Morava Corridor Motorway Project, Serbia

Supplementary Lenders Information Package
Traffic Impact Assessment

March 2021

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Acronyms and Abbreviations

AADT	Average Annual Daily Traffic
BEJV	Bechtel-ENKA Joint Venture
CoS	Corridors of Serbia
EF	Emission Factor
EHS	Environmental, Health and Safety
EP	Equator Principles
E&S	Environmental and Social
EIA	National Environmental Impact Assessment
ESDD	Environmental and Social Due Diligence
ESIA	Environmental and Social Impact Assessment
GoS	Government of the Republic of Serbia
HSM	Highway Safety Manual
HCM	Highway Capacity Manual
IESC	Independent Environmental and Social Consultant
IFC	International Finance Corporation
MCMP	Morava Corridor Motorway Project
MCTI	Ministry of Construction, Transport and Infrastructure
MIGA	Multilateral Investment Guarantee Agency
PS	Performance Standards
SLIP	Supplementary Lender Information Package
UKEF	UK Export Finance
BP	Borrow Pits
Q	Quarries
WA	Unsuitable soil deposit areas
EMEP/EEA	European Monitoring and Evaluation Programme - European Environmental Agency
PA	Passenger Car
LT	Light Truck
ST	Semy Truck
TT	Heavy Truck
AV	Heavy Trailer Truck

1 Introduction

1.1 Project Summary

The Morava Corridor Motorway Project (the Project or MCMP), a 112 km dual-carriageway tolled motorway, is planned to be developed by the Government of the Republic of Serbia (GoS). The Project links Preljina to Pojate (in central Serbia) and will be connecting to European Transport Corridors 10 and 11.

The Project is located approximately 200 km south of Belgrade in a low-level flood plain running east/ west along the West Morava River Valley. The Project also includes (i) above ground structures such as interchanges, bridges, culverts, over and under passes; (ii) a telecommunication network (digital corridor) supported by power lines, communication cables and substations to connect the planned mobile phone base stations within the motorway (at rest areas, parking lots, and near traffic loops) as well as manage traffic through various traffic control, monitoring and surveillance, and tolling systems; and (iii) river regulation works intended to protect the Project and surrounding areas from flooding. A total of 18 separate hydrotechnical structures are planned for construction, including 'cut-offs' (straightened, channelised sections of river), revetments and reconstruction of embankments. The total length of cut-offs planned is approximately 32.7 km. In addition, temporary facilities to be constructed as part of the Project comprise quarries and borrow pits, camp sites and storage areas, crushers, concrete batching plants and asphalt plants, and access roads.

GoS is the Project Owner and is represented by the Ministry of Finance with, Corridors of Serbia (CoS), on behalf of the Ministry of Construction, Transport and Infrastructure (MCTI), is the overall overseeing entity throughout the construction and expropriation phases of the Project. Another public institution, Roads of Serbia (RoS), will be the operating party for the Project. Bechtel-ENKA joint venture (BEJV) has been selected as the contractor for the design and construction of the Project.

Three separate Environmental Impact Assessment (EIA) reports have been prepared in 2019 to meet the national requirements of Serbia. Currently the Sector 2 EIA is under development.

The Lender Group is comprised of JP Morgan, UK Export Finance (UKEF) and the Multilateral Investment Guarantee Agency (MIGA) for the financing of the Project. In order to meet the requirements of the financial loan approval, an Environmental and Social Impact Assessment (ESIA) was prepared by 2U1K supported by various experts and institutions.

1.2 Background

Ramboll UK Limited (Ramboll) was appointed as the Lender Independent Environmental and Social Consultant (IESC) in order to assess the compliance and identify any gaps in the ESIA study against the Lender Group Environmental and Social (E&S) requirements, namely International Finance Corporation (IFC) Performance Standards (PS), IFC Environmental, Health and Safety (EHS) Guidelines, and Equator Principles (EP). Within the scope of Ramboll, an Environmental and Social Due Diligence (ESDD) report has been prepared.

Ramboll identified a number of gaps against the Lender Group requirements, and outlined required actions for both ESIA study and associated; the ESIA study was finalised in November 2020 as per the recommendations of the ESDD report. An additional action required the development of Supplementary Lender Information Package (SLIP), which comprises of the following five deliverables:

- Alternatives Analysis report for aggregate sourcing and GHG emission reduction;
- Traffic Impact Assessment for aggregate transport;
- Ecosystem services assessment;
- Cultural heritage assessment; and
- Informed Consultation and Participation for River Regulations and Operational Noise Impacts.

In November 2020 RINA Consulting S.p.A. (RINA) was appointed to undertake the aforementioned tasks under the SLIP.

1.3 Objective

As part of the Supplementary Lenders Information Package (SLIP), this document reports the Traffic Impact Assessment (TIA) concerning the construction activities of the MCMP project.

The main expected outputs of the TIA are:

- identification of haulage routes and details of existing traffic flows on them;
- estimation of construction traffic volumes;
- assessment of the potential impacts to the local road network.

1.4 Report Structure

This document consists of the following Sections:

- Chapter 1 provides the project summary, the purpose of this document as well as the references;
- Chapter 2 describes the methodology implemented for the Traffic Impact Assessment (TIA);
- Chapter 3 summarizes the conclusion of the analysis.

1.5 Reference Documents

The following documentation and information sources were reviewed for the development of this TIA report.

- P0023089-3-H2 Rev 0 SLIP_Alternatives Analysis draft;
- MORAVA CORRIDOR MOTORWAY PROJECT MILESTONE SUMMARY SCHEDULE;
- Morava Corridor-inputs for TIA-BEJV_Responses (BEJV 2021);
- Kmz, Shapefiles and technical documents for the route alignment, facilities and constraints;
- Kmz files reporting the locations of borrow pits, quarries and unsuitable soil deposit areas;
- Morava Corridor Motorway Project Lender's Technical Advisor Report (Ramboll, 2020);

- European Monitoring and Evaluation Programme - European Environmental Agency EMEP/EEA air pollutant emission inventory guidebook 2019;
- Traffic load chart on state roads IB category (Traffic Counting - PE "Roads of Serbia" (putevi-srbije.rs);
- Highway Capacity Manual. Washington, DC, 2000, 2: 1.;
- PART, D. Highway safety manual. American Association of State Highway and Transportation Officials: Washington, DC, USA, 2010;
- CASCETTA, Ennio. Transportation systems analysis: models and applications. Springer Science & Business Media, 2009;
- MONTELLA, Bruno. Pianificazione e controllo del traffico urbano: modelli e metodi. Cuen, 1996.

2 Traffic Impact Assessment

The purpose of the TIA is to identify the impacts that will be generated on the local transport system by the aggregate movements along the construction site in terms of congestion and pollution.

The methodological approach applied in this study is based on three main steps:

- Data collection
- Traffic modelling
- Assessment of negative externalities

The Project is a 112 km long dual-carriageway tolled motorway mostly adjacent along the West Morava River. The Project is divided into 3 sectors, as presented in Table 1 below, which divides into total of 9 sections. The Motorway will be part of the Trans European Network and will connect Corridor IX to Corridor X. The Project aims to allow safe travel whilst increasing the nation-wide import and export potential, as well as creating economic opportunities in the region. An overview of the project alignment is presented in Figure 1.

Table 1: Project Sectors and Lengths

Sector	Sections	Length (km)
Sector 1: Pojate – Kruševac	1-2-3	27.83
Sector 2: Kruševac – Adrani	4-5-6-7	53.89
Sector 3: Adrani – Preljina	8-9	30.66

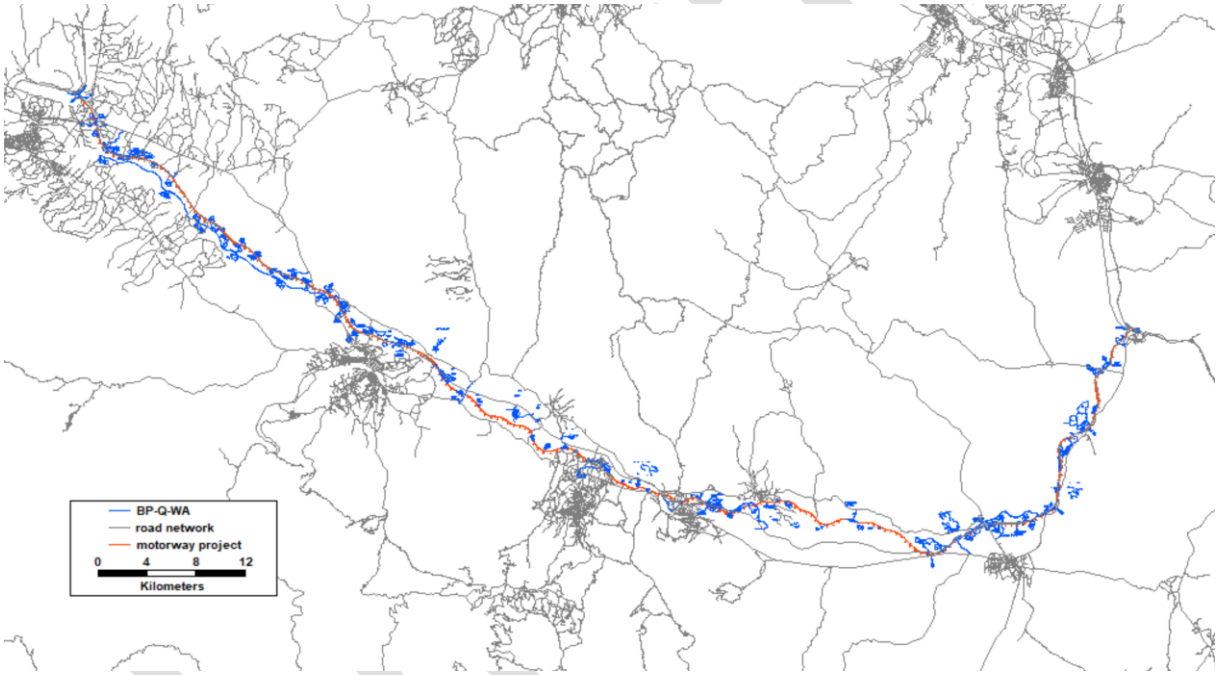
Figure 1: Route Alignment

2.1 Construction site layout – study area

The geographical area under analysis includes the motorway project alignment and all the origin and destination zones of the construction material movements, namely (Figure 2):

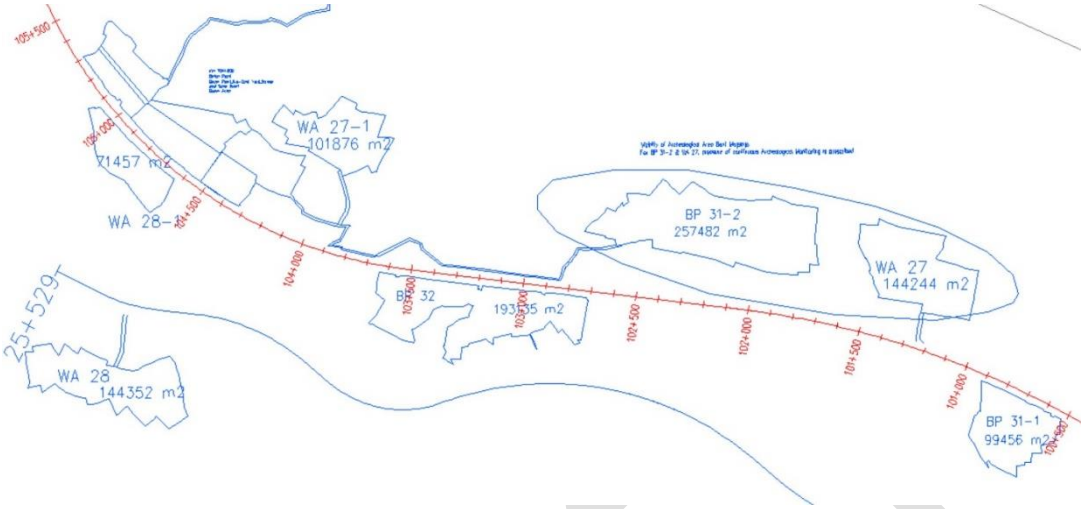
- borrow pits (BP): also referred to as a sandbox, is a large hole that has been dug for a particular purpose. The hole left behind after the material has been harvested from a construction site is called a "borrow pit."
- quarries (Q): open-pit mines in which the construction aggregate, is excavated from the ground.
- unsuitable soil deposit areas (WA): disposal areas for the construction activities' waste.

Figure 2: Motorway project site - BP, Q and WA locations –road network



Borrow pits and unsuitable soil deposit areas are located very close to the future alignment (average distance of 500 meters) of the motorway (Figure 3), thus reducing at minimum potential impacts on the existing transport mobility within the study area.

Figure 3: Example of BP and WA locations – Sector 3– Section 9



Quarries by contrast, although located pretty close to the project area (within 2 km of the project alignment), need to be connected to the construction site through IB-class roads. This has enabled the identification of the transport infrastructures to be considered for the TIA, removing all the roads that will not be affected by the heavy construction traffic. The details of the relevant roads are shown in Section 2.2.

Further details about the locations of borrow pits, quarries and unsuitable soil deposit areas are reported in the Appendix A.

Figure 4: quarry km 16 – state road 23

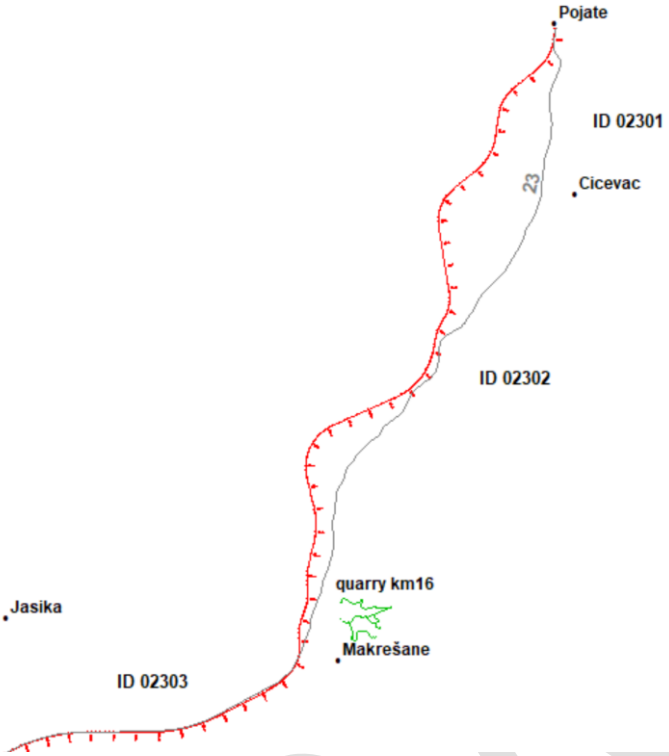


Figure 5: quarry km 25 – quarries km 54 – state road 23

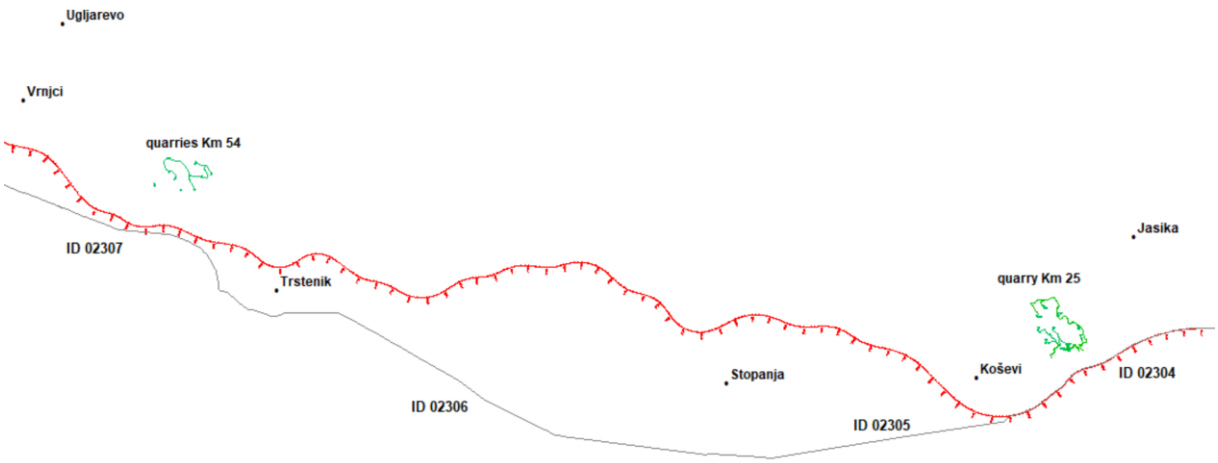


Figure 6: quarry km 75 – state road 23

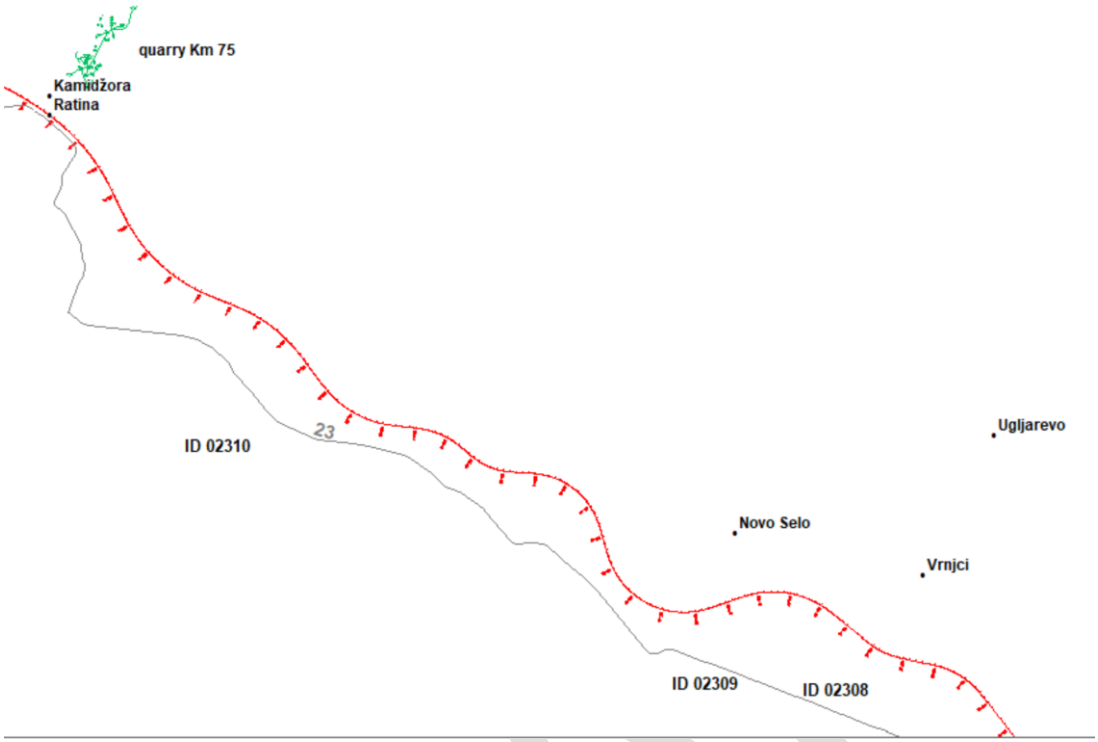


Figure 7: quarry km 75 – state road 23

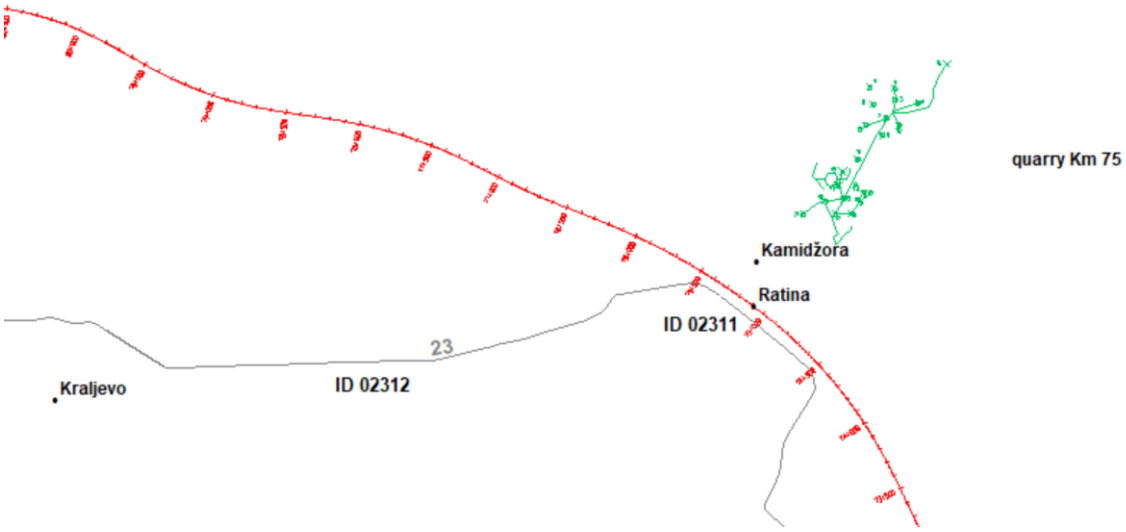
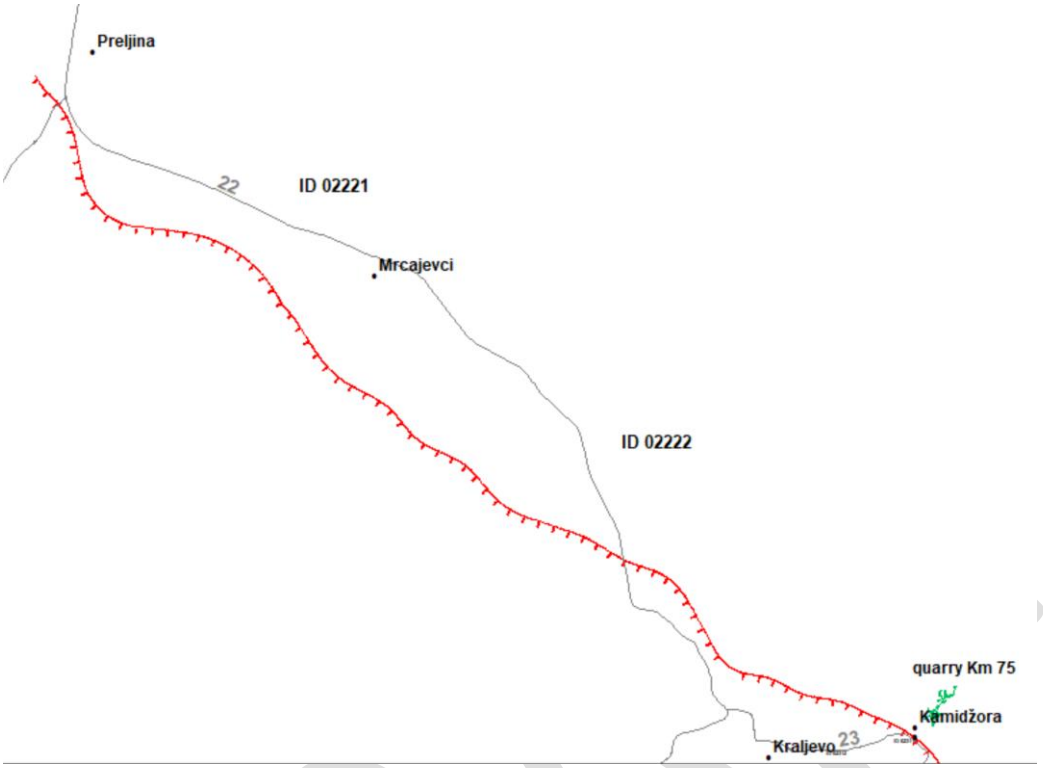


Figure 8: quarry km 75 – state road 22



2.2 Road network modelling

The MCMP project runs along the West Morava River Valley, as shown at the beginning of this chapter. The majority of the material sources and waste disposal areas are close to the construction site. It is expected that the state road 22 (between Preljina and Kraljevo) and the state road 23 (between Pojate interchange and Kraljevo) are likely to be impacted by the traffic generated for the Project construction.

Table 2 illustrates briefly the abovementioned roads.

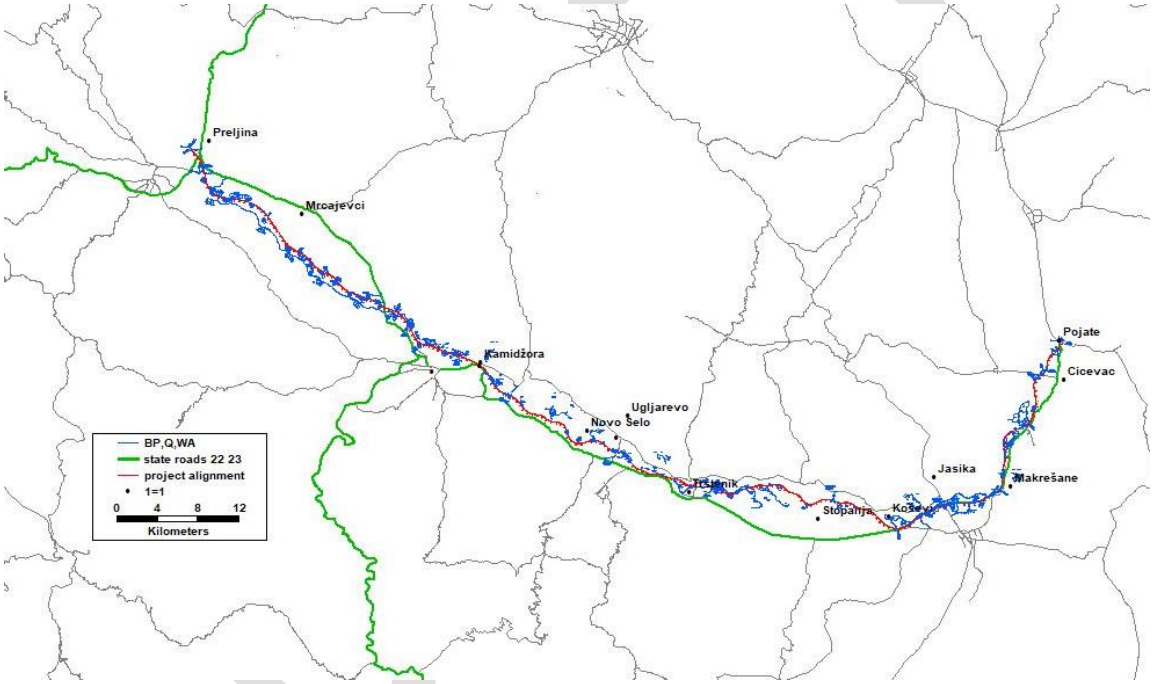
Table 2: Existing key roads adjacent to the MCMP site

Name	Hierarchy	Charateristics
State Road 22 **(**Ibar Highway)	IB-class: roads categorized as state roads. They have one lane per each direction, signs are black-on-yellow and the normal speed limit is 80 km/h.	Is a 298 km length road, with one lane for each direction, connecting Belgrade with Šumadija and Western Serbia and with Montenegro at Špiljani border crossing. It is part of the following European routes: E65 (Class-A European route), E80 (Trans-European Motorway – TEM), E761 and E763 (International E-road network).

State Road 23 Western Serbia, connecting Pojate with Montenegro at Gostun. It is located in Šumadija and Western Serbia.	IB-class: roads categorized as state roads. They have one lane per each direction, signs are black-on-yellow and the normal speed limit is 80 km/h.	It is 301 km state road located in Šumadija and Western Serbia, linking Pojate with Montenegro at Gostun. It is a main road with two traffic lanes, one for each direction and it is part of the European routes E761 and E763.

Figure 9 shows the graph representing the abovementioned roads together with the project alignment.

Figure 9: State roads 22 and 23 – project alignment



2.2.1 Traffic volumes

Traffic flows of the roads included in the model are provided by the Public Enterprise Road of Serbia (see Table 3) as Average Annual Daily Traffic (AADT) values and they referred to 2019.

Table 3: Average annual daily traffic in 2019

Section ID	Road section	Section lenght (km)	PA	BUS	LT	ST	TT	AV	Summary
02221	Preljina - Mrčajevci	12.3	11571	169	269	379	155	1000	13543
02222	Mrčajevci - Kraljevo	19.9	5679	105	170	227	98	778	7057
02301	Petlja Pojate - Ćićevac	3.9	6654	169	125	214	88	697	7947
02302	Ćićevac - Makrešane	11.9	7297	189	128	221	79	698	8612
02303	Makrešane - Kruševac (Jasika)	6.7	3457	40	122	219	177	749	4764
02304	Kruševac (Jasika) - Koševi	5	3333	86	110	147	70	537	4283
02305	Koševi - Stopanja	8.5	6674	134	172	210	122	527	7839
02306	Stopanja - Trstenik	11.2	9607	116	159	224	80	511	10697
02307	Trstenik - Vrnjci	9	8188	108	158	202	107	520	9283
02308	Vrnjci - Vrnjci (Ugljarevo)	1.3	8298	114	160	210	120	523	9425
02309	Vrnjci (Ugljarevo) - Novo Selo	2.2	7463	102	144	190	107	484	8490
02310	Novo Selo - Ratina	12.7	6893	101	136	176	102	482	7890
02311	Ratina - Kraljevo (Kamidžora)	3.6	2956	24	87	151	66	481	2765
02312	Kraljevo (Kamidžora) - Kraljevo	7.1	8274	115	160	209	119	521	9398

*Source: https://www.putevi-srbije.rs/index.php/en/traffic-counting

*PA: passenger car; BUS; LT: -light truck; ST: semy truck; TT-heavy truck; AV: heavy trailer truck.

2.3 Construction traffic impacts

The environmental impacts of the heavy traffic generated by the construction activities is mainly due to the aggregate transport from the source locations (borrow pits and quarries) to the construction site as well as to the transport to the disposal areas (unsuitable soil deposit areas).

The following types of impacts have been analysed:

- the pollutants emitted from the exhaust of the heavy vehicles' engines;
- the potential congestion generated by the increase of heavy traffic on the existing roads;
- the expected crash frequency variation due to the traffic construction.

As shown in Section 2.1, the selection of the aggregate sources as well as the identification of the disposal areas close to the project alignment will notably reduce the construction traffic impacts on the existing environment.

Based on this, it is possible to assume that:

- Since the location of BP and WA is close to the construction site (overall average distance less than 400 m), the impact generated by the aggregate transport to and from these sites in terms of heavy flow is negligible. Therefore, no traffic impact assessment is deemed necessary;
- The movements of aggregate from the selected quarries to the construction site will only affect the closest state roads, namely State Roads 22 and State Road 23. This requires the analysis of the road congestion.

Pollutant emissions instead, have to be calculated for all heavy vehicle movements.

Also, the preparation and use of borrow pits and unsuitable soil deposit areas will impact local air quality through the generation of dust during extraction of aggregate and deposition of soils and through emissions from vehicles and machinery on these sites. Additional noise and vibration impacts, as well as dust emission, may also result from any blasting undertaken at quarry sites. These impacts have been considered and quantified in the Project Alternatives Analysis for borrow pits, quarries and unsuitable soil deposit areas. We have considered local residences to be the principle sensitive receptors for these impacts, and that residences within 500m of these sites have the potential to be experience impacts in terms of air quality and noise and vibration.

2.4 Estimation of heavy vehicle movements

The construction traffic volume estimates are based on:

- The amount and the type of soil to be moved;
- The length of the haulage routes;
- The type of dumper adopted for the aggregated transport.

The total earth volumes expected to be moved amount to 48,156,400 m^3, split by

- fill: earthy material usually subsoil which has little soil organic matter or biological activity;

- waste: unsuitable soil;
- aggregate: coarse to medium-grained particulate material.

Table 4 reports the total expected volumes for each of the different types of material as well as the total amount.

Table 4: Construction material – foreseen quantities

Type of material	Total amount (m^3)
fill	20,000,000
waste	20,000,000
aggregate	8,156,400
Total Earth Movement	**48,156,400**

These values have been converted into daily volumes assuming 25 working days per month. (see Appendix B)

The differences between the average daily activities during the summer and the winter period are represented through the following coefficients:

- Coefficient over Average in Summer Days: 1.5;
- Coefficient over Average in Winter Days: 0.5.

The peak value foreseen during the summer is used conservatively to assess the impact on the traffic mobility. For what concerns the calculation of pollutant emissions, since the total value to be estimated refers to the entire construction period, the average daily value (i.e. coefficient equal to 1), is instead adopted. (Appendix B)

Based on the estimated daily volumes, for both the peak and the average day, the number of *equivalent truck movements* is calculated assuming that each dumper carries a payload of 20 m^3 (see table Table 5)

Table 5: estimated equivalent truck movements per day

	Fill from BP		Aggregate from BP		Aggregate from Quarries		Fill to WA	
	average	summer peak	average	summer peak	average	summer peak	average	summer peak
Sector 1	176	264	40	60	52	78	226	338
Sector 2	505	757	79	118	102	153	376	564
Sector 3	271	407	46	69	60	89	351	526

2.5 Estimation of pollutants

The amount of emissions is dependent on the distance travelled by the heavy vehicles within the different Sections or Sectors. The average distances are evaluated based on the locations of borrow pits, quarries and unsuitable soil deposit areas per Section/Sector, as follows:

$$AD = \frac{L_S}{n_S} * 0.5 \quad (2.1)$$

where

- L_S is the total length of the Sector/Section;
- n_S is the number of sources/disposal areas per Section/Sector.

Given the average distance, it is possible to estimate the total truck movements* km considering the round trip travelled by the heavy vehicles from the borrow pits, quarries and unsuitable soil deposit areas to the construction site and backward. The average distances evaluated for each Sector/Section are reported in the Appendix C.

Four types of pollutants have been accounted in the analysis:

- Carbon Monoxide (CO)
- Carbon Dioxide (CO_2)
- Nitrogen Oxides (NOx)
- Particulate Matter (PM_{10})

The pollutants have been evaluated according to the emission factors indicated by the EMEP/EEA air pollutant emission inventory guidebook 2019, considering a truck with the following characteristics:

- Heavy Duty Trucks
- Diesel
- Rigid >32 t

Table 6: Estimated emission factors for dumpers trucks

			EF [g/km]			
Category	**Fuel**	**Segment**	**CO**	**CO2**	**NOx**	**PM10**
Heavy Duty Trucks	Diesel	Rigid >32 t	0.97	675.46	3.13	0.15

The total emissions due to the construction activities for the entire project period are finally calculated on the base of the total km due to truck movement (i.e. number of truck movements*covered km *emission factor).

The outcome is collected in Table 7.

Table 7: Total pollutant emissions

	Daily			
	CO	**CO_2**	**NOx**	**PM10**
g	13765	9539548	44205	2118
t	0.013765287	9.539548098	0.044204956	0.002118448
	Monthly			
	CO	**CO_2**	**NOx**	**PM10**
g	344132	238488702	1105124	52961
t	0.34	238.49	1.11	0.05
	Construction Period (42 months)			
	CO	**CO_2**	**NOx**	**PM10**
g	14453552	10016525503	46415204	2224371
t	14.45	10016.53	46.42	2.22

2.6 Road congestion

As already explained in Section 2.1, the amount of heavy vehicle traffic that will travel daily on the existing roads concerns only the movements of materials from the quarries to the construction site.

This flow depends on:

- the total round-trip time assuming an average speed of 25 km/h and including also the loading and unloading activities (2 hours in total).
- the working hours per day (8 hours) which determines the number of trips per day that can be performed;
- the number of daily movements based on the Summer peak values.

Table 8 shows the estimated daily number of truck movements, the estimated daily number of trips as well as the estimated daily number of trucks based on the assumptions above.

Table 8: Estimated daily number of trucks per quarry

Sector	Quarry location	Estimated daily number of truck movements Summer Seasons	Estimated round-trip time (h)	Estimated daily number of. trips	Estimated daily number of trucks
1	Q1 - km 16	39	2.56	3	13
1	Q2 - km 25-Paracin	39	2.56	3	13

Sector	Quarry location	Estimated daily number of truck movements Summer Seasons	Estimated round-trip time (h)	Estimated daily number of. trips	Estimated daily number of trucks
2	Q3, Q4 km 54-Paracin	153	4.16	2	80
3	Q5 - km 75	89	3.23	2	37
tot		320		10	143

This heavy vehicle flow shall be converted in equivalent passenger cars (PCE) in order to assess the impact on the service level of the roads considered within the study area.

The total number of generated equivalent cars is reported in

vehicle type	PCE factor values
PA-passenger car	1
BUS	3
LT-light truck	1.5
ST-semy truck	2
TT-heavy truck	2.5
AV-heavy trailer truck	3.5

Table 10. The conversion is based on the coefficients recommended in *Montella (1996)* and shown in Table 9.

Table 9: Equivalent Passenger Cars conversion factors

vehicle type	PCE factor values
PA-passenger car	1
BUS	3

LT-light truck	1.5
ST-semy truck	2
TT-heavy truck	2.5
AV-heavy trailer truck	3.5

Table 10: Total number of trucks generated and number of PCE conversion.

Sector	Quarry location	Estimated PCE
1	km 16	33
1	km 25-Paracin	33
2	km 54-Paracin	200
3	km 75	93
tot		**359**

The current flows on the existing roads shown in Section 2.2.1 are given as average daily traffic volumes.

These are converted into daily peak values assuming that the total number of equivalent vehicles has been evaluated assuming that:

- the average daily traffic volume is equally distributed on both direction;
- the peak hour vehicles flow (VHP) is obtained multiplying the ADT per lane by a *peak hour factor (phf)* equal to 0.2.

Based on the geometric characteristics of the I B state roads 22 and 23, the road capacity has been evaluated as:

$$Cap = 525 * actual\ lane\ width * number\ of\ lanes$$

Where

- $actual\ lane\ width$= 3.50 m;
- $number\ of\ lanes$=1 (for each direction).

The results are collected in Table 11.

Table 11: Average daily traffic in PCE

Section ID	Road section	ADT - Passenger Car Equivalent
02221	Preljina - Mrčajevci	17127
02222	Mrčajevci - Kraljevo	9671
02301	petlja Pojate - Ćićevac	10436
02302	Ćićevac - Makrešane	11139
02303	Makrešane - Kruševac (Jasika)	7262
02304	Kruševac (Jasika) - Koševi	6105
02305	Koševi - Stopanja	9904
02306	Stopanja - Trstenik	12630
02307	Trstenik - Vrnjci	11241
02308	Vrnjci - Vrnjci (Ugljarevo)	11431
02309	Vrnjci (Ugljarevo) - Novo Selo	10327
02310	Novo Selo - Ratina	9694
02311	Ratina - Kraljevo (Kamidžora)	5309
02312	Kraljevo (Kamidžora) - Kraljevo	11398

The impact has been evaluated comparing the Level of Service (LOS) of the current road mobility (*Scenario 0*) with the one including also the additional flows for the construction activities (*Scenario 1*).

According to the HCM manual, the LOS is a "*quality measure describing operational conditions within a traffic stream, generally in terms of such service measures as speed and travel time, freedom to manoeuvre, traffic interruptions, and comfort and convenience".*

The level of service is given by:

$$LOS = \frac{VHP}{Cap}$$

Based on the values of the peak hour vehicles flow and the road capacity, six different LOS are defined (see Table 12).

Table 12: Level-of-Service range

LoS	VHP/road capacity		Meaning
A	0.00	0.35	This represents free-flow conditions where traffic flow is virtually zero
B	0.35	0.55	Represents reasonable free-flow conditions
C	0.55	0.75	Delivers stable flow conditions.
D	0.75	0.85	The road is operating at high density levels but stable flow still prevails.
E	0.85	1.00	Represents the level at which the capacity of the road has been reached.
F		>1.00	Describes a state of breakdown or forced flow with flows exceeding capacity.

As shown in Table 13, the increased number of heavy vehicles on the existing roads does not affect the roads LOS, which remains the same for all of them.

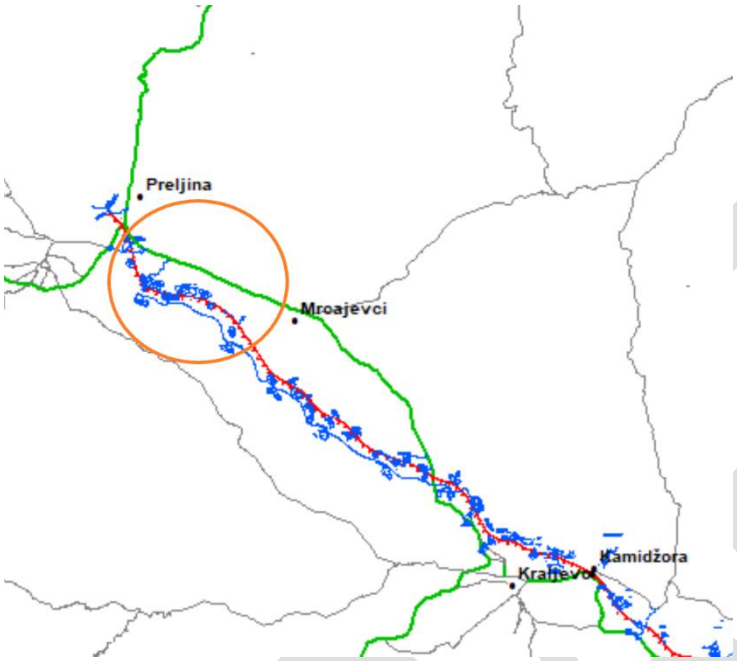
Table 13: LOS before and during the construction activities

Section ID	Road section	Scenario 0				Scenario 1			
		Daily PCE	VHP	VHP/Cap	LoS	Daily PCE	VHP	VHP/Cap	LoS
02221	Preljina - Mrčajevci	17127	1713	0.932	E	17220	1722	0.937	E
02222	Mrčajevci - Kraljevo	9671	967	0.526	B	9764	976	0.531	B
02301	petlja Pojate - Ćićevac	10436	1044	0.568	C	10469	1047	0.570	C

Section ID	Road section	Scenario 0				Scenario 1			
		Daily PCE	VHP	VHP/Cap	LoS	Daily PCE	VHP	VHP/Cap	LoS
02302	Ćićevac - Makrešane	11139	1114	0.606	C	11171	1117	0.608	C
02303	Makrešane - Kruševac (Jasika)	7262	726	0.395	B	7295	729	0.397	B
02304	Kruševac (Jasika) - Koševi	6105	610	0.332	A	6137	614	0.334	A
02305	Koševi - Stopanja	9904	990	0.539	B	10104	1010	0.550	B
02306	Stopanja - Trstenik	12630	1263	0.687	C	12830	1283	0.698	C
02307	Trstenik - Vrnjci	11241	1124	0.612	C	11441	1144	0.623	C
02308	Vrnjci - Vrnjci (Ugljarevo)	11431	1143	0.622	C	11631	1163	0.633	C
02309	Vrnjci (Ugljarevo) - Novo Selo	10327	1033	0.562	C	10527	1053	0.573	C
02310	Novo Selo - Ratina	9694	969	0.528	B	9894	989	0.538	B
02311	Ratina - Kraljevo (Kamidžora)	5309	531	0.289	A	5402	540	0.294	A
02312	Kraljevo (Kamidžora) - Kraljevo	11398	1140	0.620	C	11491	1149	0.625	C

The evaluation of the LOS revealed that section 02221 (part of the state road 22) from Preljina to Mrčajevci (Figure 10) is already affected by high level of traffic flows. For this reason, it is probably not capable to host the additional heavy flow from construction activities.

Figure 10: Section 02221 from Preljina to Mrčajevci



To reduce the traffic congestion, it is suggested to restrict the traffic on this section only to haulage operations, sending the ordinary traffic flows towards an alternative path as one shown in the figure below.

Figure 11: Alternative route for ordinary traffic flows

2.7 Safety analysis

The impacts generated by the increased number of heavy vehicles affecting the haulage routes for the movements of construction material, can be assessed in terms of percentage variation of the expected yearly crash frequency considering current traffic flow conditions (*Scenario 0*) and the ones foreseen during the construction activities (*Scenario 1*)

Based on the Highway safety manual (HSM) the estimated yearly car frequency is given by:

$$N_{spf,rs} = AADT * \mathrm{L} * 365 * 10^{-6} * e^{-0.312}$$

Where

- $N_{spf,rs}$ is the predicted total crash frequency (for two-lane rural roadway segment);
- $AADT$ is the average annual daily traffic (veh/day);
- L is the segment length (miles).

The results are shown in Table 14.

Table 14: Predicted total crash frequency

Section ID	Road section	Scenario 0	Scenario 1	
		Predicted total crash frequency	Predicted total crash frequency	Percentage variation
02221	Preljina - Mrčajevci	34.96	35.15	0.5%
02222	Mrčajevci - Kraljevo	31.94	32.24	0.9%
02301	petlja Pojate - Ćićevac	6.75	6.78	0.3%
02302	Ćićevac - Makrešane	22.00	22.06	0.3%
02303	Makrešane - Kruševac (Jasika)	8.07	8.11	0.4%
02304	Kruševac (Jasika) - Koševi	5.07	5.09	0.5%
02305	Koševi - Stopanja	13.97	14.25	2.0%
02306	Stopanja - Trstenik	23.47	23.85	1.6%
02307	Trstenik - Vrnjci	16.79	17.09	1.7%
02308	Vrnjci - Vrnjci (Ugljarevo)	2.47	2.51	1.7%
02309	Vrnjci (Ugljarevo) - Novo Selo	3.77	3.84	1.9%
02310	Novo Selo - Ratina	20.43	20.85	2.0%
02311	Ratina - Kraljevo (Kamidžora)	3.17	3.23	1.7%
02312	Kraljevo (Kamidžora) - Kraljevo	13.43	13.54	0.8%

The construction traffic generates a slightly increase of the number of expected car accidents per year (maximum positive percentage variation equal to 2%) on the roads under analysis.

3 Conclusions

This report is meant to assess the traffic impacts generated by the additional heavy traffic flow during the project construction.

The Traffic Impact Assessment (TIA) has consisted in:

- The identification of the haulage routes and the details of the existing traffic flows;
- The estimation of construction traffic volumes;
- The assessment of the potential impacts to the local road network in terms of both congestion and pollutant emissions.

The study has started with the collection of all the relevant data, including:

- the locations of selected borrow pits and quarries;
- the type and the amount of fill and aggregate that will be generated for each sector and/or section;
- the foreseen unsuitable soil deposit areas to which the aggregate will be transported;
- the detailed construction schedule providing the time-distribution of aggregate movements;
- the construction site layout;
- relevant information about the local transport system together with the current traffic volumes;

Based on these, the project alignment and the site construction layout have been analysed, and the existing roads likely to be affected by the MCMP identified. The majority of the construction material (approximately the 80%) both fill and aggregate, will be provided from selected borrow pits directly connected to the motorway alignment, Therefore, the roads affected by the project can be identified as the I-B state roads 22 and 23 providing access to the Quarries. Information on existing traffic conditions needed to assess the traffic congestion during the construction activities, has been collected from the PE "Roads of Serbia".

The negative externalities of the heavy traffic which have been assessed are:

- the pollutants emitted from the exhaust of the heavy vehicles' engines;
- the potential congestion generated by the increase of heavy traffic on the existing roads.

For what concerns the environmental impacts, the outcome related to entire project period is reported in Table 15. The pollutants considered for the analysis are:

- Carbon Monoxide (CO);
- Carbon Dioxide (CO_2);
- Nitrogen Oxides (NOx);
- Particulate Matter (PM10).

Table 15: Total pollutant emissions

	Daily			
	CO	**CO_2**	**NOx**	**PM10**
g	13765	9539548	44205	2118
t	0.013765287	9.539548098	0.044204956	0.002118448
	Monthly			
	CO	**CO_2**	**NOx**	**PM10**
g	344132	238488702	1105124	52961
t	0.34	238.49	1.11	0.05
	Construction Period (42 months)			
	CO	**CO_2**	**NOx**	**PM10**
g	14453552	10016525503	46415204	2224371
t	14.45	10016.53	46.42	2.22

It is worth highlighting that the location of borrow pits and unsuitable soil deposit areas very close to the future alignment of the motorway has reduced at minimum the potential impacts on the existing transport mobility within the study area.

In terms of traffic impacts the TIA has demonstrated that the additional heavy vehicle flows do not reduce the Level of Service of the affected roads. Table 16 reports the results.

Table 16: LOS before and during the construction activities

Section ID	Road section	Scenario 0				Scenario 1			
		Daily PCE	VHP	VHP/Cap	LoS	Daily PCE	VHP	VHP/Cap	LoS
02221	Preljina - Mrčajevci	17127	1713	0.932	E	17220	1722	0.937	E
02222	Mrčajevci - Kraljevo	9671	967	0.526	B	9764	976	0.531	B
02301	petlja Pojate - Ćićevac	10436	1044	0.568	C	10469	1047	0.570	C
02302	Ćićevac - Makrešane	11139	1114	0.606	C	11171	1117	0.608	C

Section ID	Road section	Scenario 0				Scenario 1			
		Daily PCE	VHP	VHP/Cap	LoS	Daily PCE	VHP	VHP/Cap	LoS
02303	Makrešane - Kruševac (Jasika)	7262	726	0.395	B	7295	729	0.397	B
02304	Kruševac (Jasika) - Koševi	6105	610	0.332	A	6137	614	0.334	A
02305	Koševi - Stopanja	9904	990	0.539	B	10104	1010	0.550	B
02306	Stopanja - Trstenik	12630	1263	0.687	C	12830	1283	0.698	C
02307	Trstenik - Vrnjci	11241	1124	0.612	C	11441	1144	0.623	C
02308	Vrnjci - Vrnjci (Ugljarevo)	11431	1143	0.622	C	11631	1163	0.633	C
02309	Vrnjci (Ugljarevo) - Novo Selo	10327	1033	0.562	C	10527	1053	0.573	C
02310	Novo Selo - Ratina	9694	969	0.528	B	9894	989	0.538	B
02311	Ratina - Kraljevo (Kamidžora)	5309	531	0.289	A	5402	540	0.294	A
02312	Kraljevo (Kamidžora) - Kraljevo	11398	1140	0.620	C	11491	1149	0.625	C

The evaluation of the LOS revealed that section 02221 (part of the state road 22) from Preljina to Mrčajevci (Figure 10) performs critical traffic conditions.

To reduce the traffic congestion, it is suggested that this section would be closed during the peak hour to undertake the haulage operations. An alternative route for private traffic flows to connect Preljina to Mrčajevci is proposed as shown in figure below.

Figure 12: Alternative route for private traffic

Referring to the safety assessment, the results of the analysis show that the construction traffic will minimally affect the yearly crash frequency on the selected roads (maximum percentage variation of +2%), as shown in the Table 17.

Table 17: Predicted total crash frequency

Section ID	Road section	Scenario 0	Scenario 1	
		Predicted total crash frequency	Predicted total crash frequency	Percentage variation
02221	Preljina - Mrčajevci	34.96	35.15	0.5%
02222	Mrčajevci - Kraljevo	31.94	32.24	0.9%
02301	petlja Pojate - Ćićevac	6.75	6.78	0.3%

Section ID	Road section	Scenario 0	Scenario 1	
		Predicted total crash frequency	Predicted total crash frequency	Percentage variation
02302	Ćićevac - Makrešane	22.00	22.06	0.3%
02303	Makrešane - Kruševac (Jasika)	8.07	8.11	0.4%
02304	Kruševac (Jasika) - Koševi	5.07	5.09	0.5%
02305	Koševi - Stopanja	13.97	14.25	2.0%
02306	Stopanja - Trstenik	23.47	23.85	1.6%
02307	Trstenik - Vrnjci	16.79	17.09	1.7%
02308	Vrnjci - Vrnjci (Ugljarevo)	2.47	2.51	1.7%
02309	Vrnjci (Ugljarevo) - Novo Selo	3.77	3.84	1.9%
02310	Novo Selo - Ratina	20.43	20.85	2.0%
02311	Ratina - Kraljevo (Kamidžora)	3.17	3.23	1.7%
02312	Kraljevo (Kamidžora) - Kraljevo	13.43	13.54	0.8%

Although the negative effect on safety is minimal, it is recommended to implement the following actions:

- speed limitations along the most affected sections (percentage variation of accidents >1%);
- installation of specific warning signs at entrances to the construction site to warn existing road users of entering and exiting construction traffic;
- distribution of day warning notices to advise local road users of scheduled construction activities.

Finally, the overall impact of construction externalities is defined on the basis of the assessment criteria illustrated in the following table.

Table 18: Assessment criteria

Parameter	Criteria	Description
Duration	Continuous	Lasts long time

Parameter	Criteria	Description
	Temporary	Occurs and disappear in a short time period
Time period	Immediate	Occurs in the moment of construction operations and then disappears
	Delayed	Occurs after some time and takes longer time
Reversibility	Reversible	Impact after which the environment can be returned to the previous state
	Irreversible	Impact after which the environment cannot be returned to the previous state
Significance	Very Low	Minor impact without damage to the environment
	Low	Measurable impact but with a proper planning it is not causing damage to the environment
	Medium	Significant impact, but can be controlled if relevant measures are implemented
	High	Impact that will be harmful to the environment
	Very High	Irreversible environmental impact

The overall impact assessment of each externality as well as the proposed mitigation measures are summarised in the matrix below

Table 19: Significance of impacts

Construction Impact	Receptor	Impact indicator	Significance	Duration	Reversibility	Mitigation Measures
Traffic Congestion (potential congestion generated by the increase of heavy traffic on the existing roads)	General road users of state roads 22 and 23	Level of Service	Low	Temporary	Reversible	Restict section 02221 (part of the state road 22 from Preljina to Mrčajevci) to heavy vehicles and detour the private traffic flows on the alternative path.
Traffic Safety (expected crash frequency variation due to the traffic construction)	General road users of state roads 22 and 23	Estimated yearly car frequency	Low	Temporary	Reversible	Limit speed along the most affected sections (with a percentage variation of accidents >1%)
						Provide specific warning signs at the entrances of the construction site to inform road users of the construction areas
						Provide day warning notices to advise local road users of scheduled construction activities
Air quality impact due to vehicles	Residents of nearby communities or properties to the construction site, borrow	Dust generation and pollutant emission of Nitrogen Oxides	Medium	Temporary	Reversible	It is recommended to use at least Euro 4 trucks

Construction Impact	Receptor	Impact indicator	Significance	Duration	Reversibility	Mitigation Measures
	pits, waste areas and quarries	(NOx) and Particulate matter (PM10) from construction machinery and vehicles				Limit truck speed in active construction areas to a maximum of 25 km per hour

Appendix A

Table 20: Borrow pits - locations and size.

Sector	Section	Rename	Chainage	Area(m2)
1	1	101	7+500	535225.2
1	2	2	9+500	393135.3
1	2	3	10+500	218518.2
1	3	6	19+000	86921.59
1	3	7	21+500	144929.8
1	3	107	23+750	425744.9
2	4	8	29+000	431112.2
2	4	8 -1	33+000	360673.8
2	4	9	37+500	480459.1
2	4	9 -1	38+500	185946.7
2	4	10	42+000	831564.2
2	5	10 -1	43+000	155672.7
2	5	10 -2	43+000	107615.5
2	5	10 -3	43+500	88141.9
2	5	10-4	47+000	167756.1
2	5	10-5	47+000	150396.2
2	5	11	48+000	152128.9
2	5	11-1	50+500	124078.8
2	5	12	54+400	262936.6
2	6	13	57+700	119508.4

Sector	Section	Rename	Chainage	Area(m2)
2	6	14	60+500	447776.9
2	6	15-1	64+000	276692.2
2	6	15	65+000	406629.8
2	6	16	66+800	755512.9
2	7	16-1	69+600	298376.8
2	7	17	72+500	757596.3
2	7	19	77+000	76293.4
2	7	21	78+300	101135.8
2	7	22	78+700	351742.7
3	8	23	80+200	140324
3	8	24-1	79+500	75102.9
3	8	24-2	81+300	136543.5
3	8	25	83+000	195322.8
3	8	26-1	84+500	62236.49
3	8	26-2	86+300	209574.4
3	8	27	87+500	52792.94
3	8	27-1	89+500	129796.8
3	8	27-2	91+000	135051.4
3	8	28	92+000	220804.7
3	8	28-1	93+500	207468.9
3	8	29-1	95+000	146323
3	9	31	98+500	147200.1

Sector	Section	Rename	Chainage	Area(m2)
3	9	31-1	100+700	99456.09
3	9	31-2	102+000	259294.3
3	9	32	103+500	193164.3
3	9	34	106+200	150653.4

Table 21: Unsuitable soil deposit areas - locations and size.

Sector	Section	Chainage	Capacity
Sector 1	Section 1	0+350	526,315.79
Sector 1	Section 1	2+700	526,315.79
Sector 1	Section 1	7+200	526,315.79
Sector 1	Section 2	9+000	526,315.79
Sector 1	Section 2	11+800	526,315.79
Sector 1	Section 2	12+200	526,315.79
Sector 1	Section 2	13+700	526,315.79
Sector 1	Section 3	19+000	526,315.79
Sector 1	Section 3	24+200	526,315.79
Sector 2	Section 4	27+000	526,315.79
Sector 2	Section 4	34+000	526,315.79
Sector 2	Section 4	40+500	526,315.79
Sector 2	Section 4	45+900	526,315.79
Sector 2	Section 5	48+800	526,315.79

Sector	Section	Chainage	Capacity
Sector 2	Section 5	53+500	526,315.79
Sector 2	Section 5	56+800	526,315.79
Sector 2	Section 6	60+400	526,315.79
Sector 2	Section 6	62+300	526,315.79
Sector 2	Section 6	66+500	526,315.79
Sector 2	Section 7	73+000	526,315.79
Sector 2	Section 7	78+800	526,315.79
Sector 2	Section 7	80+500	526,315.79
Sector 2	Section 7	79+000	526,315.79
Sector 2	Section 7	81+200	526,315.79
Sector 3	Section 8	82+500	526,315.79
Sector 3	Section 8	86+800	526,315.79
Sector 3	Section 8	89+100	526,315.79
Sector 3	Section 8	90+600	526,315.79
Sector 3	Section 8	91+000	526,315.79
Sector 3	Section 8	94+300	526,315.79
Sector 3	Section 8	94+800	526,315.79
Sector 3	Section 8	94+700	526,315.79
Sector 3	Section 9	97+000	526,315.79
Sector 3	Section 9	101+200	526,315.79
Sector 3	Section 9	104+000	526,315.79

Sector	Section	Chainage	Capacity
Sector 3	Section 9	104+300	526,315.79
Sector 3	Section 9	104+600	526,315.79
Sector 3	Section 9	107+600	526,315.79

Table 22: Quarries – locations

Sector	Chainage
Sector 1	km 16
Sector 2	km 25-Paracin
Sector 2	km 54-Paracin
Sector 3	km 75

Appendix B

Table 23: Estimated quantities of fill for each borrow pit: total/monthly/daily

Section	Rename	Chainage	Area(m2)	Total (m3)	Monthly (m3)	Monthly Summer Seasons (m3)	Monthly Winter Seasons (m3)	Daily (m3)	Daily Summer Seasons (m3)	Daily Winter Seasons (m3)
1	101	7+500	535225.229	1600000	38095	57143	19048	1524	2286	762
2	2	9+500	393135.331	700000	16667	25000	8333	667	1000	333
2	3	10+500	218518.231	500000	11905	17857	5952	476	714	238
3	6	19+000	86921.585	35000	833	1250	417	33	50	17
3	7	21+500	144929.844	15000	357	536	179	14	21	7
3	107	23+750	425744.915	850000	20238	30357	10119	810	1214	405
4	8	29+000	431112.187	670000	15952	23929	7976	638	957	319
4	8 -1	33+000	360673.77	470000	11190	16786	5595	448	671	224
4	9	37+500	480459.146	360000	8571	12857	4286	343	514	171
4	9 -1	38+500	185946.722	225000	5357	8036	2679	214	321	107
4	10	42+000	831564.194	475000	11310	16964	5655	452	679	226

Section	Rename	Chainage	Area(m2)	Total (m3)	Monthly (m3)	Monthly Summer Seasons (m3)	Monthly Winter Seasons (m3)	Daily (m3)	Daily Summer Seasons (m3)	Daily Winter Seasons (m3)
5	10 -1	43+000	155672.727	100000	2381	3571	1190	95	143	48
5	10 -2	43+000	107615.524	150000	3571	5357	1786	143	214	71
5	10 -3	43+500	88141.9009	170000	4048	6071	2024	162	243	81
5	10-4	47+000	167756.122	370000	8810	13214	4405	352	529	176
5	10-5	47+000	150396.231	350000	8333	12500	4167	333	500	167
5	11	48+000	152128.881	450000	10714	16071	5357	429	643	214
5	11-1	50+500	124078.791	245000	5833	8750	2917	233	350	117
5	12	54+400	262936.602	560000	13333	20000	6667	533	800	267
6	13	57+700	119508.372	200000	4762	7143	2381	190	286	95
6	14	60+500	447776.912	760000	18095	27143	9048	724	1086	362
6	15-1	64+000	276692.211	475000	11310	16964	5655	452	679	226
6	15	65+000	406629.832	780000	18571	27857	9286	743	1114	371
6	16	66+800	755512.937	565000	13452	20179	6726	538	807	269

Section	Rename	Chainage	Area(m2)	Total (m3)	Monthly (m3)	Monthly Summer Seasons (m3)	Monthly Winter Seasons (m3)	Daily (m3)	Daily Summer Seasons (m3)	Daily Winter Seasons (m3)
7	16-1	69+600	298376.756	540000	12857	19286	6429	514	771	257
7	17	72+500	757596.348	1375000	32738	49107	16369	1310	1964	655
7	19	77+000	76293.4048	255000	6071	9107	3036	243	364	121
7	21	78+300	101135.774	155000	3690	5536	1845	148	221	74
7	22	78+700	351742.666	900000	21429	32143	10714	857	1286	429
8	23	80+200	140324	210000	5000	7500	2500	200	300	100
8	24-1	79+500	75102.9	185000	4405	6607	2202	176	264	88
8	24-2	81+300	136543.453	240000	5714	8571	2857	229	343	114
8	25	83+000	195322.822	320000	7619	11429	3810	305	457	152
8	26-1	84+500	62236.487	40000	952	1429	476	38	57	19
8	26-2	86+300	209574.447	500000	11905	17857	5952	476	714	238
8	27	87+500	52792.942	125000	2976	4464	1488	119	179	60
8	27-1	89+500	129796.769	310000	7381	11071	3690	295	443	148

Section	Rename	Chainage	Area(m2)	Total (m3)	Monthly (m3)	Monthly Summer Seasons (m3)	Monthly Winter Seasons (m3)	Daily (m3)	Daily Summer Seasons (m3)	Daily Winter Seasons (m3)
8	27-2	91+000	135051.363	325000	7738	11607	3869	310	464	155
8	28	92+000	220804.725	950000	22619	33929	11310	905	1357	452
8	28-1	93+500	207468.934	400000	9524	14286	4762	381	571	190
8	29-1	95+000	146323.047	325000	7738	11607	3869	310	464	155
9	31	98+500	147200.081	400000	9524	14286	4762	381	571	190
9	31-1	100+700	99456.094	265000	6310	9464	3155	252	379	126
9	31-2	102+000	259294.281	310000	7381	11071	3690	295	443	148
9	32	103+500	193164.285	505000	12024	18036	6012	481	721	240
9	34	106+200	150653.448	290000	6905	10357	3452	276	414	138
tot			**11455333**	**20000000**	**476190**	**714286**	**238095**	**19048**	**28571**	**9524**

Table 24: Estimated quantities of aggregate required for each borrow pit: total/monthly/daily

Sector	Section	BP per section	Total (m3)	Monthly (m3)	Monthly Summer Seasons (m3)	Monthly Winter Seasons (m3)	Daily (m3)	Daily Summer Seasons (m3)	Daily Seasons (m3)
Sector 1	Section 1	1	140533	3346	5019	1673	134	201	67
Sector 1	Section 2	2	281067	6692	10038	3346	268	402	134
Sector 1	Section 3	3	421600	10038	15057	5019	402	602	201
Sector 2	Section 4	5	359818	8567	12851	4284	343	514	171
Sector 2	Section 5	8	575709	13707	20561	6854	548	822	274
Sector 2	Section 6	5	359818	8567	12851	4284	343	514	171
Sector 2	Section 7	5	359818	8567	12851	4284	343	514	171
Sector 3	Section 8	12	683370	16271	24406	8135	651	976	325
Sector 3	Section 9	5	284738	6779	10169	3390	271	407	136
tot			**3466470**	**82535**	**123803**	**41268**	**3301**	**4952**	**1651**

Table 25: Estimated quantities of aggregate required for each quarry: total/monthly/daily

Sector	Quarry	Total (m3)	Monthly (m3)	Monthly Summer Seasons (m3)	Monthly Winter Seasons (m3)	Daily (m3)	Daily Summer Seasons (m3)	Daily Seasons (m3)
Sector 1	Q1 - Km 16-Km	545600	12990	19486	6495	520	779	260
Sector 1	Q2 - Km 25-Paracin	545600	12990	19486	6495	520	779	260
Sector 2	Q3, Q4 – Km 54-Paracin	2141975	50999	76499	25500	2040	3060	1020
Sector 3	Q5 Km75	1252845	29830	44744	14915	1193	1790	597
tot		**4486020**	**106810**	**160215**	**53405**	**4272**	**6409**	**2136**

Table 26: Estimated quantities of fill destinated to each unsuitable soil deposit areas: total/monthly/daily

Sector	Section	WA	Capacity(m3)	Monthly (m3)	Monthly Summer Seasons (m3)	Monthly Winter Seasons (m3)	Daily (m3)	Daily Summer Seasons (m3)	Daily Winter Seasons (m3)
Sector 1	Section 1	3	1578947	37594	56391	18797	1504	2256	752
Sector 1	Section 2	4	2105263	50125	75188	25063	2005	3008	1003
Sector 1	Section 3	2	1052632	25063	37594	12531	1003	1504	501

Sector	Section	WA	Capacity(m3)	Monthly (m3)	Monthly Summer Seasons (m3)	Monthly Winter Seasons (m3)	Daily (m3)	Daily Summer Seasons (m3)	Daily Winter Seasons (m3)
Sector 2	Section 4	4	2105263	50125	75188	25063	2005	3008	1003
Sector 2	Section 5	3	1578947	37594	56391	18797	1504	2256	752
Sector 2	Section 6	3	1578947	37594	56391	18797	1504	2256	752
Sector 2	Section 7	5	2631579	62657	93985	31328	2506	3759	1253
Sector 3	Section 8	8	4210526	100251	150376	50125	4010	6015	2005
Sector 3	Section 9	6	3157895	75188	112782	37594	3008	4511	1504
tot		**38**	**20000000**	**476190**	**714286**	**238095**	**19048**	**28571**	**9524**

Appendix C

Table 27: Average distances of borrow pits per section

Sector	Section	Start	End	Section length (m)	no. BP	Average distance (m)
Sector 1	1	-229	8829	9058	1	4529
Sector 1	2	8829	16722	7893	2	1973
Sector 1	3	16722	27600	10878	3	1813
Sector 2	4	27600	42547	14947	5	1495
Sector 2	5	42547	56192	13645	8	853
Sector 2	6	56192	67697	11505	5	1151
Sector 2	7	67697	81503	13806	5	1381
Sector 3	8	79000	97000	18000	12	750
Sector 3	9	97000	109663	12663	5	1266
				112395		

Table 28: Average distances of unsuitable soil deposit areas per Section

Sector	Section	Start	End	km per section	no. WA	average distance (m)
Sector 1	Section 1	-229	8829	9058	3	1510
Sector 1	Section 2	8829	16722	7893	4	987
Sector 1	Section 3	16722	27600	10878	2	2720
Sector 2	Section 4	27600	42547	14947	4	1868
Sector 2	Section 5	42547	56192	13645	3	2274
Sector 2	Section 6	56192	67697	11505	3	1918
Sector 2	Section 7	67697	81503	13806	5	1381

Sector 3	Section 8	79000	97000	18000	8	1125
Sector 3	Section 9	97000	109663	12663	6	1055
				112395		

Table 29: Average distances of quarries per Sector

Sector	Start	End	Section length (m)	no. Qarries	Average distance (m)
Sector 1	-229	27600	27829	2	6957.25
Sector 2	27600	81503	53903	1	26951.5
Sector 3	79000	109663	30663	1	15331.5
			112395		

RINA Consulting Ltd.

2nd Floor Offices
Nile House, Nile Street
Brighton, BN1 1HW, UK

+44 (0)1273 819 429
rina.org