Environmental Impact Assessment

Project Number: 53178-001
May 2019

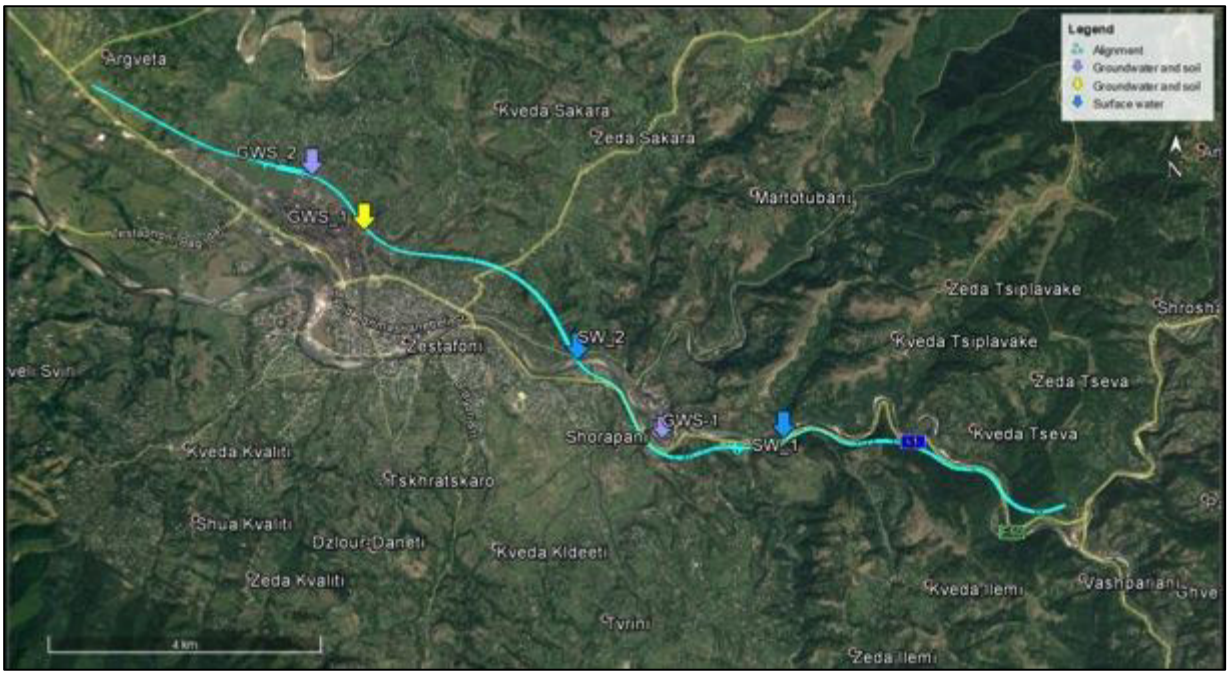
GEO: East–West Highway (Shorapani–Argveta Section) Improvement Project

Part 8 (Sections F–G)

Prepared by the Roads Department of the Ministry of Regional Development and Infrastructure of Georgia for the Asian Development Bank.

Sample ID	Coordinates	Rationale for Site Selection
SW02	42 ° 06'12.29"N / 43° 03'57.67"E	At location of Bridge BRI 4.1.04-AT/TA, Kvirila River

Figure 48: Surface Water Monitoring Locations



443. The results of the water quality monitoring are presented in **Table 34** below show that both the Dzirula and Kvirila rivers meet the national MACs for surface water quality at the sampling locations, although the levels of manganese in the Kvirila sample was above the recommended standards for drinking water. This reflects the findings of the study on manganese in the Kvirila river mentioned above.

Table 34: Surface Water Quality Monitoring Results

#	Parameter	Units	SW-1 (Dzirula)	SW-2 (Kvirila)	Method/standard	National, maximum allowable concentration
1	pH	-	8.2	8.1	ISO 10523-08	6.5-8.5
2	Electrical conductivity (EC)	S/m	0.027	0.0248	ISO 7888-85	n/a
3	Turbidity	FTU	3.87	176	ISO 7027-99	n/a
4	BOD_5,	mg/lO_2	2.7	1.7	ISO 5815-03	6
5	COD	mg/lO_2	<15	<15	ISO 6060-89	30
6	Dissolved oxygen (DO)	mg/l	9	7.6	ISO 5815-03	≥4
7	Total suspended solids (TSS)	mg/l	26	96	ISO 11923-97	increase by no more than 0.75
8	Oil and grease	mg/l	<5.0	<5.0	EPA 413,1-97	n/a
9	Total Phosphorus	mg/l	<0.1	0.1	ISO 6878-04	2
10	Total Nitrogen	mg/l	0.25	0.3	GOST 18826-73	n/a
11	Total Ammonium	mg/l	<0.1	<0.1	GOST 4192-82	0.5 mg/l NH4

#	Parameter	Units	SW-1 (Dzirula)	SW-2 (Kvirila)	Method/standard	National, maximum allowable concentration
12	TPH	mg/l	<0.04	<0.04	EPA 48,1-97	0.3
13	Total residual chlorine	mg/l	<0.05	<0.05	GOST 18190-72	n/a
14	Total Zinc	mg/l	<0.003	<0.003	ISO 8288-A-86	1
15	Dissolved Copper	mg/l	<0.003	<0.003	ISO 8288-A-86	1
16	Manganese	mg/l	<0.02	0.28	EPA 3005 A-92	1
17	Total Coliform Bacteria	100ml	680	800	ISO 9308-1:2014	≤10 000

444. No fisheries are known to exist within the Project area, although recreational fishing was observed during surveys performed by the LCF.

445. No fisheries are known to exist within the Project area, although recreational fishing was observed during surveys performed by the LCF.

F.1.5.2 Groundwater Water

Local Context

446. The water bearing strata is of contemporary alluvial deposits characterized by a free groundwater table declining along the general flow of the rivers. The shallow ground water level is 1.5m – 1.8m below ground and anticipated amplitude of groundwater level fluctuation is below 1m. At some locations near the riverbeds and groves, groundwater is very shallow depths (0.3m). Aquifers are mainly fed from rivers and precipitation.

447. As part of the Projects Geological study a number of boreholes were excavated within the Project area. Groundwater levels between generally ranged between 0.3 and 8.8 meters in depth. A number of groundwater wells and natural springs are present within the Project area and according to a recent World Bank study groundwater and springs are main sources of water supply for the Imereti population.[25]

Groundwater Quality

448. A total of two groundwater samples were collected from two wells to assess the baseline groundwater quality in the Project area. Sampling was originally intended close to Shoropani, but the monitoring team had difficulties accessing this location and as such sampled at two locations close to the GAA plant instead. **Table 35** provides a summary of the results.

Table 35: Groundwater Quality Monitoring Locations

Sample ID	Coordinates	Rationale for Site Selection
GW1	42 ° 07’11.23”N / 43° 01’40.06”E	Behind GAA Site
GW2	42 ° 07’36.52”N / 43° 01’06.14”E	Behind GAA Site

[25] Second Regional Development Project, Imereti Regional Development Program, Imereti Tourism Development Strategy. Strategic Environmental, Cultural, Historical and Social Assessment. World Bank, 2014

345. Results – The results of the groundwater monitoring indicate all parameters in sample location GWS-1 meet the national MACs and where applicable, WHO standards. GWS-2 however exhibited high hardness, total dissolved solids, calcium, manganese and sulfates.

Table 36: Groundwater Quality Monitoring Results

#	Parameter	Units	GWS-1	GWS-2	Method/standard	National limit, maximum allowable concentration	WHO, guidance values, mg/l
1	pH	-	7.35	7	ISO 10523-08	6.5-8.5	n/a
2	Dissolved oxygen (DO)	mg/l	7.1	5	ISO 5815-03	n/a	n/a
3	Electrical conductivity (EC)	S/m	0.0478	0.178	ISO 7888-85	n/a	n/a
4	Alkalinity	mg-eq/l	<0.2	<0.2	Gost 23268.3-78	n/a	n/a
5	Hardness	mg-eq/l	5.38	22.5	Gost 23268.5-78	7-10	n/a
6	Total suspended solids (TSS)	mg/l	<2.0	<2.0	ISO 11923-97	n/a	n/a
7	Total dissolved solids	mg/l	466	1946.7	Calculated	1000-1500	n/a
8	Arsenic, As	mg/l	<0.005	<0.005	Gost 4152-89	<0.01	0.01
9	Chlorides	mg/l	17	41.1	Gost 23268,17-78	<250	n/a
10	Iron, Fe	mg/l	<0.02	<0.02	EPA 3005 A-92	<0.3	n/a
11	Nitrates	mg/l	8.91	8.86	Gost 18823-73	<50	50
12	Sodium, Na	mg/l	17.1	125.4	ISO 9964-3-93	<200	n/a
13	Potassium, K	mg/l	1.05	3.08	ISO 9964-3-93	n/a	n/a
14	Calcium, Ca	mg/l	80	245	Gost 23268,5-78	<140	n/a
15	Magnesium, Mg	mg/l	16.8	124	Gost 23268,5-78	<85	n/a
16	Lead, Pb	mg/l	<0.01	<0.01	ISO 8288-A-86	<0.01	0.01
17	Sulfates	mg/l	36	960	Gost 23268,3-78	<250	n/a
18	Manganese, Mn	mg/l	<0.02	<0.02	EPA 3005 A-92	<0.4	0.4*

F.1.6 Geology & Soils

F.1.6.1 Geology

449. In the Project area, along the highway alignment, three major geological units can be identified:

1. Effusive volcanic rocks covering the crystalline basement (not exposed in Lot F4), dated Middle Jurassic. They are represented by the porphyritic complex including the following geological formations:
    a. J2b2 (A) - Tuff and tuff breccias, from moderately hard to hard. Mainly massive.
    b. J2b2 (B) - Irregular succession of porphyrites, porphyritic breccias, lava breccias, bedded tuffites, tuff and tuff breccias; mainly hard. From thinly bedded to massive.
2. Sedimentary rocks covering the volcanic units, dated Middle Miocene and represented by the following geological formations:
    a. N_1^2 (m) - Marls.
    b. N_1^2 - Limestones and sandstones. From very hard to weak, thinly bedded.

3. Quaternary soils, covering both the volcanic and the sedimentary rocky units, represented by:
    a. eQ - Eluvial cover deposits on the upper plains. Coarse and/or fine.
    b. cdQ - Colluvial deposits in the valley floors and debris at the slope bases. Coarse and/or fine.
    c. aQ - Recent alluvial and terraced deposits. Coarse.
    d. aaQ - Current alluvial deposits. Coarse.

450. From a geo-lithological point of view, along the alignment, three main homogeneous sections can be identified, depending on similar lithological conditions (**Table 37,** below):

a) From km 0+000 to 6+350 – outcropping formations are represented by volcanic rocks of the porphyritic complex, including both the mainly effusive rocks of the J2b2 (B) formation and the mainly pyroclastic rocks of the J2b2 (A) formation. The contact between this two geological units is generally a stratigraphic contact, being tuffs above lavas. In some cases, important faults cause tectonic contacts between them. In this section, tunnels are expected to be excavated in J2b2 (B) formation; bridges are expected to have their abutments and piers on quaternary deposits (aQ, aaQ and mQ with a variable thick) covering the J2b2 (B) formation; cuts are expected to be mainly in the porphyritic complex, sometime affecting the thin covering quaternary deposits.
b) From km 6+350 to ~ 10+200 – outcropping formations are mainly represented by carbonate sandstones of $N1^2$ formation, overlaying with a stratigraphic limit the J2b2 (A) formation, exposed in the major valleys. Covering quaternary deposits are widespread in this area. Several faults are observed. In this section, tunnels are expected to be excavated in the porphyritic complex (both J2b2 (A) and (B) formations) and in the $N1^2$ formation; one bridge crosses a colluvial deposit overlaying the $N1^2$ formation; one cut is expected to be excavated in the $N1^2$ formation.
c) From km ~ 10+200 to 14+726 – in this area, colluvial and alluvial deposits (cdQ and aQ) outnumbers the not-outcropping rocky formations.

Table 37: Lithology – Rikoti - Argveta

Bridges	from km	to km	length	lithology
T-TA-1	260,00	590,00	330	Irregular succession of porphyrites, porphyritic breccias, lava breccias, bedded tuffites, tuff and tuff breccias; mainly hard. From thinly bedded to massive
T-TA-2	830,00	1200,00	370	Irregular succession of porphyrites, porphyritic breccias, lava breccias, bedded tuffites, tuff and tuff breccias; mainly hard. From thinly bedded to massive
T-TA-3	3510,00	4270,00	760	Irregular succession of porphyrites, porphyritic breccias, lava breccias, bedded tuffites, tuff and tuff breccias; mainly hard. From thinly bedded to massive
T-TA-4	6320,00	6622,00	302	Tuff and tuff breccias, from moderately hard to hard. Mainly massive
	6622,00	6759,00	137	Irregular succession of porphyrites, porphyritic breccias, lava breccias, bedded tuffites, tuff and tuff breccias; mainly hard. From thinly bedded to massive
	6759,00	7020,00	261	Tuff and tuff breccias, from moderately hard to hard. Mainly massive
T-TA-5	7130,00	7496,00	366	Tuff and tuff breccias, from moderately hard to hard. Mainly massive

	7496,00	8250,00	754	Limestones and sandstones from very hard to weak, thinly bedded
T-TA-6	9280,00	9640,00	360	Limestones and sandstones from very hard to weak, thinly bedded

T-AT-1	200,00	610,00	410	Irregular succession of porphyrites, porphyritic breccias, lava breccias, bedded tuffites, tuff and tuff breccias; mainly hard. From thinly bedded to massive
T-AT-2	770,00	1220,00	450	Irregular succession of porphyrites, porphyritic breccias, lava breccias, bedded tuffites, tuff and tuff breccias; mainly hard. From thinly bedded to massive
T-AT-3	3490,00	4600,00	1110	Irregular succession of porphyrites, porphyritic breccias, lava breccias, bedded tuffites, tuff and tuff breccias; mainly hard. From thinly bedded to massive
T-AT-4	6345,00	6639,00	294	Tuff and tuff breccias, from moderately hard to hard. Mainly massive
	6639,00	6776,00	137	Irregular succession of porphyrites, porphyritic breccias, lava breccias, bedded tuffites, tuff and tuff breccias; mainly hard. From thinly bedded to massive
	6776,00	7030,00	254	Tuff and tuff breccias, from moderately hard to hard. Mainly massive
T-AT-5	7145,00	7504,00	359	Tuff and tuff breccias, from moderately hard to hard. Mainly massive
	7504,00	8300,00	796	Limestones and sandstones from very hard to weak, thinly bedded
T-AT-6	9290,00	9720,00	430	Limestones and sandstones from very hard to weak, thinly bedded

F.1.6.2 Soils

451. The soils in the Project area are very productive and range of crops are grown in the region which is well known for is wine production. Soil temperatures from Zestaphoni and topsoil thicknesses along the road alignment are shown in **Table 38** and **Table 39**.

Table 38: Soil Temperature

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average Monthly Temperature (°C)	2	3	8	15	21	26	29	28	22	15	9	4

Table 39: Topsoil Thickness in the Project Corridor

Chainage (km)	Topsoil Thickness (m)
10+100 – 10+450	0.50
10+450 – 10+820	0.70
10+820 – 11+240	0.40

Chainage (km)	Topsoil Thickness (m)
11+240 – 11+620	0.30
11+620 – 12+400	0.40
12+400 – 12+625	0.20
12+625 – 12+990	0,20
12+990 – 13+445	0.35
13+445 – 13+835	0.30
13+835 - 14+080	0.25
14+080 - 14+730	0.60

452. Hazardous wastes generated by the GAA, Chiatura manganese enrichment plant, and many small-size smelters operating in various settlements of Imereti have been identified as potential sources of soil pollution in the region. [26]

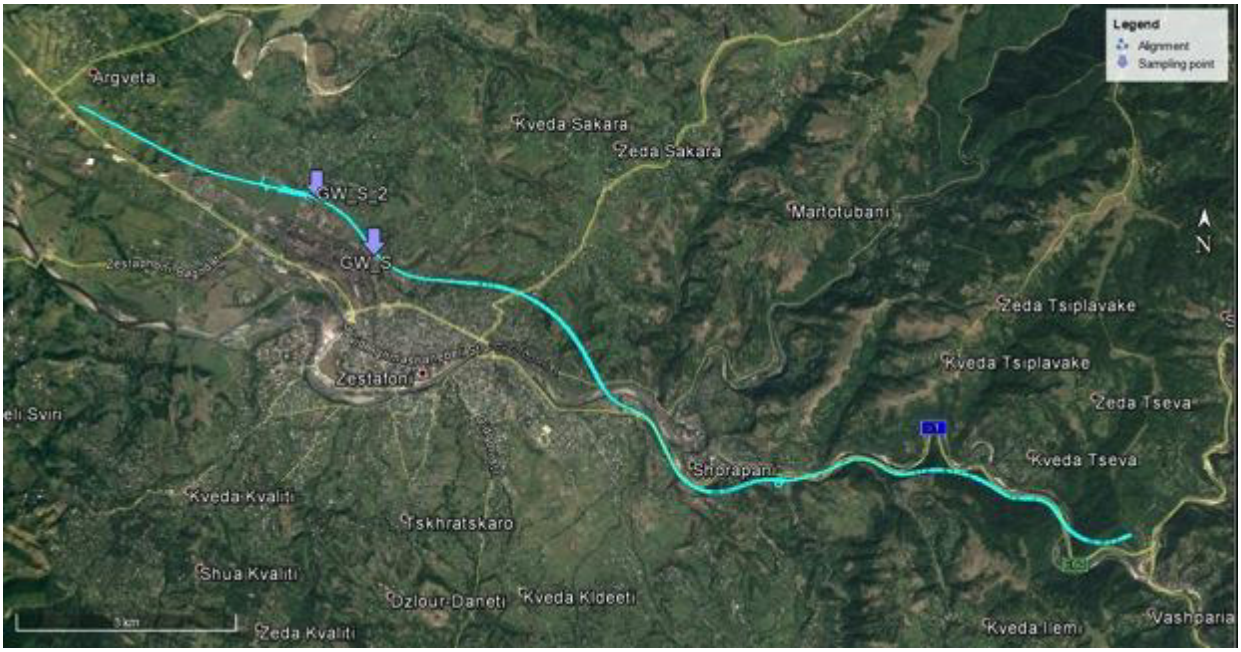
453. To assess the status of soil quality in the Project area soil sampling and analysis was undertaken in September, 2017. A total of two soil samples were collected and analyzed to determine the existing soil quality.

454. **Table 40** describes the sample locations and rationale for their selection. The sampling locations are mapped in **Figure 49**.

Table 40: Soil Monitoring Locations

Sample ID	Coordinates	Rationale for Site Selection
GW_S-1	42 ° 05'36.08"N / 43° 04'52.36"E	Behind the GAA Factory
GW_S-2	42 ° 07'36.52"N / 43° 01'06.14"E	Behind the GAA Factory

Figure 49: Soil Monitoring Locations



[26] Integrated Natural Resources Management in Watersheds of Georgia Program. USAID, 2011

Table 41: Soil Sampling Results

#	Parameter	Units	GWS-1	GWS-2	Method/standard	National limit, maximum allowable concentration	Proposed National Limit, MAC	Proposed National Preventive limits of risk elements in agricultural soil	Italian Standard For Residential Areas	UK Soil Guidelines for Residential Areas[27]
1	Copper, Cu (mobile)	mg/kg	1.35	2.30	GOST P50683-1994	3-132	60-100	60	120	
2	Zinc, Zn (mobile)	mg/kg	<0.5	3.6	GOST P50686-1994	23-220	130-200	120	150	
3	Nickel, Ni (mobile)	mg/kg	1.0	0.25	GOST P50683-1994	4-80	60-80	50	120	
4	Chromium, Cr (mobile)	mg/kg	<0.5	<0.5	GOST P50683-1994	6	100-200	90	150	
5	Lead, Pb (total)	mg/kg	41.5	47.0	ISO 14869-.1-2001	32-130	100-140	60	100	
6	Arsenic, As (total)	mg/kg	14.4	16.2	GOST 4152-89	2-10	30	20	20	32
7	Cadmium, Cd(total)	mg/kg	<2.0	<2.0	ISO 14869-.1-2001	2	0.5 – 1.0	0.5	2	
8	Polychlorinated biphenyl PCB	mg/kg	<7.0	<7.0	EPA 8082 A-2007	60	10	-	5	
9	Asbestos		nd	nd	NIOSH 9002 -1989	3-132	-	-	100 (next law)	

[27] http://webarchive.nationalarchives.gov.uk/20140328153727/http://www.environment-agency.gov.uk/static/documents/Research/SCHO0409BPVY-e-e.pdf

Table 42: US EPA 16 PAHs Results

Parameter	Unit	GWS- 1	GWS- 2	Proposed Georgian Standard, MAC	Canadian SQG, residential	Dutch Target Value[28]	Dutch Intervention Values[29]	Italian Standard for Soils in Residential Areas	Italian Standard for Soils in Industrial / Commercial Areas
Naphthalene	ug/kgdm	1.51	2.15	100	600				
Acenaphthylene	ug/kgdm	<0.5	1.98						
Acenaphthene	ug/kgdm	1.11	4.42						
Fluorene	ug/kgdm	1.20	3.29						
Phenanthrene	ug/kgdm	11.30	28.08	100	100				
Anthracene	ug/kgdm	2.16	5.81	10					
Fluoranthene	ug/kgdm	29.40	93.3	100					
Pyrene	ug/kgdm	20.50	72.2		100			5,000	50,000
Benzo(a)anthracene	ug/kgdm	15.30	51.9	1,000	100			500	10,000
Chrysene	ug/kgdm	17.70	53.08	10				5,000	50,000
Benzo(b)fluoranthene	ug/kgdm	35.80	382		100			500	10,000
Benzo(k)fluoranthene	ug/kgdm	12.20	133		100			500	10,000
Benzo(a)pyrene	ug/kgdm	26.20	270	100				100	10,000
Indeno(123cd)pyrene	ug/kgdm	11.70	207		100			100	5,000
Benzo(ghi)perylene	ug/kgdm	10.80	179					100	10,000
Dibenzo(ah)anthracene	ug/kgdm	2.44	41.6		100			100	10,000
Sum – 16 PAH	ug/kgdm	200	1,530						
Sum – 16 PAH	mg/kgdm	0.20	1.53						
Sum – 10 PAH	ug/kgdm	138.27	1,023.32			1,000	4,000		
Sum - 10 PAH	mg/kgdm	0.14	1	1		1	40		

* Parameters highlighted in green used for Dutch Sum 10 PAH Values.

[28] The target values indicate the level at which there is a sustainable soil quality. In terms of curative policy this means that the target values indicate the level that has to be achieved to fully recover the functional properties of the soil for humans and plant and animal life. Besides this the target values give an indication of the benchmark for environmental quality in the long term on the assumption of negligible risks to the ecosystem.
[29] The soil remediation intervention values indicate when the functional properties of the soil for humans, plant and animal life, is seriously impaired or threatened. They are representative of the level of contamination above which there is a serious case of soil contamination.

***** (PAH tests by ultrasonic extraction and GC/MS-SIM detection)

Table 43: Mercury report

Sample origination	Hg, mg/kgdm	Georgian regulations, mg/kg
GWS- 1	0.024	2.1 * (MPC with consideration of the background)
GWS- 2	0.089	

* Qualitative norms of the status of environment – Hygiene assessment of soil in residential areas, guidelines 2.1.7.003-02
******(Hg measured by Varian SpectrAA 220FS with Vapour Generation Accessory VGA-77 on the basis of SOP AEL 2003 (ISO17025 accredited) complied with EPA245.1 Standard Method.)

455. The results of the general soil sampling show that all parameters are within the current Georgian limits with the exception of Arsenic and Lead. However, as noted in **Section D.5.6**, these limits are considered outdated, stemming from old regulations developed during the Soviet times.

456. Assessing the results against EU limits (Italy and the UK), we can see that the results of all parameters sampled, including arsenic and lead, are well within the limits for residential areas, which are significantly lower than the ones for industrial areas, which should be the reference in this case. This, it should be said, is a direct effect of the precise choice, made by the Design Team, to move the alignment far from two piles of waste material sited on the northern boundary of the GAA, an area considered as hazardous. In addition, the results are also well within the recently proposed maximum allowable concentrations that have been developed by the MoEPA. Discussions with the UNEP indicate that these proposed limits will come into force some time in 2018. The UNEP stated that the purpose of the new limits is to harmonize them with the requirements of the Product Safety and Free Movement Code and Georgia's obligations undertaken under the Association Agreement with the European Union. Most importantly, all parameters are also below the proposed national Preventive limits of risk elements in agricultural soil, which is an important factor considering that much of the spoil material may be disposed of at the Kutaisi bypass which borders on an area of agricultural land.

457. Analysis of the PAHs shows that both samples meet the Dutch target levels meaning that the soil is considered a sustainable soil quality and will have negligible risk to the ecosystem. Levels of mercury were recoded below Georgian limits.

F.1.7 Geomorphology

458. From a morphological point of view three geomorphological structures can be recognized in the Project area:
- Zemo Imereti Highland (Plateau);
- Kolkheti piedmont undulated zone; and
- Kolkheti Lowland (alluvial plain).

459. A detailed description of the alignment of the project road in terms of geomorphology is given below.
- **KM 0.0 – 1.5.** On this segment, the river Dzirula has a sharply meandering channel and the valley acquires a narrow canyon-like shape. The valley floor width varies from 40 m to 80 m. Compared with the right slope, the left one is steeper. Slope grades varies from 27° to 43°. The valley slopes are dissected with lateral inflows and small erosion gullies. The right slop is characterized by edges of both natural and anthropic escarpment, mainly related to the old and actual railway lines. Left slope is forested and not at all stable above the road profile: important natural escarpments are reported, and landslides have been detected between km 0+450, and km 0+750, affecting the western portal of TUN 4.0.01-TA and eastern portals of TUN 4.0.02 TA/AT.
- **KM 1.5 – 2.3.** On this segment the river Dzirula valley is narrow and V-shaped. The river runs in the narrow channel the width of which is 40 - 60 m. Above-flood-plain terraces

are registered fragmentally. On both sides of the valley, slopes have equal grade and are dissected with lateral erosion gullies. The slope grade varies from 16° to 37°. Also in this section, right slopes are characterized by anthropic escarpment, while the left forested steep slopes exhibit natural escarpments, but appear to be stable.

- **KM 2.3 – 3.5.** On this segment, from south-eastern direction, the river Dzirula is joined by the river Borimela which is its left tributary. It is deeply cut into the V-shaped canyon-like narrow valley. The river Dzirula valley slopes are steep and dissected with lateral erosion gullies. The slope grades vary from 150° to 41°. Above-flood-plain terraces are registered fragmentally. In the right side of the river, many anthropic landforms are observed (railroad line embankment, escarpment, slope stabilization), while in the left slopes are noticed natural escarpment and a series of small and shallow landslides affecting the actual motor road, but not affecting the future project road.
- **KM 3.5 – 5.3.** Within this segment, the river Dzirula is sharply meandering. The width of the valley floor varies from 40 m to 300 m; the flood-plain and above-flood-plain terraces are well- defined; the left slope of the river valley is relatively steep, with its grade changing from 25° to 45°and the grade of the right slope changing from 10° to 25°. The valley slope surfaces are dissected with lateral inflows and numerous small erosion gullies. On this segment, the river Dzirula joins the river Kvirila, its right main tributary. Steep natural escarpment with well-defined edge are widespread on the left side of the river; from km 4+800 to 5+300 the slope is unstable, since landslide scarps and deposits are observed.
- **KM 5.3 – 6.3.** This segment is located within the western end of the Zemo Imereti Highland, in the river Kvirila valley that in this section is wide. The valley slopes are steep and partly dissected with lateral erosion gullies. The valley floor is represented with the river channel, the flood-plain and above-flood-plain alluvial terraces. The height of the second terrace surface is 7 – 17 m above the river level. Within this segment, one shallow left tributary flows into the river Kvirila from the south. On both sides of the valley, angle of gradient of the slopes varies from 15° to 40°. The slopes are mainly forested and stable.
- **KM 6.30 – 10.1.** In the Colchis Piedmont Undulated Zone, the middle part of the route will run from the northern periphery of the city Zestaphoni to the north-western part of village Argveta. Within this zone, there are several streams and gullies, with a general NE-SW orientation, deeply cut into relief. Between the valleys' bottom and the slope crests, the difference between absolute elevations varies between 20 and 70 m. The slopes grade varies between 14° and 27°. The slopes of the above-said gullies are covered with vegetation and stable. The valleys are characterized by a concave or flat bottom.
- **KM 10.1 – 14.7.** The last part of the Project road will run on the Colchis alluvial plain, which has absolute elevations of 145-150 m. The relief is slightly sloped (1° - 6°) south-westward. This section is characterized by the presence of 3 alluvial fans, wide from 350 m to 800 m. Natural stable escarpments are detected. In this area several anthropic landforms are present, including road embankment, edges of anthropic escarpment, deposit areas and the GAA industrial area of Zestaphoni.

F.2 Biodiversity

General

460. The project corridor crosses forest areas, agricultural land plots, hilly forest slopes, residential areas and riparian ecosystems. 17.3 hectares (ha) of the municipality of Zestaphoni is covered by forest and shrubbery.

461. Due to human pressures natural vegetation has been taken over by agricultural crops and other human development. In these areas arable lands and pastures have developed. Some of the animal species typical for the area have moved to other areas in away from

human activity. Over the time the fauna of the region has changed significantly. Animals currently found in the area of interest are mainly presented by those species that live in forested areas and/or can tolerate presence of humans. The natural forest massifs have significant value from biodiversity protection viewpoint, because of their importance as migration route for the local animal species.

Biodiversity Study

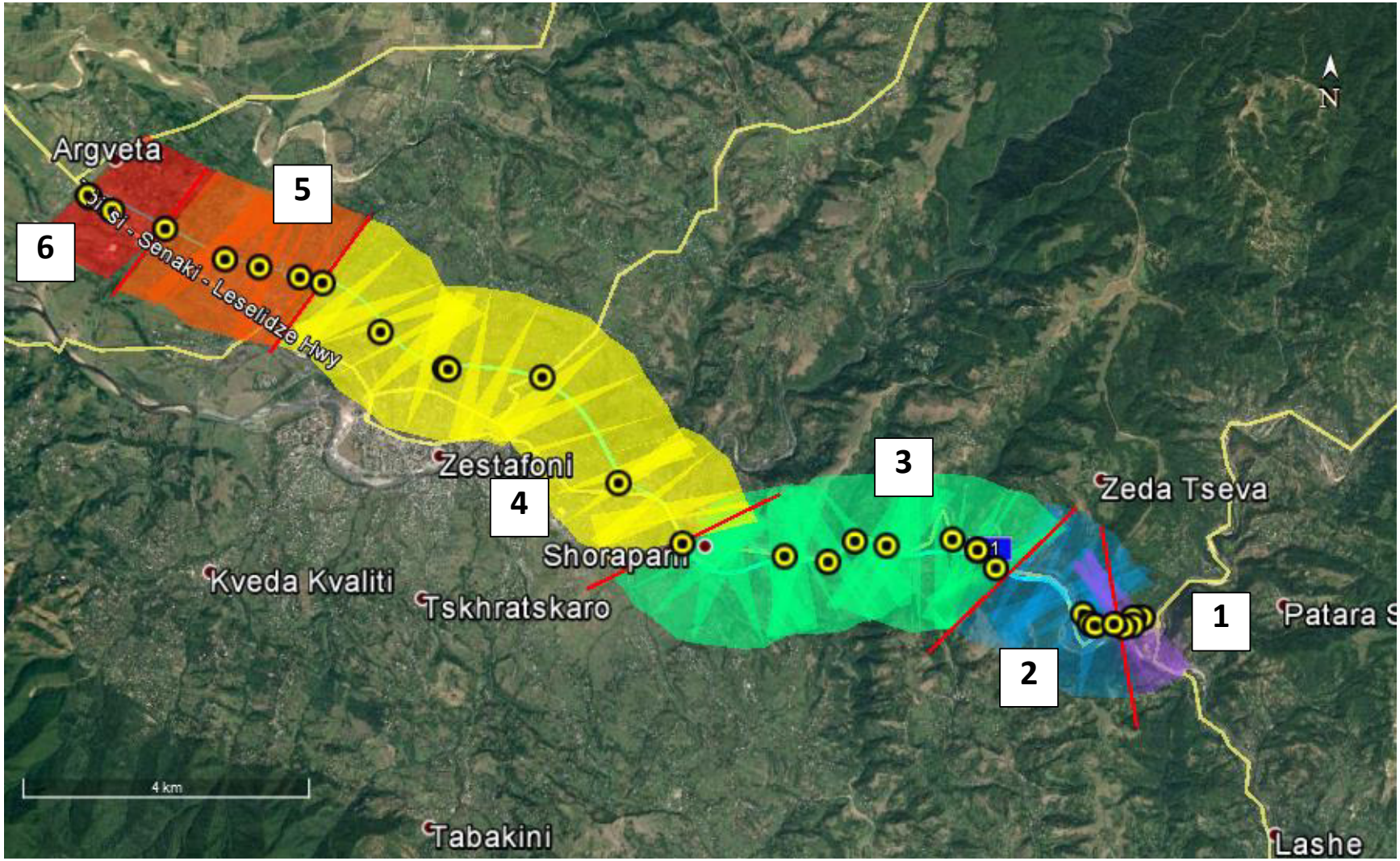
462. To fully understand the biodiversity in the Project area a biodiversity study was carried out by the LCF. The study was based on two aspects, firstly existing data was collected and analyzed in the form of a 'desk-top' study'. This was then followed up with field surveys carried out on August 8-9 and September 22-23, 2017. The aim of the study was to identify of animal species within the study area; to reveal significant habitats for inhabitant species; to determine possible impact on animal biodiversity on construction and operation phases and to develop impact mitigation measures.

F.2.1 Habitat

Habitat in the Project Area

463. The study area has been divided in 6 sections according to the habitat's types based on collection of desk-top data and also field surveys undertaken in August 8-9 and September 22-23, 2017. **Figure 50,** below illustrates the six sections and describes the flora observed during the site visit.

Figure 50: The study area with indication of the transects and boundaries of the habitats



Habitat Area 1
(coordinates X=4660943.97, Y=347314.70; X=4660861.22, Y=346918.69)

Conservation Status of the Habitat = HIGH

Located near Kveda Tseva village, in the neighboring forest massif. Is situated on limestone hill of the southern slope of the valley. Natural vegetation is heavily altered and only units of original forest remains are observed in the form of young and middle-aged trees of Georgian oak (*Quercus iberica*), Common maple (*Acer campestre*), European ash (*Fraxinus excelsior*), young and mid-term Sweet chestnut (*Castanea sativa*) trees. In the underwood Common hazel (*Corylus avellana*) shrubs dominate. Plants typical for dry ecotopes mainly Oriental hornbeam (*Carpinus orientalis*) are registered. Other species are seldom met. In the understory Butcher's-broom (*Ruscus colchicus*) and mosses are present. In the areas where hornbeam growth is not dense Hawthorn (*Crataegus sp.*), Gaiter-tree (*Thelycrania australis*), *Pomegranate* (*Punica granatum*), Black locust (*Robinia Fseudoacacia*); Ailanthus (*Ailanthus altissima*), etc are registered.

In this section of alignment forest density accounts for (0.3-0.4); canopy density 21-30%; slope tilt 10-20-25^0. Two young trees Persian walnut trees (*Juglans regia*) – protected species under the Georgia Red List (VU category) have been registered. The trees are planted in the fenced in area. A number Georgian Red List species were identified during the State Forest Fund Inventory, some of which can be found in this habitat area.

The transects surveyed within the habitat:

Y	X
4667087	332826.9
4666866	333159.7
4666602	333887.2
4666163	335707.3
4666160	334710.6


Habitat Area 2
(coordinates X=4660861.22, Y=346918.69; X=4661669.72, Y=345296.51)

Conservation Status of the Habitat = HIGH

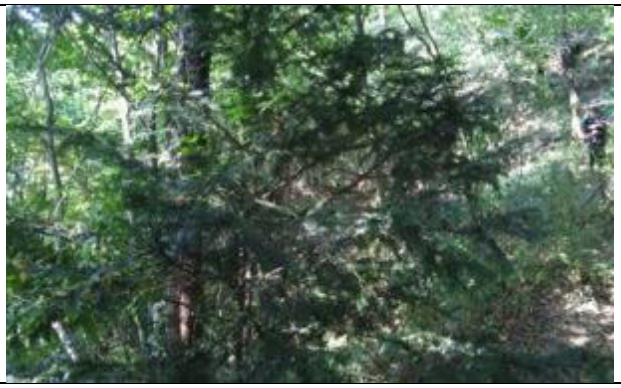
The forested zone bordering to the first site – near Kveda Tseva village; the southern slope of the forest, which is bordered by railway line from the south-west; the specie composition of the vegetation is as follows: common hornbeam (*Carpinus caucasica*), Georgian oak (*Quercus iberica*), Norway maple (*Acer platanoides*), common maple (*Acer campestre*), sweet chestnut (*Castanea sativa* VU), European pear (*Pyrus caucasica*), Oriental hornbeam (*Carpinus orientalis*). On the south slope two samplings of European Yew trees (*Taxus baccata,* Red List of Georgia VU category) have been registered (GPS X 42.086772 Y 43.114246 and X 42.086170; Y 43.143955). In the understory the following shrubs and grasses have been found: February daphne (*Daphne mezereum*), Blackberry (*Rubus*), English ivy, (*Hedera helix*), Butcher's-broom (*Ruscus colchicus*), Solomon's seal, (*Poligonatum glaberrimum*), Bracken (*Pteridium tauricum*), common fern (*Dryopteris filix mas*).

The forest is young with inclusion of individual mid-term and mature (old-growth) trees. Density is low (0.3-0.4); canopy density percentage 30-40-%; slope tilt 21-30-35^0. Trees belong to C category (timber).

Moderately modified habitat; man-caused impact medium. Of protected species two young Chestnut trees (*Castanea sativa* – VU) and two European Yew trees (*Taxus baccata* – VU). A number Georgian Red List species were identified during the State Forest Fund Inventory, all of which can be found in this habitat area.

The transects surveyed within the habitat:

Y	X
4667061	332857.4
4666605	333889.0
4666045	335182.4



Habitat Area 3 (coordinates X=4661669.72, Y=345296.51; X=4662103.27, Y=340960.28)
Conservation Status of the Habitat = LOW
Located on rocky massif of the north slope, near the central highway, where the forest is sparse (0.1-0.2) and belongs to the young forest grove group; the gradient of the slope is 25-350. Mixed vegetation types are distributed mainly of mezo-xerophilous type: Oriental hornbeam (*Carpinus orientalis*), Black locust (*Robinia Fseudoacacia*), Hawthorn (*Crataegus sp.*), Common plum (*Prunus divaricate*), Common maple (Acer campestre), Ailanthus (*Ailanthus altissima*), Common alder (*Alnus barbata*), Willow (*Salix*), Persimmons (*Diospyrus*), Fig tree (*Ficus carica*), Common hazel (*Corylus avellana*). In the upland meadows grasses are represented by: Wormwood (*Artemisia phyllostachys*), Astrodaucus orientalis, Foxtail (*Alopekurus*), (*Sambucus ebulus*), Milfoil (*Achilea setacea*), Creeping Savory (*Satureia spicigera*), Common chicory (*Cichorium intybus*), etc. The quantity and density (0.3-0.4) increases farther in the forest. Slope tilt is 10-200. In the edges Deodar cedar (*Cedrus deodora*) is planted in rows. The trees are young and mid-term. Moderately modified habitat. Impact – tree felling, grazing. Protected species not found.

The transects surveyed within the habitat:

Y	X
4666086	335515.5
4665920	335577.8
4665935	335758.3
4665806	336053.2
4664591	337726.5
4664438	339069.7
4662958	340094.0

Habitat Area 4
(coordinates X=4662103.27, Y=340960.28; X=4665805.66, Y=336053.21)

Conservation Status of the Habitat = LOW

Shorapani village, left bank of the river, riparian floodplain meadow (0-5^0), where only ruderal grassland and shrubbery is distributed. Middle-aged cedar trees are grown in rows according to age composition between floodplain and highway. Shrubs are presented by Blackberry (*Rubus*), European dwarf elder (*Sambucus ebulus*), Greenbrier (*Smilax excelsa*), Hawthorn (*Crataegus sp.*), stc. Between the forest and existing road mid-term Deodora Cedar (*Cedrus deodora*) trees. Construction is not likely to affect these plantations.

The habitat is strongly modified. The area is uses as a pasture. Grasses are represented by Blackberry (*Rubus)*, Wormwood (*Artemisia phyllostachys*), Astrodaucus orientalis, Milfoil (*Achilea setacea*), Creeping Savory (*Satureia spicigera*), Common chicory (*Cichorium intybus*), Foxtail (*Alopekurus*), European dwarf elder (*Sambucus ebulus*), etc.

Similar habitats are found in riparian forest located close to the residential area/settlement.

The transects surveyed within the habitat:

Y	X
4664580	337729.4
4662103	340960.3
4661897	342373.0
4661807	342973.6

Habitat Area 5
(coordinates X=4665805.66, Y=336053.21; X=4666602.41, Y=333887.24)

Conservation Status of the Habitat = LOW

the road goes through overpass from the left bank of Dzirula river to the right river bank, crosses the road leading to Zeda Sakara via tunnel that ends near the ruins of former cognac factory, on the forested and abandoned plot (0-5-15^0), which borders with a hill from the south. Trees and bushes are represented by: Persimmon (*Diospyros*), Ailanthus (*Ailanthus altissima*), Persian walnut (*Juglans regia* VU**),** Black locust (*Robinia fseudoacacia*), Honey locust (*Gleditschia triacanthos*), Oriental plane (*Platanus orientalis*), Pomegranate *(Punica granatum*), Oriental hornbeam (*Carpinus orientalis*), Hawthorn (*Crataegus* sp.), Plum (*Prunus divaricata*), Fig tree (*Ficus carica*), Pokeweed (*Phytolacca americana*), European dwarf elder (*Sambucus ebulus*) and invasive species Canadian goldenrod (*Solidago canadensis*).

The transects surveyed within the habitat:

Y	X
4661924	345048.6
4662077	344703.7
4662013	343789.9
4660842	347179.8
4660943	347181.2
4660861	346918.7

Habitat Area 6
(coordinates X=4666602.41, Y=333887.24; X=4667086.80, Y=332826.86)

Conservation Status of the Habitat = HIGH

This is the marginal line of urban zone of Zestaphoni city, bordered by GAA from the south-west. The project corridor will cross the meadow (0-5^0) and the motorway, which connects the city to the suburbs. Along the road plantations of Poplar are registered. The corridor goes west towards Argveta, crosses homestead plots (vineyards, orchards), turns south – to a meadow. The meadow is bordered by mature and over mature Elm Zelkova (*Zelcova carpinifolia,* VU) groves with Persian walnut trees (*Juglans regia,* VU), mature Oriental hornbeam (*Carpinus orientalis*), Plum (*Prunus divaricata*), Black locust (*Robinia*

fseudoacacia). In the last section of the road near Argveta the interchange construction is in process.

In the limits of the section 6 of alignment corridor corn, grapes, fruits are cultivated. Part of the area is used as a pasture. Two protected species Persian walnut trees (*Juglans regia,* VU) and Elm Zelkova (*Zelcova carpinifolia,* VU) are found to be in the project impact zone. No areas of State Forest Fund are found in this area.

The transects surveyed within the habitat:

Y	X
4661670	345296.5
4661010	346491.5
4660879	346583.8
4660944	347314.7

464. The Study Area does not meet the criteria for Critical Habitat because based on field survey, literature review and consultation it does not have high biodiversity value and does not support any of the qualifying interests as outlined in the table below. It is not located in a legally protected area or an area officially proposed for protection.

Critical, Natural and Modified Habitat

Critical habitats *are areas with high biodiversity value, including (i) habitat of significant importance to Critically Endangered and/or Endangered species; (ii) habitat of significant importance to endemic and/or restricted-range species; (iii) habitat supporting globally*

significant concentrations of migratory species and/or congregatory species; (iv) highly threatened and/or unique ecosystems; and/or (v) areas associated with key evolutionary processes.

***Natural habitats** are areas composed of viable assemblages of plant and/or animal species of largely native origin, and/or where human activity has not essentially modified an area's primary ecological functions and species composition.*

***Modified habitats** are areas that may contain a large proportion of plant and/or animal species of non-native origin, and/or where human activity has substantially modified an area's primary ecological functions and species composition. Modified habitats may include areas managed for agriculture, forest plantations, reclaimed coastal zones, and reclaimed wetlands.* [30]

465. Further, large portions of the Project road are located within tunnels which eliminates impacts to habitat in the areas above the tunnels (but not at the portals). Other portions of the road are located within agricultural and urban areas, classified as modified habitat.

466. State Forest Fund – The State Forest Fund (SFF) is a state-managed/controlled forest area under the management of the MoEPA but is not a protected area. Though it is not protected, for the purpose of controlling its use, the MoEPA requires all trees to be taken of the SFF registration or "de-listed" before they can be cut.

467. According to the ToR for this EIA:

"Particular attention should be given to the presence of land plots registered as the State Forest Fund (SFF). If the right of the way of the selected alignment of the road section overlaps with the territory of the SFF, The consultant should prepare:

1. *Cadastral measurement drawing for the relevant plot of the alignment (.shp files);*
2. *According to the effective law, conduct preliminary inventory of timber resources existing at the territory, which should be taken of the SFF registration, or 'de-listed';*
3. *In accordance with the Georgian legislation, provide relevant information on obtaining a cutting permit for species included in the Red List (if any);*
4. *Prepare Tree Compensation Plan according to the de-listing documentation"*

468. The Project area has been surveyed to determine the extent of the SFF that will be affected by the Project. Cadastral drawings are provided as part of **Appendix F**.

469. An inventory of the timber resources has also been prepared. A total of 1,428 trees more than 8cm in diameter were recorded for de-listing, including the following Georgian red-listed species:

- 77 Zelkova (greater than 8cm in diameter)
- 85 Chestnut (greater than 8cm in diameter)
- 38 Bladder Nut (greater than 8cm in diameter)
- 1 Yew Tree (greater than 8cm in diameter)
- 3 Circassian walnut (greater than 8cm in diameter)

470. In addition, a further 5,804 trees less than 8cm in diameter were recorded for de-listing including the following Georgian re-listed species.

- 159 Zelkova (less than 8cm in diameter)
- 2 Chestnut (less than 8cm in diameter)

6. [30] IFC Performance Standard 6 Biodiversity Conservation and Sustainable Management of Living Natural Resources. January, 2012

- 250 Bladder Nut (less than 8cm in diameter)

All of these species identified in the SFF inventory were located in Habitat Area 1 or 2. The full list of the trees to be de-listed is presented in **Appendix F** along with a map of the area.

471. Information relating to the compensation for tree cutting according to national legislation is outlined in **Section G.6.1**.

F.2.2 Fauna

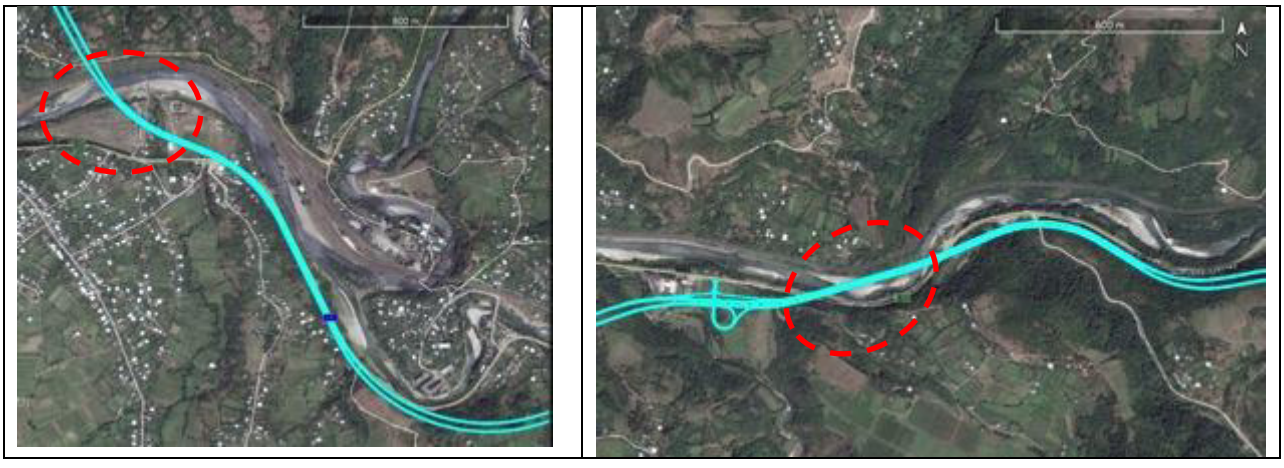
F.2.2.1 Mammals

472. Information available from references (primary and secondary data sources) have been used as a basis for description of the area. According to available information there are two species (Caucasian squirrel and Eurasian otter) considered as vulnerable in Georgia (Georgian Red List) that may be found within the Project area. The Otter is also included in the IUCN red list as near threatened (NT) (see **Table 44)**.

473. During the site visit the list of species listed above was taken as guidance. The objective of the survey was to double check available information on the site. Particular attention was paid to detection of the species listed under protected category. Therefore, specific focus was on the study of the habitats suitable for these mammals.

474. **Otter (*Lutra lutra*)** is known to be found in Kvirila river, however the sources does not provide any information on community structure and number of species in the area of interest. The Otter is river associated species mainly met in slow flowing sections of the streams/rivers. It isn't uncommon for them to travel great distances on land or through the water. This can be up to 26 km^3. However, it is important to remember that otters home range differs from their territory. The actual territory that is distinctly their own is very small. Otters mark their habitat with droppings. So, they can be registered by smell (smell of fresh cut hay). Generally, the otters are not afraid of people and can be met in the limits of residential areas. The aquatic habitats of otters are extremely vulnerable to man-made changes. Canalization of rivers, removal of bank side vegetation, dam construction, draining of wetlands, aquaculture activities and associated man-made impacts on aquatic systems are all unfavorable to otter population. The bridge locations areas (**Figure 51**) have been checked with particular care. No presence of otter has been registered in this portion of the Project road during site surveys. However, they are known to be present in other portions of the river upstream.

Figure 51: Areas Checked for the Presence of Otters



475. **Caucasian squirrel (*Sciurus anomalus*)** can be met in the deciduous forest. Their nests are usually found in the tree hollows, under rocks, inside heaps of stones, and in residential areas, such as graveyards and abandoned cattle sheds. They are diurnal, are not active in winter. The peak of activity is in summer Caucasian squirrels become most active during the early morning to morning and during the two hours before sunset in early summer. Like other tree squirrels, they are territorial. The animal marks territories with urine and feces. The marks are renewed several times every day. There is no information available regarding home range. Caucasian squirrels are herbivorous; they eat seeds and fruits and therefore, likely have an important influence on the forest ecosystem as seed dispersers. The main hazard for this specie is Siberian/red squirrel - invasive species. During the site visit the trees within the RoW of the new alignment (with exclusion of the areas where tunnels are planned) have been checked. Neither burrows, nor squirrels have been registered in the studied area. The review of the habitat along the alignment is not optimum for existence of the Caucasian squirrel. Therefore, construction and subsequent presence (operation) of the highway will not change the population trend.

476. **Bats** (order Chiroptera) are considered as vulnerable group. They are rather limited in selection of nesting shelters. Favourable shelters are hollow trees, caves and abandoned buildings. All species of bats observed in Georgia are included in the Annex II of Bonn Convention and protected by the agreement of EUROBATS. Based on this agreement, Georgia is mandatory to protect all bats inhabiting within the project area and in its vicinities.

477. **Lesser horseshoe bat (*Rhinolophus hipposideros* Bechstein)** It forages close to ground within and along the edges of broadleaf deciduous woodland, which represents its primary foraging habitat, but also in riparian vegetation, Mediterranean and sub-mediterranean shrubland. Its prey consists mainly of midges, moths and craneflies. Foraging activities take place nearly exclusively within woodland areas, while open areas are avoided. Habitat loss and fragmentation may therefore reduce the amount of suitable habitats for the Lesser Horseshoe Bat and pose a threat to this species. Summer roosts (breeding colonies) are found in natural and artificial underground sites in the southern part of the range, and in attics and buildings in the northern part of it. In winter it hibernates in underground sites (including cellars, small caves and burrows). A sedentary species, winter and summer roosts are usually found within 5-10 km (longest distance recorded 153 km). Recommended conservation measures include protecting maternity roosting sites, hibernation caves and foraging habitats.

478. **Particoloured bat (*Vespertilio murinus*)** forages in open areas over various habitat types (forest, semi-desert, urban, steppe, agricultural land). It feeds on moths and beetles. Summer roosts tend to be situated in houses or other buildings; also rarely hollow trees, nest boxes, or rock crevices. Winter roost sites include rock fissures, often (as a substitute) crevices in tall buildings (including, or especially, in cities), occasionally tree holes or cellars. Winter roosts are usually in colder sites that are exposed to temperature changes. Migrations of up to 1,780 km have been recorded, although the species is sedentary in a large part of its range. This nocturnal species appears late in the evening, sleeping in narrow crevices during the day. It lives in small colonies and often single individuals are sighted. It hibernates throughout the winter. Young are born in June/July, generally two at a time, and are stuck onto the chest of the mother during flight.

479. **Common pipistrelle (*Pipistrellus pipistrellus* Schreber)** forages in a variety of habitats including open woodland and woodland edges, Mediterranean shrublands, semi-desert, farmland, rural gardens and urban areas. It feeds on small moths and flies. Summer roosts are mainly found in buildings and trees, and individuals frequently change roost site through the maternity period. Most winter roost sites are located in crevices in buildings, although cracks in cliffs and caves and possibly holes in trees may also be used. It is not

especially migratory in most of its range, but movements of up to 1,123 km have been recorded. In at least parts of its range it seems to benefit from urbanization.

480. Indirect and short-term impact is expected on the above-mentioned species. Indirect impact means damage of the section of the ecosystem, which is significant for animals for receiving energy in the form of the food; also, replacement of migration corridors is meant under it, which will increase the background stress for fauna representatives, living in the neighboring habitats.

481. During the transect surveys within the studied corridor no mammals have been observed. Only traces of activity of the European pine marten have been registered.

Table 44: Mammals, identified within the project area based on literary sources

№	Latin name	Common name	Red List of Georgia	IUCN	Other protection	Number of section
1	*Erinaceus concolor Martin.*	Southern whitebreasted Hedgehog		LC		1/2/3/4/5/
2	*Suncus etruscus Savi.*	Pygmy whitetoothed shrew		LC	Appendix III of the Bern Convention.	1/2/3/
3	*Rhinolophus hipposideros Bechstein.*	Lesser horseshoe bat		LC	Bonn Convention (Eurobats); Bern Convention; Annex II (and IV) of EU Habitats and Species; Some habitat protection through Natura 2000	1/2/3
4	*Pipistrellus pipistrellus Schreber.*	Common pipistrelle		LC	Bonn Convention (Eurobats); Bern Convention in parts of its range where these apply, and is included in Annex IV of the EU Habitats and Species Directive.	1/2/3/
5	*Eptesicus serotinus Schreber.*	Serotine		LC	Bonn Convention (Eurobats); Bern Convention in parts of range where these apply. It is included in Annex IV of EU Habitats and Species Directive, and there is some habitat protection through Natura 2000.	1/2/3
6	*Vespertilio murinus Linnaeus.*	Particoloured bat		LC	Bonn Convention (Eurobats); Bern Convention, in parts of its range where these apply. It is included in Annex IV of EU Habitats and Species Directive	1/2/3//5/
7	*Dryomys nitedula Pallas.*	Forest dormouse		LC	Bern Convention (Appendix III); EU Habitats and Species Directive (Annex IV), in parts of its range where these apply.	1/2/3/
8	*Arvicola terrestris Linnaeus.*	Eurasian water vole		LC		4
9	*Microtus arvalis Pallas.*	Common vole		LC		1/2/3/4/5/

№	Latin name	Common name	Red List of Georgia	IUCN	Other protection	Number of section
.10	*Terricola nasarovi Shidlovsky.*	Nazarov pine vole		LC		1/2/3/
11	*Sylvaemus uralensis Pallas.*	Pygmy wood mouse				1/2/3/
12	*Mus musculus Linnaeus.*	House mouse		LC		1/3/4/5/
13	*Sciurus anomalus Gmelin.*	Caucasian squirrel	VU	LC	EU Habitats Directive (92/43) IV 21/05/92; Bern Convention II 01/03/02, in parts of its range where these apply. Occurs in protected areas. Population monitoring is recommended, particularly in parts of the range where declines have been noted.	1/2/3
14	*Lutra lutra Linnaeus.*	Eurasian otter, Common otter	VU	NT	Appendix I of CITES, Appendix II of the Bern Convention, Annexes II and IV of the EU Habitats and Species Directives.	4
15	*Mustela nivalis Linnaeus.*	Least weasel		LC	Appendix III of the Bern Convention.	1/2/3/4/5
16	*Felis silvestris Shreber.*	Wild cat		LC	CITES Appendix II (http://www.cites.org/eng/app/appendices.php); is fully protected across most of its range in Europe and Asia, but only some of its African range; is listed on the EU Habitats and Species Directive (Annex IV) as a "European protected species of animal"; listed in Appendix II of the Bern Convention. It is classed as threatened at the national level in many European range states (IUCN 2007).	1/2/3/
17	*Canis aureus Linnaeus.*	Golden jackal		LC		1/2/3/4
18	*Vulpes vulpes Linnaeus.*	Red fox		LC		1/2/3/4
19	*Canis lupus*	Wolf		LC	Bern, CITES Appendix II	1/2/3/
20	*Sus scrofa Linnaeus.*	Eurasian wild boar		LC		1/2/3/
21	*Martes martes*	European pine marten		LC	Appendix III of the Bern Convention and Annex V of the European Union Habitats Directive, and it occurs in a number of protected areas across its range.	1/2/3/

VU = Vulnerable; LC = Least Concern; NT = Near Threatened

F.2.2.2 Reptiles

482. According to the literary sources, 8 species of reptiles are known to be present in the Project area, out of which 2 are lizards, 2 – turtles and 4 – snakes (see **Table 45**). From reptiles worth to mention is endemic lizard met in the Mtkvari valley. The only Red-Listed species that is recorded on the nearby territory of the Project area is the Mediterranean turtle.

Table 45: Reptiles, known within the project area based on literary sources

№	Latin name	Common name	Georgian Red List	IUCN	Other protection	Section N
1.	*Testudo graeca* Linnaeus	Mediterranean turtle	VU	VU	-	1/4/
2	*Emys orbicularis*	European Pond Turtle	LC	NT	-	4
3.	*Natrix natrix* Linnaeus.	Ring snake	LC	LR/LC	Bern Convention	4/5
4.	*Natrix tessellate* Laurenti.	Dice snake	LC	LC	Bern Convention	4/5
5.	*Coronella austriaca* Laurenti.	Smooth snake	LC	LC	Bern Convention	1/2/
6.	*Xerotyphlops vermicularis* Strauch.	Blind Snakes	DD	LC	-	1/2/3/
7.	*Darevskia derjugini*	Artwin Lizard	LC	LC	Bern Convention	1/2/3/
8.	*Darevskia rudis*	Spiny-Tailed Lizard	LC	LC	Bern Convention	1/2/3/
9.	*Anguis fragilis*	Caucasian Slow Worm	LC	LC	Bern Convention	2/

VU = Vulnerable; NT = Near Threatened and LC = Least Concern, LR = Low risk, DD-Data Deficient

483. Due to the fact that it was extremely hot during the surveys, activity of reptiles was low as they were avoiding overheating. During the site survey only the Artwin lizard has been registered.

Figure 52: Darevska derhugini (coordinates 346891.28; 4660857.92)

Figure 53: Pelophylax ridibundus (coordinates 340072.18; 4662963.5)

F.2.2.3 Amphibians

484. According to the literary sources, the main amphibian species present in the area include:

Table 46: Amphibians, known within the project area based on literary sources

№	Latin name	Common name	Georgian Red List	IUCN	Other protection	Section N
1.	*Hyla arborea* Linnaeus	European Tree Frog	LC	LC	Bern Convention	4/5/
2.	*Pelophylax ridibundus* Pallas.	Lake frog	LC	LC	Bern Convention	4/5
3.	*Rana macrocnemis camerani* Boulenger.	Longlegged Wood Frog	LC	LC	Bern Convention	3/4/

LC = Least Concern

485. During the site survey the listed species have one individual Lake frog has been registered near Shoropani crossing (see **Figure 53** above).

F.2.2.4 Insects

486. The insects know to be present in the project area are listed in the table below.

Table 47: Insects known within the project area based on literary sources

№	Latin Name	Common name	Georgian Red List	IUCN	Section N
1.	*Mylabris quadripunctata*	Four-spotted blister beetle	NE	NE	1/2/3/5/6/
2.	*Dorcus*	Lesser stag beetle	NE	NE	1/2/3/

№	Latin Name	Common name	Georgian Red List	IUCN	Section N
	parallelipipedus				
3.	*Libellula depressa*	Broad-bodied chaser	NE	NE	2/
4.	*Morimus verecundus*	Longhorn beetle	NE	NE	2/3
5.	*Pieris napi*	Green-veined white butterfly	NE	NE	1/2/3/5
6.	*Pieris rapae*	European cabbage butterfly	NE	NE	1/2/3/4/5
7.	*Plebeius argus*	Silver-studded blue butterfly	NE	NE	1/2/3/4/5/
8.	*Nimphalis antiopa*	Mourning-cloak butterfly	NE	NE	1/2/3/4/5/6/
9.	*Lampyris noctiluca*	Glow-worm	NE	NE	1/2/3/4/5/
10.	*Geotrupes spiniger*	Dumbledor beetle	NE	NE	1/2/3/5/
11.	*Purpuricenus budensis*	Red long-horned Beetle	NE	NE	1/2/3/4/
12.	*Polyommatus amandus*	Amanda's blue butterfly	NE	NE	5/6
13.	*Polyommatus corydonius*	False chalkhill blue butterfly	NE	NE	1/2/3/4/5/6/
14.	*Polyommatus thersites*	Chapman's blue butterfly	NE	NE	1/2/3/4/5/6/
15.	*Cercopis intermedia*	Froghopper	NE	NE	1/2/3/4/5/6/
16.	*Vanessa atalanta*	Red admiral butterfly	NE	NE	1/2/3/4/5/6/
17.	*Vanessa cardui*	Painted lady butterfly	NE	NE	3/4/5/6/
18.	*Ischnura elegans*	Blue-tailed damselfly	NE	NE	3/4/
19.	*Panorpa connexa*	Scorpionfly	NE	NE	4/5/
20.	*Apis melifera*	European honey bee	NE	NE	4/5
21.	*Bombus lapidarius*	Red-tailed bumblebee,	NE	NE	4/5/
22.	*Aphis urticata*	Dark green nettle aphid	NE	NE	1/2/3/
23.	*Pieris brassicae*	Cabbage butterfly	NE	NE	1/3/5/6
24.	*Pyrrhocoris apterus*	Firebug	NE	NE	1/2/3/4/5/6/
25.	*Lymantria dispar*	Gypsy moth	NE	NE	1/2/3/
26.	*Gryllus campestris*	Field cricket	NE	NE	4/5/
27.	*Decticus verrucivorus*	Wart-biter	NE	NE	4/5/6/
28.	*Tettigonia viridissima*	Great green bush-cricket	NE	NE	5/6/

NE = not evaluated

487. Within the project area Red cricket, blue railed damselfly have been met. No butterflies were registered.

Figure 54: Gryllus campestris (coordinates 337730.19; 4664604.82)

Figure 55: Ischura elegans (coordinates 339946.92; 4662915.10)

488. The spiders know to be present in the project area are listed below.

Table 48: Insects, known within the project area based on literary sources

№	Latin name	Common name	Georgian Red List	IUICN	Section No.
1.	*Misumena vatia*	Goldenrod crab spider	NE	NE	1/2/3/
2.	*Pisaura mirabilis*	Nursery web spider	NE	NE	1/2/3/
3.	*Alopecosa schmidti*	Wolf spiders	NE	NE	1/2/3/
4.	*Micrommata virescens*	Green huntsman spider	NE	NE	1/2/3/4/5
5.	*Agelena labyrynthica*	Eurasian grass spiders	NE	NE	1/2/3/
6.	*Asianellus festivus*	Jumping spiders	NE	NE	1/2/3/
7.	*Araniella dispcliata*	Orb-weaver spider	NE	NE	1/2/3/
8.	*Dysdera crocata*	Sowbug hunter	NE	NE	1/2/3/
9.	*Phialeus chrysops*	Jumping spiders	NE	NE	3/4/5/
10.	*Argiope lobata*	Silver-faced	NE	NE	1/2/3/
11.	*Menemerus semilimbatus*	Jumping spiders	NE	NE	1/2/3/4/
12.	*Pardosa hortensis*	Wolf spiders	NE	NE	1/2/3/4/
13.	*Larinioides cornutus*	Furrow orb spider	NE	NE	1/2/3/4/5

NE = not evaluated

489. During the walkover several spider species have been registered as noted by the figures below.

Figure 56: Pisaura mirabilis (coordinates 347288.84; 4660981.14)

Figure 57: Pardosa hortensis (coordinates 344707.22; 4662074.4)

Figure 58: Asinelllus festivus (coordinates 345050/30; 4661910.7

490. The round worms, bristle worms and beetles know to be present in the project area are listed below.

Table 49: Round Worms (Nematodes), known within the project area based on literary sources.

№	Scientific Name	English Name	Georgian Name	National Red List	International Red List
1.	*Tripylina arenicola*	-	-	NE	NE
2.	*Plectus annulatus*	-	-	NE	NE
3.	*Anaplectus granulosus*	-	-	NE	NE
4.	*Mesodorylaimus bastiani*	-	-	NE	NE
5.	*Eudorylaimus acutus*	-	-	NE	NE
7.	*Pungentus silvestris*	-	-	NE	NE
8.	*Enchodelus microdorus*	-	-	NE	NE
9.	*Bursilla monhystera*	-	-	NE	NE

NE = not evaluated

Table 50: Bristle Worms (Polychaetes), known within the project area based on literary sources

№	Scientific Name	English Name	Georgian Name	National Red List	International Red List
1.	*Aelosoma hemprichi*	-	-	NE	NE
2.	*Stylaria lacustris*	-	-	NE	NE
3.	*Aulophorus furcatus*	-	-	NE	NE
4.	*Specaria josinae*	-	-	NE	NE
5.	*Ophidonais serpentine*	-	-	NE	NE
6.	*Potamotrix bedoti*	-	-	NE	NE
9.	*Lumbricus terrestris*	-	-	NE	NE
10.	*Dendrodriloides grandis*	-	-	NE	NE
11.	*Eiseniella tetraedra*	-	-	NE	NE
13.	*Helodrilus cartlicus*	-	-	NE	NE

Table 51: Oribatida, known within the project area based on literary sources

№	Scientific Name	English Name	Georgian Name	National Red List	International Red List
1.	*Epilohmannia cylindrica*	-	-	NE	NE
2.	*Rhysotritia ardua*	-	-	NE	NE
5.	*Tectocepheus velatus*	-	-	NE	NE
6.	*Oppiella fallax*	-	-	NE	NE
7.	*Quadroppia quadricarinata*	-	-	NE	NE
8.	*Suctobelbella falcate*	-	-	NE	NE
9.	*Achipteria nitens*	-	-	NE	NE
10.	*Sphaerozetes piriformis*	-	-	NE	NE
12.	*Chamobates cuspidatus*	-	-	NE	NE

F.2.3 Avi Fauna

491. The majority of birds found on the study area are presented by forest, shrubbery and other species, birds related to rocky places and waterfowls. The list of bird species potentially available in the project area (based on the desk top analysis of available data) is given in **Table 52** below. None of these species are

protected. The territory is not significant habitat for birds and does not include priority habitats for avian species (see Figure 59**).**

Figure 59: Significant Bird Habitat in Georgia

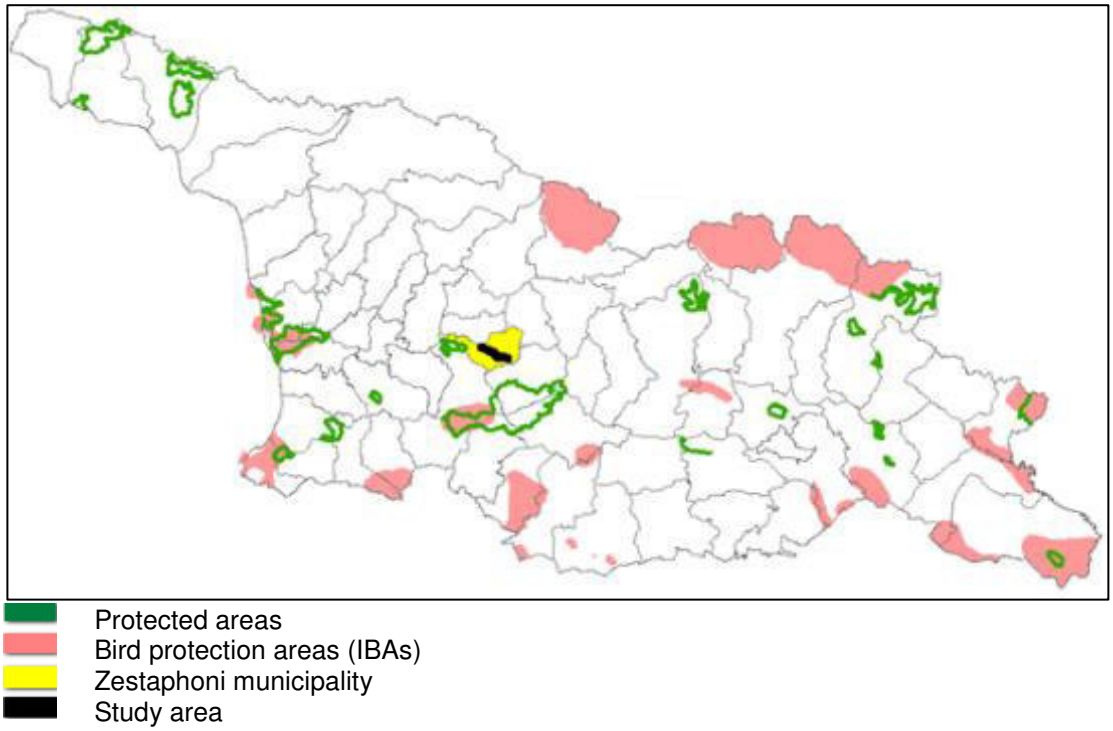


Table 52: Birds within the study area, known according to literary sources

#	Latin name	Common name	Georgian Red List	Season	IUCN	Other protection	Section
1.	*Motacilla alba*	White Wagtail	-	YR-R, M	LC	Bern Convention	1/2/3/4/5/6
2.	*Apus apus*	Common Swift	-	BB, M	LC	Bern Convention	1/2/3/4/5/6
3.	*Merops apiaster*	European Bee-eater	-	BB, M	LC		1/2/3/4/5/6
4.	*Corvus cornix*	Hooded Crow	-	YR-R	LC		1/2/3/4/5/6
5.	*Garrulus glandarius*	Eurasian Jay	-	YR-R	LC		1/2/3/4/5/6
6.	*Turdus merula*	Eurasian Blackbird	-	YR-R	LC	Bern Convention	1/2/3/4/5/6
7.	*Delichon urbicum*	House-Martin	-	BB, M	LC	Bern Convention	1/2/3/4/5/6
8.	*Sturnus vulgaris*	Common Starling	-	YR-R, M	LC		1/2/3/4/5/6
10.	*Columba livia*	Rock Dove	-	YR-R	LC		1/2/3/4/5/6
11.	*Columba oenas*	Stock Dove	-	YR-R	LC		1/2/3/4/5/6
12.	*Columba palumbus*	Wood-Pigeon	-	YR-R	LC		1/2/3/4/5/6
13.	*Hirundo rustica*	Barn Swallow	-	BB, M	LC	Bern Convention	1/2/3/4/5/6
15.	*Oriolus oriolus*	Golden Oriole	-	BB, M	LC	Bern Convention	1/2/3/4/5/6

#	Latin name	Common name	Georgian Red List	Season	IUCN	Other protection	Section
16.	*Turdus viscivorus*	Mistle Thrush	-	YR-R, M	LC	Bern Convention	1/2/3/4/5/6
17.	*Erithacus rubecula*	European Robin	-	YR-R	LC	Bern Convention	1/2/3/4/5/6
18.	*Fringilla coelebs*	Chaffinch	-	YR-R, M	LC	Bern Convention	1/2/3/4/5/6
19.	*Cuculus canorus*	Common Cuckoo	-	BB, M	LC	Bern Convention	1/2/3/4/5/6
20.	*Phoenicurus phoenicurus*	Common Redstart	-	BB, M	LC	Bern Convention	1/2/3/4/5/6
21.	*Passer domesticus*	House Sparrow	-	YR-R	LC		1/2/3/4/5/6
22.	*Carduelis carduelis*	European Goldfinch	-	YR-R, M	LC	Bern Convention	1/2/3/4/5/6
23.	*Carduelis chloris*	Greenfinch	-	YR-R, M	LC	Bern Convention	1/2/3/4/5/6
25.	*Parus major*	Great Tit	-	YR-R	LC	Bern Convention	1/2/3/4/5/6
26.	*Lanius collurio*	Red-backed Shrike	-	BB, M	LC	Bern Convention	1/2/3/4/5/6
38.	*Turdus philomelos*	Song Thrush	-	YR-R, M	LC	Bern Convention	1/2/3/4/5/6
30.	*Aegithalos caudatus*	Long-tailed Tit	-	YR-R, M	LC	Bern Convention	1/2/3/4/5/6
36.	*Falco tinnunculus*	Common Kestrel	-	YR-R, M	LC	Bonn Convention, Bern Convention	1/2/3/4/5/6
37.	*Buteo buteo*	Common Buzzard	-	YR-R, M	LC	Bonn Convention, Bern Convention	1/2/3/4/5/6
38.	*Phalacrocorax carbo*	Great Cormorant	-	YR-R, M	LC		4
39.	*Ardea cinerea*	Grey Heron	-	YR-R	LC	Bonn Convention, Bern Convention	4
41.	*Egretta garzetta*	Little Egret	-	YR-R	LC		4
42.	*Nycticorax nycticorax*	Night-Heron	-	BB, M	LC	Bonn Convention, Bern Convention	4
44.	*Tadorna ferruginea*	Ruddy Shelduck	-	YR-R	LC		4
45.	*Anas platyrhynchos*	Mallard	-	YR-R, M	LC	Bonn Convention, Bern Convention	4
46.	*Milvus migrans*	Black Kite	-	YR-R, M	LC	Bonn Convention, Bern Convention	1/2/3/4/5/6
47.	*Accipiter nisus*	Sparrowhawk	-	YR-R, M	LC	Bonn Convention, Bern	1/2/3/4/5/6

#	Latin name	Common name	Georgian Red List	Season	IUCN	Other protection	Section
						Convention	
48.	*Accipiter gentilis*	Goshawk	-	YR-R, M	LC	Bonn Convention, Bern Convention	1/2/3/4/5/6
51.	*Charadrius dubius*	Little Ringed Plover	-	YR-R, M	LC	Bonn Convention, Bern Convention	4
52.	*Larus ridibundus*	Black-headed Gull	-	YR-R, M	LC		4
55.	*Upupa epops*	Common Hoopoe	-	BB, M	LC	Bern Convention	1/2/3/4/5/6
57.	*Corvus frugilegus*	Rook	-	YR-R, M	LC		1/2/3/4/5/6
60.	*Luscinia megarhynchos*	Luscinia megarhynchos	-	BB, M	LC		1/2/3/4/5/6
61.	*Phylloscopus collybita*	Common Chiffchaff	-	BB, M	LC		2/

YR-R = nests and reproduces in the area, can be found all year round; YR-V = visitor to these areas. It does not reproduce but is here throughout the year. BB = visits the area only for reproduction
M = Migratory; it can get to the area during migration (in autumn and spring)
LC = Least Concern.

Table 53: Birds, observed within the project area during the survey

#	Latin name	Common name	Georgian Red List	Season	IUCN	Other protection	Section
1.	*Motacilla alba*	White Wagtail	-	YR-R, M	LC	Bern Convention	1/2/3
2.	*Apus apus*	Common Swift	-	BB, M	LC	Bern Convention	1/3/4/5
3.	*Merops apiaster*	European Bee-eater	-	BB, M	LC	-	2/3/
4.	*Charadrius dubius*	Little Ringed Plover	-	YR-R, M	LC	Bonn Convention, Bern Convention	4
5.	*Larus ridibundus*	Black-headed Gull	-	YR-R, M	LC	Bern Convention	4
6.	*Corvus cornix*	Hooded Crow	-	YR-R	LC	-	3/4/5/6
7.	*Garrulus glandarius*	Eurasian Jay	-	YR-R	LC	-	2/3/4/5
8.	*Turdus merula*	Eurasian Blackbird	-	YR-R	LC	Bern Convention	1/2/3/4
9.	*Delichon urbicum*	House-Martin	-	BB, M	LC	Bern Convention	2/3/4/
11.	*Upupa epops*	Common Hoopoe	-	BB, M	LC	Bern Convention	2/3/4/5
14.	*Luscinia megarhynchos*	Luscinia megarhynchos	-	BB, M	LC	-	1/2/3/
15.	*Turdus viscivorus*	Mistle Thrush	-	YR-R, M	LC	Bern Convention	1/2/3
16.	*Erithacus rubecula*	European Robin	-	YR-R	LC	Bern Convention	2/
17.	*Fringilla coelebs*	Chaffinch	-	YR-R, M	LC	Bern Convention	1/3/

#	Latin name	Common name	Georgian Red List	Season	IUCN	Other protection	Section
19.	*Phoenicurus phoenicurus*	Common Redstart	-	BB, M	LC	Bern Convention	1/2/3
20.	*Passer domesticus*	House Sparrow	-	YR-R	LC	-	1/3/5/6/
21.	*Carduelis carduelis*	European Goldfinch	-	YR-R, M	LC	Bern Convention	1/2/3/
24.	*Parus major*	Great Tit	-	YR-R	LC	Bern Convention	2/3/5
25.	*Lanius collurio*	Red-backed Shrike	-	BB, M	LC	Bern Convention	2/3
26.	*Phylloscopus collybita*	Common Chiffchaff	-	BB, M	LC		2/
27.	*Turdus philomelos*	Song Thrush	-	YR-R, M	LC	Bern Convention	2/3

YR-R = nests and reproduces in the area, can be found all year round.; YR-V = visitor to these areas. It does not reproduce but is here throughout the year. BB = visits the area only for reproduction;
M = Migratory; it can get to the area during migration (in autumn and spring)
LC = Least Concern.

F.2.4 Fish

General

492. A fish study has been undertaken on the sites where construction of bridges/river crossings is planned. The objective of the survey was to:
- Study and assess the baseline environmental condition within the project section;
- Survey of hidrobionts, fin particular, ichthyofauna living in the project area;
- Development of mitigation measures, taking into account the impact factors.

493. The study was prepared based on existing literature sources and the results of field study conducted from 18.07.2017 to 28.07.2017. In the field research information was used from the local population and amateur fishermen.

Methodology

494. The ichtyofauna study included desk top study, visual audits, field surveys, anamnesis (interview of the local population and amateur fishermen) and laboratory processing of the obtained material. The research methodology is fully coincided with the methods used in international practice.

495. Fish stock status has been be judged upon based on the following data:
- general mass of fish caught in the recent years;
- quantitative ratio of age groups;
- age of reaching the first and overall puberty of the population;
- direct influence of fish growth rate versus maturity;

Desktop Study

496. Work plan, survey route, locations for control catches and hydrochemical-hydrobiological sampling have been selected. A questionnaire for the local population and amateur fishermen was prepared.

Visual Audit

497. The visual audit to identify habitats for ichthyofauna species (geomorphology of the river bed in question, general hydrological characteristics, habitat hipsometria, relief, the river bottom hipsometria, visual - landscape background) has been carried out. Based on these data species theoretically present in the study area have been identified.

Field study

498. The field study method included:
- biological analysis of fish (length; weight; gender, maturity stage; collection, fattening coefficient, meristic and plastic characteristics, the digestive tract content);
- collection, labeling and preservation of scales for subsequent lab analysis;
- study of food base - hydroflora and hydrofauna; identification of macroinvertebrates and insects used for feeding;
- study of the status of living environment of both fish and invertebrates;
- determination of suspended solids; dissolved oxygen (using filed tester Oxi 330i); water and air temperature; pH measurements - on-site;
- sampling of water for lab analysis;
- assessment of species composition of zoobenthos and protozoa - periphyton species composition and biomass.

499. For control catches cast nets (weight 7.0 kg, mesh size 14 mm) were used. The catches were performed in control points selected along 50 m and 100 m sections. Sports-amateur fishing tools were used during the study. (No special permit or license was required). Research parameters include research of all biotic and abiotic factors related to the ecological niche.

500. During the survey catch and release principle was kept to. Every fish in the catch was registered in a special field log.

Interviews

501. The interview of local population and amateur fishermen was carried out to highlight the full picture of the Kvirila River and the Dzirula River ichthyofauna species composition. For this purpose, amateur fishermen with at least 5-10 years of fishing experience have been selected. The questionnaire was drawn up so to reduce the risk of false information (overestimation/bragging). Information confirmed by three or more respondents was assumed as reliable. During the entire study period, 5 fishermen were interviewed. (For results see **Table 56: Results of the interview of local population.**).

Laboratory Research

502. Study of age, growth and growth rate were identified through laboratory analysis of fish scales collected during the field survey.

503. The following tables indicate the fish species found in both rivers.

Table 54: List of fish species available in the rivers in the project area

Type	Kvirila River	Dzirula River
Brown trout (Salmo trutta morfa fario Linnaes, 1758)	+	-
Colchic barbel (Barbus tauricus rionica Kamensky, 1899)	+	+

Type	Kvirila River	Dzirula River
Chub (Leuciscus leuciscus Linnaeus, 1758)	+	+
Colchic chondrostoma (Chondrostoma colchicum Derjugin, 1899	+	+
Colchic khramulya (Capoeta sieboldi Steindachner, 1864)	+	+
monkey goby (Neogobius fluviatilis, Pallas 1814)	+	+
Spined loach (Cobitis taenia Linnaeus, 1758)	+	+
Common bleak (Alburnus alburnus, Linnaeus, 1758)	+	+

Table 55: Species found as the result of fishing in the project area

Common name	Latin name
Colchic khramulya	Capoeta sieboldi Steindachner, 1864
Common dace	Leuciscus leuciscus Linnaeus, 1758

504. Five fishermen were interviewed within the framework of the baseline survey: Amiran Gegetashvili; Beso Kalandadze; Misha Macharashvili; Tengo Kapanadze; Giorgi Tsertsvadze. **Table 56** provides a list of the questions asked and the answers received during the interview.

Table 56: Results of the interview of local population.

#	Question	Interview results
1	What species of fish are spread in Kvirila and the Dzirula Rivers?	Mainly: trout (only in the head of Kvirila), barbel, chub, chondrostoma, khramulya, goby, cobitis, albunus.
2	Which fishing equipment do the local fishermen prefer?	The places are good for the throw nets and for fishing-rods, thus, it is hard to say which is of higher priority.
3	How many fishes can a skilled fisherman catch in 6 hours?	It depends on the situation, sometimes you may not catch at all, or sometimes you can easily catch 10-20 fish.
4	What local fishermen use as a squid when fishing with a fishing rod?	Mostly, earthworms as well as worms found under the stones.
5	Is fishing for personal consumption or for sale?	Just for personal consumption.
6	How often are the facts of poaching and how are they fighting against them?	Poachers appear either at night or very early so that no one can notice them. There are sanctions for poaching, thus, people try not to poach.
7	Which restrictive measures do the poachers use?	They use mainly electrofishing devices.
8	Do you remember the case of catching a mature fish (with a hard roe) and was there a brown trout among them?	Seldom. The trout spawn can be seen in the head of the rivers, and the rest fish lay their eggs in spring and summer.
9	Can you describe the hard roe?	In autumn-winter period the trout roe is quite large, tasty, of orange colour, or sometimes red. Some mentioned that khramulya roe is toxic, therefore they do not eat it. The roe of the other fish is used.
10	Have you ever seen alevins with a yolk sac or a yellow shining spawn?	The trout alevins can be seen before the spring floods, but in the head of rivers. In the project area alevins of the other fish spawning in spring and summer period can be seen near the banks.
11	How popular is the project section for fishermen?	Fairly popular. One can see 2-3 fishermen on the edge of the river. In the section after Dzirula -

		Kvirila confluence, turbidity of water is high.Fish avoid the turbd water, therefore fishin in that area is pointless. The main fishing sites are in the Dzirula before the Dzirula-Kvirila confluence.
12	When does fish spawn in the project area?	Fish spawns in spring and summer.

505. The following species have been found in the catch during the study in the Dzirula River:

Colchic khramulya (Capoeta sieboldi Steindachner, 1864) - 2 units.	
Chub (Leuciscus leuciscus Linnaeus, 1758)- 1 unit.	

506. On the bottom of the Dzirula River, in the project area, colonies of invertebrate species (food base for fish) have been registered. Hydroflora, represented by perythiton, the main food base for khramulya was found. Hydroflora and hydrofauna of the Kvirila River is sparce. This is conditioned by high concentration of suspended solids. In this section fish was not registered.

F.2.5 Protected Areas

507. The nearest protected area to the Project road is the Ajameti Managed Reserve, which is located approximately 5 kilometers south west of the end point of the road (km14.7), see **Figure 60.**[31]

508. In April of 1928, 20 ha of Kutaisi forested area was declared a nature reserve and in 1935 Ajameti Botanical Reserve was established at the ground level of the Ajameti forest massif. Ajameti was formed as a strict nature reserve in 1946 to preserve rare and relict Imeretian Oak and Elm Zelkova trees. The famous oaks of Ajameti are ancient natural treasures, with some of the trees being over 250 years old.

[31] Managed nature reserves were created in 1997, according to the Law on Animals, on the basis of forest and hunting farms.

Figure 60: Location of the Ajameti Managed Reserve (reserve comprises several portions)

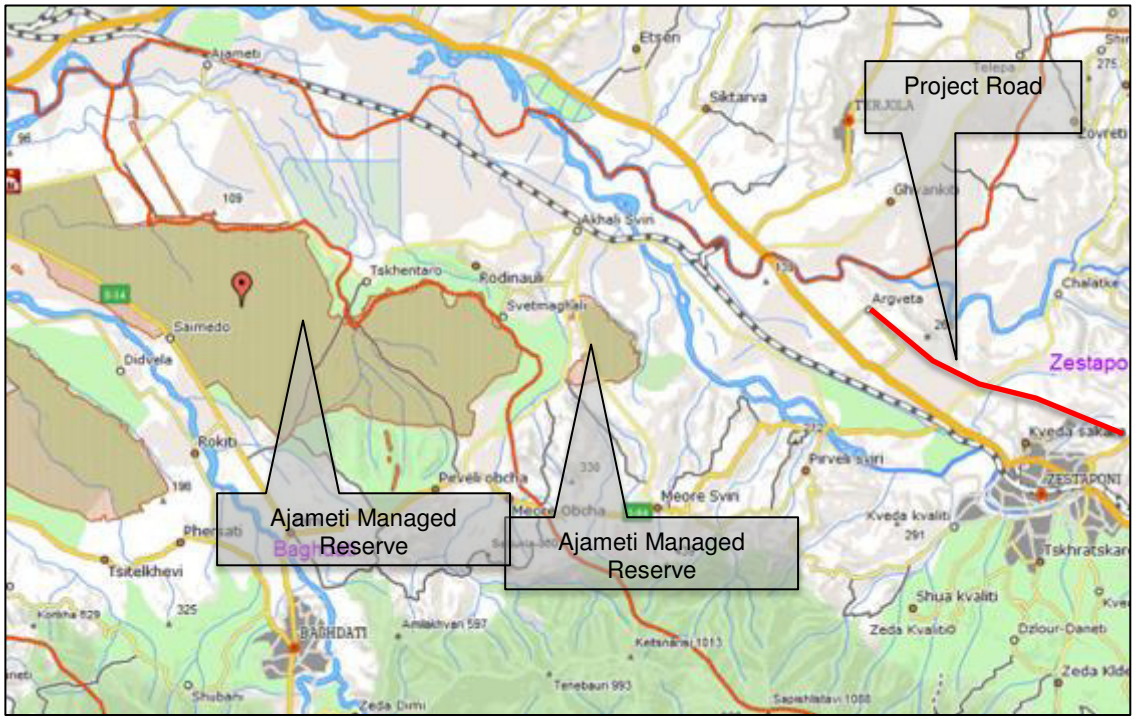
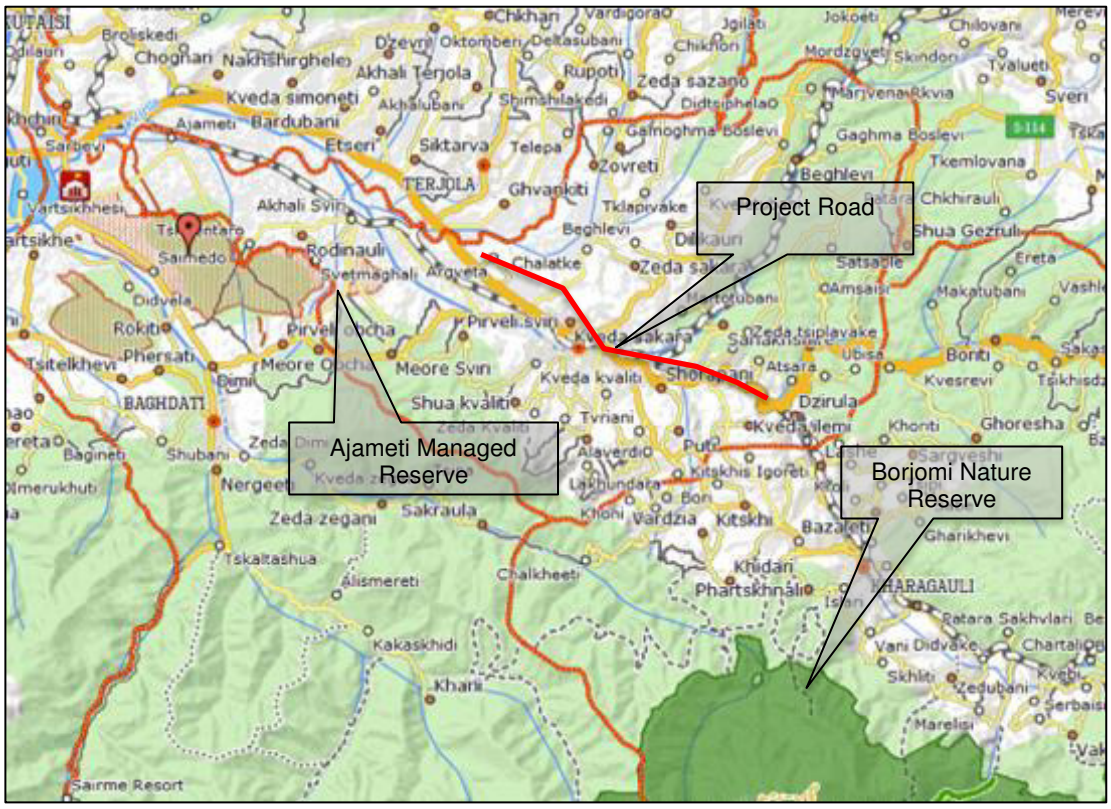


Figure 61: Ajameti Managed Reserve

509. The only other protected area in the region is the Borjomi Nature Reserve which is located more than 20 kilometers south of the start point of the Project road, see **Figure 62.**

Figure 62: Protected Areas Within the Vicinity of the Project Road



510. The nearest Important Bird Area (IBA) to the Project road is the Adjara-Imereti Ridge more than twenty kilometers south of the Project road which overlaps with the Borjomi Nature Reserve. The IBA comprises populations of the following IBA trigger species:

- Caucasian Grouse Lyrurus mlokosiewiczi (IUCN Category – NT)
- Corncrake Crex crex (IUCN Category – LC)
- Great Snipe Gallinago media (IUCN Category – NT)
- Eastern Imperial Eagle Aquila heliaca (IUCN Category – VU)

F.3 Economic Development

F.3.1 Industries & Agriculture

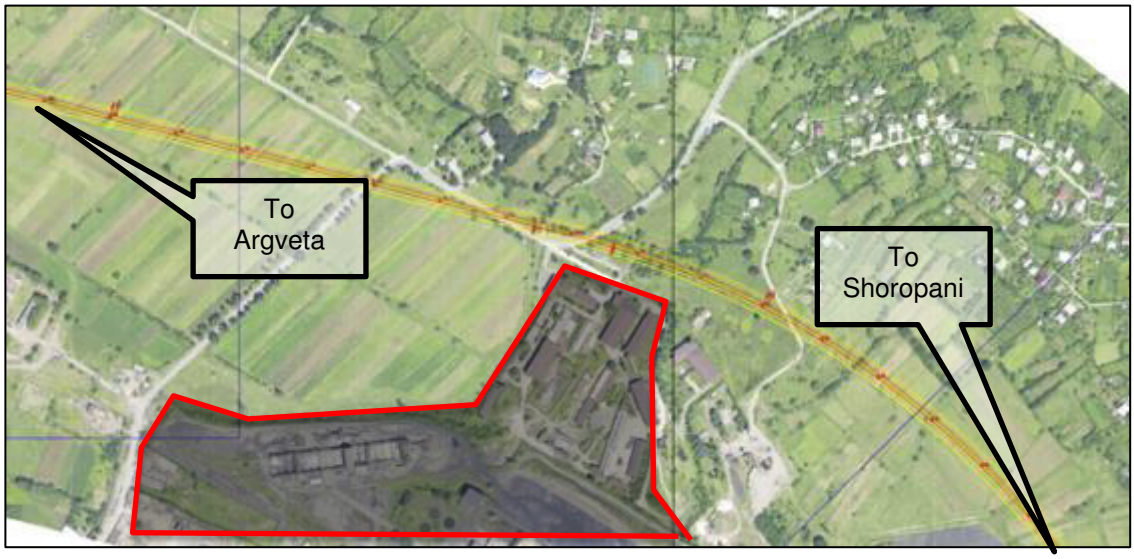
511. Viticulture is the main economic activity in the municipality of Zestaphoni providing 80% of agricultural output. Its development is supported by favorable soil-climatic conditions. Vineyards occupy 5,000 hectares within the municipality. There are two active wine producing factories in the municipality.

512. The Rioni River Basin is abundant with mineral resources. The upper courses of the basin are rich in non-ferrous metal and non-metal mineral deposits, specifically manganese which can be found in large deposits in mines close to Chiatura some 20km north east of Zestaphoni. The manganese ore deposits near Chiatura, first discovered in 1849, have been exploited since 1879. The ores include pyrolusite and psilomelane (oxide ores) and rhodochroisite (carbonate ore). The country's largest producer, Chiaturmarganets, mines manganese ores from open cast and underground operations in Chiatura, which are supplied to the nearby GAA plant in Zestaphoni.

513. Founded in 1933 by Georgian scientist Giorgi Nikoladze, Georgian Manganese's Zestaphoni Ferroalloy Plant has grown to become Georgia's largest silicomanganese processing plant and was recently purchased by an American company renaming the plant Georgian American Alloys. GAA produced over 187,000 metric tons of silicomanganese in 2012, however the mining and production of the manganese is not without its environmental problems, including impacts to air quality and impacts to the water quality of the Kvirila river, both issues are discussed above. The Project road passes almost adjacent to the north of the plant for around 2 kilometers between KM 9.7 and KM 11.8. As noted above soil samples and groundwater samples have been taken in this area to determine if contaminated the land exists within the vicinity of the GAA factory.

Figure 63: Location of GAA – Approximately Km 9.5 – Km 10.7

Figure 64: Location of GAA – Approximately Km 10.7 – Km 12.5



514. Other important industrial facilities plants in the Project area include "Saqkabeli" in Zestaphoni and "Elektroelementi" in Shorapani.

515. Agricultural land plots cover 7,027 ha of the municipality or 46% of the whole territory. 5,159 ha out of the above-mentioned area are arable lands. As for

greenhouse areas, it totals approximately 6 ha. Detailed information on Imereti region and Zestaphoni Municipality is given in **Table 57.** Other than grapes, melon and maize are predominant crops grown in the region and have been noted within the Project corridor, specifically from KM 7.0 onwards.

Table 57: Agricultural Areas (Hectares)

	Imereti	Zestaphoni
Total Agricultural	65,737	7,027
Arable	51,033	5,159
Pasture	5,410	363
Greenhouse	462	6

516.Source: www.geostat.ge

F.3.2 Infrastructure and Transportation facilities

F.3.2.1 Road, Rail and Air

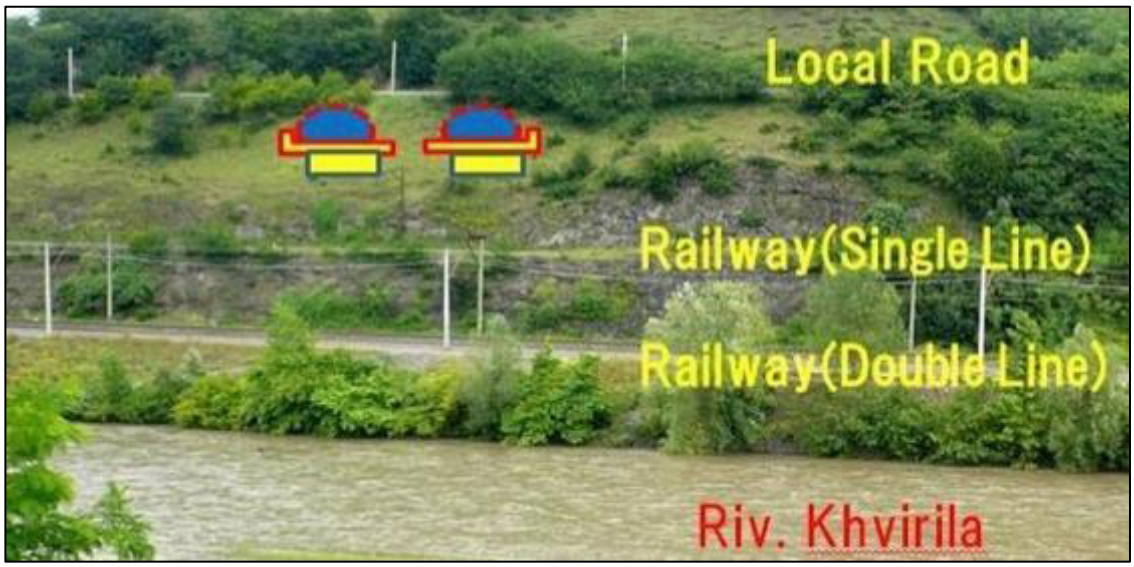
Roads

517. The road network in the Project area is dominated by the existing E-60 which links Tbilisi with Batumi. The key issue with the existing road within the Project corridor is the route through Zestaphoni which often becomes choked with traffic. The existing road does not bypass the town, rather it creeps through the town in a rather strange fashion, including a specific pinch point around the GAA factory. In the summer this point becomes extremely congested and long traffic delays can be experienced as people make their way too and from Tbilisi and Batumi for summer vacations. Numerous local roads feed onto the E-60 in Zestaphoni, and these roads vary in condition from good to very poor.

Rail

518. The main line from Tbilisi to Batumi runs broadly parallel with the Project road until it reaches Zestaphoni. In fact, in the first section of the road, between KM 0.0 and KM 6.0 the railway line and the road are only separated by a couple of hundred meters, with the road running south of the railway line. At one location, the new road alignment passes within 20 meters of the railway line (KM 2.5) and eventually passes over the railway line at KM 6.3 (see **Figure 65**) as the road heads north west to start its bypass around Zestaphoni.

Figure 65: Location of Road Crossing Railway Line



519. Georgian Railways own and operate the rail services in Georgia. There are two live lines on this route, one on a higher elevation and one on a lower elevation. The line on the higher elevation operates 4 trips per day, the lower line accommodates approximately 40 journeys per day.

F.3.2.2 Utilities

520. Networked water supply and sewage systems only exist within the main towns and cities of Georgia, including Zestaphoni. Power is provided to villages in the region and is supplied by the company "EnergoProGeorgia". Villages mainly use groundwater resources for potable and home use.

F.3.2.3 Housing Stock

521. The housing stock in the Project area comprises mainly one or two storey houses that are distributed mainly along the local roads that weave their way around the valley slopes. The only multiple storey residential buildings observed within the Project area are located in Shoropani at KM 4.3 (within 100 meters) and KM 7.9 (road passes beneath these buildings in a tunnel).

Figure 66: Buildings at KM 4.3

F.3.3 Tourism and Recreation

522. Zestaphoni is not considered an important or significant area for tourism and recreation. A recent study of foreign visitors to Imereti region indicated that less than 2% of the visitors visited Zestaphoni for recreation or vacation. [32]

523. According to RD environmental division, there are no exceptional landscapes requiring special attention along the project corridor.

F.4 Social and Cultural Resources

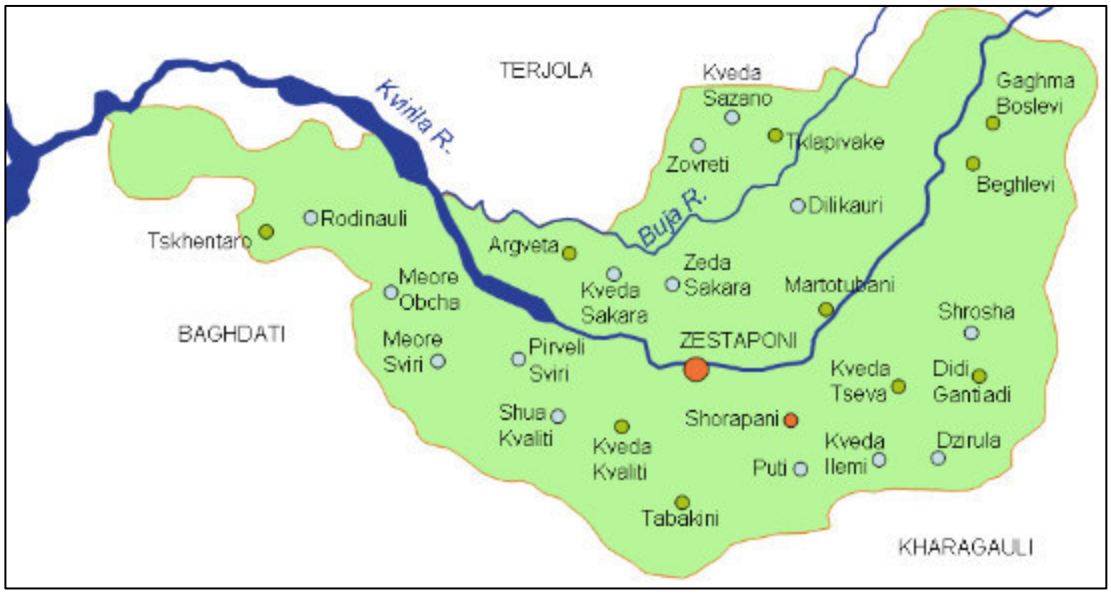
F.4.1 Socio-economic conditions

F.4.1.1 Administrative Issues

524. The Project road is located within the Region of Imereti. Imereti occupies a territory of approximately 6,552km^2 (9.4% of Georgia's area). Imereti consists of twelve administrative districts: Kutaisi (the Capital of the region), Tkibuli, Tskaltubo, Chiatura, Baghdati, Vani, Zestaphoni, Terjola, Samtredia, Sachkhere, Kharagauli, Khoni. There are 542 settlements in the region of which: 10 cities (Kutaisi, Tkibuli, Tskaltubo, Chiatura, Baghdati, Vani, Zestaphoni, Terjola, Samtredia, Sachkhere, and Khoni); 3 towns (Shoropani, Kulashi and Kharagauli); and 529 villages.

525. The Project road is located within Zestaphoni Municipality which covers a total area of 423 km^2 and includes the towns of Zestaphoni and Shoropani as well as numerous small villages as illustrated by **Figure 67.** Of its total areas 7,027 ha is occupied by agricultural land plots and 16,500 ha area – by forest.

Figure 67: Towns and Villages of Zestaphoni Municipality



526. The following settlements have been identified within the Project area.

- Kveda Tseva (KM 0)
- Shorapani (KM 4.0 – 6.0)
- Zestaphoni (KM 6.0 – 11.0)

7. [32] Second Regional Development Project, Imereti Regional Development Program, Imereti Tourism Development Strategy. Strategic Environmental, Cultural, Historical and Social Assessment. World Bank, 2014

- Kveda Sakara (KM 11.0 – 12.0)
- Argveta (KM 13.0 – 15.0)

F.4.1.2 Demographics

527. According to the most recent census data (2014), Imereti has a population of 533,906 which is a significant decrease from the 2002 census when the population was recorded as 699,666. The population of Zestaphoni was 58,401 in 2014 of which the majority was classified as rural population (see **Table 58** below).

Table 58: Population of Imereti and its Municipalities

	Total Population	Urban	Rural
Imereti	**533,906**	**258,510**	**275,396**
Kutaisi, City of	147,635	147,635	-
Baghdati Municipality	21,582	3,707	17,875
Vani Municipality	24,512	3,744	20,768
Zestaphoni Municipality	**58,401**	**20,917**	**37,124**
Terjola Municipality	35,563	4,644	30,919
Samtredia Municipality	48,562	27,020	21,542
Sachkhere Municipality	37,775	6,140	31,635
Tkibuli Municipality	20,839	9,770	11,069
Tskaltubo Municipality	56,883	11,281	45,602
Chiatura Municipality	39,884	12,803	27,081
Kharagauli Municipality	19,473	1,965	17,508
Khoni Municipality	23,570	8,987	14,583

528. According to statistics provided by Geostat, there are 12,700 pensioners, 8,200 socially unprotected people and 780 Internally Displaced People (IDPs) registered as living in Zestaphoni.

529. 99.4% of the population of Imereti are Georgians, the remaining 0.6% is made up of Abkhazians (0.1%), Russians (0.3%), Armenians (0.1%) and Osetians (0.1%). [33] There are no ethnic minorities or indigenous people in the project area.

F.4.2 Community Health & Education

F.4.2.1 Health

530. Several medical facilities have been identified in the Project area as listed below.

Table 59: Medical Facilities in the Project Area (within 1 km)

#	Name	Location	Distance from the new alignment (m)
1	Shorapin Medical Faculty	Kveda Ilemi	450

[33] www.geoxtati.ge. 2014

2	Ilmis Medical Faculty	Shorapani	1,000
3	Tskhratskaro Medical Faculty	Zestaphoni	210
4	Geo Hospital's Zestaphoni Outpatient Center	Zestaphoni	340
5	Lower Sector Medical Outpatient	Zestaphoni	10

Figure 68: Lower Sector Medical Outpatient

F.4.2.2 Safety

531. According to data provided by the RD, during the period 2012 – 2016 there were 2,713 collisions, 471 persons killed and 4,913 persons injured spread over the E-60 corridor, from km 18 to km 302 (284 km in total, from Tbilisi to Khobi) with some notable cluster locations. In other words, it means 1 collision every 16 hours, 1 person killed every 4 days and 1 person injured every 9 hours. Focusing the analysis on the Khevi – Argveta section, 351 collisions, 78 persons killed and 648 persons injured. Finally, along the F4 section 130 collisions occurred, with 30 persons killed and 218 persons injured. These data are summarized in **Table 60**, whereas **Table 61** shows the collisions rates in terms of "crashes per km". **Table 62** shows the details of the F4 section.

Table 60: Collisions and Casualties in the Period 2012 – 2016

E-60 Road Section	km	Collisions	Injured	Killed
Tbilisi – Khobi	284	2,713	4,913	471
Khevi – Argveta	50	351	648	78
F4	16	130	218	30

Table 61: Collisions and Casualties Rates in the Period 2012 – 2016 (per km)

E-60 Road Section	km	Collisions	Injured	Killed
Tbilisi – Khobi	284	9.55	17.30	1.66
Khevi – Argveta	50	7.02	12.96	1.56
F4	16	8.13	13.63	1.88

Table 62: Collisions and Casualties in Section F4

Year	Collisions	Injured	Killed
2012	25	43	11
2013	26	40	6
2014	19	38	2
2015	29	49	5
2016	31	48	6

532. As regards the collisions in the section F4, there was a low peak in 2014, but in the last two years the trend is negative. In 2016, 31 collisions occurred in this stretch, that is the highest value observed in the observed period.

533. The figures below summarize collisions by type and cause. The most part of collisions (56%) occurs between 2 or more motor vehicles; 7% of them result in the overturning of a vehicle. 24% of collisions involve pedestrians, thus showing that the protection of vulnerable road users is a major issue in this section. Another relevant category of collisions are those with obstacles (18%). As regards the causes of the crashes, according to data, the main one is defined as "wrong maneuver" (55%). It is interesting to underline that 30% of collisions are caused by dangerous overtaking and 7% by tailgating. These causes are strictly related to the type of cross-section (2 lanes) and the geometry (curvy alignment with few straight sections for safe overtaking).

Figure 69: Collisions by type (section F4, period 2012 – 2016)

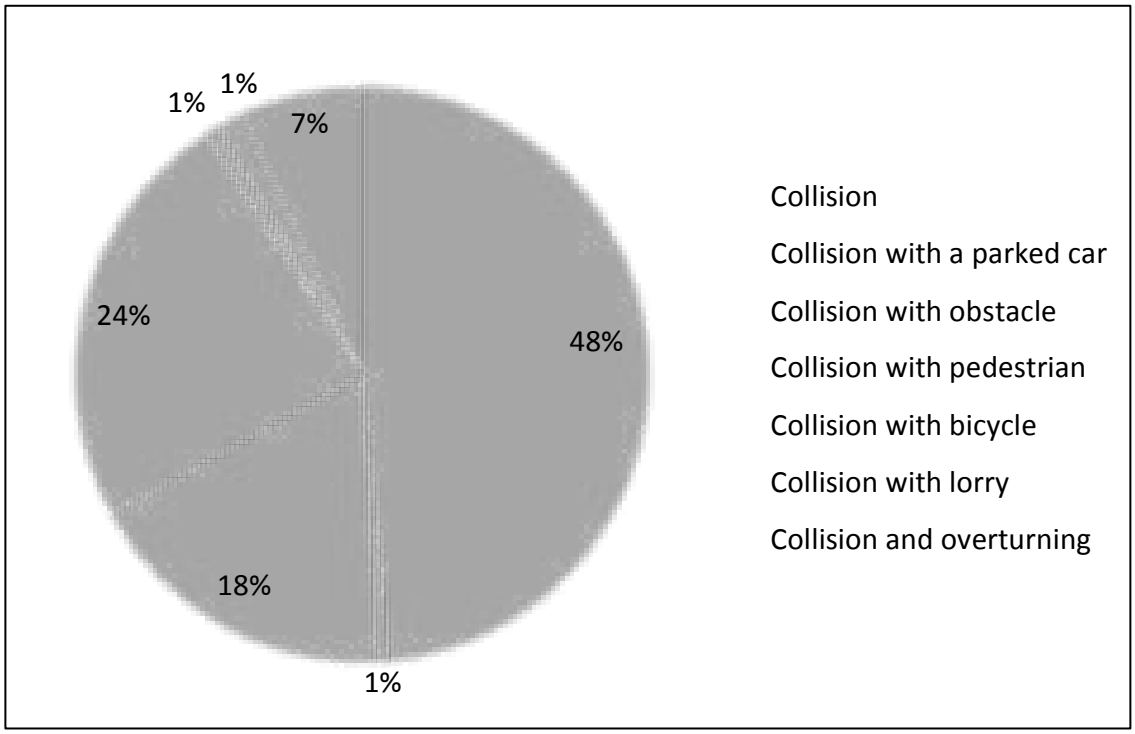
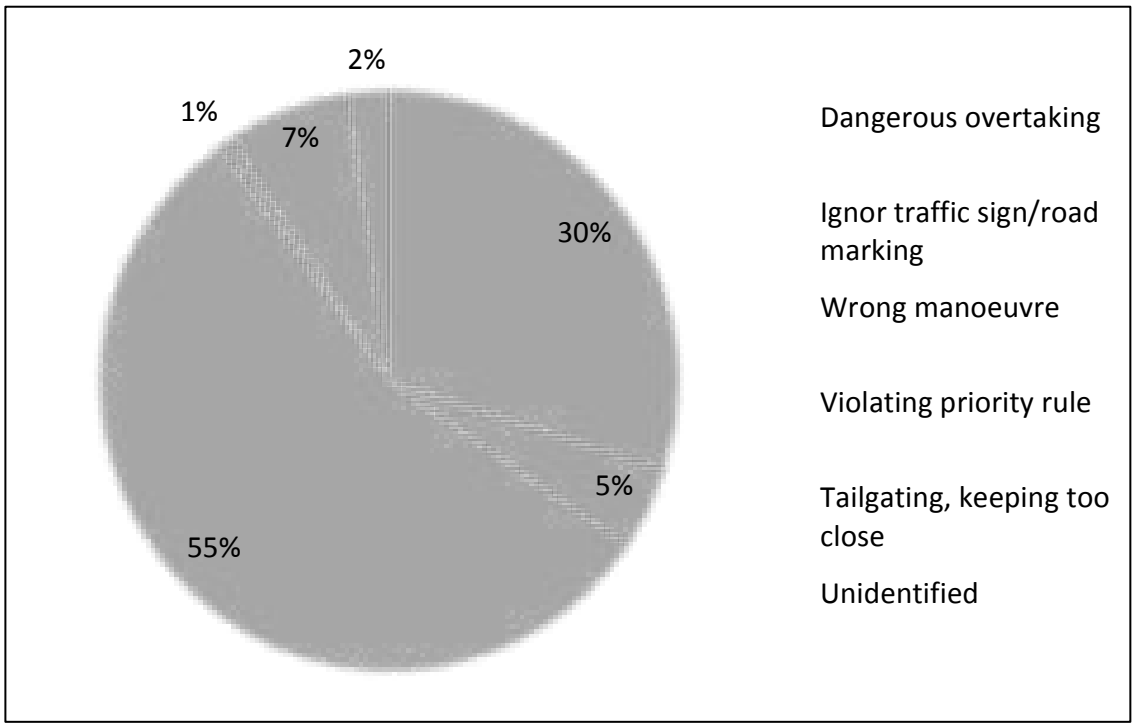


Figure 70: Collisions by cause (section F4, period 2012 – 2016)



E.4.2.3 Education and Educational Facilities

534. There are 33 public schools in Zestaphoni municipality, with 8,700 pupils. The nearest schools to the Project road are listed in the table below.

Table 63: Schools in the Project Area (within 1 km)

#	Name	Location	No. of Pupils	Distance from the new alignment (m)
1	Shoropani School	Shoropani	350	245
2	Public School of Shoropani	Shoropani	250	430
3	LEPL Zestaphoni N1 School	Zestaphoni	811	564
4	LEPL Zestaponi N6 School	Zestaphoni	432	650
5	Public school of Keda Sakare	Keda Sakare	214	1,000

F.4.3 Economy and Employment

535. According to the social survey undertaken for this Project, it is found that the average wage of the population in the target villages is 650 GEL. The majority (70%) interviewed in the social survey stated that the main source of income is wage, 20% of the surveyed families said that main source is pension/allowance, only 5 % said that it is self-employment.

536. According to the survey results on employment status, 34% of surveyed people are employed, almost 22% is unemployed, 11% are housewives, 17% students or pupils and 15% pensioners.

F.4.4 Waste Management

537. Waste management, in compliance with international standards, has been playing an increasingly important role for Georgia after the country signed the Association Agreement with the European Union (EU). Currently solid waste disposal at the landfill is the only form of waste management in Georgia. The situation with regards to domestic and industrial wastewater management is complicated, as in most cases industrial and non-industrial wastewaters are discharged into surface waters without prior treatment.

538. Inert waste, including construction waste, is partially disposed at non-hazardous waste landfills and is used for filling/leveling activities in the construction of infrastructure facilities. There are no management systems for specific waste, including separated collection systems. However, recycling of specific waste, such as tires, batteries, packaging waste, etc., or disposal (such as asbestos waste) does occur in fragmented and uncoordinated way.

539. Presently, 56 landfills are recorded in Georgia. Only four of them, one private and three state-owned landfills, comply with international standards and have an Environmental Impact Assessment (EIA) permit. These are:
- Tbilisi Norio landfill;
- Rustavi landfill;
- Borjomi landfill;
- Privately owned BP landfill.

540. According to the active legislation (Waste Management Code), construction and management of non-hazardous (municipal) landfills (excluding Tbilisi and Adjara Autonomous Republic landfills) is the responsibility of the Waste Management Company of Georgia owned by the Ministry of Regional Development and Infrastructure. The company conducts active measures to improve the conditions of the old/current landfills and construct new regional landfills. As of 2016, the Solid Waste Management Company manages the existing landfills. Twenty of them were closed and 30 of them were improved. The company continues work to construct new regional non-hazardous waste landfills. Tbilservice Group (municipal company established in 2007) manages Tbilisi's landfills.

541. Despite the above, the waste management problem remains very acute. There are still many illegal dumpsites in Georgia. Almost every rural settlement has one or more small dumpsites. They are often located on river banks or near the populated areas, thus posing a threat to human health and the environment.

542. One of the main causes of the above problem is related to the existing waste management system, especially in the rural areas. Specifically, no waste collection and removal services are provided in some of the rural areas, especially in remote villages located far from the municipal centers. Many villages are not equipped with waste containers, which forces local residents to dump their waste in the areas of their choosing. Around 18% of waste generated in the country is dumped into ravines, river banks and other illegal, spontaneously formed, dumpsites near residential areas.

543. Previously there was a landfill site in Zestaphoni adjacent to Kvaliti village. The area of the site was 2.2 hectares and received 15,000 m^3/year of waste. However, the Solid Waste Management Company of Georgia closed the Zestaphoni municipal land fill in 2016 due to the fact that it was overloaded. As such there appears to be no landfill in Zestaphoni anymore.

F.4.5 Physical and Cultural Resources

Regional Context

544. Imereti is an important historical and cultural region of Western Georgia. There are more than 450 historical, archaeological, architectural and natural monuments in the region, which give a full picture of ancient settlements, its cultural development and history. The region is home to 78 Churches, 13 Castles, 39 Archaeological Monuments and 27 Museums.

545. Findings of archaeological excavations show that the first human being in Imereti lived during the lower Palaeolithic period. Numerous flint and obsidian items, including cutting instruments and knives have been discovered in caves and settlements. During the VIII century Kutaisi became the capital of west Georgia and the capital of all Georgia in the X-XII centuries. It was during this period that Imereti had its renaissance. Unique masterpieces of Georgian architecture were created at this time – Bagrati Cathedral and Gelati Monastery Complex (UNESCO heritage site). During the XV century, after the fall of the Georgian feudal monarchy, Imereti became a separate feudal kingdom.

Project Corridor

546. Within the Project corridor the following physical cultural resources have been identified:

- **Shoropani Fortress** - Shoropani fortress is a monument of ancient times and of the Middle Ages. In historical sources, the fortress is mentioned by Strabo (I-BC - I AD), according to whom Shoropani fortress was so enormous that it contained the entire city population. According to Leonti Mroveli (IX century), the original fortress was built by the King Parnavaz I of Kartli in the III century BC. In the VI century, during the battle between Persia and Byzantium, the fortress passed from hand to hand, but it did not lose its strategic importance. The fortress was occupied by the Ottomans in 1730, and was recaptured by the King Solomon I of Imereti in 1770. Since 1983, excavations began here; the nearby territory was completely cleared and the eastern, western and northern parts of the wall became visible. Under the structures, earlier buildings of previous times were discovered. Structures of antiquity covered with flat and curved tiles and Colchis Amphorae were found. Archaeological artifacts from Shorapani fortress and adjacent area are preserved in Janashia National Museum funds. Today, arched support column of the ancient fortress are found. From the fortress to the river Kvirila passes a 60 meter tunnel of the VI century. The tunnel was restored in the late feudal era.

Figure 71: Shoropani Fortress

- **Other Archaeological Sites** – Argveta is also another area of archaeological importance. Artifacts from this area are preserved in the State museum. Archaeological finds were unearthed in 1980 during construction of a house in Argveta. These artifacts (iron axes, iron dagger, arrow heads) are now preserved in Givi Jaoshvili Zestaphoni Ethnographic Museum. According to the register these artifacts belong to early ancient period. The area seems to be an interesting area from archaeological point of view. However the area is remote from the new alignment. Archaeological materials were also found in the Zestaphoni area during construction of the GAA facility and are kept in Zestaphoni Ethnographic Museum. These items include pottery from early ancient to late ancient time. In the same area bronze dagger was found.

Figure 72: : Stonework in Zestaphoni

  Visual surveys of the alignment near the west portal of the passage under the Zestaphoni-Chiatura road detected some stonework which may have some archeological importance. In addition, a mound located 200m north to the plant may be the site of ancient settlement, while in the flatland, between the hill and the plant and old burial may be present. Finds from the area preserved in Zestaphoni museum allow to assume this possibility. Maps indicating the locations of these potential archeological sites are indicated in **Figure 75.**

- **Churches** – Only one church has been identified within the vicinity of the Project road, St Ninos, which is located approximately 300 meters south of the exit to tunnel 6, close to the boundary of the GAA facility. Numerous other churches are dotted around Zestaphoni, and Shorapani, but none of them are close enough to be impacted by the Project. Maps indicating the locations of the churches are indicated in **Figure 75.**

- **Cemeteries** – Only one cemetery has been identified within 250 meters of the Project road. The cemetery is located approximately 50 meters south of tunnel TUN 4.0.06-AT/TA

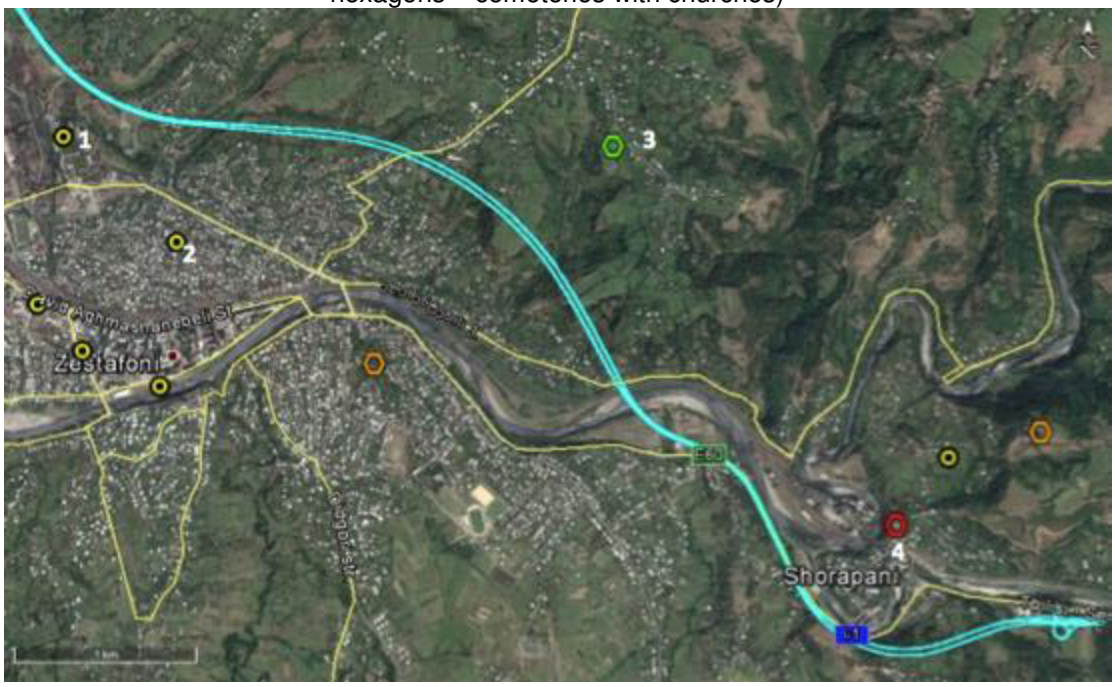
Figure 73: Cemetery close to Tunnel TUN 4.0.06-AT/TA.

- **Other Sites of Potential Cultural Value** – A small natural spring is located around km 10, close to the northern boundary of the GAA facility (see **Figure 74**). Several visitors to this area were noted during site visits.

Figure 74: Natural Spring Adjacent to the GAA Facility (KM 10.1)

Figure 75: Churches, cemeteries and places of worship in the region

(yellow circle- church, red circle – Shorapani fortress, greed hexagons – cemeteries, orange hexagons – cemeteries with churches)



1.St Nino church, approximate distance 260m; 2 – St Nickolas church, approximate distance 650m, 3 – cemetery, approximate distance 630m; 4 – Shorapani fortress , approximate distance 590m

F.4.6 Noise & Vibration

F.4.6.1 General

547. Noise and vibration within the Project corridor can be discussed in two parts, firstly the parts of the corridor that broadly follow the existing alignment, and secondly the part of the corridor that bypass to the north of Zestaphoni, more than 500 meters from the existing road.

548. Noise levels within the first part are predominantly a result of vehicle traffic on the existing road. Very little commercial, residential or industrial activities can be observed in these areas that would give rise to significant noise levels. In the second part of the corridor the alignment traverses a predominantly rural / residential landscape with the exception being the portion of the alignment that passes just to the north of the GAA facility. Noise and vibration monitoring has been undertake in both parts of the road for this EIA to determine baseline noise levels which will be used as part of the noise and vibration model presented later in this report.

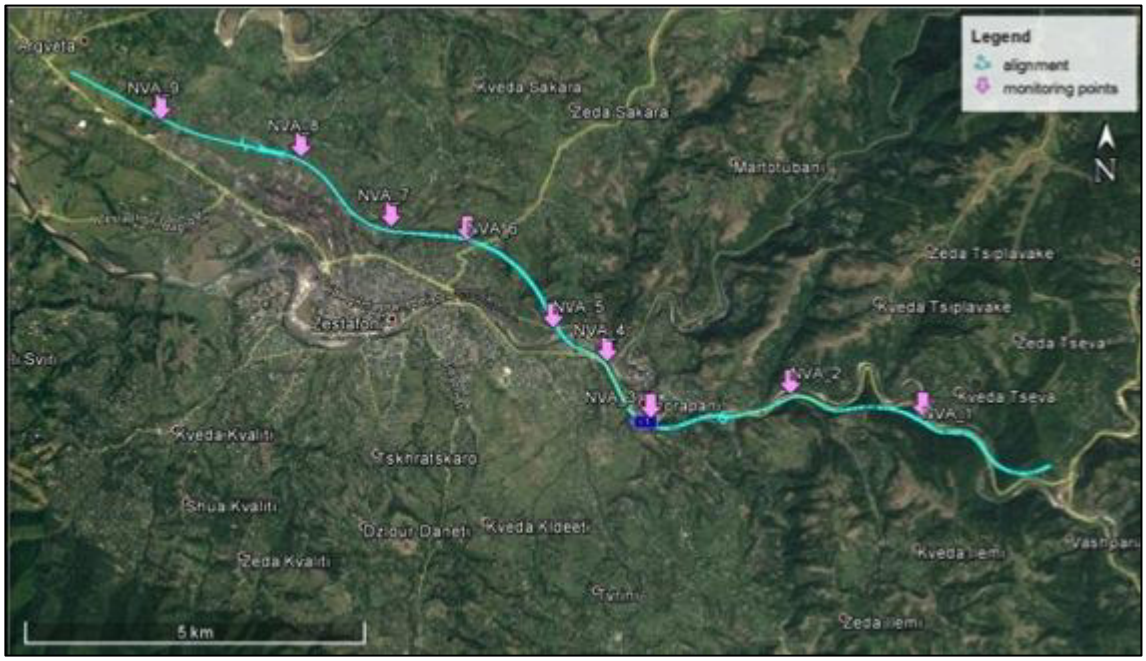
F.4.6.2 Existing Noise & Vibration Levels

549. Baseline noise and vibration monitoring was undertaken in September, 2017 at a nine locations. **Table 64** describes the sample locations and rationale for their selection. The sampling locations are mapped in **Figure 76.**

Table 64: Noise and Vibration Monitoring Locations

Sample ID	Coordinates	Approximate Location	Rationale for Site Selection
N01	42 ° 05'31.75"N / 43° 07'47.68"E	KM0.0	Start of F4, opposite a small cluster of residential properties.
N02	42 ° 05'42.77"N / 43° 06'23.19"E	KM2.2	Adjacent to a roadside restaurant. Site of embankment cutting.
N03	42 ° 05'31.72"N / 43° 04'53.87"E	KM4.3	Shoropani residential area, location of a school and exit of Tunnel 3.
N04	42 ° 05'58.49"N / 43° 04'26.10"E	KM5.5	Adjacent to residential properties.
N05	42 ° 06'14.75"N / 43° 03'51.79"E	KM6.3	At the portal to Tunnel 4.
N06	42 ° 06'56.22"N / 43° 02'57.23"E	KM8.3	Close to the portal to Tunnel 5 adjacent to residential properties.
N07	42 ° 07'02.90"N / 43° 02'08.61"E	KM9.5	Residential area at the portal to Tunnel 6 and at the end of Bridge 4.
N08	42 ° 07'36.01"N / 43° 01'11.19"E	KM11.0	North of the GAA facility and south of a residential cluster.
N09	42 ° 07'54.20"N / 42° 59'41.87"E	KM13.4	Adjacent to a small cluster of residential properties.

Figure 76: Noise and Vibration Monitoring Locations



Vibration Results

550. **Table 65** provides the baseline vibration monitoring results. Vibration values in the control points are currently too low to cause any structural or cosmetic damage and/or cause nuisance of the residents. According to the national standard the values are ranked as weak and non-perceptible.

Table 65: Baseline Vibration Monitoring Results

	Displacement, mm; peak values			Velocity, mm/s; true RMS			Transversal vibration value in dBV	Comment
	Longitudinal X	Transversal Y	Vertical Z	Longitudinal X	Transversal Y	Vertical Z		
NVA-1	**0.001**	**0.051**	0.000	0.000	**0.440**	0.000	78	Edge of the E-60 highway
NVA-2	**0.005**	**0.002**	0.000	0.000	**0.010**	0.000	40	14.9m from the centerline of E-60 highway
NVA-3	0.000	0.000	0.000	0.000	0.000	0.000		Next to internal road in Shoropani
NVA-4	**0.033**	**0.010**	**0.001**	0.000	0.000	0.000		15.2m from the centerline of E-60 highway
NVA-5	0.000	0.000	0.000	0.000	0.000	0.000		Next to the local road
NVA-6	0.000	0.000	0.000	0.000	0.000	0.000		87.5m from the centerline of Gomi-Sachkhere-Chiatura-Zestaphoni road, in about 30m from the street - Zestaphoni
NVA-7	0.000	0.000	0.000	0.000	0.000	0.000		Next to existing internal road – Kvemo Sakara
NVA-8	0.000	0.000	0.000	0.000	0.000	0.000		Next to existing internal road – Kvemo Sakara
NVA-9	0.000	0.000	0.000	0.000	0.000	0.000		Next to existing internal road – Argveta

Note:

Vibration velocity level (Lv) in dB has been defined as follows:
Lv = 20 x log10(V/Vref)
Where:

Lv = velocity level in decibels, mm/s (dBV)
V = RMS velocity amplitude, mm/s
Vref = reference velocity amplitude, mm/s (Vref=0.00005 mm/s. Reference – Order #297/ნ of the Minister of Labour, Health and Social Affairs on Approval of Standards of Quality of the State of Environment, Document ID 470.230.000.11.119.004.920)

Lv = 20 x log10(0.44/0.00005)=20x3.9=78dB (NVA-1)
Lv = 20 x log10 (0.01/0.00005)=20x2=40dB (NVA-2)

Noise monitoring results

551. **Table 66** provides the baseline noise monitoring results. The monitoring results show that noise levels close to the existing road are elevated above IFC daytime and nighttime standards. However, as the Project corridor enters the rural bypass around the north of Zestaphoni noise levels get lower and are within IFC guideline limits for daytime and nighttime noise.

552. Additional 24 hour noise monitoring was undertaken at 5 locations in April and May, 2019 to calibrate the updated noise model. The full results are presented in **Appendix I**.

Table 66: Baseline Noise Monitoring Results

#	Time	Wind speed, m/s	Wind direction	L_{eq}, dBA	L_{min},, dBA	L_{max}, dBA	L_{eq}, dBA	L_{DN}, dBA	L_{DEN}, dBA	L10, dBA	L50, dBA	L90, dBA	National limit (residential), Leq,dBA	IFC/WHO limit (residential), LAeq, dBA	EU limit, Leq, dBA	Comment
NVA-1																
1	12:30 -13:50	1.3	W	65.0	52.3	80.0	72.2	72.3	77.1	50.13	60.3	74.1	55 (Day) 45 (Night)	55 (Day) 45 (Night)	60 (Day) 55 (Evening) 45 (Night)	Edge of the E-60 highway
2	19:30-19:50	1.4	W	78.0	55.0	85.0										
3	01:30 -01:50	1.0	W	47.8	45.0	65.0										
4	06:55–07:15	1.0	W	55.5	50.0	68.0										
NVA-2																
1	13:00-13:20	2.0	SW	68.3	54.0	75.0	62.4	62.6	62.8	46.1	50.3	63.4	55 (Day) 45 (Night)	55 (Day) 45 (Night)	60 (Day) 55 (Evening) 45 (Night)	14.9m from the centerline of E-60 highway
2	18:50-19:10	1.6	SW	52.0	49.0	80.0										
3	01:00 -01:20	1.0	SW	45.0	42.0	65.0										
4	06:50-07:10	1.0	SW	48.5	44.0	68.4										
NVA-3																
1	10:30 -10:50	2,0	SW	49.0	46.0	56.0	54.2	58.4	60.5	48.3	50.0	56.6	55 (Day) 45 (Night)	55 (Day) 45 (Night)	60 (Day) 55 (Evening) 45 (Night)	Next to internal road in Shorapani
2	18:20-18:40	1.6	SW	59.0	54.0	78.0										
3	00:30-00:50	1.2	SW	48.0	46.0	56.0										
4	06:20 -06:40	1,0	SW	51.0	50.0	55.0										
NVA-4																
1	12:00-12:20	2.0	W	76.0	70.0	85.0	73	73.1	73.1	46.62	63.3	76.0	55 (Day) 45 (Night)	55 (Day) 45 (Night)	60 (Day) 55 (Evening) 45 (Night)	15.2m from the centerline of E-60 highway
2	17:50-18:10	1.2	W	76.0	53.0	83.0										
3	24:00-24:20	1,1	W	50.5	48.0	60.0										
4	05:50-06:10	1,0	W	45.0	43.0	55.0										
NVA-5																
1	10:00 -10:20	1.6	NW	57.0	54.0	61.0	72.0	72.0	72.0	43.4	50.7	71.7	55 (Day) 45 (Night)	55 (Day) 45 (Night)	60 (Day) 55 (Evening) 45 (Night)	Next to the local road
2	17:20-17:40	1.2	NW	78.0	55.0	82.0										
3	23:30-23:50	1.1	NW	44.4	40.0	50.0										
4	05:20-06:40	1,0	NW	43.0	41.0	55.0										
NVA-6																
1	09:10-09:30	1.0	SW	32.3	31.7	40.7	33.2	40.0	40.0	31.9	32.2	34.2	55 (Day) 45 (Night)	55 (Day) 45 (Night)	60 (Day) 55 (Evening) 45 (Night)	87.5m from the centerline of Gomi-Sachkhere-Chiatura-Zestaphoni road, in about 30m from the street - Zestaphoni
2	16:40-17:00	1,0	SW	35.0	33.0	40.0										
3	23:10-23:30	1.2	SW	32.0	30.6	38.3										
4	04:10-04:30	1.0	SW	31.9	31.0	47.7										
NVA-7																
1	08:30-08:50	1.5	NW	33.0	29.0	38.0	41.3	47.3	47.3	32.7	39.3	50.1	55 (Day) 45 (Night)	55 (Day) 45 (Night)	60 (Day) 55 (Evening) 45 (Night)	Next to existing internal road – Kvemo Sakara
2	16:10-16:30	1.1	NW	45.4	42.0	50.0										
3	22:50-23:10	1.0	NW	42.0	39.5	46.0										

#	Time	Wind speed, m/s	Wind direction	L_{eq}, dBA	L_{min},, dBA	L_{max}, dBA	L_{eq}, dBA	L_{DN}, dBA	L_{DEN}, dBA	L10, dBA	L50, dBA	L90, dBA	National limit (residential), Leq,dBA	IFC/WHO limit (residential), LAeq, dBA	EU limit, Leq, dBA	Comment
4	04:10-04:30	1.1	NW	32.5	30.0	35.3										
NVA-8																
1	07:30-07:50	2.2	S	42.0	38.0	44.0	43.8	48.0	48.0	35.0	42.0	46.2	55 (Day) 45 (Night)	55 (Day) 45 (Night)	60 (Day) 55 (Evening) 45 (Night)	Next to existing internal road – Kvemo Sakara
2	15:30-15:50	1.1	S	48.0	45.0	55.1										
3	22:30-22:50	1.1	S	42.0	40.0	44.2										
4	03:30-03:50	1.3	S	32.0	30.0	35.0										
NVA-9																
1	07:00-07:20	2.0	SW	39.0	35.0	48.0	44.9	49.7	49.7	35.5	41.5	47. 8	55 (Day) 45 (Night)	55 (Day) 45 (Night)	60 (Day) 55 (Evening) 45 (Night)	Next to existing internal road – Argveta
2	15:00-15:20	1.1	SW	49.4	45.0	55.0										
3	22:10-22:30	1.0	SW	44.0	42.0	52.0										
4	03:00-03:20	1.2	SW	34.0	31.0	38.0										

Note:
Daytime values are marked in red
Orange highlight indicated the sites where registered noise was found to be in allowable limits
L90, L50, L10 – statistical level = level exceeded 90%, 50% 10% of time respectively
L_{eq} - equivalent sound level
L_{DEN} – equivalent sound level/average equivalent level over 24 hr period. 5dBA is added for the interval from 19:00 to 23:00; 10dBA added for the time interval from 23:00 to 07:00
L_{DN}- average equivalent sound level over a 24 hour period, with a penalty added for noise during the nighttime hours of 22:00 to 07:00

G. Environmental Impacts and Mitigation Measures

G.1 Introduction

553. During the initial stage of the EIA process, several potential environmental and social impacts of the project were identified. The baseline surveys were conducted keeping in consideration the potential impacts. In this chapter, the potential environmental and social impacts are evaluated. The impacts have been identified based on consideration of the information presented in previous chapters. To avoid unnecessary repetition of supporting information, cross referencing to previous sections is given where necessary. Following the impact assessment, the mitigation measures related to each impact category is presented.

G.2 Impact Assessment Methodology

554. The general methodology used for impact assessment is described in this section. It describes the process of impact identification and definition, significance rating, the mitigation, management and good practice measures.

G.2.1 Identification of Significant Environmental Aspects

555. The description of each impact will have the following features:

- Definition of the impact using an impact statement identifying the Project activity or activities that causes the impact, the pathway or the environmental parameter that is changed by the activity, and the potential receptors of the impact (aspect-pathway-receptor).
- Description of the sensitivity and importance value of the receiving environment or receptors.
- Extent of change associated with the impact.
- Rating of the significance of the impact.
- Description of appropriate mitigation and management measures and potential effectiveness of the proposed measures.
- Characterization of the level of uncertainty in the impact assessment.
- The significance of an impact is determined based on the product of the consequence of the impact and the probability of its occurrence. The consequence of an impact, in turn, is a function primarily of three impact characteristics:
  - magnitude
  - spatial scale
  - timeframe

556. Magnitude is determined from quantitative or qualitative evaluation of a number of criteria including:

- Sensitivity of existing or reasonably foreseeable future receptors.
- Importance value of existing or reasonably foreseeable future receptors, described using the following:
  - inclusion in government policy.
  - level of public concern.
  - number of receptors affected.

  - intrinsic or perceived value placed on the receiving environment by stakeholders.
  - economic value to stakeholders
- Severity or degree of change to the receptor due to impact, measured qualitatively or quantitatively, and through comparison with relevant thresholds:
  - legal thresholds—established by law or regulation
  - functional thresholds if exceeded, the impacts will disrupt the functioning of an ecosystem sufficiently to destroy resources important to the nation or biosphere irreversibly and/or irretrievably
  - normative thresholds – established by social norms, usually at the local or regional level and often tied to social or economic concerns
  - preference thresholds—preferences for individuals, groups or organizations only, as distinct from society at large
  - reputational thresholds—the level of risk a company is willing to take when approaching or exceeding the above thresholds

557. Spatial scale is another impact characteristic affecting impact consequence. The spatial scale of impacts can range from localized (confined to the proposed Project Site) to extensive (national or international extent). They also may vary depending on the component being considered.

558. The impact timeframe is the third principal impact characteristic defining impact consequence and relates to either its duration or its frequency (when the impact is intermittent). Impact duration can range from relatively short (less than four years) to long (beyond the life of the Project). Frequency ranges from high (more than 10 times a year) to low (less than once a year). These timeframes will need to be established for each Project based on its specific characteristics and those of the surrounding environment.

559. Once the impact consequence is described on the basis of the above impact characteristics, the probability of impact occurrence is factored in to derive the overall impact significance. The probability relates to the likelihood of the impact occurring, not the probability that the source of the impact occurs. For example, a continuous Project activity may have an unlikely probability of impact if there are no receptors within the area influenced by that activity.

560. The reversibility of each impact at the end of construction and operation are important, as these impacts may need on-going management after operation. The reversibility of each impact at the end of construction and operation will be noted and described alongside the three primary characteristics of magnitude, spatial scale and duration.

561. The characteristics are outlined in **Table 67.**

Table 67: Characteristics Used to Describe Impact

Characteristic	Sub-components	Terms Used to Describe the Impact
Type		Positive (a benefit), negative (a cost) or neutral
Nature		Biophysical, social, cultural, health or economic

Characteristic	**Sub-components**	**Terms Used to Describe the Impact**
		Direct, indirect or cumulative or induced
Phase of the Project		Construction, operation, decommissioning or post closure
Magnitude	Sensitivity of Receptor	High, medium or low capacity to accommodate change High, medium or low conservation importance Vulnerable or threatened Rare, common, unique, endemic
	Importance or value of receptor	High, medium or low concern to some or all stakeholders High, medium or low value to some or all stakeholders (for example, for cultural beliefs) Locally, nationally or internationally important Protected by legislation or policy
	Severity or degree of change to the receptor	Gravity or seriousness of the change to the environment Intensity, influence, power or strength of the change Never, occasionally or always exceeds relevant thresholds
Spatial Scale	Area affected by impact - boundaries at local and regional extents will be different for biophysical and social impacts	Area or Volume covered Distribution Local, regional, transboundary or global
Timeframe	Length of time over which an environmental impact occurs or frequency of impact when intermittent	Short term or long term Intermittent (what frequency) or continuous Temporary or permanent Immediate effect (impact experienced immediately after causative project aspect) or delayed effect (effect of the impact is delayed for a period following the causative project aspect)

Characteristic	Sub-components	Terms Used to Describe the Impact
Probability - likelihood or chance an impact will occur		Definite (impact will occur with high likelihood of probability) Possible (impact may occur but could be influenced by either natural or project related factors) Unlikely (impact unlikely unless specific natural or Project related circumstances occur)
Reversibility/Sustainability		Potential for recovery of the endpoint from a negative impact Reversible or irreversible Sustainability for positive impacts
Confidence in impact evaluation (degree of certainty in the significance ascribed to the impact)		Scientific uncertainty – limited understanding of ecosystem (or community) and processes governing change Data uncertainty – restrictions introduced by incomplete or incomparable information, or by insufficient measurement techniques Policy uncertainty – unclear or disputed objectives, standards or guidelines

G.2.2 Impact Significance Rating

562. The impact significance rating process serves two purposes: firstly, it helps to highlight the critical impacts requiring consideration in the approval process; secondly, it serves to show the primary impact characteristics, as defined above, used to evaluate impact significance. The impact significance rating system is presented in **Table 68** and described as follows:

- **Part A**: Define impact consequence using the three primary impact characteristics of magnitude, spatial scale and duration.
- **Part B**: Use the matrix to determine a rating for impact consequence based on the definitions identified in Part A; and
- **Part C**: Use the matrix to determine the impact significance rating, which is a function of the impact consequence rating (from Part B) and the probability of occurrence.

563. Using the matrix, the significance of each described impact is rated.

Table 68: Method for Rating Significance

PART A: DEFINING CONSEQUENCE IN TERMS OF MAGNITUDE, DURATION AND SPATIAL SCALE			
Definition		Criteria	
MAGNITUDE		Negative	Positive
	Major	• Large number of receptors affected • Receptors highly sensitive and/or are of conservation importance • Substantial deterioration, nuisance or harm to receptors expected • Relevant thresholds often exceeded • Significant public concern expressed during stakeholder consultation • Receiving environment has an inherent value to stakeholders	• Large number of receptors affected • Receptors highly amenable to positive change • Receptors likely to experience a big improvement in their situation • Relevant positive thresholds often exceeded
	Moderate	• Some receptors affected • Receptors slightly sensitive and/or of moderate conservation importance • Measurable deterioration, nuisance or harm to receptors • Relevant thresholds occasionally exceeded • Limited public concern expressed during stakeholder consultation • Limited value attached to the environment	• Some receptors affected • Receptors likely to experience some improvement in their situation • Relevant positive thresholds occasionally exceeded
	Minor	• No or limited receptors within the zone of impact • Receptors not sensitive to change • Minor deterioration, nuisance or harm to receptors • Change not measurable or relevant thresholds never exceeded • Stakeholders have not expressed concerns regarding the receiving environment	• No or limited receptors affected • Receptors not sensitive to change • Minor or no improvement in current situation • Change not measurable • Relevant positive thresholds never exceeded No stakeholder comment expected

TIMEFRAME		Duration of Continuous Aspects	Frequency of Intermittent Aspects
	Short term / low frequency	• Less than 4 years from onset of impact	• Occurs less than once a year
	Medium term / medium frequency	• More than 4 years from onset of impact up to end of life of project (approximately 30 years)	• Occurs less than 10 times a year but more than once a year
	Long term / high frequency	• Impact is experienced during and beyond the life of the project (greater than 30 years)	• Occurs more than 10 times a year
SPATIAL SCALE		Biophysical	Socio-economic
	Small	• Within the defined 'area of influence'	• Within the defined 'area of influence'
	Intermediate	• Within the district in which is the facilities are located	• Within the municipality in which the activity occurs
	Extensive	• Beyond the district in which the facilities are located	• Beyond the municipality in which the activity occurs

PART B: DETERMINING CONSEQUENCE RATING

MAGNITUDE	TIMEFRAME	SPATIAL SCALE		
		Small	Intermediate	Extensive
Minor	Short term / low frequency	Low	Low	Medium
	Medium term / medium frequency	Low	Low	Medium
	Long term / high frequency	Medium	Medium	Medium
Moderate	Short term / low frequency	Low	Medium	Medium
	Medium term / medium frequency	Medium	Medium	High
	Long term / high frequency	Medium	High	High
Major	Short term / low frequency	Medium	Medium	High
	Medium term / medium frequency	Medium	Medium	High
	Long term / high frequency	High	High	High

PART C: DETERMINING SIGNIFICANCE RATING

		CONSEQUENCE		
		Low	Medium	High
PROBABILITY (of exposure to impacts)	Definite	Low	Medium	High
	Possible	Low	Medium	High
	Unlikely	Low	Low	Medium

G.3 Mitigation, Management and Good Practice Measures

564. Wherever the Project is likely to result in unacceptable impact on the environment, mitigation measures are proposed (over and above the inherent design measures included in the Project description). In addition, good practice measures may be proposed however these are unlikely to change the impact significance. In the case of positive impacts, management measures are suggested to optimize the benefits to be gained. Where mitigation measures are required the impact will be rated again to show the residual impact after implementation of management controls.

565. The following mitigation hierarchy will be utilized in selecting practical mitigation measures for unacceptable impacts as follows (in order of preference):
- Avoid the impact wherever possible by removing the cause(s).
- Reduce the impact as far as possible by limiting the cause(s).
- Ameliorate the impact by protecting the receptor from the cause(s) of the impact.
- Providing compensatory measures to offset the impact, particularly where an impact is of high significance and none of the above are appropriate.

G.4 Screening of Impacts

566. Based on the impact assessment methodology discussed above, **Table 69** presents the possible impacts of the proposed Project. Each impact is discussed further in this chapter.

Table 69: Impact Screening

Aspect	Phase	Impact	Receptors	No. of Receptors Affected	Sensitivity of Receptors	Level of Public Concern	Risk of Exceeding Legal Threshold	Magnitude	Timeframe	Spatial Scale	Consequence	Probability	Significance
Air Quality	C	Emissions from stationary sources	Nearby communities	L	M	L	M	MOD	H/F	SMALL	MED	DEF	M
	C	Exhaust Emissions from construction vehicles and generators	Nearby communities	M	M	L	M	MOD	H/F	SMALL	MED	DEF	M
	C	Dust from the movement of vehicles, stockpiles, etc.	Nearby communities / Agric. Crops	M	M	M	M	MOD	H/F	SMALL	MED	DEF	M
	O	Vehicle Emissions from traffic using the road.	Nearby communities	M	H	M	M	MOD	LT	SMALL	MED	DEF	M
Climate Change	C	GHG Emissions from road construction.	Global	H	L	L	-	MIN	H/F	EXT	MED	DEF	M
	O	GHG Emissions from vehicle emissions.	Global	H	L	L	-	MIN	LT	EXT	MED	DEF	M
Soils	C	Soil erosion on unstable slopes caused by poor construction works.	Nearby communities / Water bodies	L	M	M	M	MOD	M/F	INTER	MED	POSS	M
	O	Soil erosion caused by poorly designed erosion protection measures, drainage, etc.	Nearby communities / Water bodies	L	M	M	M	MOD	MT	INTER	MED	POSS	M
	C	Contaminated Soil	Nearby	L	H	L	H	MAJ	MT	SMALL	HIGH	POSS	H

Aspect	Phase	Impact	Receptors	No. of Receptors Affected	Sensitivity of Receptors	Level of Public Concern	Risk of Exceeding Legal Threshold	Magnitude	Timeframe	Spatial Scale	Consequence	Probability	Significance
			communities / Water bodies										
	C	Soil contamination via spills and leaks of hazardous liquids from construction camps.	Soil / Water bodies / Ground water	L	M	L	M	MOD	M/F	SMALL	MED	POSS	M
Hydrology	C	Flooding caused by blocking existing drainage structures.	Nearby communities	M	M	M	-	MOD	M/F	SMALL	MED	POSS	M
	O	Flooding caused by poorly designed drainage structures.	Nearby communities	M	M	M	-	MOD	LT	SMALL	MED	POSS	M
	C	Water contamination from construction camps, etc.	Nearby communities / Water bodies	M	M	L	M	MOD	M/F	INTER	MED	POSS	M
	C	Excessive water extraction affecting local water supplies.	Nearby communities / Aquatic wildlife	L	L	L	L	MIN	H/F	SMALL	MED	UNLIKE	L
	O	Ground water supply degraded by new tunnels.	Nearby communities	M	M	L	-	MOD	LT	SMALL	MED	POSS	M
Flora & Fauna	C	Degradation of habitat caused during site clearing.	Terrestrial wildlife	M	H	L	-	MOD	L/F	SMALL	LOW	DEF	L

Aspect	Phase	Impact	Receptors	No. of Receptors Affected	Sensitivity of Receptors	Level of Public Concern	Risk of Exceeding Legal Threshold	Magnitude	Timeframe	Spatial Scale	Consequence	Probability	Significance
	C	Tree cutting.	Terrestrial wildlife	H	H	L	M	MAJ	ST	SMALL	MED	DEF	M
	O	Blocking migration routes of animals.	Terrestrial wildlife	L	H	L	-	MOD	MT	SMALL	MED	UNLIKE	L
Infrastructure and Transport	C	Damage to access roads caused by construction vehicles.	Nearby communities / Road Users	M	L	M	-	MOD	MT	INTER	MED	POSS	M
	C	Traffic delays due to road works.	Nearby communities / Road Users	M	M	M	-	MOD	H/F	SMALL	MED	DEF	M
	C	Limited accessibility to properties as road works block access.	Nearby communities	M	M	L	-	MOD	MT	SMALL	MED	POSS	M
	C	Temporary disruption to utilities while they are removed to make way for construction works.	Nearby communities	M	M	L	-	MOD	MT	SMALL	MED	DEF	M
Land Use	C	Loss of land and property due to the new road.	Nearby communities	H	H	H	-	MAJ	MT	SMALL	MED	DEF	M
	C	Disruption to businesses caused by reduced access to the business.	Nearby communities	M	H	H	-	MAJ	H/F	SMALL	HIGH	POSS	H
	O	Reduced income for businesses no longer	Nearby communities	M	H	H	-	MAJ	MT	SMALL	MED	POSS	M

Aspect	Phase	Impact	Receptors	No. of Receptors Affected	Sensitivity of Receptors	Level of Public Concern	Risk of Exceeding Legal Threshold	Magnitude	Timeframe	Spatial Scale	Consequence	Probability	Significance
		located by the road.											
	O	Induced changes.	Nearby communities	M	M	L	-	MIN	LT	SMALL	MED	UNLIKE	L
Waste	C	Pollution from hazardous waste from construction camps, etc.	Nearby communities / Water bodies	M	M	L	H	MOD	H/F	INTER	HIGH	POSS	H
	C	Pollution from inert waste from construction camps, etc.	Nearby communities / Water bodies	M	M	L	H	MOD	H/F	INTER	HIGH	POSS	H
	C	Tunnel and embankment spoil	Communities /	H	H	H	M	MAJ	ST	INTER	MED	DEF	M
OHS / Community Health and Safety	C	Accidents and injuries during the construction phase.	Communities / Contractors staff	H	H	H	H	MAJ	H/F	INTER	HIGH	POSS	H
	C	STD's contracted and spread by workers.	Nearby communities / Contractors staff	M	H	L	-	MOD	L/F	INTER	MED	POSS	M
Emergencies	C	Fires, explosions, etc, at site.	Nearby communities / Contractors staff	M	H	L	M	MOD	S/T	SMALL	LOW	POSS	L
PCR	C	Damage to PCR caused during construction.	PCR site and its users	M	M	L	-	MOD	H/F	SMALL	MED	POSS	M

Aspect	Phase	Impact	Receptors	No. of Receptors Affected	Sensitivity of Receptors	Level of Public Concern	Risk of Exceeding Legal Threshold	Magnitude	Timeframe	Spatial Scale	Consequence	Probability	Significance
	O	Effects to PCR in terms of elevated noise, dust, etc.	PCR site and its users	M	M	L	-	MOD	MT	SMALL	MED	UNLIKE	L
Noise	C	Elevated noise levels from construction equipment.	Contractors staff / Nearby communities	H	H	L	H	MAJ	H/F	SMALL	HIGH	DEF	H
	O	Elevated noise levels from vehicles using the road.	Nearby communities	H	H	M	H	MAJ	M/T	SMALL	MED	DEF	M
Vibration	C	Damage to properties caused during blasting and piling.	Nearby communities	M	H	M	H	MAJ	M/F	SMALL	MED	POSS	M
	O	Damage to properties from vehicle movement vibration.	Nearby communities	L	H	M	L	MOD	MT	SMALL	MED	UNLIKE	L

Key: H: High / M: Medium / L: Low / MAJ: Major / MOD: Moderate / MIN: Minimum / H/F: High Frequency / M/F: Low Frequency / L/F: Low Frequency / LT: Long term / MT: Medium Term / ST: Short term / MED: Medium / DEF: Definitely / POSS: Possible: / UNLIKE: Unlikely

Aspect	Phase	Impact	Receptors	No. of Receptors Affected	Sensitivity of Receptors	Level of Public Concern	Risk of Exceeding Legal Threshold	Magnitude	Timeframe	Spatial Scale	Consequence	Probability	Significance
Air Quality	C	Emissions from stationary sources	Nearby communities	L	M	L	M	MOD	H/F	SMALL	MED	DEF	M
	C	Exhaust Emissions from construction vehicles and generators	Nearby communities	M	M	L	M	MOD	H/F	SMALL	MED	DEF	M
	C	Dust from the movement of vehicles, stockpiles, etc.	Nearby communities / Agric. Crops	M	M	M	M	MOD	H/F	SMALL	MED	DEF	M
	O	Vehicle Emissions from traffic using the road.	Nearby communities	M	H	M	M	MOD	LT	SMALL	MED	DEF	M
Climate Change	C	GHG Emissions from road construction.	Global	H	L	L	-	MIN	H/F	EXT	MED	DEF	M
	O	GHG Emissions from vehicle emissions.	Global	H	L	L	-	MIN	LT	EXT	MED	DEF	M
Soils	C	Soil erosion on unstable slopes caused by poor construction works.	Nearby communities / Water bodies	L	M	M	M	MOD	M/F	INTER	MED	POSS	M
	O	Soil erosion caused by poorly designed erosion protection measures, drainage, etc.	Nearby communities / Water bodies	L	M	M	M	MOD	MT	INTER	MED	POSS	M
	C	Soil contamination via spills and leaks of hazardous liquids from construction camps.	Soil / Water bodies / Ground water	L	M	L	M	MOD	M/F	SMALL	MED	POSS	M

Hydrology	C	Flooding caused by blocking existing drainage structures.	Nearby communities	M	M	M	-	MOD	M/F	SMALL	MED	POSS	M
	O	Flooding caused by poorly designed drainage structures.	Nearby communities	M	M	M	-	MOD	LT	SMALL	MED	POSS	M
	C	Water contamination from construction camps, etc.	Nearby communities / Water bodies	M	M	L	M	MOD	M/F	INTER	MED	POSS	M
	C	Excessive water extraction affecting local water supplies.	Nearby communities / Aquatic wildlife	L	L	L	L	MIN	H/F	SMALL	MED	UNLIKE	L
	O	Ground water supply degraded by new tunnels.	Nearby communities	M	M	L	-	MOD	LT	SMALL	MED	POSS	M
Flora & Fauna	C	Degradation of habitat caused during site clearing.	Terrestrial wildlife	M	H	L	-	MOD	L/F	SMALL	LOW	DEF	L
	C	Tree cutting.	Terrestrial wildlife	H	H	L	M	MAJ	ST	SMALL	MED	DEF	M
	O	Blocking migration routes of animals.	Terrestrial wildlife	L	H	L	-	MOD	MT	SMALL	MED	UNLIKE	L
Infrastructure and Transport	C	Damage to access roads caused by construction vehicles.	Nearby communities / Road Users	M	L	M	-	MOD	MT	INTER	MED	POSS	M
	C	Traffic delays due to road works.	Nearby communities / Road Users	M	M	M	-	MOD	H/F	SMALL	MED	DEF	M
	C	Limited accessibility to properties as road works block access.	Nearby communities	M	M	L	-	MOD	MT	SMALL	MED	POSS	M
	C	Temporary disruption to utilities while they are removed to make way for construction works.	Nearby communities	M	M	L	-	MOD	MT	SMALL	MED	DEF	M

Land Use	C	Loss of land and property due to the new road.	Nearby communities	H	H	H	-	MAJ	MT	SMALL	MED	DEF	M
	C	Disruption to businesses caused by reduced access to the business.	Nearby communities	M	H	H	-	MAJ	H/F	SMALL	HIGH	POSS	H
	O	Reduced income for businesses no longer located by the road.	Nearby communities	M	H	H	-	MAJ	MT	SMALL	MED	POSS	M
	O	Induced changes.	Nearby communities	M	M	L	-	MIN	LT	SMALL	MED	UNLIKE	L
Waste	C	Pollution from hazardous waste from construction camps, etc.	Nearby communities / Water bodies	M	M	L	H	MOD	H/F	INTER	HIGH	POSS	H
	C	Pollution from inert waste from construction camps, etc.	Nearby communities / Water bodies	M	M	L	H	MOD	H/F	INTER	HIGH	POSS	H
	C	Tunnel and embankment spoil	Communities /	H	H	H	M	MAJ	ST	INTER	MED	DEF	M
OHS / Community Health and Safety	C	Accidents and injuries during the construction phase.	Communities / Contractors staff	H	H	H	H	MAJ	H/F	INTER	HIGH	POSS	H
	C	STD's contracted and spread by workers.	Nearby communities / Contractors staff	M	H	L	-	MOD	L/F	INTER	MED	POSS	M
Emergencies	C	Fires, explosions, etc, at site.	Nearby communities / Contractors staff	M	H	L	M	MOD	S/T	SMALL	LOW	POSS	L
PCR	C	Damage to PCR caused during construction.	PCR site and its users	M	M	L	-	MOD	H/F	SMALL	MED	POSS	M
	O	Effects to PCR in terms of elevated noise, dust, etc.	PCR site and its users	M	M	L	-	MOD	MT	SMALL	MED	UNLIKE	L
Noise	C	Elevated noise levels	Contractors	H	H	L	H	MAJ	H/F	SMALL	HIGH	DEF	H

		from construction equipment.	staff / Nearby communities										
	O	Elevated noise levels from vehicles using the road.	Nearby communities	H	H	M	H	MAJ	M/T	SMALL	MED	DEF	M
Vibration	C	Damage to properties caused during blasting and piling.	Nearby communities	M	H	M	H	MAJ	M/F	SMALL	MED	POSS	M
	O	Damage to properties from vehicle movement vibration.	Nearby communities	L	H	M	L	MOD	MT	SMALL	MED	UNLIKE	L

Key: H: High / M: Medium / L: Low / MAJ: Major / MOD: Moderate / MIN: Minimum / H/F: High Frequency / M/F: Low Frequency / L/F: Low Frequency / LT: Long term / MT: Medium Term / ST: Short term / MED: Medium / DEF: Definitely / POSS: Possible: / UNLIKE: Unlikely

G.5 Physical Resources

G.5.1 Air quality

Potential Air Quality Impacts

567. The potential impacts of the Project to air quality are described as follows:

Design and Pre-construction Phase

568. The road rehabilitation works are generally intermittent and not permanent in a specific site, the works move along the Project road as work progresses and as such air quality impacts will be short term in specific locations. However, fugitive emissions will be emitted on a longer-term basis from stationary sources such as quarries and asphalt plants. These sites can however be selected prior to construction and be placed in an area where it can cause the least impact on human and ecologic receptors.

Construction Phase

569. During construction, air quality is likely to be degraded by a range of operational activities including:

- Exhaust emissions from the operation of construction machinery (e.g. Nitrogen Oxides (NO_X), Sulfur Oxides (SO_X) and Carbon Monoxide (CO));
- Open burning of waste materials; and
- Dust generated from quarries haul roads, unpaved roads, exposed soils and material stock-piles.

570. Dust is the major air quality problem from construction sites. Dust is a problem for a variety of reasons, as outlined below:

- Inconvenience to local people. For example, people may have to re-wash laundry that has been put outdoors to dry, and wash windows, curtains and vehicles. Dust can contaminate meat hanging up in open-air butchers and other food that is exposed to it in homes, shops and open-air restaurants, giving food a gritty texture.
- Health and safety problems. Dust may affect health by irritating eyes and worsening the health of people with asthma. Dust can reduce visibility for drivers on roads. It can also be blown for long distances by the wind.
- Crop damage. Even low concentrations of dust can affect plant and fruit growth as far away as one kilometer from a construction site. Plant growth is particularly susceptible to dusts that are highly alkaline, for example limestone and cement dust. Dust deposited during light rainfall can cause the soil surface to form a crust increasing run-off.
- Impact on ecology. Dust blowing onto watercourses may damage ecology by increasing sedimentation, reducing sunlight and suffocating fish. It may also affect plant growth and change the species of plants growing in an area. Dust may also damage trees and other vegetation planted as part of the construction contract.
- Damage to plant and equipment. Within the construction site, dust can cause mechanical or electrical problems in sensitive equipment such as computers. It can also increase abrasion of moving parts in equipment and clogging of air filters.

Operational Phase

571. The main source of air pollution during the operational phase will be vehicles moving on the highway. The main pollutants are: CO; NO_X; hydrocarbons (HC); SO_2; carbon dioxide (CO_2); and particulate matter (PM). These compounds can damage health and/or the environment. The concentration of pollutants generated by vehicles depends on factors such as the number, type and speed of vehicles. The effect of air pollution on local people depends on the distance between them and the road, wind direction, topography and other factors. The main direct effects are in the area closest to the road as the rapid dispersion and dilution of exhaust gases quickly reduces their concentrations to levels at which risks are minimal.

572. The impacts associated with air quality in the operational phase of the Project have been assessed using an air dispersion model. The findings of which are presented below.

Time frame of the model

573. The modelling has been developed for each of the below scenarios:
- Scenario year 2019
- Scenario year 2034.

574. The number of vehicles has been divided in 24 hours according to the provided traffic flow; the results of the modelling will be represented into values of concentration/time (hourly levels) for the considered pollutants in correspondence of the selected receptors.

Spatial domain and receptors

575. The model takes into consideration an area by far larger than the road strips and has been enlarged according to the morphology, the distribution of settlements and potential receptors for a total of about 20 square kilometres. The domain is a rectangle having dimensions of 6 km x 3.5 km; calculations have been carried out on the basis of progressive advancements for the road. Six main receptors have been inserted in group of three at the north and south of the road. They have been used for the considerations in terms of respect or excess of allowable limits.

Results

576. The results of the modelling are organized as follows:
- Scenario 2019 (probable start of road service).
- Scenario 2034.

577. The values of the concentration of pollutants are calculated in correspondence of the six selected receptors. The average yearly values and the values considered of reference by the present-day legislation are put into evidence together to verify the threshold of acceptability. It must be put into evidence that the values only refer to the traffic in the new road, and do not consider any other external source.

Table 70: Average yearly contribution of the road traffic to the background (concentration / µg/m^3)

Receptors	PM10	PM2.5	NO_2	NO_X	CO	SO_2	C6H6
Receptor 1 North	0.315	0.236	7.393	14.706	2.314	0.005	0.01
Receptor 2 North	0.156	0.113	3.171	6.553	1.072	0.002	0.005
Receptor 3 North	0.088	0.062	1.730	3.491	0.563	0.001	0.002
Receptor 1 South	0.617	0.469	9.215	23.806	4.666	0.01	0.021
Receptor 2 South	0.236	0.174	3.173	8.419	1.688	0.004	0.007
Receptor 3 South	0.164	0.119	2.094	5.584	1.128	0.002	0.005

578. The above values represent the contribution of the traffic to the background values in the year 2019 when the road is expected to enter in full service. With reference to the PM_{10} it can be assumed with high confidence a background value of 17 µg/m^3 in is in accordance with the field measurements carried in September 2017.

Scenario for the interval years 2019 to 2034

579. The following estimations have been calculated according to **Table 70**, which reports the estimated increments/year of the average monthly concentration for the expected traffic increments. When background values are available, they are considered into the calculations.

580. The average resulting values are presented in the below **Table 71** and **Table 72** which shows the increments, the background and the final expect values.

Table 71: - PM_{10} (µg/m^3) Comparison of expected values at 2019, background and limits

Receptor	Δ estimated yearly increment (aver.) PM_{10}	Background level	Total	Limits (year)
Receptor 1 North	0,315	17	17.315	40.0
Receptor 2 North	0,156	17	17.156	40.0
Receptor 3 North	0,088	17	17.088	40.0
Receptor 1 South	0,617	17	17.617	40.0
Receptor 2 South	0,236	17	17.236	40.0
Receptor 3 South	0,164	17	17.164	40.0

581. The data analysis confirms that the emission of PM_{10} generated by the traffic, at 2019, is very limited and even taking into account the background levels will not exceed the allowable limits. It must be taken into account that the largest part of the traffic generating the background will be diverted into the new road, for that the above scenario has to be considered very conservative.

Table 72: - NO_2 (µg/m^3) Comparison of expected values at 2019, background and limits

Receptor	yearly estimated Δ (average increment) NO_2	Background level	Total	Limits (in one year)
Receptor 1 North	7.393	-	7.393	40
Receptor 2 North	3.171	-	3.171	40
Receptor 3 North	1.730	-	1.730	40
Receptor 1 South	9.215	-	9.215	40
Receptor 2 South	3.173	-	3.173	40
Receptor 3 South	2.094	-	2.094	40

582. The impact of the NO_2 emissions can only be perceived in the proximity of the road; there are no background data available.

583. The application of increment of emissions determined by the expected increase of traffic, permitted to develop the following tables (**Table 73, Table 74, Table 75** and **Table 76**) where the yearly increment of pollution for the considered pollutants is put into evidence. This data is also mapped in **Figure 77** to **Figure 88.**

Table 73: General scenario at 2034 for PM_{10}, NO_X and NO_2

Receptors	PM_{10}	$PM_{2.5}$	NO_2	NO_X	CO	SO_2	C6H6
Receptor 1 North	0.442	0.332	7.850	17.745	3.267	0.007	0.014
Receptor 2 North	0.220	0.160	3.417	8.019	1.528	0.003	0.007
Receptor 3 North	0.125	0.088	1.879	4.276	0.813	0.002	0.004
Receptor 1 South	0.872	0.663	10.299	29.579	6.612	0.015	0.029
Receptor 2 South	0.337	0.250	3.631	10.609	2.424	0.005	0.011
Receptor 3 South	0.235	0.171	2.429	7.103	1.635	0.004	0.007

Table 74: Yearly scenario 2019 to 2034 for PM_{10} (including background at 2019)

year	**Receptor** 1 North	**Receptor** 2 North	**Receptor** 3 North	**Receptor** 1 South	**Receptor** 2 South	**Receptor** 3 South
2019	17.32	17.16	17.09	17.62	17.24	17.16
2034	17.44	17.22	17.12	17.87	17.34	17.24

Table 75: Yearly scenario 2019 to 2034 for NO_2 (No background)

year	**Receptor** 1 North	**Receptor** 2 North	**Receptor** 3 North	**Receptor** 1 South	**Receptor** 2 South	**Receptor** 3 South
2019	7.39	3.17	1.73	9.21	3.17	2.09
2034	7.85	3.42	1.88	10.30	3.63	2.43

Table 76: Yearly scenario 2019 to 2034 for CO (No background)

year	**Receptor** 1 North	**Receptor** 2 North	**Receptor** 3 North	**Receptor** 1 South	**Receptor** 2 South	**Receptor** 3 South
2019	2.31	1.07	0.56	4.67	1.69	1.13
2034	3.27	1.53	0.81	6.61	2.42	1.63

584. The analysis of the impact on operational phase air quality determined by the traffic on the new road suggests that there are no negative impacts on the environment. In addition to the fact that the maximum allowable limits are not surpassed, it must be taken into account that the road provides benefits in term of vehicular emission due to the smoother drive and optimized alignment.

585. The emissions of vehicles on a highway are lower than vehicles driving a urban type road as the existing one where the frequent bends, inclination and traffic congestions do not allow a fluid drive. If a similar traffic flow should transit via the existing road, the emissions would be almost 20% higher.

Figure 77: PM10, 2019 (Km 0 – Km 8)

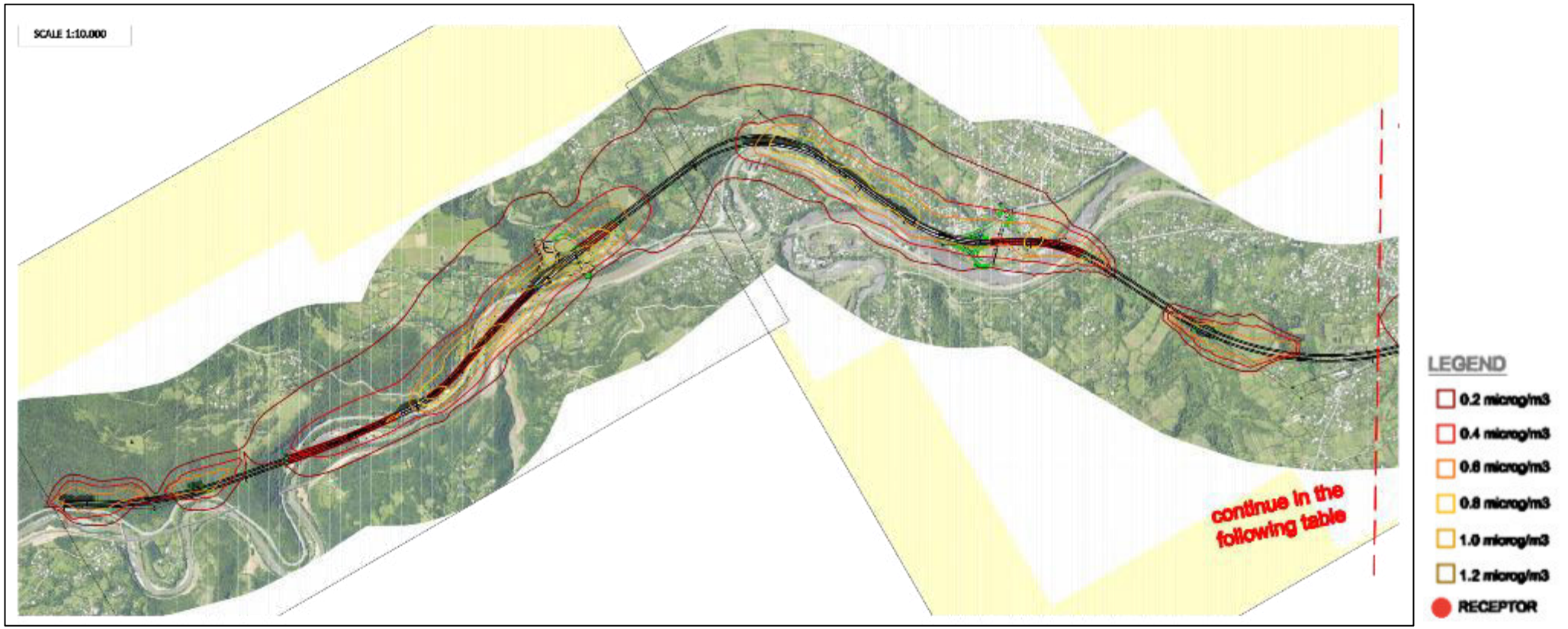


Figure 78: PM10, 2034 (Km 0 – Km 8)

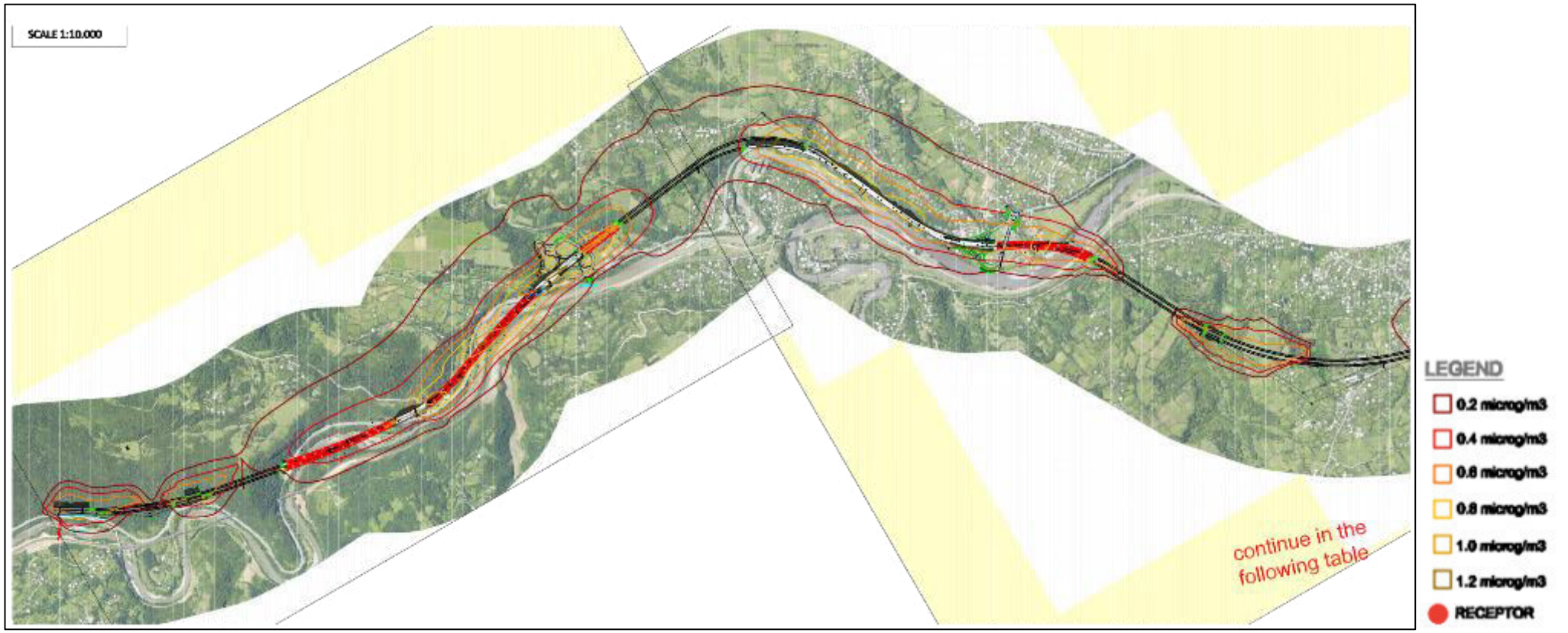


Figure 79: PM10, 2019 (Km 8 – Km 14.7)

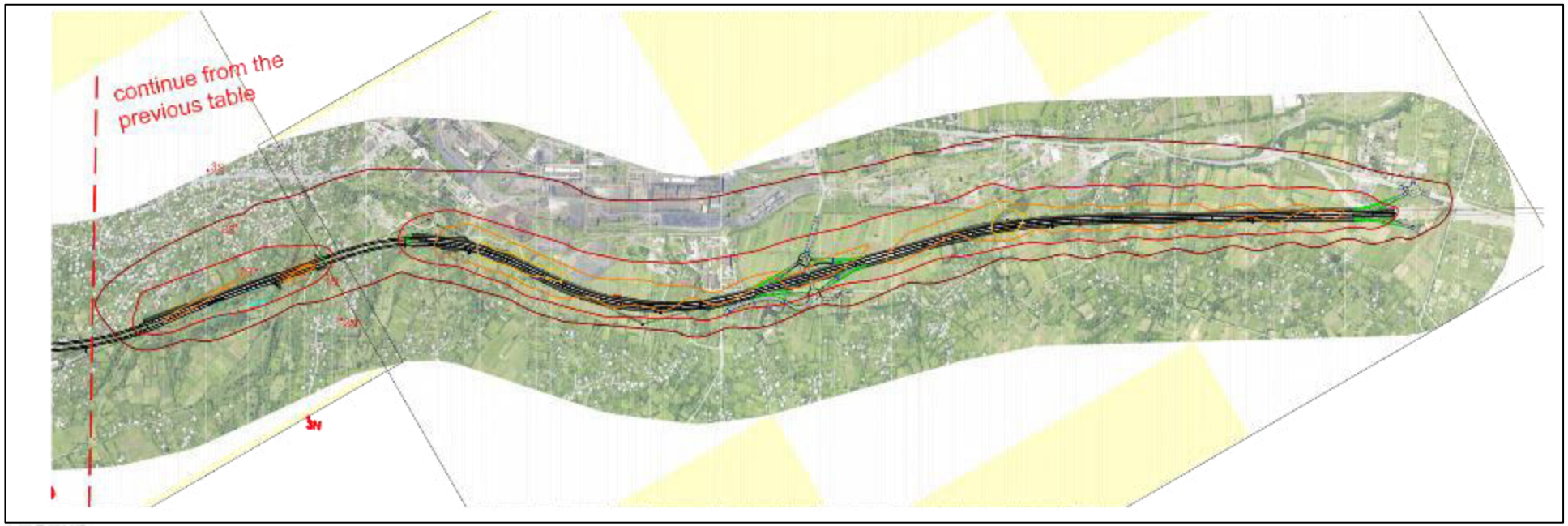


Figure 80: PM10, 2034 (Km 8 – Km 14.7)

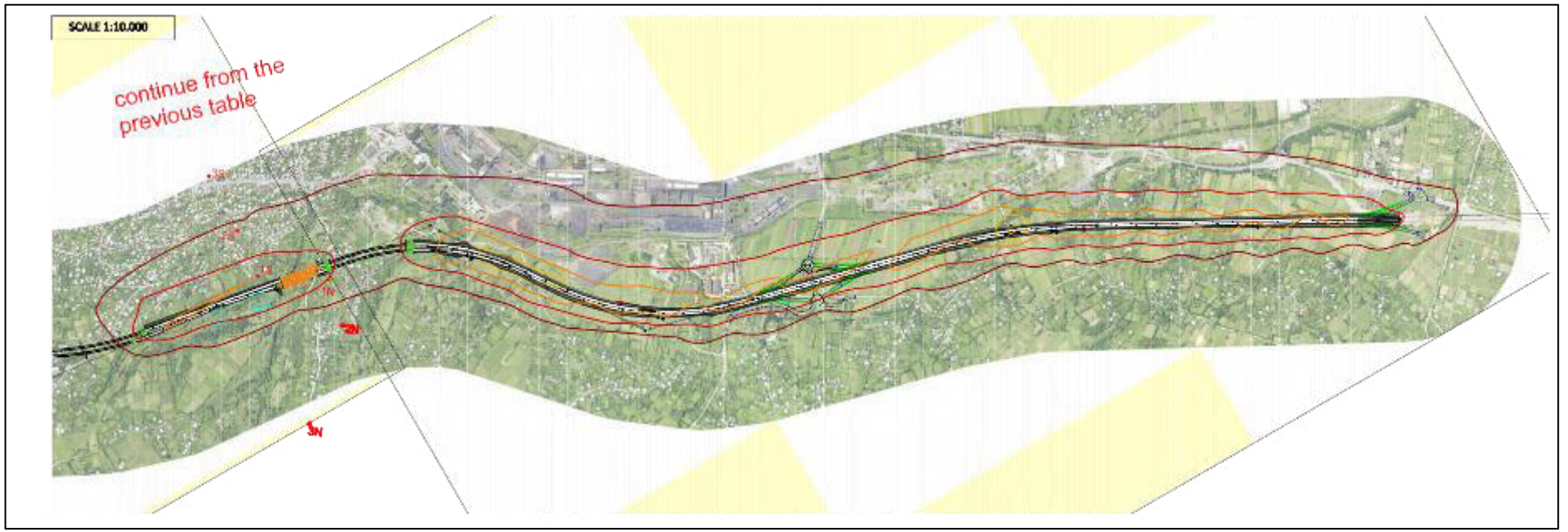


Figure 81: NO2, 2019 (Km 0 – Km 8)

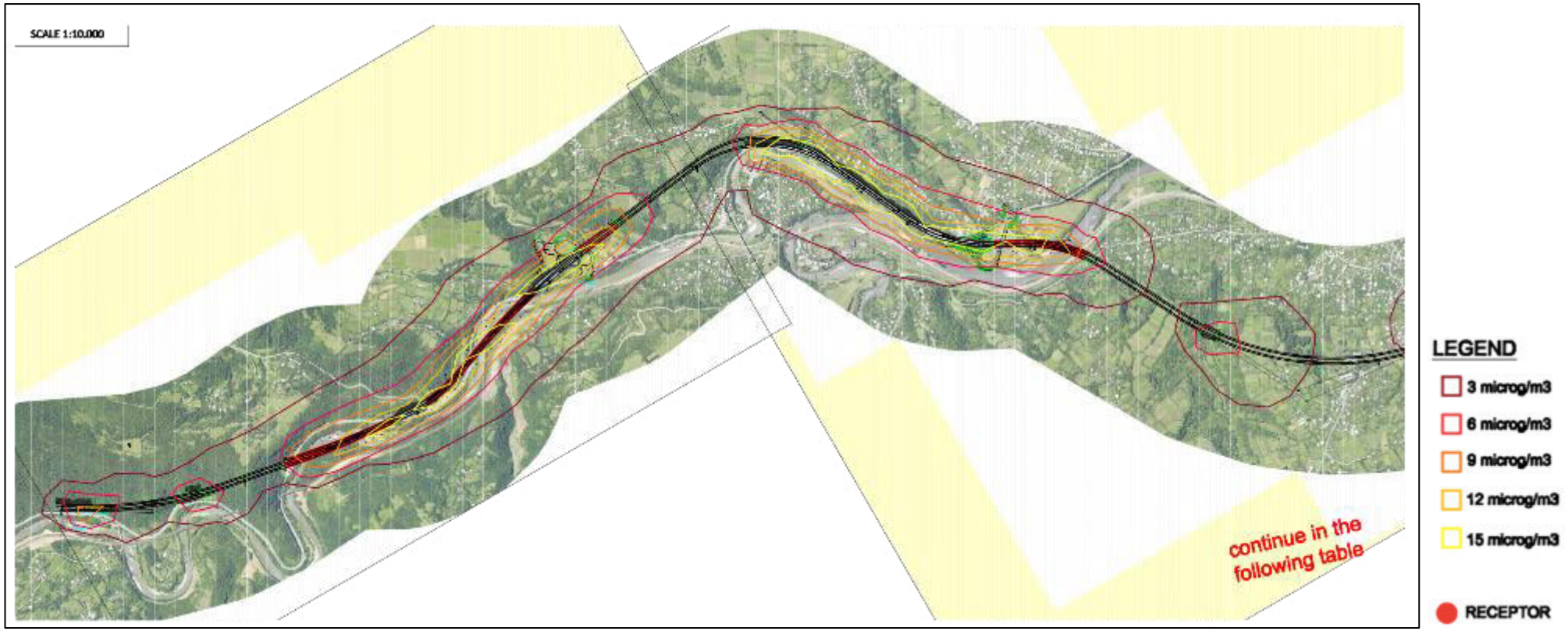


Figure 82: NO2, 2034 (Km 0 – Km 8)

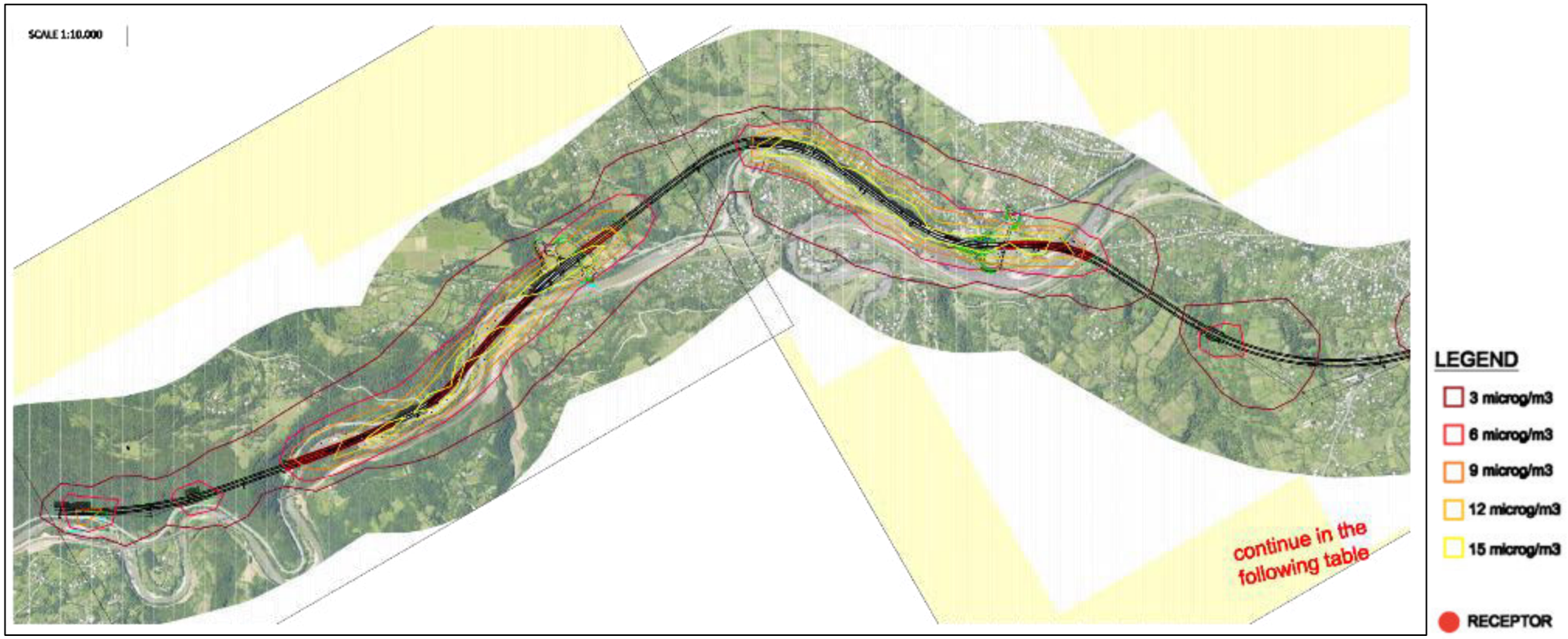


Figure 83: NO2, 2019 (Km 8 – Km 14.7)

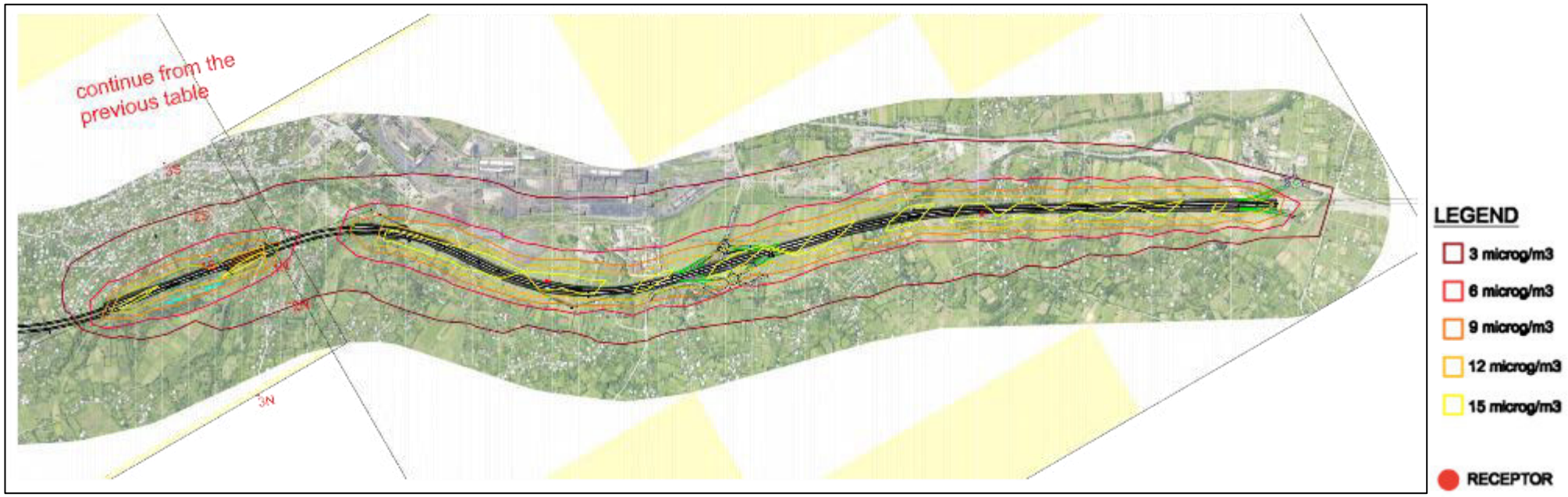


Figure 84: NO2, 2034 (Km 8 – Km 14.7)

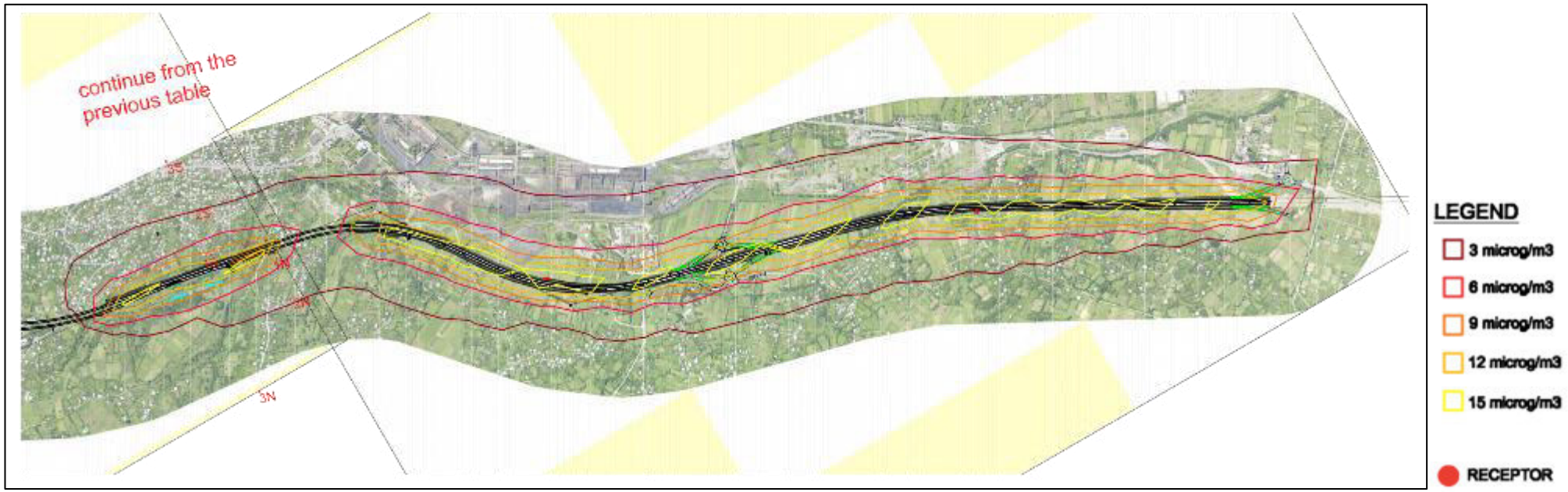


Figure 85: CO, 2019 (Km 0 – Km 8)

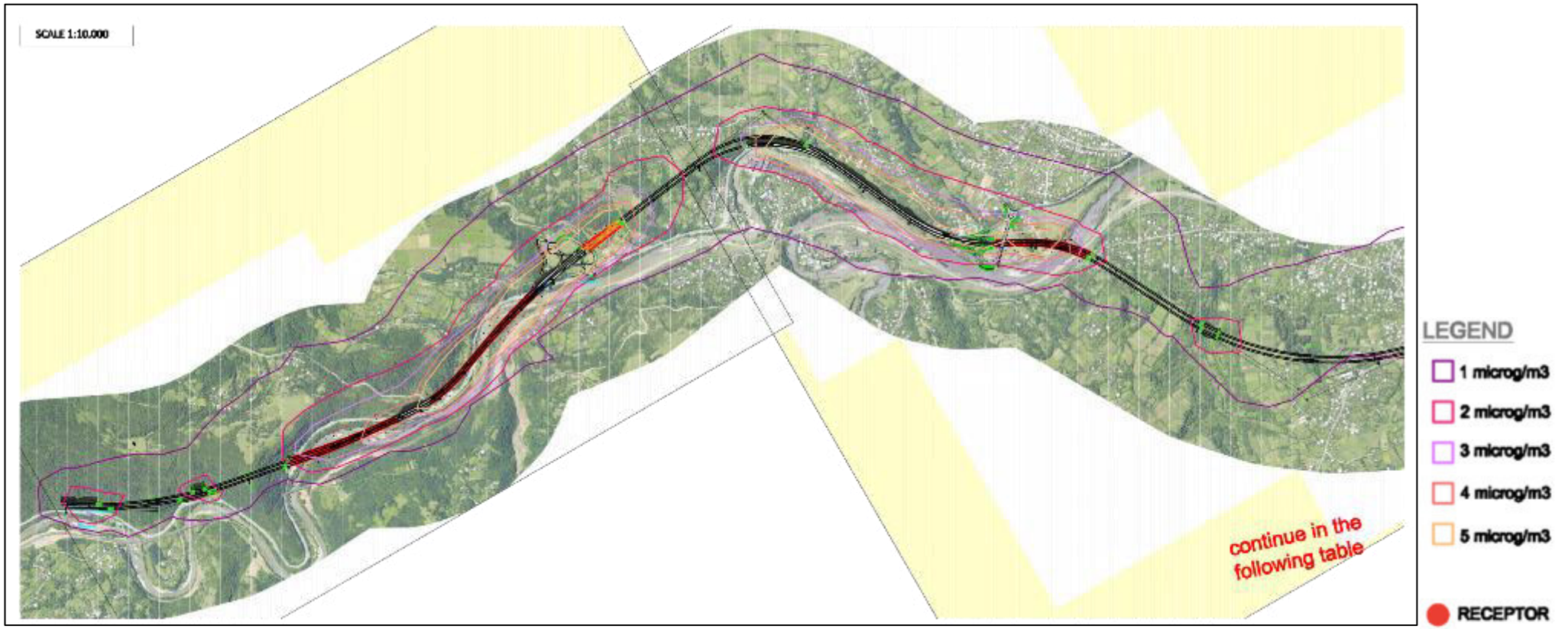


Figure 86: CO, 2034 (Km 0 – Km 8)

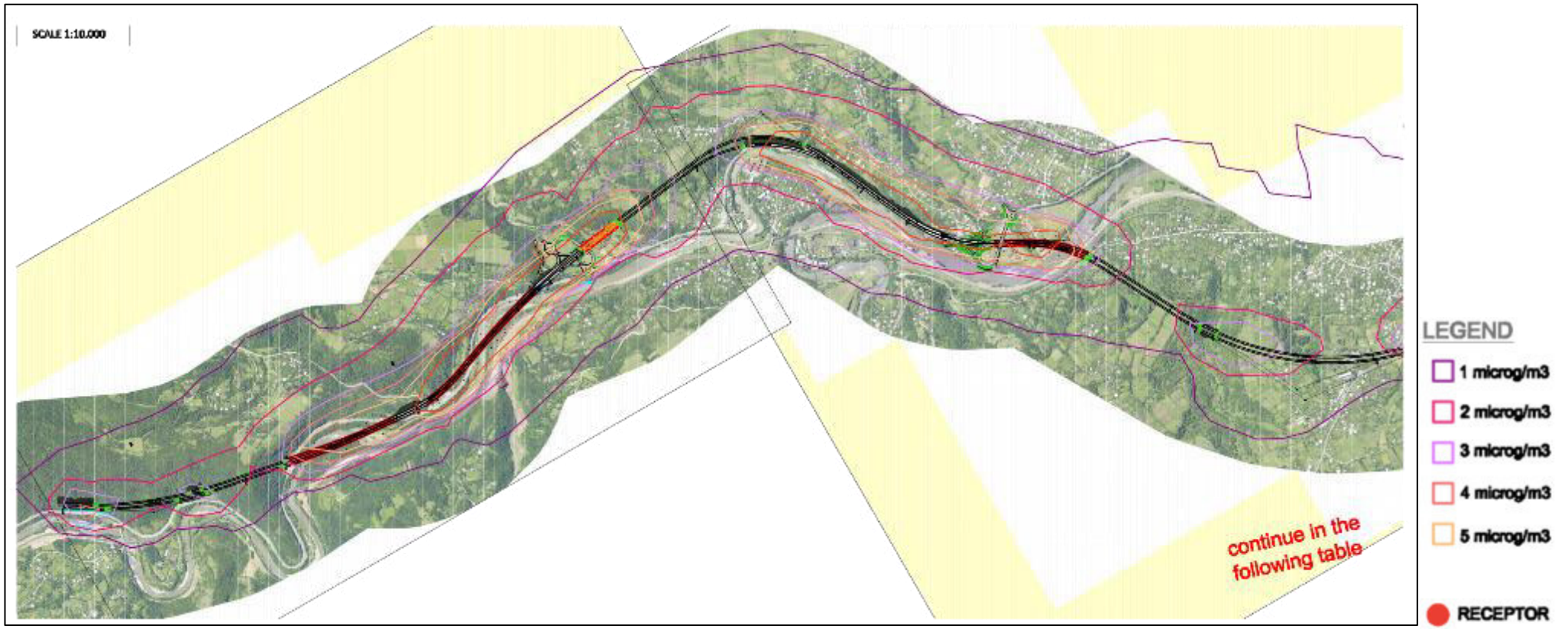
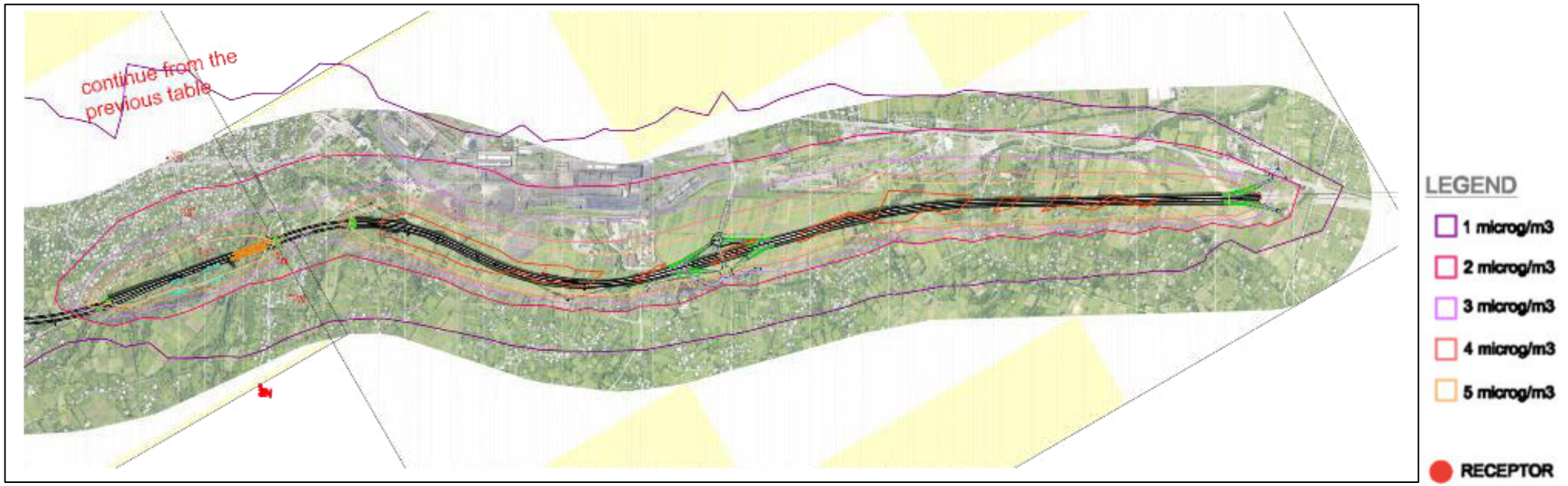


Figure 87: CO, 2019 (Km 8 – Km 14.7)

Figure 88: CO, 2034 (Km 8 – Km 14.7)



586. The new road will have a positive impact on the air quality in term of reduced emissions compared to a similar flow of traffic along the existing one; it can also be pointed out that no air quality limits will be exceeded even considering that the composition of the fleet of vehicles is maintained. The higher values are recorded to the south of the road due to the main wind directions and morphology, these values are anyhow lower than the limits.

587. In addition, it is reasonable to consider that in the next years a large part of the obsolete and aging vehicles now in circulation will be substituted by less polluting ones with additional benefits to air quality.

Mitigation and Management Actions

Pre-construction Phase

588. Locations for crushing facilities, concrete batching yards and asphalt plants will require approval from the Engineer, MoEPA and the RD during the Pre-construction phase. Efforts will be made to ensure that these facilities are as near to the Project road as practical to avoid unnecessary journeys and potential dust issues from vehicle movements during construction works on unpaved roads in urban areas. Haul routes will be prepared and submitted to the Engineer as part of his Traffic Management Plan (TMP).

589. To prevent impacts arising from asphalt plants, construction camps, batching plants and rock crushing plants, they will be prohibited within 500 meters of any urban area or sensitive receptor (school, hospital, etc). The locations of these facilities will be indicated within the Contractors SEMP. Baseline air quality monitoring will also be undertaken by the Contractor during the pre-construction phase as described below under the recommended monitoring.

590. To adequately manage air quality impacts the Contractor will be responsible for the preparation of an Air Quality Plan, submitted to the Engineer as part of the SEMP. The plan will detail the actions to be taken to minimize dust generation (e.g. spraying un-surfaced roads with water (including the types of equipment, sources of water, locations for watering and schedule), covering stock-piles, etc) and will identify the type, age and standard of equipment to be used and will also provide details of the air quality monitoring program for baseline and routine monitoring. The Plan will also include contingencies for the accidental release of toxic air pollutants.

Construction Phase

591. The Contractor will be responsible, through compliance with this EMP and his SEMP, for the following;

(i) Exhaust emissions - No furnaces, boilers or other similar plant or equipment using any fuel that may produce air pollutants will be installed without prior written consent of the Engineer. Construction equipment will be maintained to a good standard and fitted with pollution control devices regularly monitored by the Contractor and Engineer.

(ii) Open burning of waste materials - No burning of debris or other materials will occur on the Site.

(iii) Dust generated from haul roads, unpaved roads, material stock piles, etc: