of major structures, bridges and piers is chosen in a way to avoid riverbeds and other watercourses. • Clearance of structures above water is designed to be resistant on a 100 year flood level, in a way that the bottom level of the structure must be minimum 1.1 m above the 100 year flood level. This was particularly important to be implemented in the Toplica River potential flooding area, i.e. from km 22+000 to km 39+000 (area between Prokuplje and Pločnik) 	Negligible

Impact description	Impact assessment for the area of the interest	Mitigation measures	Residual impact
		<ul style="list-style-type: none"> • Embankment was raised in Toplica River potential flooding area, from km 22+000 to km 39+000, also according to the 100 year flood level. Embankment is stabilized on that sections with a gabion mattress (wire boxes filled with a large crushed stone) in order to avoid embankment to be washed away by flood water withdrawal • On high cuts along the alignment, especially on Prokuplje bypass section, km 17+000 to km 22+000, slope protection and land stabilization is also proposed. Protection with a wire mesh and anchoring is proposed in order to avoid potential rock falls and landslides. 	

7 Monitoring Programme

7.1 Environmental Monitoring

Proposed environmental monitoring during construction and operation stage is provided in Table 87 and Table 88.

Table 87 Construction stage environmental monitoring

Receptor	Location	Indicator	Frequency	Responsibility
Surface water quality	The Toplica River and all streams along the route, in the construction areas, before and after construction work zone	Natural stream flow and slowing of flow due to the sediment load	Prior to construction of bridges and riverbed regulations Visual	Contractor Supervisor
Soil erosion and sediment control	All construction sites and access roads Areas prone to erosion Disturbed areas	Erosion status/ soil stability	Daily After major rainfalls Visual or by erosion control devices, where required	Contractor Supervisor
Disposal of excavated material (spoil) and top soil stockpiles	Spoil disposal areas and top soil stock piles	Stability / erosion issues	Daily Visual	Contractor Supervisor
Soil quality	On every 4 km of highway route. In zones of 3, 10 and 100 m far from the highway route, on its left and right side.	Particle size distribution, soil reaction, calcium carbonate content, organic matter content, EC (due to use of salt on roads), soil compaction	Once prior to construction	Contractor Supervisor
Groundwater	Dewatering areas (if any)	Groundwater level in dewatering wells to be monitored until the natural regime is re-established	Weekly Monitoring equipment	Contractor Supervisor
Noise and vibration	In the zone of affected receptors: Merošina, Jugbogdanovac, Arbanasce, Mala Plana and Beloljin	Noise levels Vibration levels	Only in the event of complaint	Contractor Supervisor

Receptor	Location	Indicator	Frequency	Responsibility
Air quality	Maintenance locations for construction vehicles, plants and machinery, access roads, especially when adjacent to human and ecological receptors	Fugitive dust, fine particulate matter (PM2.5, PM10) and exhaust emissions	Daily	Contractor Supervisor
Terrestrial habitats and species	Along the route	Percentage of completion of required measures, including: passages, barriers, surveys for tortoises and nests. Percentage of implementation of mitigation measures, such as delimitation of clearance area, use of existing road network, fencing for protection of river banks and other habitats, timing of works Percentage of existing and new roads used for the Project to assess additional fragmentation Pre / During / Post Construction Survey	Monthly Monthly	Contractor Supervisor
Restoration of natural vegetation	At areas of natural and semi-natural habitats, especially riverine habitats	Photographs to compare before and after restoration situation at crossings	Before clearing of vegetation and after completion of restoration	
Water quality	At the river crossings	Water turbidity and suspended solids Dissolved oxygen Oil and grease	During crossing works One month after completion of works	

Receptor	Location	Indicator	Frequency	Responsibility
River flow	At all permanent water courses that will be affected by construction works (Krajковаčka, Jugbogdanovačka, Draguška and Backa River)	River flow	One year before crossing and one year after completion of works	
River restoration	At all river crossings	Photographs to compare before and after restoration situation at crossings	Before starting of works and after completion	
Cultural Heritage	Along the route	Archaeological findings	During entire duration of earthworks	Institute for Cultural Heritage Protection of Nis
Landscape	Construction sites and ancillary areas	Landscape planting and seeding requirements Progress of new landscape works through the construction	Periodically, upon completion of construction at the section Visual	Contractor Supervisor

Table 88 Operational stage environmental monitoring

Receptor	Location	Indicator	Frequency	Responsibility
Soil and groundwater	Affected area	Spillage accident	Only in the event of accident Collect contaminated soil by authorized companies	PERS
Soil quality	same as in the case of sampling during the construction phase	Particle size distribution, soil reaction, calcium carbonate content, organic matter content, EC (due to use of salt on roads), soil compaction	Once in spring and once in autumn	PERS
Air quality	Near populated areas (Five points where baseline measurements were conducted)	CO ₂ , NO ₂ , CO, PM ₁₀ , black smoke	For the full motorway profile phase (M), after 2045,	PERS

Receptor	Location	Indicator	Frequency	Responsibility
Surface water	Affected surface water body	Spillage accident	Only in the event of accident Collect using pumps, buckets and tanks. For bigger watercourses use floating barriers and skimmers and absorption aids	PERS
Erosion	Slopes of cuttings, embankments, other areas prone to erosion	Land stability/signs of erosion	Twice per year Visual	PERS
Terrestrial ecology (species and habitats)	Animal crossings, bio-corridors underneath the bridges.	Use of crossings/passages by fauna based on traces. Status of crossings (vegetation at entrances, water levels, presence of obstacles).	Twice a year in the non winter season. If passages are not used alternative locations or measures should be considered.	PERS
	Areas where restoration works will be implemented	Status of newly created habitat Presence of native species in the restored zones	Every six months for the first five years of operation. Depending on progress, additional planting may be required	PERS
	At selected intervals along the road	Road mortality per species or species group so that any 'hot spot' areas can be identified	Quarterly for at least the first 2 years of operation. If hot-spots of road mortality are detected, modifications to passages and/or ecological corridors should be considered.	PERS

Receptor	Location	Indicator	Frequency	Responsibility
	At selected sites of suitable habitat along the road, depending on species/species group	<p>Presence and relative abundance of bird species (include EU protected species as well as species indicated by Institute of Nature Protection).</p> <p>Presence and relative abundance of mammals and herpetofauna (EU 92/43/EEC Annex II species as well as species indicated by Institute of Nature Protection).</p> <p>Changes in trends and spatial distribution of game species (roe deer, wild boar, grey partridge and quail).</p>	Once a year. Based on research results compared to baseline study, identify and prescribe measures to mitigate highway residual effect (if any)	<p>PERS</p> <p>It is also important to engage professional organizations.</p> <p>For game species cooperation with local hunting associations is important as they possess time-series data</p>
Freshwater ecology	In the river crossings to ensure no-effect	<p>Fish populations (species presence and relative abundance)</p> <p>Turbidity</p> <p>Phytoplankton</p> <p>Macrobenthos populations (abundance and diversity)</p> <p>Aquatic vegetation</p>	Quarterly for the first 2 years of operation	PERS
Landscape	Slopes of cuttings and embankment, tunnel portals, watercourses and banks underneath the bridges; Bridge abutments, etc.	<p>Condition of vegetation cover</p> <p>Condition of rehabilitated zones and threatening processes (e.g. flood, erosion etc.) that may affect the success of rehabilitation</p>	Annually in spring Visual	PERS

7.1.1 Soil monitoring

Soil monitoring in the construction phase

Highway route predominantly passes through agricultural area, therefore monitoring of agricultural land is performed in accordance with the Law on Agricultural Land ("Official Gazette of RS", no. 62/2006 and 41/2009) and its Regulations on allowed amounts of hazardous and harmful substances in soil and irrigation water and methods of their analysis ("Official Gazette of RS", no. 23/94).

Other areas which are not categorized as agricultural lands are monitored according to Regulation on a program of systematic monitoring of soil quality indicators for evaluation of risk of soil degradation and methodology for development of remediation programs ("Off. Gazette of RS", no. 88/2010). This Regulation is synchronised with recommendations from the proposal of EU Directive (Proposal for a Soil Framework Directive – COM (2006)232).

Proposal for soil monitoring in a phase of highway construction is that sampling sites are located on every 4 km of highway route. The soil is sampled individually in zones of 3, 10 and 100 m far from the highway route, on its left and right side. Therefore, six samples should be collected on every 4 km of the route. Composite sample from each sampling location is made by mixing soil samples from 0-30 cm depth, from 10 different locations on every 100 m. The whole highway route will be covered by this manner. Sampling locations must be recorded with GPS device and it will present an integral part of an information system on the impact of highway construction and exploitation on the soil. It is necessary to describe locations from which the samples are taken. Therefore, total (minimum) of 66 samples would represent the quality of soil in the phase of highway construction.

In the context of soil monitoring it is necessary to determine basic physical and chemical properties such as particle size distribution, soil reaction, calcium carbonate content, organic matter content, EC (due to use of salt on roads), soil compaction, but also prescribed harmful and polluting substances from Regulation on allowed amounts of hazardous and harmful substances in soil and water for irrigation, as well as other diffuse pollutants, such as PM10, PAHs, PCBs, SO2, NOx, if established their presence in the air on locations where air quality is measured, which are near the highway. Assessment of soil quality is performed by comparison of obtained results with maximum allowed amounts of hazardous and harmful substances and threshold values for pesticide residues. Assessment of soil quality from non-agricultural areas is performed based on mentioned Regulation on a program of systematic monitoring of soil quality, and upon the interpretation of obtained values and comparison of threshold and remediation values of hazardous and harmful substances and values, which may point out to a significant soil contamination.

Soil monitoring in operation phase

In the phase of E80 highway operation it is necessary to timely monitor soil quality. Sampling should be done on the same sites and according to distance zones from the highway, same as in the case of sampling during the construction phase. In the case of agricultural production, it is necessary to monitor soil quality in spring and autumn, together with plants sampling, while in a case of other land use it is necessary to monitor soil annually. This methodology creates conditions for reporting on soil quality during highway operation. Data elaboration could result in the proposal of eventual measures for soil improvement, since the results of initial state and operation phase are possible to be compared. If it turns out that there is no soil pollution during operation phase, sampling and measurement interval in further operation could be increased on every second year, or every third year on some sites. Monitoring of soil quality should be synchronized with air and water quality measurements around highway sections.

7.1.2 Biomonitoring

In the analysed area it is necessary to continuously monitor the parameters that affect on the deterioration of the quality of air, water and soil. In order to monitor changes in the environment on the basis of these parameters, it is necessary to plan the establishment of a control system for taking appropriate measures.

In biomonitoring bird fauna, it is necessary to organize at least one-year monitoring in the operation phase, and based on the results of research prescribe measures to mitigate the effects. For this purpose, it is necessary to organise a consultation process with key stakeholders (institutions or organizations) to assess the capacity to implement monitoring on the motorway and confirm the main elements of the monitoring plan.

Biomonitoring of mammal fauna can be implemented through the recording frequency trampling of animals on the roadway, and overall changes in populations, considering the pre-constructional phase. For this purpose, it is important to engage professional organizations. Cooperation with local hunting associations to record changes in trends in the number and spatial distribution of mammal species that are significant huntable species (roe deer, wild boar, grey partridge and quail primarily) is one of the ways of implementation of biomonitoring.

As a result of biomonitoring, there may be the possibility of building additional special crossings for mammals at certain locations or enhance the fencing of the highway in order to minimise accidents and mortality.

Specific area plans will be necessary for key areas included above (eg Toplica River alluvion) in order to verify restoration and the mitigation of impacts.

The following locations should be considered:

- Bridge over Aleksandrovački Stream, km 2+988
- Krajковаčka River regulation, km 8+105
- Lepajski Stream regulation, km 8+514
- Pipe culvert, km 10+538
- Jugbogdanovačka River regulation, km 14+062
- Suvi Stream regulation, km 14+235
- Ciganski Stream regulation, km 17+785
- Stržavska River regulation, km 18+433
- Trnavska River regulation, km 22+680
- Junction Prokuplje West, the maintenance and control base, km 23+600
- Drenovački Stream regulation, km 29+019
- Zdravinjska River regulation, km 30+108
- Zdravinjska River regulation, km 31+791
- Bridge over Draguska river, km 34+928

- Suvodolski Stream regulation, 37+533
- Bridge over Backa river in km 38+278
- Bridge over Toplica river in km 38+550

7.2 Social Monitoring

Proposed social monitoring during construction and operation stage is provided in Table 89 and Table 90.

Table 89 Construction stage social monitoring

Receptor	Location	Indicator	Frequency and proposed mitigation measure	Responsibility
Physical and economic displacement	Each permanently or temporarily displaced property	Complaints from affected persons through the grievance mechanism.	To be defined by the RAP	Municipal authorities Tax administration
Noise and vibration	In the zone of affected receptors	Noise levels Vibration levels	Only in the event of complaint mobile barriers for noise protection	Supervision
Community health and safety	Affected community areas	Safety barriers and signage. Accidents involving the local community members Complaints from residents through the grievance mechanism.	Daily during construction	Contractor Supervision
Roads	All haulage routes	Condition of roads, need for repair, periodical cleaning	Random checks/minimum once per week Visual	Contractor Supervision
Cultural heritage	All construction areas along the route	Presence of chance finds, according to the relevant procedure	Visual	Contractor Supervision
Occupational health and safety	All construction sites along the route	Injuries PPE and safety equipment; according to regulatory requirements; Complaints from workers through the grievance mechanism.	Continuously Visual	Contractor Supervision

Table 90 Operational stage social monitoring

Receptor	Location	Indicator	Frequency and proposed mitigation measure	Responsibility
Noise and vibration	In the zone of affected receptors	Noise levels	Only in the event of complaint New barriers for noise protection	PERS
Community health and safety	Affected community areas	Accidents Complaints from residents through the grievance mechanism.	Annually	PERS
Occupational health and safety	All workplaces obliged to health surveys	Worker's health PPE and safety equipment; according to regulatory requirements; Complaints from workers through the grievance mechanism.	According to the OHS Management Plan and OHS Risk Assessment	PERS

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Annex 1 Social Impact Assessment Study (SIA)

(in separate report)

Annex 2 Noise maps

(in separate files)

Annex 3 Maps of right-of-way, Preview map, Cross-sections, Junctions, River regulations

(in separate files)

Annex 4 EIA Scoping Application and the Decision

(in separate files)

Annex 5 Selection of alignment route and Option analysis

(in separate files)

Annex 6 Opinions of Institutes

(in separate files)

Annex 7 Location Conditions

(in separate files)

Annex 8 Implementation Recommendations

(in separate files)

Annex 9 Environmental measurements results

(in separate files)

Annex 10 Appropriate Assessment Screening

(in separate report)