Roads Department,
Ministry of Regional Development
and Infrastructure (RDMRDI)

Preparatory Survey for East-West Highway (E-60) Development Project (Phase 2) in Georgia

Final Report

Disclosure Document

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JAPAN INTERNATIONAL COOPERATION AGENCY

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Oriental Consultants Global Co., Ltd.

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< Tables on chapters 7 and 9 have been removed because of confidential information.>

Abbreviations

AADT	Average Annual Daily Traffic
AC	Asphalt Concrete
ADB	Asian Development Bank
AGF	All Ground Fasten
AHs	Affected Households
Aps	Affected Persons
ATC	Automatic Traffic Count
BOT	Build-Operate-Transfer
CAGR	Compound Annual Growth Rate
CBR	California Bearing Ratio
CC	Cement Concrete
CPCB	Central Pollution Control Board
CTCS	Classified Traffic Count Survey
DBFO	Design-Build-Finance-Operate
DBST	Double Bituminous Surface Treatment
D/D or DD	Detail Design
DEM	Digital Elevation Model
DPR	Detailed Project Report
DSM	Digital Surface Model
DTM	Digital Terrain Model
ESC	Environment and Social Consideration
EIA	Environmental Impact Assessment
EIRR	Economic Internal Rates of Return
EMMP	Environmental Mitigation and Monitoring Plan
EMP	Environment Management Plan
EPC	Engineering-Procurement-Construction
EWHCIP	East-West Highway Corridor Improvement Project
F/S or FS	Feasibility Study
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GOJ	Government of Japan
GPS	Global Positioning System
GSDP	Gross State Domestic Product
HFL	High Flood Level
ICB	International Competitive Bidding
IEE	Initial Environmental Examination
IRI	International Roughness Index
IUCN	International Union for Conservation of Nature
JICA	Japan International Cooperation Agency
JST	JICA Survey Team
KP	Kilo Post
LARAP	Land Acquisition and Resettlement Action Plan
LCV	Light Commercial Vehicle

LGV	Light Goods Vehicle
LiDAR	Light Detection and Ranging / Laser Imaging Detection and Ranging
MDB	Multilateral Development Bank
MMC	Manual Classification Count
MoENRP	Ministry of Environment, Natural Resources and Protection
NHCC	National Highway Control Center
OD	Origin and Destination
PAP(s)	Project Affected Person(s)
PCI	Per Capita Income
PCU	Passenger Car Units
PHF	Peak Hour Factor
PM	Penetration Macadam
PPP	Public-Private-Partnership
RAP	Resettlement Action Plan
RPF	Resettlement Policy Framework
R&IPDP	Resettlement and Indigenous People Development Plan
RDMRDI	Roads Department, Ministry of Regional Development and Infrastructure
ROW	Right of Way
RSI	Roadside Interview
SBST	Single Bituminous Surface Treatment
SEIA	Summary Environmental Impact Assessment
SES	Socio-Economic Survey
SEZ	Special Economic Zone
SIA	Social Impact Assessment
SVF	Seasonal Variation Factors
TA	Technical Assistance
TEM	Trans European Motorway
TOR	Terms of Reference
TRACECA	Transport Corridor Europe-Caucasus-Asia
TTC	Travel Time Cost
V/C or VCR	Volume Capacity Ratio
VGF	Viability Gap Funding
VOC	Vehicle Operating Cost
WB	World Bank

Executive Summary

1. Introduction

(1) Project Background

The International trunk highway crossing the east to west in Georgia (hereinafter referred to as East-West Highway) is a logistics keystone of connecting Europe and Asia and has a function as promoting of development of the Caucasus regional economy.

Georgia is in a geopolitically important location as an energy and commodities transport corridor between Europe, Asia, Russia and Middle Eastern countries. The transport system in Georgia comprises of land-based transport via highways and railways, maritime-based transport via Poti and Batumi ports, and air transport. The highway network of 22,000 km is the predominant means for land-based transport. Forty percent of cargo and more than 90 percent of passengers depend on the highways. The East-West Highway is a 460 km international trunk highway that spans from the border at Azerbaijan to the coast of the Black Sea. This highway is part of the international highway network connecting Europe and Asia, and plays an important role in the region. In addition, the East-West Highway carries about 60% of the international cargo to and from Georgia. The traffic has been growing 12% annually on average since 2005.

In the region connecting Europe and Asia (east-west), Russia and the Middle East (north-south), the transportation of energy and goods passes through this corridor, as the export route of the Caspian Sea oil and gas pipeline to Europe, as well as the Caucasus countries and Central Asia, as a logistics relay base in each country, its importance is increasing. Regarding logistics, there are two international ports, Poti port and Batumi port on the Black Sea coast, however, the Georgia Government is proceeding with new development of Anaklia Port on the coast near Abkhazia region since these existing two ports does not have a sufficient water depth. When the Anaklia Port is opened, the traffic volume through the East-West Highway is expected to further increase with neighboring countries such as Azerbaijan and Central Asian countries. In addition, a new port is being developed in Azerbaijan at about 65 km south of Baku, which will be designed and developed to take on the major points of the TRACECA line connecting Europe, Central Asia and China. For those reasons, East-West Highway Improvement is placed as the top priority project in the national development plan "Georgia 2020".


Source: JICA Survey Team

Figure S-1: Current Situation of the East-West Highway (E-60)

This project section goes from Argveta to Shorapani, which is a part of the unimproved Argveta and Chumateleti section, and a bottle neck for transport on the East-West Highway. This highway section goes through narrow mountainous topographies that would need tunnels and bridges for efficient travel. In addition, safety measures against falling rocks, slope failures, and landslides are crucial for the prevention of road blocks caused by disasters.

The World Bank (WB), Asian Development Bank (ADB), and European Investment Bank (EIB) have financed and provided assistance towards project development starting from the eastern side. Japan International Cooperation Agency (JICA) has provided assistance to the Zestafoni-Kutaisi-Samtredia section of the East-West Highway for two stages: East-west Highway Development Project I (approved in December 2009) and East-west Highway Development Project II (approved in March 2016) as Phase I of the project.

ADB is currently conduct the Detail Design (D/D) of the Argveta-Khevi section of E60; including the Argveta-Shorapani section of the highway which the Georgian Government applied for financing from the Japanese Government (East-West Highway Development Project Phase II) based on the F/S conducted by the WB.

(2) Project Outline

Table S-1: Outline of the Project

1) Project Name:	East-West Highway Development Project Phase II
2) Scope of request (Target section):	• Road improvement and widening to four lanes of 14.7 km of the existing E60 between Argveta and Shorapani of Imeleti State, including 12 tunnels and 14 bridges. • Road Safety Measures (Falling rock, slope protection etc.) • Consulting services (D/D review, construction supervision etc.)
3) Target Area:	Shorapani and Argveta in Imeleti State of Georgia
4) Relevant Government Organizations:	Roads Department, Ministry of Regional Development and Infrastructure (RDMRDI)

Source: JICA Survey Team

(3) Objectives of the Study

The objectives of the study are to implement necessary reviews for a Japanese Loan Project of the East-West Highway Development Project (Phase 2) by examining possible application of Japanese technologies, and by reviewing the D/D being conducted by ADB. More specifically, upon review of the D/D; the project outline, project costs, implementation schedule, procurement and construction methods, possible application of Japanese technologies and methods, implementation organization, operation and maintenance organization and environment and social consideration will be investigated. Thorough investigations will be conducted for road/ tunnel construction, bridge types, and road safety measures.

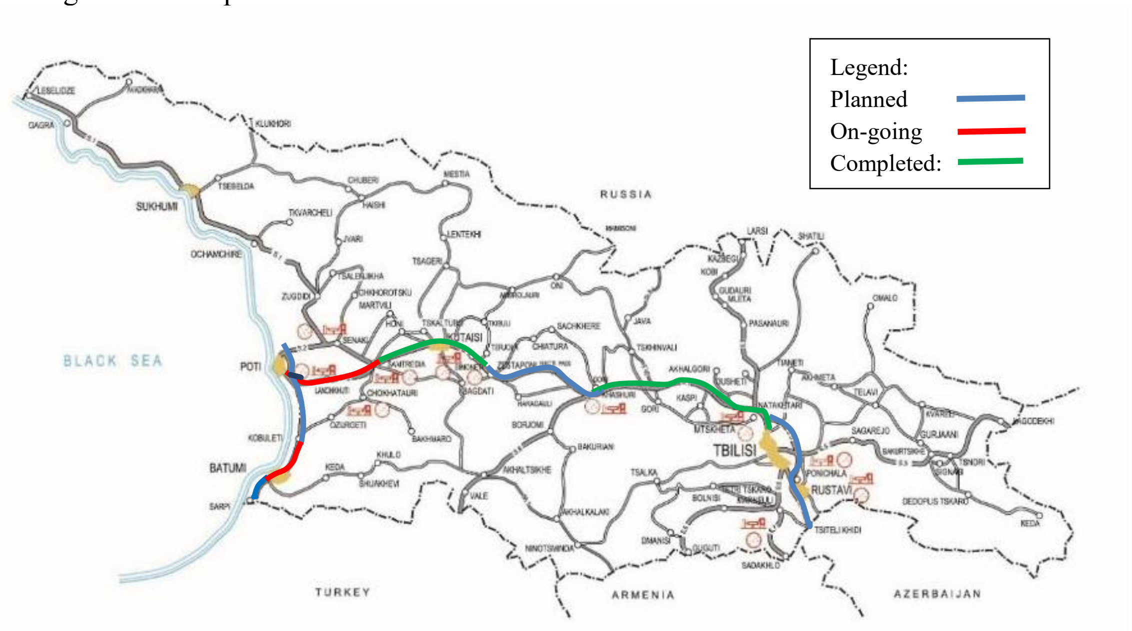
2. Present Condition of the Study Roads

(1) Present Status of Roads and Transport in Study Area

Major trunk highways in Georgia are composed of international important highways that are also parts of Trans European Motorway (TEM) network such as primary trunk highways (S1-S13) of E-60 (Poti-Tbilisi-Red Bridge), E-70 (Poti-Batumi-Sarpi) and secondary trunk highways. Other categories of the roads of around 15,000 km[1] of local roads, which are the responsibility of cities and local governments. The current trunk road network is roughly 7.000 km.

[1] 15,415 km by GIRCA Economic Review, 13,426 km by Road Sector of Georgia, Overview (RD)

Economic growth and sustainable development of Georgia largely depends in efficient use of its geo-political potential as a transit country. The function of Georgia, as a part of Europe- Caucasus-Asia transport corridor that transport of commodities and energy and transit of fuel and gas produced in Caspian regions to Europe via pipelines, has significantly increased. The East-west Highway Development has started from Tbilisi on westward by World Bank (WB), Asian Development Bank (ADB), and European Investment Bank (EIB) as well as Japan (JICA) The only section between Tbilisi and the Black Sea that has not started yet is a 67 km section going through the Rikoti pass.



Source: Road Sector of Georgia, Overview

Figure S-2: Progress of East-West Highway Construction

Table S-2: Status of East–West Highway Development

Road Section	Length	Planned /Upgrading	Financier	Completion Date
Tbilisi – Natakhari	11 km	4-lane, dual carriageway	State Budget	Completed
Natakhari - Aghaiani	16 km	4-lane, dual carriageway	State Budget	Completed
Aghaiani - Ruisi	50 km	4-lane, dual carriageway	World Bank	Completed
Ruisi - Agara	19 km	4-lane, dual carriageway	World Bank 2014	Completed
Agara – Zemo Osiauri	12 km	4-lane, dual carriageway	World Bank 2015	Completed
Zemo Osiauri - Chumateleti	14 km	4-lane, dual carriageway	World Bank	Under Preparation
Chumateleti - Argveta	51 km	4-lane, dual carriageway	WB, ADB, JICA	Design Stage
Zestafoni - Samtredia	59 km	2 to 4-lane, dual carriageway	JICA	Completed
Samtredia – Choloki	70 km	4-lane, dual carriageway	EIB 2016	Ongoing
Choloki – Kobuleti bypass	33 km	2-lane single carriageway	ADB 2016	Under Preparation

Source: JICA Survey Team based on F/S Report as of 2017

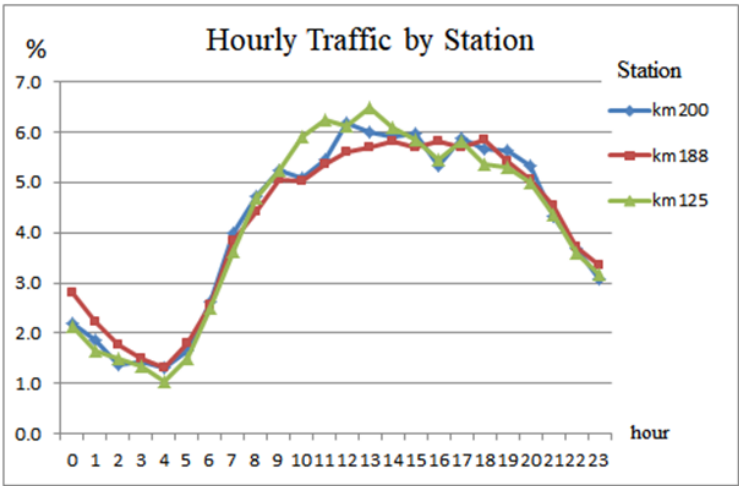
The traffic volume around Tbilisi is the highest of all other sections. Annual average traffic near the area reached 37,000[2] vpd in 2013 with a heavy vehicle mix of 17%, and 49,000 vpd in 2016 with a heavy vehicle mix of 28%. The volume decreases with the distance from Tbilisi.

The traffic of the Shorapani -Argveta project section has less short-distant traffic because the section is 150 km away from Tbilisi. However, long-distant traffic of trucks and buses traversing from Azerbaijan and Turkey (passing through Georgia) occupy a significant proportion of traffic (37-38%)[3].

<u>Traffic Condition of the Project Area</u>

1) Three locations of automatic traffic counting station data are analyzed regarding ratio of hourly traffic volume to daily volume. The results are shown in figure below. It can be said the peak ratios are low.

2) Spot speed data at the three locations are summed up by vehicle type and traffic direction. It can be said the speeds are high considering regulation speed is 50 km/h.



Source: RDMRDI auto count data

Figure S-3: Hourly Traffic Volume on Three Stations

Table S-3: Spot Speed

					unit:km/h	
	km125		km188		km200	
	to east	to west	to east	to west	to east	to west
small vehicle	67.6	69.4	61.9	69.7	57.8	50.0
medium vehicle					57.4	51.2
large vehicle	64.5	63.1	54.0	65.2	50.9	46.4
volume(veh/12h)	6,904	6,205	5,662	4,847	6,883	6,651

Source: IRDMRD's ATD data

3) Level of service

TEM specifies traffic capacity following the American HCM (Highway Capacity Manual), it is:

[2] Georgia Road Department (RD)
[3] Survey by D/D Consultant in 2017

Possible capacity = 2,800 × 0.93 × 0.82 = 2,135 (pcu/h)

Using km 188 station peak hour traffic volume, v/c equals to 0.72、then the level of service is "D".

(2) Social and Economic Conditions

Georgia declared independence from Soviet Union in 1991. The first few years of the formation of an independent, market-based economic system were especially difficult for Georgia: civil unrest, armed conflicts in Abkhazia and South Ossetia, extremely high crime rates, the loss of old, traditional markets and suppliers and the absence of new connections and suppliers to adequately replace old ones, and high rates of workforce migration. This workforce migration reflects the trend of population over the years. The population of Georgia excluding South Ossetia and Abkhazia was 4.4 million[4] in 2008 and 3.73 million according to 2014 census. It has declined since 1992 when the population was about 5.5 million[5].

Current economic growth is significant and stable indicating growth of 6-7 % from 2010 to 2013 with some exception of the minus growth by war in 2009 and weak growth by Russian economic downturn. However, the increase of job opportunities is not significant because industrial and commercial structures still remain same as before. As a result, unemployment rates rose from 13.3 percent in 2007 to 16.5 percent in 2008; by 2012, the rate had dropped to 15 percent, which is still high.

Georgia's economy had predominantly depended on agriculture before the 20th century. The modern economy of Georgia is supported by the tourism industry of the Black Sea, fruit, tea, grapes, and as a large-scale industry of wine production. The metal industry, machinery, chemical production and garment industry were the core of the economy until the Soviet Union collapse. Most of these industries lost their market share and have been unable to rebound since.

Its gross domestic product fell sharply following the collapse of the Soviet Union. But it recovered in the mid-2000s, growing in double digits of USD 6,411 million thanks to the economic and democratic reforms brought by the peaceful Rose Revolution. Georgia's economy enjoys a relatively free and transparent operation. Georgia is the least corrupt nation[6] in the Black Sea region among all of its immediate neighbours, as well as nearby European Union states.

3. Traffic Demand Forecast

(1) General

This chapter first reviews the traffic forecasts prepared by the F/S;[7] then examines the traffic forecasts with a focus on existing traffic and traffic growth rates; and lastly proposes an updated forecast.

(2) Review of F/S Traffic Forecast

The F/S first estimated the Annual Average Daily Traffic (AADT) and Origin-Destination (OD), mainly based on historical Automatic Traffic Counts (ATC) data and traffic survey results including those of ATC, Manual Classification Counts (MCC), and OD survey. It then provided

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[4] Georgia Statistics
[5] United Nations, Department of Statistics, Demographic Yearbook
[6] Transparency International's 2015 report
[7] The study title is: RDMRDI, *Upgrade of Feasibility Studies for E-60 Highway Section from Zemo Osiauri to Argveta and Undertaking Detailed Design for E-60 Highway Section from Zemo Osiauri to Chumateleti (Feasibility Study for E-60 Highway Section from Zemo Osiauri to Argveta)*, Final Report, December 2015.

the traffic forecast by vehicle type and count station up to the year 2049, following the setting of traffic growth rates, as well as generated and induced traffic.

(3) Traffic Survey / Axle Load Survey

Traffic surveys were conducted in October and November 2014, to collect traffic data for the traffic forecasts for the East-west Highway between Zemo Osiauri and Argveta. These traffic counts (as of 2014) revealed that the Shorapani–Zestafoni section carries about 11,000 vehicles per day, while the Zestafoni–Argveta section carries about 14,000-15,000 vehicles per day. In order to verify the F/S traffic count data, Automatic Traffic Counts were conducted in July 2017 as part of the D/D at the following three locations

(4) Confirmation of Existing Traffic Forecast

ATC data for Km 179 between Rikoti and Zestafoni and Km 215 between Zestafoni and Kutaisi over the 2007-2016 period, although some fluctuations, the total traffic increased at an average rate of 8.5-9.0% per year are observed.

AADT in by D/D ATC results with seasonal adjustment is assumed at 14,489 vehicles per day at Km 188 and 17,060 vehicles per day at km 200. Thus, the 2019 traffic assumed in the F/S at Km 188 is considered slightly underestimated, while that at Km 200 is considered reasonable, considering that the 2019 AADT in the F/S is 13,872 vehicles per day at Km 188 and 18,519 vehicles per day at Km 200.

In order to examine the traffic growth rates assumed in the F/S various assumptions have been made on of which is that the Georgian GDP would grow at 4.5% per year in the future. This assumption has been made considering the short-term GDP growth rate forecasts by international organizations and a major institute. The traffic growth rates in the F/S are considered slightly underestimated in the short- and medium-terms, and within a reasonable range in the long-term, considering the growth rates established in this survey.

(5) Projection of Future Traffic

Considering the existing traffic examined and traffic growth rates established in Subsection 3.4, it would be better to update the traffic forecast from the F/S. Therefore, it is proposed using the parameters established in the previous sections that, the traffic of the Shorapani–Zestafoni East section should be updated.

(6) Comparison between the F/S Forecast and the Updated Forecast

The F/S forecast and the updated forecast are compared. The key points related to the first-year traffic and traffic growth rates are summarized below, with details compared in Table S-4.

- The first-year traffic assumed in the F/S on the Shorapani–Zestafoni East section is considered slightly underestimated, while that on the Zestafoni West–Argveta section is considered reasonable.
- The traffic growth rates in the F/S are considered slightly underestimated in the short- and medium-term, and are considered within a reasonable range in the long-term,

Table S-4: Comparison between the F/S Forecast and Updated Forecast

	F/S Forecast	Updated Forecast
First-year traffic	The first-year traffic of the Shorapani–Zestafoni East section is projected at 14,208 vehicles per day, and that of the Zestafoni West–Argveta section is projected at 15,158 vehicles per day.	The first-year traffic of the Shorapani–Zestafoni East section was set at 14,884 vehicles per day, and that of the Zestafoni West–Argveta section was set equal to that of the F/S (i.e., 15,158 vehicles per day).
Traffic growth rates	Traffic growth rates obtained from the F/S forecast are 4.7% per year in 2019-2029, 3.3% per year in 2029-2039, and 2.6% per year in 2039-2049.	Whilst traffic growth rates for passenger were set at 5.9% per year in 2019-2029, 4.2% per year in 2029-2039, and 2.8% per year in 2039-2049; those for freight were set at 5.4% per year in 2019-2029, 3.9% per year in 2029-2039, and 2.5% per year in 2039-2049.
Forecast results	On the Shorapani–Zestafoni East section, the total number of daily traffic is projected at 22,405 in 2029, 30,915 in 2039, and 39,971 in 2049. On the Zestafoni West–Argveta section, it is projected at 23,910 in 2029, 32,997 in 2039, and 42,666 in 2049.	On the Shorapani–Zestafoni East section, the total number of daily traffic was set at 25,950 in 2029, 38,780 in 2039, and 50,517 in 2049. On the Zestafoni West–Argveta section, it was set at 26,451 in 2029, 39,555 in 2039, and 51,551 in 2049.

Source: JICA Survey Team

4. Detail Design of E60 F4 Section (Shorapani and Argveta)

(1) Natural Conditions

<u>Meteorological and Hydrological Surveys</u>

After discussion with D/D study team and a careful reviewing of the D/D study report, JICA Survey Team's comments on achievements and issues to be considered are summarized as follows;

- Observation data from two meteorological stations located in the vicinity of the project road were disclosed in the D/D study report. The detailed data offering service for a fee is currently available by application to the Hydro-meteorological Department under the National Environmental Agency.
- According to the comments based on the site survey by JICA expert in October 2017, it was recommended that a fluid analysis (flood simulation) based on hydrological survey and a study on the inhibition of cross-sectional area of a river and the scoring around bridge pier should be implemented when necessary. Based on this situation, hydrological and hydraulic study including flood simulation has been conducted in the D/D study. As a result of the complete analysis, the safety of the highway bridge in design has been secured against hydrological conditions.
- In terms of flood protection measures in Georgia, the Bank Protection Division under the Road Department is responsible for overseeing the river protection work for the bridge piers and river structures such as embankment. Technical support from this Division will be expected when river/bank protection work is needed in case of the road bridge construction and river bed erosion measures.
- According to the D/D study report, not sites where specific data has been found relating to climate change. However it can be assumed that there will be an increase in average annual temperatures of between 1 and 1.5 degrees over the next 30 years and that

precipitation will decrease. The number of hot days may increase. Therefore, it was confirmed that consideration of suitable pavement types shall be taken.

Topographical Surveys

Having a careful reviewing of the D/D study report and discussion with D/D study team, JICA Survey Team's comments on achievements of topographical surveys and issues to be considered are summarized as follows;

- In terms of aerial photograph, enough resolution and accuracy were ensured by 9.94 cm in pixel size.
- Regarding airplane laser measurements, enough resolution and accuracy ware confirmed as follows:
  - i Original data is in error (Standard Deviation) by less than 0.0676 m (10 cm<)
  - ii As a result of final adjustment, the difference between the Lidar GCP data and the GPS ground surface data are less than 10 cm.
  - iii Mesh data corresponding to DTM and DSM were confirmed by the grid 5 m × 0.5 m.
- Additional surveys (Celerimetric surveys) have been conducted for the validation of aero-topographic survey and river cross sections (47 sections) using hydraulic simulation model. Since there are not enough/ detailed topographic data at the tunnel portal, additional topographic surveys should be conducted in some critical area when needed.
- Since topographic surveying using a "drone" has been conducted by the JICA Survey Team, the obtained results is not enough to acquire topographical information in terms of landslide and slope condition because of the vegetative cover on the slope. Therefore, additional topographic surveys are to be expected when necessary.
- It was confirmed that the above data from topographic surveys has been widely used in the D/D study. For example, CAD maps for longitudinal section and lateral sections with an interval of 10 m, and topographical maps with 1 m contour line are available to use.

Geomorphological Field Survey

From a geological and geotechnical point of view, discussion with D/D study team and a careful reviewing of the D/D study report have been performed somehow with a time delay. JICA Survey Team's comments on achievements and issues to be considered are summarized as follows;

- Despite having a short-term of D/D study phase, the achievement of the comprehensive geological and geotechnical investigations including boring surveys, geological (geo-morphological) field surveys, geophysical investigations and laboratory test should be received much recognition.
- Sufficient amount of necessary items have been conducted in the geological survey, site survey and geophysical survey respectively. However, most boreholes were not located at the necessary points such as tunnel portal and bridge pier, which was inefficient to identify the geological condition. With respect to the mapping of geological profile in consideration of geomechanics classification, the results of geophysical survey and geological survey do not fully reflect for the detailed design.
- The results of laboratory tests for rock specimen (outcrop rock sample and boring core sample), undisturbed sample and disturbed sample were quite satisfactory. However, the description about how the result can be effectively used in the detailed design and the construction plan is insufficient.

- As part of natural condition survey (topographical survey, meteorological and hydrological survey and geological survey), the utility survey has been conducted for identifying the public facilities which could have an effect on the project road. However, there was not enough description relating to the concrete object that is likely to hinder the road construction. It seems necessary to refer to this matter in association with environmental and social considerations (EIA).
- Since the vehicle mounted boring machine cannot be applied to the location such as an off the road and steep slope in the D/D study, the geological survey for the tunnel portal, bridge pier and abutment were not satisfactory conducted. In order to improve accuracy of detailed design and ensure the basis of quantity, additional boring survey is necessary.
- However, with respect to some geologically unidentified positions due to the repeated changes of the road alignment and the topographically difficult condition such as a steep slope and a landslide dangerous area, additional investigations (boring) will be necessary based on the recommendations from JICA Survey Team.
- Reviewing the result of geological surveys as a whole, it was identified that the foundation bedrock of the project road is relative stable in geology. Since the potential concerns in terms of geology will be noted as follows, mainly from safety issues, it will be required to deal with these specific issues independently in the construction phase.
    - Falling rock preventive countermeasure for the tunnel portal sites (TB-1, 2, 3 and 4).
    - Detailed investigation and countermeasures for the landslide dangerous area.
    - Slope protection method (rockfall prevention method) between TB-1 and TB-2
    - Possible negative impact on tunnel excavation, open cut and high embankment (in terms of differential settlement) due to the soft rock and the weathered rock such as marl and calcareous sedimentary rocks which are distributed in the north of the Zestafoni.
    - Counter measure for sudden spring water when excavating tunnel (low possibility because of the findings of geo-tectonic investigations such as fault, inferred fault and fracture zone).
    - Possible groundwater lowering in some cases due to tunnel excavation.
    - Shortage of accurate data on the thickness of river bed sediments and the depth of foundation bed rock for bridge pier and abutment construction due to insufficient investigation.
- According to the field survey from the hydro-geological point of view and EIA, some existing wells having possibilities to be influenced by tunnel excavation have been found along the project road. There are some concerns that the lowering ground water (drying up of the existing well and the farmland) and differential settlement of ground surface caused by the tunnel excavation and earth cutting. In order to know the detailed ground water table and their seasonal changes, ground water monitoring through before and after construction phase is necessary

<u>Slope Survey</u>

General

JICA survey team provided the final linearity from the D/D consultant and the range of the caution points in the slope investigation extracted on the topographic map based on the planar linearity indicated by FS before the cutting position was determined. As a result, some of the sloping caution points were avoided by linear changes. However, it is undeniable that investigation on the necessity of native slope survey and cut surface treatment measures is inadequate, pointed out the necessity of additional investigation.

Extraction of the Specific Site Requiring Special Attention in the Preliminary Desk Research
The criterion for site extraction requiring special attention is based on the designation type for a "Steep Slope Area in Danger of Failure" in Japan, as follows:

- The project road is adjacent to the natural slope which is more than 5 meters in height,
- The project road is adjacent to the natural slope where the inclination angle is more than 30 degrees.

Moreover, the survey extended up to the Knick line of the natural slope. Since a mountain stream was found in the natural slope, a course tracing of falling rock and a detailed investigation of the possible debris flows were conducted. The target slope, taking into consideration the slope measures, is selected in the case that a planned cut slope height is over 5 meters.

Results of Field Reconnaissance
In the slope on the Tbilisi side of Tunnel 1 (T1), since the slope is stable and the topsoil is covered, there is almost no source of falling rocks. However, surface water flowing down to the high position of the glue surface is assumed at the time of rain, so it seems to be desirable to install a vertical drainage plant in the cut slope.

The upper slope of the section between T1 and T2 is over 150 m in height and it is assumed that rocks and rocks are seen in the natural slope. In fact, since a stepped stone exceeding a diameter of one meter is recognized at the bottom of the slope, it is necessary to have a falling rock prevention work to fix these after investigating the distribution of rocks and tangles.

On the other hand, there is a landform estimated to be a landslide of 150 m in length and 100 m in width at the end of the T1 tunnel, are supposed to be installed to counter the landslide are installed in the surrounding area. Also, as a result of the horizontal boring conducted by the D/D consultant in the vicinity, a sandy core has been collected up to the excavation length of 22 m, and the possibility of landslide block cannot be denied.

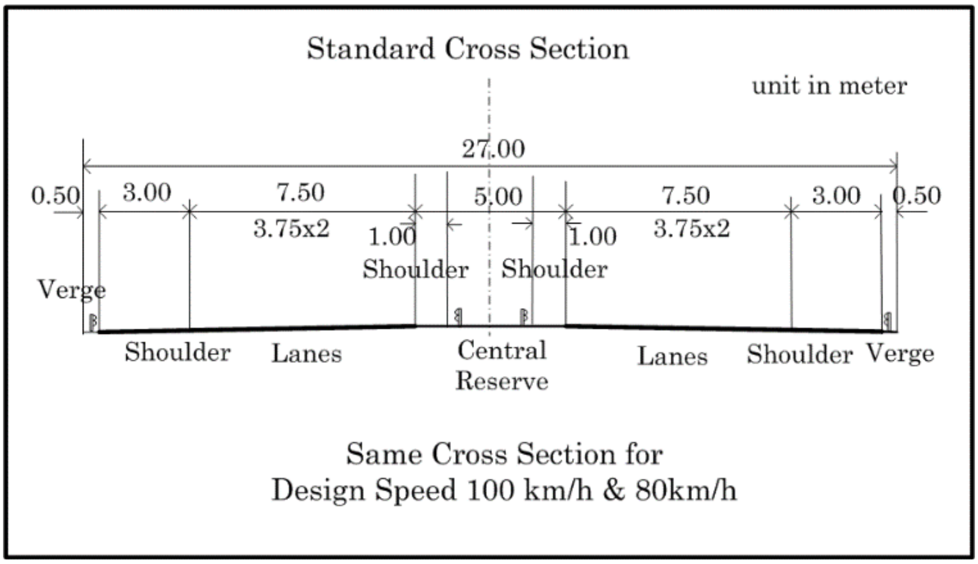
Since the slope at the end point side of T3 - TA (Tbilisi-Argveta bound) becomes a cut slope, countermeasures against slopes are unnecessary. The mountain stream near the tunnel entrance has no running water all the time and measures for mountain streams are unnecessary.

As the slope on the Tbilisi side of the interchange is removed by cuts and the boring survey results it is assumed that the weathering depth is as shallow as 4 to 6 m, and fresh rocks will be exposed on the cutting surface of slope; therefore, no protective work is required.

(2) Detail Design of F4 Section of E-60 Section of Shorapani-Argveta

<u>The Design Standard to be applied</u>

Geometric Design Standard
The TEM (Trans-European North-South Motorway) Standard was considered as the primary standard, and the Georgian Standard (SNIP) as the secondary standard. For any items not covered by these, AASHTO, Japanese Standard and that of other countries will be referred to. A standard cross section, common for design speed 80 km/h and 100 km/h is decided through negotiation with RDMRDI and IRD.



Source: JICA Survey Team

Figure S-4: Standard Cross Section in the D/D

Bridge Structure

The Bridge plan in Lot F4 was studied and established by DD consultant (IRD/ADB fund) simultaneously with the road alignment under the study and agreement of JICA Survey Team.

Among the bridges, we decided to select 3-steel bridges BRI4004, BRI4002 and BRI4004 as STEP ; Japanese technology applicable. The main items are

1. Rationalized Steel Plate Girder, for the advantage of simplification and time reduction of construction work.
2. Weathering Steel Bridge, for the advantage of reduction of maintenance cost.
3. Composite Deck Slab, for the advantage of safety and time reduction of construction work and high durability.

With regard to the steel superstructure design work, designing by DD consultant was difficult because it is unique Japanese technology including design method, and due to temporal and contractual restrictions, that it was decided to carry out preliminary design with necessary accuracy for the bid by JICA Survey Team. As for the substructure design, DD consultant carried out it using the reaction forces calculated by JICA Survey Team.

The bridges would be planned to cross the meandering river of Dzirula at several locations. JICA Survey Team suggested DD consultant to carry out flood analysis of the effect of bridge construction for the purpose of minimizing it. In addition, JICA Survey Team recommended some additional restrictions of pier design in river with reference to Japanese Standard.

Regarding the superstructure design standard, we decided to implement in accordance with Japanese standard because it is unique Japanese technology and is thought that the design based on Japanese standard can cover the design by Eurocode as a result. The design work was executed based on “Specification for Highway Bridges (Japan Road Association)” and other design manuals in Japan.

Slope Protection

Possible risk factors of the existing road that will likely cause traffic obstacles are falling rocks and downward earthflows along a surface failure of the cut slope. In addition, serious damage from falling rocks, earth and sand on the natural slope, disaster/ traffic obstacles caused by sediments and falling rocks, as well as runoff from the mountain stream despite relatively low precipitation are possible.

Based on the current road alignment design and earthwork, these positions are assumed to have a certain risk factor and coverage of the survey is included in the attached documents.

Since the targeted slope assumes to have certain levels of risk, the type, scale and characteristics of the risks will be identified during the field survey, and the following applicable policies will be referred to; "Road Earthworks - Cut Slope and Slope Stability Guidelines (Japan Road Association, 2009)", "Rock Fall Prevention Handbook (Japan Road Association, 2000), and "A Prevention of Landslide Technology Guidance and the Commentary (Ministry of Land, Infrastructure, Transport and Tourism, 2008)".

Geometric Design of the Project Highway

Although the minimum radius of curvature for design speed 80 km/h is 240 m, 400 m is set up as a minimum to be attained. The alignment along River Dzirula was designed using R=400 m, however, the alignment was drastically improved by bridges crossing the river afterward.

Source: IRD Design Sheet

Figure S-5: Alignment

The former clumsy alignment in the hilly areas in Zestafoni by FS is improved by using adequate transition curves. Four interchanges are planned, two of them near the starting point of F4 section are a kind of trumpet type, and two of them near the end point are diamond type. All of them have roundabout type intersections with the existing road.

Tunnel Design

Positions and Extensions of Tunnels
The total extension of the total of 12 tunnels is 8,515.09 m, consisting of 7,975.409 m of tunnel by drilling & blasting method and 539.69 m of tunnel by cut & cover method.

Positions of Portals
The position of the portal is not appropriate at the Argveta side of the tunnel 6 (T-AT-6, T-TA-6). JST considers that it is desirable to change the portal position of Argveta side from 9+726.883 to 9+642.883 for T-AT-6 and from 9+709.02 to 9+625.02 for T-TA-6 Tunnel length may be shortened by 84 m each.

Tunnel Invert Design
The design of D/D consultant is design method based on the analysis called ADECO (Analisi delle DEformazioni COntrollate, Analysis of Controlled Deformation) Method. Based on analytical methods, because there is a tendency to look at input data on the safe side, in particular, invert is designed to be as thick as 70 to 80 cm throughout the tunnel section. It is thick when compared with the standard support pattern at the time of construction of the tunnel at the two lane road in Japan, and it is different from Japan's design philosophy and construction records which does not require invert when the ground conditions are relatively good.

Tunnel Drainage System

In the final design plan of drainage system by D/D consultant, the spring water collected by the covering waterproofing work is guided through a cross drainage machine (φ 150 mm) at an interval of 50 m, and one position at each tunnel length A drainage worker (φ 250 mm) is to be installed. On the other hand, in the Japanese design, it is common to conduct through a transverse drainage plant (φ 150 mm) at 50 m intervals, and to provide a longitudinal drainage (φ 300 mm) across the entire length of the tunnel in the center of the tunnel. Comparing the Japanese procedure with current D/D plan, it is considered that there is no problem with the D / D draft conception guidance ability outside the tunnel pit.

Design of Emergency Cross Passage (Bypass)

In the design by D/D consultant, Ventilation fan, double door, evacuation room, etc., are provided in evacuation contact pitches, but JST suggests that it is desirable not to install these incidental facilities as much as possible because the objective is to allow for speedy evacuation.

Necessity of Mechanical Excavation Method

Tunnel 5 (T-AT-5, T-TA-5) and tunnel 6 (T-AT-6, T-TA-6) have shallow overburden. Since private houses are scattered right above the tunnel, various environmental problems such as vibration and noise for residents and structures must be reflected in the design. Machine drilling is generally applied under such conditions. The examination results on the vibration when adopting drilling & blasting excavation method were conducted.

Most people who are indoors feel shaking. Some people are frightened, which is equivalent to a weak earthquake of 3 degrees on the seismic scale. As a regulation value, when calculating the distance that the blasting vibration level at nighttime is 64 dB (daytime 79 dB) proposed by the Japan Explosive Society, it is necessary to be 103 m away from private house.

From the above results, it is desirable that the tunnel 5 and the tunnel 6 should be applied to the mechanical drilling method.

Specification of Mechanical Excavation Machine (Road Header)

The geology of tunnel 5 (T-AT-5, T-TA-5) and tunnel 6 (T-AT-6, T-TA-6) to be excavated is limestone sandstone (Calcarenite). The unconfined compressive strength varies 11.5 to 85.6 N/mm^2, which is wide, indicate that there is a possibility that delays of excavation may occur at places where the strength is high. Judging from the strength of the ground, high-performance excavation machines should be selected.

Required Number of Mechanical Excavation Machine (Road Header)

Tunnels to be excavated using a mechanical excavation machine (road header) are 4 tunnels (at 2 places) and the length is T-AT-5: 1,193 m, T-TA-5: 1,152 m, T-AT-6: 450 m, T-AT-6: 444 m.

For T-AT-5 and T-TA-5, since the excavation tunnel length exceeds 1,000 m, and mechanical excavation machine has no mobility, each tunnel needs a dedicated machine

On the other hand, T-AT-6 and T-TA-6 are short tunnels located at the same location, and about 70% of tunnel length requires auxiliary method. The tunnel excavation will be finished in two days or three days. It is judged that excavation of both tunnels is possible with one machine.
Therefore, it is judged that the number of mechanical excavation machine (road header) necessary for excavating T5 and T6 is three.

Slope and Slope Protection Design

General
A suitable stabilizing method for the design slope will be selected based on the geological conditions. The following slope protection works will be selected as countermeasures for slope failure (rock fall) of the cut slope:

- Soil
- Rock quality (if fragile)
- Weathering
- Degradation of rock quality after cut slope work

Slope stabilizing methods will be selected when the cut slope is applied for landslide blocking. According to the field reconnaissance, identifying a geomorphological feature of doubtful landslide near the AT sta.0+550, special attention for design of cut slope near the tunnel mouth will be needed.

When unstable or loose rocks are present on the natural slope (such as upper part of slope or a slope adjacent to the road), passive countermeasure or rock fall prevention method should be incorporated in order to prevent rocks falling on the road. In any case, a field reconnaissance will be required for identifying the above.

According to the results of the field survey of these caution points, the slope having the falling rock origin at the upper side of the slope is limited to the slope between T1 and T2.

Cut Slope Countermeasure Work
From the geological distribution, the cut slope point numbers 1 to 6 shown in Table S-5 are located in hard rocks, the cut slope point numbers 7 through 10 are positioned in soft rocks. The standard slope gradient for Japanese is 1: 0.3 to 1: 0.8 (73.3° to 51.3°) for hard rock and 1: 0.5 to 1: 1.2 (63.43° to 39.8°) for soft rock.

The cut slope point number 1'-2, 2, 2' are sharp by about 5°, but it is judged that the glue surface protection work is unnecessary.

As the tunnel well head slope of the cut slope point number 7 is sharper than the standard by about 15°, it is considered that concrete spraying is necessary like other tunnel opening.

The other cut slopes are within the standard slope, but the cut slope point number 8,10, and 10 'are expected to have high groundwater level with the slope surface corresponding to the weathered part from the boring survey results.

Landslide Countermeasure Work
Prior to tunnel construction, it is necessary to identify the existence of landslide and the position of sliding surface and to investigate the possibility of triggering landslide activity due to slack tunnel drilling and tunnel excavation.

Based on the results of the survey, we will consider the countermeasure policy, but it is possible to consider a method such as changing the tunnel alignment and construction formation to maintain a sufficient separation from the sliding surface and avoiding it or constructing a landslide preventive pile.

Rock Fall Countermeasure Work

Local situation and countermeasures policy

The extension of the light portion between T1 and T2 is 50 m and the steep slope with the specific height up to the urgent line reaching 150 m. Unstable rocks are distributed, and falling rocks are a concern. A number of falling rocks exceeding 1 m in diameter are in fact recognized along the current road.

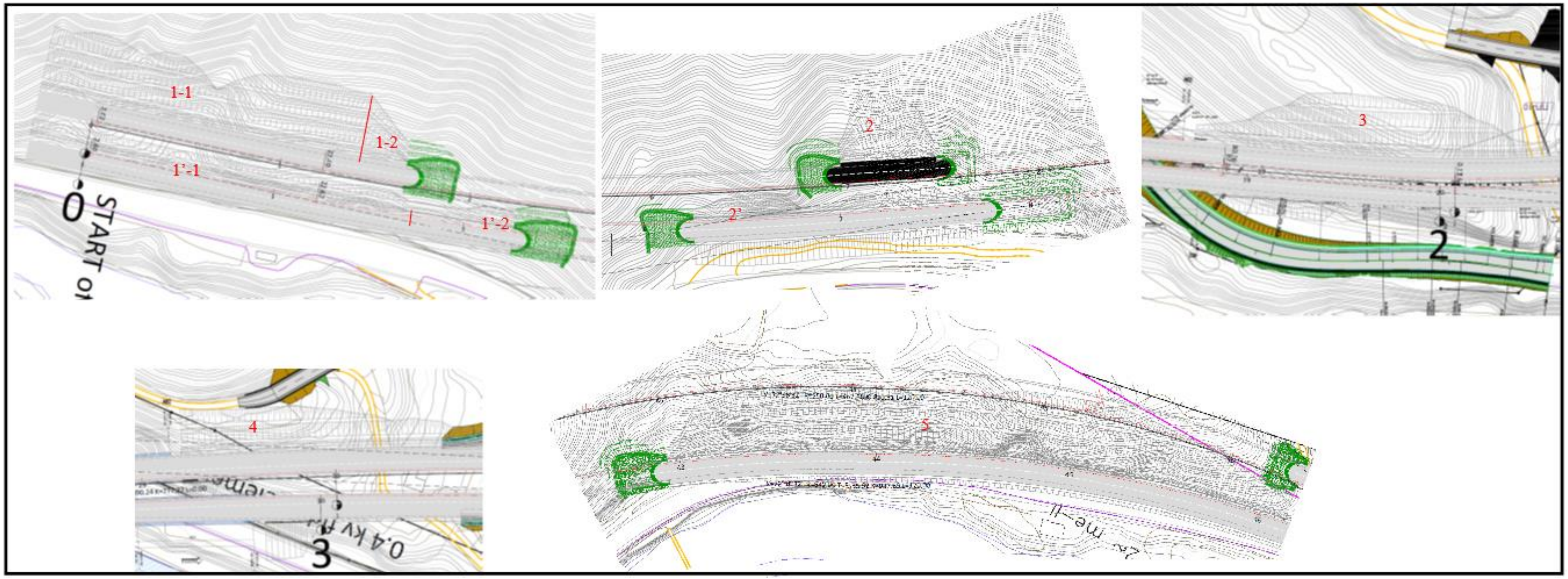
When the source position is high, it is expected that the falling rock energy will be enormous, so it is difficult to calculate the design external force of the standby countermeasure worker. Therefore, after specifying the distribution range of target rocks, we should take countermeasures against the source.

Table S-5: Quantity of Slope Protector

Cut slpoe point number	Position	STA	Lithology	Borhole number	Weathered depth	Borhole water level	Gradient(°)	Cut slope heghit	Section length (m)	slope distance (m)	Cut slope area (m^2)	Rock fall source area (m^2)	Countermeasure work
1−1	From T1 to the origin sideAT	0 + 0 ～ 0 + 138	Porphyrite	BH−38	8.5m	−10.9m	59	32	138	37.33	3,783.39		No need
1−2		0 + 138 ～ 0 + 163					68.9	32	25	34.31	629.93		No need
1'−1		0 + 0 ～ 0 + 170		BH−37	9m	−14.2m	45.0	4	170	5.66	961.67		No need
1'−2		0 + 170 ～ 0 + 224					78.7	21	54	21.42	963.68		No need
2	Between T1 and T2AT	0 + 696 ～ 0 + 747	Porphyrite				78.7	25	51	25.49	1,014.16	20% of 69290m^2 13,858	Rock fall prevention work
2'	Between T1 and T2TA	0 + 625 ～ 0 + 682	Porphyrite20m	BH−52	20m	−	78.7	25	57	25.49	1,133.47		
3	Between B1 and B2AT	1 + 878 ～ 2 + 45	Porphyrite2.5m	BH−27,28	4.0m,7m	−6.6,−5.7m	59.0	31	167	36.17	4,968.11		No need
4	Between B2 and B3AT	2 + 920 ～ 3 + 61	Porphyrite	BH−24	8m	−5.9m	59.0	24	141	28.00	2,960.92		No need
5	Between T3 and B4TA	4 + 294 ～ 4 + 614	Porphyrite	BH−32,49	0m	−6.8,−m	59.0	41	320	47.83	12,132.99		No need
6−1	Between T3 and B4AT	4 + 618 ～ 4 + 829	Porphyrite				45.0	12	211	16.97	3,580.79		No need
6−2		4 + 829 ～ 5 + 364	Porphyrite	BH−44,45	5m,4m	−8.8,10.3m	59.0	24	535	28.00	11,234.68		No need
6−3		5 + 260 ～ 5 + 308	Porphyriteト				59.0	31	48	8.17	195.99		No need
6−4		5 + 364 ～ 5 + 550	Porphyrite	BH−46	6.4m	−13.2m	45.0	13	186	18.38	3,419.57		No need
7	Between T5 and B5TA	8 + 257 ～ 8 + 286	Sandstone5.5m	BH−26	16.6m	−5.15m	78.7	12	29	12.24	266.16		shotcrete
8−1	Between T5 and B5AT	8 + 328 ～ 8 + 575					53.0	18	247	22.54	4,639.16		seed spraying method
8−2		8 + 575 ～ 9 + 40	Sandstone2.8m	BH−10	5.3m	−18.45m	53.0	14	465	17.53	8,151.40		No need
9	Between B5 and T6TA	9 + 218 ～ 9 + 264	Sandstone3.65m	BH−17	5.5m	−5.1m	45.0	17	46	24.04	845.70		No need
10	From T6 to the end point sideAT	9 + 726 ～ 9 + 908	Sandstone8.7m	BH−7	13.6m	−5.0m	53.0	13	182	16.28	2,962.55		seed spraying method
10'	From T6 to the end point sideTA	9 + 708 ～ 9 + 818					45.0	5	110	7.07	777.82		seed spraying method

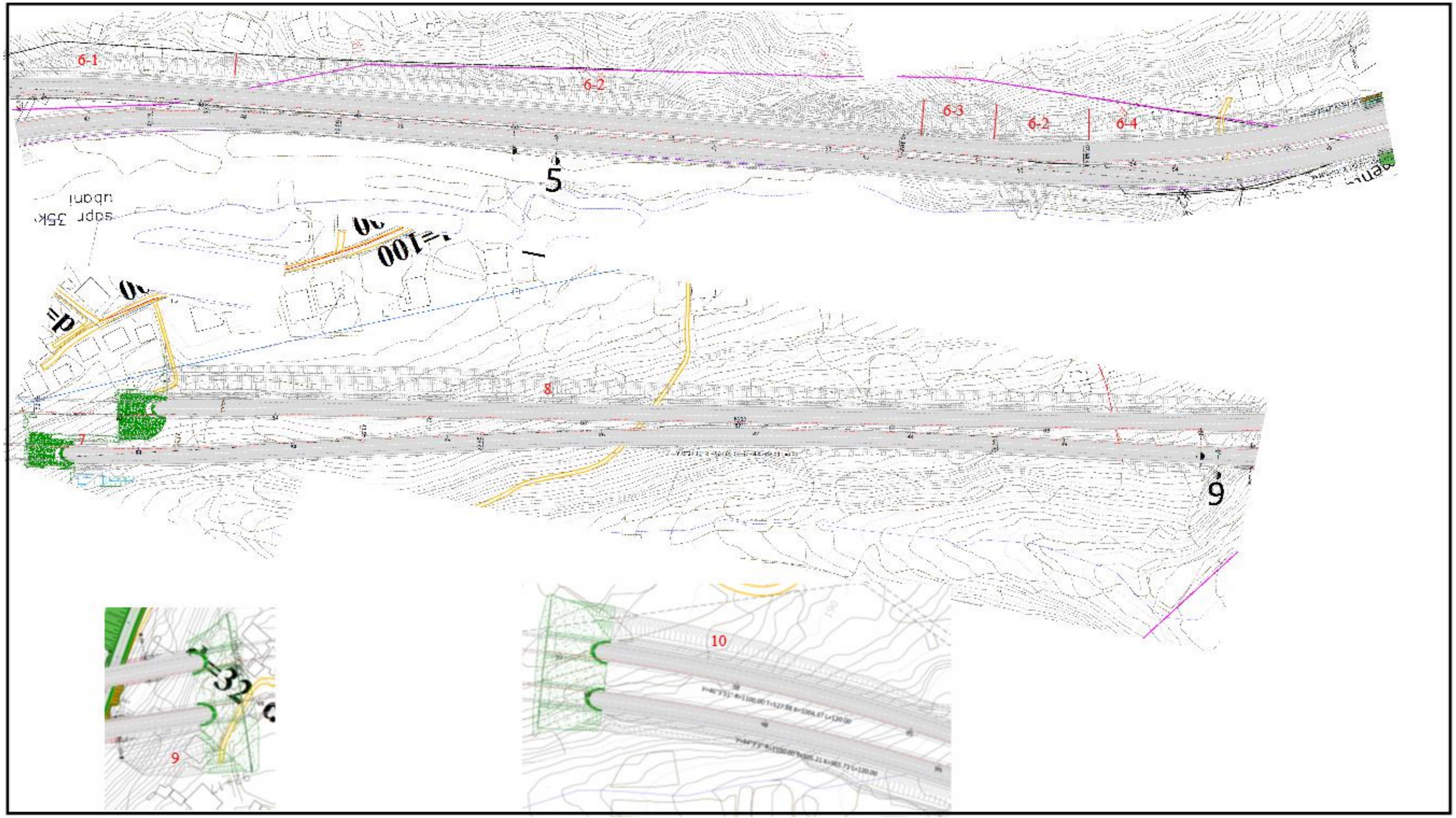
A part has been removed because of confidential information.

Source: JICA Survey Team



Source: JICA Survey Team based on the D/D, DFR

Figure S-6: Falling Stone Prevention Work (1)



Source: JICA Survey Team based on the D/D, DFR

Figure S-7: Falling Stone Prevention Work (2)

Traffic Control Devices and Safety Facilities

Road Sign
Guide signs at interchange diverging are implemented at 1,000 m before nose, then 500 m, and the diverging areas, following TEM. Not so many warning and regulation signs are needed for the Highway.

Roadway Marking
Whereas the longitudes markings along outer edge line of carriageway are adequate, the broken lines between lanes are not adequate. The ration of segment and gap is 1:3. It should be smaller, TEM, for example, specifies 1:2. The implementation of arrows and raised bars (noise bar) on the main line pavement should be deleted, because of low effectiveness and adverse influence to traffic safety.

Safety Facilities
Guard rails at outer edge and concrete barriers at inner edge are properly designed, to prevent vehicles go beyond the line, thus contribute to prevent fatal accidents.

ITS（Intelligent Transportation System）

Vehicle detectors, CCTV's, and emergency telephones and so on are implemented along the Highway to detect incidents such as traffic accident, vehicle break down, frozen surface, maintenance works and so on. The information is transmitted to NHCC (National Highway Control Center) at Kutaisi, then, processed. The processed information is presented to the users through VMS, VTS and public broadcasting, internet. And, according to the incidents nature, mobilization of emergency vehicles such as ambulance is requested.

5. Applicable Japanese Technologies for E60 F4 Section

(1) Bridge Design

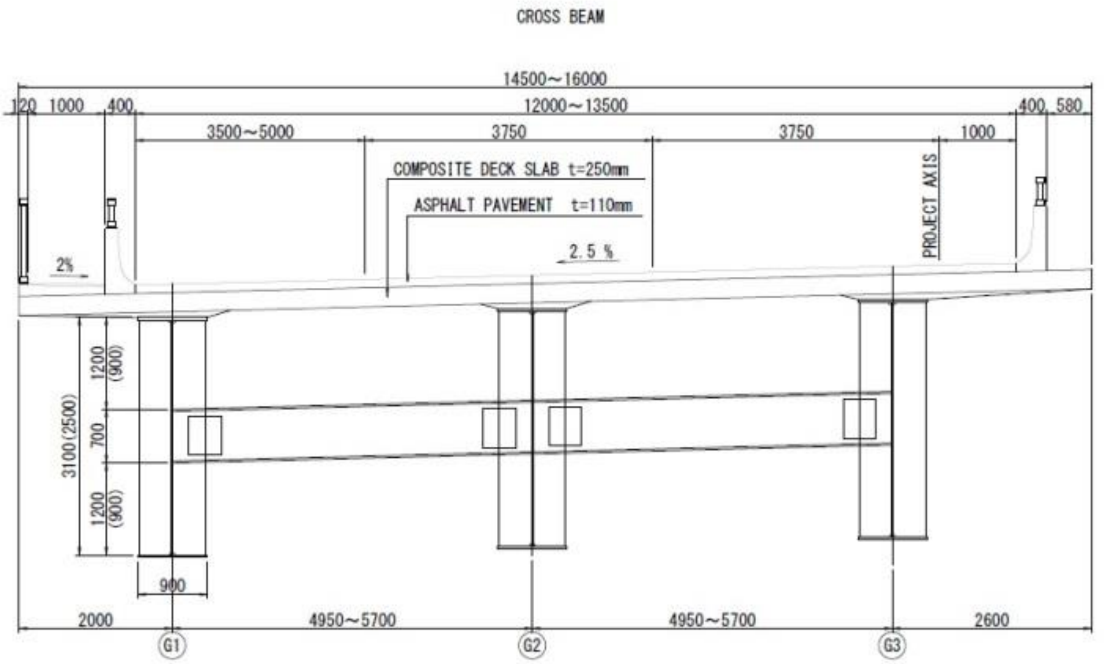
Regarding Weathering Steel, it was decided to adopt confirming that there is no use of Anti-freezing agent in Georgia.

JICA Survey Team adopted whole length continuous girder type which is no-expansion joint to get the smooth driving feeling, also it has the advantage in improvement of earthquake resistance and reduction of maintenance cost.

In addition, "Horizontal Force Dispersing Bearing" which is one of the typical Japanese technologies of anti-seismic was adopted. It resulted in reduction of foundation size of piers in the rivers.

As a design note of rationalized plate girder, the design manual of Japan stated as follows.

1) The center span of deck should be preferably around 6 m (5~7 m).
2) The overhang length at the side of deck should be 0.4 or less than the center span.
3) The width of the upper and lower flanges should be less than 1/3 of the web height. (to prevent from reduction in allowable compressive stress due to local buckling)
4) The transverse girder should be a steel plate type, and not use small pieces such as vertical / horizontal ribs, brackets etc. as much as possible.



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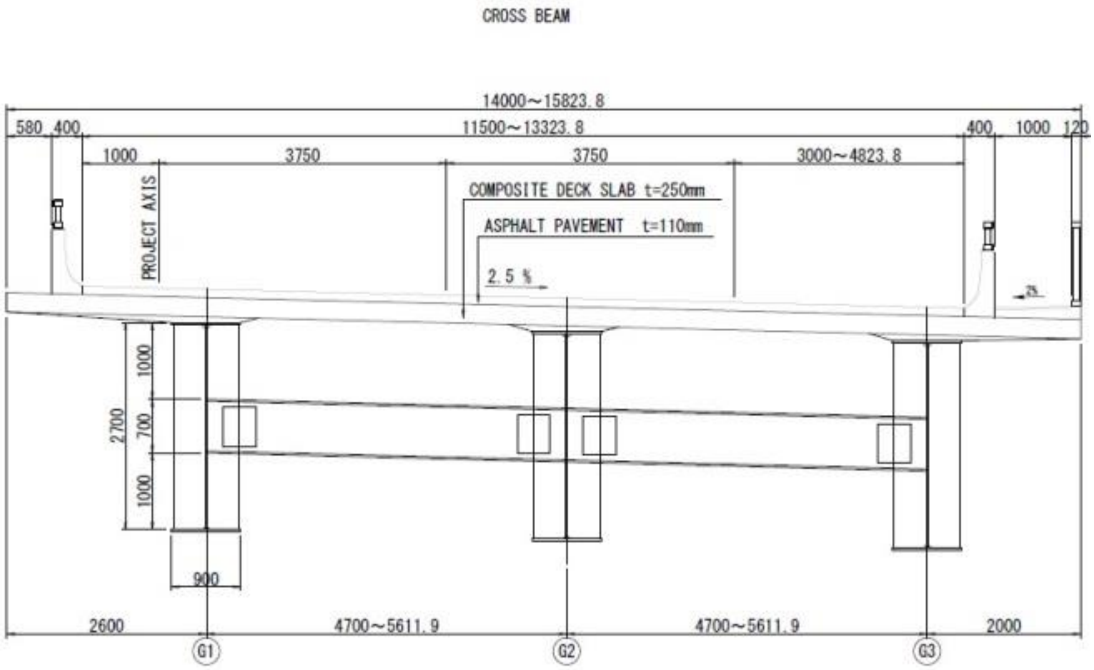

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Source: JICA Survey Team

Figure S-8: Cross Section of Superstructure

(2) Tunnel Design

Applicable Japanese Technologies

Table S-6 shows possible Japanese bridge technologies which could be applied to this project. However, all these application would not be adopted in this project since the STEP condition was largely satisfied along with the application of bridge technology and it was not possible to obtain the consensus from RD due to the increase in initial investment cost.

Table S-6: Applicable Japanese Technologies for Tunnels

Item	Location / Construction	Purpose
Mechanical Excavation Method	• 2 locations (4 tunnels) north of Zestafoni • Soft rock geology	• Elimination of vibration effects on structures near or above the tunnel. • Reduction of over-break
Auxiliary Method Long Steel Pipe Forepiling (AGF Method)	• For shallow overburden sections, for portals and for fault fracture zones	• Ensure stability during excavation
Automatic Cleaning Machine (Belt-Type) (attached separating agent coating device type)	• For cleaning concrete casting surface of lining form • Coating of separating agent	• Clean surface of concrete lining after construction • Simultaneous coating of separating agent • Reduction of cycle time
Concrete Filling Control System	• Perfect filling of concrete in crown part	• Overfilling of concrete in crown part
Pulling-out Vibrator System	• Compaction of placed concrete in crown part	• Uniform compaction

Source: JICA Survey Team

(3) Design of Cut Slope and Slope Protection Measures

Design of Cut Slope

The mountain streams around AT sta.0 + 020 and ATsta.0 + 060 in the cut slope point number 1 are cut and the exit of the mountain stream becomes a high position of the cut slope. Therefore it is necessary to install a vertical drainage on the cut slope. But the upper slope There is no necessity for Sabo measures to streams because there is no exposure rock that is the source of falling rocks.

In the design of the cut slope of the D/D consultant, no protective cut slope protection technique has been proposed, but in Japan, in the case of strong weathered rock and soil, in the case of seed spraying, shotcrete framework, rocks, A concrete shotcrete and the like are commonly used.

Considering that the rainfall is less than Japan, we propose to install a seed spraying plant and a drainage work on the cut slope where weathered rocks with high groundwater level are distributed.

The cut slope point number 8 ATsta.8 + 328 to 9 + 040, The cut slope point number 10 AT 9 + 726 to 9 + 98 and the cut slope point number 10' TA 9 + 78 to 9 + 818 The ground surface is deeply weathered from the nearby boring survey results, since it is expected that the order will be high, construction of the seed spraying work is preferable to prevent corrosion of the slope.

The cut slope point number 7 TA 8 + 257 ~ 8 + 286 is a steep slope of 79° with weathered rock, it is necessary to prevent collapse of the slope by concrete spraying works.

Design of Slope Protection Work

In the vicinity of TAsta.0 + 625 - ATsta.0 + 747 (the cut slope point number 2,2'), according to the field reconnaissance, loose rocks (including lapilli tuff) are expected on the natural slope above the top of the cut slope. As a countermeasure here, the Mighty-net method, which is a rock fall prevention net with greenery promoting (Tokyo Rope MFG.CO., LTD NETIS Registration Number KK-100030V) can be recommended. Using high-durable specification materials enable a long life (Even in a strong salt damage area, we have a track record of 27 years) of use and a reduction of maintenance cost.

Applicable Japanese Technologies

For the design of cut slopes in general, the blowing seed method or the slope frame method will be selected when the makeup of the surface is soil. On the other hand, the spraying method will be applied for a makeup of solid rock.

On the other hand, regarding measures for loose and/or falling stones on the natural slope, the fall prevention method is recommended as passive prevention work.

6. Procurement and Implementation Plan

(1) Project Executing Agency; RDMRDI

RDMRDI currently employs approximately 190 staff and is responsible for planning, rehabilitation and maintenance of International and Secondary roads totaling approximately 7,000 km. The amount of loans provided by the international donors has increased noticeably since 2017. RDMRDI will utilize the experience obtained over the last 10 years through the Projects under those international donor's supports for this Project.

(2) Procurement Plan

Overall Schedule

The Government of Georgia has been envisaging the completion of Khevi – Argveta section consisting of F2, F3 and this Project (F4) by the end of Year 2020. This indicates that all activities including procurement of contractors and a supervision consultant, and construction for F4 section shall be completed within extremely tight schedule of 3 years.

According to RDMRDI's schedule;

Duration between pledge and the signing of construction contract, 7 months (JICA standard duration 12-14 months)

Construction Period under the Contract 30 months (the survey team proposed construction period of 4-5 years, the road department is currently considering 33-36 months)

Procurement of the contractor under STEP will be proceeded;

i. Without PQ,
ii. Application of JICA Standard Bidding Documents in accordance with "Guidelines for Procurements under Japanese ODA Loans", Single Stage "One Envelope"

a) STEP

The Government of Georgia has shown a keen interest on the application of the Japanese technologies for the areas in bridge, tunnel and slope protection works. Requirements for STEP under STEP Operational Rules have been examined. Current procurement plan is based on STEP.

b) Packaging

Packaging of the Project (splitting to multiple contracts) was considered taking into account the size of each package being reasonable, interaction of each package being minimal, and shortening of the construction schedule, the JICA Survey Team proposed 2 packages (dividing into eastern section and western section of Bridge 4).

Road Maintenance

RDMRDI has been trying the introduction of Output-and Performance based Contract (OPRC), longer maintenance contract period (to 3 years from current 1 year contract), enlargement of scope (from single work to road, bridge and tunnel combined), supervision of the maintenance contract by a monitoring consultant (similar to the Engineer for construction contract) through pilot projects.

Contract period for most of the maintenance works becomes 3 years from 2018.

Construction Schedule and Method

Notwithstanding the extent of the scope of works (12 tunnels totaling 8,515 m in length and 14 bridges totaling span length of 5,010 m, total road length of approximately 14,700 m in both ways), the construction period required under the Contract is merely 30 months, which appears to be extremely tight.

The result of analysis on construction period and cost by the survey team indicated 4-5 construction period being an optimum construction period.

It is possible to physically complete the Project within 2.5 years provided that the contractor simultaneously proceeds different works by the employment of many construction parties, and ample resources, and the supervision of the works is proceeded smoothly, as the interactions of each work are minimal. The road department is considering the extension of the period to 33-36 months.

The bridges 1, 2 and 4 are steel bridges and are subject to STEP, application of rational girders to the superstructure is designed. Erection of superstructures of all bridges including pre-stressed concrete bridges are performed by cranes (200-250 ton) under current design. Temporary steel bents and substantial working platform are required for the lifting works by the cranes, as the erections are performed from river bed or existing ground. The construction of abutments at the terminal side of Bridge 4 occurs adjacent to existing Georgian rails, temporary protection wall along access ramp to the abutments and temporary platform over the railways may be required. It is essential to communicate with Georgian railways throughout the Project.

The use of blasting is planned for the excavation of tunnel 1, 2, 3, and 4, as hard rock is expected for the tunnels, road headers are considered for the excavation of tunnel 5 and 6, as soft rock is expected for the tunnels.

Total excavation volume of approximately 2,200,000 m^3 and filling volume of approximately 1,500,000 m^3, disposal material of 700,000 m^3 are estimated. RDMRDI proposes the transportation of the disposal material to the New Kutaisi Bypass site located approximately 20 km west from the site as the stockpile area, and considers the use of the material as filling material for the Bypass project.

7. Preliminary Project Cost Estimates

(A part of this summary has been removed because of confidential information.)

8. Environmental and Social Considerations

The Environmental Impact Assessment (EIA) and Land Acquisition and Resettlement Plan (LARP) were prepared by the DD consultant hired by ADB. The JICA Survey Team reviewed the drafts for conformity with Georgian legislation and the JICA Guidelines.

Potential impacts from the Project were assessed and screened comprehensively by category. Low to medium impacts are expected in most areas. Potentially high impact during the construction phase is expected from loss of land and property due to the new road, accidents and injuries to workers, and damage to properties caused during blasting and piling. Potentially high impact during the operational phase is expected from noise from increasing vehicles.

JST reviewed the final EIA submitted in March 2018 and confirmed that discussion results between JICA/JST/RD were properly reflected as followed, including issues that were pending such as potential soil contamination and mitigation measures for noise impact.

- Potential Soil Contamination

Should the results of additional sampling indicate any elevated levels of contamination, further testing of the excavated soils in this area will be required during the construction phase by the Contractor, and a proper mitigation measure for soil removal should be considered.

- Mitigation Measures for Noise Impact

Maximum of 5,950 m of noise barrier is recommended in the final EIA based on the model prediction for 2037, and this is incorporated into the detailed design. In reality, however, these barriers are to be constructed after operation begins if it is considered necessary based on noise monitoring and if the affected persons want the noise barrier to be constructed.

In the meantime, the LARP study revealed following impacts caused by land acquisition and resettlement for the Project.

- Project affected land (approximate 64 ha)

Project affected land plots (642,825m^2) have been grouped in following categories according to ownership types, based on legal right on ownership:

I category: Project affected private land plots, registered in Public Register: 381 with total affected area of 378,749 m^2.
II category: Legalizable project affected land plots: 194 land plot with affected area of 150,965 m^2.
III category: Non legalizable; ownership is not subject for legalization- 2 land plot, with total area of 11,956 m^2
IV category: State land (is not occupied arbitrarily by population) 32 plot with affected area 101,155 m^2.

- Affected Households : 21 HHs
- Impact on Business : 14 business facilities (4 restaurants, 2 is little shops and other 8 little factories or other industrial facilities) and loss of job of 41 people
- Impact on Agricultural Crops: 1,003,602 m^2 of corn, beans and other vegetables.
- Impact on Trees: 14,552 trees on 301 land

9. Economic Analysis

(A part of this summary has been removed because of confidential information.)

10. Project Evaluation

(1) Project Description

Georgia is in a geopolitically important location as an energy and commodities transport corridor between Europe, Asia, Russia and Middle Eastern countries. This corridor becomes more and more important for providing transport of oil and gas products from Caspian Sea to European countries and logistic bases between Central Asia and Caucasian countries. Thus, the East-west Highway Development is the Georgia's highest priority projects under these circumstances. This highway section of 67 km that is so far left undeveloped goes through narrow mountainous topographies that would need urgent construction.

This project section goes from Shorapani to Argveta going through narrow mountainous terrain. In order to provide a 4-lane International Standard highway tunnels and bridges would need for efficient travel. In addition, safety measures against falling rocks, slope failures, and landslides are crucial for the prevention of road blocks caused by disasters to ensure reliable and safe transport.

(2) Project Evaluation

Relevance of the Design

TEM (Trans European Motorway) is used for the geometric design of the highway in principle. GS (Georgian Standard), AASHTO of USA, Japanese Standards could be used if there are no items in TEM to apply. SNIP could be used only for examining the existing road designed by SNIP.

For bridge design, AASHTO and BS are widely used for international bidding in harmonized with Snip. For F4 section by ADB D/D consultant Eurocode (EN) is used. Steel super structures to be applied STEP is designed by the Japanese Standards, which is not familiar among Georgia engineers. The design standards of steel super structures (STEP application) are exclusively Japanese Standards, which also cover Eurocode as a result.

Tunnel length is predominant among other structures such as bridges or embankment in this section.

Tunnel excavation methods are generally divided into by blasting or by machinery depending on rocks and its environment. Machinery excavation could be applied to shallow tunnels under residences or buildings where noise and vibration would be a problem.

Geology of the site found by site visit are mainly composed of coarse-grained sandstone, volcano history tuff, tuff breccia and andesite of which simple strata direction is west-north-west to east-south-east and flat toward south 5 to 15 degrees. From the geological distribution, most of the cut slope belongs to hard rocks and some are soft rocks. Cut slope of hard rocks is very steep and slope protection is not necessary. If falling rocks either inside or outside of right-of-way is expected the protection by steel net is considered.

The highway pavement is generally classified by a flexible and rigid pavement. The rigid pavement (concrete pavement) needs higher initial investment but poor riding quality compared with asphalt pavement. Despite, Georgian Government decided to use concrete pavement for the East-west Highway because cement is locally obtained and thus economical and less maintenance required. Local contractors are very used to the concrete pavement because it is used in the neighboring sections.

This project is classified as category A based on the JICA Guidelines for Environmental and Social Considerations (April 2010) (hereinafter referred to as the "JICA Guidelines"), being a road sector project likely to cause environmental and social impacts.

Relevance of the Project

Georgian Government through the National Development Plan (Georgia 2020) emphasizes the importance of road development including the East-West Highway as a priority project to streamline domestic and international transport. In such situation, the Road Department of Georgia has decided the construction of E-60 as a key developmental action based on the priorities of road development.

The project follows these upper level plans and the results of the economic analysis say that the calculated value of EIRR is 13.03% for the basic cases. The development of the highway, therefore, is considered feasible from the national economy's point of view.

Effectiveness of the Project

The quantitative effect of the development of the highway will be evaluated as follows. The value for performance indicators were estimated for the base year (2017) and the target year 2023, two years after the project completion.

Table S-7: Targeted Outcome for the Project

Performance Indicators	Section/Location	Baseline (2016) Value	Target Year (2023) Value
Annual Average Daily Traffic (vehicles/day)	Dzirula (km 188)	14,489	18,589
	Argveta (km 200)	17,060	18,938
Average Travel Time (minutes/vehicle)	Shorapani ~ Argveta	20.64	11.03
Average Travel Speed (km/hour)	Shorapani ~ Argveta	50	80

Source: JICA Survey Team

The impact to existing villages would be minimum because road of this section is designed to be away from existing E-60 Highway and most of the sections are designed as tunnels. The new highway has a better riding quality because of smooth alignment, less operation costs and higher traffic safety compared to the existing E-60 highway. It is expected to have higher growth of logistic movement in the future, too. Construction of the Zestafoni bypass detours built-up areas of the town and would improve living environment of noise, air quality and vibration. It is expected that heavy traffic on the new expressway also improve traffic safety and traffic congestion of the existing E-60 by increased number of heavy traffic, which is currently going through city areas.

11. Conclusions and Recommendations

Despite being an important route for the Government of Georgia, the construction of the corresponding section was delayed due to severe topography and weather conditions. In such circumstances, even at a high cost, the new highway is worth constructing as the highway would provide higher quality of traveling performance and safety. Its effectiveness has been confirmed through the quantitative and qualitative effects discussed in the previous chapter and therefore, it is concluded that the project is effective and valid.

Although the Road Department is currently considering the development of the organizational structure, equipment/personnel, technology for road maintenance and management as these are common issues for the East-West Highway, further enhancement of traffic management, including information collection and dissemination is desirable for keeping the highway being used effectively. From such point of view, a visit to Japan to understand the maintenance and management state of the Japanese roads would be effective, in order to strengthen the management structure in Georgia.

Chapter 1 Introduction

1.1 Project Background

The International trunk highway crossing the east to west in Georgia (hereinafter referred to as East-West Highway) is a logistics keystone of connecting Europe and Asia and has a function as promoting of development of the Caucasus regional economy.

Georgia is in a geopolitically important location as an energy and commodities transport corridor between Europe, Asia, Russia and Middle Eastern countries. The transport system in Georgia comprises of land-based transport via highways and railways, maritime-based transport via Poti and Batumi ports, and air transport. The highway network of 22,000 km is the predominant means for land-based transport. Forty percent of cargo and more than 90 percent of passengers depend on the highways. The East West Highway is a 460 km international trunk highway that spans from the border at Azerbaijan to the coast of the Black Sea. This highway is part of the international highway network connecting Europe and Asia, and plays an important role in the region. In addition, the East West Highway carries about 60% of the international cargo to and from Georgia. The traffic has been growing 12% annually on average since 2005.

In the region connecting Europe and Asia (east-west), Russia and the Middle East (north-south), the transportation of energy and goods passes through this corridor, as the export route of the Caspian Sea oil and gas pipeline to Europe, as well as the Caucasus countries and Central Asia, as a logistics relay base in each country, its importance is increasing. Regarding logistics, there are two international ports, Poti port and Batumi port on the Black Sea coast, however, the Georgia Government is proceeding with new development of Anaklia Port on the coast near Abkhazia region since these existing two ports does not have a sufficient water depth. When the Anaklia Port is opened, the traffic volume through the East-West Highway is expected to further increase with neighboring countries such as Azerbaijan and Central Asian countries. In addition, a new port is being developed in Azerbaijan at about 65 km south of Baku, which will be designed and developed to take on the major points of the TRACECA line connecting Europe, Central Asia and China. For those reasons, East-West Highway Improvement is placed as the top priority project in the national development plan “Georgia 2020”.

Source: JICA Survey Team

Figure 1-1: Current Situation of the East-West Highway (E-60)

This project section goes from Argveta to Shorapani, which is a part of the unimproved Argveta and Chumateleti section, and a bottle neck for transport on the East West Highway. This highway section goes through narrow mountainous topographies that would need tunnels and bridges for efficient travel. In addition, safety measures against falling rocks, slope failures, and landslides are crucial for the prevention of road blocks caused by disasters.

The World Bank (WB), Asian Development Bank (ADB), and European Investment Bank (EIB) have financed and provided assistance towards project development starting from the eastern side. Japan International Cooperation Agency (JICA) has provided assistance to the Zestafoni-Kutaisi-Samtredia section of the East West Highway for two stages: East-west Highway Development Project I (approved in December 2009) and East-west Highway Development Project II (approved in March 2016) as Phase I of the project.

ADB is currently conduct the Detail Design (D/D) of the Khevi-Argveta section of E60; including the Shorapani-Argveta section of the highway which the Georgian Government applied for financing from the Japanese Government (East-west Highway Development Project Phase II) based on the F/S conducted by the WB.

1.2 Project Outline

Table 1-1: Outline of the Project

1) Project Name:	East West Highway Development Project Phase II
2) Scope of request (Target section):	• Road improvement and widening to four lanes of 14.7 km of the existing E60 between Shorapani and Argveta of Imeleti State, including 12 tunnels and 14 bridges. • Road Safety Measures (Falling rock, slope protection etc.) • Consulting services (D/D review, construction supervision etc.)
3) Target Area:	Shorapani and Argveta in Imeleti State of Georgia
4) Relevant Government Organizations:	Roads Department, Ministry of Regional Development and Infrastructure (RDMRDI)

Source: JICA Survey Team

1.3 Objectives of the Study

The objectives of the study are to implement necessary reviews for a Japanese Loan Project of the East West Highway Development Project (Phase 2) by examining possible application of Japanese technologies, and by reviewing the D/D being conducted by ADB. More specifically, upon review of the D/D; the project outline, project costs, implementation schedule, procurement and construction methods, possible application of Japanese technologies and methods, implementation organization, operation and maintenance organization and environment and social consideration will be investigated. Thorough investigations will be conducted for road/ tunnel construction, bridge types, and road safety measures.

Chapter 2 Present Condition of the Study Roads

2.1 Present Status of Roads and Transport in Study Area

2.1.1 Road Development in Georgia

Major trunk highways in Georgia are composed of international important highways that are also parts of Trans European Motorway (TEM) network such as primary trunk highways (S1-S13) of E-60 (Redbridge-Tbilisi-Poti), E-70 (Poti-Batumi-Sarpi) and secondary trunk highways. Key projects related to the development of Georgian road infrastructure and road maintenance works of these two categories of highways are implemented by the Roads Department under the Ministry of Regional Development and Infrastructure. Other categories of the roads of around 15,000 km[1] of local roads are the responsibility of cities and local governments. The current trunk road network of roughly 7,000 km is shown in Table 2-1.

Table 2-1: List of International Trunk Highways

Index	Trunk Highway	Total Length
S-1 (E-60) (E-97) (E-117)	Tbilisi-Senaki Leselidze (Russian Federation Border)	552 km
S-2 (E-60) (E-70)	Senaki-Poti (Bypass)-Sarpi	119 km
S-3 (E-117)	Mtskheta-Stepandtsminda-Larsi (Russian Federation Border)	139 km
S-4 (E-60) (E-117)	Tbilisi-Tsiteli Khidi (Border of Republic of Azerbaijan)	57 km
S-5	Tbilisi-Bakurtikhe-Lagodekhi (Border of Republic of Azerbaijan)	160 km
S-6 (E-117)	Ponichala -Marneuli-Geguti (Border of Republic of Armenia)	98 km
S-7 (E001)	Marneuli (from Kostava Street) to Sadakhlo) (Border of Republic of Armenia)	34 km
S-8 (E-691)	Khashuri-Akhaltsikhe-Vale	97 km
S-9 (E-60) (E-117)	Entrance to Tbilisi	49 km
S-10	Gori (Interchange)-Tskhinvali-Gupta-Java-Roki (Russian Federation Border)	92,5 km
S-11 (E-691)	Akhaltsikhe-Ninotsminda (Border of Republic of Armenia)	112 km
S-12 (E-692)	Samtredia-Lanchkhuti-Grigoleti	57 km
S-13	Akhalkalaki-Kartsakhi	36,5 km

Note: International Road (S Road) corresponds to E- Highway in the table.
Source: Website of Road Department of Georgia

The total length of international trunk highways is 1,603 km[2], whereas secondary (from No. 1 through No. 201) roads is 5,298 km.

[1] 15,415 km by GIRCA Economic Review, 13,426 km by Road Sector of Georgia, Overview (RD)
[2] 2017 RDMRDI Website

Note: The route number written in Georgian language is the same as “S” in English. (Table 2-1)
Source: RDMRDI Homepage

Figure 2-1: International Trunk Highway Network of Georgia (“S” Route)

Priorities of the road development by the Road Department of Georgia (RD) are:

- Gradual integration with EU road standards
- Ensure safe road infrastructure
- Rational planning of road infrastructure
- Development of improved road management system
- Improvement of monitoring functions
- Ensure competitive environment in the sector
- Environmental protection
- Improvement of social and resettlement policy

Based on these priorities, RD decided on the following developmental actions:

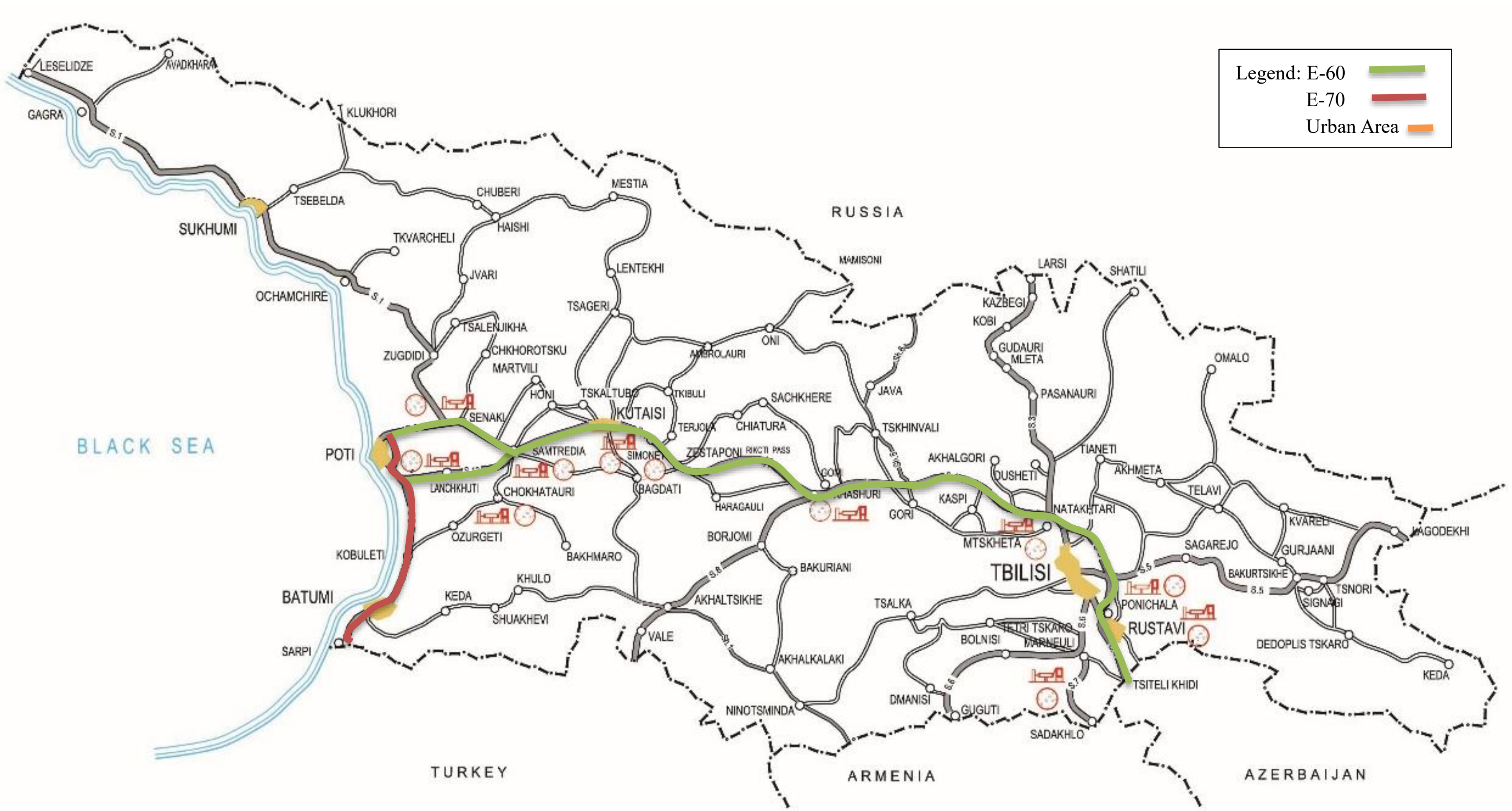
- Construction of the E-60 and E-70 Highways
- Construction and rehabilitation of international roads
- Construction of secondary roads, rehabilitation – periodic repair
- Construction and rehabilitation of structures
- Maintenance and operation of roads
- Working on prospective road infrastructure projects
- Ensuring riverbank protection activities

Currently, the Roads Department is responsible for 1,603 km of international roadway and 5,298 km of secondary roadway. The highways are distinguished by high amounts of transit vehicles from international road networks E-60 (Redbridge-Tbilisi-Poti) and E-70 (Poti-Batumi-Sarpi). These two roads join each other at the port city of Poti and represent the main transit roadway totaling 450 km in length. Upgrading of E-60 and E-70 highways commenced in 2006 and is being implemented in stages.

Road Development Projects

The Road Department of Georgia is currently implementing projects which amount to about 1,200 km in total being composed of 200 km of ongoing, 500 km of procurement and planning and 450 km of construction planning stage as listed in Table 2-2.

As shown in the table, there are numerous investors providing funding including international lending organizations as well as the Government.



Source: Pre-feasibility Study for the modernization of existing roads Poti-Tbilisi-Red Bridge, Report 2004

Figure 2-2: Trunk Highway Network of Georgia

Table 2-2: The Roads Department of Georgia Project List (as of June 6, 2017)

N	Road Name (Section)	Length (km)	Donor	Preparation of design documents		Bidding period of construction works		Implementation of construction works		Status
				Start	End	Start	End	Start	End	
Ongoing Construction										
1	Zestafoni-Kutaisi New Bypass (Upgrading and Construction of Zestafoni-Kutaisi New Bypass Section of the E-60 Highway)	59.00	JICA					Jul-13	Jan-18	Construction
2	Samtredia-Grigoleti (LOT-I) (Upgrading and Construction of Samtredia-Grigoleti Section of the E-60 Highway Lot-I)	11.50	EIB					May-14	Dec-19	Construction
3	Samtredia-Grigoleti (LOT-II) (Upgrading and Construction of Samtredia-Grigoleti Section of the E-60 Highway Lot-II)	18.50	EIB					Mar-16	Dec-19	Construction
4	Samtredia-Grigoleti (LOT-IV) (Upgrading and Construction of Samtredia-Grigoleti Section of the E-60 Highway Lot-IV)	9.50	EIB					May-15	Dec-18	Construction
5	Kobuleti Bypass (LOT II) (Upgrading and Construction of Kobuleti Bypass Section of the E-70 Highway Lot II)	18.00	ADB					May-13	Jun-18	Construction
6	Construction of Akhmeta-Telavi-Bakurtsikhe-Gza (Bakurtsikhe-Gurjaani) Bypass Road (15 km)	15.00	WB					Dec-16	Jun-19	Construction
7	Devdoraki Tunnel	1.20	GOG					Mar-17	Jun-18	Contract is signed
8	Stefentsminda-Sameba Church	5.66	GOG					Apr-17	Nov-18	Contract is signed
9	Zestafoni-Kutaisi Lightning (Upgrading and Construction of Zestafoni-Kutaisi New Bypass Section of the E-60 Highway)	15.17	JICA					Jun-17	Feb-18	Construction

N	Road Name (Section)	Length (km)	Donor	Preparation of design documents		Bidding period of construction works		Implementation of construction works		Status
				Start	End	Start	End	Start	End	
Ongoing and planned construction bidding										
1	Batumi Bypass Road (Upgrading and Construction of Batumi Bypass Road Section of the E-70 Highway)	14.30	ADB+ AIIB			Oct-16	Jul-17	Oct-17	May-20	Contract is signed
2	Samtredia-Grigoleti (LOT III) (Upgrading and Construction of Samtredia-Grigoleti Section of the E-60 Highway Lot III)	12.00	EIB			Oct-16	Jun-17	Sep-17	Nov-19	Contract is signed
3	Zemo Osiauri-Chumateleti (LOT I) Upgrading and Construction of Zemo Osiauri-Chumateleti Section of the E-60 Highway Lot I)	8.25	EIB			Feb-16	Jul-17	Aug-17	Aug-19	Contract is signed
4	Zemo Osiauri-Chumateleti (LOT II) (Upgrading and Construction of Zemo Osiauri-Chumateleti Section of the E-60 Highway Lot II)	14.50	WB			Feb-16	Jul-17	Aug-17	Aug-20	Contract is signed
5	Grigoleti-Choloki (Upgrading and Construction of Grigoleti-Choloki Section of the E-60 Highway)	14.50	EIB	Apr-16	Jul-17	Aug-17	Feb-18	May-18	May-20	Contract is signed
6	Dzirula-Moliti (LOT I) (Secondary road improvement project linking Dzirula-Chumateleti-Kharagauli)	24.6	ADB	Feb-17	Jul-17	Aug-17	Feb-18	May-18	May-20	Contract is signed
7	Moliti-Chumateleti (LOT II) (Secondary road improvement project linking Dzirula-Chumateleti-Kharagauli)		ADB	Feb-17	Jan-18	Feb-18	Jul-18	Aug-18	Feb-21	Detailed design
8	Khulo-Goderdzi (LOT I) (Reconstruction and Rehabilitation of the road section of Khulo-Goderdzi)	29.70	KUWAIT			Feb-17	Aug-17	Sep-17	Sep-19	Detailed design /bidding procedure
9	Goderdzi-Zarzma (LOT II)	17.40	WB				Aug-17	Sep-17	Sep-19	Detailed design /bidding

N	Road Name (Section)	Length (km)	Donor	Preparation of design documents		Bidding period of construction works		Implementation of construction works		Status
				Start	End	Start	End	Start	End	
										procedure
10	Construction of Bridge over Debeda River (Sadakhlo-Bagratashen Bridge Project)	0.11	EBRD			Jul-16				Contract is signed
11	Sino-Juta-Roshka-Shatili-Omalo-Khadori Gorge-Akhmeta-Batsara	250.00	GOG	Dec-16	Feb-18	Aug-17	Sep-17	Oct-17	Oct-20	Contract is signed
12	Baghdati-Abastumani	60.00	GOG	Jan-17	Jan-18	Aug-17	Sep-17	Oct-17	Oct-20	Contract is signed
13	Zemo Imereti-Racha	50.00	GOG	Jan-17	Jan-18	Aug-17	Sep-17	Oct-17	Oct-20	Contract is signed
14	Kobuleti Bypass (LOT I) Lightening	12.40	ADB			Jun-17	Nov-17	Dec-17	May-18	Bidding procedure
Ongoing design of construction										
1	Chumateleti-Khevi (F1) (Upgrading and Construction of Chumateleti-Khevi Section of the E-60 Highway)	11.20	WB	Feb-17	Mar-17	May-18	Oct-18	Nov-18	Nov-21	Detailed design
2	Khevi-Ubisa (F2) (Upgrading and Construction of Khevi-Ubisa Section of the E-60 Highway)	15.50	ADB	Apr-17	Apr-18	Jun-18	Nov-18	Dec-18	Dec-21	Detailed design
3	Ubisa-Shorapani (F3) (Upgrading and Construction of Ubisa–Shorapani Section of the E-60 Highway)	11.60	EIB	Apr-17	Mar-18	May-18	Oct-18	Nov-18	Dec-21	Detailed design
4	Shorapani-Argveta (F4) (Upgrading and Construction of Shorapani=Argveta Section of the E-60 Highway)	14.70	JICA	Apr-17	Dec-17	Feb-18	Aug -18	Oct-18	Oct-20	Detailed design
5	Kvesheti-Kobi (Preparation of Pre - Feasibility Study and Feasibility Study for Jinvali - Larsi Road and Detailed Design for the Construction of Kvesheti -Kobi Road Section)	26.00	WB	May-17	May-18	July-18	Dec-18	Jun-19	Jan-22	F/S & Detailed design

N	Road Name (Section)	Length (km)	Donor	Preparation of design documents		Bidding period of construction works		Implementation of construction works		Status
				Start	End	Start	End	Start	End	
6	Natakhtari-Zhinvali	30.00		Jun-17	Sept-18	Dec-18	May-19	Apr-19	Dec-21	F/S & Detailed design
7	Batumi (Chorokhi)-Sarpi	11.00	ADB+ AIIB	Dec-17	Sept-18	Nov-18	Apr-19	May-19	Nov-21	F/S & Detailed design
8	Rustavi-Red Bridge	35.00	ADB	Feb-17	Mar-18	May-18	Oct-18	Nov-18	May-21	Detailed design
9	Algeti-Sadakhlo	40.00		Feb-17	May-18	July-18	Dec-18	Jan-19	July-21	Detailed design
10	Tbilisi-Sagarejo (Preparation of Feasibility Study for Upgrading of Tbilisi-Bakurtsikhe, Tsnori-Lagodekhi Road and Detailed Design for the Upgrading of Tbilisi-Sagarejo and Sagarejo-Bakurtsikhe Road	30.00	WB	Jun-17	May-18	Jul-18	Dec-18	Jan-19	July-21	F/S & Detailed design
11	Sagarejo-Bakursikhe (same as above)	50.00	WB	Jun-17	Jun-18	Aug-18	Feb-19	Marc-19	Marc-21	F/S & Detailed design
12	Zugdidi-Anaklia (PFS and FS)	90.00	WB	Feb-17	Nov-18	Dec-18	May-19	Jun-19	Dec-20	Pre F/S &F/S
13	Gurjaani (Chumalaki)-Telavi Bypass	30.00	WB	Mar-17	Dec-17					Bidding procedure
14	Bakurtsikhe-Tsnori	16.00	WB	Mar-17	Feb-18	Feb-18	Apr-18	Oct-18	Apr-21	Bidding procedure
15	Bridge over Rioni river nearby Poti	5.00		Apr-16	Nov-17	Jan-18	Jun-18	Jul-18	July-20	Detailed design
16	Lentekhi-Mestia	35.00	GOG	Dec-16	July-18					Bidding procedure

Source: RDMRDI Website (http://www.georoad.ge/?lang=geo&act=pages&func=menu&pid=1389164951)

2.1.2 East-West Highway Development

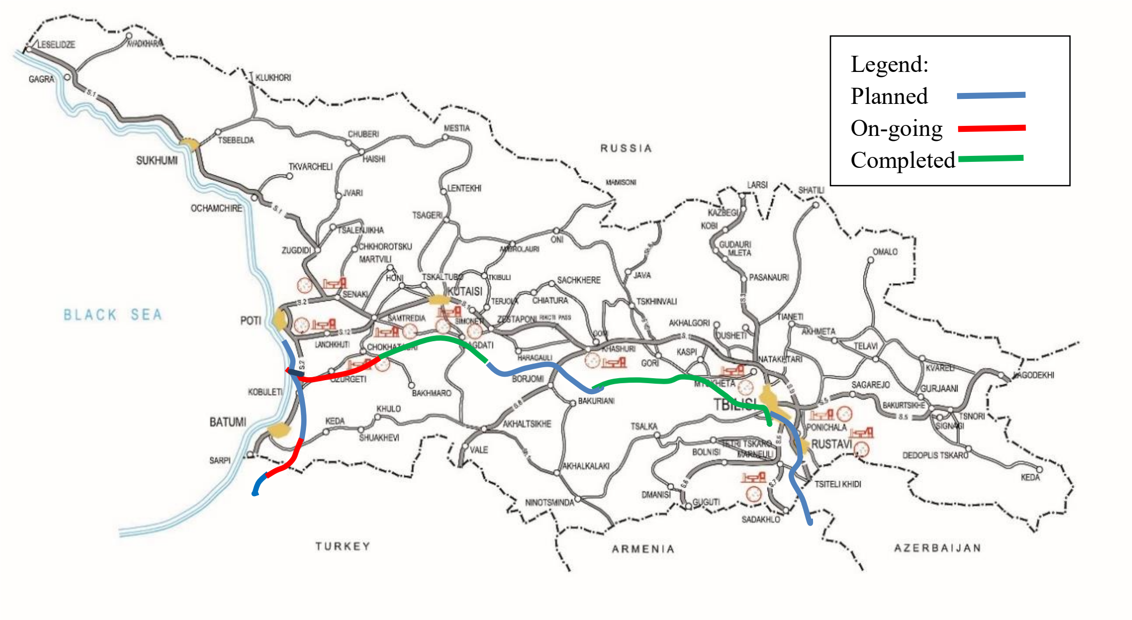
Economic growth and sustainable development of Georgia largely depend on efficient use of its geo-political potential as a transit country. The function of Georgia, as a part of Europe- Caucasus-Asia transport corridor that transport commodities and energy and transit fuel and gas produced in Caspian regions to Europe via pipelines, has significantly increased. Especially since the collapse the Soviet Union the importance of Europe- Caucasus- Asia transport by Georgia corridor has become much stronger in the 1990s.

The position of Georgia as a transit country became evident when the concept of developing corridor connecting the European East-West Corridor to Asia via Black Sea and South Caucasus finally reaching Caspian Sea was planned. This corridor has been developed as Trans European Transport Corridors in Europe and Asia Highways in the central Asian countries following the concept.

TRACECA (Transport Corridor Europe-Caucasus-Asia) was established at a conference in Brussels in May 1993, upon the signing of a Multilateral Agreement on International Transport for the development of transport initiatives (including the establishment and development of a road corridor) between the EU member states, the Caucasus, and Central Asia countries.

The program supports the political and economic independence of the former Soviet Union republics through enhancing their access to European and global markets, and to strengthen economic relations, trade and transport in the regions of the Black Sea basin through road, rail and sea. TRACECA members include Armenia, Azerbaijan, Bulgaria, Georgia, Kazakhstan, Kyrgyz Republic, Moldova, Romania, Tajikistan, Turkey, Turkmenistan, Ukraine, and Uzbekistan. Georgian is a key member among these countries.

Under these circumstances, the East-West Highway development is part of the TRACECA network and very important not only for Georgia, but also for neighboring countries as an international corridor for the transportation of goods and passengers. The World Bank (WB), Asian Development Bank (ADB), and European Investment Bank (EIB) as well as JICA have supported the development, which started from Tbilisi on westward. The only section between Tbilisi and the Black Sea that has not started yet is a 67 km section going through the Rikoti pass. The section is high in altitude with steep mountains and goes through the pass where there is a lot of snowfall in winter. The existing road (E60) is winding with steep slopes, which have caused falling rocks and slope failures. The development projects east of Tbilisi are Tbilisi Bypass (55 km), Rustavi – Red Bridge (35 km), Rustavi – Sadakhlo (30 km). Table 2-2 indicates the present situation of the East-west Highway development between Tbilisi and the Black Sea area by donors.



Source: Road Sector of Georgia, Overview

Figure 2-3: Progress of East-West Highway Construction

Table 2-3: Status of East–West Highway Development

Road Section	Length	Planned/ Upgrading	Financier	Completion Date
Tbilisi – Natakhari	11 km	4-lane, dual carriageway	State Budget	Completed
Natakhari - Aghaiani	16 km	4-lane, dual carriageway	State Budget	Completed
Aghaiani - Ruisi	50 km	4-lane, dual carriageway	World Bank	Completed
Ruisi - Agara	19 km	4-lane, dual carriageway	World Bank 2014	Competed
Agara – Zemo Osiauri	12 km	4-lane, dual carriageway	World Bank 2015	Completed
Zemo Osiauri - Chumateleti	14 km	4-lane, dual carriageway	World Bank	Under Preparation
Chumateleti - Argveta	51 km	4-lane, dual carriageway	WB, ADB, JICA	Design Stage
Zestafoni - Samtredia	59 km	2 to 4-lane, dual carriageway	JICA	Completed
Samtredia – Choloki	70 km	4-lane, dual carriageway	EIB 2016	Ongoing
Choloki – Kobuleti bypass	33 km	2-lane single carriageway	ADB 2016	Under Preparation
Batumi Bypass Road Project	14.3 km	2 lane single carriageway	ADB & AIIB 2017	Ongoing

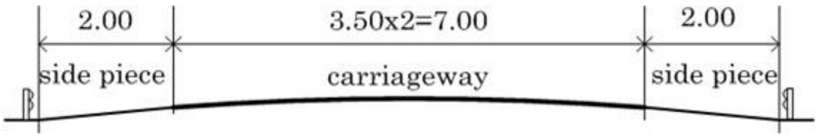
Source: JICA Survey Team based on F/S Report as of 2017

2.1.3 Traffic Conditions of the Project Area

The road network in Georgia is relatively well developed despite rolling and mountainous terrain. Georgia is one of the key members of Transport Corridor Europe-Caucasus-Asia (TRACECA) due to its geographical location and political importance. It is also expected to become a busy hub of the Modern Silk road in the near future because it is located in the middle of Europe and Asia. The National Development Plan (Georgia 2020) emphasizes the importance of road development including the East-West Highway as a priority project to streamline domestic and international transport, increase road network safety/ convenience of logistic center, and strengthen economies of the region.

(1) Road Condition

The present national highway S-1 (E-60) is a part of Trans European Motorway network. This route is considered to be an internationally important highway and classified as an international trunk highway. The geometric features of the road is specified by the Georgian Standard shown in the figure for design speed of 80 km/h.



Source: JICA Survey Team based on GS

Figure 2-4: E-60 Cross Section

(2) Traffic Condition

1) General

East-West highway development started from Tbilisi on westward. The traffic volume around Tbilisi is the highest of all other sections. Annual average traffic near the area reached 37,000 vpd[3] in 2013 with a heavy vehicle mix of 17%, and 49,000 vpd in 2016 with a heavy vehicle mix of 28%. On the other hand, traffic at Natakhtari located about 30 km from Tbilisi recorded 21,000 vpd in 2013 with a heavy vehicle mix of 21%, and 26,000 vpd in 2016 with a heavy vehicle mix of 30%. The four-lane highway can handle these traffic volumes for the time being, but there will be difficulties in keeping adequate service levels in the future. The traffic volume in 2016 on the four-lane section between Tbilisi and Khashuri was around 20,000 vpd with a heavy vehicle mix of 30%.

The traffic of the Shorapani-Argveta project section has less short-distant traffic because the section is 150 km away from Tbilisi. However, long-distant traffic of trucks and buses traversing from Azerbaijan and Turkey (passing through Georgia) occupy a significant proportion of traffic (37-38%)[4]. Table 2-4 indicates current traffic count results.

Table 2-4: Traffic Conditions of East-West Highway

	Survey by D/D consultant 1)	Survey by RD	FS Traffic Survey	Traffic forecast of FS		
				Low estimates	moderate	High estimates
	2017	2016	2014	2019		
Location 3 km 188 (Rikoti-Zestafoni)	17,249	12,855 2)	11,072	13,000	13,900	15,000
Location 4 km 200 (Zestafoni-Kutaisi)	20,310	14,656 3)	14,291 4)	15,400	18,000	19,400

Unit: Vehicle per day
1) Survey results do not reflect yearly average because it did not consider seasonal variations
2) Survey location by RD was 179 km post
3) Survey location by RD was 215 km post
4) By manual count, other data by automatic count was 15,186 vpd.
Source: Prepared by JICA Survey Team based on D/D Consultant and RDMRDI, F/S

[3] Georgia Road Department (RD)
[4] Survey by D/D Consultant in 2017

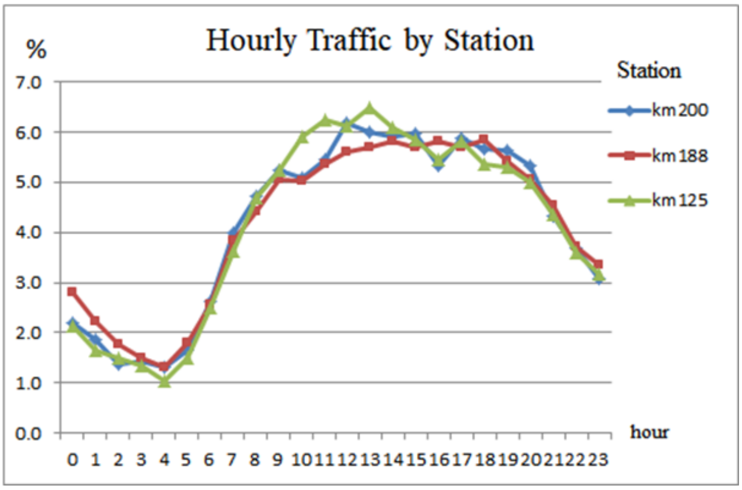
The present traffic volume of E60 from the count data seems to be very close to the capacity of two-way, two-lane road, depending on the location. When the improvement work of E60 to connect to the new highway starts in the near future, it is necessary to build the new two-lane road first, while the existing traffic can still use the old section. Once the new two-lane is completed, the traffic can use the new section. Then, another two-lane road will be constructed. Thus, traffic management of the construction site is very important and should be carefully examined during D/D stage.

2) Hourly traffic volume

Traffic condition is analyzed based on the data from Automatic Counting Station managed by RDMRDI. The analyses are also included in ITR2 by DD consultant, but, here mainly percentage of hourly traffic to daily traffic is analyzed. Stations are km200, km188 and km125.

a) Hourly traffic on the stations

The hourly traffic volume ratio on July 26th through three stations is shown in Figure 2-5. Traffic on each station shows no obvious peak pattern, and percentage is low especially at km188, it did not touch even 6%.

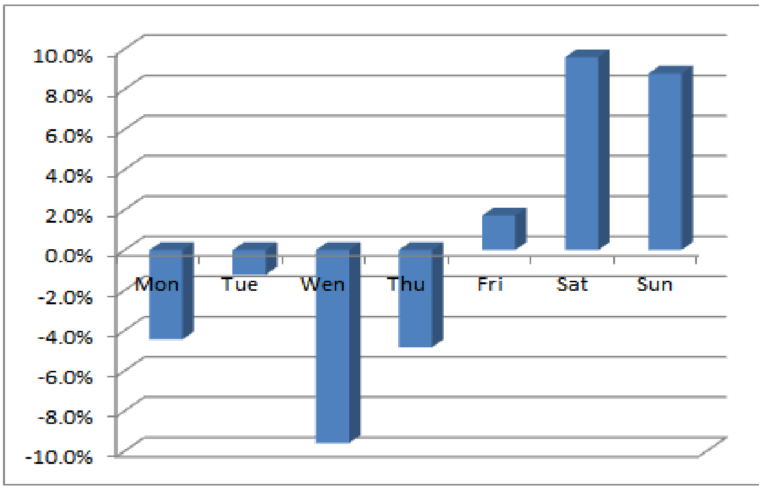


Source: RDMRDI auto count data

Figure 2-5: Hourly Traffic Volume on Three Stations

b) Weekly traffic pattern

Daily traffic volume on km188 through a week is analyzed and is shown in Figure 2-6. The pattern shows high volume on Saturday and Sunday. As the same pattern was reported on FS report it might be the feature of the region.



Source: RDMRDI auto count data

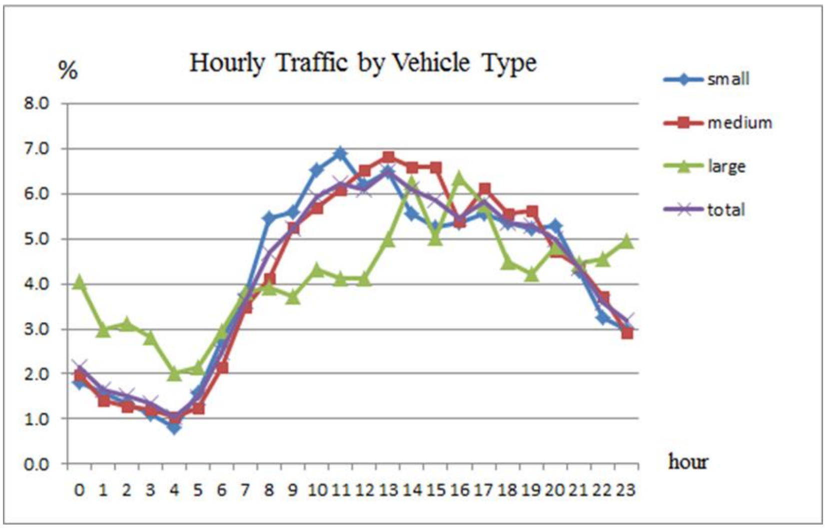
Figure 2-6: Weekly Traffic Fluctuation

3) Hourly Traffic Volume by Vehicle Type

Hourly traffic volume by vehicle type is shown in Table 2-5 and Figure 2-7. Vehicle component ratio is:

- Small vehicle (Car, 2-wheel): 43.9%
- Medium vehicle (Medium-sized car, Pick-up, Minibus): 45.2%
- Large vehicle (Bus, Truck, Trailer, >3-axle): 10.9%.

The vehicle type is decided by their length measured by occupancy by detector.



Source: RDMRDI auto count data

Figure 2-7: Hourly Traffic by Vehicle Type

Table 2-5: Hourly Traffic Volume by Vehicle Type

hour	small vehicle		medium vehicle		large vehicle		total	
	volume	%	volume	%	volume	%	vehicle	%
0	157	1.8	187	2.1	81	3.8	425	2.2
1	145	1.7	164	1.8	79	3.7	388	2.0
2	86	1.0	145	1.6	51	2.4	282	1.4
3	92	1.1	95	1.1	36	1.7	223	1.1
4	82	1.0	91	1.0	32	1.5	205	1.0
5	132	1.5	122	1.4	60	2.8	314	1.6
6	223	2.6	201	2.2	64	3.0	488	2.5
7	333	3.9	323	3.6	69	3.2	725	3.7
8	419	4.9	389	4.4	76	3.5	884	4.5
9	488	5.7	487	5.4	89	4	1,064	5.4
10	554	6.5	520	5.8	101	5	1,175	6.0
11	538	6.3	508	5.7	104	5	1,150	5.9
12	576	6.8	511	5.7	99	5	1,186	6.0
13	567	6.6	540	6.0	111	5	1,218	6.2
14	517	6.1	558	6.2	123	6	1,198	6.1
15	480	5.6	533	6.0	120	6	1,133	5.8
16	470	5.5	569	6.4	152	7	1,191	6.1
17	494	5.8	570	6.4	125	6	1,189	6.1
18	471	5.5	546	6.1	96	4	1,113	5.7
19	457	5.4	490	5.5	112	5	1,059	5.4
20	377	4.4	430	4.8	118	5	925	4.7
21	336	3.9	401	4.5	103	5	840	4.3
22	295	3.5	305	3.4	70	3	670	3.4
23	241	2.8	252	2.8	86	4	579	3.0
total	8,530	100	8,937	100	2,157	100	19,624	100
Vehicle component (%)								
		43.5		45.5		11.0		
daitime (12hr) traffic volume							13,226	
nighttime (12hr) traffic volume							6,398	
daitime ratio to daily traffic							1.48	

Source: RDMRDI's ATC data

4) Speed characteristic

Spot speeds are measured at the three stations. The measurement results are summarized in Table 2-6. Only the Station at km 200, vehicle types are classified in three types, but at the other stations they are two. This summary is made only for daytime traffic.

The measured speeds are high, considering posted speed limit is 50 km/h. At station km188, higher speed of westward traffic might be affected by down slope from Rikoti tunnel.

Table 2-6: Traffic Speed by Vehicle Type

unit : km/h

	km125		km188		km200	
	to east	to west	to east	to west	to east	to west
small vehicle	67.6	69.4	61.9	69.7	57.8	50.0
medium vehicle					57.4	51.2
large vehicle	64.5	63.1	54.0	65.2	50.9	46.4
volume(veh/12h)	6,904	6,205	5,662	4,847	6,883	6,651

Source: RDMRDI's ATC data

5) Capacity

a) capacity calculation
Capacity of the road is defined in TEM following American HCM. Following that way the capacity of E-60 is tried to be obtained.

$C_c = C_B * \gamma_L * \gamma_T$

C_C : possible capacity (pcu/h)

C_B : basic capacity (pcu/h) = 2,800

γ_L : 0.93 (reduction for lane width less than 3.60 m)

γ_T : 0.82 (reduction by mixing of large vehicle)

$\gamma_T = 100 / (100+(E_T-1)*P_T) = 100 / (100+(3-1)*11)$

E_H : 3

P_T : percentage of heavy vehicle : 11%

$C_c = 2{,}800 \times 0.93 \times 0.82 = 2135$ (pcu/h)
The capacity of 2,135 pcu/h for E-60 is obtained.

b) v/c calculation
For traffic volume, station at km200 27 July 13:00 is used. (Table 2-5)
pcu = 577+625+110*3 = 1532 pcu/hr (peek hour)
v/c = 1532/2135 = 0.72

Level of Service is deemed "D" according to Table 2b of TEM (Table 2-7). It means traffic condition is approaching to its capacity, but there is still a room for increase of traffic.

Table 2-7: Traffic Volume/Capacity Ratio and Level of Service

TEM Standards and Recommended Practice

Table 2b – Source HCM 1997

LEVELS OF SERVICE FOR SINGLE TWO-LANE HIGHWAY (INITIAL MOTORWAY CONSTRUCTION STAGE) SEGMENTS

Level of Service	% Time Delay	v/c RATIO (1)																				
		LEVEL TERRAIN							ROLLING TERRAIN							MOUNTAINOUS TERRAIN						
		AVG SPD[2] km/h	PERCENT NO PASSING ZONES						AVG SPD[2] km/h	PERCENT NO PASSING ZONES						AVG SPD[2] km/h	PERCENT NO PASSING ZONES					
			0	20	40	60	80	100		0	20	40	60	80	100		0	20	40	60	80	100
A	30	93	0.15	0.12	0.09	0.07	0.05	0.04	92	0.15	0.10	0.07	0.05	0.04	0.03	90	0.14	0.09	0.07	0.04	0.02	0.01
B	45	88	0.27	0.24	0.21	0.19	0.17	0.16	87	0.26	0.23	0.19	0.17	0.15	0.13	87	0.25	0.20	0.16	0.13	0.12	0.10
C	60	83	0.43	0.39	0.36	0.34	0.33	0.32	82	0.42	0.39	0.35	0.32	0.30	0.28	79	0.39	0.33	0.28	0.23	0.20	0.16
D	75	80	0.64	0.62	0.60	0.59	0.58	0.57	79	0.62	0.57	0.52	0.48	0.46	0.43	72	0.58	0.50	0.45	0.40	0.37	0.33
E	>75	72	1.00	1.00	1.00	1.00	1.00	1.00	64	0.97	0.94	0.92	0.91	0.90	0.90	56	0.91	0.87	0.84	0.82	0.80	0.78
F	100	<72	-	-	-	-	-	-	<64	-	-	-	-	-	-	<56	-	-	-	-	-	-

(1) Ratio of flow rate to an ideal capacity of 2800 pc/h in both directions.
(2) These speeds are provided for information only and apply to roads with design speeds of 100km/h or higher.

Source: TEM Standard

2.2 Social and Economic Conditions

2.2.1 Social Conditions

Georgia is a country of Transcaucasia located at the eastern end of the Black Sea on the south flanks of the main crest of the Greater Caucasus Mountains. It is bounded on the north and northeast by Russia, on the east and southeast by Azerbaijan, and on the south by Armenia and Turkey. Georgia was the center of the peoples' movement and thus has been occupied several times in the history. Yet it maintains its culture and religion, geographical location, and political importance, which made the hub of the peoples' movement in the area.

In 1936 Georgia became a union republic and continued as such until the collapse of the Soviet Union, when Georgia declared independence from the Soviet Union on April 9, 1991. The 1990s was a period of instability and civil unrest in Georgia. The first few years of the formation of an independent, market-based economic system were especially difficult for Georgia: civil unrest, armed conflicts in Abkhazia and South Ossetia, energy and transport blockades, high crime rates, severed economic ties, the loss of old, traditional markets and suppliers and the absence of new connections and suppliers to adequately replace old ones, high rates of workforce migration. The population of Georgia excluding South Ossetia and Abkhazia was 4.4 million[5] in 2008 and 3.73 million according to 2014 census. It has declined since 1992 when the population was about 5.5 million[6]. The population of Tbilisi has recorded the highest (1.11 million), occupying 30% of the national population. The second largest city with a population of 152,000 is far less, which indicates the excessive concentration of population in the capital city.

Georgia experienced a long economic downturn due to several political revolutions since independence. In 2004 Georgia introduced a new economic and political reforms. The main goal of the reforms was to establish an environment in the country that would grow the economy, return a sense of dignity to the citizens of Georgia and give the country an opportunity to achieve sustainable development. In the economic sector, the main aim of the government was to change the business climate to make it much friendlier for Georgian entrepreneurs and the increased economic activity, which resulted in higher economic growth and a dramatic reduction in poverty levels. Other aspects of economic growth have strong relations with efficient use of natural resources, securing safety and prevention of natural disasters that would be brought by economic growth. Therefore, Government of Georgia's goal is to create foundations for long-term inclusive economic growth and improve the welfare of the population.

Current economic growth is significant and stable indicating growth of 6-7% from 2010 to 2013 with some exception of the minus growth by war in 2009 and weak growth by Russian economic downturn. However, increase of job opportunities is not significant because industrial and commercial structures still remain the same as before. As a result, unemployment rates rose from 13.3% in 2007 to 16.5% in 2008; by 2012, the rate had dropped to 15%. Over the same period, however, youth unemployment (15-19 age group) rose from 27.7% (2007) to 36.9% (2012). The future population decrease of young age group who are expected to assume a role for economic development of the country is a concern.

[5] Georgia Statistics
[6] United Nations, Department of Statistics, Demographic Yearbook

2.2.2 Economic Conditions

Georgia's economy had predominantly depended on agriculture before the 20th century. The modern economy of Georgia is supported by the tourism industry of the Black Sea, fruit, tea, grapes, and a large-scale industry of wine production. The metal industry, machinery, chemical production and garment industry were the core of the economy until the collapse of the Soviet Union. Most of these industries lost their market share and have been unable to rebound ever since.

Its gross domestic product fell sharply following the collapse of the Soviet Union. The growth rate dropped to USD 2,514 million in 1994 and USD 3,057 million in 2000. But it recovered in the mid-2000s, growing in double digits of USD 6,411 million thanks to the economic and democratic reforms brought by the peaceful Rose Revolution. Georgia's economy enjoys a relatively free and transparent operation. According to Transparency International's 2017 report, Georgia is the least corrupt nation in the Black Sea region among all of its immediate neighbours, as well as nearby European Union states. Table 2-8 shows GDP and Per Capita Income since 2010.

Table 2-8: GDP and Per Capita Income since 2010

	2010	2011	2012	2013	2014	2015	2016
GDP real growth, percent	6.2	7.2	6.4	3.4	4.6	2.9	2.7
GDP deflator, percent	8.5	9.5	1.1	-0.8	3.8	5.9	4.0
GDP per capita (at current prices), GEL	4,675.7	5,447.1	5,818.1	5,987.6	6,491.6	8,550.9	9,117.7
GDP per capita (at current prices), USD	2,623.0	3,230.7	3,523.4	3,599.6	3,676.2	3,766.6	3,852.5
GDP at current prices, mil. USD	11,636.5	14,438.5	15,846.8	16,139.9	16,507.8	13,988.1	14,332.8

Source: geostat.ge/index.php?action=page&p_id=119&lang

The EU and Georgia signed an Association Agreement on 27 June 2014 which has entered into force since 1 July 2016. The agreement introduces a preferential trade regime – the Deep and Comprehensive Free Trade Area (DCFTA). The EU is the main trade partner of Georgia. Around 29%[7] of its trade takes place with the EU. The DCFTA creates a closer economic integration of Georgia with the EU based on reforms in trade-related areas. It removes all import duties on goods and provides for broad mutual access to trade in services. After the agreement Georgia trade recorded increased in 2015.

The Free Trade Agreement between China and Georgia will officially take effect on 1 January 2018. Once the agreement takes effect, Georgia will eliminate tariffs on 96.5%[8] of Chinese exports, while almost 91% of China's imports from Georgia will become tariff-free immediately. A further 3% will be exempted from tariffs within five years. Georgia's main exports to China are copper ore, iron ore, nuts, wine, spirits, gold and semi-finished products. China ships construction machinery, manufacturing equipment, steel, electronics, textiles, garments and household appliances to Georgia.

7 http://ec.europa.eu/trade/po;icy/countiries-and-regions/
8 China Daily USA 05/15/2017

Chapter 3 Traffic Demand Forecast

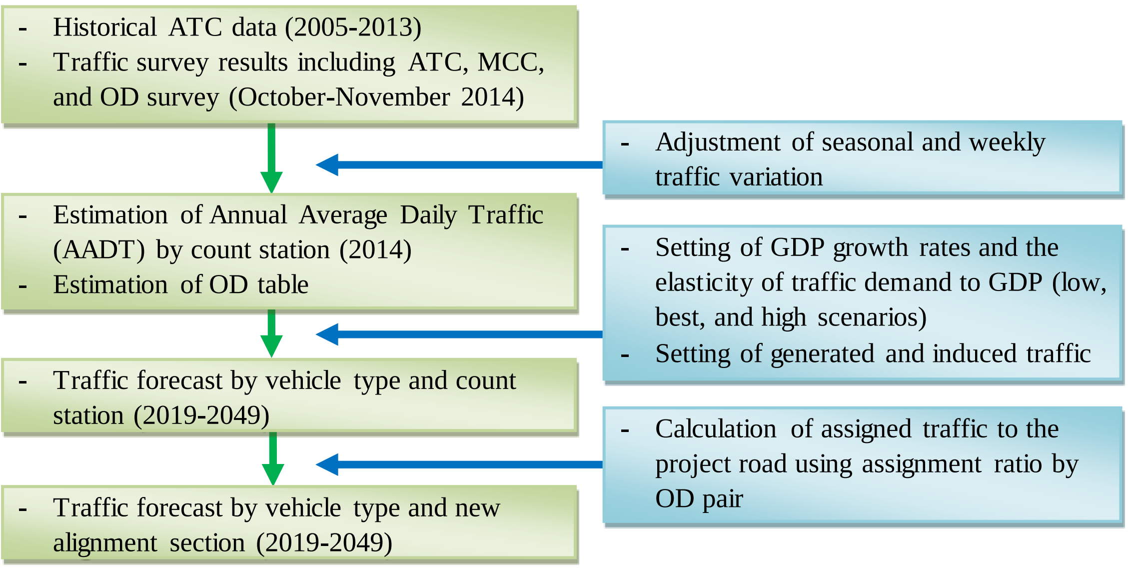
3.1 General

This chapter first reviews the traffic forecasts prepared by the F/S;[1] then examines the traffic forecasts with a focus on existing traffic and traffic growth rates; and lastly proposes an updated forecast. The steps taken are as follows: (i) existing forecast in the F/S was examined and key points were summarized, (ii) the existing traffic was examined with close reference to the RDMRDI and D/D traffic counts, (iii) the traffic growth rates assumed in the F/S were examined, assuming the GDP growth rates and the elasticity of demand to GDP, and (iv) updated traffic forecasts for the Shorapani–Zestafoni East and Zestafoni West–Argveta sections was proposed.

3.2 Review of F/S Traffic Forecast

3.2.1 Methodology

Figure 3-1 shows the overview of the traffic forecasting process employed by the World Bank-funded F/S. The F/S first estimated the Annual Average Daily Traffic (AADT) and Origin-Destination (OD), mainly based on historical Automatic Traffic Counts (ATC) data and traffic survey results including those of ATC, Manual Classification Counts (MCC), and OD survey. It then provided the traffic forecast by vehicle type and count station up to the year 2049, following the setting of traffic growth rates, as well as generated and induced traffic. The F/S lastly provided the traffic forecast by vehicle type and new alignment section, following the calculation of assigned traffic to the new road after the completion of the project using assignment ratio of OD pair. This traffic forecast methodology employed in the F/S does not have any issues; therefore, it is considered reasonable.[2]



Abbreviations: ATC = Automatic Traffic Count, GDP = Gross Domestic Product, OD = Origin-Destination, MCC = Manual Classification Count
Source: JICA Survey Team based on the F/S

Figure 3-1: Overview of the Traffic Forecast Methodology Employed in the F/S

[1] The study title is: RDMRDI, *Upgrade of Feasibility Studies for E-60 Highway Section from Zemo Osiauri to Argveta and Undertaking Detailed Design for E-60 Highway Section from Zemo Osiauri to Chumateleti (Feasibility Study for E-60 Highway Section from Zemo Osiauri to Argveta)*, Final Report, December 2015.
[2] Note that the traffic forecast indicated in the latest World Bank project appraisal document for the East-west Highway is consistent with the forecast prepared in the F/S (Source: World Bank, *East-west Highway Corridor Improvement Project*, Project Appraisal Document, October 2015).

3.2.2 Results

The results of the F/S forecast for the new road in the survey section are summarized as follows:

- The F/S forecast of two-way traffic for the best scenario on the Shorapani– Zestafoni East and Zestafoni West–Argveta sections is shown in Table 3-1 (note that only the forecast for major years is excerpted). It provides the forecast from 2019 to 2049, assuming the highway opens in 2019.

- On the Shorapani–Zestafoni East section, the total number of daily traffic in 2019 was projected at 14,208, of which 58% were cars, 12% were buses, 12% were light goods vehicle (LGV), and 18% were trucks. Its forecast was projected to reach 39,971 in 2049, up from 22,405 in 2029 and 30,915 in 2039.

- On the Zestafoni West–Argveta section, the total number of daily traffic in 2019 was projected at 15,158, of which 60% were cars, 12% were buses, 11% were LGV, and 17% were trucks. Its forecast was projected to reach 42,666 in 2049, up from 23,910 in 2029 and 32,997 in 2039.

Table 3-1: F/S Forecast for New Road in Survey Section

Year	Car	Minibus	Bus	LGV	2-axle	3-axle	4-axle+	Total
Shorapani–Zestafoni East section on the new road								
2019	8,256	1,537	145	1,706	262	168	2,134	14,208
2029	13,103	2,440	222	2,708	402	258	3,272	22,405
2039	18,129	3,376	303	3,747	548	351	4,461	30,915
2049	23,491	4,375	387	4,855	702	450	5,711	39,971
Zestafoni West–Argveta section on the new road								
2019	9,037	1,659	214	1,728	417	199	1,904	15,158
2029	14,343	2,634	328	2,742	639	306	2,918	23,910
2039	19,844	3,644	447	3,794	871	417	3,980	32,997
2049	25,714	4,722	572	4,916	1,115	533	5,094	42,666

Abbreviation: LGV = Light Goods Vehicle
Notes: (i) Above figures do not include traffic of existing roads. (ii) Car includes private cars, taxis, and four-wheel drive vehicles, which are being used as private cars; minibus includes buses of up to 15 seats; LGV includes vans and pick-ups; 2-axle includes trucks with a total of two axles and six wheels; 3-axle includes trucks with a single axle at the front and two axles at the rear; and 4-axle+ includes trucks with four or more axles or truck-trailer combinations with four or more axles.
Source: JICA Survey Team based on the F/S

- Traffic growth rates obtained from the F/S forecast are presented in Table 3-2; indicating 4.4-4.7% growth per year from 2019-2029, 3.1-3.3% per year from 2029-2039, and 2.5-2.6% per year from 2039-2049 for both sections.

Table 3-2: Traffic Growth Rates Calculated from the F/S

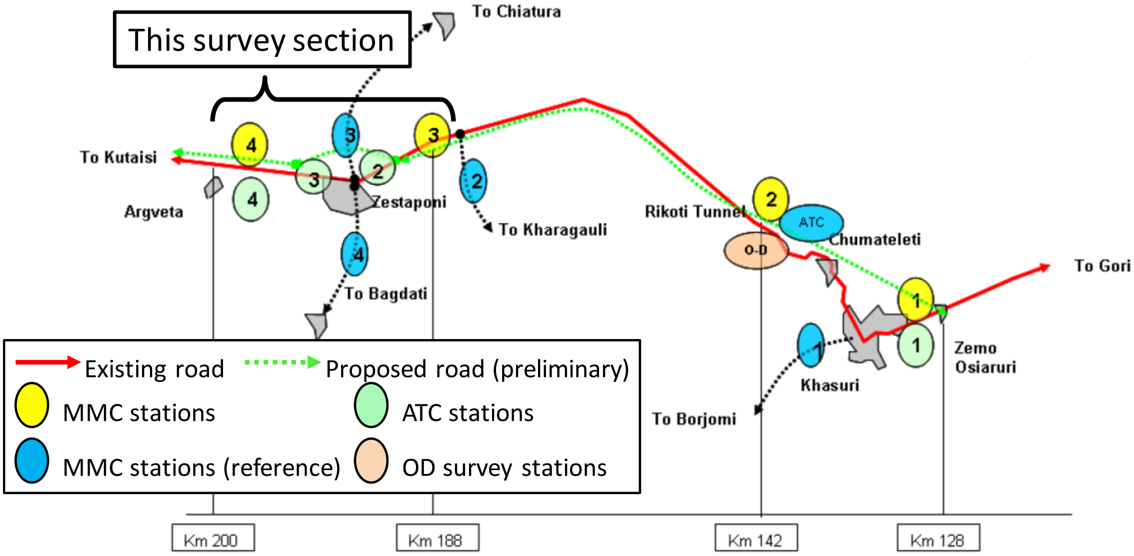
Year	Car	Minibus	Bus	LGV	2-axle	3-axle	4-axle+	Total
Shorapani–Zestafoni East section on the new road								
2019-2029	4.7%	4.7%	4.4%	4.7%	4.4%	4.4%	4.4%	4.7%
2029-2039	3.3%	3.3%	3.2%	3.3%	3.1%	3.1%	3.1%	3.3%
2039-2049	2.6%	2.6%	2.5%	2.6%	2.5%	2.5%	2.5%	2.6%
Zestafoni West–Argveta section on the new road								
2019-2029	4.7%	4.7%	4.4%	4.7%	4.4%	4.4%	4.4%	4.7%
2029-2039	3.3%	3.3%	3.1%	3.3%	3.1%	3.1%	3.2%	3.3%
2039-2049	2.6%	2.6%	2.5%	2.6%	2.5%	2.5%	2.5%	2.6%

Abbreviation: LGV = Light Goods Vehicle
Source: JICA Survey Team based on the F/S

3.3 Traffic Survey / Axle Load Survey

3.3.1 F/S Traffic Survey

Traffic surveys were conducted in October and November 2014, to collect traffic data for the traffic forecasts for the East-west Highway between Zemo Osiauri and Argveta. These include, among other things, Automatic Traffic Counts (four stations), Manual Classification Counts (eight stations, four of which are as a reference), and Origin-Destination survey (one station). These traffic survey stations in the F/S are depicted in Figure 3-2, covering this survey section between Shorapani and Argveta.



Abbreviations: ATC = Automatic Traffic Count, OD = Origin-Destination, MCC = Manual Classification Count
Notes: (i) The number in the figure (1~4) indicates the traffic survey location number in the F/S. (ii) The MMC stations indicate the locations to identify traffic volume on the existing road, while the MMC stations (reference) indicate the locations to estimate the diverted traffic from Borjomi, Karagauli, Bagdati, and Chiatura to the proposed road.
Source: F/S

Figure 3-2: Traffic Survey Locations in the F/S

These traffic counts (as of 2014) revealed that the Shorapani–Zestafoni section carries about 11,000 vehicles per day, while the Zestafoni–Argveta section carries about 14,000-15,000 vehicles per day (Table 3-3). Of these, 59% are cars, 11% are buses, 12% are LGV, and 18% are trucks. In addition, 8% of all vehicles surveyed were of international origins, of which 62% were trucks with four or more axles and 35% were buses.

Table 3-3: Results of F/S Traffic Count, 2014

Location*	2014 Traffic (vehicle per day)
Dzirula (MCC3), Km 188	11,072
Zestafoni East (ATC2)	11,391
Zestafoni West (ATC3)	14,107
Argveta (MCC4), Km 200	14,291
Argveta (ATC4)	15,186

Abbreviations: ATC = Automatic Traffic Count, MCC = Manual Classification Count
Note: The character and number in parenthesis indicates the type and location of traffic surveys in the F/S
Source: F/S

3.3.2 D/D Traffic Survey

In order to verify the F/S traffic count data, Automatic Traffic Counts were conducted in July 2017 as part of the D/D at the following three locations: (i) Km 125 between Zemo Osiaruri and Khasuri East, (ii) Km 188 between the intersection to Kharagauli and Zestafoni, and (iii) Km 200 between Zestafoni and Argveta. These locations are the same as the traffic count stations established in the F/S. Traffic counts at Km 125 and Km 200 were undertaken for three consecutive days, while at Km 188 for seven consecutive days. The preliminary results are shown in Table 3-4, indicating about 17,000-20,000 vehicles per day in the survey section. Nevertheless, it should be noted that this is raw data and require adjustment to obtain an Annual Average Daily Traffic (see Subsection 3.4.1 (2) for details).

Table 3-4: Preliminary Results of D/D Traffic Count, July 2017

Unit : vpd

	Car	Minibus & Pick-up	Bus & Truck	Trailer & > 3-axle	Total
Zemo Osiaruri, Km 125	14,196	3,137	1,994	1,276	20,604
Dzirula, Km 188	11,826	2,626	1,684	1,113	17,249
Argveta, Km 200	12,614	4,948	1,624	1,123	20,310

Source: D/D Consultant

3.3.3 Axle Load Survey

In Georgia, axle load control is conducted by the Patrol Police Department under the Ministry of Internal Affairs. According to the Patrol Police Department, vehicle weighing equipment is located at Kharagauli (Km 152) of the East-west Highway. According to Article 129 of the Administrative Offences Code of Georgia, overloaded vehicles are re-examined and adequate measures are taken against the violation.[3]

[3] According to Article 129 of the Administrative Offences Code, a fine of GEL 500 shall be enforced for the driver of the vehicle and/or the owner of the vehicle for each excess ton in the following cases: (i) travelling on a road by vehicle whose maximum load on each driving or dead axle exceeds 10 tons, (ii) the actual mass of which exceeds 44 tons, and/or (iii) the actual mass of which exceeds the maximum permitted weight.

Table 3-5 shows the number of violations of article 129, number of overloading cases among them, and total excessive weight over the 2013-2017 period (note that the 2017 data is up to July). The Patrol Police Department identified a range of 129-242 violations against the article; 79-173 cases of these were overloading with total excessive weight of 54-250 tons. These indicate an average of 0.6-1.7 tons of overloading per re-examined vehicle.

Table 3-5: Violations, Overloading, and Excessive Weight, 2013-2017

Year	Number of Violations	Number of Overloading	Total Excessive Weight (kg)
2013	242	88	145,310
2014	521	173	250,040
2015	217	79	116,605
2016	155	89	54,370
2017*	129	114	100,990

Note: The 2017 data is up to July.
Source: Patrol Police Department

3.4 Confirmation of Existing Traffic Forecast

3.4.1 Existing Traffic

(1) RDMRDI Automatic Traffic Count

RDMRDI conducts periodic Automatic Traffic Counts (ATC) on its road network (i.e., international roads and secondary roads) including the East-west Highway. The ATC is undertaken three times a year in April, July, and October, with a duration of 48 hours respectively. It provides average daily traffic data in the following vehicle categories: (i) cars, (ii) minibuses and pick-ups, (iii) buses and trucks, and (iv) trailers and three or more axle trucks.

Table 3-6 presents the ATC data for Km 179 between Rikoti and Zestafoni and Km 215 between Zestafoni and Kutaisi over the 2007-2016 period. Although some fluctuations are observed, the total traffic increased at an average rate of 8.5-9.0% per year, with growth rates of 8.8-9.1% for cars, 6.0-8.8% for minibuses and pick-ups, 12.2-13.8% for buses and trucks, and 2.0-6.7% for trailers and three or more axle trucks. In 2016, there were 12,855 vehicles on the Rikoti–Zestafoni section, and 14,656 vehicles on the Zestafoni–Kutaisi section.

Table 3-6: Historical Automatic Traffic Counts, 2007-2016

	Car	Minibus & Pick-up	Bus & Truck	Trailer & > 3-axle	Total
Rikoti–Zestafoni Section (Km 179)					
2007	4,243	750	356	567	5,917
2008	5,427	699	429	770	7,325
2009	4,733	824	465	658	6,680
2010	5,106	1,067	543	778	7,494
2011	6,288	1,629	714	934	9,565
2012	6,140	886	507	1,044	8,577
2013	9,090	790	690	1,312	11,882
2014	8,373	846	583	1,107	10,909
2015	9,465	324	792	1,413	11,993
2016	9,090	1,608	1,143	1,014	12,855
Annual average growth rate	8.8%	8.8%	13.8%	6.7%	9.0%
Zestafoni–Kutaisi Section (Km 215)					
2007	4,971	996	498	573	7,039
2008	6,288	1,043	556	701	8,588
2009	6,221	1,521	657	634	9,033
2010	6,258	1,493	583	563	8,897
2011	6,604	962	592	868	9,026
2012	9,585	1,325	737	912	12,558
2013	12,730	1,241	907	1,927	16,805
2014	11,822	1,133	777	1,185	14,917
2015	12,121	1,688	829	1,147	15,786
2016	10,879	1,682	1,410	685	14,656
Annual average growth rate	9.1%	6.0%	12.2%	2.0%	8.5%

Note: Average from ATC in April, July, and October of each year.
Source: RDMRDI

Table 3-7 compares the Annual Average Daily Traffic (AADT) in 2014 between the ATC results by RDMRDI and the traffic count results in the F/S. The traffic of the Rikoti–Zestafoni section was 10,909 vehicles per day by RDMRDI, and 11,072 vehicles per day in the F/S. The Zestafoni–Kutaisi section was 14,917 vehicles per day by RDMRDI, and 14,739 vehicles per day in the F/S. These indicates that the traffic count by RDMRDI is comparable to that in the F/S for both sections.

Table 3-7: Traffic Count Comparison of RDMRDI and F/S

	RDMRDI in 2014	F/S in 2014
Rikoti–Zestafoni section	10,909	11,072
Zestafoni–Kutaisi section	14,917	14,739*

Notes: (i) RDMRDI counts traffic at Km 179 and Km 215, the F/S at Km 188 and Km 200. (ii) The F/S traffic of the Zestafoni–Kutaisi section is an average of ATC and MCC results.
Source: JICA Survey Team based on RDMRDI and the F/S

(2) D/D Automatic Traffic Counts

As presented in Subsection 3.3.2 above, the preliminary results of Automatic Traffic Counts in the D/D were 17,249 vehicles per day at Dzirula (Km) 188 and 20,310 vehicles per day at Argveta (Km 200). Note that these traffic counts were as of July 2017, and require adjustment to AADT considering the seasonal variation. Assuming an adjustment factor of 0.84 (=12,855/15,224: 12,855 was 2016 AADT at Km 179, while 15,224 was the daily traffic in July 2016 at the same location) obtained from ATC in 2016[4], AADT in the D/D is assumed at 14,489 vehicles per day at Km 188 and 17,060 vehicles per day at km 200. Table 3-8 compares the traffic between the D/D and F/S. Considering that the 2019 AADT in the F/S is 13,872 vehicles per day at Km 188 and 18,519 vehicles per day at Km 200, the 2019 traffic assumed in the F/S at Km 188 is considered slightly underestimated, while that at Km 200 is considered reasonable.

Table 3-8: Traffic Count Comparison of D/D and F/S

	D/D, July 2017	D/D, 2017 AADT	F/S, 2019 AADT
Rikoti–Zestafoni section	17,249	14,489	13,872
Zestafoni–Kutaisi section	20,310	17,060	18,519*

Abbreviation: AADT =
Notes: (i) Both D/D and F/S count traffic at Km 188 and Km 200. (ii) The F/S traffic of the Zestafoni–Kutaisi section is an average of ATC and MCC results.
Source: JICA Survey Team based on D/D Consultant and the F/S

3.4.2 Traffic Growth Rates

In order to examine the traffic growth rates assumed in the F/S, the following assumptions have been made:

- It is assumed that the Georgian GDP would grow at 4.5% per year in the future. This assumption was prepared considering the short-term GDP growth rate forecasts by international organizations and a major institute. As shown in Table 3-9, the forecasts in 2020-2022 are in the range of 3.5-5.5%.

Table 3-9: Georgian GDP Growth Rate Forecasts by Each Institute (%)

Year	IMF[1)]	WB[2)]	ADB[3)]	EIU[4)]
2017	3.5	3.5	3.8	4.0
2018	4.0	4.0	4.5	3.3
2019	4.5	4.5	-	3.2
2020	5.0	-	-	3.5
2021	5.5	-	-	3.7
2022	5.5	-	-	-

Source: 1) IMF, World Economic Outlook Database, April 2017.
2) World Bank, Global Economic Prospects, June 2017.
3) ADB, Asian Development Outlook 2017, April 2017.
4) Economic Intelligent Unit (EIU), Country Report: Georgia, 2nd Quarter 2017.

- The GDP growth rate was assumed to decrease gradually over time, which is analytically conservative, and reach 2.5% per year in the long run.

- The elasticity of traffic demand to GDP was assumed at 1.3 for passenger traffic including cars, minibuses, and buses; and 1.2 for freight traffic including light goods vehicles (LGVs) and trucks in the short-term (during 2019-2029), referring to the assumptions

[4] The adjustment factor of 0.84 (=14,656/17,485 : 14,656 is 2016 AADT at Km 215, 17,485 was the daily traffic in July 2016) was also derived when it was calculated using the Km 215 data.

from the World Bank appraisal document.[5] Furthermore, this elasticity of demand to GDP was assumed to decrease gradually over time, which is considered analytically conservative.

Table 3-10 summarizes the parameters established based on the assumptions made above.

Table 3-10: Assumptions of Each Parameter for Demand Forecast

Year	GDP Growth Rate (%)	Elasticity of Demand to GDP	
		Passenger Traffic	Freight Traffic
2019-2029	4.5	1.3	1.2
2029-2039	3.5	1.2	1.1
2039-2049	2.5	1.1	1.0

Source: JICA Survey Team

Table 3-11 compares the traffic growth rates assumed in the F/S to the growth rate established in this survey (GDP growth rate times the elasticity of demand to GDP). The traffic growth rates in the F/S are considered slightly underestimated in the short- and medium-term, and are considered within a reasonable range in the long-term, considering the growth rates established in this survey.

Table 3-11: Traffic Growth Rates

Year	F/S	This Survey	
		Passenger Traffic	Freight Traffic
2019-2029	4.7	5.9	5.4
2029-2039	3.3	4.2	3.9
2039-2049	2.6	2.8	2.5

Source: JICA Survey Team

3.5 Projection of Future Traffic

Considering the existing traffic examined in Subsection 3.4.1 and traffic growth rates established in Subsection 3.4.2, it would be better to update the traffic forecast from the F/S. Therefore, it is proposed using the parameters established in the previous sections that, the traffic of the Shorapani–Zestafoni East section be updated as shown in Table 3-12 and Figure 3-3, and the Zestafoni West–Argveta section be updated as shown in Table 3-13 and Figure 3-4.[6]

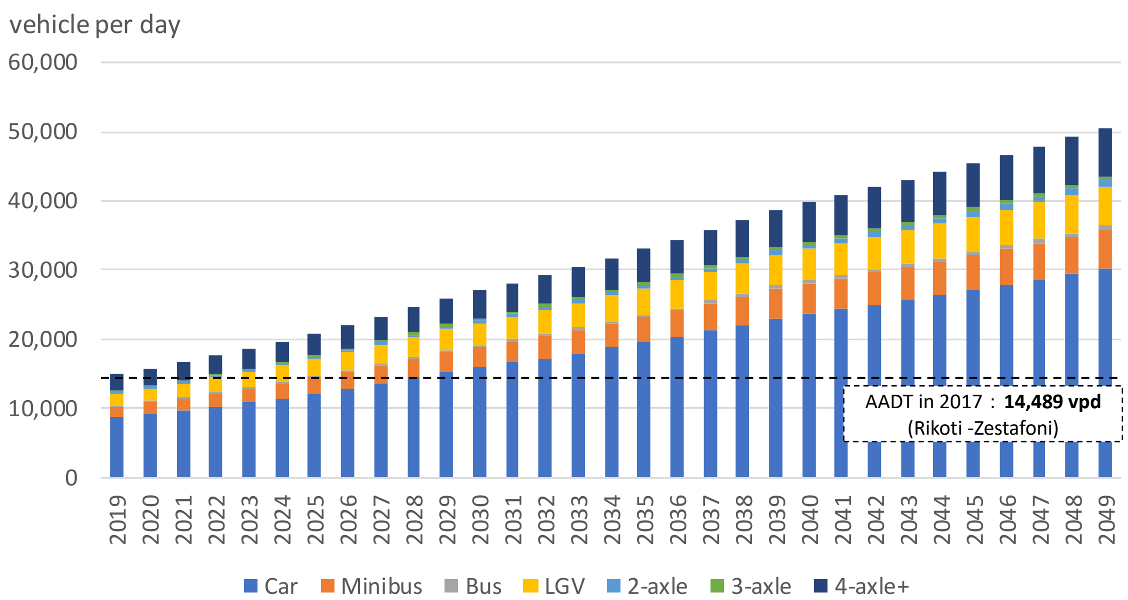
[5] Source: World Bank, *East-west Highway Corridor Improvement Project*, Project Appraisal Document, October 2015

[6] Note that the first-year traffic (i.e., 2019) of the Shorapani–Zestafoni East section was set at 14,884 vehicles per day based on the following assumptions: (i) the 2017 traffic is assumed at 14,000 vehicles per day referring to the existing data including D/D traffic counts, (ii) this 2017 traffic rate was used to calculate the 2019 traffic assuming the traffic growth rates established in Subsection 3.4.2, and considering the generated traffic of 7%, and (iii) 89% of this 2019 traffic on the existing road was assigned to the project road following the assumption in the F/S. The 2019 traffic of the Zestafoni West–Argveta section was assumed equal to that of the F/S based on the D/D traffic count.

Table 3-12: Updated Traffic Forecast on the Shorapani–Zestafoni East Section, 2019–2049

Year	Car	Minibus	Bus	LGV	2-axle	3-axle	4-axle+	Total
2019	8,649	1,610	152	1,787	274	176	2,235	14,884
2020	9,155	1,704	161	1,884	289	185	2,356	15,734
2021	9,690	1,804	170	1,985	305	196	2,483	16,633
2022	10,257	1,910	180	2,093	321	206	2,618	17,584
2023	10,857	2,021	191	2,206	339	217	2,759	18,589
2024	11,492	2,139	202	2,325	357	229	2,908	19,652
2025	12,164	2,265	214	2,450	376	241	3,065	20,775
2026	12,876	2,397	226	2,583	397	254	3,230	21,963
2027	13,629	2,537	239	2,722	418	268	3,405	23,219
2028	14,427	2,686	253	2,869	441	283	3,589	24,547
2029	15,271	2,843	268	3,024	464	298	3,782	25,950
2030	15,912	2,962	279	3,140	482	309	3,928	27,014
2031	16,580	3,087	291	3,261	501	321	4,079	28,121
2032	17,277	3,216	303	3,387	520	334	4,236	29,273
2033	18,002	3,351	316	3,517	540	346	4,400	30,473
2034	18,758	3,492	329	3,653	561	360	4,569	31,722
2035	19,546	3,639	343	3,793	583	374	4,745	33,022
2036	20,367	3,792	358	3,939	605	388	4,927	34,376
2037	21,223	3,951	373	4,091	628	403	5,117	35,785
2038	22,114	4,117	388	4,248	652	418	5,314	37,253
2039	23,043	4,290	405	4,412	678	434	5,519	38,780
2040	23,676	4,408	416	4,522	695	445	5,657	39,819
2041	24,327	4,529	427	4,635	712	456	5,798	40,885
2042	24,996	4,654	439	4,751	730	468	5,943	41,981
2043	25,684	4,782	451	4,870	748	480	6,092	43,106
2044	26,390	4,913	463	4,992	767	492	6,244	44,260
2045	27,116	5,048	476	5,116	786	504	6,400	45,446
2046	27,862	5,187	489	5,244	805	516	6,560	46,664
2047	28,628	5,330	503	5,375	826	529	6,724	47,915
2048	29,415	5,476	517	5,510	846	543	6,892	49,199
2049	30,224	5,627	531	5,648	867	556	7,065	50,517

Source: JICA Survey Team



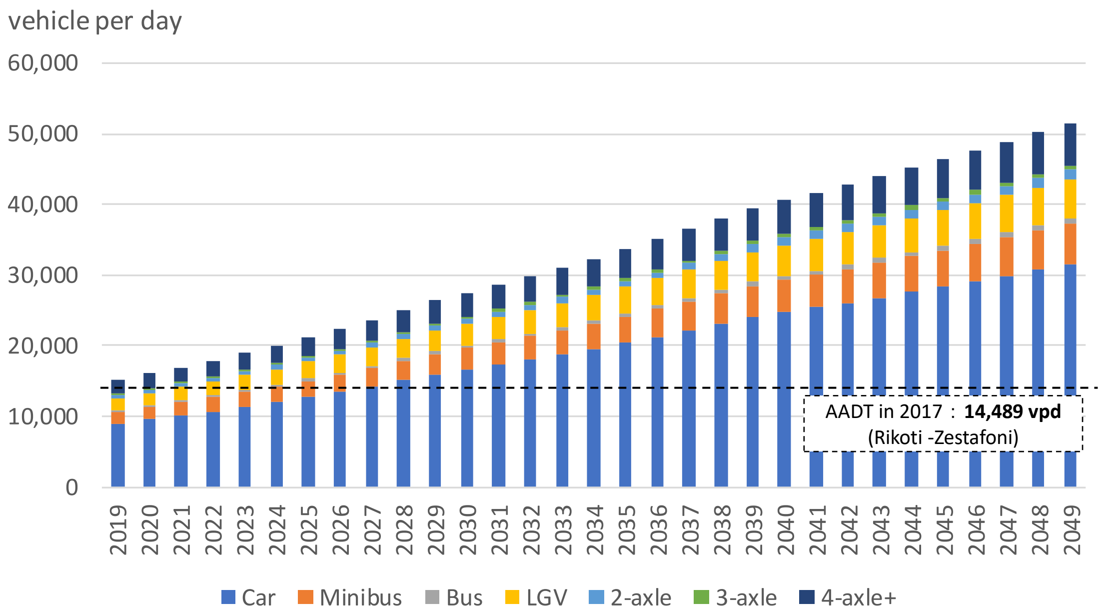
Source: JICA Survey Team

Figure 3-3: Updated Traffic Forecast on the Shorapani–Zestafoni East Section, 2019–2049

Table 3-13: Updated Traffic Forecast on the Zestafoni West–Argveta Section, 2019-2049

Year	Car	Minibus	Bus	LGV	2-axle	3-axle	4-axle+	Total
2019	9,037	1,659	214	1,728	417	199	1,904	15,158
2020	9,566	1,756	227	1,821	440	210	2,007	16,026
2021	10,125	1,859	240	1,920	463	221	2,115	16,943
2022	10,718	1,968	254	2,023	488	233	2,229	17,913
2023	11,345	2,083	269	2,133	515	246	2,350	18,938
2024	12,008	2,204	284	2,248	542	259	2,477	20,023
2025	12,711	2,333	301	2,369	572	273	2,610	21,169
2026	13,454	2,470	319	2,497	603	288	2,751	22,381
2027	14,241	2,614	337	2,632	635	303	2,900	23,663
2028	15,074	2,767	357	2,774	669	319	3,057	25,018
2029	15,956	2,929	378	2,924	706	337	3,222	26,451
2030	16,626	3,052	394	3,036	733	350	3,346	27,537
2031	17,325	3,180	410	3,153	761	363	3,474	28,667
2032	18,052	3,314	427	3,275	790	377	3,608	29,844
2033	18,811	3,453	445	3,401	821	392	3,747	31,070
2034	19,601	3,598	464	3,532	852	407	3,891	32,345
2035	20,424	3,749	484	3,668	885	422	4,041	33,673
2036	21,282	3,907	504	3,809	919	439	4,197	35,056
2037	22,176	4,071	525	3,956	955	456	4,358	36,496
2038	23,107	4,242	547	4,108	991	473	4,526	37,994
2039	24,077	4,420	570	4,266	1,029	491	4,700	39,555
2040	24,740	4,542	586	4,373	1,055	504	4,818	40,616
2041	25,420	4,667	602	4,482	1,082	516	4,938	41,706
2042	26,119	4,795	619	4,594	1,109	529	5,062	42,826
2043	26,837	4,927	636	4,709	1,136	542	5,188	43,975
2044	27,575	5,062	653	4,827	1,165	556	5,318	45,156
2045	28,334	5,201	671	4,947	1,194	570	5,451	46,368
2046	29,113	5,344	689	5,071	1,224	584	5,587	47,612
2047	29,913	5,491	708	5,198	1,254	599	5,727	48,891
2048	30,736	5,642	728	5,328	1,286	614	5,870	50,203
2049	31,581	5,798	748	5,461	1,318	629	6,017	51,551

Source: JICA Survey Team



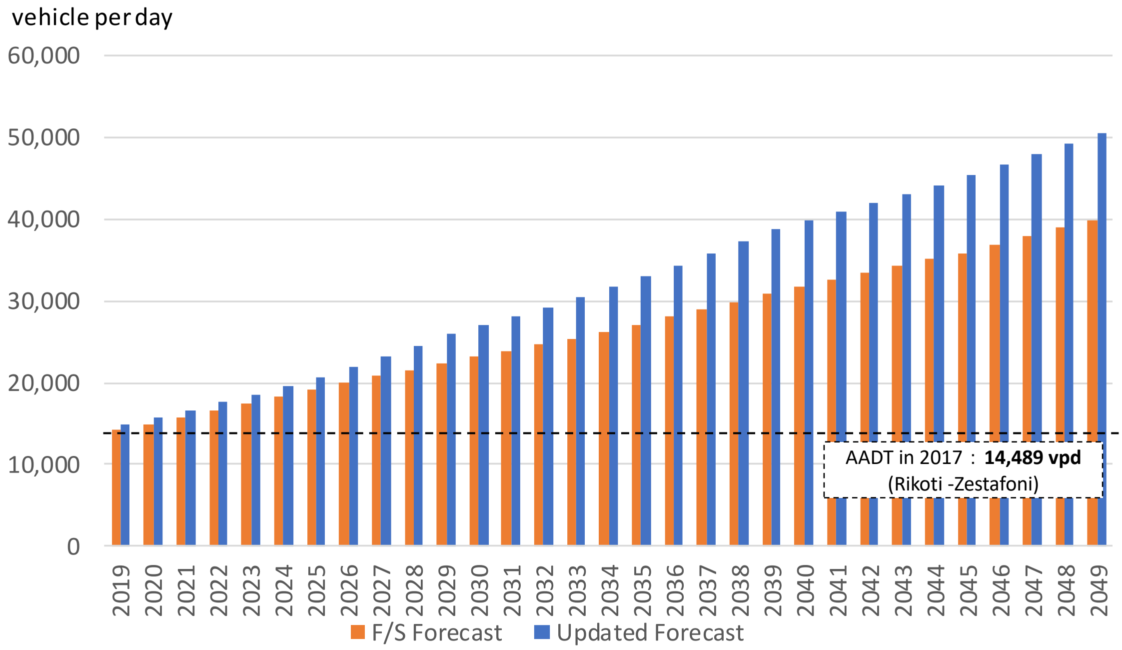
Source: JICA Survey Team

Figure 3-4: Updated Traffic Forecast on the Zestafoni West–Argveta Section, 2019-2049

3.6 Comparison between the F/S Forecast and the Updated Forecast

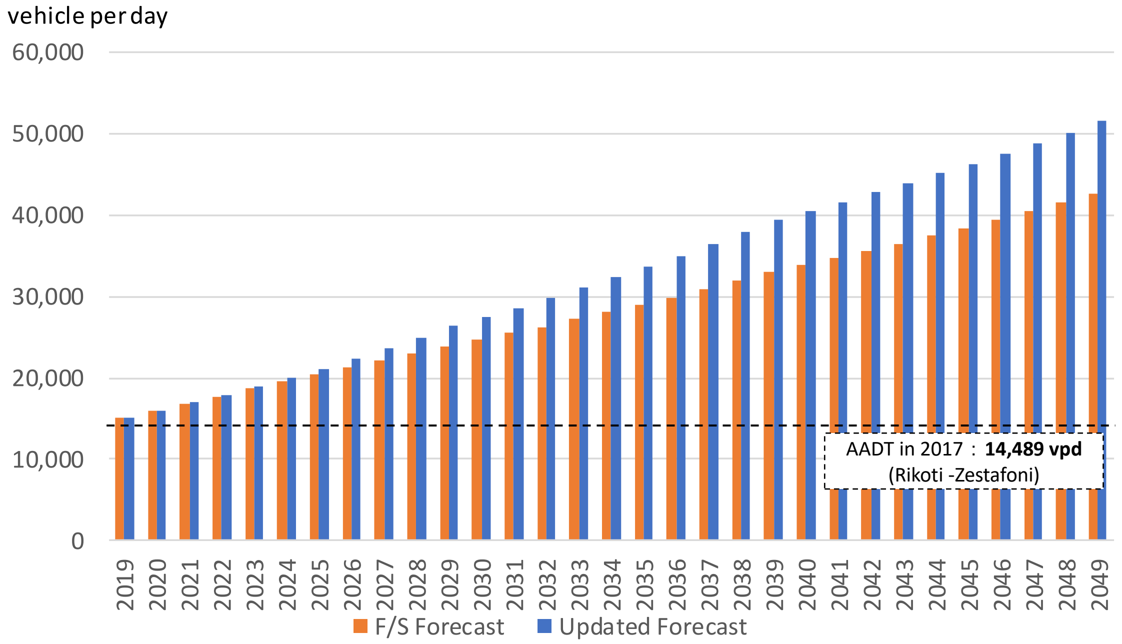
The F/S forecast and the updated forecast are compared as shown in Figure 3-5 (for the Shorapani–Zestafoni East section) and Figure 3-6 (for the Zestafoni West–Argveta section). The key points related to the first-year traffic and traffic growth rates are summarized below, with details compared in Table 3-14.

- The first-year traffic assumed in the F/S on the Shorapani–Zestafoni East section is considered slightly underestimated, while that on the Zestafoni West–Argveta section is considered reasonable.
- The traffic growth rates in the F/S are considered slightly underestimated in the short- and medium-term, and are considered within a reasonable range in the long-term, taking into account the growth rates established in this survey.



Source: JICA Survey Team

Figure 3-5: Comparison between the F/S Forecast and the Updated Forecast on the Shorapani–Zestafoni East Section, 2019–2049



Source: JICA Survey Team

Figure 3-6: Comparison between the F/S Forecast and the Updated Forecast on the Zestafoni West–Argveta Section, 2019–2049

Table 3-14: Comparison between the F/S Forecast and Updated Forecast

	F/S Forecast	Updated Forecast
First-year traffic	The first-year traffic of the Shorapani–Zestafoni East section is projected at 14,208 vehicles per day, and that of the Zestafoni West–Argveta section is projected at 15,158 vehicles per day.	The first-year traffic of the Shorapani–Zestafoni East section was set at 14,884 vehicles per day, and that of the Zestafoni West–Argveta section was set equal to that of the F/S (i.e., 15,158 vehicles per day).
Traffic growth rates	Traffic growth rates obtained from the F/S forecast are 4.7% per year in 2019-2029, 3.3% per year in 2029-2039, and 2.6% per year in 2039-2049.	Whilst traffic growth rates for passenger were set at 5.9% per year in 2019-2029, 4.2% per year in 2029-2039, and 2.8% per year in 2039-2049; those for freight were set at 5.4% per year in 2019-2029, 3.9% per year in 2029-2039, and 2.5% per year in 2039-2049.
Forecast results	On the Shorapani–Zestafoni East section, the total number of daily traffic is projected at 22,405 in 2029, 30,915 in 2039, and 39,971 in 2049. On the Zestafoni West–Argveta section, it is projected at 23,910 in 2029, 32,997 in 2039, and 42,666 in 2049.	On the Shorapani–Zestafoni East section, the total number of daily traffic was set at 25,950 in 2029, 38,780 in 2039, and 50,517 in 2049. On the Zestafoni West–Argveta section, it was set at 26,451 in 2029, 39,555 in 2039, and 51,551 in 2049.

Source: JICA Survey Team

Chapter 4 Detail Design of E60 F4 Section (Shorapani and Argveta)

4.1 Natural Conditions

4.1.1 Meteorological and Hydrological Surveys

(1) General

The project road (an improvement of the existing highway) from Argveta to Shorapani runs on the southern river bank of the Dzirula River in mountainous areas. As the Highway goes west, the terrain becomes gentler and hilly in Shorapani, and flat in Argveta. Overall, the terrain condition is not that tough for vertical alignment. The highest point is 210 m (above sea level) and around 140 m in flat areas. However, the project road goes through narrow mountainous topographies that would need tunnels and bridges for efficient travel. In addition, safety measures against falling rocks, slope failures, and landslides are crucial for prevention of road blocks caused by disasters.

(2) Climate Condition

As described in the F/S report, climate conditions of the project area is based on data provided by the Tsipha Meteorological station, which is situated in the center of the area of concern. According to this data, the average yearly temperature is + 6.2 °C, the minimum air temperature is –24 °C, and the maximum air temperature is +38 °C. The yearly average relative humidity is 76%, 59% for the hottest month and 70% for the coldest month respectively. The average yearly precipitation amount is 1,187 mm, with a maximum daily precipitation amount of 102 mm. Large amounts of precipitation is typical for the Kolkheti mountain forests. The average duration of snow cover is 6-20 days. On the other hand, based on the monitoring data from 1982 to 2012 at the Zestaponi Meteorological station, which is situated to the south of the area of concern, is summarized as follows.

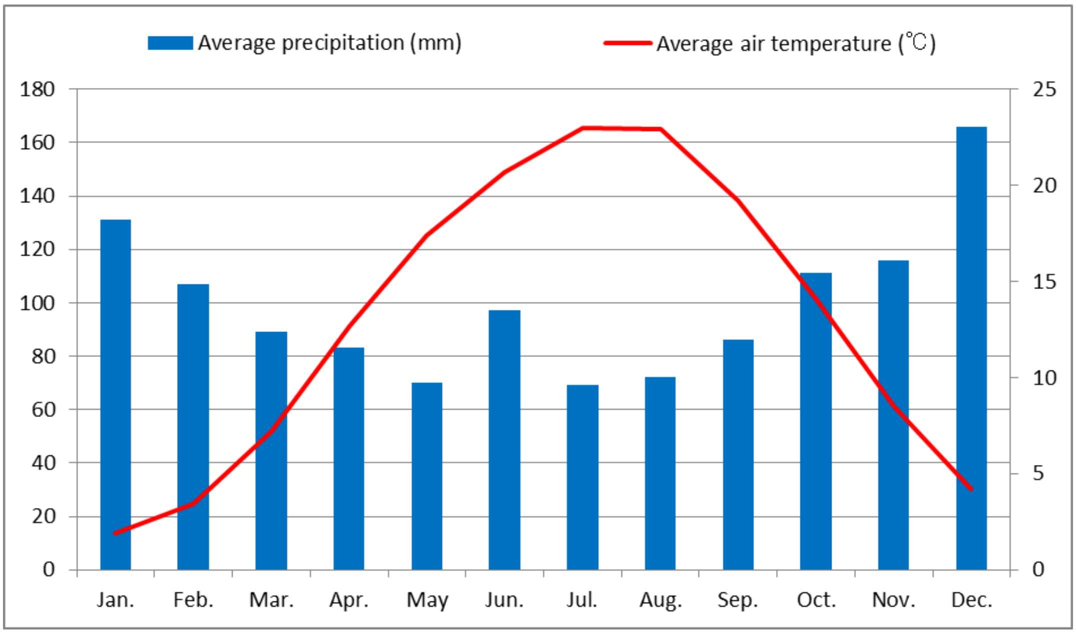
<u>Summary of Climate Condition at the Metrological Station of Zestaponi</u>

- Altitude: +163 m
- Climate classification (Köppen-Geiger Klassifikation): Cfa, warm and humid climate
- Yearly average temperature: +12.9 °C
- Monthly maximum temperature: +23 °C (July)
- Monthly minimum temperature: -+1.9 °C (January)
- Yearly average precipitation: 1,197 mm
- Monthly average precipitation: 97 mm
- Monthly maximum precipitation: 166 mm (December)
- Monthly minimum precipitation: 69 mm (July)
- Source: https://pt.climate-data.org/location/28416/

Table 4-1: Summary of Climate Condition at the Metrological Station of Zestaponi

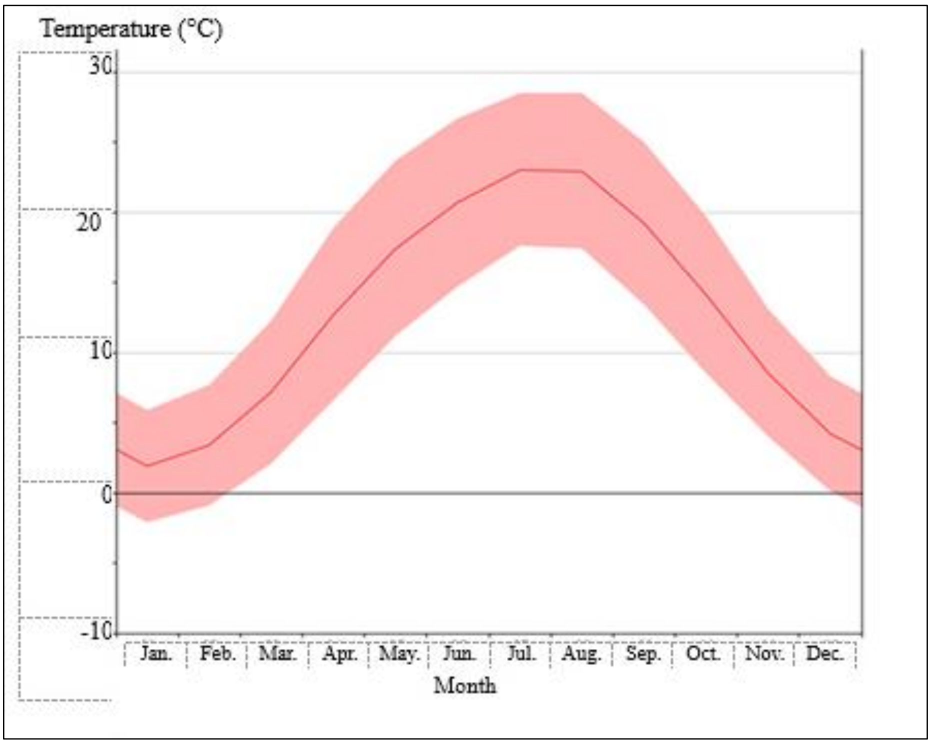
	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Average air temperature (°C)	1.9	3.4	7.2	12.7	17.4	20.7	23	22.9	19.2	14.1	8.5	4.2
Minimum air temperature (°C)	-2.1	-0.9	2.1	6.6	11.2	14.7	17.6	17.4	13.4	8.5	4	0.1
Maximum air temperature (°C)	5.9	7.7	12.3	18.9	23.7	26.7	28.5	28.5	25	19.7	13.1	8.3
Average precipitation (mm)	131	107	89	83	70	97	69	72	86	111	116	166

Source: https://pt.climate-data.org/location/28416/



Source: https://pt.climate-data.org/location/28416/

Figure 4-1: Monthly Average Temperature and Precipitation



Source: https://pt.climate-data.org/location/28416/

Figure 4-2: Monthly Average Temperature with a Width of Change

(3) Hydrological Survey

a. Introduction

Hydrological and hydraulic study's aim is to evaluate discharges with different recurrence period for every water body which cross the design road. Design recurrence periods depend on the type of water body as follows.

- Bridge over main rivers (catchment areas > 1 km^2): 100 years with verification for 200 years
- Culverts over creeks and gullies (catchment areas < 1 km^2): 50 years
- Motorway platform drainage elements: 50 years
- Other roads: 20 years

Hydrological and hydraulic study was developed with the following steps:

(i). Preliminary investigations to identify major water courses flowing across design road (both existing and new carriageway)
(ii). Inventory of major drainage structures crossing existing road and design motorway
(iii). Hydrological Analysis, with the evaluation of design discharges for considered waterbodies at road crossing points (see the hydrological report)
(iv). Hydraulic Analysis to determine the appropriate dimensions of structures conveying flows through design road
(v). Preparation of a detailed Hydraulic Report including River analysis, Culvert analysis and Platform drainage

b. Hydrological Survey

(i). **Water flow rates for rivers with a catchment area of more than 400 km^2**

The Dzirula and Kvirila rivers are the most important water bodies in the area, having catchment areas of 1,204 and 2,450 km^2 respectively. They are winding rivers, running into narrow v-shaped valleys with steep slopes. This outstanding erosive tendency is due to high longitudinal gradients (average gradients >10 ‰).

Maximum water discharge values for aforementioned rivers with a catchment area of more than 400 km^2 indicated in the Figure 4-3 was evaluated by empirical-regional formula provided in the hydrological reference book "Surface water resources of the USSR (volume IX, issue I, 1969)", which is derived specially for the Kvirila River and its tributary basins.

A result of calculated values of maximum flow rate of the Dzirula River and the Kvirila River obtained by the recommended empirical-regional formula is summarized in the Table 4-2.

Source: GD-REP-4000-GE-GR-0001_General Report

Figure 4-3: River Basin Boundaries for Hydrological Study

Table 4-2: Calculated Maximum Flow Rate of Dzirula River and Kvirila River

PK	River	F, sq.km	Q0.2%, m^3/s	Q0.5%, m^3/s	Q1%, m^3/s	Q5%, m^3/s	Q10%, m^3/s
-10+00	Dzirula	1,177	1,276	1,084	959	639	544
13+50	Dzirula	1,192	1,285	1,092	966	644	547
25+00	Dzirula	1,204	1,292	1,098	972	648	551
62+00	Kvirila	2,450	1,924	1,634	1,466	964	820

Source: GD-REP-4000-GE-GR-0001_General Report

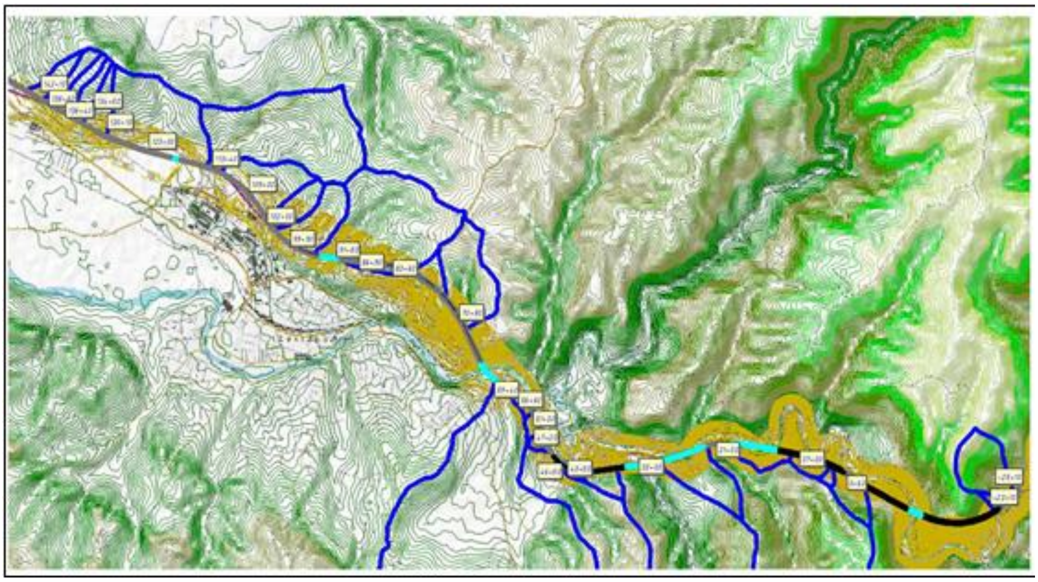
(ii). **Water flow rates for small rivers with a catchment area of up to 400 km²**

The determination of the maximum water flow rates for rivers with a catchment area of up to 400 km^2 have been determined by three methods:

- Calculation of the maximum expenditure by the Regional formula;
- Calculation of maximum flow rates according to PMP-91 "Surveys and Design of Rail and Road Bridge Crossings over Waterways"; and
- Calculation of the maximum flow rates according to Standard SP 33-101-2003 "Determination of design hydrological performance".

Calculated maximum flow rate of small rivers by above different methods are summarized in the Table 4-3.

The choice of the design water discharge for a structure on watercourses should be performed on the basis of a comparison of the calculated values with those observed at hydrological stations. However, given the insufficient amount of observational data on small watercourses (with a catchment area of less than 20 km^2), as well as the predominance of local factors of runoff formation over regional ones, large water discharge values from the values obtained by different methods were used.



Source: GD-REP-4000-GE-GR-0001_General Report

Figure 4-4: Small River Basin Boundaries for Hydrological Study

Table 4-3: Calculated Maximum Flow Rate of Small Rivers by Different Methods

PK	F, sq.km	Q 1% m³/s			Q 10% m³/s		
		SP 33-101-2003	PMP-91	Regional Formula	SP 33-101-2003	PMP-91	Regional Formula
-25+10	0.55	5.34	8.21	8.15	2.99	1.10	3.42
-23+10	0.05	0.54	1.38	1.80	0.30	0.19	0.75
00+60	0.26	2.74	4.58	4.89	1.53	0.62	2.05
07+00	0.11	1.20	2.51	2.99	0.67	0.34	1.25
21+00	8.52	20.9	45.3	30.8	11.69	6.09	12.9
33+00	59.6	75.9	1.37	85.9	42.52	18.4	36.1
43+50	0.04	0.43	1.08	1.39	0.24	0.14	0.58
46+50	1.72	5.90	15.4	12.2	3.30	2.07	5.14
47+20	0.04	0.41	0.97	1.20	0.23	0.13	0.51
51+30	0.06	0.63	1.34	1.59	0.35	0.18	0.67
56+60	0.05	0.52	1.13	1.36	0.29	0.15	0.57
59+40	9.86	29.0	48.5	34.5	16.23	6.50	14.5
70+80	0.80	7.02	9.18	8.27	3.93	1.23	3.47
83+60	0.03	0.33	0.79	1.03	0.18	0.11	0.43
86+90	0.04	0.42	0.96	1.19	0.24	0.13	0.50
91+80	1.88	10.56	16.2	12.9	5.92	2.17	5.43
99+90	0.50	3.30	6.09	5.46	1.85	0.82	2.29
102+00	0.26	2.30	3.89	3.83	1.29	0.52	1.61
109+00	0.58	5.62	7.18	6.68	3.15	0.97	2.81
113+40	2.14	12.1	16.8	13.2	6.77	2.26	5.54
123+00	1.31	10.8	12.4	10.5	6.07	1.66	4.40
130+10	0.22	2.07	3.46	3.50	1.16	0.47	1.47
134+50	0.16	1.54	2.74	2.87	0.86	0.37	1.21
136+40	0.16	1.10	2.83	3.01	0.61	0.38	1.27
138+60	0.17	1.17	2.96	3.13	0.65	0.40	1.32
142+10	0.17	1.08	2.95	3.11	0.61	0.40	1.31

Source: MA-HYD-4000-GE-RP-0101_Hydraulic Report

c. Hydraulic Examination for Design Bridge

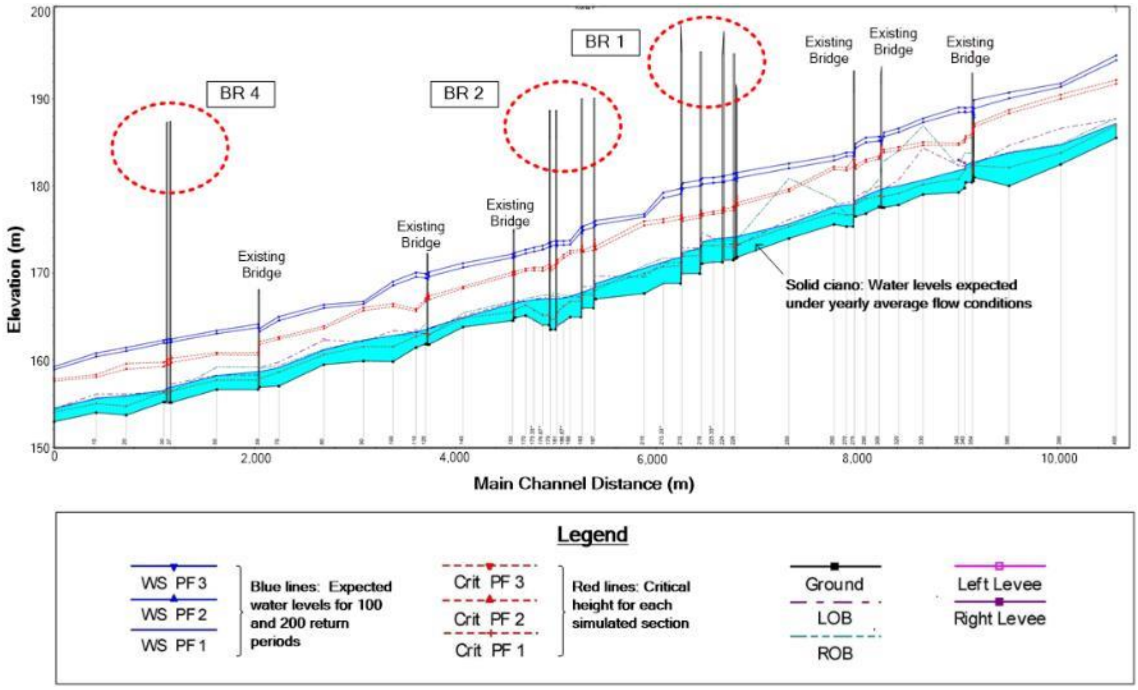
A complete analysis of flow conditions occurring on the Kvirila River for extreme events (100 and 200 years return periods) for design bridges 1, 2 and 4 have been simulated using 1-dimensional steady state analysis (Hec-ras software).

(i). Design discharge

Adopted discharges are 1,446 and 1,625 m^3/s respectively for 100 and 200 return periods, as obtained by the empirical-regional formula provided in the hydrological reference book «Surface water resources of the USSR, volume IX, issue I, 1969», which is derived specially for the Kvirila River and its tributary basins (see the hydrology report). Average annual discharge (61 m^3/s) is given in “Hazardous Events on the Black Sea Rivers, their dynamics and Regulation” published on the Journal of Earth Science and Engineering 5 (2015) 130-133, doi: 10.17265/2159-581X/2015. 01. 005.

(ii). **River simulation results**

Simulation results for Design Bridge 1, 2 and 4 are summarized below in Figure 4-5, and detailed simulated profiles are shown in Figure 4-6, Figure 4-7, and Figure 4-8 respectively. Numerical output is given in Table 4-4 for each Bridge and along the entire course of the Kvirila River (with a close position to F4). In Figure 4-5, solid Ciano indicates water levels expected under yearly average flow conditions, while blue lines represent expected water levels for 100 and 200 return periods. Red lines give critical height for each simulated section.



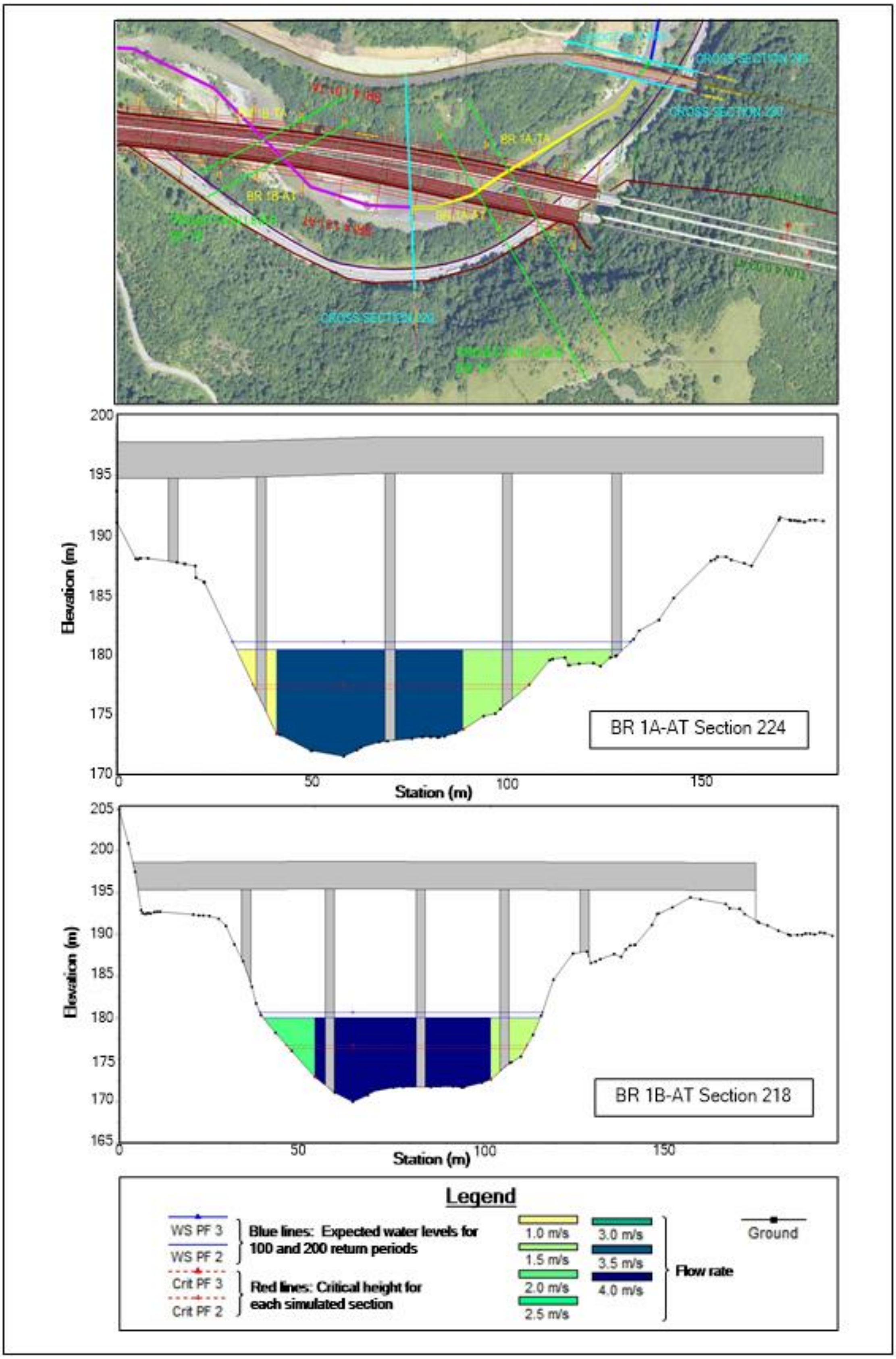
Source: MA-HYD-4000-GE-RP-0101 Hydraulic Report

Figure 4-5: Simulation Results of the Kvirila River

Table 4-4: Expected Freeboards and Increase in Water Levels

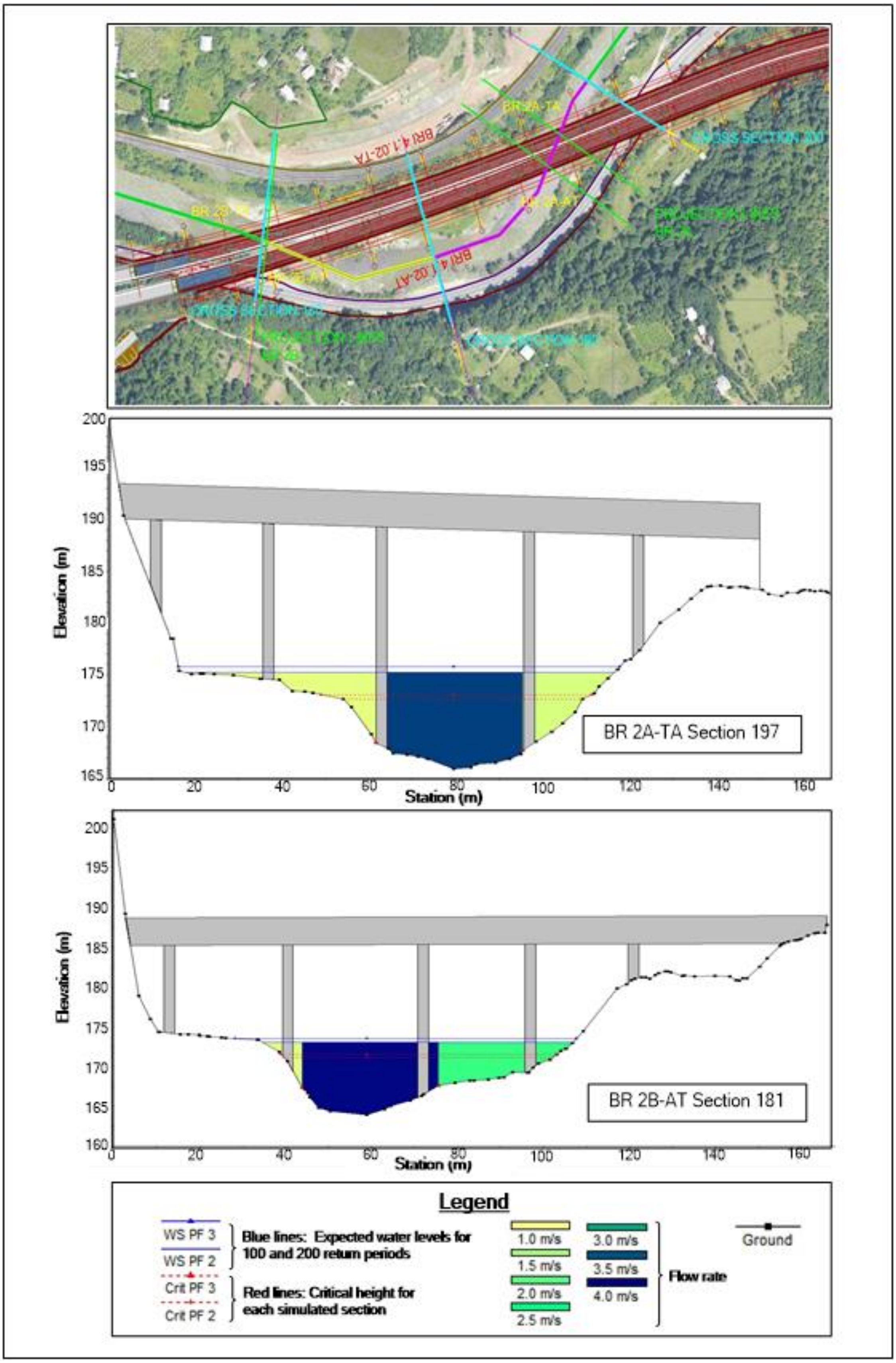
Bridge	Section	Min. Channel Elevation(m)	Existing Water Level (m)	Design Water Level (m)	Max. Water Depth (m)	Lower Chord (m)	Freeboard (m)	Increase in Water Level (m)
BR 1A-TA	228	171.68	180.97	181.50	9.82	194.77	13.27	0.53
BR 1A-AT	224	171.48	180.60	181.17	9.69	194.77	13.60	0.57
BR 1B-AT	218	171.07	180.38	180.92	9.85	195.20	14.28	0.54
BR 1B-TA	215	169.94	179.95	180.37	10.43	195.20	14.83	0.42
BR 2A-TA	197	167.01	175.50	176.02	9.01	188.10	12.08	0.52
BR 2A-AT	193	165.97	174.86	175.38	9.41	188.10	12.72	0.52
BR 2B-AT	181	163.96	173.40	173.70	9.74	185.54	11.84	0.30
BR 2B-TA	179	163.48	173.42	173.59	10.17	185.43	11.84	0.17
BR 4-TA	37	155.11	162.39	162.44	7.33	183.20	20.76	0.57
BR 4-AT	33	155.13	162.36	162.38	7.25	183.20	20.82	0.53

Source: MA-HYD-4000-GE-RP-0101_Hydraulic Report



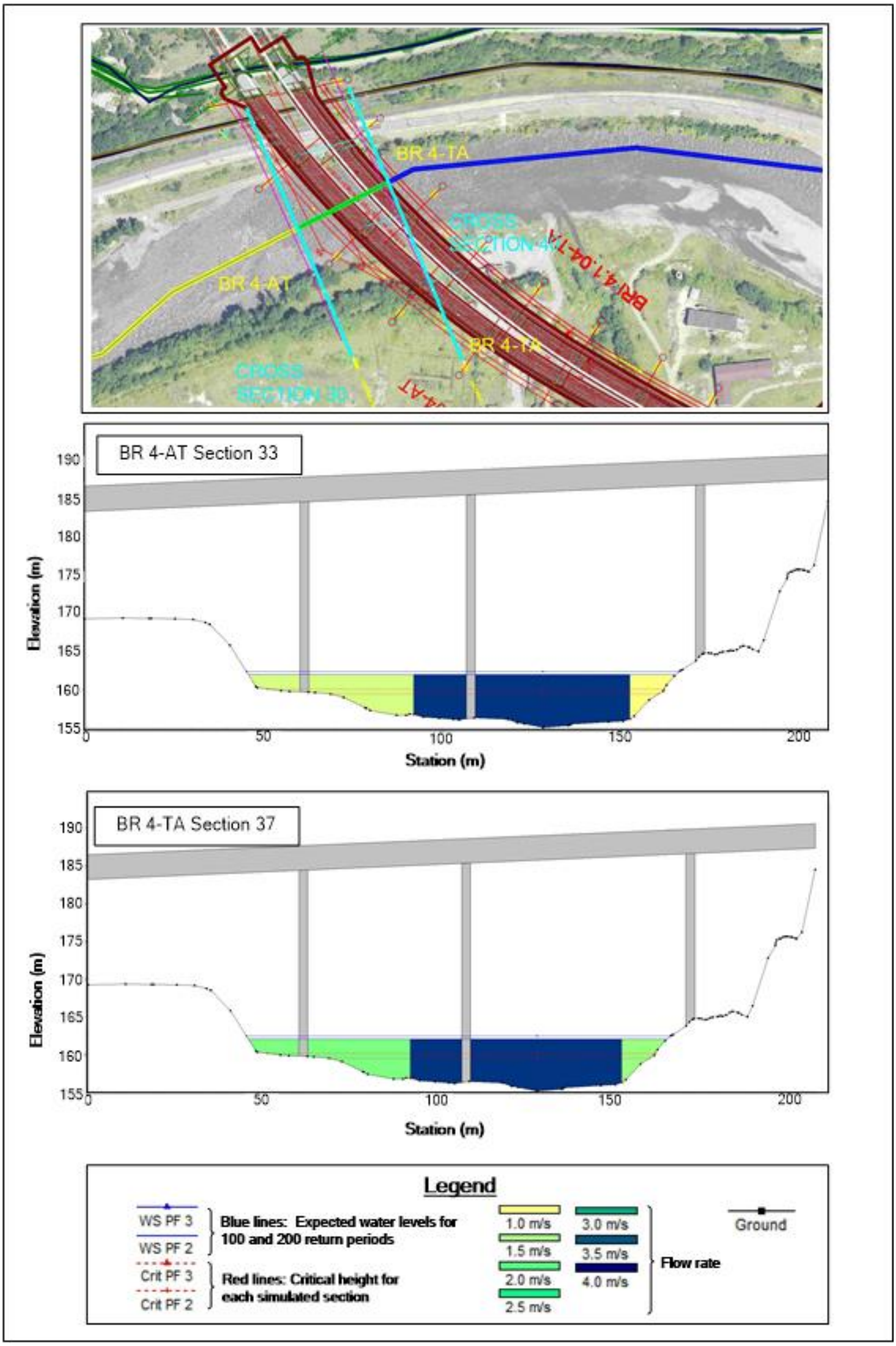
Source: MA-HYD-4000-GE-RP-0101_Hydraulic Report

Figure 4-6: Simulation Results for Design Bridge 1



Source: MA-HYD-4000-GE-RP-0101_Hydraulic Report

Figure 4-7: Simulation Results for Design Bridge 2



Source: MA-HYD-4000-GE-RP-0101_Hydraulic Report

Figure 4-8: Simulation Results for Design Bridge 4

(iii). **Scouring around piers**

In order to estimate maximum scouring depth around bridge piers, Breusers approach was adopted. Results for piers of Bridge 1A are summarized in Table 4-5.

Table 4-5: Result of Scour Calculations for Bridge 1A

Bridge	**01/A TA**			**01/A AT**			
Pier Nr.	**Pier 2**	**Pier 3**	**Pier 4**	**Pier 2**	**Pier 3**	**Pier 4**	**Pier 5**
Velocity (m/s)	3.542	3.542	3.542	3.542	3.542	3.542	3.542
Pier width and length (m)	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Scour depth (m)	2.27	2.33	2.06	2.32	2.33	2.32	2.20

Source: MA-HYD-4000-GE-RP-0101_Hydraulic Report

d. Hydraulic Study for Culverts and Platform Drainage System

(i). **Culverts**

The most fitting standard culvert size is chosen according to i) local discharge as provided by the hydrological study or estimated from IDF curves; ii) local topography, including longitudinal slope; and iii) possible interconnections of two or more interfered channels.

For culvert design, methodology for culverts analysis was provided, as well as hydrological methods to determine design discharge for smaller basins, and for drainage. This methodology is based on the interpolation of discharge expected with the two methods (PMP91 and regional method) described in the previous section. Analysis of culverts was described based on the following steps.

- Culverts identification
- Hydraulic conditions
- Culverts models
- Hydrological calculations
- Design discharges
- Hydraulic conditions (results)
- Culverts final design

(ii). **Platform drainage system**

In the D/D study report, different elements were described and calculations methods reported based on the following steps. Results for channel and pipes dimensions were organized within specific tables in the report.

- Tiles average distance design
- Concrete grated gutter
- Pipes network design
- Drainage of bridges

(4) Comments on Meteorological and Hydrological Surveys

With respect to the meteorological and hydrological surveys, the followings should be identified in general, and data and information will be effectively used for the D/D study and the construction work on the project road.

- Weather-related natural disaster occurred in the past.
- Influence of the snow and/or precipitation, freezing, fog, and wind on the road traffic and the construction phase in the vicinity of project road.
- Hydrological data, flood history, river works (bank protection), flood control system, and flood control plan associated with the Dzirula and Kvirila rivers.
- River simulation result (expected water levels of the Dzirula and Kvirila rivers) based on the design discharges for 100 and 200 return periods.
- Hydrological study on the inhibition of cross-sectional area of a river due to the bridge pier construction and the scoring around bridge pier.
- Detailed study of hydrological condition such as local discharges along the project road for the design of culverts and drainage system.

JST has suggested the followings as confirmation items during the D/D study period.

- Proposed plans on construction phase and maintenance management in consideration of actual meteorological conditions such as freezing and snow fall along the project road.
- Suitable bridge design corresponding to hydraulic analysis results (river simulation for examination of the inhibition of cross-sectional area of a river and the scoring around bridge pier).
- Detailed hydrological survey reflecting the determination of design water discharges for the design of culverts and drainage system on the project road
- Necessity of flood protection measures such as bank protection in the widening section of the existing road (along the Kvirila River).

After discussion with D/D study team and a careful reviewing of the D/D study report, JST's comments on achievements and issues to be considered are summarized as follows.

- Observation data from two meteorological stations located in the vicinity of the project road were disclosed in the D/D study report. The detailed data offering service for a fee is currently available by application to the Hydro-meteorological Department under the National Environmental Agency.
- According to the comments based on the site survey by JICA expert in October 2017, it was recommended that a fluid analysis (flood simulation) based on hydrological survey and a study on the inhibition of cross-sectional area of a river and the scouring around bridge pier should be implemented when necessary. Based on this situation, hydrological and hydraulic study including flood simulation has been conducted in the D/D study. As a result of the complete analysis, the safety of the highway bridge in design has been secured against hydrological conditions.
- In terms of flood protection measures in Georgia, the Bank Protection Division under the Road Department is responsible for overseeing the river protection work for the bridge piers and river structures such as embankment. Technical support from this Division will be expected when river/bank protection work is needed in case of the road bridge construction and river bed erosion measures.
- According to the D/D study report, no specific data has been found relating to climate change. However it can be assumed that there will be an increase in average annual temperatures of between 1 and 1.5 degrees over the next 30 years and that precipitation will decrease. The number of hot days may increase. Therefore, it was confirmed that suitability of pavement type should be taken into consideration.

4.1.2 Topographical Survey

(1) Aero-Topographic Survey

According to the D/D study report, aero-topographic survey has been conducted with the following contents.

- The mapping is based on UTM Projection, Datum WGS84; Fuse 38N
- Orthometric heights obtained using a Georgian Quasi-geoid 2012
- Aircraft: PARTENAVIA P68C-TC (I-GEMK)
- Sensors: Rigel LMS-Q780i with GNSS/IMU system made by Applanix model 510. Al connected and configurated with Hasselblad H5D with calibrated lens with 80 mm of focal length
- Side overlap: 60% (5 pts/m^2 or more)

LiDAR[1] post-processing consisted of trajectory compensation and final adjustment of each LiDAR strip. After post processing, results show less than 10 cm difference between GPS[2] ground data and Lidar data. Processed outputs:

- 3D cloud of points (LAS format)
- 3D DTM[3]/DSM[4] (grid 0.5 m × 0.5 m,)
- 2D Map (scale 1:1,000; isoipses every 1 m, DWG format)
- Ortho photo (Resolution of aerial photograph: Pixel size 9.94 cm)

Above listed 3D outputs were used for road design, while 2D maps and Orthophoto are attached as cartographic background to the road design layout.

(2) Celerimetric Topographical Survey

Celerimetric surveys were conducted for the following purposes.

- Validation of the Aero-Topographical Survey of some critical areas
- River cross sections and river crossings (bridges)

The survey was conducted with the following instruments.

- Tree (3) TOPCON double frequency GPS stations
- One (1) TOPCON LN3002 total station with both laser and infrared length measurement

The survey was based on the reference system prepared for the Aero-Topographical Survey on May 2017, and complemented with additional points.

River cross sections and river crossings survey were needed to input the current geometry of the river into the hydraulic model in order to assess the impact of the new infrastructure (mainly new bridges and retaining walls) and prevent any adverse interference or hazard for the road structures and usability.

The survey was executed in <u>47 river cross sections (Hydraulic model requires definition of river cross sections all along the stretches to be modeled, with an average interval of less than 200-300</u>

[1] LiDAR: Light Detection and Ranging / Laser Imaging Detection and Ranging
[2] GPS: Global Positioning System
[3] DTM: Digital Terrain Model
[4] DSM: Digital Surface Model

m) and 10 existing crossings; and whenever possible, sections were extended from the railway line track on one side to the existing roadside.

Low water levels made possible an extremely accurate consideration of wet riverbed. Similarly piers and decks of existing bridges were represented carefully to provide a trustful picture of the current interferences to river flow.

(3) Comments on Topographical Survey

With respect to the topographical surveys, the followings should be identified in general, and data and information will be effectively used for the D/D study and the construction phase on the project road.

- Confirming a resolution and a measuring accuracy on the airplane laser survey
- Confirming a three-dimensional map such as DTM and DSM obtained by a three-dimensional map preparation processing system with classifying on-ground object shapes and a ground surface on the basis of a high density elevation model at an on-ground position obtained by airplane laser measurement
- Confirming a center line survey, transverse survey and bathymetric survey

In addition, JST has proposed the following as confirmation items during the D/D study period.

- Need for a detailed topographic surveying using a drone
- Confirming an additional cross-sectional surveying for a detailed design such as a site for slope protection measures, landslide site, tunnel portal, and river crossing (embankment and river bed)

After discussion with D/D study team and a careful reviewing of the D/D study report, JST's comments on achievements and issues to be considered are summarized as follows.

- In terms of aerial photograph, enough resolution and accuracy were ensured by 9.94 cm in pixel size.
- Regarding airplane laser measurements, enough resolution and accuracy were confirmed as follows:
  - i Original data is in error (Standard Deviation) by less than 0.0676 m (10 cm<).
  - ii As a result of final adjustment, the difference between the Lidar GCP data and the GPS ground surface data is less than 10 cm.
  - iii Mesh data corresponding to DTM and DSM were confirmed by 0.5 m × 0.5 m grid.
- Additional surveys (Celerimetric surveys) have been conducted for the validation of aero-topographic survey and river cross sections (47 sections) using hydraulic simulation model. Since there are not enough/ detailed topographic data at the tunnel portal, additional topographic surveys should be conducted in some critical areas when needed.
- Results obtained by topographic surveying conducted by the JST using a "drone" are not enough to acquire topographical information in terms of landslide and slope condition because of vegetative cover on the slope. Therefore, additional topographic surveys are to be expected when necessary.
- It was confirmed that the above data from topographic surveys has been widely used in the D/D study. For example, CAD maps for longitudinal section and lateral sections with an interval of 10 m, and topographical maps with 1 m contour line are useful.

4.1.3 Geomorphological Field Survey

(1) Geological Survey on Site

In order to make a detailed geologic model of the study area, the following geological investigations on site have been carried out:

- Detailed geological, geomorphologic and geo-mechanical field survey
  - 36 points
- Geotechnical investigations
  - 48 boreholes (vertical)
  - 5 boreholes (horizontal)
- Geophysical investigations
  - Reflection: 19
  - P+S Wave Refraction: 23
  - P Wave Refraction: 50
  - ERT (Electrical Resistivity Test): 17

A location of the above geological surveys along the project road alignment is shown in Figure 4-9 and Figure 4-10. The results of these investigations and tests were used for the detailed design of the project road and creation of geological maps and profiles.

(2) Laboratory Tests

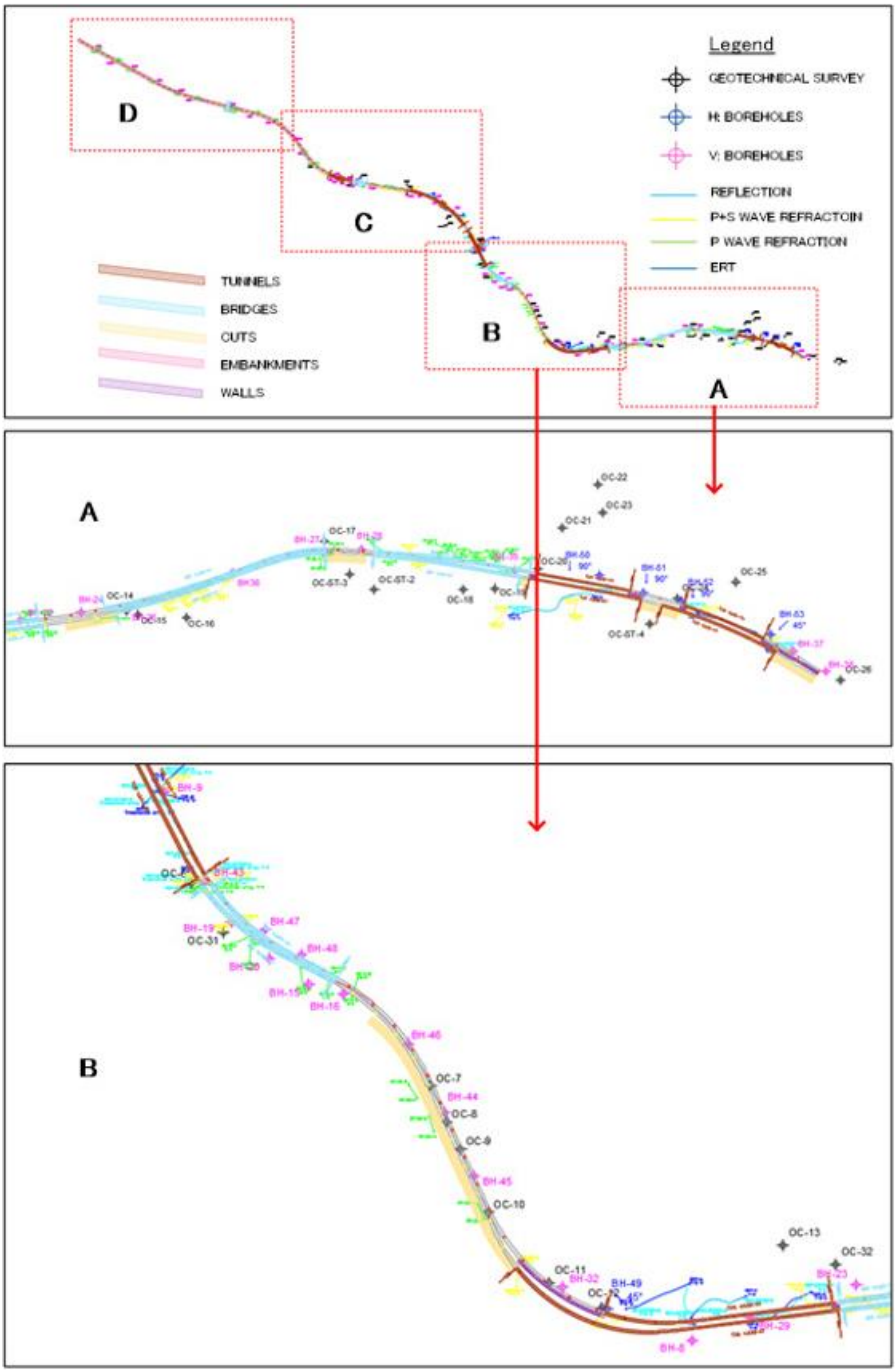
In order to identify the geological-geotechnical characteristics of soils and the rocks along the project alignment, laboratory tests have been performed as follows:

- 55 outcrop rock samples for bulk density, unconfined compression strength test with young modulus determination, point load test, etc.
- 68 core rock samples for mechanical characteristics such as uni-axial compression test, unconfined compression strength test with young modules determination, etc.
- 18 undisturbed soil samples for the physical characteristics and mechanical characteristics such as UU tri-axial compression test, direct shear test, etc.
- 20 SPT soil samples for consistency limits, granulometric analysis, soils classification, specific weight of the particles

(3) Utilities Surveys

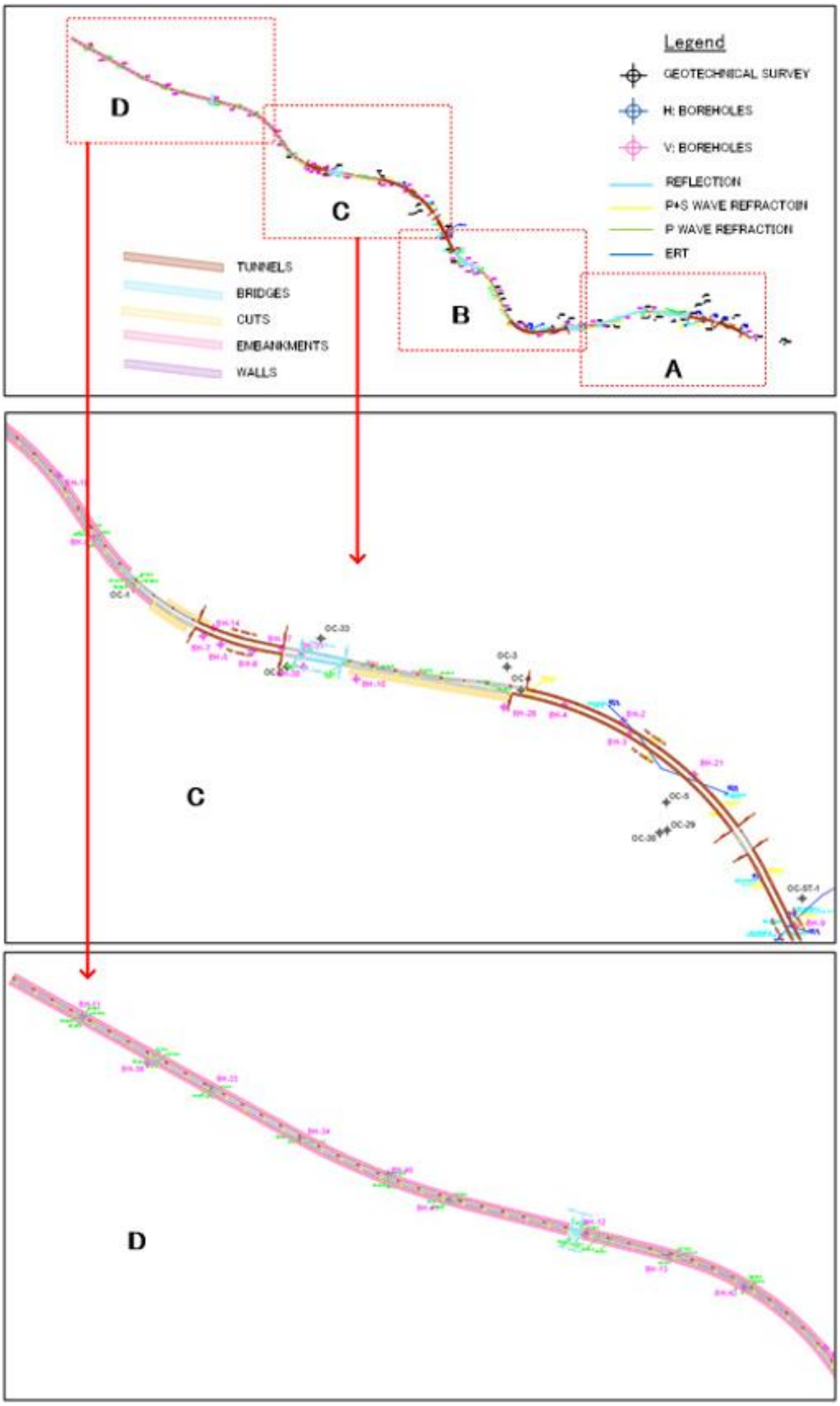
The following interfered utilities in the road corridor were identified with the location and reported in the road design maps.

- Local Area Electricity: Energo Pro Georgia
- Gas Transmission Pipelines: Socar Georgia
- Water Pipelines: United Water Supply Company of Georgia
- Internet Fibre Optic Cable: PC MAX
- Internet Fibre Optic Cable: FOPTNET
- Internet Fibre Optic Cable: DELTA COMM
- Internet Fibre Optic Cable: SILKNET



Source: GD-GEO-4000-GE-RP-0001-GEOLOGICAL REPORT

Figure 4-9: Location of Geological Survey on Site (1)



Source: GD-GEO-4000-GE-RP-0001-GEOLOGICAL REPORT

Figure 4-10: Location of Geological Survey on Site (2)

(4) Geomorphologic Map (Geomorphologic Analysis)

Detailed geomorphologic maps at a 1:2,000 scale have been made by following activities:

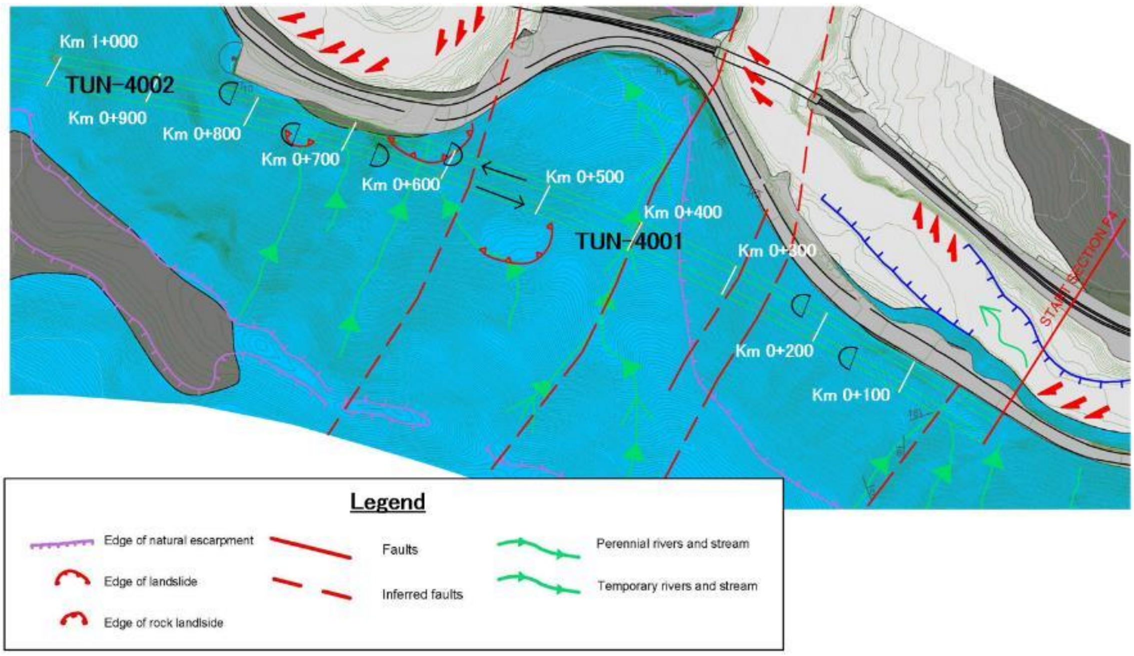
- Aerial photo interpretation, to preliminarily identify the main landforms.
- Geomorphologic survey to define and design such landforms and properly interpret their nature.
- Landforms have been mapped on the base of the morphological agents that formed and modifies them:
  - Landforms related to fluvial activity (agent: water)
  - Landforms related to mass movements and landslides (agent: gravity)
  - Landforms related to anthropic activity (agent: men).

A secondary river system, mainly made up of temporary streams, is widespread all over the study area. The small valleys are narrow, mainly V shaped when the water network is on volcanic rocks, while on sedimentary lithologies they are characterized by a concave or flat bottom. Two edges of alluvial terraces are identified along the Kvirila and Dzirula rivers and their main tributaries. River bank erosion is present where the energy of the river flow is high, in correspondence of meanders. Three alluvial fans are identified at the end of the project alignment, where an embankment is foreseen.

Landforms related to gravity are also widespread, mainly represented by edges of natural escarpments. Few landslides (edges and deposits) have been detected. Generally, they do not affect the project alignment, except for two mass movements as shown in Figure 4-11:

- At about km 0+500, affecting TUN 4.0.01-TA/AT and the western portal of TUN 4.0.01-TA.
- At about km 0+750, affecting eastern portals of TUN 4.0.02 TA/AT.

Anthropic landforms are related to deposits areas, the industrial area of Zestaponi and railway and road embankments.



Source: GD-REP-4000-GE-GR-0001_General Report

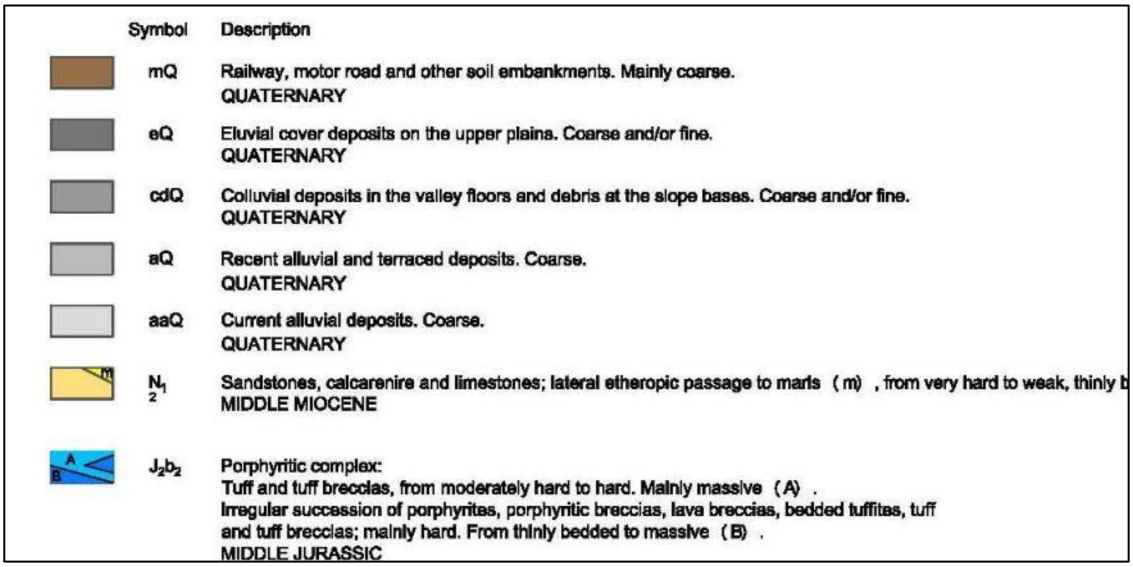
Figure 4-11: Location of Landslides

(5) Geological Map

The road alignment (Khevi-Argveta section of the E60 Highway route) is located in the central part of the Georgian Block (GAMKRELIDZE I.P., GAMKRELIDZE P.D., 1977), in the Transcaucasian Massif, between the southern slope of the Great Caucasus fold system (north) and the Adjara-Trialeti fold zone in the Lesser Caucasus (south). The Transcaucasian Massif consists of a crystalline basement, exposed in the Loki, Khrami and Dzirula massifs which coincide with the Zemo Imereti Plateau, an elevated part of the intermountain plain of Georgia.

Geological map was made in accordance with the following methods:

- As a base map, geological formations have been grouped on the basis of their morphological nature as follows (see Figure 4-12):
  - Eluvial and colluvial deposits, debris at the base of the slopes, fine to coarse, including eQ, cdQ and mQ formations.
  - Alluvial and terraced deposits, coarse, including aQ and aaQ formations.
  - Limestones and sandstones from very hard to weak, thinly bedded, corresponding to the N12 formation.
  - Porphyritic complex: tuff and tuff breccias, porphyrites, porphyritic breccias, lavas, lava breccias, bedded tuff, from thinly bedded to massive, including J2b2 (A) and J2b2 (B).
- Tectonic and geological elements have been reported on the map (faults, stratigraphic contacts, orientations of layers).



Source: GD-GEO-4000-GE-RP-0001-GEOLOGICAL REPORT

Figure 4-12: Geological Formations in the Project Site

A detailed geological map and a longitudinal geological profile at a 1:2,000 scale have been made with following results:

- <u>Geological survey: </u>it involved a preliminary gathering and analysis of bibliographic data, a field survey along an area wide enough to include every present significant lithology, detect the borders and the stratigraphic relations between each geological formation and identify the major geological structures (faults and folds).

- Geotechnical investigation: 53 boreholes have been performed, together with on site tests (SPT, pressure meter tests, lugeon tests to geotechnical characterize the different lithologies) in order to identify the limits of geological formations and their relations.
- Geophysical investigation: it consisted in high-resolution seismic refraction tomography tests, high resolution seismic reflection test and high resolution Electrical Resistivity Tomography tests, whose results have been used for stratigraphic correlation and for fracture degree and faults detection.

As indicated in the geological map and profile, in the survey area, along the highway alignment, three major geological units can be identified:

- **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:
  - J2b2 (A) - Tuff and tuff breccias, from moderately hard to hard. Mainly massive.
  - J2b2 (B) - Irregular succession of porphyrites, porphyritic breccias, lava breccias, bedded tuff, tuff and tuff breccias; mainly hard. From thinly bedded to massive.
- **Sedimentary rocks** covering the volcanic units, dated Middle Miocene and represented by the following geological formations:
  - N12 (m) - Marls.
  - N12 - Limestones and sandstones. From very hard to weak, thinly bedded.
- **Quaternary soils**, covering both the volcanic and the sedimentary rocky units, represented by:
  - eQ - Eluvial cover deposits on the upper plains. Coarse and/or fine.
  - cdQ - Colluvial deposits in the valley floors and debris at the slope bases. Coarse and/or fine.
  - aQ - Recent alluvial and terraced deposits. Coarse.
  - aaQ - Current alluvial deposits. Coarse.
  - mQ - Railway, motor road and other soil embankments. Mainly coarse.

From a geo-lithological point of view, along the alignment, three main homogeneous sections can be identified, depending on similar lithological conditions as shown in Table 4-6.

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 J_2b_2 (B) formation and the mainly pyroclastic rocks of the J_2b_2 (A) formation. The contact between these 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 J_2b_2 (B) formation; bridges are expected to have their abutments and piers on quaternary deposits (aQ, aaQ and mQ with a variable thick) covering the J_2b_2 (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 N_1^2 formation, overlaying with a stratigraphic limit the J_2b_2 (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 J_2b_2 (A) and (B) formations) and in the N_1^2 formation; one bridge crosses a colluvial deposit overlaying the N_1^2 formation; one cut is expected to be excavated in the N_1^2 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 4-6: Summary of Lithological Condition on Lot F4

Homogeneous Segments	Chainage (km)	Structures	Geological formations	Fault
A	0+000 – 6+350	TUN 4.0.01	The tunnel is excavated in J_2b_2 (B)	Faults or inferred faults intersect the alignment at the following chainage: km 0+054, km 0+256, km 0+292, km 0+399, km 0+570, km 1+605, km 1+631, km 2+913, km 3+722, km 4+119, km 4+181, km 4+273, km 4+547. At least 4 faults longitudinally affect the alignment between around km 6+200 and 6+500
		TUN 4.0.02	The tunnel is excavated in J_2b_2 (B)	
		BRI 4.1.01	The bridge crosses quaternary deposits (aQ, aaQ, mQ) covering the J_2b_2 (B) formation	
		BRI 4.1.02	The bridge crosses quaternary deposits (cdQ, aQ, aaQ, mQ) covering the J_2b_2 (B) formation	
		BRI 4.1.03	The bridge crosses quaternary deposits (cdQ, aQ, aaQ) covering the J_2b_2 (B) formation	
		TUN 4.0.03	The tunnel is excavated in J_2b_2 (B)	
		BRI 4.1.04	The bridge crosses quaternary deposits (aQ, aaQ, mQ) covering the J_2b_2 (B) formation	
B	6+350 – 10+200	TUN 4.0.04	The tunnel is excavated in J_2b_2 (A) and J_2b_2 (B)	At least 4 faults or inferred faults longitudinally affect the alignment between around km 6+200 and 6+500. Faults or inferred faults intersect the alignment at the following chainage: km 6+641, km 7+077, km 7+446, km 7+520, km 7+602, km 7+710, km 7+752
		TUN 4.0.05	The tunnel is excavated in J_2b_2 (A) and N_1^2	
		BRI 4.1.05	The bridge crosses N_1^2 formation and aQ formation covering it	
		TUN 4.0.06	The tunnel is excavated in N_1^2 formation	
C	10+200 – 14+726	overpasses & underpasses	embankment, overpasses and underpasses in cdQ and aQ formations, above N_1^2 (m) and N_1^2 formations	-

Source: GD-GEO-4000-GE-RP-0001-GEOLOGICAL REPORT

(6) Geotechnical Study

a. Rock Mass Characteristic

By means of the geo-mechanical survey and compression tests on rock samples, the design parameters for the rock formations have been estimated. Following 3 rock formations are encountered for the works outdoors along the road alignment, mainly excavations of the sections in cut and openings of the tunnels:

- N_1^2
- J_2b_2 (A)
- J_2b_2 (B)

It is underlined that in the geo-mechanical surveys on rocky outcrops, the marls of the N_1^2 (m) formation has not been encountered, since it has been encountered only in some boreholes. As a consequence, the parameters found for the N_1^2 formation refer exclusively to limestone, sandstones and calcarenites.

Based on the information gathered during the geo-mechanical surveys, a rock mass classification according to Bieniawski has been performed in order to evaluate the rock mass parameter RMR_base in dry conditions.

In addition to the parameters of the Mohr-Coulomb failure criterion, the parameter JRC of the Barton-Bandis model for the joints strength has been calculated, which is necessary for the stability analysis of the sections in cut by considering the blocks stability with the joints conditions (orientation and strength). For the sake of the safety, the minimum value of JRC has been conservatively assumed among the several joints in each geo-mechanical survey. Instead, the value of φ base in the Barton-Bandis model has been estimated from literature (see Table 4-7).

In order to consider the influence of the filling material inside the joints, the parameters of the Mohr-Coulomb failure criterion of the filling material, clayey filling materials for N_1^2 and J_2B_2 (A) and J_2B_2 (B), have been estimated from literature on the basis of the rock mass (Table 4-7). During the stability analysis, a proper choice is recommended between the parameters of the Barton-Bandis model and the parameters of the Mohr-Coulomb failure criterion of the clayey filling material.

Table 4-7: Rock Parameters

Rock formation		φ (Rock Mass)	C (Rock Mass)	E (Rock Mass)	φ base (Joints)	JRC (Joints)	φ (Filling Material)	C (Filling Materials)
		(°)	(kPa)	(GPa)	(°)	(°)	(°)	(kPa)
N_1^2	Average	31	231	8.1	30	2.00	27	0
	Max.	31	225	7.5	35	2.00	28	0
	Min.	30	220	7.1	25	2.00	26	0
J_2B_2 (A)	Average	38	298	19.1	31	2.74	27	0
	Max.	43	345	38.0	34	4.00	28	0
	Min.	35	265	6.0	28	2.00	26	0
J_2B_2 (B)	Average	35	267	6.8	31	2.00	27	0
	Max.	42	340	36	34	2.00	28	0
	Min.	32	235	8.4	28	2.00	26	0

Source: GD-GTE-4000-GE-RP-0201_Section F4 - GEOTECHINCAL REPORT

b. Characteristic of Soil and Marl

Following main types of soils have been encountered along the highway alignment:

- Sandy Gravels and Gravelly Sands
- Silty Clays
- Soil embankment

From a geological-geotechnical point of view, two main zones can be distinguished:

1) One zone from BH1 at chainage 10+283 to BH11 at chainage 14+360, where there is an alternation of the Sandy Gravel and the Silty Clays over the clayey marls and the thickness of these soil varies between 5 m and about 20 m.
2) Another zone from BH1 at chainage 10+283 at BH38 at chainage 0+0022, where the thickness of the soils (mainly Sandy Gravel) is really modest on the crests and reaches the highest values in correspondence of the “valleys” where the bridges are located.

The “soil embankment” consists of the embankments of railways and roads. It should be noted that in some cases (i.e. BHs 8, 32, 37, 38) for the superficial layers (upper 10 m-15 m usually) the geotechnical profile may show the presence of rock formations instead of the soils found in the boreholes. This is due to the fact that the boreholes are located at a certain distance from the center line of the highway alignment. Also the top level of these boreholes may differ significantly from the ground level on the center line. Therefore, both the distance from the center line and the difference of level have been reported in the geotechnical profile.

(i). **Sandy Gravels and Gravelly Sands (gS-sG)**

The Characterization of this geotechnical unit has been performed on the basis of the following information:

- Standard Penetration Test
- Granulometric analysis

From the values of the Nspt and from the effective vertical stress the N1(60) has been calculated, in order to determine the relative density Dr Considering the averaged value of N1(60) =26 a range for the relative density has been estimated Dr= 65-85 % (Clayton, 1995) and the peak shear resistance angle between 36°- 38° has been calculated by means of (Schmertmann, 1978). From the N1(60) also the operative drained Young modulus has been calculate, which on average is E'=95 MPa.

Even if the Nspt values are quite dispersed, on average it can be said that these Sandy Gravels and Gravelly Sands are medium dense to dense. They should not represent a problem for bearing capacity and settlements of shallow foundations or the embankments.

Table 4-8: Gravel and Sand, Geotechnical Parameters

Nspt_ Min	Nspt_ Averaged	Nspt_ Max	N1(60)_ Min	N1(60)_ Average	N1(60)_ Max	Dr_ Average (%)	φ_ Average (°)	C' (kPa)	E'_Min (Mpa)	E'_ Average (Mpa)	E'_ Max (Mpa)	Gamma (kN/m^3)
3	26	67	5	26	60	65-85	36-38	0	11	95	347	20

Gamma= unit weight of the ground
Source: GD-GTE-4000-GE-RP-0201_Section F4 - GEOTECHINCAL REPORT

(ii). **Silty Clays (sC)**

The Characterization of this geotechnical unit has been performed on the basis of the following information:

- Standard Penetration Test
- Oedometric tests
- Shear Tests
- Granulometric analysis and Atterberg's Limits
- Pressuremeter tests

From the Granulometric analysis and Atterberg's Limits and the Oedometric tests it has been inferred the soil classification as Silty Clays. From the above mentioned tests the following parameters have been calculated (see Table 4-9):

- overconsolidation ratio OCR
- consolidation factor cv
- hydraulic permeability kv
- Plasticity Index PI

Table 4-9: Silty Clays: Results of Oedometer and Shear Tests

	Cv (m^2/s)	OCR	Kv (m/s)	PI (%)	c' (kPa)	φ' (°)	Gamma (kN/m^3)
Min	9.6E-09	1.6	1.0E-11	19	52	20	18
Average	7.5E-08	3.7	1.5E-10	28	63	23	19.5
Max	2.5E-07	8.4	5.7E-10	37	76	25	21

Source: GD-GTE-4000-GE-RP-0201_Section F4 - GEOTECHINCAL REPORT

From the above results it can be stated these Silty Clays are strongly over consolidated, in fact this aspect has also been confirmed by the Nspt and by the shear tests, where an effective cohesion c' of (52-76) kPa has been measured.

In order to determine the undrained shear resistance Su (or Cu) the following data and tests have been considered:

- Values of the Nspt (Terzaghi and Peck, 1967, Stroud, 1974)
- Pressure meter tests (Mair and Wood, 1987)
- Plasticity Index and Over consolidation ratio (Skempton and Henkel, 1953, Ladd et al., 1977, Lancellotta, 1992)

(iii). **Soil of the embankments (mQ)**

The Characterization of this geotechnical unit has been performed on the basis of the engineering experience.

Table 4-10: Geotechnical Parameters for the Soil of the Existing Embankments

	Gamma (kN/m^3)	φ' (°)	c' (kPa)	E' (MPa)
Min.	18	34	0	40
Average	20	35	0	60
Max.	22	36	0	80

Source: GD-GTE-4000-GE-RP-0201_Section F4 - GEOTECHINCAL REPORT

(iv). **Clayey Marls and Marly Clay (MC)**

The clayey marls have been found in the boreholes from BH18 chainage 10+582 to BH11 chainage 14+360 at a depth ranging between 5 m and 20 m. They have been encountered neither in the geomechanical surveys on the outcrops nor in the rock samples from the boreholes.

Considering that often an alternation of clayey marls and marly clays has been found in the boreholes, for the sake of safety design, the (Stroud, 1974) method has been used to find the undrained shear resistance Su, by assuming the same factor Cu/Nspt=5 as for the clays.

The undrained modulus Eu has been estimated adopting the same ratio Eu/Su=500. The drained Young's modulus has been estimated by means of the formula with the drained Poisson's coefficient nu=0.15 for the clayey marls (see Table 4-11).

Regarding the clayey marls, a drained Mohr-Coulomb-Terzaghi shear resistance angle φ' and effective cohesion c' have been estimated, by reasonably assuming the same shear resistance angle φ' of the overlying silty clays and increasing the effective cohesion c'. The increase of the effective cohesion c' has been estimated by comparing the undrained shear resistance Su of the silty clays and the clayey marls.

Table 4-11: Geotechnical Parameters for the Clayey Marls

	Gamma (kN/m^3)	N SPT	N1(60)	Cu_SPT (Stroud) (kPa)	Eu_SPT (Stroud) (MPa)	E'_SPT (Stroud) (MPa)	c' (kPa)	φ' (°)
Min	20	20	13	100	50	38	127	20
Average	22	62	48	308	154	118	288	23
Max	24	90	68	450	225	173	320	25

Source: GD-GTE-4000-GE-RP-0201_Section F4 - GEOTECHINCAL REPORT

(7) Water Table and Hydraulic Permeability

The water table has been reported in the geotechnical profile, and following measurements have been performed in the boreholes during the drilling activity.

In the zone between BH1 and BH11 (km10+283 - km 14+283), the water table is located at different depths inside the soils layer overlying the marls. For safety reasons, higher values of the water table should be considered in all cases of the design of embankment.

In the zone from BH1 to BH38 (km10+283 - km 0+022), water table passes through the rock formations and the soils. A general increase of the water level in correspondence of the crests is assumed in this zone, but caution should be taken during construction of the tunnels.

It is suggested to monitor the ground water level with seasonal oscillation by means of the installed piezometers and eventually increase the number of piezometers, especially in correspondence of the tunnels.

From the Lugeon tests the hydraulic permeability of the three rock formations N_1^2, J_2b_2 (A), J_2b_2 (B) has been estimated. The hydraulic permeability of the clayey marls can be assumed to be the same order of magnitude of the N_1^2 formation. In the Table 4-12, measured hydraulic permeability of all the rocks and soils has been summarized.

Table 4-12: Summary of Hydraulic Permeability on Rocks and Soils

Rocks and Soils		k_min (m/s)	k_average (m/s)	k_max (m/s)
Rock type	N_1^2	5.E-08	2.E-07	3.E-07
	J_2B_2 (A)	1.E-07	4.E-07	6.E-07
	J_2B_2 (B)	4.E-07	8.E-07	1.E-06
Soil type	Gravelly Sand and Sandy Gravel	1.E-04	1.E-03	1.E-02
	Silty Clays	1.0E-11	1.5E-10	5.7E-10
	Soil embankment	1.E-06	5.E-06	1.E-05

Source: GD-GTE-4000-GE-RP-0201_Section F4 - GEOTECHINCAL REPORT

(8) Comments on Geological Survey and Geotechnical Study

From a geo-lithological point of view, the following findings should be identified through the geological investigation and the geotechnical analysis in general, and the data and information should be effectively used for the D/D study and the construction phase in terms of the project road.

- Depth and distribution of surface soil, bedrock (soft/hard) and their weathered zone based on the result of geological/geo-morphological field survey and boring core sample.

- Anticipated marl and calcareous rock layer, landslide morphology, slope failure, and falling stones of natural slope.
- Tectonic and geologic elements such as faults (inferred faults) and fracture zone.
- Confirmation of the tunnel bedrock (earth covering, depth and distribution of bedrock, and rock mass characteristic).
- Analyzing result of geophysical survey (Reflection, Refraction, and ERT).
- Results of laboratory test for soil and rock mass characteristics.
- As a result of hydro-geological field survey including groundwater monitoring (lugeon test and piezometric reading in the well and borehole), consideration for the spring water drainage corresponding to the tunnel excavation and impact on the groundwater lowering to the vicinity (existing well, crop land) of the project road.
- Drying out of the existing well and water quality degradation due to the ground excavation in the vicinity of the project road.

In addition, JST has given the following comments as confirmation items during the D/D study period.

- From the geo-technical point of view, appropriate and sufficient survey results should be presented so as to enable an appropriate slope design corresponding to the safe gradient of a slope and a suitable slope protection method.
- Additional geological survey (boring) for identifying the landslide and provision of a proposal for the necessary measures.
- Proposal for additional geological surveys (boring) due to the repeated changes of the road alignment and the difficult condition as a steep slope.
- Identifying the depth of top soil and the soil property (laboratory test) in the section of embankment
- Identifying the depth of top soil and the soil property (laboratory test) in the section of embankment
- Based on the geological (boring) survey and geophysical investigation, identifying the rock (including soil) mass classification of natural ground so as to reflect the tunnel excavation methods.
- Calculation of excavated rock and soil quantities based on the soil and rock mass classification of natural ground.
- Consideration of the lowering ground water (drying up of the existing well and influence to the farmland) caused by the tunnel excavation and earth cutting and necessity of groundwater monitoring.

After discussion with D/D study team and a careful reviewing of the D/D study report, JST's comments on achievements and issues to be considered are summarized as follows;

- Despite the short time period available for D/D study phase, the comprehensive geological and geotechnical investigations including boring surveys, geological (geo-morphological) field surveys, geophysical investigations and laboratory test were successfully completed as planned.
- Sufficient amount of necessary items have been conducted in the geological survey, site survey and geophysical survey respectively. However, most boreholes were not located at the necessary points such as tunnel portal and bridge pier, which was inefficient to identify the geological condition. With respect to the mapping of geological profile in consideration of geomechanics classification, the results of geophysical survey and geological survey do not fully reflect for the detailed design.
- The results of laboratory tests for rock specimen (outcrop rock sample and boring core sample), undisturbed sample and disturbed sample were quite satisfactory. However, the

description about how the result can be effectively used in the detailed design and the construction plan is insufficient.

- As part of natural condition survey (topographical survey, meteorological and hydrological survey and geological survey), the utility survey has been conducted for identifying the public facilities which could have an effect on the project road. However, there was not enough description relating to the concrete object that is likely to hinder the road construction. It seems necessary to refer to this matter in association with environmental and social considerations (EIA).
- Since the vehicle mounted boring machine cannot be applied to the location such as an off the road and steep slope in the D/D study, the geological survey for the tunnel portal, bridge pier and abutment were not satisfactory conducted. In order to improve accuracy of detailed design and ensure the basis of quantity, additional boring survey is necessary.
- With respect to some geologically unidentified positions due to the repeated changes of the road alignment and the topographically difficult condition such as a steep slope and a landslide dangerous area, additional investigations (boring) will be necessary based on the recommendations from JST. In the detailed investigation of the landslide, JST would like to judge the presence or absence of landslide activity by the boring survey that reaches the assumed slip plane.
- Reviewing the result of geological surveys as a whole, it was identified that the foundation bedrock of the project road is geologically relatively stable. Since the potential concerns in terms of geology will be noted as follows, mainly for safety issues, it will be required to deal with these specific issues independently in the construction phase.
    - Falling rock preventive countermeasure for the tunnel portal sites (TB-1, 2, 3 and 4).
    - Detailed investigation and countermeasures for the areas with potential landslides
    - Slope protection method (rockfall prevention method) between TB-1 and TB-2
    - Possible negative impact on tunnel excavation, open cut and high embankment (in terms of differential settlement) due to the soft rock and the weathered rock such as marl and calcareous sedimentary rocks which are distributed in the north of the Zestafoni.
    - Counter measure for sudden spring water when excavating tunnel (low possibility because of the findings of geo-tectonic investigations such as fault, inferred fault and fracture zone).
    - Possible groundwater lowering in some cases due to tunnel excavation.
    - Shortage of accurate data on the thickness of river bed sediments and the depth of foundation bed rock for bridge pier and abutment construction due to insufficient investigation.
- According to the field survey from the hydro-geological point of view and EIA, some existing wells having possibilities to be influenced by tunnel excavation have been found along the project road. There are some concerns that the lowering ground water (drying up of the existing well and the farmland) and differential settlement of ground surface caused by the tunnel excavation and earth cutting. In order to know the detailed ground water table and their seasonal changes, ground water monitoring before and after construction phase is necessary.

(9) Additional Geotechnical Investigation

Additional geotechnical investigation along E-60 from Shorapani to Argveta was implemented as a part of the Preparatory Survey financed by JICA for the Project since April 2018 until August 2018. The purpose of additional drillings and relevant laboratory tests are to identify geological feature at possible tunnel portal locations and bridge pier locations along E-60 from Shorapani to Argveta and at a possible land slide location. The list of additional borings is shown in the following table. Detailed data such as drilling log, photos and result of laboratory test are included in Appendix 4.5.

Table 4-13: List of Additional Borings

NO.	Location (Distance)	Coordinate (UTM)*1		Elevation (m)*2	Depth (m)	Geology (Bed Rock)	Drilling Works		Remarks
		X (mE)	Y (mN)				Start	End	
1	Tbilisi side of Tunnel 1 (0.27 km)	345,278.09	4,661,700.00	218	11.2	J2B2(B), Porphyrite	12/08/18	14/08/18	
2	Argveta side of Tunnel 1 (0.64 km)	344,941.35	4,661,824.95	210	14.5	J2B2(B), Porphyrite	15/07/18	23/07/18	
3	Argveta side of Tunnel 1 (0.61 km)	344,974.83	4,661,852.91	199	18.8	J2B2(B), Porphyrite	23/07/18	29/07/18	
4	Argveta side of Tunnel 1 (0.57 km)	344,998.43	4,661,828.63	219	10.0	J2B2(B), Porphyrite	05/08/18	10/08/18	
5	Tbilisi side of Tunnel 2 (0.85 km)	344,723.90	4,661,888.62		0.0	J2B2(B), Porphyrite	Cancelled		
6	Argveta side of Tunnel 2 (1.19 km)	344,394.50	4,661,954.68		0.0	J2B2(B), Porphyrite	Cancelled		
7	Tbilisi side of Tunnel 3 (3.52 km)	342,066.66	4,661,697.29	253	30.0	J2B2(A), Tuff Breccia	21/05/18	24/05/18	
8	Argveta side of Tunnel 3 (4.56 km)	341,093.68	4,661,817.20	211	20.0	J2B2(A), Tuff Breccia	27/04/18	28/04/18	
9	Argveta side of Tunnel 4 (6.99 km)	339,728.45	4,663,748.65		0.0	J2B2(A), Tuff	Cancelled		
10	Tbilisi side of Tunnel 5 (7.19 km)	339,614.22	4,663,909.64		0.0	J2B2(A), Tuff	Cancelled		
11	Argveta side of Tunnel 5 (8.23 km)	338,737.37	4,664,490.31	238	20.0	N12(m), Calcarenite	15/08/18	17/08/18	
12	BR-1-1 (1.26 km)	344,314.73	4,661,964.79	196	8.0	J2B2(B), Porphyrite	11/04/18	11/04/18	
13	BR-1-2 (1.31 km)	344,257.27	4,661,959.50	187	25.0	J2B2(B), Porphyrite	10/04/18	11/04/18	
14	BR-1-3 (1.41 km)	344,147.57	4,661,994.86	174	15.0	J2B2(A), Tuff Breccia, Porphyrite	25/07/18	27/07/18	
15	BR-1-4 (1.55 km)	344,022.48	4,662,002.86	175	15.0	J2B2(B), Porphyrite	21/07/18	23/07/18	
16	BR-1-5 (1.76 km)	343,823.20	4,662,011.30	191	16.0	J2B2(B), Porphyrite	24/04/18	25/04/18	
17	BR-1-6 (1.85 km)	343,717.76	4,662,021.07	200	18.0	J2B2(B), Porphyrite	16/04/18	17/04/18	
18	BR-2-1 (2.12 km)	343,481.50	4,662,035.81	187	5.0	J2B2(B), Porphyrite	11/07/18	13/07/18	
19	BR-2-2 (2.23 km)	343,338.33	4,662,036.70	175	10.0	J2B2(B), Porphyrite	12/04/18	12/04/18	
20	BR-2-3 (2.36 km)	343,233.28	4,661,981.82	183	20.0	J2B2(B), Porphyrite	04/04/18	05/04/18	
21	BR-2-4 (2.59 km)	343,019.85	4,661,884.35	172	20.0	J2B2(B), Porphyrite	15/07/18	17/07/18	
22	BR-2-5 (2.76 km)	342,838.04	4,661,853.21	168	15.0	J2B2(B), Porphyrite	17/07/18	19/07/18	
23	BR-2-6 (2.89 km)	342,696.19	4,661,820.57	175	10.0	J2B2(B), Porphyrite	19/07/18	20/07/18	
24	BR-3-1 (3.23 km)	342,374.20	4,661,745.64	177	10.0	J2B2(B), Porphyrite	13/04/18	14/04/18	
25	BR-3-2 (3.38 km)	342,239.64	4,661,741.20	171	10.0	J2B2(B), Porphyrite	14/04/18	14/04/18	
26	BR-3-3 (3.45 km)	342,180.35	4,661,731.52	171	20.0	J2B2(B), Porphyrite	15/04/18	16/04/18	
27	BR-3-4 (3.48 km)	342,155.75	4,661,738.07	169	8.0	J2B2(B), Porphyrite	26/04/18	26/04/18	
28	BR-4 (6.27 km)	340,046.82	4,663,091.59	161	15.0	J2B2(B), Porphyrite	11/07/18	14/07/18	

NO.	Location (Distance)	Coordinate (UTM)*1		Elevation (m)*2	Depth (m)	Geology (Bed Rock)	Drilling Works		Remarks
		X (mE)	Y (mN)				Start	End	
29	BR-5-1 (9.04 km)	337,949.74	4,664,553.02	208	28.0	N12(m), Calcarenite	01/05/18	03/05/18	
30	BR-5-2 (9.08 km)	337,894.01	4,664,561.19	197	23.0	N12(m), Calcarenite	04/05/18	07/05/18	
31	BR-5-3 (9.15 km)	337,818.42	4,664,587.03	176	25.0	N12(m), Calcarenite	07/05/18	10/05/18	
32	Risk check for Land slide (0.58 km)	344,964.37	4,661,857.77	192	90.0	J2B2(B), Porphyrite	11/04/18	16/04/18	Horizontal Boring

*1: GPS on-site survey data (error in 5-10 m) measured by JICA Survey Team
*2: Reading data from Google map and topographical map with a scale of 1 to 1,000 by JICA Survey Team
Source: JICA Survey Team

Observations related to Tunnel designing part

➢ The Portal of Tbilisi side for Tunnel-1 (BH-01)

11.2-meter drilling in total length was carried out, 1.5-meter of soil, 1.0-meter of soft rocks (1.5 meter to 2.5 meter depth), and 8.7-meter of hard rocks (> 2.5 meter depth) were confirmed. On the other hand, according to the geophysical investigation results implemented by D/D consultant (See Figure 4-13 and Table 4-15), the following results were confirmed:

- Vp = 460 meter/sec (Unit 1) (Surface to 1.0 meter depth)
- Vp = 1,050 meter/sec (Unit 2) (1.0 meter to 4.0 meter depth)
- Vp = 1,570 meter/sec (Unit 3) (> 4.0 meter depth)

Although the recovered core has hardness, the rate of the total core recovery is low. It is thought that it was difficult to recover a soft part including a discontinuous planes. As a result, it is judged that the proportion and property of the soft parts including the discontinuous planes affects the elastic wave velocity.

➢ Shallow overburden section at the end of Tunnel-1 (BH-02)

14.5-meter drilling in total length was carried out, 9.0-meter of soil and 5.5-meter of hard rocks (> 9.0 meter depth) were confirmed. A shallow overburden area was able to observe separately from the portal section around the portal of Argveta side for T-AT-1. (See Figure 4-15 to Figure 4-18) As can be estimated from the relationship between existing ground elevation and planned elevation, the distribution of the soil layer is expected to reach the lower part of the tunnel excavation face in this shallow overburden section.

➢ The Portal of Argveta side for Tunnel-1 (BH-03, BH-04)

At BH-03, 18.8-meter drilling in total length was carried out, 4.5-meter of soil and 14.3-meter of hard rocks (> 4.5 meter depth) were confirmed. Also at BH-04, 10.0-meter drilling in total length was carried out, 1.0-meter of soil and 9.0-meter of hard rocks (> 1.0 meter depth) were confirmed.

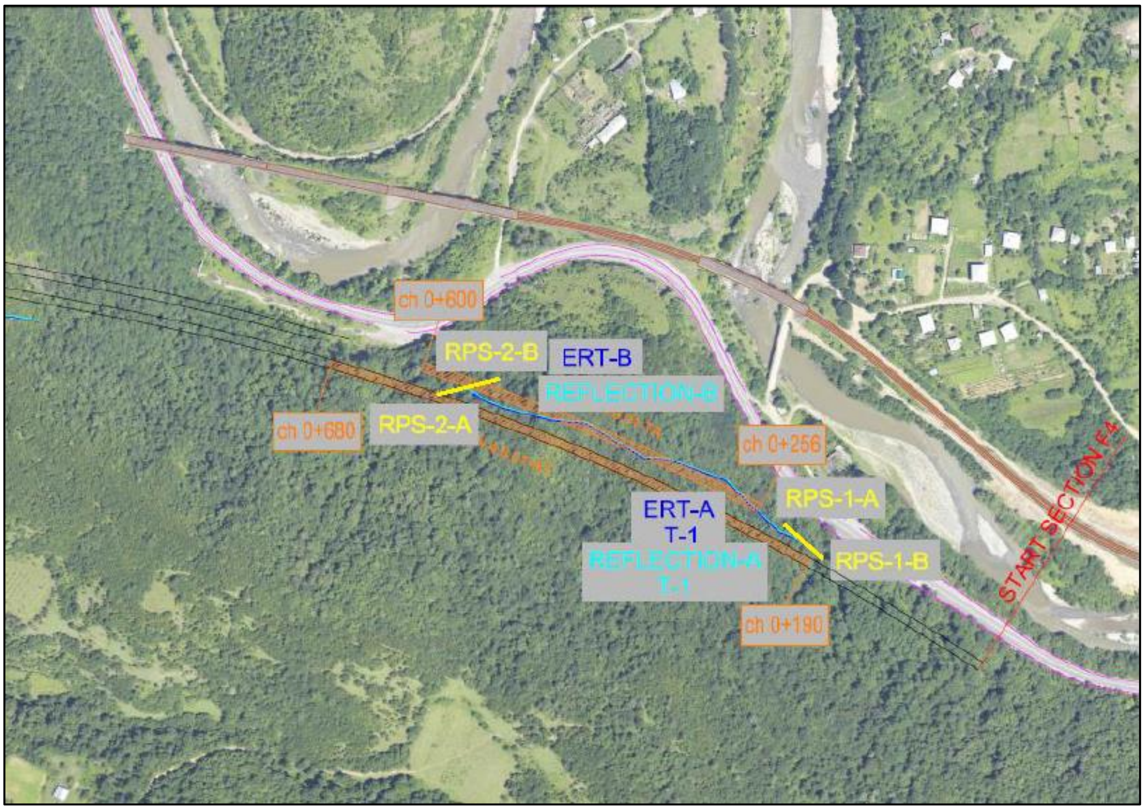
Considering both BH-03 and BH-04, it can be assumed that the soil thickness from the surface would be 1.0 to 4.5 meter depth, and that weathering part including the discontinuous layer would be progressing although the rock hardness is adequate up to about 9.0-meter depth at the portal area of Argveta side for Tunnel-1.

➢ The Portal of Argveta side for Tunnel-5 (BH-11)

20.0-meter drilling in total length was carried out, 0.3-meter of soil and 19.7-meter of calcarenite classified as a kind of soft rocks were confirmed.

As shown in Figure 4-19, the existing borehole survey points of BH-02 and BH-26 are located on the extension line of the same slope in the longitudinal and transverse direction as the additional borehole of BH-11. At BH-02 (existing survey), 12.0-meter of soil and a certain meter depth of calcarenite classified as a kind of soft rocks deeper than 12.0-meter depth were confirmed. Also at BH-26 (existing survey), 8.5-meter of soil and a certain meter depth of calcarenite deeper than 8.5-meter depth were confirmed.

Based on the above results, it is expected that the soil layer would gradually become thicker from the additional boring point BH-11 near the mountain stream toward the top of the slope.



Source: GD-GTE-4000-GE-RP-0201_Section F4 - GEOTECHINCAL REPORT

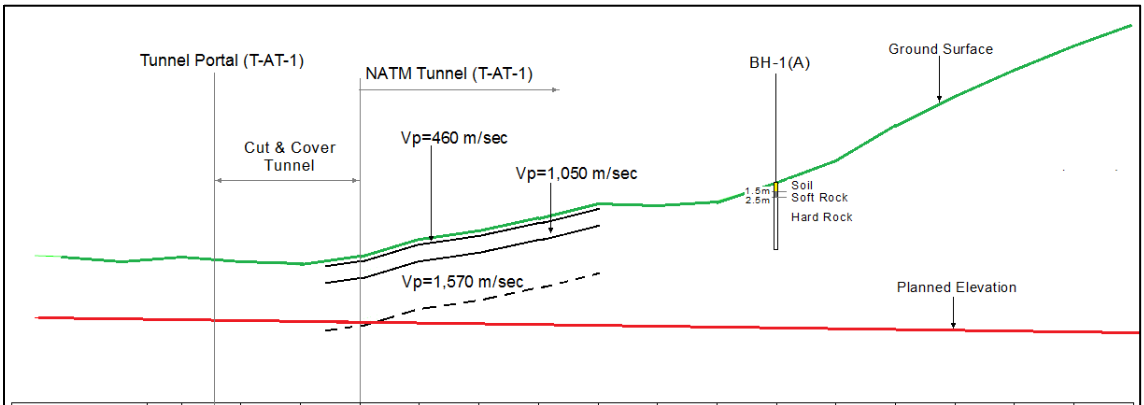
Figure 4-13: Locations of Geophysical Investigation around Tunnel-1

Table 4-14: Geophysical Investigation Result around the Portal of Tbilisi Side for Tunnel-1

RPS-2

Seismo-Stratigraphy	Layer Bed Depth (m)	Thickness (m)	Vp (m/sec)	Presumable Lithology
Unit 1	1.5	1.5	550	TS
Unit 2	5	3.5	1,020	J2b2B Alt (Porphyrite)
Unit 3	undefined	7	1,700	J2b2B (Porphyrite)

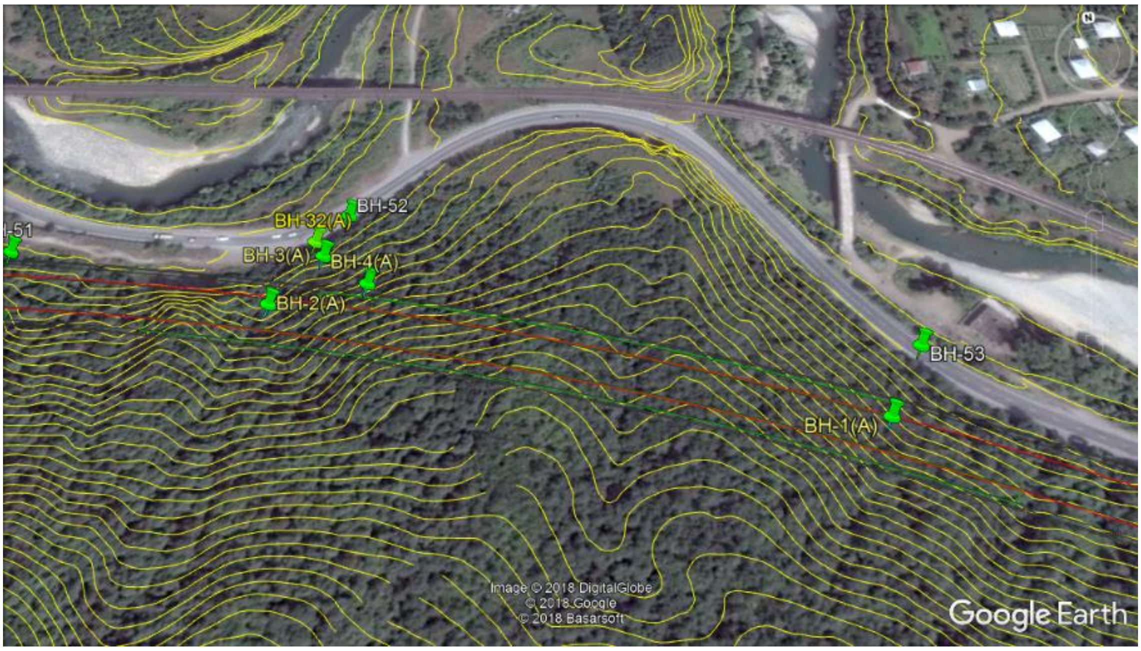
Source: GD-GTE-4000-GE-RP-0201_Section F4 - GEOTECHINCAL REPORT



Station	0+160	0+170	0+180	0+190	0+200	0+210	0+220	0+230	0+240	0+250	0+260	0+270	0+280	0+290	0+300	0+310
Existing Ground Elevation	217.31	216.52	215.92	217.39	220.20	221.63	223.77	226.13	225.97	226.61	229.74	233.40	239.34	244.05	248.69	252.64
Planned Elevation	206.68	206.54	206.41	206.27	206.14	206.00	205.87	205.74	205.60	205.47	205.33	205.20	205.06	204.93	204.80	204.66

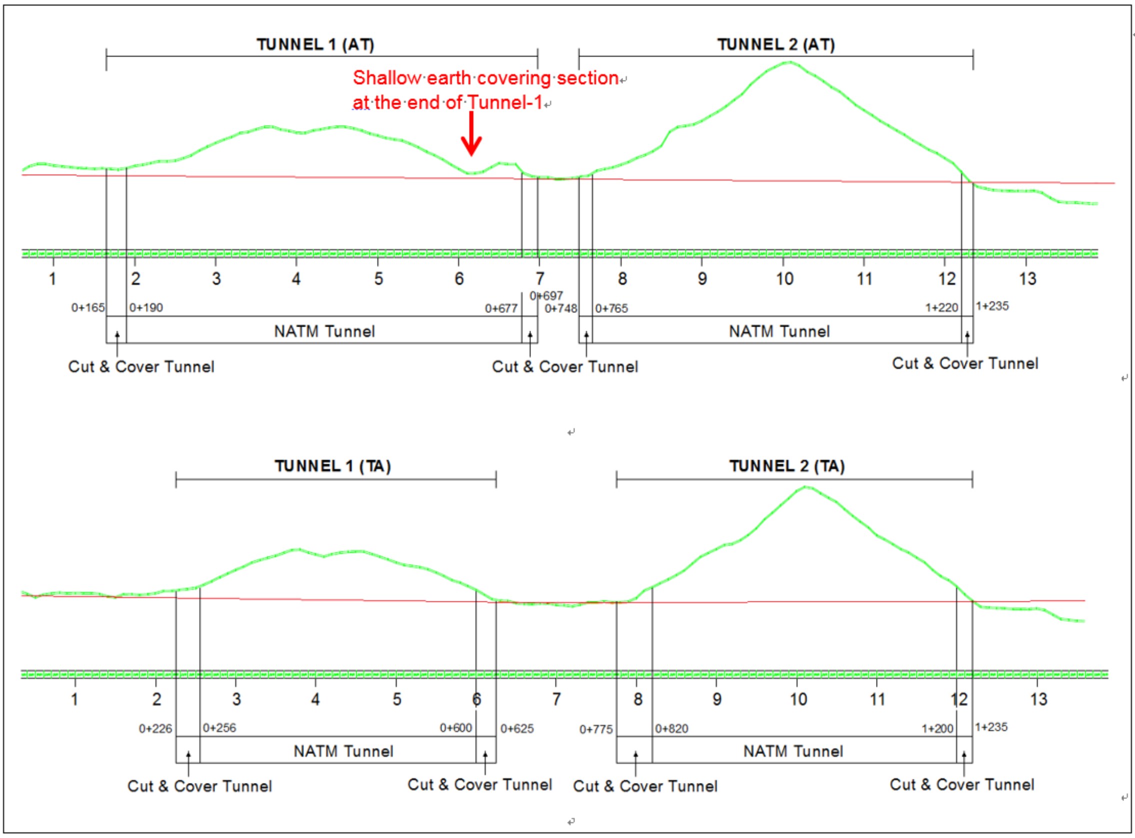
Source: JICA Survey Team

Figure 4-14: Result of Geophysical Investigation and Additional Drilling Investigation at the Start of Tunnel-1



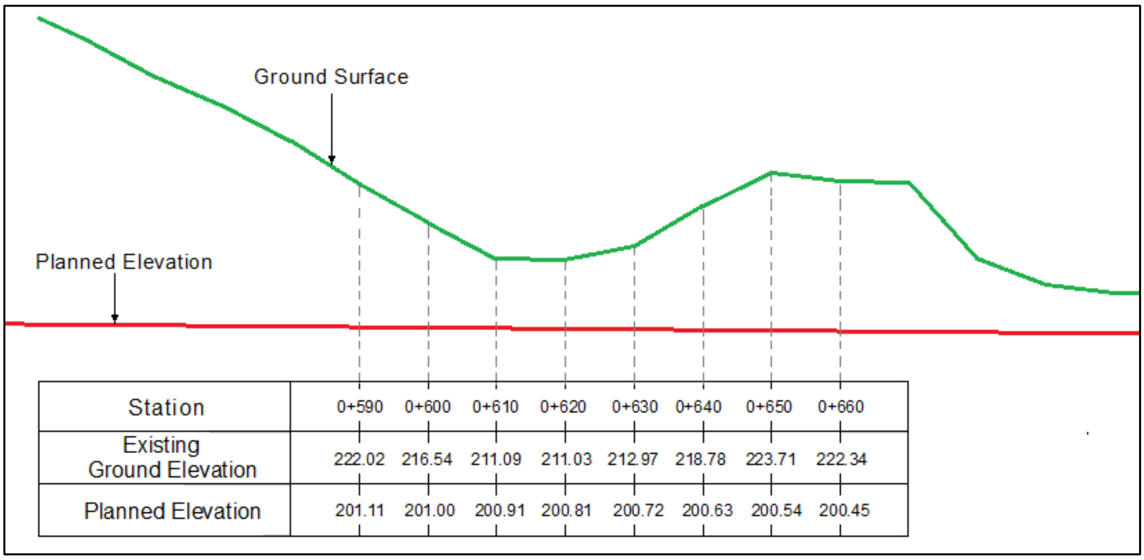
Source: JICA Survey Team

Figure 4-15: Locations of Additional Borehole Survey around Tunnel-1



Source: JICA Survey Team created based on the Final Report by D/D Consultant

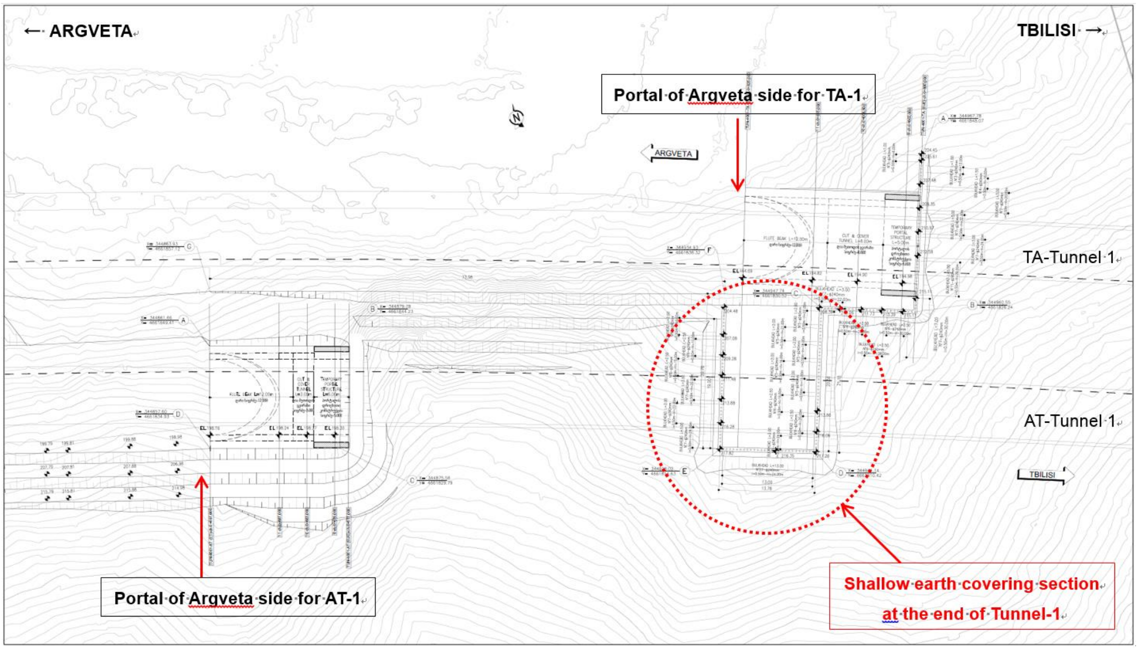
Figure 4-16: Location of Shallow Overburden Section at the End of Tunnel-1 (Longitudinal Profile)



Station	0+590	0+600	0+610	0+620	0+630	0+640	0+650	0+660
Existing Ground Elevation	222.02	216.54	211.09	211.03	212.97	218.78	223.71	222.34
Planned Elevation	201.11	201.00	200.91	200.81	200.72	200.63	200.54	200.45

Source: JICA Survey Team created based on the Final Report by D/D Consultant

Figure 4-17: Location of Shallow Overburden Section at the End of Tunnel-1 (Longitudinal Profile, Enlarge)



Source: JICA Survey Team created based on the Final Report by D/D Consultant

Figure 4-18: Location of Shallow Earth Covering Section at the End of Tunnel-1 (Top View Plan)

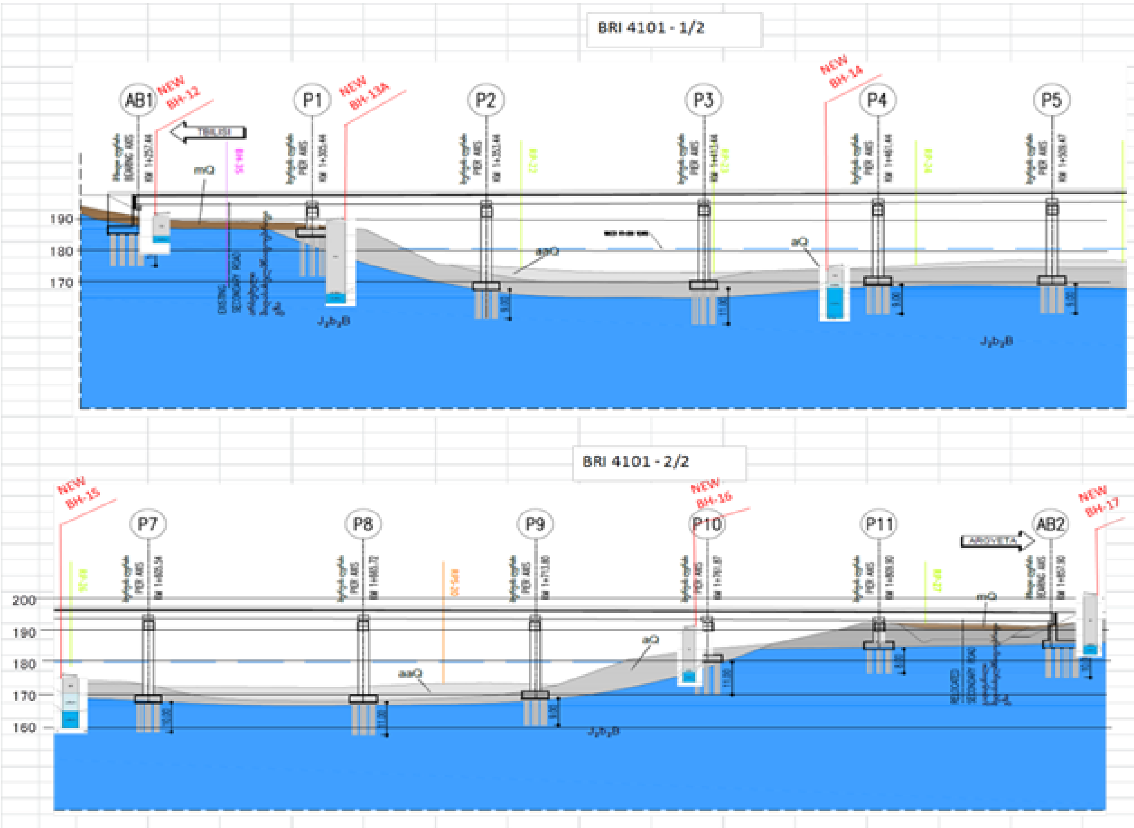
Source: JICA Survey Team

Figure 4-19: Locations of Additional Borehole Survey around Tunnel-5

Observations related to Bridge designing part

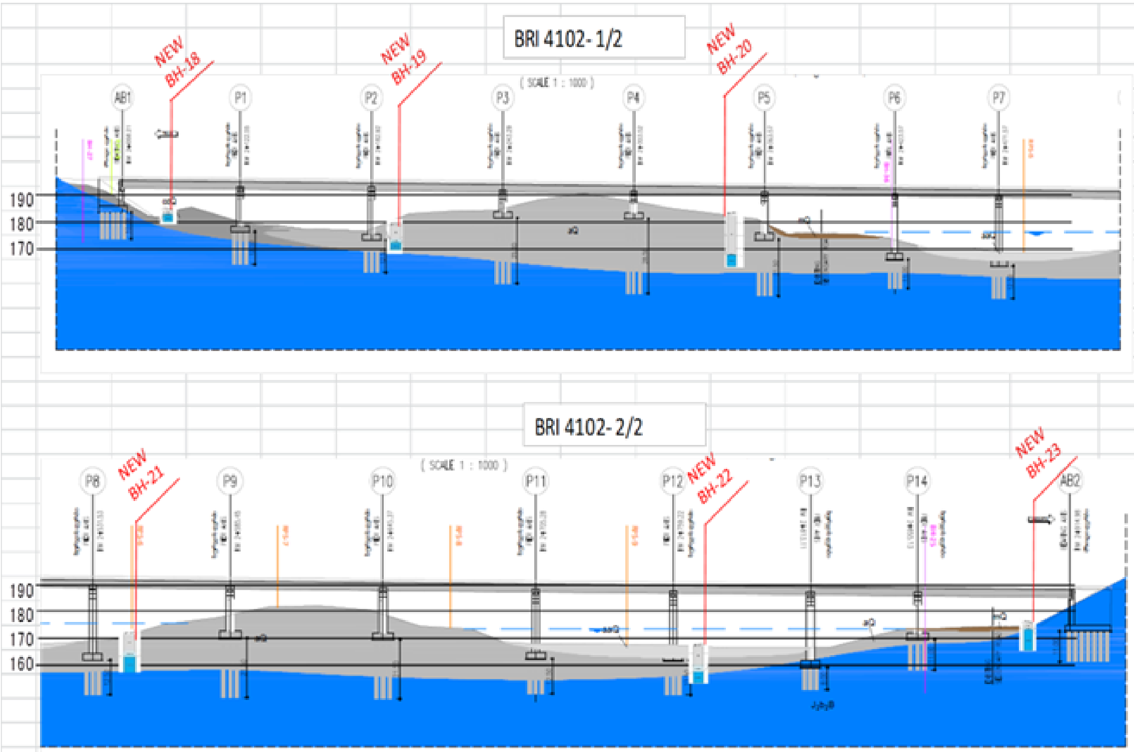
The geotechnical investigation executed in the D/D by IRD at the bridge locations was mainly based on the geophysical investigation and the drilling boreholes were minimum. Therefore, the additional geotechnical investigation was carried out for confirmation of the geological characteristics and studying of the construction method by the contractor at the construction phase.

Figure 4-20 to Figure 4-24 indicate the additional borehole logs; "NEW BH-12~31" on the geological profiles used for bridge design in the D/D. It shows that there are some parts of the soil layer inclination difference from the D/D at the steep slope locations (around 1 km + 250 to 350), and there are some differences about the degree of weathering of rock. However, taking account of the laboratory test results and the core photographs, it is considered that the geological profiles in the D/D were generally suitable.



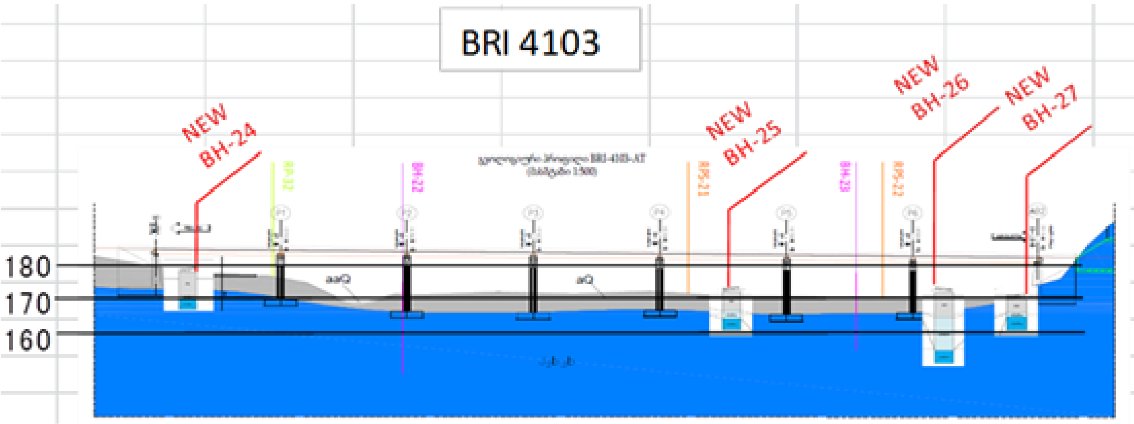
Source: JICA Survey Team created based on the Final Report by D/D Consultant

Figure 4-20: BRI4101 - Geological Profile



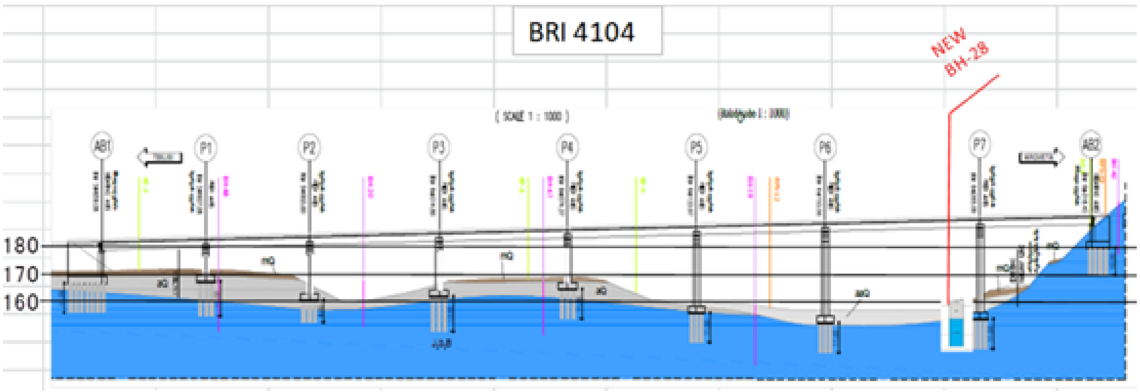
Source: JICA Survey Team created based on the Final Report by D/D Consultant

Figure 4-21: BRI4102 - Geological Profile



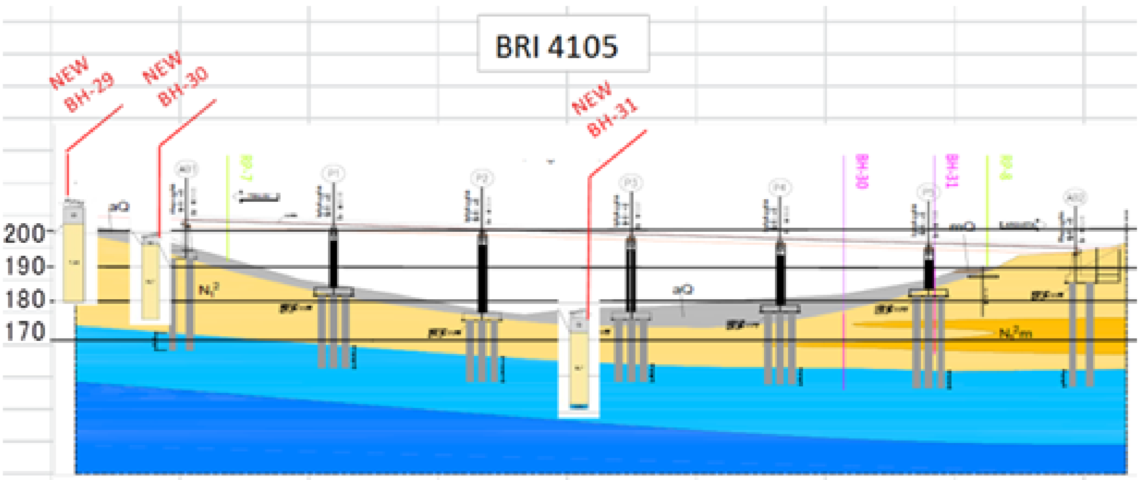
Source: JICA Survey Team created based on the Final Report by D/D Consultant

Figure 4-22: BRI4103 - Geological Profile



Source: JICA Survey Team created based on the Final Report by D/D Consultant

Figure 4-23: BRI4104 - Geological Profile



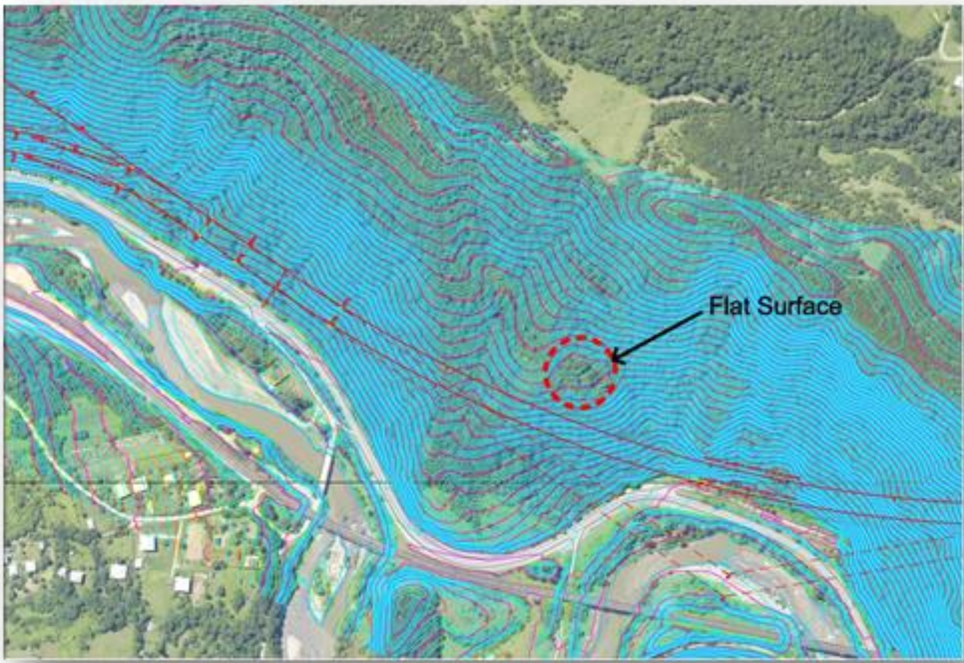
Source: JICA Survey Team created based on the Final Report by D/D Consultant

Figure 4-24: BRI4105 - Geological Profile

<u>Observations related to Landslide potentials</u>

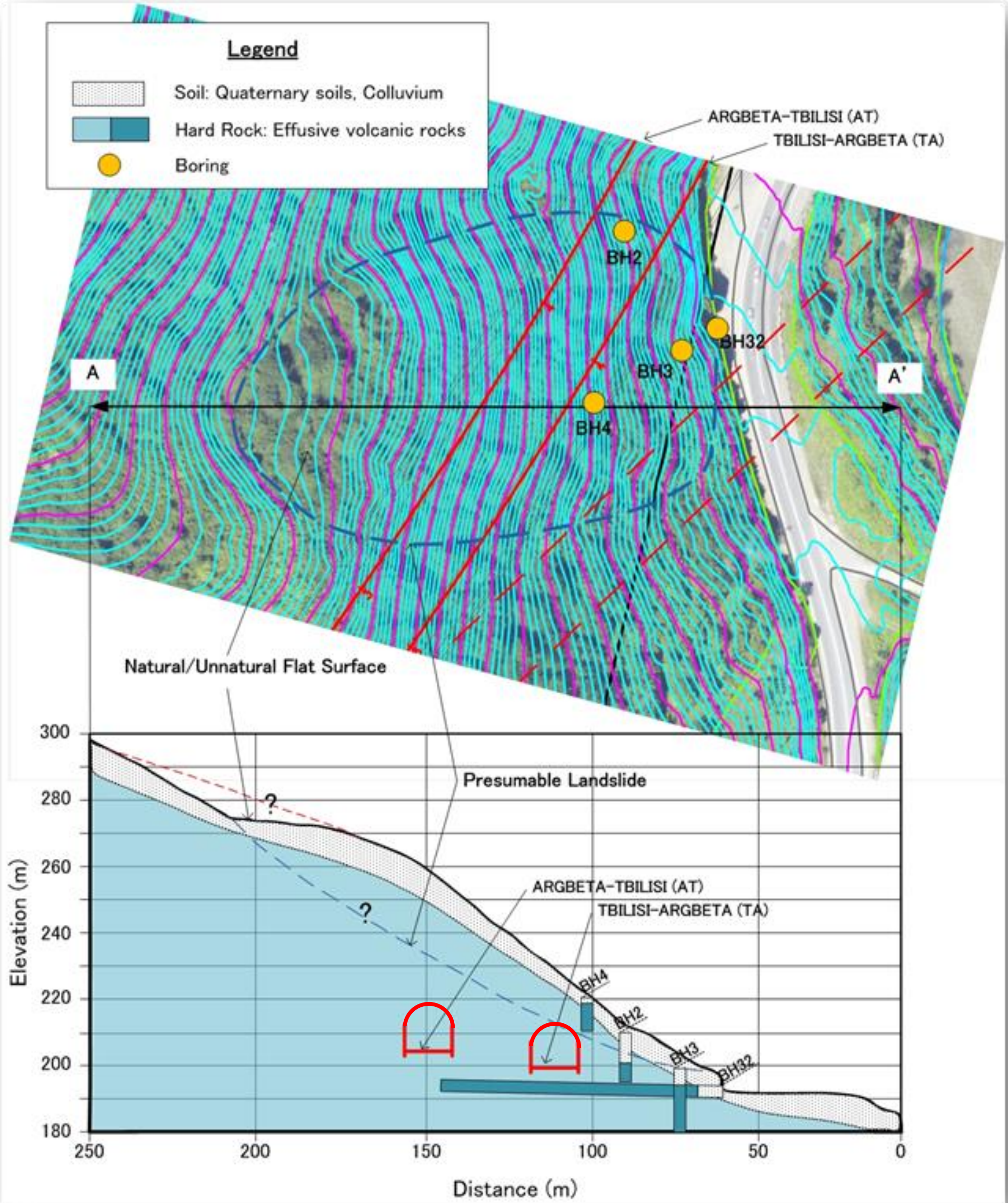
In order to identify the presence of landslide in the open section between Tunnel-1 and Tunnel-2 (0.6 km from the starting point), additional geological investigation with three vertical drillings and one horizontal drilling was conducted. As a result of this drilling investigation and additional filed reconnaissance, the followings are summarized as a conclusion:

- As shown in the geographical map with the scale of 1:1,000 (see Figure 4-25), there is a flat surface on the hillside between Tunnel-1 and Tunnel-2, and the existence of terraces at the same altitude is not recognized. From those facts, it can be assumed that the flat part would be a presumable landslide OR an artificial landform transforming such as a past land reclamation.
- As illustrated in Figure 4-26 with the geological profile based on the result of drilling investigation, the bed rock composed of porphyrites can be seen in a comparatively shallow position with the fresh and hard properties.
- According to the additional field reconnaissance, the specific or active signs of landslide activities cannot be found in the presumable land slide area. However, there is a possibility of slope collapse due to loosening of the bedrock by tunnel excavation on this section, hence, it is necessary to select an appropriate construction method which can avoid this loosening failure.



Source: JICA Survey Team created based on the Final Report by D/D Consultant

Figure 4-25: Geomorphological Features of Presumable Landslide

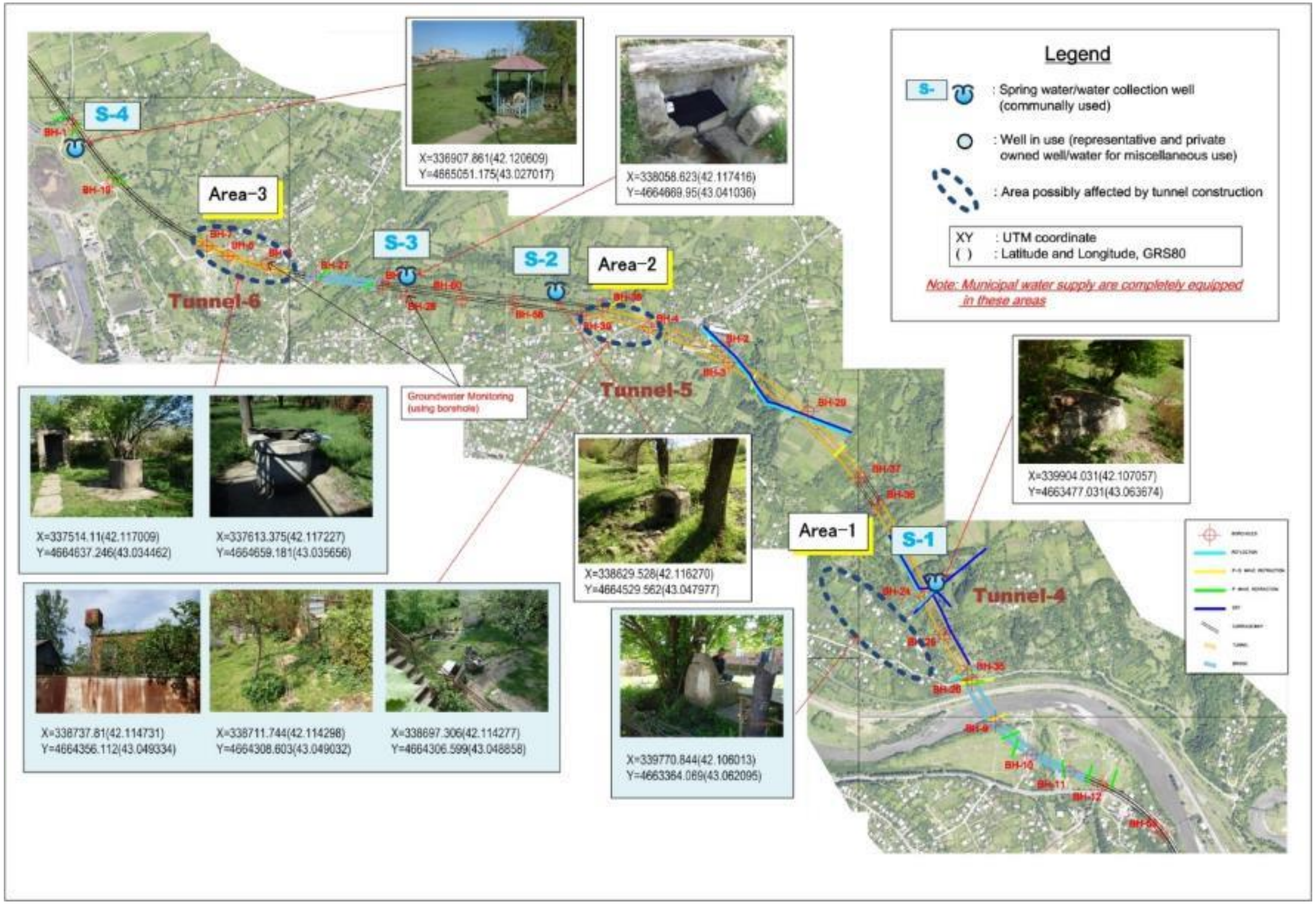


Source: JICA Survey Team created based on the Final Report by D/D Consultant

Figure 4-26: Geological Profile of Presumable Landslide

(10) Additional Reconnaissance Survey on Groundwater Use

Reconnaissance survey for the ground water use along E-60 from Shorapani to Argveta was conducted as a part of the Preparatory Survey for the Project. As a survey results, the area possible affected by tunnel construction can be assumed as in the following figure.



Source: JICA Survey Team

Figure 4-27: Overview of Groundwater Use

(11) Additional Reconnaissance Survey on Archeological Remains

According to the Archeological Report (D-ARC-4000-GE-RP-0060) by D/D consultant, the stonework has been detected near the Argveta side of Tunnel 5 (8.23 km) where the additional geological survey (Boring No. 11) has been conducted by chance. As a result of the geological investigation for Boring No. 11 (see Figure 4-28), the calcarenites was observed in the core sample, and the exposition of the calcarenites can be seen on the ground surface around here. The calcarenites is easy in processing stone materials used as building materials from ancient time in this area. From archaeological point of view, special attention should be paid to this area when constructing the tunnel.

Source: JICA Survey Team

Figure 4-28: Archeological Remains near the Tunnel 5

4.1.4 Slope Survey

(1) General

With respect to slope investigation, in general, a site survey would be conducted after an alignment is fixed. Furthermore, an investigation to determine the necessity of cut slope measures would be conducted after identifying the location of cut slope. However, under the current ongoing DD study, the JICA survey team presented only limited currently available information related to the specific site requiring special attention, and the slope survey is based on the alignment presented by reviewing the FS study, and results of the field reconnaissance. Detailed comments for the slope survey corresponding to the progress of the DD study will be presented by the JICA survey team hereafter. After that, some of the caution points are avoided by an alignment change.

(2) Extraction of the Specific Site Requiring Special Attention in the Preliminary Desk Research

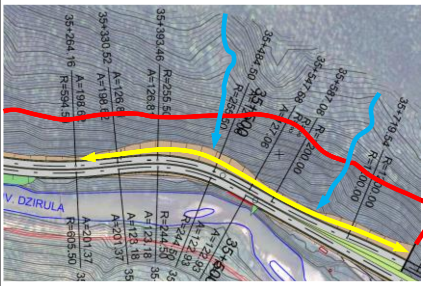
The criterion for site extraction requiring special attention is based on the designation type for a "Steep Slope Area in Danger of Failure" in Japan, as follows:

- The project road is adjacent to the natural slope which is more than 5 meters in height.
- The project road is adjacent to the natural slope where the inclination angle is more than 30 degrees.

Moreover, the survey extended up to the Knick line of the natural slope.

Since a mountain stream was found in the natural slope, a course tracing of falling rock and a detailed investigation of the possible debris flows were conducted. The target slope, taking into consideration the slope measures, is selected in the case that a planned cut slope height is over 5 meters. The stereoscopic photography extracted from Google Earth and a specific site requiring special attention are shown as follows:

Sta. 35+260 ~ Sta.35+850

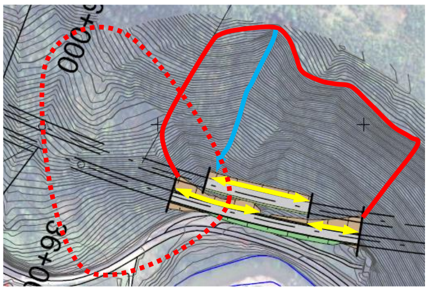


Legend
- Slope survey range by field reconnaissance (red outline)
- Slope protection work to be considered (yellow arrow range)
- Marked mountain stream (blue arrow line)

Source: JICA Survey Team

Figure 4-29: Marked Slope (Sta. 35+260 ~ Sta.35+850)[5]

Sta.36+150 ~ Sta.36+250



Legend
- Slope survey range by field reconnaissance (solid red outline)

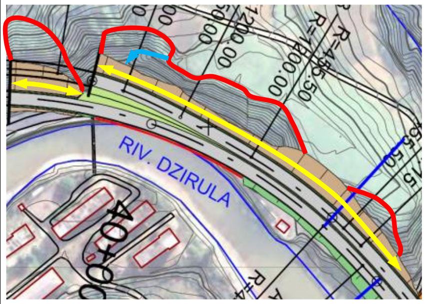
  For landslide survey:
- Slope protection work to be considered (yellow arrow range)
- Marked mountain stream (blue arrow line):

Source: JICA Survey Team

Figure 4-30: Marked Slope (Sta.36+150 ~ Sta.36+250)

[5] These two photos are stereo types for stereoscopic vision, and are attached both for confirming topography and rock form. Following two photos are attached both for the same reason.

Sta.39+800 ~ Sta.40+200

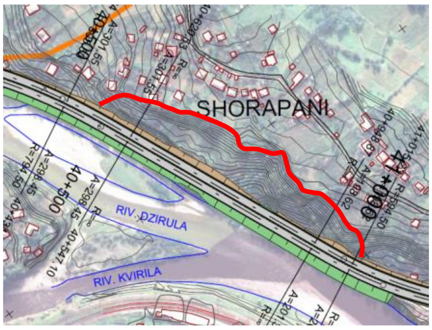


Legend
- Slope survey range by field reconnaissance (red outline)
- Slope protection work to be considered (yellow arrow range)
- Marked mountain stream (blue arrow line)

Source: JICA Survey Team

Figure 4-31: Marked Slope (Sta.39+800 ~ Sta.40+200)

Sta.40+400 ~ Sta.41



Legend
- Slope survey range by field reconnaissance (red outline)
- Slope protection work to be considered (yellow arrow range)
- Marked mountain stream (blue arrow line)

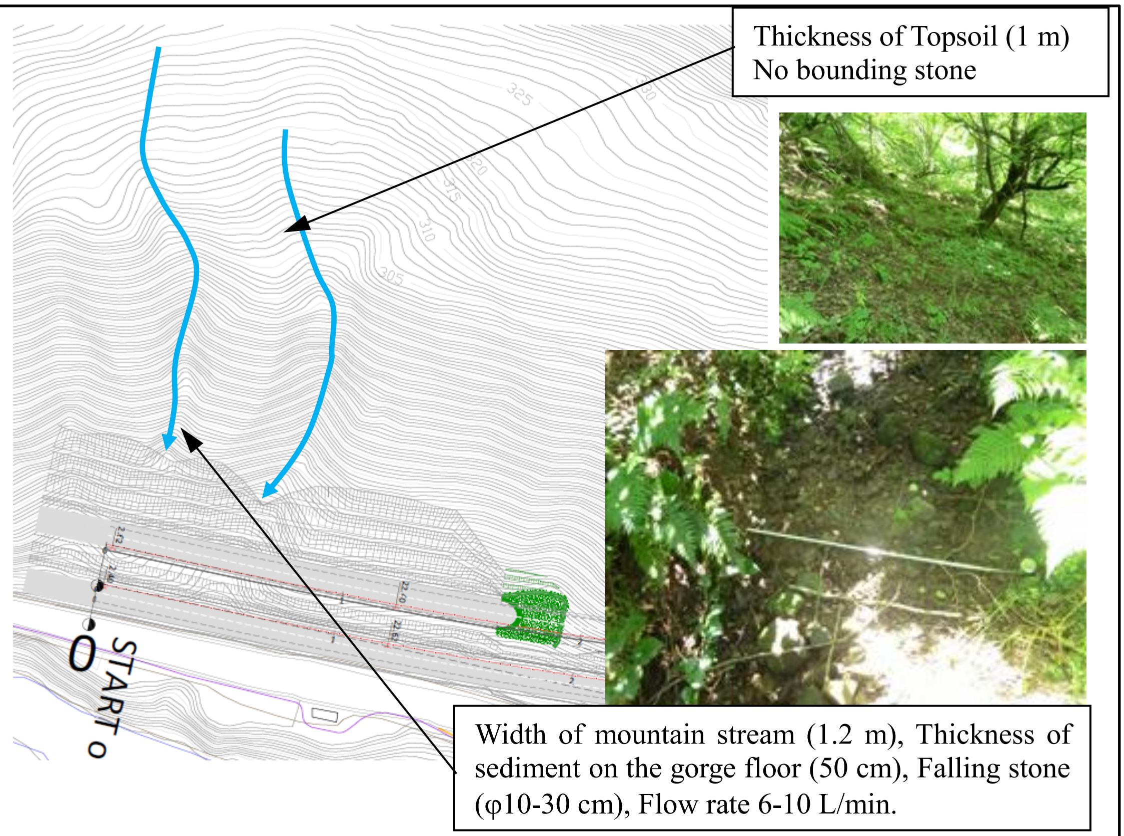
Source: JICA Survey Team

Figure 4-32: Marked Slope (Sta.40+400 ~ Sta.41)

(3) Results of Field Reconnaissance

A summary of field reconnaissance for the site requiring special attention is presented as follows:

In the slope on the Tbilisi side of Tunnel 1 (T1) (see Figure 4-33), since the slope is stable and the topsoil is covered, there is almost no source of falling rocks. However, although surface water is small, surface water flowing down to the high position of the glue surface is assumed at the time of rain, so it seems to be desirable to install a vertical drainage plant in the cut slope.



ATsta.0+000 ~ Sta.0+164

Comment：

- Vertical drainage is necessary on the slope surface directly under the mountain stream section
- Necessity of source measures for falling stone is low

Source: JICA Survey Team

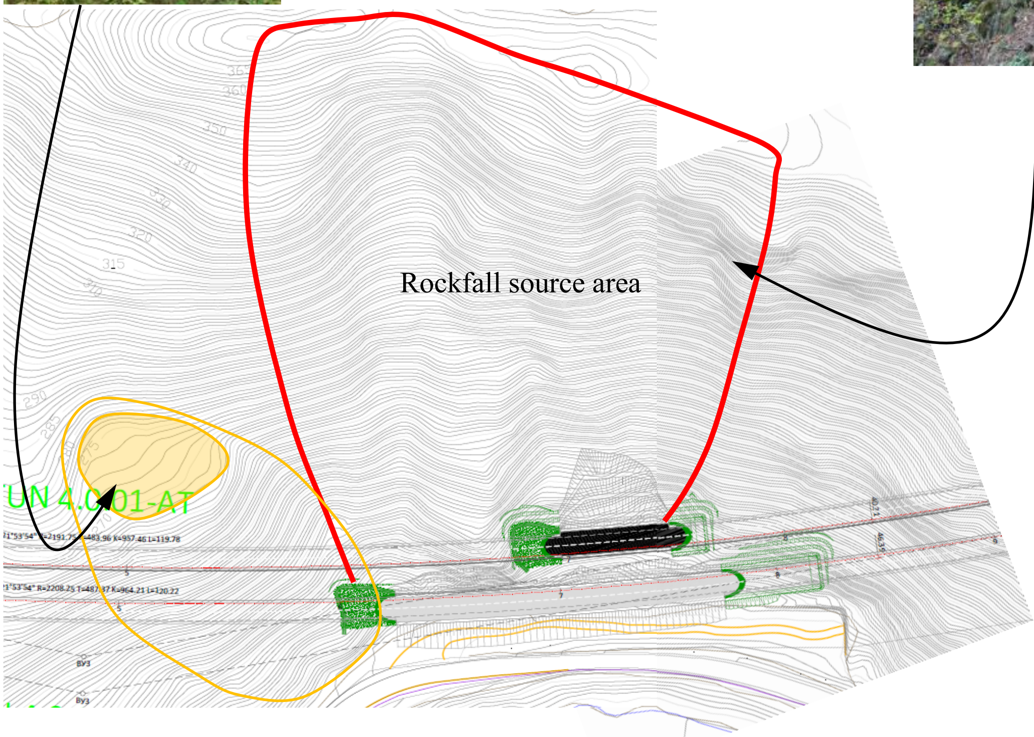
Figure 4-33: Marked Slope (ATsta.0+000 ~ ATsta.0+164)

The upper slope of the section between T1 and T2 is over 150 m in height and it is assumed that rocks and rocks are seen in the natural slope (see Figure 4-34). In fact, since a stepped stone exceeding a diameter of one meter is recognized at the bottom of the slope, it is necessary to have a falling rock prevention work to fix these after investigating the distribution of rocks and tangles.

On the other hand, there is a landform estimated to be a landslide of 150 m in length and 100 m in width at the end of the T1 tunnel, and drainage canals that are supposed to be installed to counter the landslide are installed in the surrounding area (see Figure 4-36). Also, as a result of the horizontal boring conducted by the DD consultant in the vicinity, a sandy core has been collected up to the excavation length of 22 m (see Figure 4-37), and the possibility of landslide block cannot be denied.

Flat surface of head of landslide block

Outcrop rock in nature slope H = 15 m



TAsta.0+625 ~ ATsta.0+747

Comment:

- A landslide block is estimated in the yellow line. A drilling survey was planned by the DD consultant on the flat surface of the head (yellow shaded hat) but it is not carried out because it is difficult to carry in.
- Necessity of source measures for falling stone is high due to a lot of bounding stone observed.

Falling stone (1.4 × 1.4 × 0.6 m) other 2

Source: JICA Survey Team

Figure 4-34: Marked Slope (TAsta.0+625 ~ ATsta.0+747)

Source: JICA Survey Team

Figure 4-35: Outcrop Rocks in Nature Slopes

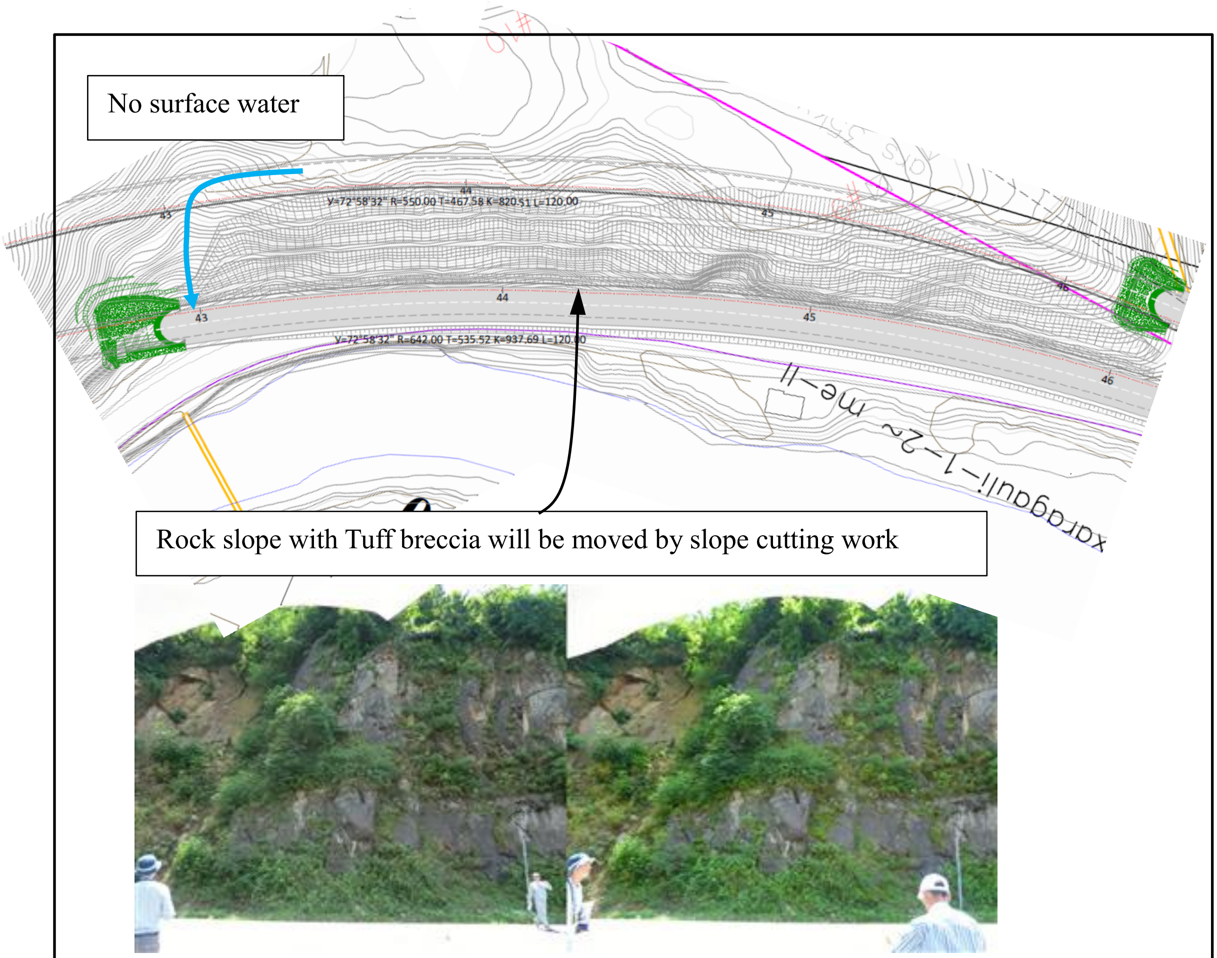
Source: JICA Survey Team

Figure 4-36: Existing Drainage Canals

Source: IRD

Figure 4-37: The horizontal boring core of BH 52

Since the slope at the end point side of T3 - TA becomes a cut slope, countermeasures against slopes are unnecessary. The mountain stream near the tunnel entrance has no running water at all time, and the zero-order basin and the catchment area (0.26 ha) is small; therefore, measures for mountain streams are unnecessary.



<u>TAsta.4+294 ~ TAsta.4+614</u>

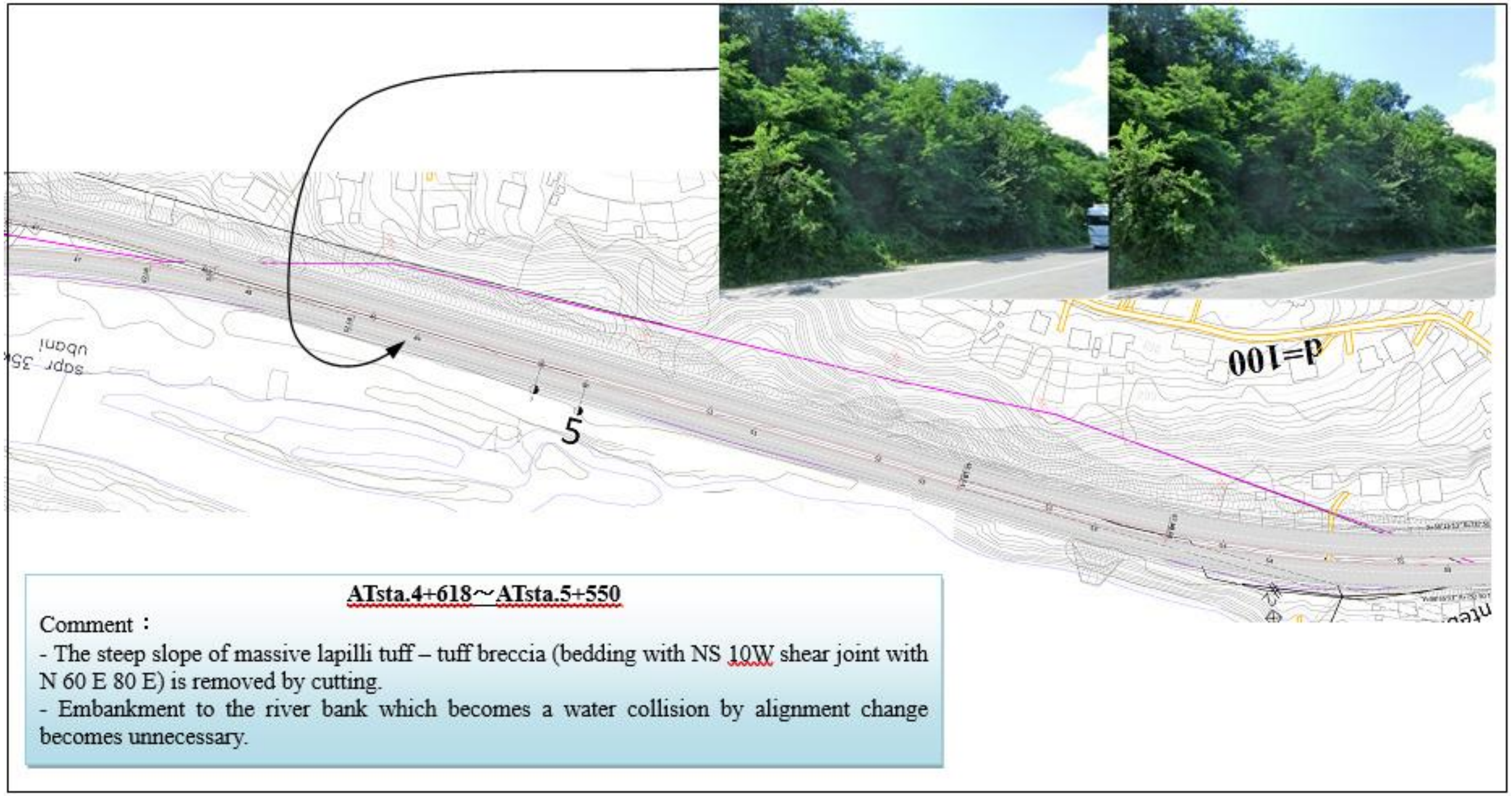
Comment:

- While in deep field reconnaissance by JICA survey team has not been conducted in this area, the survey results by DD consultant will be examined.

Source: JICA Survey Team

Figure 4-38: Marked Slope (TAsta.4+294 ~ TAsta.4+614)

The slope on the Tbilisi side of the interchange (IC-1) is removed by cuts. Based on boring survey results it is assumed that the weathering depth is as shallow as 4 to 6 m, and fresh rocks will be exposed on the cutting surface of slope; therefore, no protective work is required.



Source: JICA Survey Team

Figure 4-39: Marked Slope (ATsta.4+618 ~ ATsta.5+550)

4.2 Detail Design of F4 Section of E-60 Section of Shorapani-Argveta

4.2.1 General

Detail design of the Shorapani-Argveta section F4 (14.7 km) has been conducted by IRD ENGINEERING S.R.L. & SPEA Engineering S.p.A. (D/D consultant) since April 11, 2017. The section is planned along very steep valleys from the starting point until Zestafoni town then reaches relatively gentle hills soon after Zestafoni bypass section and connects to Argveta IC, currently under construction. The horizontal alignment in the F/S used the minimum radius based on the Trans European Motorway Standard (TEM). D/D consultant recognizes the problem of using minimum radius for traffic safety. The JICA survey team was also aware of this and proposed to the D/D consultant to use optimal design specifications rather than minimums. The D/D consultant and JICA team agreed and discussed with RD. They decided on 400 m as a “minimum” radius for the 80 km design speed section.

Because F/S design was intended to use minimum requirements of TEM, very steep horizontal curves were frequently employed, and the planned road came close to the existing highway in many points. After review and revision of this previous alignment, the final center line of the highway goes through difficult terrain, which necessitates more tunnels and bridges going straight to cross the winding rivers, making construction costs much higher than ordinary sections of the highway. In terms of overall construction period, time required for tunnel construction is the key factor.

4.2.2 The Design Standard to be applied

(1) Geometric Design Standard

1) TEM Standard

The TEM (Trans-European North-South Motorway) Standard was considered as the primary standard, and the Georgian Standard (SNIP) as the secondary standard. For any items not covered by these, AASHTO, Japanese Standard and that of other countries will be referred to. The design components used in the F/S are summarized in Table 4-15.

Table 4-15: Design Standard of Main Parameters

Design Speed	120 km/h			100 km/h			80 km/h		
Design Standard	TEM	Georgian	SNIP	TEM	Georgian	SNIP	TEM	Georgian	SNIP (1)
Min. Horizontal Radius	650m	700m	800m	450m	450m	600 m	240 m	250 m	250 m
Max. Super elevation	7%	7%	6%	7%	7%	6%	7%	7%	6%
Normal Cross-Falls on curves greater than	3,500m	3,300m	3,000m	2,500m	2,300m	3,000m	2,000m	1,200m	3,000m
Maximum Grade (gradient)	4%	4%	4%	5%	5%	5%	6%	6%	6%
Min Vertical Crest Curve	-2	22,600m (3)	15,000m	-2	10,000m (3)	10,000m	-2	5,000m (3)	5,000m
Min. Vertical Sag Curve	12,000m	7,700m (3)		6,000m	4,900m (3)		3,000m	3,200m (3)	1,000m
Min. Stopping Sight Distance	200m (4)	250m	250m	150m (4)	200m	200m	100m (4)	140m	150m

Notes:
(1) values allowed for mountainous terrain
(2) concave curves should have a vertical acceleration of no more than 0.25 m/sec2
(3) values for stopping sight distance
(4) values for straight and level conditions

Source: F/S Report

2) Japanese Standard

Japanese Highway Law prescribes an ordinance of highway design standards, specifying the general technical standards of highways for new construction and improvements. This is called Japanese Geometric Design Standard. The main feature is that it outlines special standards for severe conditions such as mountainous or densely populated urban areas. In these special cases, where attention to safety should be secured, loosened specifications can be applied exceptionally. While special tightened design standards for the main line around interchanges where maneuvers of merging, diverging and weaving take place, the minimum radius of curvature, the steepest vertical gradient, and the design standard for main line of interchange are introduced.

a. Minimum radius of curvature

For the minimum radii of curvature, there are three different definitions. They are standard minimum, absolute minimum and desirable minimum. Those definitions are tabulated in Table 4-16. The absolute minimum could be applied for special cases in severe conditions.

Table 4-16: Minimum Radius of Curvature

Design speed	120km/h			100km/h			80km/h		
	Abs. Min.	St'd Min.	Des' Min.	Abs. Min.	St'd Min.	Des' Min.	Abs. Min.	St'd Min.	Des' Min.
Min. Horizontal Curve Radius (m)	570	710	1000	380	460	700	230	280	400
Max.Super elevation (%)	10	6	6	10	6	6	10	6	7
Max. Lateral Friction Coefficient f	0.099	0.100	0.053	0.107	0.111	0.052	0.119	0.120	0.056

Source: Japanese Standard

b. Transition curve

The minimum length of transition curve and minimum radius that does not need transition curve are defined below.

Table 4-17: Specifications for Transition Curve

	unit:m	
design speed	100km/h	80km/h
Minimum length of transition curve	85	70
Minimum radius without transition curve	3000	2000

Source: Japanese Standard

c. Maximum vertical gradient

For each design speed, the allowable maximum gradients are defined, separating normal and special cases. For special cases, lengths are limited for each gradient so that excess speed reduction would not occur.

Table 4-18: Maximum Vertical Gradient

Design Speed								
120km/h			100km/h			80km/h		
Max.Gradient		limit length (m)	Max.Gradient		limit length (m)	Max.Gradient		limit length (m)
Normal	special		Normal	special		Normal	special	
2%	3%	800	3%	4%	700	4%	5%	600
	4%	500		5%	500		6%	500
	5%	400		6%	400		7%	400

Source: Japanese Standard

d. Alignment around Ramp Terminal

Alignments around interchange ramp terminals should meet higher specifications, as merging and diverging maneuvers take place. Therefore, Japanese Standard defines special parameters near ramp terminals as shown Table 4-19.

*The left column for each design speed indicates a normal case, and the right is a special case.

Table 4-19: Parameters around Ramp Terminal

Design Speed(km/h)		120km/h		100km/h		80km/h	
Min. Horizontal Radius (m)		2,000	1,500	1,500	1,000	1,100	700
Max. Gradient (%)		2.0	2.0	2.0	3.0	3.0	4.0
Min. Vertical Curve (m)	Crest	45,000	23,000	25,000	15,000	12,000	6,000
	Sag	16,000	12,000	12,000	8,000	8,000	4,000

Source: Japanese Standard

<u>3) Standard Cross Section</u>

The cross section components used in F/S are shown in Table 4-20. Based on these figures, negotiations have been taking place with RDMRDI, IRD and JST to decide on the final cross section to be designed in D/D.

The lane width for design speed of 80 km/h is decided to be 3.75 m following TEM standard, and the central reserve is decided to be 3.00 m, also following TEM standard.

Table 4-20: Cross Section Component Width in F/S

Unit: meter

Design Speed	Lane number	Lane	Shoulder	Verge	Central reserve	Total width
100 km/h	4	3.75	3.00	0.50	5.00	27.00
80 km/h	4	3.50	3.00	0.50	5.00	26.00

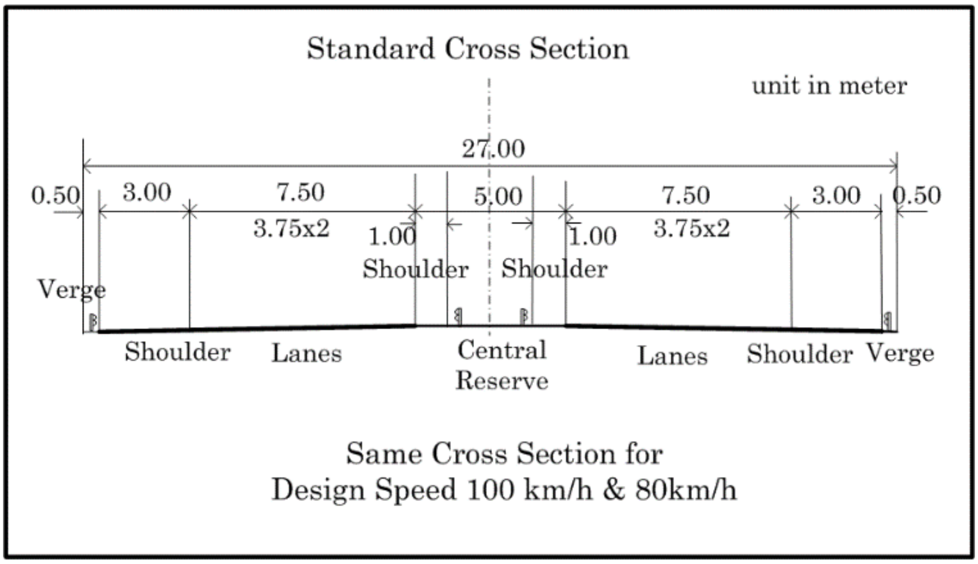
Source: F/S Report

Table 4-21: Cross Section Component Width for D/D

Unit: meter

Design Speed	Lane number	Lane	Shoulder	Verge	Central reserve	Total width
100 km/h	4	3.75	3.00	0.50	5.00	27.00
80 km/h	4	3.75	3.00	0.50	5.00	27.00

Source: JICA Survey Team based on the D/D IT/R-1



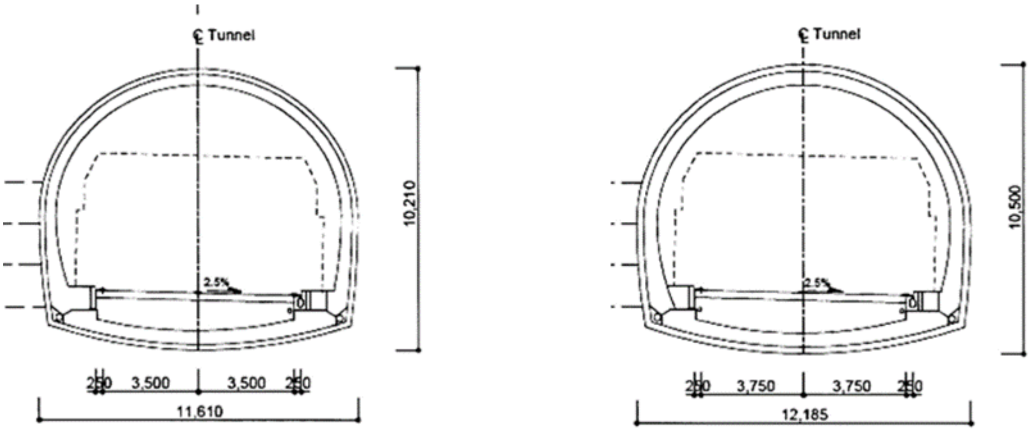
Source: JICA Survey Team

Figure 4-40: Standard Cross Section for D/D

4) Tunnel Cross Section

The tunnel cross sections designed in F/S are shown in Figure 4-41. The most prominent feature is that shoulders are very narrow (only 0.25 m for both design speeds), compared to wider shoulder width for standard cross section. It is difficult to say whether this tunnel can be operated safely.

To improve traffic safety, cross sections with widened shoulder widths for tunnel are proposed by JST, as shown in Figure 4-42. Curb to curb distance for 80 km/h design speed is 9.00 m, in the event two large vehicles were stopped side-by-side, one lane of traffic flow would still be guaranteed. For design speed 100 km/h, the width is 10.5 m which can accommodate stopped vehicles on the shoulder without disturbing lane traffic flow.

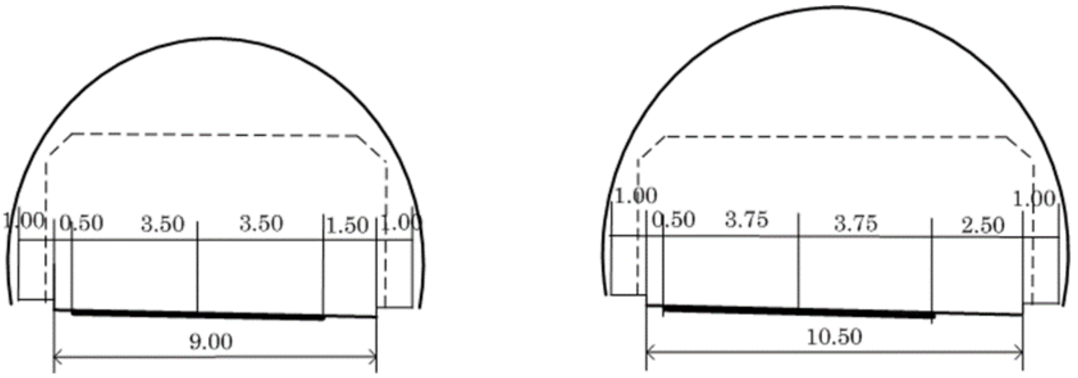


Design Speed: 80 km/h | Design Speed: 100 km/h

Unit: meter

Source: F/S Report

Figure 4-41: Tunnel Cross Sections in F/S



Design Speed: 80 km/h | Design Speed: 100 km/h

Unit: meter

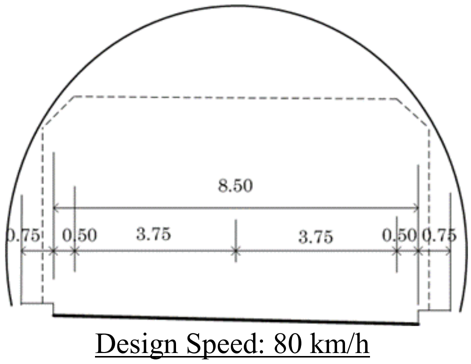
Source: JICA Survey Team

Figure 4-42: Tunnel Cross Sections Proposed by JST

Based on these figures, negotiations have been taken place with RDMRDI, IRD and JST to decide on the final cross section to be designed in D/D.

Figure 4-43 shows the final tunnel cross section for the D/D. Of course, while wider shoulders would improve traffic safety in tunnels, the cost increase must be controlled as much as possible. The shoulder of 0.50 m is still wider than the previous practice in Georgia, also the adoption of the wider shoulder in F4 section might extent over the other sections, resulting huge cost increase.

Specified sight distances of 100 m for design speed 80 km/h by the granted side clearance on a curvature, minimum radius is 526 m. (calculated by R=l^2/8*D)



Unit: meter

Source: JICA Survey Team

Figure 4-43: Final Decision of Tunnel Cross Section

(2) Bridge Structure

In Georgia's construction projects, the client, the contractor and the academic sector have a lot of influence on the technology to be used (often using systems from the former Soviet era), and therefore SNIP-GOST (Russian standard) is generally utilized. However, since SNIP is not as practical as AASHTO and BS (EN) etc., for international bidding projects AASHTO or BS etc., should be used in conjunction with SNIP (e.g. after designing by AASHTO, check with SNIP's load).

On the other hand, Eurocode (EN) may be used for the D/D, so it is a question as to how to align with SNIP. In the case of the STEP application, the recognizing of the Japanese Road Bridge Specification is quite low in Georgia, so it is necessary to clearly indicate the relationship between EN and SNIP. Furthermore, when procuring material in Georgia it is necessary to clarify the relationship between the Japanese Industrial Standard and GOST.

For steel superstructure design which is STEP application, we decided to implement in accordance with Japanese standards (Specifications for Highway Bridges), because it is a unique Japanese technology and the design based on Japanese standards can conceivably also cover the design by Eurocode.

(3) Slope Protection

Possible risk factors of the existing road that will likely cause traffic obstacles are falling rocks and downward earthflows along a surface failure of the cut slope. In addition, serious damage from falling rocks, earth and sand on the natural slope, disaster/ traffic obstacles caused by sediments and falling rocks, as well as runoff from the mountain stream despite relatively low precipitation, are possible.

Based on the current road alignment design and earthwork, these positions are assumed to have a certain risk factor and coverage of the survey is included in the attached documents.

Since the targeted slope assumes to have certain levels of risk, the type, scale and characteristics of the risks will be identified during the field survey, and the following applicable policies will be referred to: "Road Earthworks - Cut Slope and Slope Stability Guidelines (Japan Road Association, 2009)", "Rock Fall Prevention Handbook (Japan Road Association, 2000), and "A Prevention of Landslide Technology Guidance and the Commentary (Ministry of Land, Infrastructure, Transport and Tourism, 2008)".

4.2.3 Geometric Design of the Project Highway

(1) Conditions on Geometric Design

1) Design Speed Section

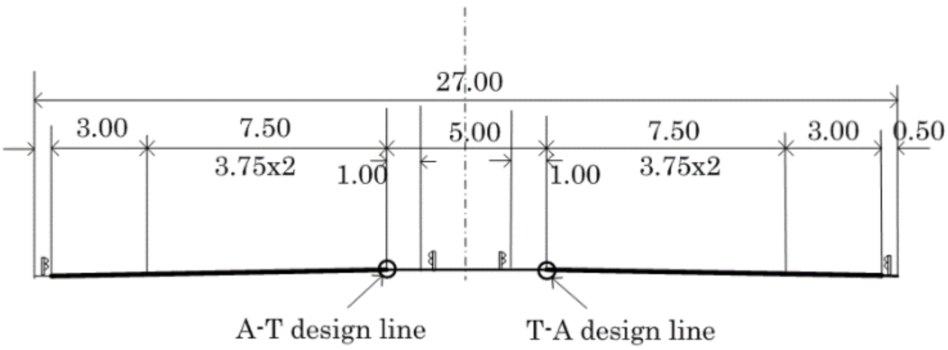
In the F/S a design speed of 80 km/h was applied for the mountainous areas along the Dzirula River, and 100 km/h was applied for the hilly area in Zestafoni. The boundary of these two design speeds was considered at the crossing bridge of the Kvirila River. The discussions with RDMRDI, IRD and JST determined that the boundary is to be shifted about 2 km westward.

2) Starting Point of F4 Section

In FS, the starting point of F4 was at the abutment of the bridge crossing the Dzirula Fiver, and for the horizontal design, a minimum radius of 250 m was used. In the DD there were options to improve the design by using a larger radius or placing a tunnel. When the DD was started those decisions had not been made yet. Therefore, to not affect the DD of F4 section, the starting point was shifted westward. The new starting point is km35+700.931 by FS chainage.

3) Design line

The design lines in DD, also in FS, are at inner edge of lanes as shown in Figure 4-44. This type of design line is commonly used where directional carriageways are designed independently. Then, there is no center line alignment.



Source: JICA Survey Team

Figure 4-44: Design Lines

4) Minimum Radius

A minimum radius used in the design speed 80 km/h section is 400 m. It is not standard but a target to be attained. In the actual design all curved sections have radii larger than 400 m. To get minimum radii, by the same manner for design speed 100 km/h, 120 km/h, the minimum radii are 700 m and 1,000 m respectively. They are called “desirable minimum” by the Japanese standard, shown in Table 4-22.

Table 4-22: Desirable Minimum by Japanese Standard

	120 km/h	100 km/h	80 km/h
Radius (m)	1,000	700	400
Super elevation (%)	6	6	7
Lateral friction	0.05	0.05	0.05

Source: Japanese standard

Direction: Argrave --> Tbilisi

Vertex No.	1	2	3	4	5	6	7	8		9	10	11
Curve Direction	L	L	L	R	R	L	R	L		R	L	R
Vertx Angle (Deg)	21.90	5.31	25.03	12.72	72.98	38.25	35.66	53.46		46.06	41.59	14.76
Radius of Curvature (m)	2,191.50	3,100.00	798.00	3,500.00	550.00	747.50	750.00	1,488.75		1,100.00	1,297.50	3,302.50
Clothoid Length (m)	120.00	0.00	119.75	0.00	120.00	120.00	120.00	119.55		120.00	119.88	0.00
Clothoid Parameter (A)	512.82	0.00	309.13	0.00	256.90	299.50	300.00	421.88		363.32	394.39	0.00
Tangent Length (m)	484.02	143.84	237.17	390.24	467.58	319.50	301.49	809.75		527.88	552.86	427.65
Curve Length (m)	957.59	287.48	468.38	777.28	820.52	619.07	586.81	1,508.69		1,004.37	1,061.72	850.57

Direction: Tbilisi --> Argraveta

Vertex No.	1	2	3	4	5	6	7	8	9	10	11	12
Curve Direction	R	R	R	L	L	R	L	R	L	L	R	L
Vertx Angle (Deg)	21.90	5.31	25.03	12.72	72.98	38.25	35.66	56.92	5.47	44.05	41.59	14.76
Radius of Curvature (m)	2,208.75	3,700.00	803.00	3,500.00	642.00	753.00	750.00	1,511.25	3,500.00	1,100.00	1,302.50	3,297.50
Clothoid Length (m)	119.78	0.00	120.25	0.00	120.00	120.00	120.00	120.45	0.00	120.00	120.12	0.00
Clothoid Parameter (A)	514.36	0.00	310.74	0.00	277.56	300.60	300.00	426.65	0.00	363.32	395.55	0.00
Tangent Length (m)	487.25	171.68	238.53	390.24	535.52	321.41	301.49	879.58	167.18	505.21	554.88	427.00
Curve Length (m)	963.96	343.12	471.07	777.28	937.69	622.74	586.81	1,621.74	334.11	965.72	1,065.59	849.28

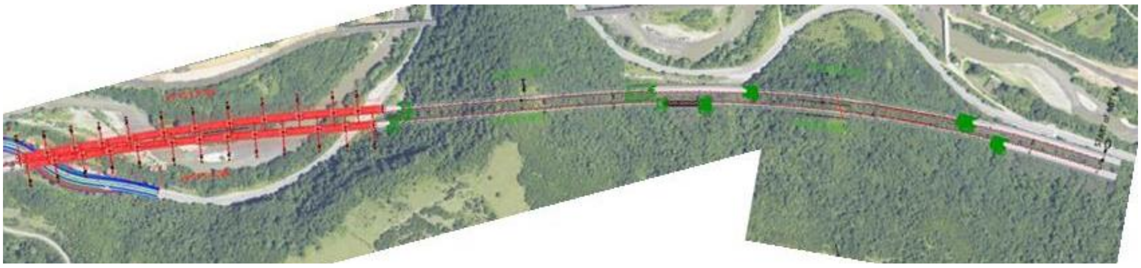
Source: IRD Design Drawing

Figure 4-45: Design Parameters

(2) The Design Features of Several Sections

1) Starting point of F4 section

In the FS the minimum radius of 250 m was used to follow the alignment of the Dzirula River. However, the alignment is very much improved by the bridge (Br-1) crossing the Dzirula by erecting piers on the fords of the river on opposite side.

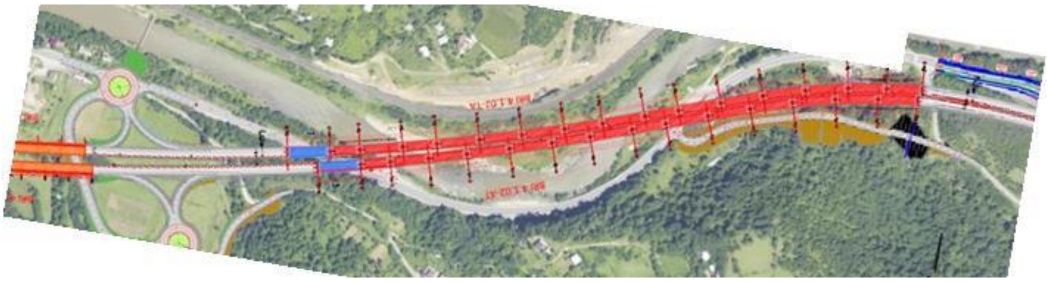


Source: IRD Design Sheet

Figure 4-46: Start Point of F4 Section

2) Kveda Ilemi Area

In the F/S, "S" shaped curves with R=250 m were designed in the Kveda Ilemi area. However, in the D/D alignments are straightened tremendously through construction of a bridge over the Dzirula.

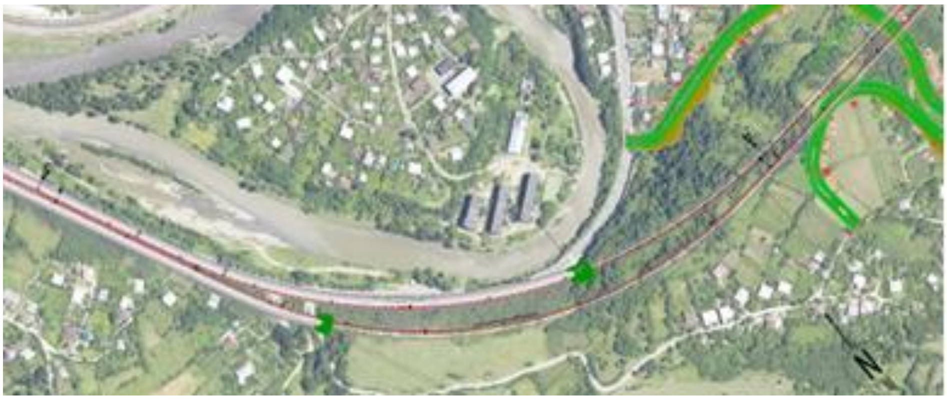


Source: IRD Design Sheet

Figure 4-47: Alignment around Kveda Ilemi

3) Alignment around Tunnel -3

At intersecting point #7 the A-T carriageway is cutting structure, and A-T carriageway is tunnel structure because of descending slope to the Dzirula. It is requested to make the distance between carriageways larger than normal separation, as the structure type is very unstable. To this end the radius of A-T carriageway was made smaller so that the secant length became bigger. The alignment is shown in Figure 4-48.



Source: IRD drawing

Figure 4-48: Alignment at #7 (Tun -3)

4) Alignment around IC No. 2

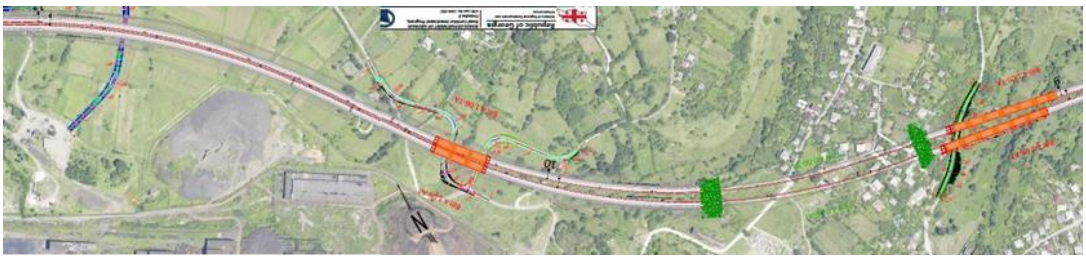
The alignment around IC No. 2 (Shorapani West IC) was "S" shape curve using circle of 550 m. Alignments around interchange ramp terminals should meet higher specifications, as merging and diverging maneuvers take place there. Therefore, Japanese Standard defines special parameters near ramp terminals as shown Table 4-19. Then the alignment was changed to use radius of 750 m as shown Figure 4-49.

Source: IRD drawing

Figure 4-49: Alignment at IC-2

5) Hilly Area of Zestafoni

In the hilly area of Zestafoni, there were many direct connections of circular curves with straight lines, and circular curves connect with other circular curves having adverse directions in the F/S. However in the D/D, those alignments are improved using appropriate transition curves.



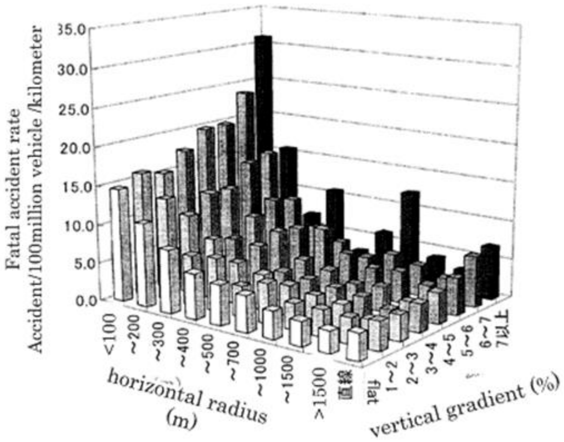
Source: IRD drawing

Figure 4-50: Alignment at Hilly Area at Zestafoni

(3) Evaluation of Alignments

One way to evaluate the alignment is a method using traffic accidents. Alignment groups were made by cross ranking horizontal and vertical alignments, and fatal accidents on the national highways for each alignment group were accumulated. Then, accident rates were calculated by dividing the number of accidents by traffic volume in terms of vehicle kilometer. The accidents data was integrated over three years starting in 1996, and traffic volume data was obtained from a "traffic census" (nationwide traffic volume and speed surveys) in 1999. The results are shown graphically in Figure 4-51.

The accident rate denotes every accident per 100 million vehicle kilometer. According to this figure, on flat terrain the accident rate decreases tremendously for a radius range between 100 m to 400 m, and decreases slowly when 400 m to over 1500 meters. The accident rate of horizontal radius 250 m (between 200 m and 300 m) is more than 10, and that of for 450 m is around 6. It can be said by these facts that a small radius of 250 m would be more hazardous.



Source: Japanese Standard

Figure 4-51: Fatal Accident Rate by Road Linearity (General National Highway)

(4) Vertical Alignments

1) Section along the Dzirula River

In order to improve the horizontal alignments in this section, piers are erected on the fords in the river to construct bridges. This improvement effect spreads over the vertical alignments. In the F/S there was a section with maximum gradient of 3.5%, however, it became below 2% in the D/D. There is a maximum gradient of 2% on the section that crosses over The Kvirila River and railways on the opposite side of the bank.

2) Hilly Section around Zestafoni

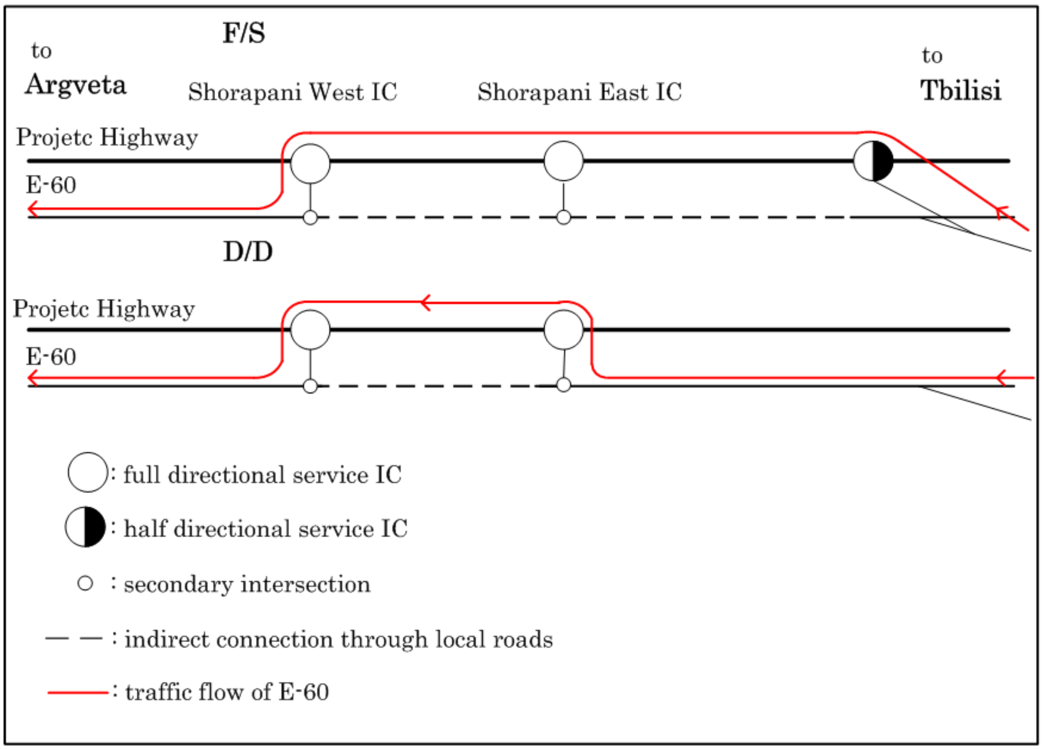
Although the vertical alignment of this section seems to be similar to that of the F/S, it is much improved. For example, the design sections of short lengths which had different gradients were combined to form long design sections, and this effectively lowers the gradient.

(5) Interchange (IC)

1) Traffic Flow around Shorapani IC

In the F/S three ICs were planned between the starting point of the F4 section and the Kvirila River. The IC near the starting point is a half IC, serving only for the Argveta direction. Since the construction method of the project Highway from this IC to West Shorapani IC would be the widening of the present E-60 ROW, then the traffic of E-60 of this section would shift to the project Highway as the former E-60 would be blocked.

However, the traffic function of E-60 will be preserved in the D/D for this section as shown in Figure 4-52. By doing this, it will not be necessary to construct the interchange in the narrow area between the Dzirula River and steep slope.



Source: JICA Survey Team

Figure 4-52: Traffic Flow of E-60 and the Project Highway

2) IC-1 (Shorapani East)

This IC is a kind of trumpet type IC, providing a loop ramp way for the left turning traffic facing to Tbilisi. As the distance from the main line to the existing E-60 is short, the right turning ramps and left turning ramps are connected separately to a roundabout at E-60. The arrangement of ramp way to the Argveta direction is confined by the Tunnel -3 near the IC.

Source: IRD drawing

Figure 4-53: IC-1 (Shorapani East)

A local road on the mountain side is connected at left turning loop, forming a roundabout, because, an independent roadway to connect to E-60 is limited by main line structures.

3) IC-2 (Shorapani West)

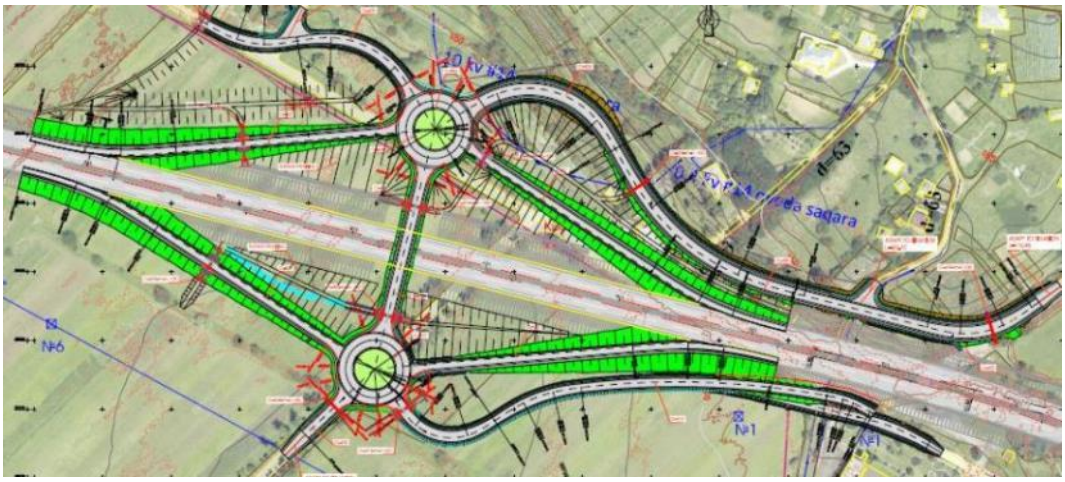
A loop ramp is provided for the left turning traffic facing to Argveta. The diverging and merging nose positions are confined by the long span Br-4. And, the right turning and the left turning ramp ways are separately connected to E-60, forming roundabout intersection.

Source: IRD drawing

Figure 4-54: IC-2 (Shorapani West)

4) IC-3 (Zestafoni West)

This is a diamond type interchange with two roundabout intersections for the connection of the ramp ways with local roads. The connecting local road crosses the main line by a bridge.



Source: IRD drawing

Figure 4-55: IC-3 (Zestafoni West)

<u>5) IC-4 (Argveta)</u>

There are two roundabout intersections connecting to ramp way. The construction works are already started by Phase 1 project.

Source: IRD drawing

Figure 4-56: IC-4 (Argveta) (End Point)

4.2.4 Bridge Design

(1) General

The Bridge plan in Lot F4 was studied and decided by DD consultant (IRD/ADB fund) simultaneously with the road alignment under the study and agreement of JICA Survey Team (JST). The result is shown in Table 4-23.

Table 4-23: Outline of Bridges in F4 Section

No.	Direction	Location (km) Start	Location (km) End	Length (m)	Width (m)	Number of Span	Span Arrangement	Approx.Max Pier height (m)	Crossing	Type
BR4001	TA	1+246.25	1+875.70	630	14.0	12	42x2+60x4+54+60+48x4	23	Riv.Dzirula	Steel
	AT	1+257.44	1+857.90	600		12	48x2+60+48x4+60+48x4			
BR4002	TA	2+071.76	2+965.06	894	14.4-14.0 -16.0	16	48+54+60x4+48+60+54+60x3+48+60+42+60	21	Riv.Dzirula	Steel
	AT	2+068.21	2+914.98	846		15	54+60x5+48+60+54+60x2+54x2+42+60			
BR4003	TA	3+249.82	3+485.82	236	15.5-14.0	7	33 + 34 x5 + 33	13	IC	PSC
	AT	3+230.00	3+466.00	236		7	33 + 34 x5 + 33		Riv. Barimela	
BR4004	TA	5+833.97	6+276.62	438	16.0 - 14.5	8	48x2+54x4+72+54	31	IC Riv.Putula	Steel
	AT	5+859.08	6+316.45	462		8	48x2+60x4+72+54		Riv. Kvirila Railway	
BR4005	TA	9+009.00	9+211.00	202	14.0	6	33 + 34 x4 + 33	15	Valley	PSC
	AT	9+048.00	9+250.00	202		6	33 + 34 x4 + 33			
BR4006	TA	10+121	10+220	99	14.0	3	33x3	10	Valley	PSC
	AT	10+145	10+243	98		3	33x3			
BR4007	TA	7+034	7+066	32	14.0	1	33	6	Valley	PSC
	AT	7+064	7+097	33		1	33			
Total Length (m)		Steel (m)		PSC (m)		subtotal(m)				
	TA	1962	3,870	570	1,140	2,532	Grand Total (m)			
	AT	1908		570		2,478	5,010			
	TA;Tbilisi →Argveda AT;Argveda→Tbilisi								; STEP Applicable	

Source: JICA Survey Team

Among these bridges, we decided to adopt the superstructures of 3-steel bridges BR4001, BR4002 and BR4004 as STEP; Japanese technology applicable.

Regarding design work, it was difficult for the DD consultant because the technology and design method are uniquely Japanese, and also due to temporal and contractual restrictions, it was decided to carry out preliminary design of superstructure with necessary accuracy for the bid by JICA Survey Team (JST).[6]

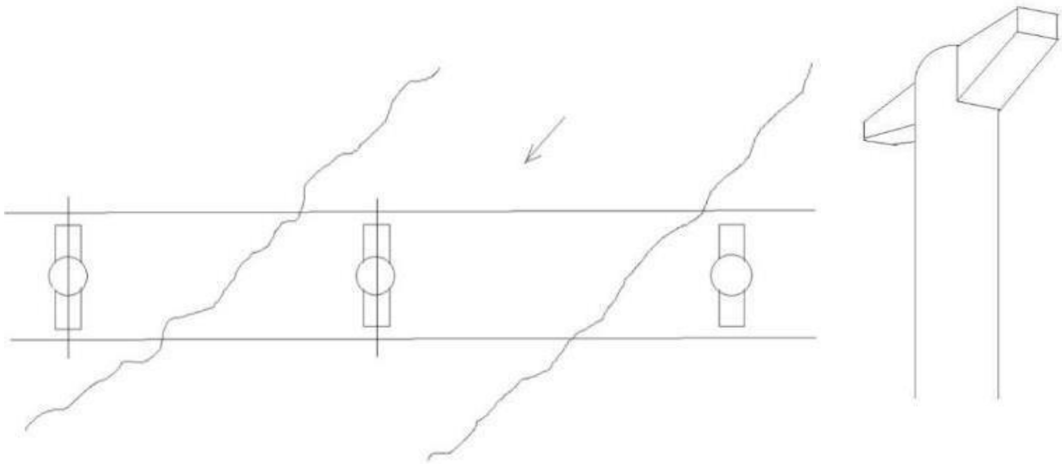
With regard to the design standards, we decided to implement in accordance with Japanese standards because it is unique Japanese technology and the design based on Japanese standards can conceivably cover the design by Eurocode as a result.

(2) Bridge over the Meandering River

BR4001 and BR4002 cross the meandering river of the Dzirula in a linear manner and further cross the existing E60 road at both ends. Since the flow direction of the meandering part is not constant, the cross section of the pier column can be circular. In this case, the local scouring depth is the same as the oval type which has the same width of shorter side as the diameter (Evaluating Scour at Bridges (FHWA)). On the other hand, the river width varies from about 50 m to 100 m, therefor assuming that one pier of φ 3.0 m circular section is in the river, the river inhibition rate (total piers width / planned river width (%)) is 6% at the maximum (Allowable value is 7% in case of expressway in Japan).

The maximum pier height is 23 m, and it is considered that RC columns are possible. In addition, in the case of a circular column, since the direction of cross beam on which the bearings are mounted can be freely selected, it is a merit that the direction of support line on superstructure can be right angle (straight bridge). (Figure 4-57)

On the other hand, in the Dzirula River area, there are many existing road and railway bridges which have piers in the river, and in reference to “Hydraulic Report” (GD.HYD.4000.GE.RP.0120 / IRD December 2017), the span length of the bridge; 60 to 72 meters is considered reasonable.



Source: JICA Survey Team

Figure 4-57: Benefits of “Round-Column” Bridge Piers in Rivers

[6] As for the substructure detailed design, DD consultant carried out using the reaction forces calculated by JST in the above work.

Currently, the clear criteria or standard for restricting river structure have not been developed in Georgia, so JST presented the following conditions.

1) If the oval section column cannot be installed in the oval shape parallel to the flow direction, circular section column can be used.
2) If the planned riverbed level is not set, the foundation of pier shall be set at 0.5 m or more below the current riverbed.
3) The structure should not disturb the river flow as much as possible, even during the construction period.

(3) Steel Superstructure Design

JST adopted whole length continuous girder type which is no-expansion joint to get the smooth driving feeling, also it has the advantage in improvement of earthquake resistance and reduction of maintenance cost.

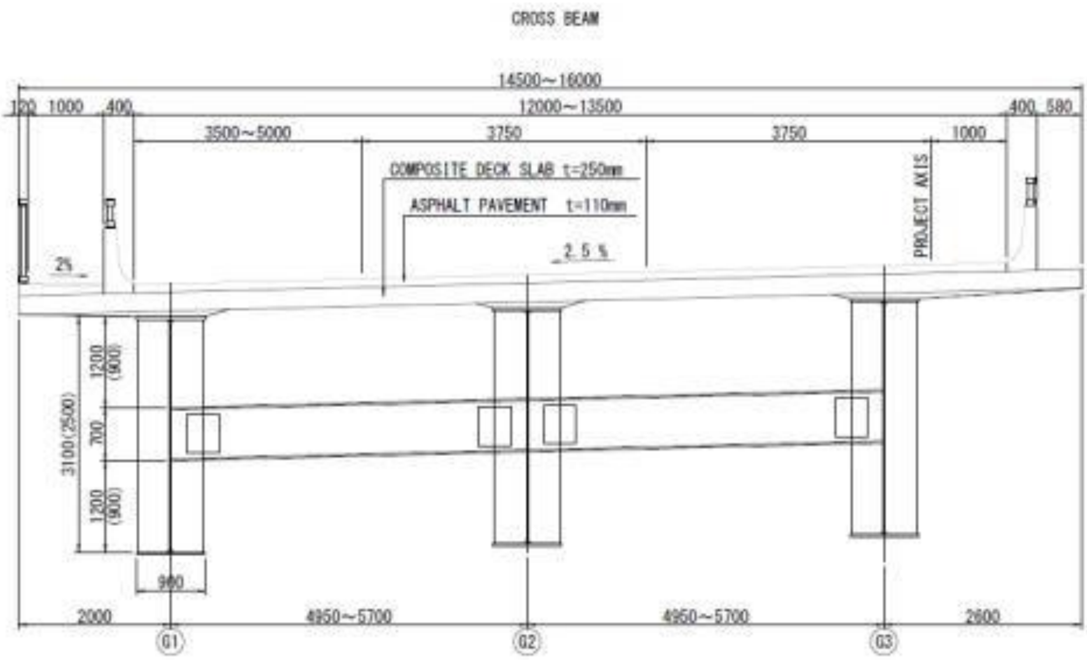
In addition, “Horizontal Force Dispersing Bearing” which is one of the typical Japanese technologies of anti-seismic was adopted. It resulted in reduction of foundation size of piers in the rivers.

As a design note of rationalized plate girder, the design manual of Japan stated as follows.

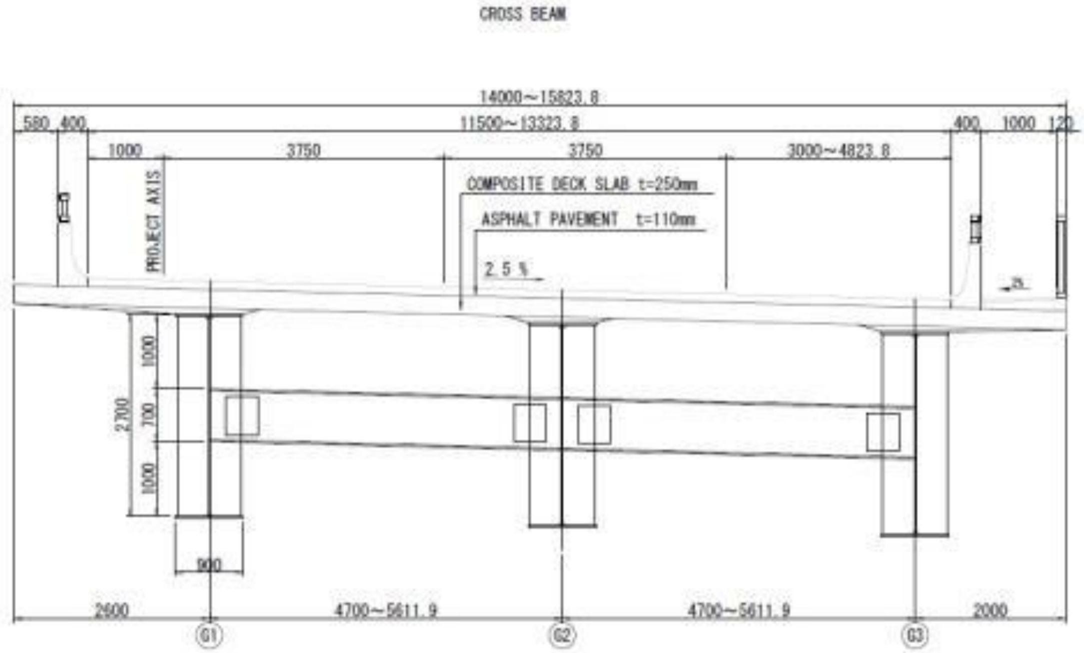
1) The center span of deck should be preferably around 6 m (5~7 m).
2) The overhang length at the side of deck should be 0.4 or less than the center span.
3) The width of the upper and lower flanges should be less than 1/3 of the web height. (to prevent from reduction in allowable compressive stress due to local buckling)
4) The transverse girder should be a steel plate type, and not use small pieces such as vertical / horizontal ribs, brackets etc. as much as possible.

Regarding Weathering Steel, it was decided to adopt confirming that there is no use of Anti-freezing agent in Georgia.

The adopted section is shown in Figure 4-58.
The design result is shown in Appendix 4.1.



BRI4004AT



BRI4001AT, BRI4002AT

Source: JICA Survey Team

Figure 4-58: Cross Section of Superstructure

4.2.5 Tunnel Design

(1) Position and Extension of Tunnels

Table 4-24 shows the change history in the position and length of each tunnel section from FS to the final detailed design. Table 4-25 shows the position, the length and excavation tunnel and cut & cover tunnel of each tunnel in the final detailed design. Important items from both tables are as follows.

1) As shown in Table 4-24, the total extension length of 10 tunnels (at 5 places) was 6,775 m in the FS. But in the final detailed design, this expanded to a total of 12 tunnels (at 6 places) with a length of 8,514.399 m.
2) Two additional tunnels (T-AT-6, T-TA-6) were planned as cut sections in FS, although the two additional tunnels were examined as a cut & cover tunnel at the initial stage of detailed design, finally it was changed as an excavation tunnel by lowering the longitudinal profile.
3) As shown in Table 4-25, the total extension of the total of 12 tunnels is 8,514.399 m, consisting of 7,975.4 m of tunnel by drilling & blasting method and 539.69 m of tunnel by cut & cover method. The cut and cover tunnels are planned at the start and the end of 12 tunnels. In the background in which many cut & cover tunnels were planned, since the positional relationship between the tunnel axis and the current slope is bad, minimization of cut slope is the biggest reason.

(2) Position of Portal

Figures 1 to 30 (in Appendix 4.4) show the positional relationship between the tunnel and the topography in the portal zone and low overburden zone. Since most of the tunnel portals are located under the unsymmetrical earth pressure of steep slope, the height of the cut slope between tunnel 1 (T-AT-1) and tunnel 2 (T-AT-2) exceeds 40 m.

Therefore, in the final detailed design, to minimize the section remaining as a rock slope after cut work, it is designed to provide a cutting tunnel section that can be dealt with on a steep cut slope which should be stable during construction.

However, JST pointed out to D/D consultant that the position of the portal is not appropriate at the Argveta side of the tunnel 6 (T-AT-6, T-TA-6) and we have continuously discussed it. As shown in Figure 27 and Figure 30 (in Appendix 4.4), JST considers that the extension of the tunnel 6 on the current D/D proposal would be wastefully long and could be shortened by approx. 80 m. Since the height of overburden is shallower than 10 m and there is a high possibility that the soil formation will appear on the excavation face, securing stability during tunnel excavation is not sufficient and the construction cost is higher than the other sections. Moreover, as there are no private houses around, no significant environmental considerations are needed. Therefore, as shown in Figure 4-59, JST considers that it is desirable to change the portal position of Argveta side from 9+726.883 to 9+642.883 for T-AT-6 and from 9+709.02 to 9+625.02 for T-TA-6.

(3) Unnecessariness of Tunnel Invert

The design method of DD consultant is based on the analysis called ADECO (Analisi delle DEformazioni COntrollate, Analysis of Controlled Deformation) Method.

Based on analytical methods, because there is a tendency to look at input data on the danger side, in particular, invert is designed to be as thick as 70 to 80 cm throughout the tunnel section (see Table 4-26). It is thick when compared with the standard support pattern at the time of construction of the tunnel at the two lane road in Japan shown in Table 4-27, and it is different from Japan's design philosophy and construction records which does not require invert when the ground conditions are relatively good.

Concerning the necessity of invert, JST discussed with the tunnel engineer of DD Consultant. If the ground condition during construction is Class II or more (RMR≥61) by ground classification based on RMR method (Table 4-28), there was an opinion that it is acceptable that no invert is provided, and however, the opinion has not reflected into the current design. JST suggests that it should be reviewed again at the construction phase based on the actual ground conditions.

(4) Drainage System of Tunnel

Water leakage in tunnels not only degrades the functions of linings and in-tunnel facilities and reduces their durability but also has an adverse effect on travel on the road in the tunnel due to the road surface freezing and the freezing of water in winter. Appropriate waterproofing and drainage systems therefore should be designed. During the tunnel excavation, groundwater surrounding the tunnel is generally drained without being allowed to remain behind the lining, to control high groundwater pressure or prevent water leakage through the lining.

Generally, control measures for such tunnel water leakage include i) waterproofing by applying waterproofing membranes after taking appropriate measures behind the lining to prevent water leakage inside the lining, ii) drainage systems such as back surface drainage materials and side drains to carry away water flowing into the tunnel and prevent standing water. If water is submerged on the back of the lining, water pressure acts on the lining as an external force which may impair the stability of the tunnel. In addition, if leakage etc. occurs from the lining, problems related to tunnel durability and maintenance such as deterioration of the lining due to frost damage, the corrosion and short-circuit of lighting / disaster prevention equipment occur. Especially, the loss amount due to the shortening of equipment renewal time due to leakage leads to the increase of maintenance cost.

In designing the drainage system, it is necessary to have the function of discharging spring water in the tunnel, washing sewage in the tunnel, bring-in water accompanying the driving of the car, water leakage etc. promptly out of the tunnel. For this purpose, it is necessary to ensure sufficient cross-section and gradient of water passage, and it is necessary to keep in mind that it is appropriate design in consideration of separation of drainage system and future maintenance and management method. Figure 4-60 compares the design of DD consultant and general design in Japan on the drainage system of tunnel.

In the final design plan of drainage system by D/D consultant, the spring water collected by the covering waterproofing work is guided through a cross drainage machine (φ 150 mm) at an interval of 50 m, and one position at each tunnel length A drainage worker (φ 250 mm) is to be installed. On the other hand, in the Japanese design, it is common to conduct through a transverse drainage plant (φ 150 mm) at 50 m intervals, and to provide a longitudinal drainage (φ 300 mm) across the entire length of the tunnel in the center of the tunnel. Comparing the Japanese procedure with current D/D plan, it is considered that there is no problem with the D / D draft conception guidance ability outside the tunnel pit.

(5) Lining Thickness around the Niche

In the tunnel, equipment related to emergency facilities such as an emergency telephone box, a fire hydrant, a fire extinguisher, a distribution board for lighting, etc. are generally installed. These equipment are usually installed on the side wall portion, but because the margin of the tunnel cross section is small, it is necessary to prepare a space (niche) for storing in the lining beforehand if the equipment size is large.

As shown in Figure 4-61, there was a difference in the design of the DD consultant and the general design in Japan, with respect to the lining thickness in the vicinity of the box unloading part, the design by D/D consultant is thinner than the Japanese design. However, since the size of the emergency facilities installed in this tunnel grade is not large, it is considered that the lining thickness in the vicinity of the box punched part is acceptable with the suggested value of DD consultant.

(6) Design of Emergency Cross Passage (Bypass)

In the F-4 section, 12 tunnels (at 6 places) are planned, but due to the length of each tunnel, emergency cross passage is planned at five locations in total (two locations between T-AT-3 and T-TA-3, one location between T-AT-4 and T-TA-4, and two locations between T-TA-5 and T-TA-5). All are emergency cross passage for people. The emergency cross passage is a facility for evacuating the drivers and the passengers etc. from the tunnel where the fire occurred to the outside of the tunnel.

As shown in Figure 4-62, in the design by D/D consultant, Ventilation fan, double door, evacuation room, etc., are provided in evacuation contact pitches, but JST suggests that it is desirable not to install these incidental facilities as much as possible because the objective is to allow for speedy evacuation.

(7) Necessity of Mechanical Excavation Method

Tunnel 5 (T-AT-5, T-TA-5) and tunnel 6 (T-AT-6, T-TA-6) have shallow overburden. Since private houses are scattered right above the tunnel, various environmental problems such as vibration and noise for residents and structures must be reflected in the design. Machine drilling is generally applied under such conditions.

The examination results on the vibration when adopting drilling & blasting excavation method are as follows.

When predicting vibrations during drilling & blasting excavation at Sta,7+900 (the highest location on the Argveta side of tunnel 5, which overburden is about 36 m) where the apartment house is located directly above, as shown in the calculation result A of the ground vibration level of Table 4-29, 80.4 dB was predicted. According to Table 4-30, most of people who are indoors feel shaking and some people are frightened, which is equivalent to a weak earthquake of 3 degrees on the seismic scale.

As a regulation value, when calculating the distance that the blasting vibration level at nighttime is 64 dB (daytime 79 dB) proposed by the Japan Explosive Society, as shown in the calculation result B of the ground vibration level of Table 4-29, it is necessary to be 103 m away from private houses.

In consideration of the above-described investigation results, in the case of tunnel T-AT-5, about 52% of excavation tunnel length is predicted to be affected by blasting vibration (between Sta.7+700 and Sta.8+300). In the case of the tunnel T-TA-5, about 65% of the excavation tunnel length is expected to be affected by blasting vibration (between Sta.7+520 to Sta.8+230, and 160 m section near Sta.7+520).

From the above results, it is desirable that the tunnel 5 and the tunnel 6 should be applied to the mechanical drilling method.

(8) Specification of Mechanical Excavation Machine (Road Header)

Table 4-31 shows the results of laboratory tests using the cores collected during the boring survey and Table 4-32 shows the results of laboratory tests using the specimen collected during the outcrop of the ground surface.

The geological condition of tunnel 5 (T-AT-5, T-TA-5) and tunnel 6 (T-AT-6, T-TA-6) to be excavated is limestone sandstone (Calcarenite). The unconfined compressive strength varies 11.5 to 85.6 N/mm^2, which is wide, indicate that there is a possibility that delays of excavation may occur at places where the strength is high. Therefore, in choosing excavators, it is desirable to bring the most powerful machine to the site.

Various excavators are launched from manufacturers who manufacture mechanical excavation machines. In Japan, machines targeting unconfined compressive strength of 20 N/mm^2 of ground and machines targeting up to around 50 N/mm^2 are being launched.

Unconfined compressive strength obtained for samples near tunnel planning depth is often higher than 20 N/mm^2. When choosing an excavating machine targeting an unconfined compressive strength of 20 N/mm^2, it is necessary to consider that there will be more delays in excavation or difficult sections. Judging from the strength of the ground, high-performance excavation machines should be selected.

(9) Required Number of Mechanical Excavation Machine (Road Header)

Tunnels to be excavated using a mechanical excavation machine (road header) are 4 tunnels (at 2 places) and the length is T-AT-5: 1,193 m, T-TA-5: 1,152 m, T-AT-6: 450 m, T-AT-6: 444 m.

For T-AT-5 and T-TA-5, since the excavation tunnel length exceeds 1,000 m, and mechanical excavation machine has no mobility, each tunnel needs a dedicated machine.

On the other hand, T-AT-6 and T-TA-6 are short tunnels located at the same location, and about 70% of tunnel length requires auxiliary method. The auxiliary method (Vault forepoling in the D/D Consultant report) requires a construction period of 2 days (resin type injection material) or 3 days (injection material of cement type) per 1 shift. After construction of the auxiliary method, the tunnel excavation will be finished in two days or three days.

When the excavation in the section of 9 to 10 m where the auxiliary method was applied is completed, a construction period of 2 days or 3 days is necessary for auxiliary method as a new 1 shift. After the construction of auxiliary method, the tunnel excavation takes 2 days or 3 days.

In tunnel 6, such work is repeated in the section of 70% or more of the tunnel length. When T-AT-6 constructs auxiliary method, T-TA-6 performs excavation work. On the contrary, when T-AT-6 performs excavation work, T-TA-6 implements construction of auxiliary method.

Although there is no mobility of the mechanical excavation machine (road header), since the position of the portal is the same for both tunnels (T-TA-6 and T-AT-6) and it is on the same elevation, even if there is a delay in excavation work by sharing machines, it is judged that it would not be a problem in the whole construction schedule.

Therefore, it is judged that the number of mechanical excavation machine (road header) necessary for excavating tunnel 5 and tunnel 6 is three.

Table 4-24: Change History in the Position and Length of Each Tunnel

Location		F/S		Interim 1		Final	
		TBILISI → ARGVETA (TA)	ARGVETA → TBILISI (AT)	TBILISI → ARGVETA (TA)	ARGVETA → TBILISI (AT)	TBILISI → ARGVETA (TA)	ARGVETA → TBILISI (AT)
TUNNEL-1	T-TA-1	300 m		330 m (0+260 ~ 0+590)		399 m (0+226 ~ 0+625)	
	T-AT-1		390 m		490 m (0+190 ~ 0+680)		532 m (0+165 ~ 0+697)
TUNNEL-2	T-TA-2	455 m		370 m (0+830 ~ 1+200)		445 m (0+775 ~ 1+220)	
	T-AT-2		780 m		460 m (0+760 ~ 1+220)		487 m (0+748 ~ 1+235)
TUNNEL-3	T-TA-3	570 m		770 m (3+500 ~ 4+270)		803.45 m (3+490 ~ 4+293.45)	
	T-AT-3		685 m		1,125 m (3+475 ~ 4+610)		1,161.411 m (3+475.31 ~ 4+636.721)
TUNNEL-4	T-TA-4	720 m		700 m (6+320 ~ 7+020)		734.7 m (6+288.32 ~ 7+023.02)	
	T-AT-4		690 m		685 m (6+345 ~ 7+030)		713.53 m (6+331.35 ~ 7+044.88)
TUNNEL-5	T-TA-5	1,085 m		1,120 m (7+130 ~ 8+250)		1,152 m (7+107.02 ~ 8+259.02)	
	T-AT-5		1,100 m		1,155 m (7+145 ~ 8+300)		1,193 m (7+136.883 ~ 8+329.883)
TUNNEL-6	T-TA-6			350 m (9+350 ~ 9+700)		444 m (9+265.02 ~ 9+709.02)	
	T-AT-6				350 m (9+350 ~ 9+700)		450 m (9+276.883 ~ 9+726.883)
Sub-Total		3,130 m	3,645 m	3,290 m	7,205 m	3,978.15 m	4,536.94 m
Total		6,775 m		7,905 m		8,515.09 m	

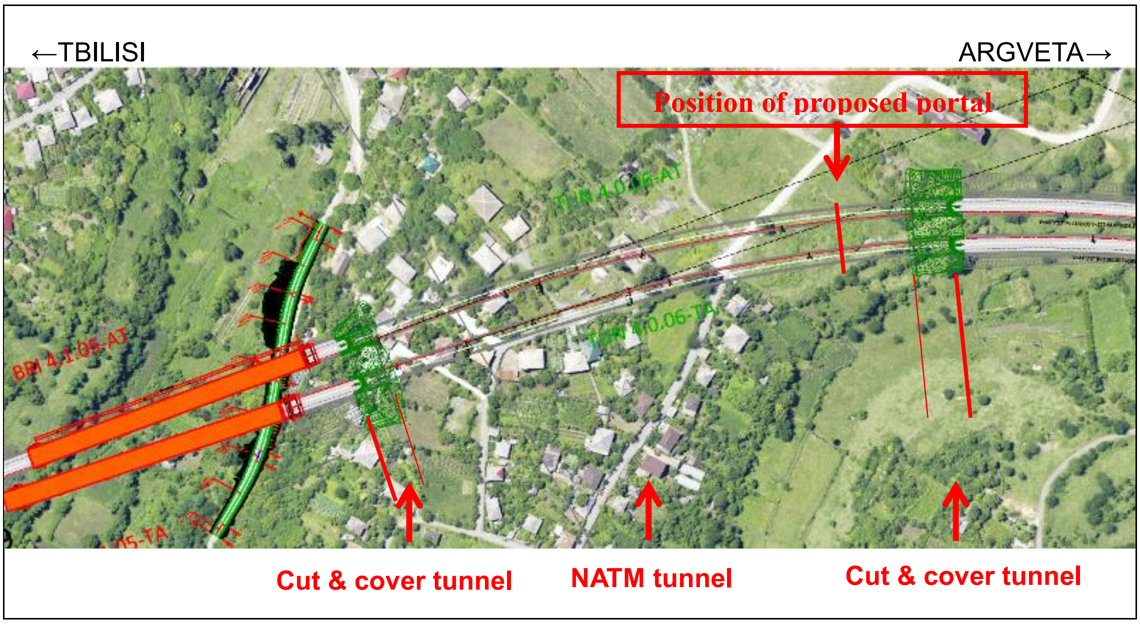
Source: created by JICA study team based on draft final report of DD consultant

Table 4-25: Position and Length of Each Tunnel in the Final Detailed Design

		TBILISI → ARGVETA (TA)	**ARGVETA → TBILISI (AT)**	**Cut & Cover Tunnel (Tbilisi side)**	**Excavation Tunnel (NATM Tunnel)**	**Cut & Cover Tunnel (Argveta side)**
TUNNEL-1	T-TA-1	399 m (0+226 ~ 0+625)		30 m (0+226 ~ 0+256)	344 m (0+256 ~ 0+600)	25 m (0+600 ~ 0+625)
	T-AT-1		532 m (0+165 ~ 0+697)	25 m (0+165 ~ 0+190)	487 m (0+190 ~ 0+677)	20 m (0+677 ~ 0+697)
TUNNE-2	T-TA-2	445 m (0+775 ~ 1+220)		45 m (0+775 ~ 0+820)	380 m (0+820 ~ 1+200)	20 m (1+200 ~ 1+220)
	T-AT-2		487 m (0+748 ~ 1+235)	17 m (0+748 ~ 0+765)	455 m (0+765 ~ 1+220)	15 m (1+220 ~ 1+235)
TUNNEL-3	T-TA-3	803.45 m (3+490 ~ 4+293.45)		15 m (3+490 ~ 3+505)	763.453 m (3+505 ~ 4+268.453)	25 m (4+268.453 ~ 4+293.453)
	T-AT-3		1,161.411 m (3+475.31 ~ 4+636.721)	6.69 m (3+475.31 ~ 3+482)	1,138.721 m (3+482 ~ 4+620.721)	16 m (3+620.721 ~ 4+636.721)
TUNNEL-4	T-TA-4	734.7 m (6+288.32 ~ 7+023.02)		20 m (6+288.32 ~ 6+308.32)	699.704 m (6+308.316 ~ 7+008.02)	15 m (7+008.02 ~ 7+023.02)
	T-AT-4		713.53 m (6+331.35 ~ 7+044.88)	20 m (6+331.35 ~ 6+351.35)	678.531 m (6+351.352 ~ 7+029.883)	15 m (7+029.883 ~ 7+044.883)
TUNNEL-5	T-TA-5	1,152 m (7+107.02 ~ 8+259.02)		15 m (7+107.02 ~ 7+122.02)	1,107 m (7+122.02 ~ 8+229.02)	30 m (8+229.02 ~ 8+259.02)
	T-AT-5		1,193 m (7+136.883 ~ 8+329.883)	15 m (7+136.883 ~ 7+151.883)	1,148 m (7+151.883 ~ 8+299.883)	30 m (8+299.883 ~ 8+329.883)
TUNNEL-6	T-TA-6	444 m (9+265.02 ~ 9+709.02)		25 m (9+265.02 ~ 9+290.02)	384 m (9+290.02 ~ 9+674.02)	35 m (9+674.02 ~ 9+709.02)
	T-AT-6		450 m (9+276.883 ~ 9+726.883)	25 m (9+276.883 ~ 9+301.883)	390 m (9+301.883 ~ 9+691.883)	35 m (9+691.883 ~ 9+726.883)
Sub-Total		3,978.15 m	4,536.94 m	258.69 m	7,975.409 m	281 m
Total		8,519.09 m		8,515.09 m		

NATM tunnel	7,975.40 m
Cut & Cover tunnel	539.69 m

Source: created by JICA study team based on draft final report of DD consultant



Source: created by JICA study team based on Shop Drawing of DD consultant

Figure 4-59: Location of Portal in T-AT-6 and T-TA-6

Table 4-26: Standard Support Pattern of DD Consultant (1/2) (General Section)

Support \ Ground Condition			Good to Very Good rock mass condition			Good to Weak rock mass condition			
			A0	A1	A0V	B0	B1	B0V	B2V
SHOTCRETE	Material		SFRS	SFRS	SFRS	SFRS	SFRS	SFRS	SFRS
	Thickness (cm)		20	20	20	20	20	20	20
	Quality		C 32/40	C 32/40	C 32/40	C 32/40	C 32/40	C 32/40	C 32/40
	Steel Fiber Quantity		≧ 30 kg/m^3	≧ 30 kg/m^3	≧ 30 kg/m^3	≧ 30 kg/m^3	≧ 30 kg/m^3	≧ 30 kg/m^3	≧ 30 kg/m^3
ROCK BOLT	Length (m)		-	6	-	-	6	-	-
	Diameter (mm)		-	25	-	-	25	-	-
	Spacing (m)	Circumferential	-	2.05	-		2.05	-	
		Longitudinal	-	1.2	-		1.4	-	
	Numbers		-	9-10 Stagged	-	-	9-10 Stagged	-	-
	Anchorage Method		-	Grouting	-	-	Grouting	-	-
	Area of Installation		-	Top Heading, 162°	-	-	Top Heading、	-	-
STEEL SUPPORT	Material		S275	-	S275	S275	S275	S275	S275
	Identification		2 IPN 160	-	2 IPN 160	2 IPN 180	2 IPN 180	2 IPN 180	2 IPN 180
	Spacing (mm)		1.2	-	1.0	1.2	1.4	1.0	1.0
FOREPOLING	Material				S 355 Steel Pipe			S 355 Steel Pipe	S 355 Steel Pipe
	Length (m)				15			15	15
	Center to CENTER (cm)				39			39	39
	Area of Installation				Top Heading 132°			Top Heading 132°	Top Heading 132°
	Numbers				39			39	39
	Diameter of Steel Pipe (Outer, mm)				114.3			114.3	114.3
	Overlap Length (m)				Min. 5 m			Min. 5 m	Min. 5 m
	Diameter of the Borehole (mm)				160			160	160
	Radial Inclination (%)				5.83 (3°~ 4°)			5.83 (3°~ 4°)	5.83 (3°~ 4°)
CORE-FACE REINFORCE-MENT	Material								Fiber Glass Bolt
	Length (m)								18
	OVERLAP (m)								8
	Numbers								55
	Grouting Material								Cement
LINING THICKNESS	Strength Class		C 28/35	C 28/35	C 28/35	C 28/35	C 28/35	C 28/35	C 28/35
	Vault (Crown, Side Wall) (cm)		40	40	40 - 110	65	65	40 - 110	40 - 110
	INVERT (cm)		70	70	70	80	80	80	80

Source: created by JICA study team based on Shop Drawing of DD consultant

Table 4-26: Standard Support Pattern of DD Consultant (2/2) (Enlarging Section)

Support		Ground Condition	Good to Very Good rock mass condition			Good to Weak rock mass condition			
			A0 Wide	A1 Wide	A0V Wide	B0 Wide	B1 Wide	B0V Wide	B2V Wide
SHOTCRETE	Material		SFRS	SFRS	SFRS	SFRS	SFRS	SFRS	SFRS
	Thickness (cm)		20	20	20	20	20	20	20
	Quality		C 32/40	C 32/40	C 32/40	C 32/40	C 32/40	C 32/40	C 32/40
	Steel Fiber Quantity		≧ 30 kg/m^3	≧ 30 kg/m^3	≧ 30 kg/m^3	≧ 30 kg/m^3	≧ 30 kg/m^3	≧ 30 kg/m^3	≧ 30 kg/m^3
ROCK BOLT	Length (m)		-	6	-	-	6	-	-
	Diameter (mm)		-	25	-	-	25	-	-
	Spacing (m)	Circumferential	-	2.05	-		2.05	-	
		Longitudinal	-	1.2	-		1.4	-	
	Numbers		-	9-10 Stagged	-	-	9-10 Stagged	-	-
	Anchorage Method		-	Grouting	-	-	Grouting	-	-
	Area of Installation		-	Top Heading, 162°	-	-	Top Heading、	-	-
STEEL SUPPORT	Material		S275	-	S275	S275	S275	S275	S275
	Identification		2 IPN 160	-	2 IPN 160	2 IPN 180	2 IPN 180	2 IPN 180	2 IPN 180
	Spacing (mm)		1.2	-	1.0	1.2	1.4	1.0	1.0
FOREPOLING	Material				S 355 Steel Pipe			S 355 Steel Pipe	S 355 Steel Pipe
	Length (m)				15			15	15
	Center to CENTER (cm)				39			39	39
	Area of Installation				Top Heading 132°			Top Heading 132°	Top Heading 132°
	Numbers				39			39	39
	Diameter of Steel Pipe (Outer, mm)				114.3			114.3	114.3
	Overlap Length (m)				Min. 5 m			Min..5 m	Min. 5 m
	Diameter of the Borehole (mm)				160			160	160
	Radial Inclination (%)				5.83 (3°~ 4°)			5.83 (3°~ 4°)	5.83 (3°~ 4°)
CORE-FACE REINFORCE-MENT	Material								Fiber Glass Bolt
	Length (m)								18
	OVERLAP (m)								8
	Numbers								55
	Grouting Material								Cement
LINING THICKNESS	Strength Class		C 28/35	C 28/35	C 28/35	C 28/35	C 28/35	C 28/35	C 28/35
	Vault (Crown、Side Wall) (cm)		52	52	52 - 122	77	77	52-122	52-122
	INVERT (cm)		70	70	70	80	80	80	80

Source: created by JICA study team based on Shop Drawing of DD consultant

Table 4-27: Standard Support Pattern of Road Tunnel in Japan

(Ordinary section tunnel, inner width: about 8.5 m to 12.5 m)

General section:

Class of ground	Support pattern	Standard Round Length (m)	Rock bolt				Steel support			Wire mesh	Thickness of Shotcrete (cm)	Thickness of Lining	
			Length (m)	Spacing		Area of Installation	Top heading	Bench	Spacing (m)			Arch, Side Wall (cm)	Invert (cm)
				Circumferential Direction (m)	Longitudinal Direction (m)								
B	B	2.0	3.0	1.5	2.0	Top heading 120°	—	—	—	—	5	30	
CI	CI	1.5	3.0	1.5	1.5	Top heading	—	—	—	—	10	30	(40)
CII	CII-a	1.2	3.0	1.5	1.2	Top heading, Bench	—	—	—	—	10	30	(40)
	CII-b						H-125	—	1.2				
DI	DI-a	1.0	3.0	1.2	1.0	Top heading, Bench	H-125	H-125	1.0	Top heading, Bench	15	30	45
	DI-b		4.0										
DII	DII	1.0 or less	4.0	1.2	1.0 or less	Top heading, Bench	H-150	H-150	1.0 or less	Top heading, Bench	20	30	50

Portal zone:

Support pattern	Round Length (m)	Rock bolt				Steel support			Wire mesh	Thickness of Shotcrete (cm)	Thickness of Lining	
		Length (m)	Spacing		Area of Installation	Top heading	Bench	Spacing (m)			Arch, Side Wall (cm)	Invert (cm)
			Circumferential Direction (m)	Longitudinal Direction (m)								
DIIIa	1.0	4.0 (3.0)	1.2 (.06)	1.0 (1.0)	Top heading、Bench	H-200	H-200	1.0	Top heading, Bench	25	35	50

Notes: the values in parentheses represent the specification for foerpoling.
Source: Standard Specifications for tunneling- 2006: Mountain Tunnels, Japanese Society of Civil Engineers

Table 4-28: Ground Classification by RMR Method

A. Classification Parameters and their Rating

No.	Parameter		Ranges of Values						
1	Strength of intact rock material	Point-load strength Index (MPa)	> 10	4 - 10	2 - 4	1 - 2	For this low range, uniaxial compressive test is preferred		
		Uniaxial compressive strength (MPa)	> 250	100 - 250	50 - 100	25 - 50	5 - 25	1 - 5	< 1
	Rating		15	12	7	4	2	1	0
2	Drill core quality RQD (%)		90 - 100	75 - 90	50 - 75	25 - 50	< 25		
	Rating		20	17	13	8	3		
3	Spacing of discontinuities		> 2 m	0.6 – 2 m	200 – 600 mm	60 – 200 mm	< 60 mm		
	Rating		20	15	10	8	5		
4	Condition of discontinuities		Very rough surfaces Not continuous No separation Unweathered wall rock	Slightly rough surfaces Separation < 1 mm Slightly weathered Walls	Slightly rough surfaces Separation < 1 mm Highly weathered wall	Slickensided surfaces or Gouge < 5 mm Separation 1 – 5 mm Continuous	Soft gouge > 5 mm or Separation > 5 mm Continuous		
	Rating		30	25	20	10	0		
5	Groundwater	Inflow per 10 m Tunnel length (L/min)	None	< 10	10 - 25	25 - 125	> 125		
		Ratio of Joint water pressure and Major principal stress	0	< 0.1	0.1 – 0.2	0.2 – 0.5	> 0.5		
		General conditions	Completely dry	Damp	Wet	Dripping	Flowing		
	Rating		15	10	7	4	0		

B. Rating Adjustment for Discontinuity Orientations

Strike and Dip Orientations of Discontinuities		Very Favorable	Favorable	Fair	Unfavorable	Very unfavorable
Ratings	Tunnels and Mines	0	-2	-5	-10	-12
	Foundations	0	-2	-7	-15	-25
	Slopes	0	-5	-25	-50	-60

C. Rock Mass Classes Determined from Total Ratings

Ratings	100 -81	80 - 61	60 - 41	40 - 21	< 20
Class No.	I	**II**	III	IV	V
Description	Very good	Good rock	Fair rock	Poor rock	Very poor rock

D. Meaning of Rock Mass Classes

Class No.	I	II	III	IV	V
Average stand-up time	20 years for 15-m span	1 year for 10-m span	1 week for 5-m span	10 hours for 2.5-m span	30 minutes for 1-m span
Cohesion of the rock mass (kPa)	> 400	300 - 400	200 - 300	100 - 200	< 100
Friction angle of the rock mass (deg)	> 45	35 - 45	25 - 35	15 - 25	< 15

E. Effect of discontinuity strike and dip orientations in tunneling

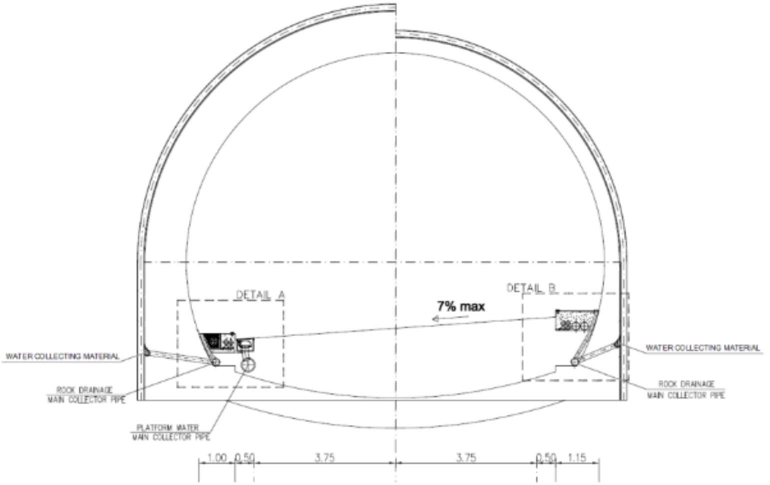
Strike perpendicular to tunnel axis			
Drive with dip		Drive against dip	
Dip 45 - 90	Dip 20 - 45	Dip 45 - 90	Dip 20 – 45
Very favorable	favorable	Fair	Unfavorable

Strike parallel to tunnel axis		Irrespective of strike
Dip 20 - 45	Dip 45 - 90	Dip 0 – 20
Fair	Very unfavorable	Fair

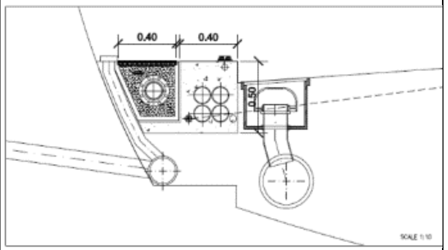
Source: Engineering Rock Mass Classification, Z.T.Bieniawski

Design of DD Consultant	General Design in Japan

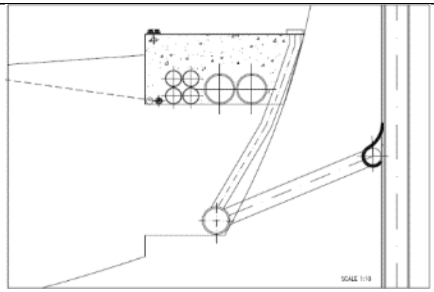
Design of DD Consultant



Cross Section



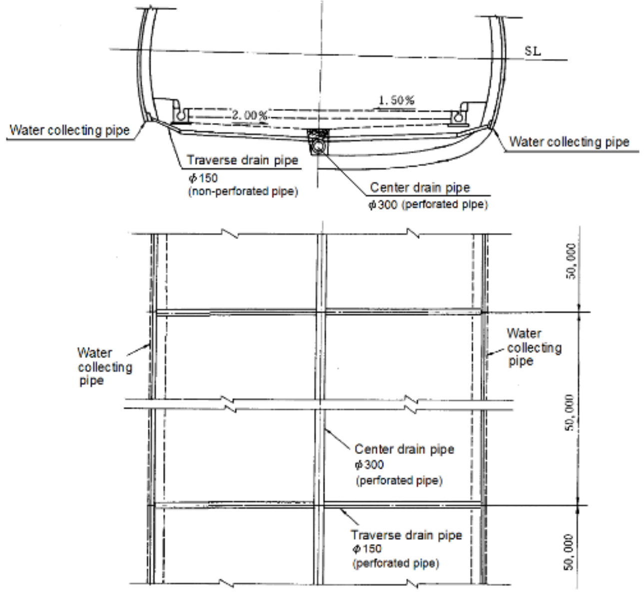
Detail A



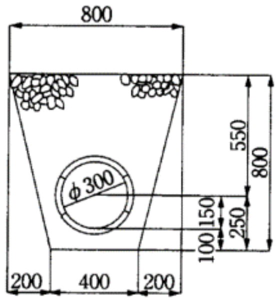
Detail B

Platform Water Collector Pipe: 32 cm /37 cm
Rock Drainage Collector Pipe: 17.7 cm / 20 cm
(Inner Diameter / Outer Diameter)

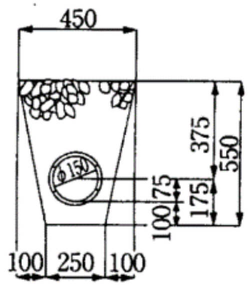
General Design in Japan



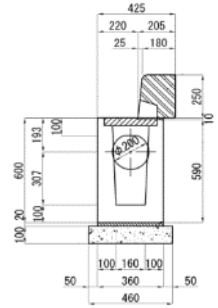
Cross section and Plan view



Center drain pipe



Traverse drain pipe



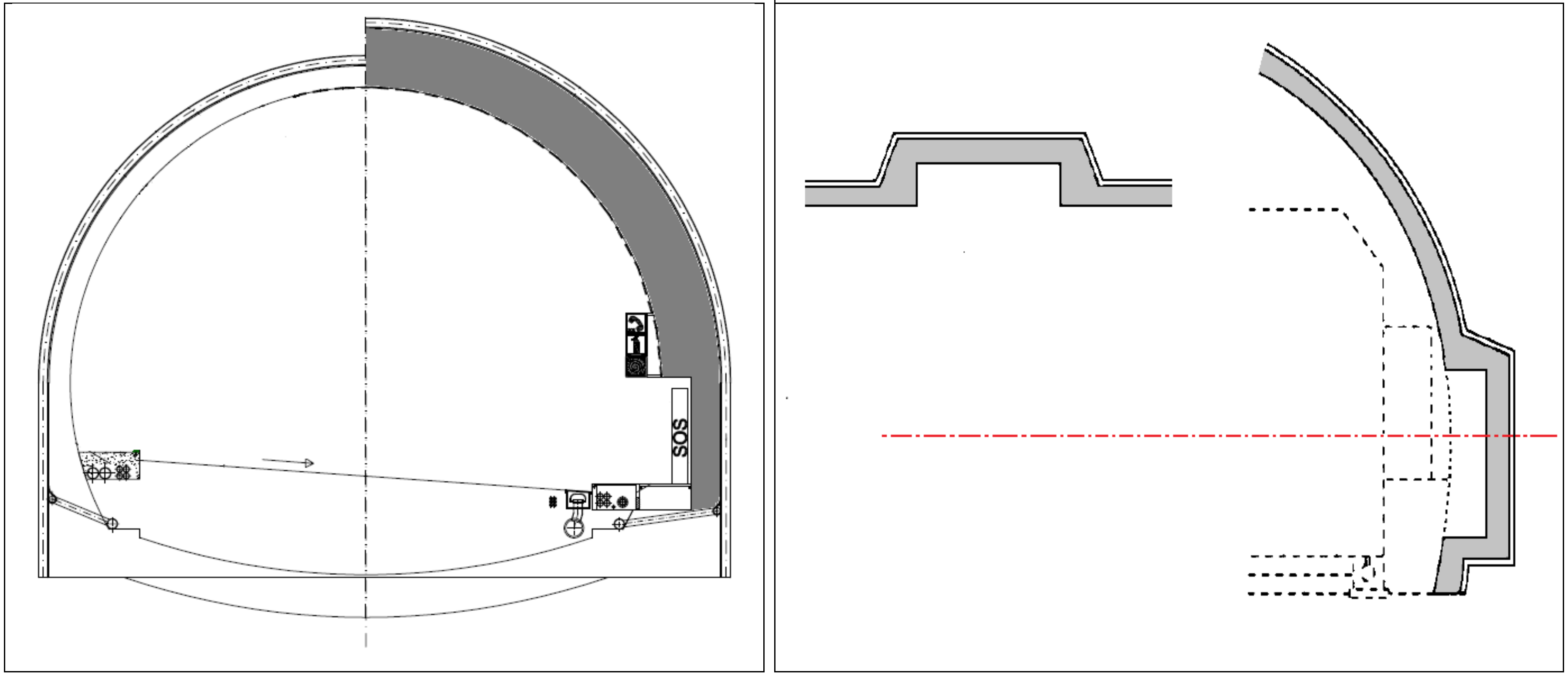
Side ditch

Source: created by JICA study team based on Shop Drawing of DD consultant

Source: Volume III, Design Procedures, Nippon Express Cooperation (NEXCO)

Figure 4-60: Comparison of Drainage System

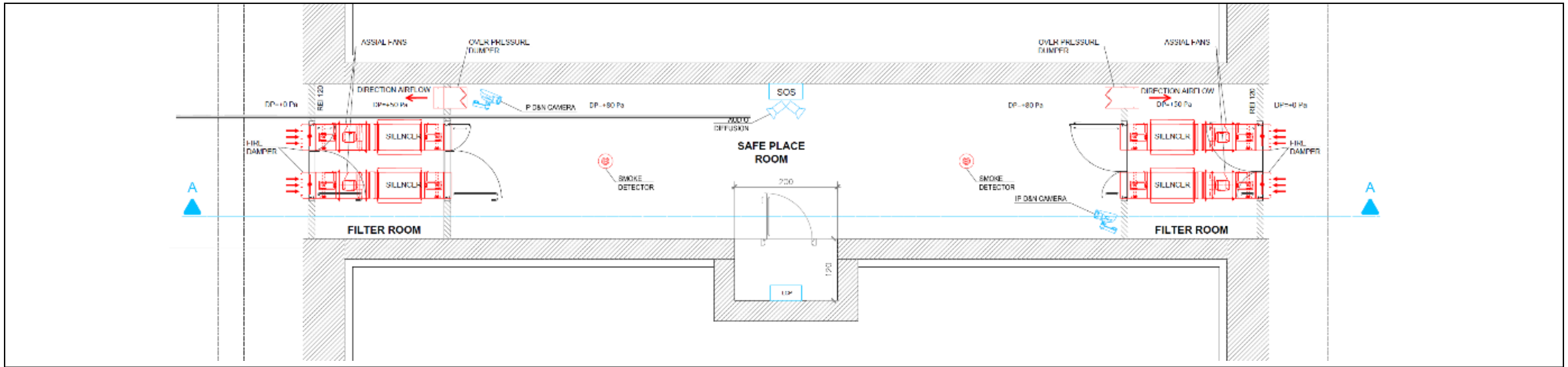
Design of DD Consultant	General Design in Japan



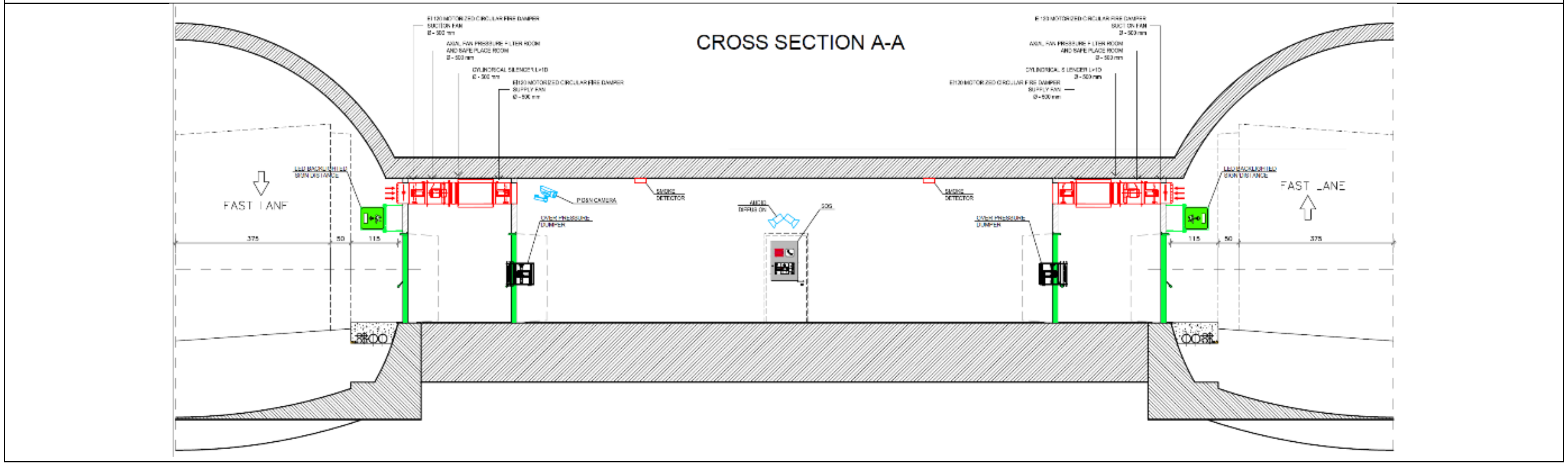
Source: Draft Final Report of DD consultant

Source: Volume III, Design Procedures, Nippon Express Cooperation (NEXCO)

Figure 4-61: Comparison of Lining Thickness around the Niche



Plan View



Cross Section View

Source: Interim (2) Report of DD consultant

Figure 4-62: Design of Emergency Cross Passage by DD Consultant

Table 4-29: Prediction of Vibration during Blasting

Calculation formula of vibration level during blasting:

Maximum vibration speed: $\boldsymbol{V_{peak} = K \times W^{m} \times D^{-n}}$		
Vibration level: $L_{vr} = 20 \times \log(V_{peak}) + 10 \times \log(1 - e^{(-Td/0.63)}) + N$		
Here, V_{peak}	:	Displacement velocity on ground (cm/sec, kine)
K	:	Coefficient due to blasting condition and rock properties
W	:	Maximum charge weight per delay period (center cut: 5 kg):
m	:	Constant (average = 2/3)
n	:	Constant (real wave = 2.0)
D	:	Minimum distance from blasting point (m)
L_{vr}	:	Vibration level (dB)
Td	:	Vibration duration (sec) on the rock =0.1, on the ground = approx. 0.5
N		Correction factor when converting displacement speed to vibration level (=85 dB)

Property of explosives, Number of free face and Maximum *K* value:

Properties of explosives			*K* value for blast pattern		
			Number of free face		
			1	2	3
Type of explosive	Detonation pressure (kg/cm^2)	Detonation velocity (m/sec)	V-cut	Burn cut	Other cut
Dynamite	130 X 10^3	6,500	1,000	700	500
Slurry Explosive	110 X 10^3	6,000	**700**	500	250
Controlled blasting	50 X 10^3	2,800	200	150	100
AN-FO	80 X 10^3	3,800	300	200	150
Static crushing agent	2 X 10^3	60	50	25	25
Application condition (D=5-1,500 m, W=0.1-3,000 kg)					

Source: Study on design and construction of tunnel in proximity to structures etc. (Part 2) Report, Japan tunneling association

Prediction result of ground vibration A:

Vibration of the ground at Sta.7 + 900 where the apartment house is located right above the tunnel

Charging amount per stage (*W*)	*m*	*n*	*K*	*D*	V_{peak}	*Td*	*N*	**Prediction Value L_{vr} (dB)**	Remarks
5.0 kg	2/3	2	700	40 m	1.279	0.15	85	**80.4**	Center cut

Prediction result of ground vibration B

Calculation of the shortest distance that satisfies 64 dB which is the nighttime regulation value

Charging amount per stage (*W*)	*m*	*n*	*K*	***D***	V_{peak}	*Td*	*N*	Nighttime regulation value L_{vr} (dB)	Remarks
5.0 kg	2/3	2	700	**103 m**	0.193	0.15	85	64.0	Center cut

Table 4-30: The Displacement Acceleration and Vibration Level Corresponding to the Seismic Intensity Class of the Japan Meteorological Agency

Magni-tude	Effects on people	Residences	Other buildings	Peak Ground Acceleration (cm/s^2)	Vibration Level (dB)
0	Not felt by all or most people.		Buildings will not receive damage.	Less than 0.8	Less than 55
1	Felt by only some people indoors.		Upper sections of multi-story buildings may feel the earthquake.	0.8–2.5	55–65
2	Felt by many to most people indoors. Some people awake.	Homes and apartment buildings will shake but will receive no damage.	No buildings receive damage.	2.5–8.0	65–75
3	Felt by most to all people indoors. Some people are frightened.	Houses may shake strongly. Less earthquake-resistant houses can receive slight damage.	Buildings may receive slight damage if not earthquake-resistant. None to very light damage to earthquake-resistant and normal buildings.	8.0–25	75–85
4	Many people are frightened. Some people try to escape from danger. Most sleeping people awake.	Less earthquake-resistant homes can suffer slight damage. Most homes shake strongly and small cracks may appear. The entirety of apartment buildings will shake.	Other buildings can receive slight damage. Earthquake-resistant structures will survive, most likely without damage.	25–80	85–95
5-lower	Most people try to escape from danger by running outside. Some people find it difficult to move.	Less earthquake-resistant homes and apartments suffer damage to walls and pillars.	Cracks are formed in walls of less earthquake-resistant buildings. Normal and earthquake-resistant structures receive slight damage.	80–140	95–105
5-upper	Many people are considerably frightened and find it difficult to move.	Less earthquake-resistant homes and apartments suffer heavy/significant damage to walls and pillars and can lean.	Medium to large cracks are formed in walls. Crossbeams and pillars of less earthquake-resistant buildings and even highly earthquake-resistant buildings also have cracks.	140–250	
6-lower	Difficult to keep standing.	Less earthquake-resistant houses collapse and even walls and pillars of other homes are damaged. Apartment buildings can collapse by floors falling down onto each other.	Less earthquake-resistant buildings easily receive heavy damage and may be destroyed. Even highly earthquake-resistant buildings have large cracks in walls and will be moderately damaged, at least. In some buildings, wall tiles and windowpanes are damaged and fall.	250–315	105–110
6-upper	Impossible to keep standing and to move without crawling.	Less earthquake-resistant houses will collapse or be severely damaged. In some cases, highly earthquake-resistant residences are heavily damaged. Multi-story apartment buildings will fall down partially or completely.	Many walls collapse, or at least are severely damaged. Some less earthquake-resistant buildings collapse. Even highly earthquake-resistant buildings suffer severe damage.	315–400	
7	Thrown by the shaking and impossible to move at will.	Most or all residences collapse or receive severe damage, no matter how earthquake-resistant they are.	Most or all buildings (even earthquake-resistant ones) suffer severe damage.	Greater than 400	Greater than 110

Source: Created by JICA Survey Team based on document of Japan Meteorological Agency and Japan explosive industry association

Table 4-31: Laboratory Test Result Using Bored Core

Tunnel No.	Borehole No.	Specimen Depth (m)	Lithology Symbol	Station	Unconfined Compressive Strength (N/mm^2)
Tunnel 3	BH-8	72.6-72.81	J_2B_2B	3+977	60.89
		80.1-80.33	J_2B_2B	3+977	60.75
		83.2-83.5	J_2B_2B	3+977	69.6
	BH-29	40.40-41.11	J_2B_2B	3+744	50.09
		46.6-46.84	J_2B_2B	3+774	21.32
		54.6-54.92	J_2B_2B	3+774	62.47
		58.73-58.95	J_2B_2B	3+744	87.88
Tunnel 4	BH-9	13.9-14.3	J_2B_2B	6+659	95.42
		18.15-18.35	J_2B_2B	6+659	46.63
Tunnel 5	BH-2	44.1-44.8	N_1^2	7+781	19.42
		49.98-50.06	N_1^2	7+781	23.16
		54.6-54.9	J_2B_2A	7+781	11.27
	BH-3	30.43-30.63	N_1^2	7+760	13.05
		35.19-35.42	N_1^2	7+760	11.49
		41.33-41.75	N_1^2	7+760	14.56
		46.94-47.32	N_1^2	7+760	8.41
	BH-4	20.05-20.38	N_1^2	8+066	47.87
		24.43-24.71	N_1^2	8+066	19.95
		29.25-29.47	N_1^2	8+066	79.44
		35.6-35.82	N_1^2	8+066	8.19
	BH-21	47.6-47.84	N_1^2	7+436	13.62
		54.7-54.96	N_1^2	7+436	13.82
		57.66-58.05	J_2B_2A	7+436	37.54
	BH-26	8.80-9.02	N_1^2	8+316	22.06
		15.1-15.4	N_1^2	8+316	42.71
		21.05-21.35	N_1^2	8+316	19.59
Tunnel 6	BH-5	7.10-7.38	N_1^2	9+563	11.09
		13.0-13.25	N_1^2	9+563	24.29
		17.95-18.26	N_1^2	9+563	21.55
		21.80-22.08	N_1^2	9+563	26.84
	BH-6	18.20-18.50	N_1^2	9+428	85.60
		24.75-25.00	N_1^2	9+428	35.32
	BH-7	11.30-11.52	N_1^2	9+644	16.17
		15.30-15.60	N_1^2	9+644	27.84
		21.36-21.56	N_1^2	9+644	26.06
		25.25-25.47	N_1^2	9+644	31.88
	BH-14	4.7-5.0	N_1^2	9+617	10.07
		9.90-10.10	N_1^2	9+617	25.59
		14.0-14.28	N_1^2	9+617	74.23
	BH-17	3.75-4.05	N_1^2	9+301	23.82
		9.70-9.94	N_1^2	9+301	23.98
		14.47-14.79	N_1^2	9+301	19.81

Lithology Symbol / N_1^2: Calcarenite, J_2B_2A: Tuff, J_2B_2B: Porphyrite
Source: created by JICA study team based on draft final report of DD consultant

Table 4-32: Laboratory Test Results Using Specimen of Outcrop

Tunnel No.	Outcrop No. (Sample No.)	Coordinate		Lithology Symbol	Unconfined Compressive Strength (N/mm^2)
		X	Y		
Tunnel 1	24 (18)	344,936	4,661,865	J_2B_2A	40.27
	25 (19)	345,168	4,661,931	J_2B_2A	119.21
	25 (SS-19)	345,168	4,661,931	J_2B_2A	133.19
	26 BH-29	345,586	4,661,535	J_2B_2A	177.45
Tunnel 2	18 (14)	344,083	4,661,900	J_2B_2A	92.14
	20 (33)	344,380	4,661,985	J_2B_2A	111.18
	23 (17)	344,639	4,662,211	J_2B_2A	75.37
Tunnel 3	11 (9.1)	341,176	4,661,814	J_2B_2A	79.34
	11 (9.2)	341,176	4,661,814	J_2B_2A	64.12
	12 (SS-10)	341,353	4,661,728	J_2B_2A	73.67
	13 (31)	341,952	4,661,940	J_2B_2A	71.58
	13 (SS-21)	341,952	4,661,940	J_2B_2B	111.30
Tunnel 4	ST-1	339,928	4,663,582	N_1^2	32.49
	6 (5.2)	339,991	4,663,156	J_2B_2A	26.71
	6 (6)	339,838	4,663,423	J_2B_2A	55.66
Tunnel 5	3 (3)	338,659	4,664,578	N_1^2	17.41
	3 (SS-6)	338,659	4,664,578	N_1^2	45.64
	4	338,720	4,664,478	N_1^2	31.69
	29 (SS-4)	339,315	4,663,864	N_1^2	30.66
Tunnel 6	1 (1)	337,049	4,664,918	N_1^2	43.06
	2 (2)	337,711	4,664,578	N_1^2	28.98
	33 (27)	337,859	4,664,699	N_1^2	25.79

Lithology Symbol / N_1^2: Calcarenite, J_2B_2A: Tuff, J_2B_2B: Porphyrite
Source: created by JICA study team based on draft final report of DD consultant

4.2.6 Slope and Slope Protection Design

(1) General

A suitable stabilizing method for the design slope will be selected based on geological conditions. The following slope protection works will be selected as countermeasures for slope failure (rock fall) of the cut slope:

- Soil
- Rock quality (if fragile)
- Weathering
- Degradation of rock quality after cut slope work

Slope stabilizing methods will be selected when the cut slope is applied for landslide blocking. According to the field reconnaissance, in identifying a geomorphological feature of doubtful landslide near the AT sta.0+550, special attention for design of cut slope near the tunnel mouth will be needed.

When unstable or loose rocks are present on the natural slope (such as upper part of slope or a slope adjacent to the road), passive countermeasure or rock fall prevention method should be incorporated in order to prevent rocks falling on the road. In any case, a field reconnaissance will be required for identifying the above.

According to the results of the field survey of these caution points, slope having the falling rock origin at the upper side of the slope is limited to the slope between T1 and T2.

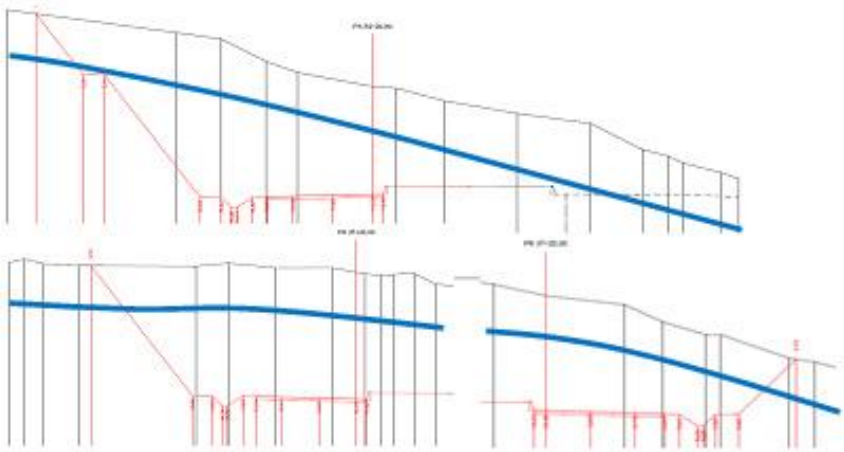
(2) Cut Slope Countermeasure Work

From the geological distribution, the cut slope point numbers 1 to 6 shown in the following figure are located in hard rocks, the cut slope point numbers 7 through 10 are positioned in soft rocks. The standard slope gradient for Japanese is 1: 0.3 to 1: 0.8 (73.3° to 51.3°) for hard rock and 1: 0.5 to 1: 1.2 (63.43° to 39.8°) for soft rock.

The cut slope point number 1'-2, 2,2' are sharp by about 5°, but it is judged that the glue surface protection work is unnecessary.

As the tunnel well head slope of the cut slope point number 7 is sharper than the standard by about 15°, it is considered that concrete spraying is necessary like other tunnel opening.

The other cut slopes are within the standard slope, but the cut slope point number 8,10, and 10 ' are expected to have high groundwater level with the slope surface corresponding to the weathered part from the boring survey results.



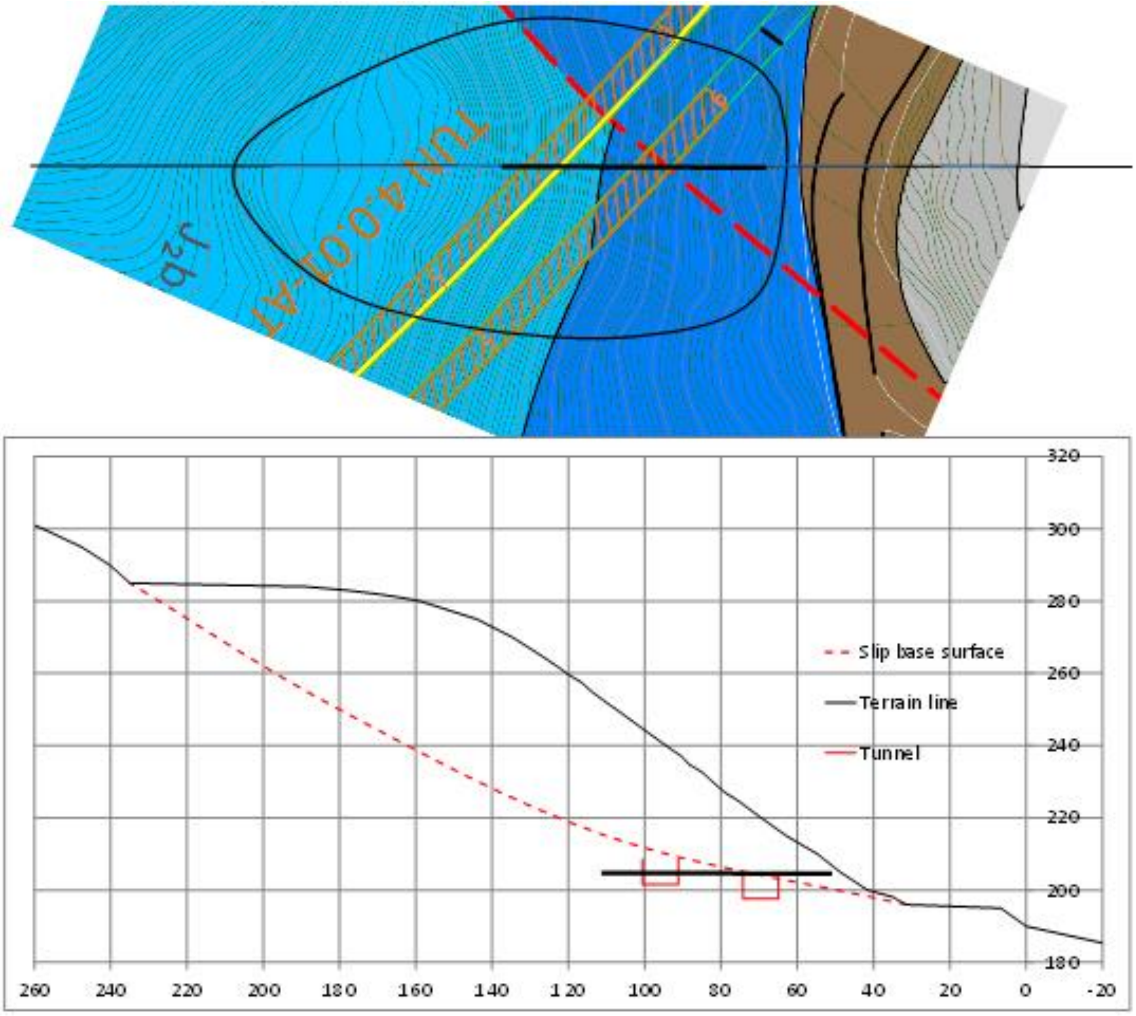
Source: JICA Survey Team based on the D/D FD/R

Figure 4-63: Recommended Cut Slope Drainer and Seed Spraying Method (the Cut Slope Point Number 8,10,10') (Blue Line is Underground Water Level Line)

(3) Landslide Countermeasure Work

Prior to tunnel construction, it is necessary to identify the existence of landslide and the position of sliding surface and to investigate the possibility of triggering landslide activity due to slack tunnel drilling and tunnel excavation.

Landslide assumed vertical sectional view and boring survey plan position map are shown in Figure 4-64. Based on the results of the survey, we will consider the countermeasure policy, but it is possible to consider a method such as changing the tunnel alignment and construction formation to maintain a sufficient separation from the sliding surface and avoiding it or constructing a landslide preventive pile.



Source: JICA Survey Team based on the D/D FD/R

Figure 4-64: Landslide Assumption Longitudinal Sectional View and Boring Survey Plan Position Map

(4) Rock Fall Countermeasure Work

<u>1) Local Situation and Countermeasures Policy</u>

The extension of the light portion between T1 and T2 is 50 m with a continuous steep slope with the specific height up to the urgent line reaching 150 m. Unstable rocks are distributed (see Figure 4-65), and falling rocks are a concern. A number of falling rocks exceeding 1 m in diameter are in fact recognized along the current road (see Figure 4-66).

Source: JICA Survey Team

Figure 4-65: Outcrop Rocks in Nature Slopes

Source: JICA Survey Team

Figure 4-66: A Falling Rock aside from the Current Road

When the source position is high, it is expected that the falling rock energy will be enormous, so it is difficult to calculate the design external force of the standby countermeasure worker. Therefore, after specifying the distribution range of target rocks, we will take countermeasures against the source (see Figure 4-67).

Source: TOKYO SEIKO Co LTD

Figure 4-67: Falling Stone Prevention Work

2) Specification of Countermeasures

The maximum range that can be a source of falling rock is the range shown in the following figure, which is 69,290 m^2. Among these ranges, the necessary scope of countermeasures against source policies shall be narrowed down by reviewing the rock distribution at the time of construction.

As a measure against the source, JST propose a falling stone prevention work. It shall be of high durability specification (HDZ 35 specified in JIS H 8641: 350 g / m 2 or more) which can be anticipated to reduce maintenance with a useful life of 50 years or more.

Source: JICA Survey Team

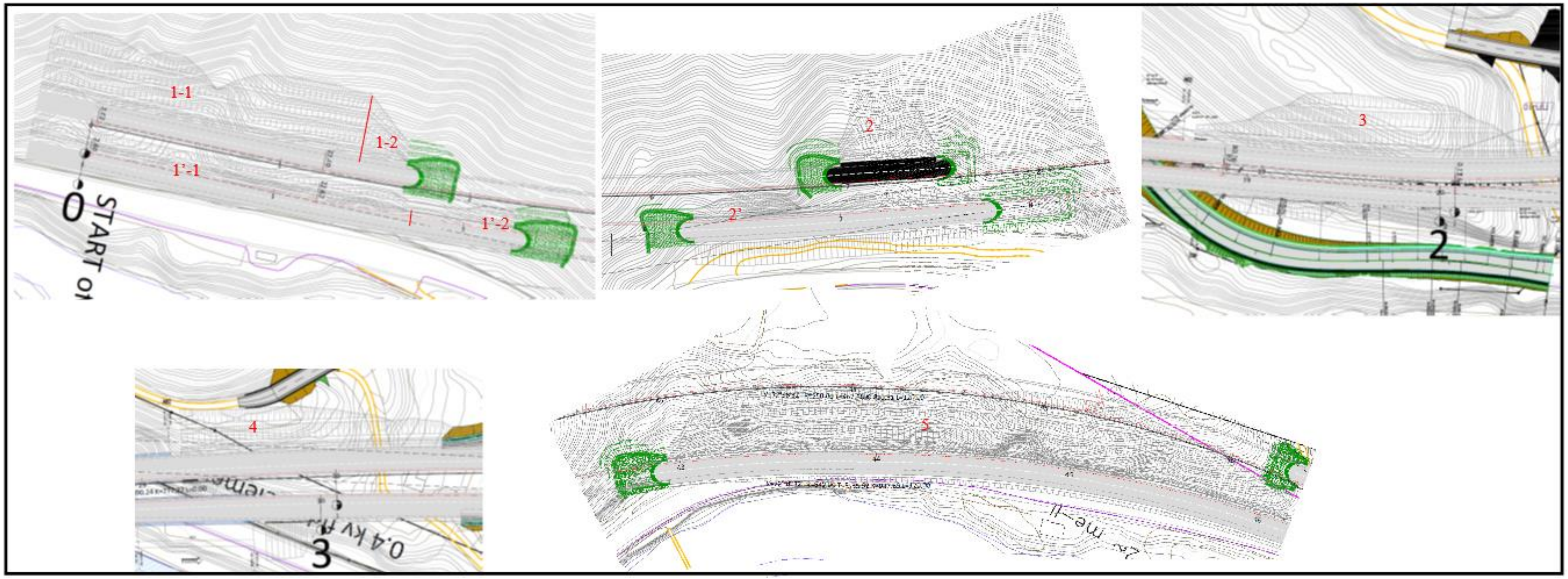
Figure 4-68: Range of Rockfall Sources Reaching the Road

Table 4-33: Quantity of Slope Protector

Cut slpoe point number	Position	STA	Lithology	Borhole number	Weathered depth	Borhole water level	Gradient(°)	Cut slope heghit	Section length (m)	slope distance (m)	Cut slope area (m^2)	Rock fall source area (m^2)	Countermeasure work
1−1	From T1 to the origin sideAT	0 + 0 ～ 0 + 138	Porphyrite	BH−38	8.5m	−10.9m	59	32	138	37.33	3,783.39		No need
1−2		0 + 138 ～ 0 + 163					68.9	32	25	34.31	629.93		No need
1'−1		0 + 0 ～ 0 + 170		BH−37	9m	−14.2m	45.0	4	170	5.66	961.67		No need
1'−2		0 + 170 ～ 0 + 224					78.7	21	54	21.42	963.68		No need
2	Between T1 and T2AT	0 + 696 ～ 0 + 747	Porphyrite				78.7	25	51	25.49	1,014.16	20% of 69290m^2 13,858	Rock fall prevention work
2'	Between T1 and T2TA	0 + 625 ～ 0 + 682	Porphyrite20m	BH−52	20m	−	78.7	25	57	25.49	1,133.47		
3	Between B1 and B2AT	1 + 878 ～ 2 + 45	Porphyrite2.5m	BH−27,28	4.0m,7m	−6.6,−5.7m	59.0	31	167	36.17	4,968.11		No need
4	Between B2 and B3AT	2 + 920 ～ 3 + 61	Porphyrite	BH−24	8m	−5.9m	59.0	24	141	28.00	2,960.92		No need
5	Between T3 and B4TA	4 + 294 ～ 4 + 614	Porphyrite	BH−32,49	0m	−6.8,−m	59.0	41	320	47.83	12,132.99		No need
6−1	Between T3 and B4AT	4 + 618 ～ 4 + 829	Porphyrite				45.0	12	211	16.97	3,580.79		No need
6−2		4 + 829 ～ 5 + 364	Porphyrite	BH−44,45	5m,4m	−8.8,10.3m	59.0	24	535	28.00	11,234.68		No need
6−3		5 + 260 ～ 5 + 308	Porphyriteト				59.0	31	48	8.17	195.99		No need
6−4		5 + 364 ～ 5 + 550	Porphyrite	BH−46	6.4m	−13.2m	45.0	13	186	18.38	3,419.57		No need
7	Between T5 and B5TA	8 + 257 ～ 8 + 286	Sandstone5.5m	BH−26	16.6m	−5.15m	78.7	12	29	12.24	266.16		shotcrete
8−1	Between T5 and B5AT	8 + 328 ～ 8 + 575					53.0	18	247	22.54	4,639.16		seed spraying method
8−2		8 + 575 ～ 9 + 40	Sandstone2.8m	BH−10	5.3m	−18.45m	53.0	14	465	17.53	8,151.40		No need
9	Between B5 and T6TA	9 + 218 ～ 9 + 264	Sandstone3.65m	BH−17	5.5m	−5.1m	45.0	17	46	24.04	845.70		No need
10	From T6 to the end point sideAT	9 + 726 ～ 9 + 908	Sandstone8.7m	BH−7	13.6m	−5.0m	53.0	13	182	16.28	2,962.55		seed spraying method
10'	From T6 to the end point sideTA	9 + 708 ～ 9 + 818					45.0	5	110	7.07	777.82		seed spraying method

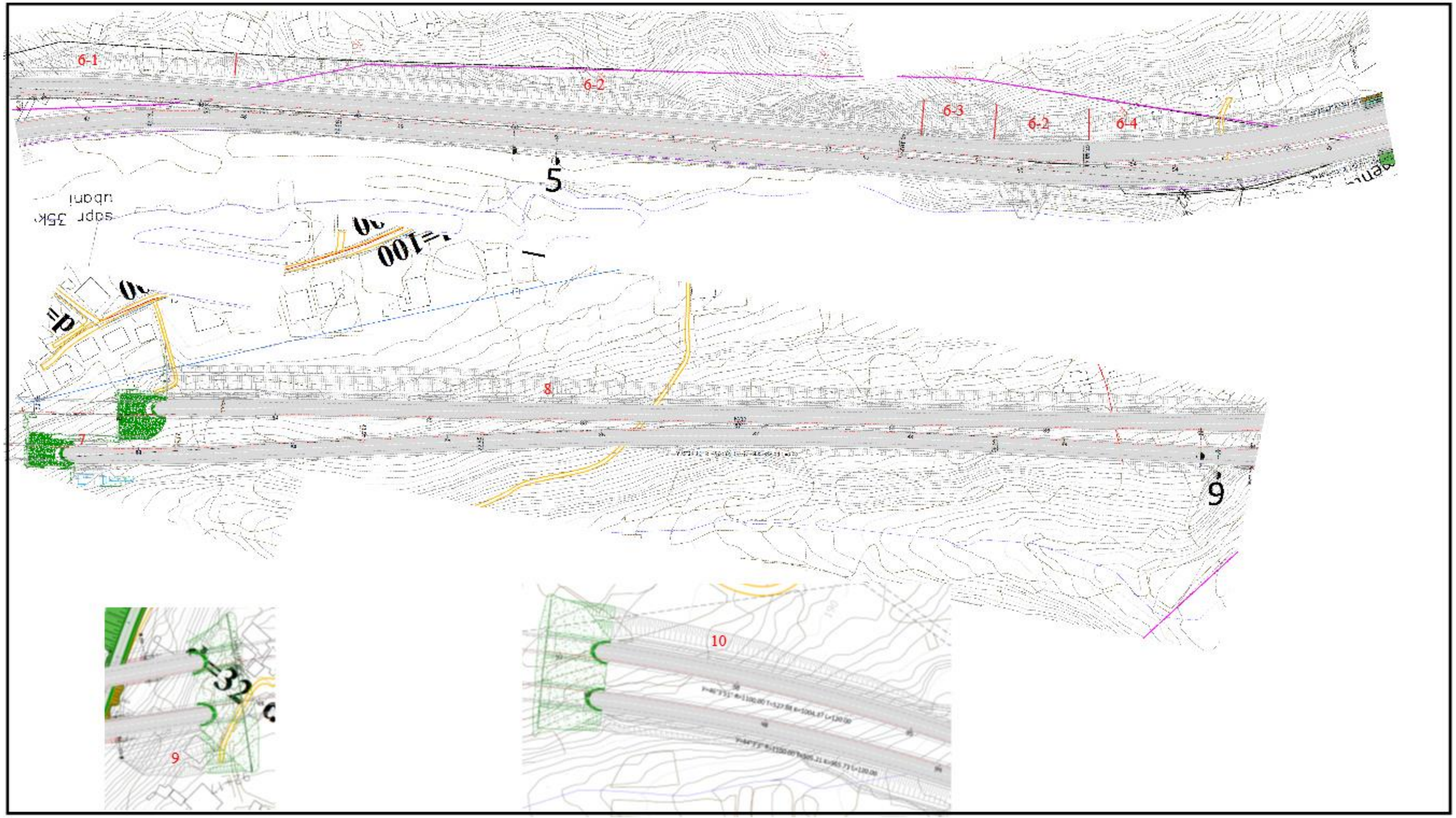
A part has been removed because of confidential information.

Source: JICA Survey Team



Source: JICA Survey Team based on the D/D FD/R

Figure 4-69: Falling Stone Prevention Work (1)



Source: JICA Survey Team based on the D/D FD/R

Figure 4-70: Falling Stone Prevention Work (2)

4.2.7 Pavement Design

The F/S compared the AASHTO and the RStO (German Standard: Richitlinien fur die Standardisherung des Ober-baues von Verkersflachen) based on Equivalent Single Axle Loading (ESAL) for 20 years for each section (shown in the table below). The design parameter for axle loading of AASHTO is 8.15 tons, and RStO 12 is 10 tons. According to agencies concerned overloading rate is not as high as worrying about pavement damages but due to higher rate of transit traffic it is highly possible to have heavier traffic. Therefore, care must be taken for the pavement design.

Table 4-34: Equivalent Single Axle Loading by F/S

Section	Cumulative ESA (unit: 10^6 (two way)
Zestafoni-east-west	244.907
Zestafini-Argveta	282.568

Source: WB, F/S

Highway pavement can generally be categorized as either flexible (asphalt) or rigid (concrete). Rigid pavement needs higher initial investment but has poor riding quality compared to flexible pavement. Nevertheless, the Government of Georgia used concrete pavement for the East-west Highway because cement is locally obtainable thus economical, and less maintenance is required. The concrete slab of 28 cm, crushed aggregate of 25 cm base course and sand-gravel mix of 30 cm sub-base pavement is used for the Phase 1 project.

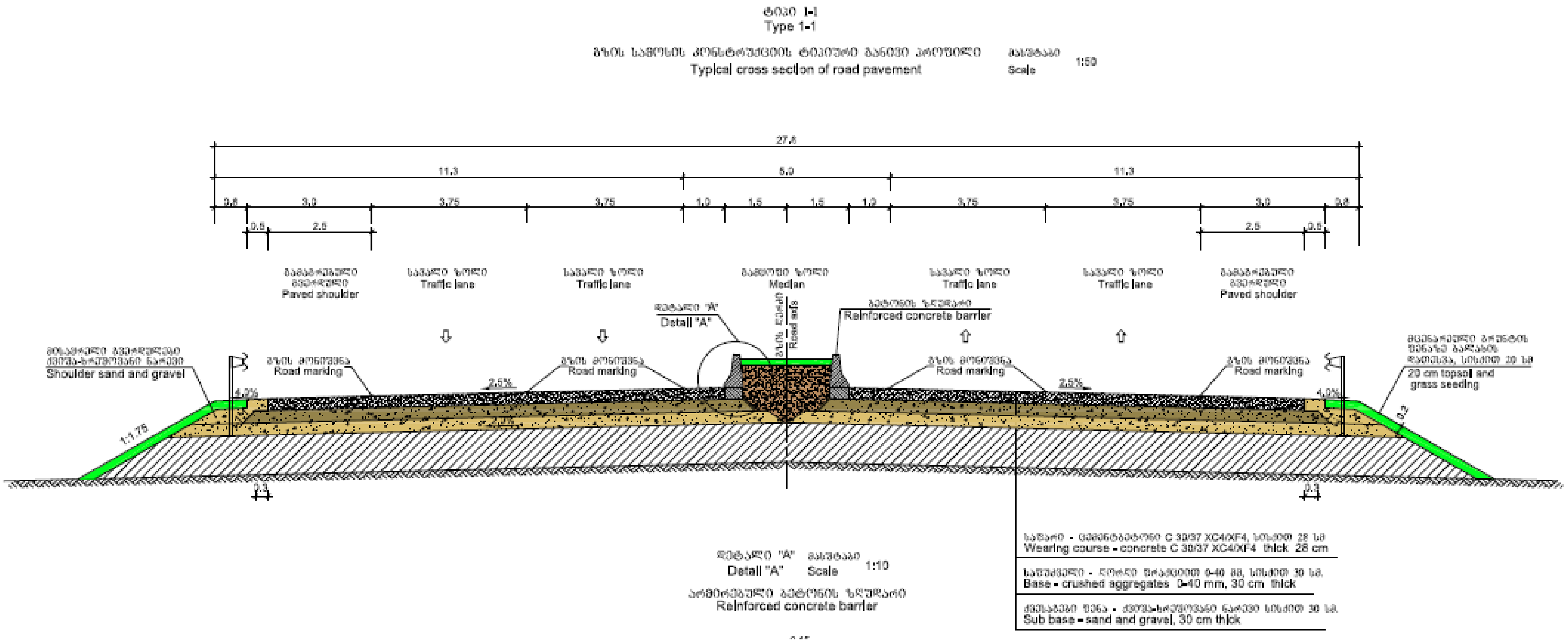
The concrete pavement with 28 cm concrete slab, 30 cm crushed aggregate base and 30 cm sand-gravel mix sub-base is used for the F4 section in considering the increased traffic volume and implementation time.

Table 4-35: Pavement Layer proposed by D/D

N	Pavement layers	Thicknesses of layers mm
1	Cement concrete (pavement)	280
2	Crushed aggregates (base course)	300
3	Sand-gravel mix (underlying layer)	300

Source: ADB F4 section D/D

The standard cross section of the pavement is shown in the following figure.

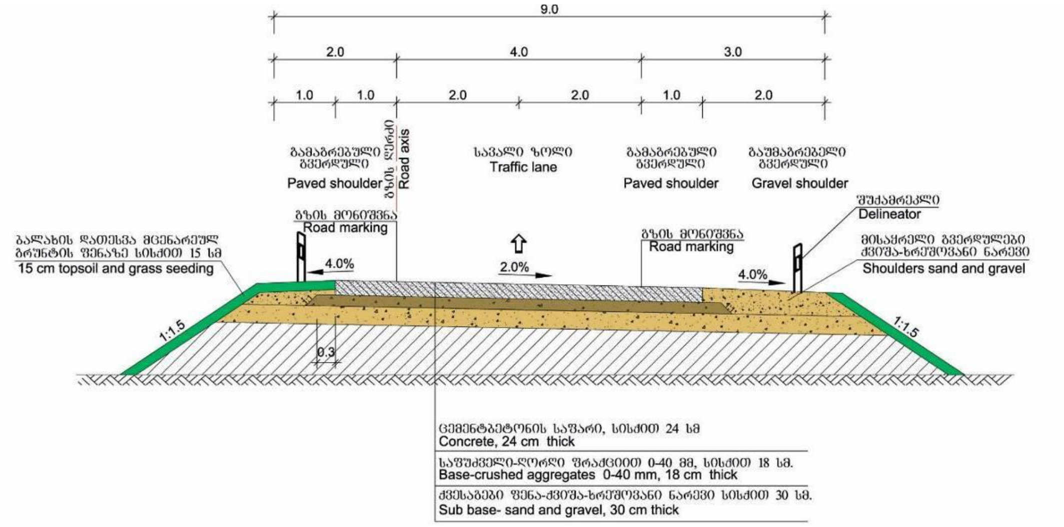


Source: ADB F4 section D/D

Figure 4-71: Standard Cross Section of Concrete Pavement

The pavement on the bridge is a flexible pavement of 11 cm thickness over waterproof layer of the concrete deck. The pavement of IC is different from the main line as shown in the figure. Main features of the geometry is:

- Carriageway width: 4.0 m
- Paved shoulder width: 1.0 m
- Unpaved shoulder width: 1.0 m
- Unpaved shoulder width of right-hand side: 2.0 m



Source: ADB F4 section D/D

Figure 4-72: Cross Section of IC Ramps

As shown in the figure the pavement is composed of 24 cm concrete slab surface, 20 cm crushed aggregate base 0∸40 mm and 30 cm sand-aggregate mix sub-base.

4.2.8 Drainage Design

(1) Principle of Culvert Design

The culvert size for the design requirements is chosen by i) local discharge as provided by the hydrological study or estimated from IDF curves; ii) local topography, including longitudinal slope; and iii) possible interconnections of two or more interfered channels.

For culvert design, methodology for culverts analysis was provided, as well as hydrological methods to determine design discharge for smaller basins, and for drainage. This methodology is based on the interpolation of discharge expected with the two methods (PMP91 and regional method) described in the previous section. Analysis of culverts was described based on the following steps.

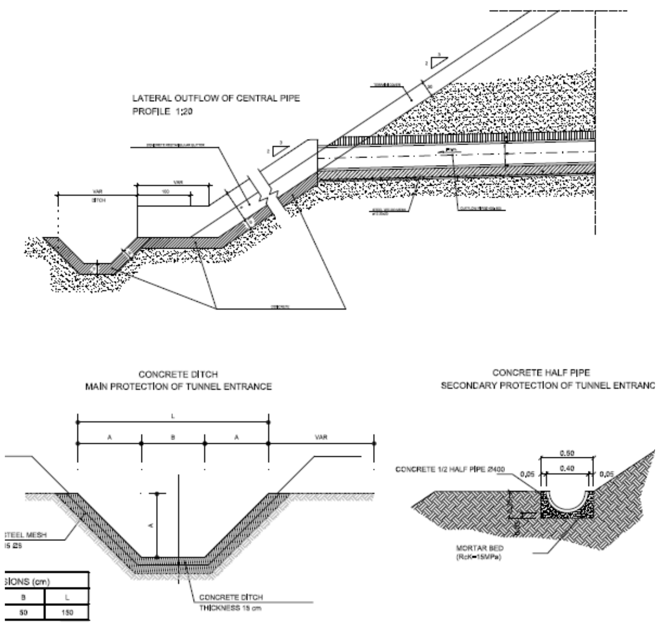
- Culverts identification
- Hydraulic conditions
- Culverts models
- Hydrological calculations
- Design discharges
- Hydraulic conditions (results)
- Culverts final design

(2) Road Drainage System

In the D/D study report, different elements were described and calculations methods were reported based on the following steps. Results for channel and pipes dimensions were organized within specific tables in the report.

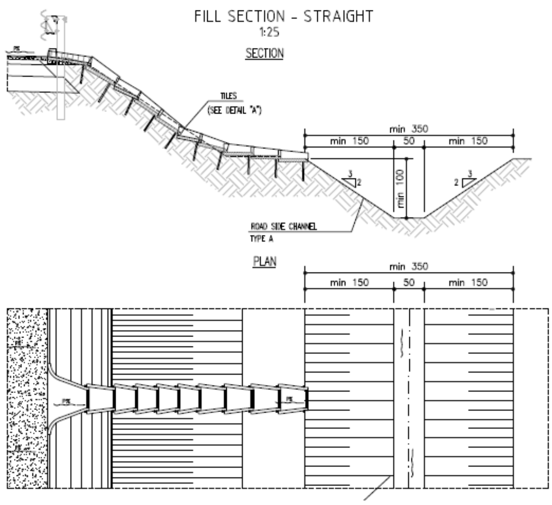
- Drainage pipe and distance design
- Concrete gutter
- Pipes network design
- Drainage of bridges

The following figures are examples of drainage system used in D/D.



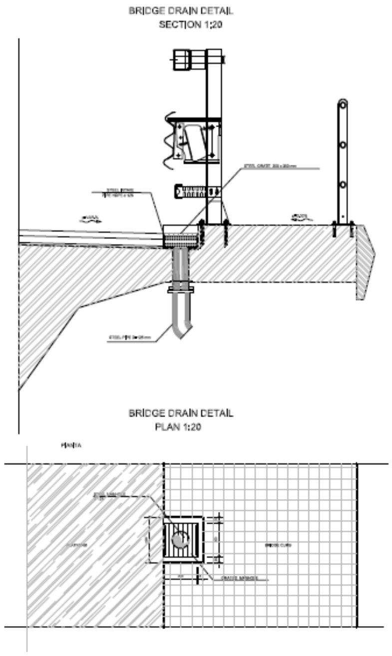
Source: DD Report

Figure 4-73: Transverse Drainage, Side Ditch and Drainage of Step of the Slope



Source: DD Report

Figure 4-74: Vertical Drain and Side Ditch of the Embankment Edge



Source: DD Report

Figure 4-75: Bridge Drain Pipe

4.2.9 Traffic Control Devices and Safety Facilities

The purpose of traffic control devices is to promote highway safety and efficiency by providing for the orderly movement of all users on highway. Traffic control devices notify road users of regulations and provide warning and guidance.

(1) Road Signs

Traffic signs fall into three broad functional classes. On highways generally only guide signs are needed.

1) Warning Sign

This sign calls attention to hazardous conditions according to the highway environment. Necessary signs may include "caution merging traffic ahead" before merging point of interchange or "caution falling rocks".

2) Regulatory Sign

This sign conveys message to drivers, obligations, regulations and prohibitions. On highways speed regulation would be the only necessary sign. Figure 4-76 shows examples of these signs.

Caution merging traffic ahead	Caution falling rocks	Speed regulation
		

Source: Various standard

Figure 4-76: Examples of Warning and Regulation Signs

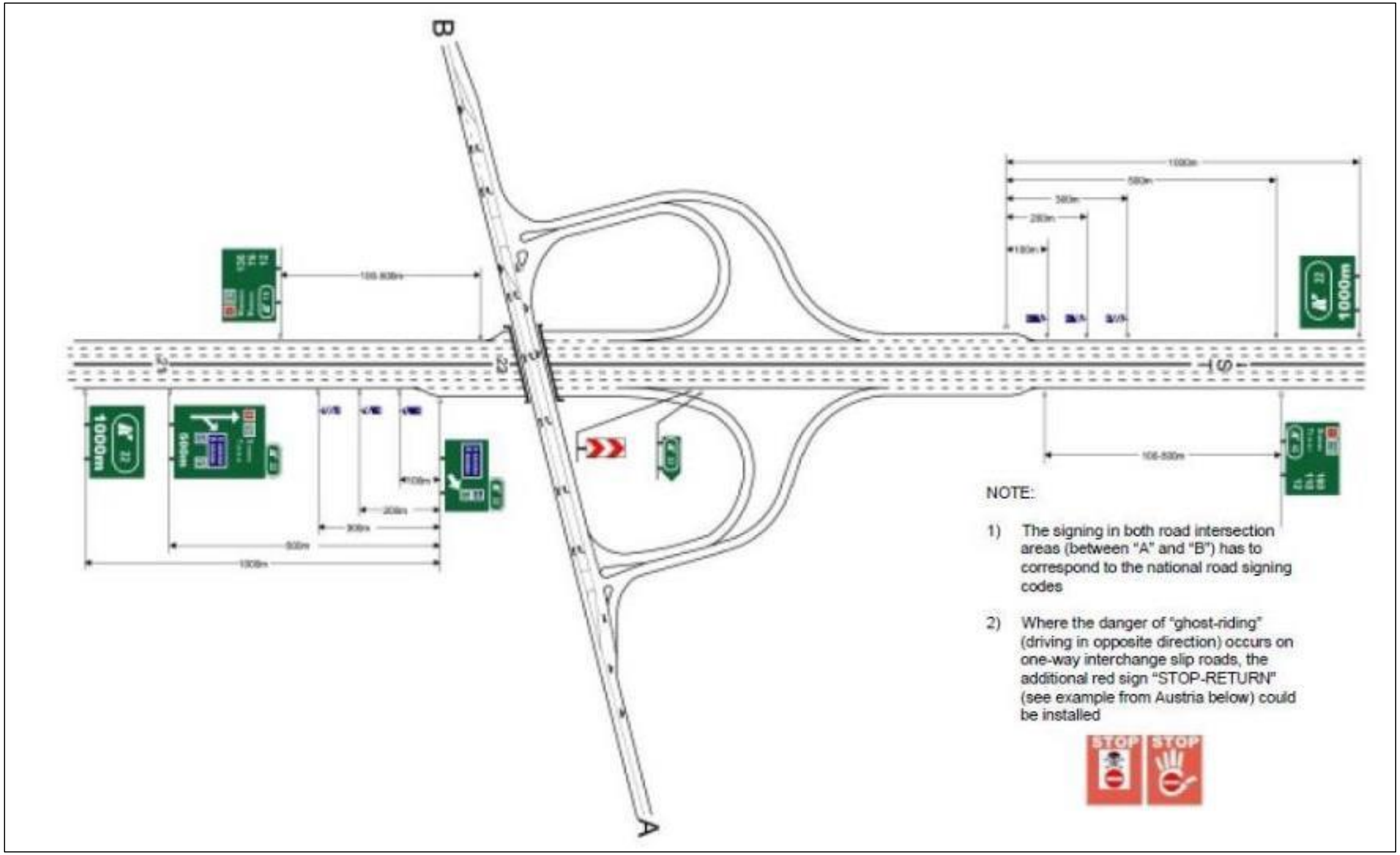
3) Guide or Informational Signs

These signs are used to provide directions to motorists, including route designation, available services, points of interest and other geographic, recreational, or cultural sites.

a. Directions and exit guide at interchange diverging point
The project highway has four interchanges, and there are two locations where two interchanges are planned at relatively short intervals. The existence of tunnel sections before interchanges also restricts the placement of guide signs.

A directional sign should be installed at 1,000 m before diverging point, then at 500 m, and at diverging point, as shown in Figure 4-77. The signs are properly planned in DD.

b. Other guide signs
Names of places, rivers and famous sightseeing spots should be properly signed. These are not drawn on the design sheets as of now, presumably because they are not finalized yet.



Source: TEM

Figure 4-77: Directional Signs at Interchange

(2) Markings

Markings on highways have important functions in providing guidance and information for the road user. Their visibility can be limited by snow, debris, and water on or adjacent to the markings. Marking durability is affected by material characteristics, traffic volumes, weather, and location.

1) Longitude Line

Longitude line, usually with a width of 15 cm, is implemented to delineate the carriageway's outmost line over the entire carriageway. This is properly designed in DD.

2) Broken Line

a. Carriageway center between lanes
Broken line consists of segments and gaps. The ratio of segment and gap varies according to standards. They are summarized in Table 4-36. The broken line used in DD has a ratio of 1:3. The gap is too long referring to other standards shown in Table 4-36. It is recommended to use a ratio of 1:2 which is defined by TEM.

Table 4-36: Ratio of Segment and Gap of Broken Line

Standards	L1	L2	Notes
TEM	1	2	
America	3	5	MUTCD*(RP)
Japan	1	1.5	Guide Line(RP)

*Manual on Uniform Traffic Control Devices
Source: JICA Survey Team

b. Boundary lines between interchange additional lanes and main lines
There are other short broken lines which are applied at the boundary lines between additional lanes and main lanes at interchanges. The ratio of segment and gaps varies from 1:1-3, and the width is usually wide, 20 cm to 40 cm. They are properly planned in DD.

3) Miscellaneous Markings

a. Arrows
Arrows are painted on pavement to direct traffic. They are convenient tools to guide traffic on highways, especially during temporary two lane operations. They would not be needed at completed four lane sections.

b. Indication at gore
In order to direct traffic at nose of diverging and merging traffic at IC, triangle shapes are painted. They are properly planned.

c. Raised bar
To convey special message to drivers by shock, raised bars are implemented on pavement. The implementation of the bars should be contemplated, as the shock is very strong to drivers. They should be used at lines which will not be crossed by ordinary driving.

To implement raised bars (noise bars) on the highway surface will give damage to both vehicles and pavements. Also, astonished by the abrupt shock, the drivers might brake suddenly, causing rear-head collisions, and motorcycles might turnover. The intention to implement such devices giving strong shocks to drives is not obvious. If the intentions are to let the drivers reduce speed and pay attention to diverging traffic, there must be another way to convey the same message rather than the noise bars. Implementation of noise bars is not recommended.

4) Delineator

Delineator is a small reflectorized device installed at guard rails and concrete barriers to guide drivers of the alignments of the highway. Delineators are particularly beneficial at locations where the alignment might be confusing or unexpected, such as at lane-reduction transitions and curves. They are effective guidance devices at night and during adverse weather, maintaining visibility even when the roadway is wet or snow covered.

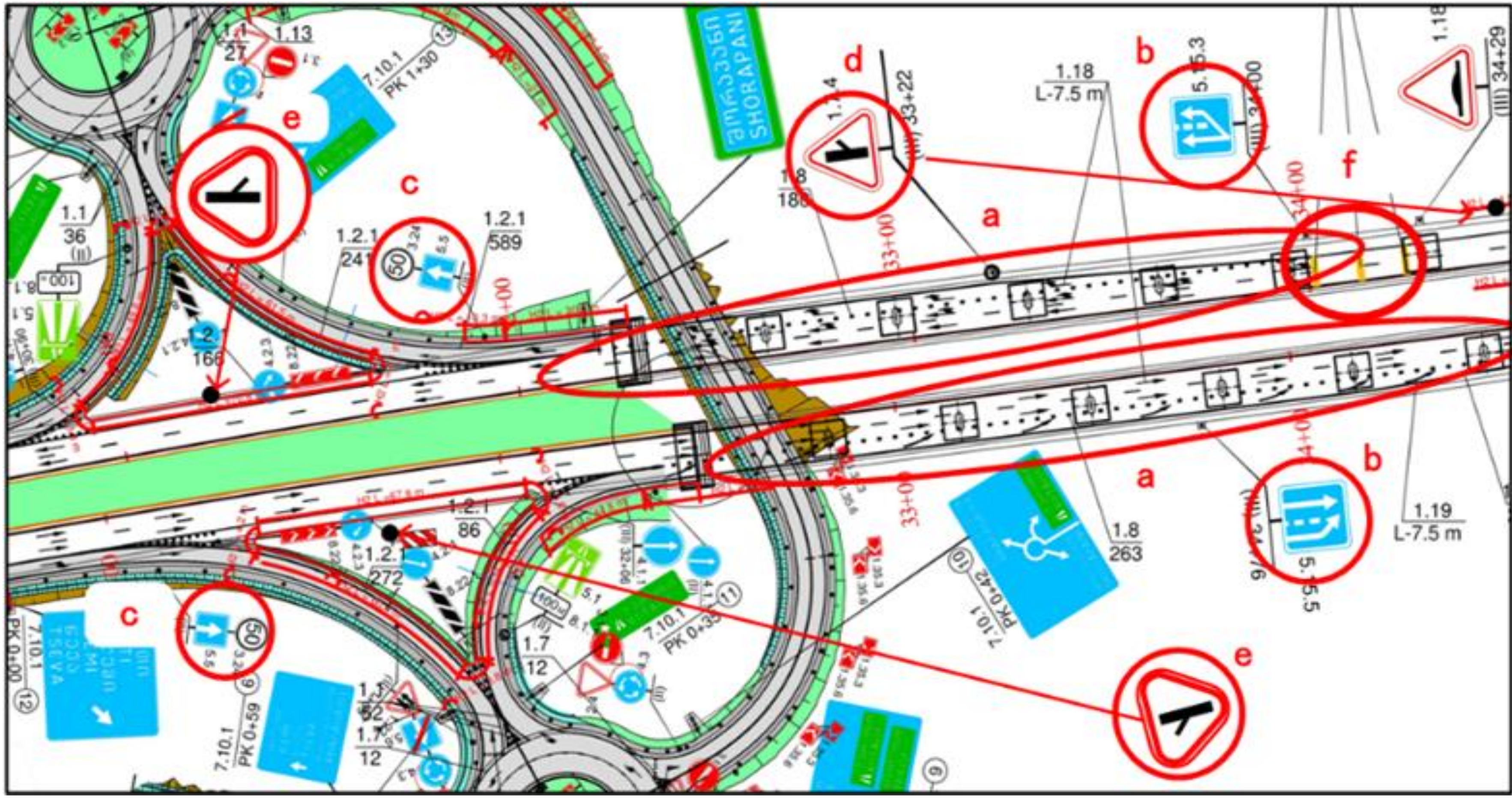
Devices designed in DD seem to have good reflecting performance, but they might be too small for nighttime visibility at a distance. For round shapes, diameter of more than 7 cm is needed.

5) Arrangement of Devices at Interchange

Below observations are made on the arrangements of various devices at IC-1 (Shorapani IC).

a) So many arrows on pavements do not seem necessary. Most would be ignored, because drivers in these areas will be focusing their attention on the movement of other vehicles rather than on road surfaces.
b) Meaning of warning signs for merging (5.15.5) and diverging (5.15.3) is not clear, if the central white broken line can be crossed or not. In addition, in the present position they appeal only to the drivers on the additional lanes, but they should also appeal to the traffic on the main lanes.
c) The regulation speed should be 40 km/h as the design speed of ramp way is 40 km/h. Regulation speed should be equal to or below the design speed.
d) If the warning sign “1.7.4” is for diverging traffic, its position should be moved to before the taper of additional lane begins.
e) A warning sign for merging traffic ahead can be added at main line before merging lane starts.
f) Implementation of noise bars is dangerous, thus not recommended.

In conclusion, other than the obviously necessary directional guide sign at diverging places, the only other devices recommended for implementation at interchange are e) caution to merging traffic ahead, and c) speed regulation of 40 km/h.

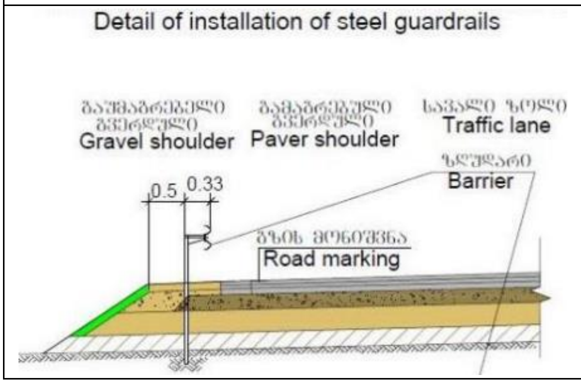
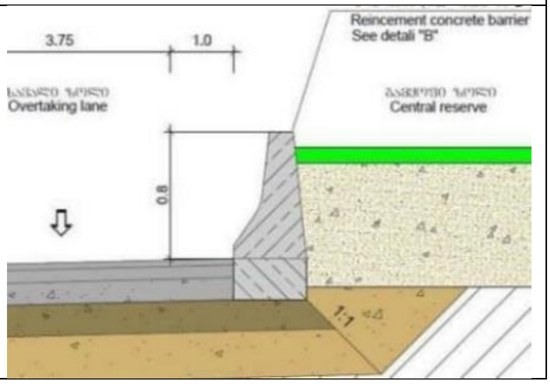


Source: comments by JICA Survey Team are drawn on IRD design sheet

Figure 4-78: Implementation of Devices at Interchange

(3) Guard Rail

Guard rail is implemented along carriageway outer edge lines, to prevent vehicles from going beyond the edge line, thus contributing to prevent fatal accidents. Guard rails at outer edge and concrete barriers at inner edge in DD, as shown in Figure 4-79, are properly designed.

Guard Rail	Concrete Barrier
	

Source: IRD drawing

Figure 4-79: Safety Facilities

4.2.10 Intelligent Transportation System

(1) Background

The East West Highway runs from the Red Bridge at the Azerbaijan Border to the Poti Port at the Black Sea coast for around 392 km. The Government has been giving high priority to completing the upgrading of the East West Highway to four lane international motorway standards.

The Roads Department (RD) of Georgia is committed to improving the quality not only of the transport infrastructure, but also the transport services. Therefore, it is seeking a deployment of an ITS technology to provide on time information to road users, enhance road safety and increase efficiency of operations on the existing and future sections of the East-West Highway.

RD started formulating the ITS masterplan assisted by the World Bank, and the work finished in 2016 (henceforth referred as “ITS master plan 2016”). The ITS masterplan 2016 consists of need assessment and ITS strategy and action plan.

In this section, overall plan and time schedule of deployment of ITS facilities and devices follow the ITS masterplan 2016, ITS system which should be introduced to F4 section and devices deployment plan will be elaborated.

(2) Necessity to Introduce ITS

As the East West Highway will be constructed following motorway standard, the influence of the Highway will spread to the surrounding areas. Once its traffic should be stranded the adverse impact also spread to the areas. To prevent the occurrence of such adverse incident the traffic on the Highway should be surveyed and controlled properly with deployment of necessary devices.

Motorway is a closed space, access is provided only through limited interchanges, so it is necessary to inform users the occurrence of incidents in order to mitigate anxiety of the users.

(3) Time Schedule of Deployment of Facilities and Devices

Time schedule of deployment of facilities is divided into three stages according to the ITS masterplan 2016.

1) very short term (2017~2018)
   CCTV and VTS are implemented for the four lane complete sections in order to survey and control the Highway. The control center will be the call center of Road Department.
2) short term (2019~2020)
   Devices are implemented further to strengthen the function of the surveillance and control. Control Center will be the NHCC at Natakhatari IC.
3) long term (2021~2025)
   Necessary devices will be implemented for the sections of the Highway which are almost completed. Control centers will be at Tbilisi, Kutaisi and Batumi.

Phase 2 section including F4 is scheduled as long term deployment, coinciding with the completion year of highway facilities. National Highway Control Center (NHCC) will be established at Tbilisi, Kutaisi and Batumi. The section from Poti to Rikoti tunnel including the F4 section will fall under the jurisdiction of Kutaisi National Highway Control Center (NHCC). Therefore, F4 section will be controlled and managed by Kutaisi NHCC.

(4) Fundamental Function of ITS

1) Traffic Information Collection System

To collect information of traffic conditions on the Highway, it is necessary to deploy proper devices at suitable locations.

a. Closed Circuit Television (CCTV)
The visual information of CCTV helps operators to perceive the traffic flow and facilities situation of the Highway immediately. It will be installed at interchanges and long bridges to superintend the situation.

b. Vehicle Detection System
There are many types of devices to count traffic volume. It is preferable to install the devices that can measure volume, speed, occupancy and vehicle types.

- Induction loop coil type:
  It is recommendable, by the accuracy of measurement and low maintenance cost. However, they have to be installed under surface, by installing pipe at the same time of implementing pavement, or digging the pavement surface after completion.
- Ultrasonic type:
  Ejected ultrasonic wave reflects at vehicles, then is received by the same device. The principle is similar to radar. Only difference is their media, radar uses micro wave. It can measure vehicle height being installed overhead.
- There are various other types. One that use micro wave can measure speed by Doppler Effect.

VDS should be installed on the section between IC where traffic volume is uniform.

c. Emergency Telephone System
Highway users can contact operators through this special purpose telephone when incident occurs. Users can report about the incidents and request rescue depend on the necessity.

d. Patrol car

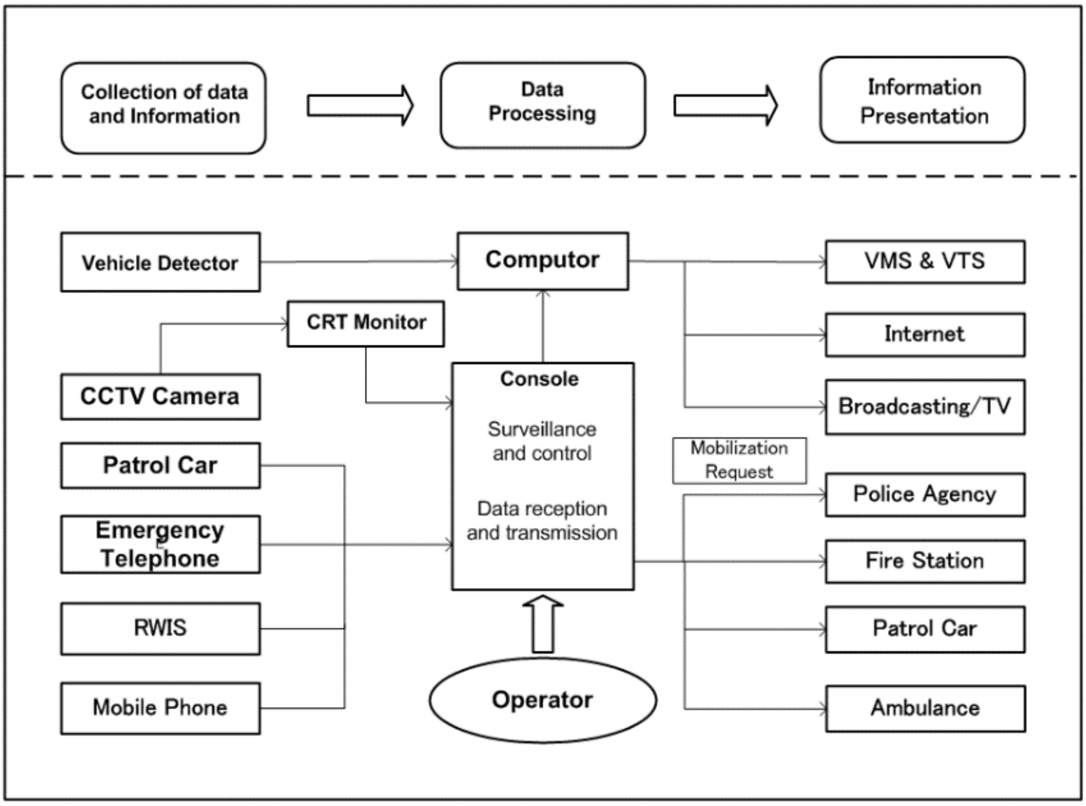
Patrol cars will be constantly monitoring the Highway. If it encounters an incident, the details of the incident will be transmitted to HNCC.

e. Mobile phone and internet

Device should be set up so that information of incidents could be transmitted through mobile phone and internet.

2) Processing of Data and Information

Collected information and data are transmitted to central equipment at NHCC. The data from VDS are sent to computer directly, whereas information from other devices will be examined by operator then sent to console. Then, they are processed using proper software.



Source: JICA Survey Team

Figure 4-80: Information Flow between ITS Facilities and Devices

3) Information Dissemination

Processed information is presented on VMS and VTS by operator manually or automatically by computer message production process. This information can be provided to internet and Broad casting and television.

According to the nature of the incidents, mobilization of patrol car, ambulance, fire engine will be requested to rescue those who are involved in incidents.

This flow of information is shown in Figure 4-80.

(5) ITS Systems to be Introduced to F4 Section

The ITS systems to be introduced to F4 section are examined, and necessary devices to be deployed are planned.

1) Incidents Detection System

Incidents on motorway are listed up as follows

a) traffic accident, vehicle break down, traffic congestion
b) fallen objects on roadway
c) abnormal weather (heavy rain, strong wind, mist, snow, frozen surface)
d) maintenance works, inspections, cleaning works
e) intrusion of wild animal, cattle and poultry
f) fire on roadside
g) damages of highway structure (land slide, fallen rocks, damage of road facilities)

Those incidents should be detected, and the information transmitted to HNCC through various devices, as soon as possible. Operator processes the information, and messages to be presented at VMS and VTS are transmitted.

2) Speed Control System

a. Variable speed regulation
If a proper speed regulation should be implemented in case of abrupt environmental changes such as weather conditions, changes of speed regulation are transmitted to VMS and VTS.

b. Enforcement of speed offender
As over speeding is dangerous for other vehicles in traffic stream, over speeding should be properly regulated. Vehicle speed is measured by VDS, and vehicles are identified based on license plate recognition by ANPR (Automatic Number Plate Recognition). The vehicle owner with offences may receive warnings or charges.

3) Bridge Management System

There are many long span bridges in F4 section, and traffic flow is affected with strong wind, heavy rain, snow, frozen surface on the bridges. These incidents can be forecasted using measurements of RWIS (Road Weather Information System), the traffic and bridge conditions are confirmed by VDS and CCTV. The central processing units output countermeasures such as speed regulation, lane and roadway regulation and recommendation of exit from highway.

4) Tunnel Management System

This is mentioned in tunnel section of this report.

(6) Devices Deployment Plan

To attain above mentioned functions, various devices are planned to be installed.

a) EM (Emergency Telephone)
   Installation at every 2 km, where it is in tunnel it could be shifted. 8 locations
b) VDS (Vehicle Detection System)
   They are installed at the section between interchanges, where traffic volume deems to be homogeneous. The section between IC-1 and IC-2 is especially important, because the traffic on the existing E-60 will use this section adding to the normal traffic of the Highway. 4 locations

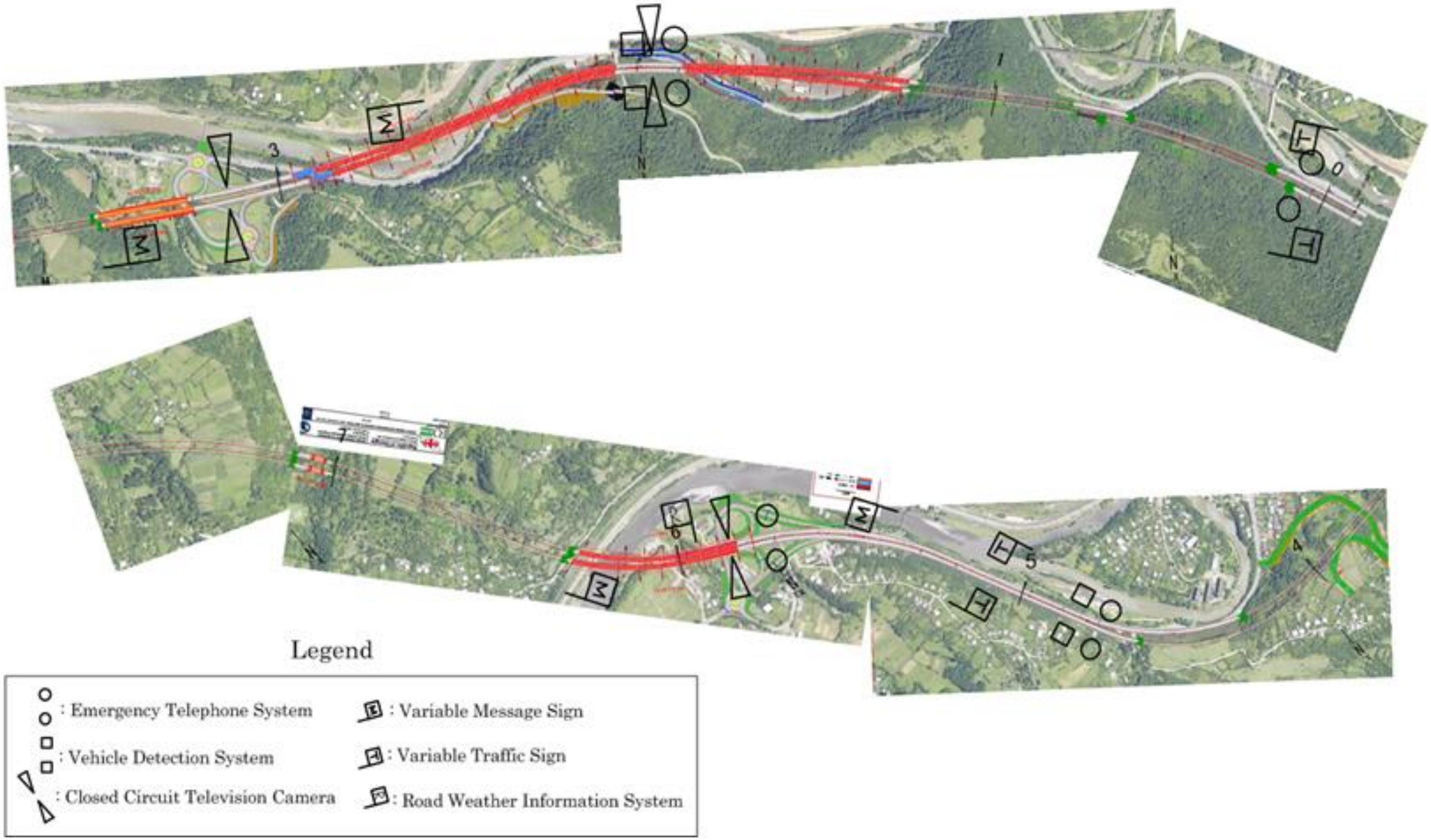
c) CCTV (Closed Circuit Television)
They are installed at long span bridges and interchanges. 4 locations

d) VMS (Variable Message Sign)
They are installed at diverging points of interchanges, so that the users can select their route of trip. 7 locations.

e) VTS (Variable Traffic Sign)
They are installed at every 5 km points, to present message of speed and lane regulation. 5 locations

f) RWIS (Road Weather Information System)
They are installed at Br-1 and Br-2, and Br-4 to measure weather conditions. 2 locations.

This deployment plan is shown in Figure 4-81 and Figure 4-82.



Source: JICA Survey Team

Figure 4-81: IST Devices Deployment Plan (1)

Source: JICA Survey Team

Figure 4-82: IST Devices Deployment Plan (2)

4.2.11 Soil Management Plan

Regarding the disposal of the Soil, JST received designation from RD that the sediment disposal site is "the 2nd term construction section of Kutaisi bypass (river / future Kutaisi-Tbilisi lane) (F2, F3 Sections are included)". The exact disposal site of surplus soil is Chishura area about 20 km west from the end of construction point.

Concerns

- For rock drilling caused by tunnel blasting / excavation, size and material often become irregular and secondary crushing is necessary. Also, in the case of unsuitable soil, it cannot be used as a backfill material in some cases, and temporary sedimentary storage space is required near the tunnel opening.
- For temporary placement of drilled soil (unnecessary soil), RD needs to designate a place. Also, it is necessary to separately pay for the costs of movement, transportation, filling, safety measures, etc.
- Because there are few filling sections on the side of Shorapani, soil must be transported in the direction of Argveta. It is predicted that the congestion on the current road becomes severe as the construction term will be shortened due to the requirements of RD, and it will be a rushed construction.

Chapter 5 Applicable Japanese Technologies for E60 F4 Section

5.1 Introduction

Upon request of the Georgian Government, the JICA survey team examined possibilities of applying Japanese technologies for tunnels, bridges, and measures against falling rocks and slope failures for quality infrastructure implementation. Main points of examinations will be enhancing advantages of Japanese technologies including operation, maintenance, costs, efficient construction/ economies, and increased safety. Japanese technologies include tunnel construction, bridge types, and measures against falling rocks and slope failures for quality infrastructure implementation considering difficult natural conditions and limited space for construction. In addition, the examination ranges from traffic management of existing E60 (during construction when part of the road is going to be used as a new highway section) to road and tunnel construction methods, bridge implementation, etc.

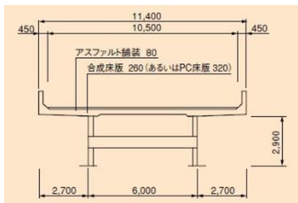
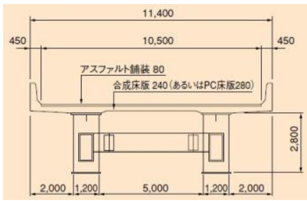
The results of the examination were presented and explained to RDMRDI and ADB upon discussion with JICA of the features and advantages of utilizing Japanese technologies in these areas. The examination also includes initial construction costs, durability, life-cycle costs, cost performance (considering maintenance costs), safety benefits, and possible shortening of construction periods in comparison with conventional methods of construction.

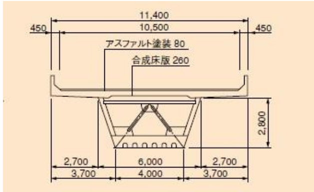
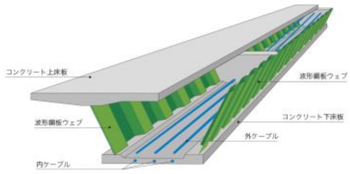
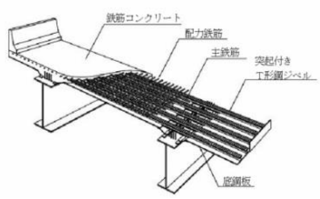
5.2 Bridge Design

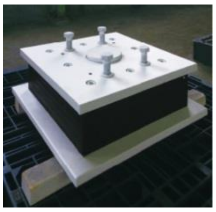
(1) Overview of Japanese Technologies

Japan has extensive experience in bridge construction on expressways through mountainous areas. Table 5-1 shows possible Japanese bridge technologies applicable to this project.

Table 5-1: Applicable Japanese Technologies for Bridges

No.	Work Item	Name of Method	Summary of Method	Advantages	Image/Photo	STEP
1	Superstructure Type	Rationalized Steel Girder (Plate girder)	By reducing the number of main girders, small material pieces such as longitudinal and lateral ribs are greatly reduced, and the construction period can be shortened.	: Reduction of Steel qty. : Simplification of fabrication : Reduction of fabrication and construction time		✓
2	Superstructure Type (Curved girder)	Rationalized Steel Girder (Narrow Box girder)	By narrowing the box main girder cross section, small material pieces such as longitudinal and lateral ribs are greatly reduced, and the construction period can be shortened.	: Reduction of Steel qty. : Simplification of fabrication : Reduction of fabrication and construction time		

No.	Work Item	Name of Method	Summary of Method	Advantages	Image/Photo	STEP
3	Superstructure Type (Curved girder)	Rationalized Steel Girder (Open Box girder)	Composite Box girder combined with composite slab. Small material pieces such as longitudinal and lateral ribs are greatly reduced, and the construction period can be shortened.	: Reduction of Steel qty. : Simplification of fabrication : Reduction of fabrication and construction time		
4	Superstructure Type	Rationalized Truss Bridge	Truss Bridge combined with composite slab. Small material pieces such as longitudinal and lateral ribs are greatly reduced, and the construction period can be shortened.	: Reduction of Steel qty. : Simplification of fabrication : Reduction of fabrication and construction time		
5	Superstructure Type	Corrugated Steel- web PC Bridge	Weight reduction of PC Bridge by using corrugated steel web	: Increase possible span length : Simplification of fabrication : Reduction of fabrication and construction time		
6	Superstructure Material	Weathering Steel	Protective rust-proof coating is applied which reduces maintenance, it is a superior method for L.C.C.	: Significant reduction of maintenance cost		✓
7	Superstructure Deck slab	Composite Deck slab (SCC) (Steel Concrete Composite)	Combined with Rationalized steel girder. Install steel bottom plates together with main girder.	: Simple and safe method of deck slab work at high place. : Reduction of construction period : High durability.		✓
8	Bridge Bearing System	Horizontal Force Dispersing Bearing	Multi-support system on continuous beam. with laminated rubber bearings.	: More seismic resistant : Smoother driving and Maintenance-free due to no joints		✓

No.	Work Item	Name of Method	Summary of Method	Advantages	Image/Photo	STEP
9	Anti-corrosion for Bearings	Bearings with TAPS (Transfer Arc Plasma Spray)	Use the most durable ant-corrosion coating system TAPS onto metal part of bearing.	: 100 years anti-corrosion for bearing reduces maintenance costs.		✓
10	Foundation on Steep slope	Oblique circular cylinder cofferdam	Cofferdam on Steep slope using soil nailing and shotcrete in circular shape.	: Safer method of construction on steep slope. : Good work efficiency and environmentally-friendly due to minimal working area.		
11	RC high pier construction Method	Self-climbing slip-form system	Starts with finished lower part and lifts up the formwork with falsework for the next upper section	: Reducing construction period for RC high piers.		

Source: JICA Survey Team

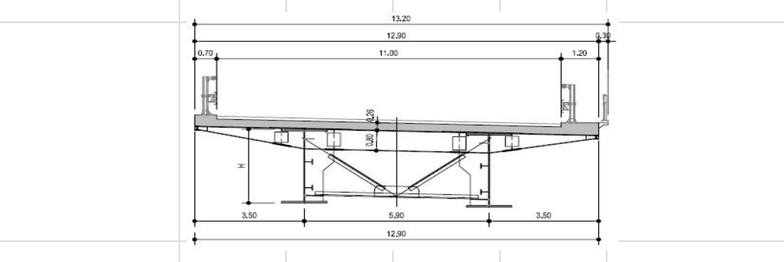
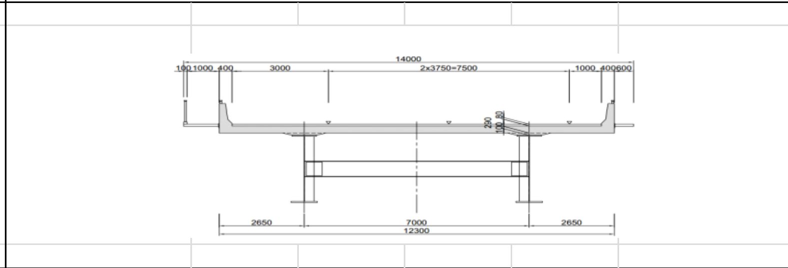
(2) Applicable Japanese Technologies

The following items are applicable Japanese Technologies for steel bridges in F4 section.

1) Rationalized Steel Girder
2) Weathering Steel
3) Composite Deck Slab (SCC)
4) Horizontal Force Dispersing Bearing
5) Bearings with TAPS (Transfer Arc Plasma Spraying)

Table 5-2 shows the comparison study for Application of Japanese Technology (STEP) and General method (D/D consultant proposal).

Table 5-2: Comparison Table for STEP Application Method

Work Item	Steel Bridge Superstructure	
Work Method	IRD Proposed Method	STEP Applicable Method
	Ladder Deck + Corten Bridge	Rationalized Girder Bridge + Weathering Steel
Illustration		
Technical Description	Two main girders structure employed in Europe. Composite structure design by main/cross girders and reinforced concrete deck. Concrete deck is supported by main/cross girders and spanning for bridge axis direction. Many concrete joints due to movable scaffolding size restriction. Concrete deck repair work is hard because it is designed as composite structure. Corrosion protection by application of Corten steel. Continuous beam system will be addopted.	Very popular non-composite bridge structure in Japan which consists of two rationalized steel girders and a steel-concrete composite deck. A steel-concrete composite deck consists of steel bottom plate reinforced by steel ribs and concrete and it is designed as one direction deck supported by the main girders with haunch. Deck concrete repair work is easy since it is designed as non-composite structure. Corrosion protection by application of weathering steel. Continuous beam with "Horizontal force dispersing system will be addopted.
A part has been removed because of confidential information.		
Site Duration	100%	80 % (Site duaration 20% reduction)
Construction work Safety	Concrete deck work is executed by movable scaffolding after steel girder launching erection thus high place work is required.	It is possible to execute main girder launching erection with steel-concrete composite deck installed thus safer deck concrete work and shorter construction period is secured
Procurement	In Georgia	Steel material: from Japan Fabrication: Fabrication shops in South East Asia to which Japanese companies invest
Evaluation		1) In addition to economical and technological rationality, a considerable shortening of the construction period and high safety can be secured. 2) The durability of bridge deck which is the main factor of the bridge lifetime has been confirmed by experiments. 3) Life cycle cost is greatly reduced by high quality weathering steel. 4) Anti-seismic, riding confort and high durability because of continuous beam with horizontal force dispersing system.

Source: JICA Survey Team

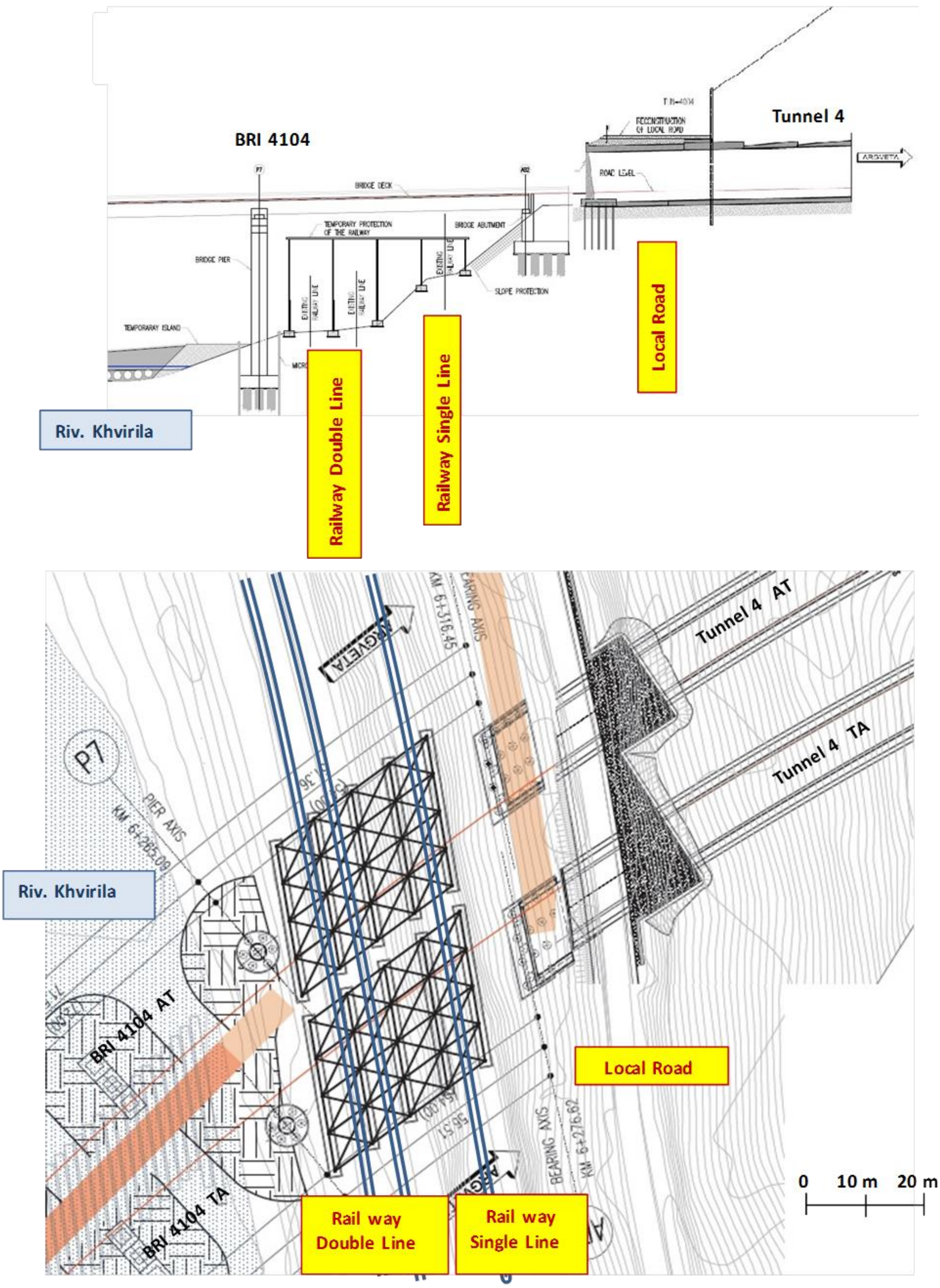
(3) Neighboring Construction at the End of Bridge BR4004

At the end of Bridge BR 4004 to the start of Tunnel 4, Georgia trunk line (double tracks), branch line (single track) and local road along the Kvirila River run parallel to each other at intervals of several tens of meters. In vertical direction we have only 16.6 m space; 23 m (between railway track and local road) – 6.4 m (the railway construction limit)) for all the construction works; the bridge (5.2 m road clearance + bridge superstructure height + temporary work space) or the tunnel (over burden + tunnel structure height about 10.5 m + temporary construction space). (Figure 5-2)

The optimum structure design at this spot, safety, and prompt construction are important issues of this project. As Japan has extensive experience of construction work at such congested situations, Japanese technology could be well utilized.

Source: JICA Survey Team

Figure 5-1: Elevation Differences with Related Facilities about BR4004



Source: JICA Survey Team

Figure 5-2: Neighboring Construction Plan around the End of BR4004

5.3 Tunnel Design

Table 5-3 shows possible Japanese tunnel technologies applicable to this project. However, all these application would not be adopted in this project since the STEP condition was largely satisfied along with the application of bridge technology and it was not possible to obtain the consensus from RD due to the increase in initial investment cost.

Table 5-3: Applicable Japanese Technologies for Tunnels

Item	Location / Construction	Purpose
Mechanical Excavation Method	• 2 locations (4 tunnels) north of Zestafoni • Soft rock geology	• Elimination of vibration effects on structures near or above the tunnel. • Reduction of over-break
Auxiliary Method Long Steel Pipe Forepiling (AGF Method)	• For shallow sections and for portal	• Ensure stability during excavation
Control system for jet-fans driven by inverter	• Tunnel ventilation	• Cheap electricity cost during maintenance
Automatic Cleaning Machine (Belt-Type) (attached separating agent coating device type)	• For cleaning concrete casting surface of lining form • Coating of separating agent	• Clean surface of concrete lining after construction • Reduction of cycle time • Simultaneous coating of separating agent
Concrete Filling Control System	• Perfect filling of concrete in crown part	• Overfilling of concrete in crown part
Pulling-out Vibrator System	• Compaction of placed concrete in crown part	• Uniform compaction

Source: JICA Survey Team

5.4 Design of Cut Slope and Slope Protection Measures

5.4.1 Design of Cut Slope

The mountain streams around AT sta.0 + 020 and ATsta.0 + 060 in the cut slope point number 1 are cut, and the exit point of the mountain stream becomes the high position of the cut slope. Therefore, it is necessary to install a vertical drainage on the cut slope. However, there is no need for Sabo measures to streams because there is no rock exposure to be the source of falling rocks.

In the design of the cut slope of the DD consultant, no protective cut slope protection technique has been proposed, but in Japan, in the case of strong weathered rock and soil, and in the case of seed spraying, shotcrete framework, or rocks, a concrete shotcrete and the like are commonly used.

Considering that rainfall is less than Japan, we propose to install a seed spraying plant and a drainage work on the cut slope where weathered rocks with high groundwater level are distributed.

In the cut slope point number 8 ATsta.8 + 328 to 9 + 040, the cut slope point number 10 AT 9 + 726 to 9 + 98, and the cut slope point number 10' TA 9 + 78 to 9 + 818, nearby boring survey results show that the ground surface is deeply weathered. Since it is expected that the order will be high, construction of the seed spraying work is preferable to prevent corrosion of the slope.

The cut slope point number 7 TA 8 + 257 ~ 8 + 286 is a steep slope of 79 ° with weathered rock. It is necessary to prevent collapse of the slope by concrete spraying works.

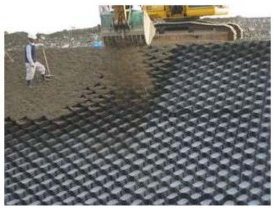
5.4.2 Design of Slope Protection Work

In the vicinity of TAsta.0 + 625 - ATsta.0 + 747 (the cut slope point number 2,2'), according to the field reconnaissance, loose rocks (including lapilli tuff) are expected on the natural slope above the top of the cut slope. As a countermeasure here, the Mighty-net method, which is a rock fall prevention net with greenery promoting (Tokyo Rope MFG.CO., LTD NETIS Registration Number KK-100030V) can be recommended. Using high-durable specification materials enables a long life (even in a strong salt damage area, we have a track record of 27 years) of use and a reduction of maintenance cost.

5.4.3 Applicable Japanese Technologies

For the design of cut slopes in general, the blowing seed method or the slope frame method will be selected when the makeup of the surface is soil. On the other hand, spraying method will be applied for a makeup of solid rock. Design of the slope and slope protection method using Japanese technology are summarized in Table 5-4.

Table 5-4: Cut Slope Protection Method Using Japanese Technology

S/N	Conventional Technology (Generic Name)	Name of Construction Method (Registry No. of NETIS, Japan)	Summary of Cut Slope Protection Method	Advantages	Site Work Image
1	Mortar Spraying Slope Frame Method (200 mm) + vegetation base material spray method (t=3 cm in the frame)	GT Frame method (CB-070019-V)	Cut slope surface protection method using geo-grid and short fiber mixed reinforced sand	• Skip sheet curing, reduce waste treating work, more economical, and reduce environmental footprint • Skip arrangement of reinforcement and sheet curing in the frame leads to shortening of construction period and work load. • Use of light weight and compact materials leads to improvement of safety by avoiding accidents such as falls	
2	Precast Frame Method	Stereo Geo-grid & Geo-web method (HK-090006-V)	Slope protection using light weight flame method	• More economical • Light weight materials and ease in work lead to shortening of work period and improvement of work quality • No hanging work, using light weight and small materials contributes to improvement of safety	
3	Precast Concrete Frame Method	Hybrid-Cell Method (HK-090008-VE)	High frame slope protection method and soil binding method	• Small working space using light weight and compact materials is available. • Simple work cycling with expansion and filling processes avoids set-up change and idling • Adhesion force with existing slope avoids slipping of materials (covering seeds with soil and frame method)	

S/N	Conventional Technology (Generic Name)	Name of Construction Method (Registry No. of NETIS, Japan)	Summary of Cut Slope Protection Method	Advantages	Site Work Image
4	Vegetation base material spray method (t=3 cm in the frame)	Soil-tecter (CB-100042-VE)	Slope protection and seeding using erosion preventing type vegetation mat	• Erosion protective effect • Shortening of work period and improvement of workability • Increasing alternatives for production of vegetation and seeds	
5	Vegetation base material spray method (t=3 cm in the frame)	Vegetation Mat with wire netting method (CB-090029-VE)	Vegetation mat method with Kamakura-mat fertilizing bag	• Three layer structure composed of iron net, palm fiber net and vegetation mat give protective effect to snow fall, melting snow and freezing • Reduction of construction cost (reduction rate is 12.65%) • Reduction of working period (reduction rate is 32.96%)	
6	Spraying-in-place concrete frame method	DEN- Panel method (KT-070060-V)	Vegetation type pressure steel plate for reinforcement of cutting slope surface	• Simplifying work with only installation of the secondary products leads to the shortening of work period • Reducing the management input for quality control • Installation of light weight secondary products reduces working time on the slope, and improves workability	
7	Spraying –in place concrete frame with rock bolt method	RS Panel (QS-100006-VE)	Reaction plate using long glass-fiber reinforced plastic foam based on recycle technology	• Use of corrosion-resistant material has long-term advantage for permanent structures. Small size of frame unit allows planting trees • Reduced weight saves manpower required and improves workability. Pre-fabric products are advantageous to shortening of working period and saving on costs	
8	Spraying –in place concrete frame with rock bolt method	EP Pressure receiving plate (TH-110011-VE)	Environmental-friendly pressure receiving plate for cut slope reinforcing soil, using recycled material. Greening on the whole slope is available.	• Environmental load reduction using recycled plastic materials. Weight reduction contributes to cost savings on manpower construction and improvement of safety. • By using a frame that is thinner than spraying slope frame, greening of entire slope is possible. Furthermore, corrosion due to rain water is evitable.	

S/N	Conventional Technology (Generic Name)	Name of Construction Method (Registry No. of NETIS, Japan)	Summary of Cut Slope Protection Method	Advantages	Site Work Image
9	Pre-cast concrete drain method	Pre-cast seal plate (CB-100017-VE)	Pre-cast plate can protect from rainwater and spring water which causes soil erosion and leaking of water around small step drain ditch and a vertical drain ditch.	• By skipping curing and placement of concrete on site contributes to the shortening of work period (reduction ratio is 78%) • Expansion joint being formed at regular intervals (2 m) can prevent crazing due to drying shrinkage • Improve both quality control for concrete materials and resistance to freezing and thawing in cold areas.	

Source: Ministry of Land, Infrastructure and Transport, 2017

On the other hand, regarding measures for loose and/or falling stones on the natural slope, the fall prevention method is recommended as passive prevention work. Natural slope protection methods using Japanese technology are summarized as shown in Table 5-5.

Table 5-5: Natural Slope Protection Methods using Japanese Technology

S/N	Conventional Technology (Generic Name)	Name of Construction Method (Registry No. of NETIS, Japan)	Summary of Cut Slope Protection Method	Advantages	Site Work Image
10	Rock fall guard fence (Stone guard) installation work	Mount rock Fence method (KT-080032-VE)	Environmentally-friendly rock fall guard fence installable in the upper half of the slope	• Can be installed due to using steel pipe for substructure (the base), it is possible to install the fence covering a wide range such as half way up the slope. • According to the above reason, it is possible to construct the fence near the source of falling stone, and therefore, it is advantageous to capture falling stones with low energy impact absorption.	
11	Rock fall guard net (Rock net) installation method with pipe anchor	PAD-anchor method (HK-070002-V)	Snow slide preventive fence, Small pipe anchor method for rock fall guard net	• Reduction of work period and improvement of workability by shortening the drilling time for anchoring work in mixtures of soil and rock. • Omission of mortar infilling work and its management practice contributes to shortening of work period and improvement of workability. • Improves safety of work by remote operating for anchoring	

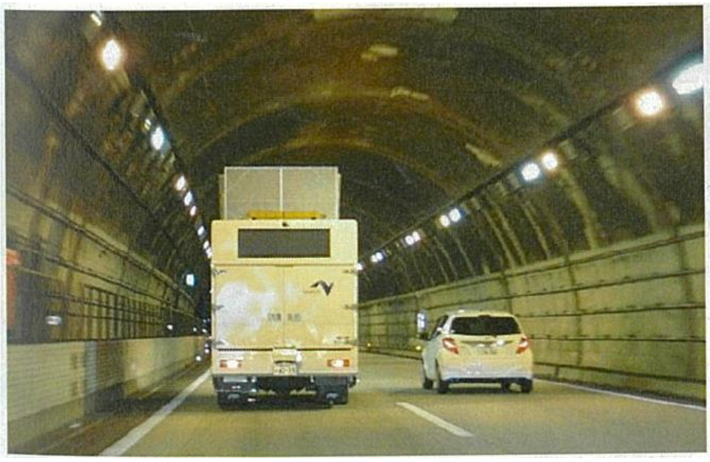
S/N	Conventional Technology (Generic Name)	Name of Construction Method (Registry No. of NETIS, Japan)	Summary of Cut Slope Protection Method	Advantages	Site Work Image
12	Rock fall guard net (Rock net) installation method with Spraying –in place concrete frame (Cross section of Beam: 300×300 mm)	Mighty-net method (KK-100030-VE)	Slope stabilizing method	• Shortening of work period without large scale slope cutting and mortar spraying • Improvement of workability by decreasing work management items like quality control for concrete • Recovering of natural vegetation is expected without concrete construction. Takes landscape into consideration.	
13	Falling stone prevention work (Rope net work) (Rope hanger)	Falling stone prevention work (Plus net)	Environmentally adaptive falling rock prevention method	• Change of form and type according to rock size and situation • Can be constructed without damaging vegetation such as trees	
14	Falling rock and debris flow measures method	Curtain net method (SK-980029-VE)	High energy impact absorption rock fall prevention fence	• High energy impact absorption of rock fall. • Height of the pocket column is relatively high, and the pocket is wide. • Little constraints to install a pocket column due to wide space of each column • Maintenance is easy • High durability and corrosion-resistant	
15	Debris flow measures method	Suspension cable screen method (SK-010019-A)	High energy impact absorption rock fall prevention fence utilizing the local mountain stream on the slope	• High resistance against repeated falling rock • High protecting function against debris flow and drift wood	

Source: Ministry of Land, Infrastructure and Transport, 2017

5.5 Road Maintenance Technology

The training in Japan for the staff of RD and Ministry of Finance was held in February 2018 and the curriculum was included about the road maintenance technology which is conducted by NEXCO West and its group company. The trainees had a high interest in the special inspection vehicle for tunnel/bridge maintenance and management which NEXCO possesses. Specifically, it seems that the following three(3) kinds of vehicles are the most interested for them.

Table 5-6: Inspection Vehicles for Road Maintenance in Japan

1	No-destructive Inspection Vehicle for Tunnel Inner Concrete	
2	Inspection Vehicle for visual check and hammering test inside the tunnels	
3	Inspection Vehicle for visual check and hammering test under the girders (BT-400, BT-200)	

Source: NEXCO West and West Nippon Expressway Engineering Chugoku Co., Ltd.

In fact, RDMRDI and JICA had a discussion if RDMRDI would purchase these inspection vehicles, however, each vehicle has the following issues and eventually its installation in Georgia was cancelled at this time.

1	No-destructive Inspection Vehicle for Tunnel Inner Concrete	● There are some strict procedure in case this vehicle would export outside of Japan since the vehicle contains the radioactive substances. ● A certain level of technical capability is required for inspectors and equipment operators.
2	Inspection Vehicle for visual check and hammering test inside the tunnels	● This is still under development by West Nippon Expressway Engineering Chugoku Co., Ltd. ● The purchase amount of the vehicle was more expensive than RDMRDI's expectation.
3	Inspection Vehicle for visual check and hammering test under the girders (BT-400, BT-200)	● The purchase amount of the vehicle was more expensive than RDMRDI's expectation.

5.6 Measures for Reduction of Construction Period

5.6.1 Bridge

As described in 5.2, reduction of construction period is also included as an important feature of the application of Japanese Technology for bridges. The items are follows.

1. Rationalized steel girder: Plate girder
   Reduction of the number of main girder, simplification of cross beams, reduction of small pieces, such as lateral/longitudinal ribs, shorten the production period (a few months) and site assembling period.

2. Composite Deck Slab (SCC)
   With the prefabricated steel bottom plate which is easy to assemble on site, we can omit the form/scaffolding installation and removal work which is the most time-consuming and risky work of superstructure construction. Thus we can reduce construction period greatly as well as improve safety.

Overall, site construction period can be reduced by 20% (about three(3) months) compared to the conventional method.

Regarding substructure work, the number of applicable substructures, RC high pier (>30 m) or pier on steep slope, were not so many in F4 section, thus we decided not to adopt the method.

5.6.2 Tunnel

(1) Simultaneous Construction of Excavation and Concrete Lining

Simultaneous construction of tunnel excavation and placement of lining concrete at constant intervals shortens tunnel construction period for 4 tunnels on the north side of the Zestafoni area.

In the 2 tunnels on the north side of Zestafoni area, because private houses are scattered just above or around the tunnel in the section of more than half of the tunnel extension on the west side and geology is composed of soft rocks, mechanical excavation method is necessary.

In the case of mechanical excavation method, since there is no influence on blasting vibration and no influence on succeeding work such as fly stones at the time of blasting, it is possible to simultaneous construction with concrete and lining, so the construction period will be shortened.

(2) Long-Hole Blasting

For 2 locations 4 tunnels (T-AT-1/T-TA-1, T-AT-2/T-TA-2) on the Tbilisi side of this project section, since there are few private houses around these tunnels and geology is expected to be hard rock, applying long-hole blasting can shorten the cycle time and contribute to shortening the construction period.

Based on the Japanese standards, it is difficult to adopt around length of 2.0 m or more. However, in the case of overseas, there are many cases where the round length is 2 m or more. The DD consultant also suggests a maximum round length as shown in Table 5-7.

Although it should be judged from the results of face observation and monitoring during the excavation, if possible, it is necessary to adopt long-hole blasting and shorten the construction period.

Furthermore, by quickly completing these tunnels that are shorter in tunnel length than other tunnels earlier, it will also be used to operate the lining form for other tunnels. It will also be useful for total construction costs.

Table 5-7: Maximum Round Length of DD Consultant

Ground Type	A0	A1	A0V	B0	B1	B0V	B2V
Maximum Round Length (m)	3.6	3.0	1.0	3.6	2.8	1.0	1.0

Source: MA-TUN-4000-GE-EX-0301～0307, Drawings of DD Consultant

5.6.3 Construction Management

The following points have been revised in consultation with the D/D consultant, and the process has been shortened by these multiple factors. However, in order to protect the road opening time indicated by RD, simultaneous construction is required for all sections, and rushed construction work is anticipated.

- Change of the road alignment
  - Review of driving speed, reconsideration of radius of curvature, review of longitudinal gradient
  - Increase of tunnel section and bridge section
  - Minimization of current road widening section (current road improvement)

- Change of structure
  - Review of bridge structure (upper part) (weight loss of bridge piers due to long span)
  - Review of interchange (position and format)

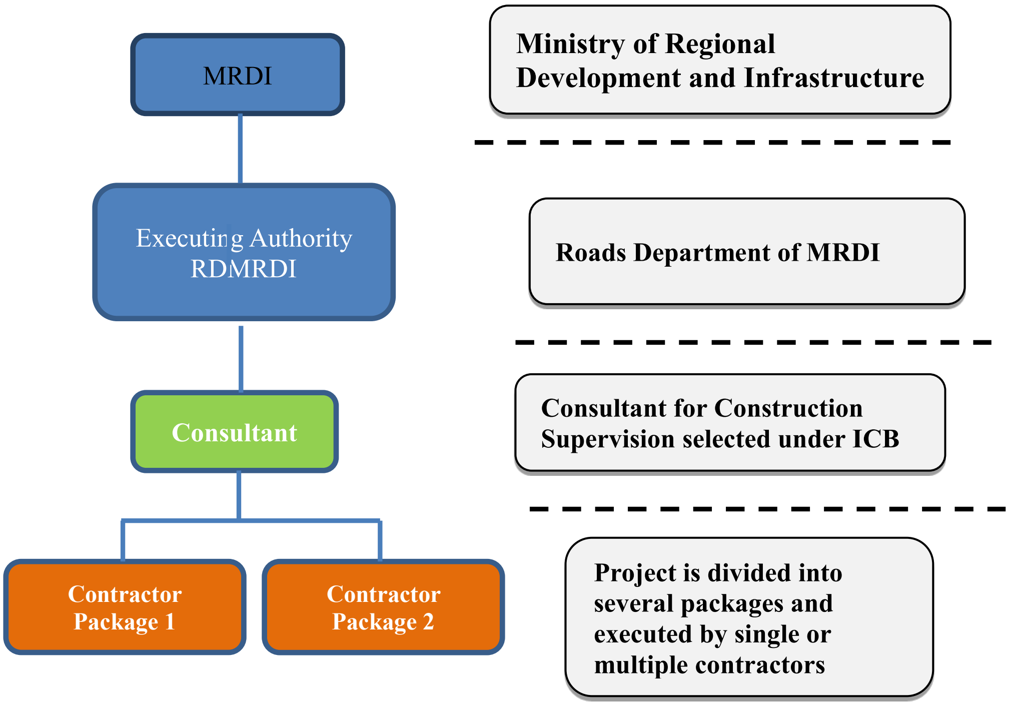
- Change of construction machine
  - Introduction of tunnel engineer, large free-form section excavation machine (high efficiency)
  - Introduction of tunnel engineering, high-performance slide form

Chapter 6 Procurement and Implementation Plan

6.1 Project Framework

6.1.1 Overall Project Framework and Parties

Various parties are involved in the implementation of the Project, each with specific roles. Figure 6-1 shows the relationship of the parties and overall implementation framework of the Project.



Abbreviation: ICB = International Competitive Bidding
Source: JICA Survey Team

Figure 6-1: Overall Project Framework

The roles of each party in the Project are summarized in Table 6-1.

Table 6-1: Roles of Each Party

Party	Role	Note
MRDI	Responsible for road infrastructure and planning. Liaison with JICA, other Ministries and Agencies concerning the Project.	
RDMRDI	Responsible for construction, maintenance, operation and management of national and secondary roads totalling 7,000 km. Communicates all matters concerning the Project with MRDI, Regional Office, Consultant and Contractor.	
Consultant	Act as Authority's engineer providing day to day administration and supervision of the Project.	
Contractors	Contractors to execute packages.	The Project will be divided into two packages.

Source: JICA Survey Team

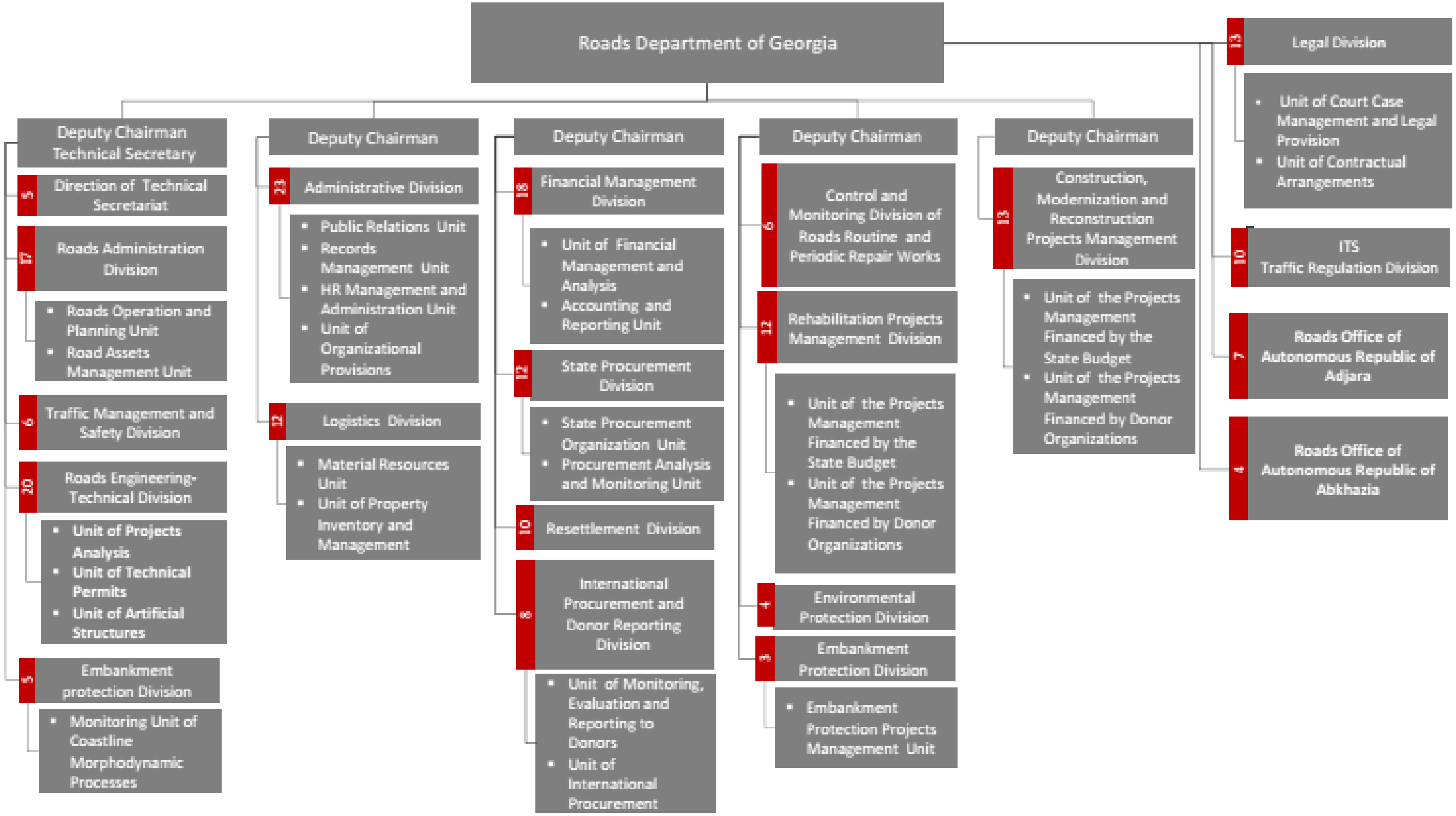
6.1.2 Project Executing Agency

(1) Organization

Figure 6-2 shows the organization structure of RDMRDI including sections, function and numbers of stuff. RDMRDI has a total of approximately 190 staff (150 at their headquarters and 40 in regional offices). RDMRDI is responsible for approximately 7,000 km of international and secondary roads. Therefore, the staff-road network ratio is approx. 2.7 staff per 100 km, which is not small compared to other road agencies in transitioning economies[1]. RDMRDI is responsible for construction, maintenance, operation, and management of international and secondary roads. All constructions and supervisions of new road projects are contracted out to service providers by competitive tender process.

The services previously performed in-house including routine & periodic and rehabilitation works have been being contracted out to contractors, as the volume and importance of the maintenance works increases. Details of the maintenance works are presented in Section 6.3.4.

[1] Tanzania (TRANROADS, approx. 2.3 staff/100 km), Ghana (Department of Feeder Roads approx. 1.4 staff/100 km), India (National Highway Authority, approx. 2.1 staff/100 km)



Source: RDMRDI

Figure 6-2: Organization Structure of RDMRDI

(2) Project Executed by RDMRDI

Table 6-2 shows annual expenditures on international and secondary roads. Construction of new roads financed by international donors such as WB, EIB, ADB, and JICA has dramatically increased since 2007.

Table 6-2: Expenditures on International and Secondary Roads (US$ million)

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
GDP	5,126	6,411	7,745	10,173	12,795	10,767	11,638	14,367	14,367	16,143	16,506	13,989
New Construction	2	10	29	41	37	83	129	131	173	58	57	44
-Government Budget		8	29	25	7	17	27	38	41	10	10	7
- Donors	2	2		16	30	67	102	93	133	48	47	37
GDP Share %	0.0%	0.2%	0.4%	0.4%	0.3%	0.8%	1.2%	0.9%	1.2%	0.4%	0.4%	0.3%
Rehabilitation/Periodic Maintenance	24	40	52	92	96	182	249	174	92			
-Government Budget	10	33	42	74	69	79	62	99	63	N/A	N/A	N/A
-MCG					19	67	118	39	0			
-Donors—	14	6	10	18	7	36	69	36	29			
GDP Share%	0.5%	0.6%	0.7%	0.9%	0.8%	1.7%	2.3%	1.2%	0.6%			
Routine Maintenance	12	11	16	18	18	18	16	19	21	21	21	18
-Government Budget	12	11	16	18	18	18	16	19	21	21	21	18
GDP Share %	0.2%	0.2%	0.2%	0.2%	0.1%	0.2%	0.2%	0.1%	0.1%	0.1%	0.1%	0.1%
Total	38	61	97	151	151	283	394	324	286			
GDP Share %	0.7%	1.0%	1.3%	1.5%	1.2%	2.6%	3.6%	2.3%	2.0%			

Source: World Bank, *Forth East West Highway Improvement Project*, Project Appraisal Document, April 2013 (2004 - 2012), RDMRDI; (2013 – 2015)
Exchange Rate from National Statistics Office of Georgia

Table 6-3 lists ongoing road projects funded by international donors. Total funding received from donors including WB, ADB, JICA, EIB, and EU reaches 1.1 billion GEL (0.44 billion US $). These projects required rigorous process for procurement of contractors and consultants, project management, financial management, maintenance of roads etc. Strict rules to prevent fraudulent and corrupt acts are also imposed by the donors.

The experiences and knowledge obtained through these projects have provided RDMRDI with sufficient capacity to procure resources required for the projects, and to manage and maintain the projects to international donor standards.

RDMRDI engages external specialists, such as National Forensics Bureau to deal with complicated issues, as RDMRDI has been experiencing shortage of internal staff and also to obtain independent opinion. This approach is effective, however it is reported that the process often requires long lead time.

The International Procurement and Donor Reporting Service Section administrates the selection of contractors and consultants. Technical divisions including; Roads Administration Service, Traffic Management and Safety Service, and Road Engineering Service provide engineering services to maintain existing road network, and to supervise construction of new roads and rehabilitation of existing ones. The maintenance of existing and newly constructed roads are managed under Road Current and Periodic Maintenance Control and Monitoring Service, the Environment Protection Service assesses the environmental management plan and other documents prepared by contractors and monitors impact during construction. Resettlement Service administrates all matters related to resettlement of parties and individuals affected by the Project.

Financial management and disbursements is done by an external organization, Transport Reform and Rehabilitation Centre.

Table 6-3: Donor-Supported Projects and Programs Envisaged in the State Budget as of 31 March 2017

Projects	Date of Agreement	Project Closing Date	Agreed Amount (thousand)			Comments
			Currency of Loan/Grant			
			Currency	Credit	Grant	
Road Infrastructure						
Fourth East-West Highway Improvement Project (Agara–Zemo Osiauri) (WB)	6.6.2013	28.2.2018	SDR	24,500		- Construction of the Agara–Zemo Osiauri section (approx. 12 km) of Highway (construction works are ongoing; 7 km is open to traffic); - Construction of a riverbank protection (approx. 3.4 km) structure (completed); - F/S and other preparatory activities (including Second Rikoti Tunnel) for the construction of the Rikoti–Zestafoni section of Highway (completed).
			USD	38,000		
East-West Highway Corridor Improvement Project (Zemo Osiauri–Rikoti) (WB, EIB)	10.2.2016	31.12.2020	USD	140,000		- Construction of the Zemo Osiauri–Chumaleti section (approx. 14.1 km) of the Highway (tendering procedures are ongoing); - Providing support for capacity building to RDMRDI; - Technical Assistance to the Ministry of Economy and Sustainable Development of Georgia in preparation of F/S to identify priority logistic sites (ongoing); - Preparation of designs and supporting studies for future investments for road network development.
			EUR	49,450		
Road Corridor Investment Program (Kobuleti Bypass Road) (ADB)	29.10.2009	31.12.2017	SDR	75,892		- Construction of a new Kobuleti Bypass Road (approx. 32 km); first section (12.4+1.3 km) of the Highway is open for traffic; construction works are ongoing for second section.
			USD	140,000		
Batumi New Bypass Road (ADB, AIIB)						- Construction of Batumi Bypass two-lane 14.3 km Road (planned); - Maintenance of approx. 200 km International and Local roads (planned)
East-West Highway Improvement Project (Zestafoni–Kutaisi–Samtredia) (JICA)	16.12.2009	24.6.2023	JPY	22,132,000		- Construction on the Zestafoni–Kutaisi section (construction works are ongoing); - Construction of a new Kutaisi Bypass (construction works completed for 17.3 km of the highway was opened for traffic in 2014);

Projects	Date of Agreement	Project Closing Date	Agreed Amount (thousand) Currency of Loan/Grant			Comments
			Currency	Credit	Grant	
Road Infrastructure						
						- Construction of a new road from Kutaisi to Samtredia (construction works are completed and 24 km is open to traffic).
East-West Highway Improvement Project (Samtredia–Grigoleti–Kobuleti) (EIB, EU)	11.5.2012	28.11.2019	EUR	200,000	20,000	- Construction of a new four lane highway (approx. 52 km) from Samtredia to Gregoleti (construction works are ongoing except for Lot III with a length of 12 km); - F/S of the new sections and preparation of the D/D of the road sections of Poti–Grigoleti and Grigoleti–Kobuleti Bypass Road (River Choloki) (ongoing).
Section Secondary and Local Roads Project (SLRP II) (WB)	22.3.2012	30.6.2019	SDR USD	25,800 30,000		- Rehabilitation of secondary and local roads in different regions of Georgia (approx. 225 km in total) (rehabilitation works are ongoing).
Third Secondary and Local Roads Project (SLRP III) (WB)	9.7.2014	30.9.2018	USD	75,000		- Rehabilitation of secondary and local roads in different regions of Georgia (approx. 200 km in total) (rehabilitation works are ongoing).
Secondary Road Asset Management Project (WB)	28.3.2016	31.12.2021	USD	40,000		- Rehabilitation and/or periodic maintenance, technical works of selected secondary road sections in Guria region (planned); - Rehabilitation of selected secondary road sections in Mtskheta–Mtianeti, Racha–Lechkhumi and Shida Kartli regions (tendering procedures are ongoing); - Monitoring and supervision of works contracts (contract negotiations are ongoing).
Batumi–Akhaltsikhe Road Project (Khulo–Goderdzi Section) (Kuwait Fund)	17.1.2017	31.12.2020	KWD	8,000		- Rehabilitation-construction of the Khulo–Goderdzi Section of the Batumi–Akhaltsikhe Road Project (approx. 29 km, 2 lane road) (prequalification selection procedures for building contractor are ongoing).
Sadakhlo–Bagratashen Bridge Project (EBRD)	30.12.2016	31.12.2019	EUR	6,000		- Construction of a new bridge at the Sadakhlo–Bagratashen border crossing between Armenia and Georgia (tendering procedures for building contractors and supervision company are ongoing).

Abbreviations: ADB = Asian Development Bank, AIIB = Asian Infrastructure Investment Bank, D/D = Detailed Design, EBRD = European Bank for Reconstruction and Development, EIB = European Investment Bank, EU = European Union, F/S = Feasibility Study, JICA = Japan International Cooperation Agency, WB = World Bank
Source: MRDI Homepage

6.2 Project Procurement

The procurement of goods and services for the Project is carried out in accordance with the standard procedures adopted by RDMRDI for most highway projects, including those funded by international donors. Georgia Public Procurement Law and the Guidelines for Procurement under Japanese ODA Loans are also strictly observed.

6.2.1 Procurement Schedule

Figure 6-3 presents overall project procurement schedule envisaged by RDMRDI for the Project. The Government of Georgia has a strong commitment to complete the Project by the end of Year 2020 or in early 2021.

All activities necessary for the construction contract including environmental clearance, preparation of bidding documents, Loan Agreement, selection of a supervision consultant and a main contractor are scheduled to bring the commencement of construction as early stage as possible.

The tender for the supervision consultant will be announced immediately after the completion of bidding documents for the construction, selection process normally takes 12 months under JICA standard, RDMRDI intends to shorten the period to 5 months mainly by expediting RDMRDI internal processes.

The tender for the construction is called upon the pledge of the finance by JICA, JICA recommends 10 months for the process excluding the period required for the preparation of bidding documents, and RDMRDI aims to shorten the period to 5 month mainly by expediting RDMRDI internal process.

The JICA Study Team strongly recommended followings;

a) Extent the preparation period of bidding documents by the contractors from 2 months to 3 months to provide bidders enough time for their thorough investigation of the Project,
b) Full land acquisition prior to the signing of the construction contract as oppose to the RDMRDI's current plan (50% prior to the signing of the contract, remaining 50% during the mobilization activities by the selected contractor).

EW Highway F4 Section (Argveta-Dzilura) - Road Department Target Plan, Construction Period of 2.5 Years (30 months)

29 Nov'17

No.		Activity	Duration: Road Department Plan	Duration: JICA Standard	Party	Note
1		Pre Conditions				
	a	EIA Report	DFR by 15 Dec '17 FR by 31 Jan '18		IRD, JST	
	b	RAP Report	Draft by 24 Dec '17 Final by 15 Jan '18		IRD, JST	
	c	JICA Advisory Committee for EIA and RAP	Final comments by early March		JICA	
	d	EIA Approved by GOG	2.5 mths		RD	
	e	EIA Disclosure Period		120 days	JICA	
2	a	JICA Loan Appraisal Mission			JICA	
	b	Pledge			JICA	
	c	Loan Agreement			GoG - JICA	
3		Bidding Document Preparation				
	a	Design Drawings	31-Jan		IRD, JST and RD	
	b	Specifications				
	c	Bill of Quantities				
	e	Adjustment to STEP				
	f	Finalize Bidding Document				
	g	Approved by RD	1 mth		RD	
	h	Endorsed by JICA	2 mths		JICA	
4		Selection of Supervision Consultant	5 mths	12 mths	Excluding preparation of Bid Docs (3mths)	
	a	Preparation of Bid Documents and Approval by JICA		3 mths	Party engaged by RD	
	b	RFP Issue and Proposal Preparation	1.5 mths		Consultants	
	c	Evaluation of Technical Proposal + JICA Concurren	1 mth		Evaluation and Recommendation by committee consisting of staff from International Donor, Legal and Technical Departments (4 - 5 staff)	Quality and Cost Based Selection
	d	Financial Proposal Opening + JICA Concurrence	0.5 mth			
	e	Negotiation and GOG Approval	1 mth		Approval by Committee representing each Department (11- 13 Department Heads)	
	f	JICA Concurrence	1 mth		JICA	
	g	Award			RD	
5		Selection of Contractor	5 mths	10 mths	Excludes preparation of Bid Docs (3mths)	Without PQ/Option A "One Envelope"
	a	PQ	No PQ under STEP			
	b	Tender Call			RD	
	c	Tender Preparation	2 mths	3 mths	Contractors	
	d	Tender Evaluation	1 mth	2 mths	Evaluation and Recommendation by	Lowest Bid and Post Qualification
	e	JICA Approval of Bid Evaluation		1 mth	JICA	
	f	Contract Negotiation and GoG Approval	1 mth	2 mths	Approval by Committee representing each	
	g	JICA Concurrence	1 mth	1 mth	JICA	
	h	Contract Award		1 mth	RD	
6		2 Separate Contracts, West ; CH 0 - Bridge 4 (excluded), East ; Bridge 4 (included) - Argveta				2.5 Years (30 mths), 2 Contracts Basis
	a	Site work	2.5 years		Contractor	Site Acquisition (50% prior to contract signing, remaining 50% during contractor's mobilization)
	b	Defect Notification Period	2 years			

Critical Pass

Abbreviations: ADB = Asian Development Bank, EOI = Expression of Interest, JICA = Japan International Cooperation Agency, LAR = Land Acquisition and Resettlement, RAP = Resettlement Action Plan, RFP = Request for Proposal, RFQ = Request for Quotation,
Source: JICA Survey Team

Figure 6-3: Overall Project Procurement Schedule

6.2.2 Procurement Procedures

RDMRDI engages a consultant to assist in the preparation of bidding documents. A committee of four to five staff from International Procurement and Donor Reporting Service, Legal Service, and technical sections of RDMRDI leads the preparation of the bid, evaluation and selection of the Contractor. The recommendation is approved by a committee consisting of 11-13 heads of divisions chaired by the Deputy Chairman of RDMRDI. RDMRDI, for all state budget procurements, is governed by the provision of the Public Procurement Law (PPL) which has mandated the use of e-procurement. The staff are familiar with PPL and attended several programs conducted by the State Procurement Agency. RDMRDI intends to shorten their internal processes as much as practically possible to expedite procurement process, for example, RDMRDI committee will shorten the period for the evaluation and recommendation of tender, 2 months normally recommended by JICA, to less than one month.

6.2.3 Procurement of Consultant

A consultant will be procured through International Competitive Bidding process in accordance with the Guidelines for the Employment of Consultants under Japanese ODA Loans. The consultant will be selected in accordance with the Quality- and Cost-Based Selection (QCBS) method. The main role of the consultant is to provide supervisory services during the execution of construction packages. The consultant also assists in the preparation of additional documents required for the bidding, modification of documents, and evaluation and selection of bidders.

6.2.4 Land Acquisition

Following the notification of a land requirement (Right of Way, ROW), a series of public meetings for stakeholders affected by the proposed road are arranged to hear their comments, and a draft Resettlement Action Plan (RAP) is prepared by the detailed design consultant. The draft RAP including Acquisition and Compensation Scheme is reviewed by RDMRDI and submitted to JICA for its endorsement. Review and approval of the RAP by RDMRDI committee will take 1.5 months and scheduled to be finalized by the early March 2018.

The JICA study team strongly recommends that all activities related to land acquisition and resettlement, such as compensation payment for displacement, shall be planned and executed prior to the commencement of civil works to avoid the delay of the works and additional cost associated with the delay.

6.2.5 Procurement of Contractor

(1) Japanese Technologies and Packaging

Application of Japanese Technologies

There are six major steel bridges totalling 3,870 m in span length, twelve major tunnels totalling 8,515 m in length, and slope protection works in very complex geology along the proposed road. Japanese technologies applicable in these structures are identified and examined as to the economic and technical advantages over other technologies. The Special Terms for Economic Partnership (STEP) is considered if:

a) the technologies are justified;
b) requirements for the terms (including not less than 30% of total contract price being accounted by goods from Japan and services by Japanese company); and
c) GOG is in agreement with the terms of STEP.

The bidding documents prepared by D/D Consultant need to be modified to accommodate STEP, the modification work will be assisted by the JICA survey team.

Packaging

Packaging of the Project into several works is considered. The packaging is designed to achieve the following:

a) cost of each package being similar;
b) construction period of each package being similar; and
c) impact of works of one package has minimal impact on the progress of other packages.

Three (3) different package options are considered taking into account above conditions;

- Option 1 - Single Package
- Option 2 - 2 Packages, East and West, and
- Option 3 - 3 Packages, East, Central and West.

These 3 options are compared, Table 6-4 summarises the assessment of the options. The JICA survey team recommends “Option 2 - 2 Packages, East and West”. mainly due to less interaction between packages.

Table 6-4: Possible Packaging of the Works and Comparison

	Option 1- Single Package	**Option 2 – 2 Packages (2 Contracts)**	**Option 3 – 3 Packages (3 Contracts)**
Description	Single contractor to complete entire works	The works are split into 2 separate Contracts and performed by different main Contractors; • Package 1: East (Start-Bridge 4 excluding Bridge 4) • Package 2: West (Bridge 4 – End, including Bridge 4)	The works are split into 3 separate Contracts and performed by different main Contractors; • Package 1: East (Start-Bridge 2 including Bridge 2) • Package 2: Central (Road 5 – Road 9) • Package 3: West (Tunnel 5 – End, including Tunnel 5) (Refer Figure 6-4)
Construction	The main contractor to mobilize enormous resources in very short time to complete entire works in 2.5 years. It is anticipated that the Contractor has to organize 9 bridge parties, 9 tunnel parties and 6 road parties. Require a large international and experienced contractor	Much more manageable size, as resources requirement for each contractor becomes half, this will most likely expedite the progress of the works. There are several inter- contractual issues, such as who is responsible for treatment of excavated material from Package 1-East, which will be used for fill for Package 2.	Much more manageable size, as resources requirement for each contractor becomes almost one third of Option 1, however the contractors are expected to face more operational restrictions compared with Option 2, for example, Package 1 contractor has to haul excavated material through Contractor's site of Package 2, these restrictions may hinder the overall progress of the works
Project Management (PM)	Project supervision for single contract	The Engineer to have additional resources to manage 2 separate contracts. Additional Cost, assume 5% of the project cost as the supervision cost, 5% × (13,535,000) = 700,000	The Engineer to have additional resources to manage 2 separate contracts. Additional Cost, assume 5 % of the project cost as the supervision cost 5% × (22,396,000) = 1,100,000
STEP	Very few, or no contractors eligible for STEP.	More chance of receiving bids from eligible contractors for STEP.	Reasonable contract size for prospective eligible contractors for STEP.

	Option 1- Single Package	**Option 2 – 2 Packages (2 Contracts)**	**Option 3 – 3 Packages (3 Contracts)**
Assessment	Too large contract size for prospective eligible contractor for STEP.	2 packages will contribute to expedite the progress of works, maximum possible size of contract for eligible contractor for STEP.	More participation of prospective contractor for STEP, however, contractors face operational restrictions, which will impede the progress of works.
Recommendation		Recommended	

Source: JICA Survey Team

(2) Bidding

ICB is applied for bidding of packages. It is strongly recommended to call tender when the entire ROW required for the Project is acquired by the state government.

JICA Standard Bidding Documents are used for the tender, RDMRDI plans to apply post – qualification (without Pre-qualification process) to expedite the tender process. RDMRDI considers the application of JICA bidding procedures for "Without Pre-qualification, Option A, One Envelop". Bidding Document were prepared by D/D consultant and the invitation for Bids has announced on June 15th, 2018.

Bidders are allowed to submit bidding documents including technical and financial sections within **45** days from the notice of tender invitation for **the East West Highway Improvement Project Phase I**. The JICA Survey Team strongly recommends longer periods for bid preparation of bidders, as this allows bidders to assess bidding documents, particularly requirements and quantity of works, and to investigate site conditions for thorough preparation of their proposals. the JICA survey team strongly recommends the bidding preparation period of no less than 60 days, preferably 90 days for a large and complex civil work like this Project.

(3) Evaluation and Award

RDMRDI normally completes evaluation of bidding documents within 30 days from the closing date of the bid, and prepares recommendations and approval for the committee comprising of the head of divisions in RDMRDI. The Letter of Award to the successful bidder is issued upon approval of the contractor by the committee, and the concurrence by JICA. The implementation schedule allocates approximately five (5) months from the invitation of bid, to the issue of the Letter of Award.

6.2.6 Defects Liability

The Contractor is liable under the Contract to remedy defects identified by the Engineer from date of issue of the Taking-over Certificate until the expiry of the Defects Notification Period, which is extendable up to two years under certain circumstances. RDMRDI expects to apply 2 years Defect Liability period due to the size and complexity of the Project.

The Engineer issues the Defects Liability Certificate upon expiration of the Period under the Contract.

6.2.7 Maintenance

No maintenance service is included in the construction contract. All maintenance works of RDMRDI are contracted out to local contractors selected through competitive tender process, while supervision of the works is carried out in-house. RDMRDI specifies the techniques, materials, and quantities to be used for the maintenance works. Duration of the maintenance contract, which includes winter and routine maintenance, is normally 12 months. RDMRDI introduces 3 years contract period for the most of maintenance contracts from 2018.

6.3 Project Implementation

6.3.1 Procurement Support

Whilst the Consultant selected through ICB provides supervision services during the construction in accordance with the TOR and Service Contract set up by RDMRDI, they also provide assistance during the preparation of the bidding documents, evaluation, and selection of the Contractor for the Project.

6.3.2 Construction Supervision Service

A team consisting of specialists in respective areas is deployed. The Team also includes engineers who support the specialists. These engineers include Residential Engineers, Site supervisors, and engineers for different disciplines, Quantity surveyors, Safety experts, and Environment and Resettlement experts. The specialists and their roles are summarized in Table 6-5.

Table 6-5: Specialists and Their Roles

	Specialist & Main Staff	No	Role
1	Team Leader	1	a) oversees overall status of the Project concerning budget, quality, and progress of the works; and makes decisions whenever necessary for matters affecting the Project to maintain the expected outcome, b) liaise with the Authority, Stakeholders, the Contractor and other parties concerning the Project, this includes correspondence, and c) issues various certifications to the Contractor.
2	Snr Highway Engineer	1	a) reviews highway design prepared by the Contractor, b) overall supervision of road work including preparation of instructions, and other documents concerning road works, c) provides inspections and advice concerning road works during the work, and d) reviews design modifications of road works undertaken by the Contractor during the works.
3	Snr Bridge Engineers	2	a) reviews bridge design prepared by the Contractor, b) overall supervision of bridge works including preparation of instructions, and other documents concerning bridge works, c) provides inspections and advice concerning bridge works during the work and d) reviews design modifications of bridge works undertaken by the Contractor during the works.
4	Snr Tunnel Engineers	2	a) reviews tunnel design prepared by the Contractor, b) overall supervision of tunnel works including preparation of instructions, and other documents concerning bridge works, c) provides inspections and advice concerning tunnel works during the work and d) reviews design modifications of tunnel works undertaken by the Contractor during the works.
5	Snr Geotechnical Engineer	1	a) reviews design for road, bridge and other structural designs including slope protection structures, b) provides inspections and advice concerning subsurface conditions of the site during the work, and c) reviews design modifications undertaken by the Contractor.
6	Snr Material/Pavement Engineer	1	a) reviews material reports submitted by the Contractor, b) reviews material proposed in the Contractor's design, c) reviews material used by the Contractor during the works, d) Manages all test results performed for the Project including preparation of reports, and e) supervises lab technicians.

	Specialist & Main Staff	No	Role
7	Snr Labour Safety Expert	1	a) reviews Safety Plan submitted by the Contractor, b) conducts safety audit, and reviews audit performed by the Contractor's Safety Consultant, c) supervises overall safety activities performed by the Contractor, d) provides inspections and advice concerning safety issues, and e) prepares safety reports.
8	Snr Traffic Safety Expert	1	a) reviews traffic safety plan submitted by the Contractor, b) supervises overall traffic safety activities performed by the Contractor c) provides inspections and advice concerning safety issues, and d) prepares safety reports.
9	Contract Specialist	1	a) prepares and reviews letters concerning all contractual matters, b) recommends necessary actions concerning the Project for Team Leader, c) controls all registers for contracts including the Contract and the Consultant Service Contract, d) prepares certificates for Stage Payment Statement submitted by the Contractor, e) prepares various project reports including Monthly Project Reports, Financial Status Reports, etc. and f) liaisons with Dispute Board.
10	Snr Environmental Specialist	1	a) reviews Environment Management Plan submitted by the Contractor, b) conducts environment audit during the construction, c) provides inspections and advice concerning environmental issues, d) prepares environment status reports, and
11	Snr Resettlement Specialist		a) monitors status of resettlement and prepares report.

Source: JICA Survey Team

A group of staff supporting the above specialists and engineers is also employed. The group includes Quantity surveyor, CAD operators, Field engineers, Surveyors, Quality control engineers, Laboratory technicians, Office manager, Secretary, Document controller, and Accountant.

The Team provides supervision services during the works and the Defect Notification Period. Staff level will be adjusted from time to time according to the progress of works and will be reduced to minimum levels towards the end of the Project, a skeleton staff will then be maintained during the Defect Notification Period.

6.3.3 Construction Phase

Past experiences in Georgia indicate that foreign construction firms were engaged in most large construction contracts, and subcontracted portions of the works to local firms. As local construction firms are still not equipped with resources to manage large size civil contracts, this trend will continue for some time.

The Contractor selected through ICB detailed in the previous section mobilises resources required for the Project. All documents, including construction method and schedule, environmental management plan, safety management plan, traffic management plan, etc., are prepared by the Contractor and approved by the Engineer. Quality, progress, and cost of the works are constantly monitored by the Engineer and reported to RDMRDI. The Engineer takes necessary actions to minimise adverse effects on the Project, such as defects and/or delays in accordance with the contract. The Indicative construction plan including possible sources of material required for the Project, viable construction method, and anticipated construction schedule is discussed in Section 6.4

6.3.4 Operation and Maintenance

(1) During the Contract

The Contractor is responsible for any defects for two years (Defects Notification Period) commencing from the date of the issuance of the Taking-over Certificate. The Engineer performs various roles during the Defects Notification Period.

(2) Routine & Periodic Maintenance and Rehabilitation

RDMRDI is responsible for the routine and periodic maintenance of international and secondary roads totaling approximately 7,000 km. Table 6-6 shows annual expenses for routine and periodic maintenance, annual maintenance cost per km in 2016 was approximately 3,300 US$/km. Half of the budget is normally spent for winter maintenance, the budget for summer maintenance (grass cutting, drainage cleaning, patching, pothole repair, etc.) appears insufficient.

The expenditure for the annual maintenance significantly has increased in 2017.

Table 6-6: Annual Expenditure for Routine and Periodic Maintenance for International and Secondary Roads

routine and periodic Maintenance - actual expenses (including winter)								
	year	Routin (M/GEL)		Periodic (M/GEL)	bridge (M/GEL)	tunnels (M/GEL)	total (milion GEL)	Total in (million US$)
		International roads	secondary roads					
1	2012	15.7	19.7	Included in Routin	no separate contract	-	35.4	
2	2013	15.1	19.1		no separate contract	0.7	34.9	21.0
3	2014	15.0	20.0		no separate contract	1.0	36.0	20.3
4	2015	17.5	22.7		no separate contract	1.0	41.2	18.2
5	2016	20.0	25.0		1.7	1.3	48.0	20.2
routine and periodic maintenance (including winter)								
6	2017 January - august	27.9	32.6	4.00	1.9	1.0	67.4	
	2017 January - December	= 67.4 million GEL x (12 months/8 months)					101.1	37.5

Source: RDMRDI

RDMRDI divided International and secondary roads into 22 zones. The project area is covered in Zone 11 and 14.

All routine & periodic maintenance works and rehabilitation works are contracted out to local contractors zone by zone. RDMRDI introduced Output-and Performance based Contract (OPRC) through two pilot projects i.e. Kakheti Region, Rehabilitation and Maintenance Project and Guria Project. The maintenance contractor performed the work to satisfy performance indicators set up under the contract instead of traditional bill items and specification approach. RDMRDI engaged a monitoring consultant selected through ICB, the monitoring consultant plays similar role with supervision consultant of construction contract, and administrates the pilot projects and report the status on the pilot projects to RDMRDI.

Although depending on the result of the pilot projects, RDMRDI plans to;

a) extend the contract period from normal 12 months contract period to longer period (3 years)
b) apply multiple zones per contract instead of traditional single zone per contract,
c) cover maintenance works for bridges, tunnels and roads in single the contract,

Table 6-7 summarizes responsibility and roles of each party during Defect Liability Period and Maintenance Period.

Table 6-7: Responsibility and Roles of Contractor, Engineer and RDMRDI during Defects Notification Period and Maintenance Period

Defects Notification Period		
Period	**The Contractor**	**The Engineer**
Defects Liability Period	a) shall restore and rectify all defect works observed by the Authority's Engineer, and b) shall investigate the cause of the defect and prepare reports.	a) site inspections and prepare reports, b) supervision and inspection of the remedial works performed by the Contractor, and c) issue Defects Liability Certificate upon completion of the period.
Routine and Periodic Maintenance by separate contractor		
	The Contractor	**RDMRDI**
Maintenance Period of separate Contractor	a) shall provide periodic (at least once a month) and ad hoc maintenance works in accordance with maintenance specifications, attend joint inspections between the Contractor and RDMRDI's Engineer, and prepare Maintenance Statements, b) shall maintain safety of road users at all times, and c) no closure of any lanes during the period unless prior approval by the RDMRDI's Engineer is obtained, d) shall maintain and operate a round-the-clock vehicle rescue post with a mobile crane.	a) prepare the Maintenance Program, b) attend the periodic and ad hoc joint inspections and review the Maintenance Statement prepared by the Contractor, c) supervision of the Contractor's maintenance work and prepare Maintenance Inspection Report, d) prepare payment certificates, and e) issue Performance Certificate upon completion of the Maintenance Period. **Note:** RDMRDI appointed Monitoring Consultant for the supervision of maintenance contracts performed by contractors for two pilot projects. This arrangement will expand to maintenance works for other zones in future.

Source: JICA Survey Team

6.4 Construction Plan

6.4.1 Scope of Works

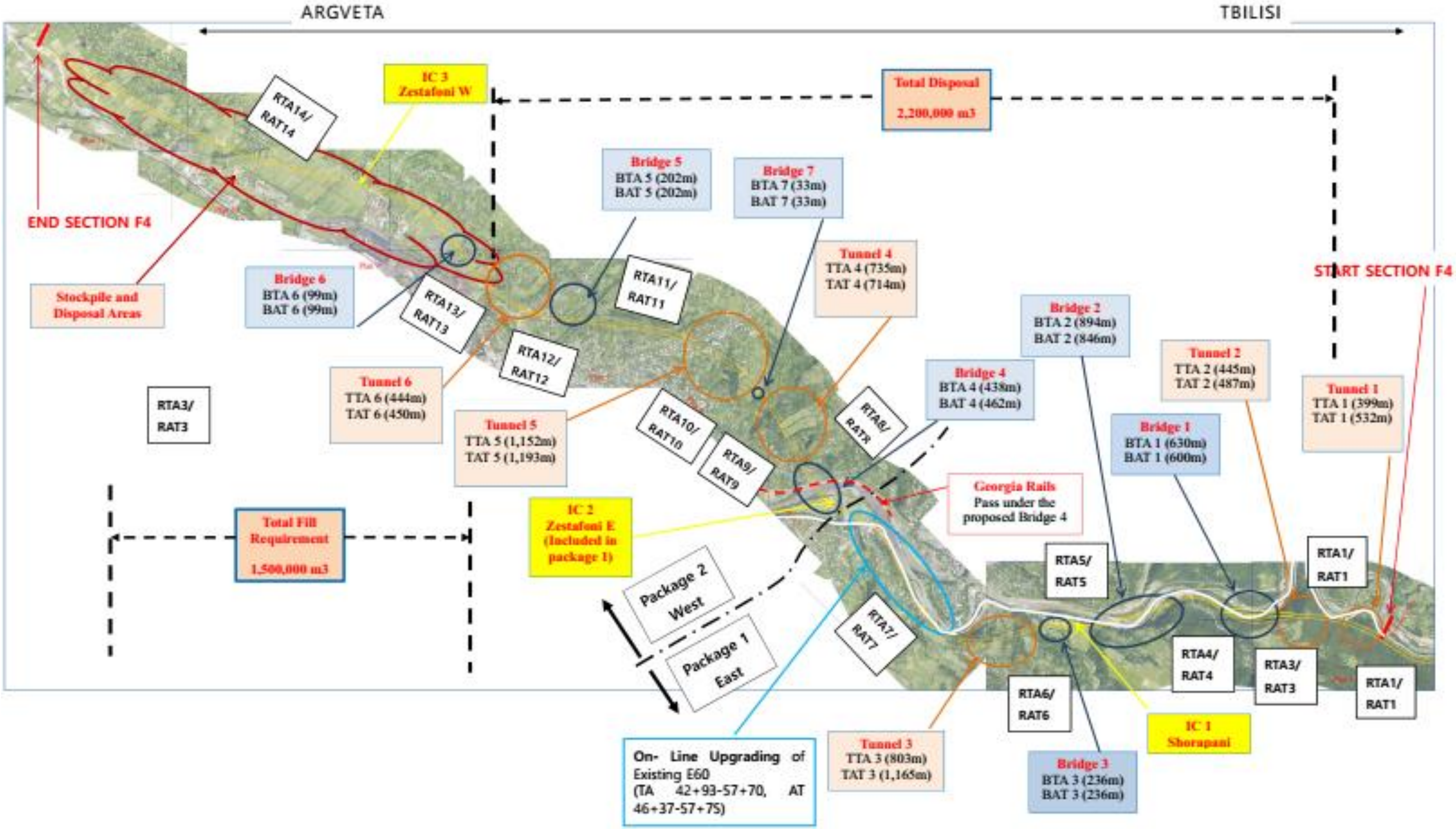
The Works include construction of 14 major bridges, 12 major tunnels, 3 Interchanges and 14 road sections located between those structures. 5 Retaining walls along part of the road sections and Interchange, slope protection, one overpass, culverts in 3 different sections totalling 1,432 m, and relocation of existing utilities including power lines, gas line, water main and fibre optical cable, are also included in the works.

Table 6-8 summarizes the scope of the works. Figure 6-4 indicates the location of each work.

Table 6-8: Summary of Scope of Works for the Project

<table>
<tr><th colspan="2" rowspan="2">Work</th><th colspan="3">Quantity</th><th rowspan="2">Description</th></tr>
<tr><th>Unit</th><th>Tbilisi-Argveta</th><th>Argveta-Tbilisi</th></tr>
<tr><td rowspan="8">1</td><td>Bridge</td><td>Span Length (m)</td><td></td><td></td><td></td></tr>
<tr><td>Bridge 1</td><td></td><td>630</td><td>600</td><td>12 spans rationalized steel girder bridge, circular column piers with direct or pile foundations</td></tr>
<tr><td>Bridge 2</td><td></td><td>894</td><td>846</td><td>15 and 16 spans rationalized steel girder bridge, circular column piers with direct or pile foundations</td></tr>
<tr><td>Bridge 3</td><td></td><td>236</td><td>236</td><td>7 spans pre-stressed concrete girder bridge, rectangular column piers with direct foundations.</td></tr>
<tr><td>Bridge 4</td><td></td><td>438</td><td>462</td><td>9 spans curved rationalized steel girder bridge, circular column piers with direct or pile foundations</td></tr>
<tr><td>Bridge 5</td><td></td><td>198</td><td>198</td><td>6 spans pre-stressed concrete girder bridge, rectangular column piers with direct foundations.</td></tr>
<tr><td>Bridge 6</td><td></td><td>97</td><td>97</td><td>3 spans pre-stressed concrete girder bridge, In-Situ bored concrete piles (1.2 m dia).</td></tr>
<tr><td>Bridge 7</td><td></td><td>33</td><td>33</td><td>Single span pre-stressed concrete girder bridge, In-Situ bored concrete piles (1.2 m dia).</td></tr>
<tr><td rowspan="7">2</td><td>Tunnels</td><td>Length (m)</td><td></td><td></td><td></td></tr>
<tr><td>Tunnel 1</td><td></td><td>399</td><td>532</td><td>Blasting</td></tr>
<tr><td>Tunnel 2</td><td></td><td>445</td><td>487</td><td>Blasting</td></tr>
<tr><td>Tunnel 3</td><td></td><td>796</td><td>1,161</td><td>Blasting</td></tr>
<tr><td>Tunnel 4</td><td></td><td>738</td><td>717</td><td>Bleaker and Blasting</td></tr>
<tr><td>Tunnel 5</td><td></td><td>1,152</td><td>1,193</td><td>Roadheader</td></tr>
<tr><td>Tunnel 6</td><td></td><td>444</td><td>450</td><td>Roadheader</td></tr>
<tr><td>3</td><td>Interchanges</td><td>Pavement area (m^2)</td><td colspan="2">38,914</td><td>3 locations, Shorapani IC, Zestafoni East IC and West IC</td></tr>
<tr><td>4</td><td>Roads</td><td>Length (m)</td><td>8,219</td><td>7,710</td><td>7 road sections in East and 7 road sections in West</td></tr>
<tr><td>5</td><td>Slope Protection</td><td>Slope Area (m^2)</td><td colspan="2">69,000</td><td>Rock fall protection by steel net in Road 1 section</td></tr>
<tr><td>6</td><td>Retaining Walls</td><td>Length (m)</td><td colspan="2">612</td><td>Reversed T Shaped concrete retaining wall at 6 different locations. Retaining wall adjacent to tunnel portals of Tunnel 4 is excluded</td></tr>
<tr><td>7</td><td>Culverts</td><td>Length (lm)</td><td colspan="2">1,432</td><td>3 different sections, 2 × 2.5, 4 × 2.5, 6 × 4.5</td></tr>
<tr><td>8</td><td>Overpass</td><td>Span length (m)</td><td>32</td><td>32</td><td>Single span pre-stressed concrete girder bridge</td></tr>
<tr><td>9</td><td>Relocation of Utilities</td><td></td><td></td><td></td><td>Relocation of power line, fibre optic cable, gas pipeline, water lines. Installation of lighting for road and bridges</td></tr>
</table>

Source: JICA Survey Team based on D/D drawings as of 25 December 2017



Source: JICA Survey Team based on D/D drawings and reports as of 25 December 2017

Figure 6-4: Location of Works

6.4.2 Construction Method

The proposed alignment travels along the existing E60 to the crossing point of River Kvirila at the east of Zestafoni (referred Eastern section), then heads north to bypass the town and is terminated at Argveta Interchange which is currently under construction (referred Western section).

The eastern section are characterized by hilly terrain with relatively simple geology and hard rock, thus significant volume of rock excavation is required and transported to the western section where the major embankment work is required.

Tunnels and bridges occupy approximately 60% of the eastern section in length.

Hilly terrain dominates the half of the western section at Tbilisi side, relatively flat land covers the remaining of the western section.

Contrast to the eastern section, approximately 65% of the western section in length is road works involving embankment.

Interaction of tunnel works, bridge works and road works are minimal and upgrading of the existing E60 are required in few sections of the alignment, therefore the works can be commenced at multiple work fronts to shorten the construction period.

General construction method for major bridges and tunnels, temporary diversion of existing traffic on E60 and local roads, haulage of material excavated from tunnel sites are discussed.

(1) Bridges

Table 6-9 summarizes characteristics of each bridge and construction method considered for each bridge.

Raft foundations are applied for most of substructures, pipe piles well foundation with diameter of 6 m are used for piers adjacent to main stream of rivers. In-situ concrete bored piles are applied for Bridge 5, 6 and 7. Slip form is considered for the columns of the piers with height more than 10 m, conventional form system is used for the remaining concrete works.

200-250 ton crawler cranes are considered for the erection of all superstructures, lifting by 2 cranes is necessary for steel bridge section with large lifting height. Temporary access ramps to river bed are required at Bridge 1 and Bridge 2.

As an access ramp to Abutment 2 of Bridge 4 is close to Georgian Railways, protection wall is constructed along the ramp, platform over the railways may be required for the protection of railways against falling material. The works shall be closely coordinated with Georgian Railways.

(2) Tunnels

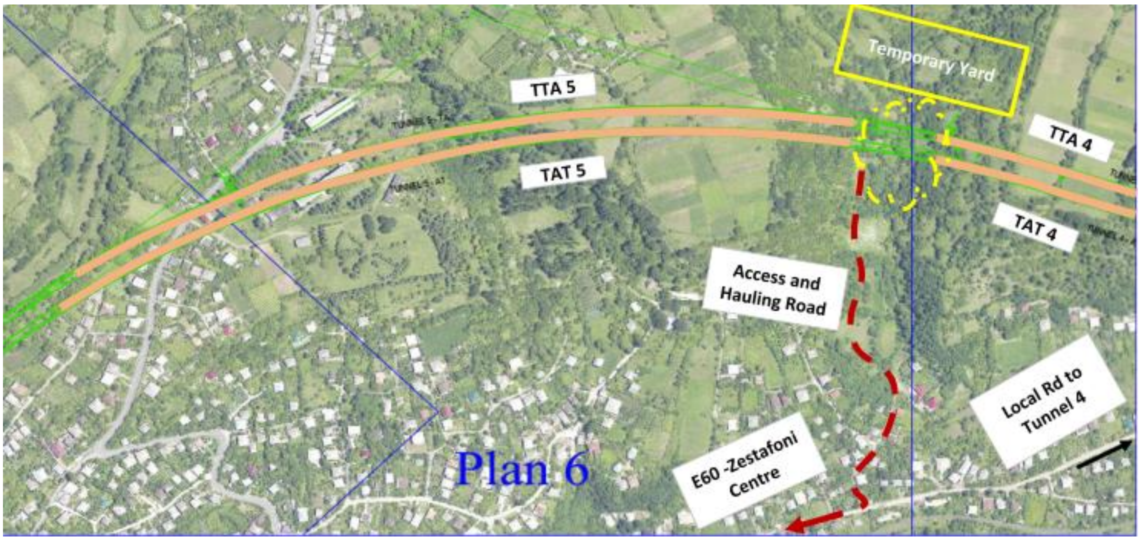
Table 6-10 summarizes characteristics of each tunnel and construction method considered for each tunnel.

Excavation
Geotechnical report indicates presence of hard rock with Unconfined Compressive Strength (UCS) over 100 N/mm^2 for Tunnel 1 and 2, UCS between 50-90 N/mm^2 for Tunnel 3 and 4. Blasting method is applied for those tunnels. Much softer rock, UCS less than 50 N/mm^2 is expected at Tunnel 5 and 6, therefore application of mechanical drilling by roadheader is feasible.

Temporary yard (approximately 100 m × 300 m) is required at each tunnel site to facilitate temporary facilities including power, concrete facilities, water treatment, storages, workshop, etc.

2 shift and 2 cycles (excavation and 1st lining) is considered, daily progress of 2-4 m/day is anticipated.

Haulage
Excavated material from Tunnel 1, 2 and 3 will be transported through existing E60 to embankment section in western section. Local road indicated in Figure 6-5 is used as a temporary haulage road to transport material excavated from Tunnel 4 and 5 to E60 in Zestafoni town. Material from T6 is directly transported to the embankment area for further treatment.



Source: JICA Survey Team

Figure 6-5: Proposed Haulage Road from Temporary Yard between Tunnel 4 and Tunnel 5

Table 6-9: Summary of Characteristics of Bridges and Construction Method

Bridge	Chainage	Span Length (m)	Type of Superstructure and Erection	Piers and construction		Temporally Facilities	Construction Period
				Type of Foundation	Construction		
BTA1	1+246 - 1+876	630	12 Spans Rationalized Steel Girders, Erection by Crane 200- 250 ton	11 piers per bridge. 6 m diameter wells made of micro piles (800 mm) for piers adjacent to river, raft foundation for remaining piers, and all abutments.	100 ton crane with piling rig and earth auger. Crum shell. Consider slip form for columns with height more than 10 m, conventional form for remaining columns.	Access ramp from E60 to river bed, assembling yard, crane working platform, steel bents,	2 separate parties. Substructures-21 mths/Bridge, Superstructure 12 mths/Bridge
BAT1	1+258 - 1+858	600					
BTA2	2+071 - 2+965	894	15 and 16 Spans Rationalized Steel Girders, Erection by Crane 200- 250 ton	14 and 15 piers per bridge. pile foundation for piers adjacent to river, raft foundation for remaining piers, and all abutments.			2 separate parties. Substructures-21 mths/Bridge, Superstructure 12 mths/bridge
BAT2	2+069 - 3+915	846					
BTA3	3+250 - 3+486	236	7 Spans Pre-stressed concrete girder bridge, Erection by crane 200- 250 ton	Raft foundations	Conventional form works	Temporary access road, working platform	Single party. Substructures-18 mths Superstructure -12 mths
BAT3	3+230 - 3+466	236					
BTA4	5+834 - 6+272	438	9 Spans curved Rationalized Steel Girders, Erection by Crane 200- 250 ton	8 piers per bridge. pile foundation for piers adjacent to river, raft foundation for remaining piers, and all abutments.	100 ton crane with piling rig and earth auger. Crum shell Consider slip form for columns with height more than 10 m, conventional form for remaining columns.	Access ramp from E60 to river bed, assembling yard, crane working platform, steel bents, cofferdams. Separate access ramp to abutment 2, the ramp requires protection wall for Georgian railways.	2 separate parties. Substructures-15 mths/Bridge, Superstructure 12 mths/bridge
BAT4	5+859 - 6+321	462					

Bridge	Chainage	Span Length (m)	Type of Superstructure and Erection	Piers and construction		Temporally Facilities	Construction Period
				Type of Foundation	Construction		
BTA5	9+011 - 9+209	198	6 Spans Pre-stressed concrete girder bridge, Erection by crane 200- 250 ton	Raft foundations	Consider slip form for columns with height more than 10 m, conventional form for remaining columns.	Temporary access road, working platform	Single party. Substructures-15 mths Superstructure -9 mths
BAT5	9+050 - 9+248	198					
BTA6	10+122 - 10+219	97	3 Spans Pre-stressed concrete girder bridge, Erection by crane 200- 250 ton	1.2 m dia, In situ concrete bored piles	100 ton crawler crane with piling rig with earth auger, conventional form work	Access road, working platform for crane	Single party. Substructures-12 mths Superstructure -6 mths
BAT6	10+146 - 10+243	97					
BAT 7	7+034 - 7+067	33	Single Span Pre-stressed concrete girder bridge, Erection by crane 200- 250 ton	1.2 m dia, In situ concrete bored piles	100 ton crawler crane with piling rig with earth auger, conventional form work	Access road, working platform for crane	Single party. Substructures-6 mths Superstructure -2 mths
BAT 7	7+064 - 7+097	33					

Source: JICA Survey Team based on D/D drawings and reports as of 25 December 2017

Table 6-10: Summary of Characteristics of each Tunnel and Construction Method

Tunnel	Chainage	Length	Geology/Ground Condition		Direction of Excavation	Excavation	Support Type	Stockpile and Haulage of excavated material	Progress and Construction Period
			UCS *1 (N/mm^2)	Underground water					
TTA1	0+266 - 0+625	339	> 100	Not significant	A ---> T	Blasting	Steel Ribs + Fore Poling (A0v, B0v and B2v) = 266 m Rock Bolt (A1) = 122 m Steel Ribs (A0, B0, and B1) = 443 m	Area between TTA1 and TTA2. Existing E60	3 m/day, 21 mths by single parties
TAT1	0+165 - 0+697	532							
TTA2	0+775 - 1+220	445	> 100	Not significant	T ---> A	Blasting	Steel Ribs + Fore Poling (A0v, B0v and B2v) = 250 m Rock Bolt (A1) = 158 m Steel Ribs (A0, B0, and B1) = 427 m		3 m/day, 21 mths by single parties
TAT2	0+748 - 1+235	487							
TTA3	3+490 - 4+286	796	50-90	Not significant	A ---> T	Blasting	Steel Ribs + Fore Poling (A0v, B0v and B2v) = 400 m Rock Bolt (A1) = 470 m Steel Ribs (A0, B0, and B1) = 1,032 m	Area at Argveta side. Use new Road AT to IC 2, then E60	3-5 m/day, 18 mths by 2 separate parties.
TAT3	3+472 - 4+633	1,161							
TTA4	6+288 - 7+026	738	50-95	Not significant	A ---> T	Bleaker and Blasting	Steel Ribs + Fore Poling (A0v, B0v and B2v) = 400 m Rock Bolt (A1) = 360 m Steel Ribs (A0, B0, and B1) = 618 m	Area between Tunnel 4 and Tunnel 5, Use existing local road to E60	2 -3 m/day, 24 mths by 2 separate parties.
TAT4	6+331 - 7+048	715							
TTA5	7+107 - 8+259	1,152	10-50	Not significant	T ---> A	Roadheader output over 300 kW	Steel Ribs + Fore Poling (A0v, B0v and B2v) = 645 m Rock Bolt (A1) = 540 m Steel Ribs (A0, B0, and B1) = 1,070 m	Area between Tunnel 4 and Tunnel 5, Use existing local road to E60	5 m/day, 24 mths by 2 separate parties
TAT5	7+137 - 8+330	1,193							

Tunnel	Chainage	Length	Geology/Ground Condition		Direction of Excavation	Excavation	Support Type	Stockpile and Haulage of excavated material	Progress and Construction Period
			UCS *1 (N/mm^2)	Underground water					
TTA6	9+265 - 9+709	444	10-50	Not significant	A ---> T	Roadheader output over 300 kW	Steel Ribs + Fore Poling (A0v, B0v and B2v) = 478 m Steel Ribs (A0, B0, and B1) = 296 m	Argveta side, Directly to fill area.	5 m/day, 21 mths by 2 separate parties
TAT6	9+277 - 9+727	450							

Source: JICA Survey Team based on D/D drawings and reports as of 25 December 2017

Figure 6-6 shows anticipated average daily truck traffic (no/day). The construction of F2 (Khevi-Ubisa) and F3 (Ubisa – Shorapani) sections are also expected during same period with this Project (F4, Shorapani - Argveta), numbers of trucks from F2 and F3 are also indicated in Figure 6-6. Additional numbers of daily trucks during the peak period of the tunnel excavation is expected to be vicinity of 1,560 trucks/day, which counts approximately 11% of current average daily traffic count of 15,000/day. Estimated average daily traffic during the construction is 16,560 trucks/day, which is close to the maximum daily traffic volume for 2 lanes road, 20,000 no/day (when inflow of large trucks are considered, the number drops to 18,000 no/day). Several locations in Zestafoni, such as railway line crossing, round about, and L shaped corner will experience bottleneck. Restriction of dump trucks for the construction to the existing road located in southern side of railways is considered as a mitigation measure.

(3) Diversion

Traffic diversions are required at following 4 locations indicated in Figure 6-7;

Diversion 1 (Ch 1 + 900)
During the construction of Piers 11 and Abutments 2 of bridges BTA/BAT 1, erection of superstructures of the bridge 1 over existing E60 and reconstruction of short section of existing E60, traffic on the E60 is temporally diverted to local road (existing local load + newly constructed local road) indicated in Figure 6-7.

Diversion 2 (Ch 4 + 600 – Ch 5 + 550)
Proposed alignment of RTA for this section overlies existing E60 alignment as shown in Figure 6-7. Earthwork of RAT7 for this section is proceeded prior to road works on RTA7, the section of RAT7 is utilised as a hauling road for the material excavated from Tunnel 3.

Road works on RTA7 of this section commence once tunnel TAT3 is completed and traffic on existing E60 is diverted on to RAT7.

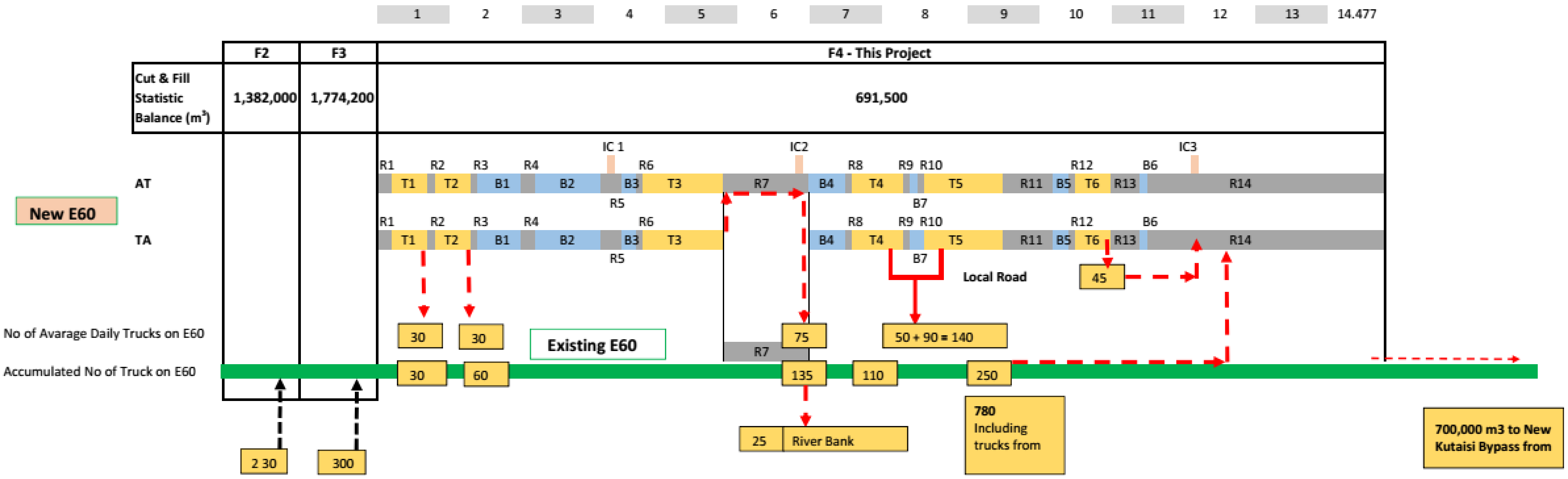
Diversion 3 (Ch 5 + 600)
Proposed alignment crosses over the existing E60 around Ch 5 + 600, traffic on E60 is diverted to IC 2 and directed to E60 as indicated in Figure 6-7 during the works of the crossover section.

Diversion 4 Local Road between Abutments 2 of Bridge 4 and portals of Tunnel 4
The local road is closed during the construction of the abutments of bridge BAT/BTA 4, the portals of tunnels TAT4/TTA4, and retaining wall along the local road. Temporary road is secured to provide the resident living in eastern side of the working area an access to E60 as indicated in Figure 6-7, construction of a temporary bridge over River Kvirila is required.

(4) Disposal

Approximately 700,000 m^3 of excavated material from the Project is subject to disposal. Road Department proposed the proposed construction site for The New Kutaisi Bypass, approximately 20 km west. Exact timing of the construction of the Bypass is not finalized yet.

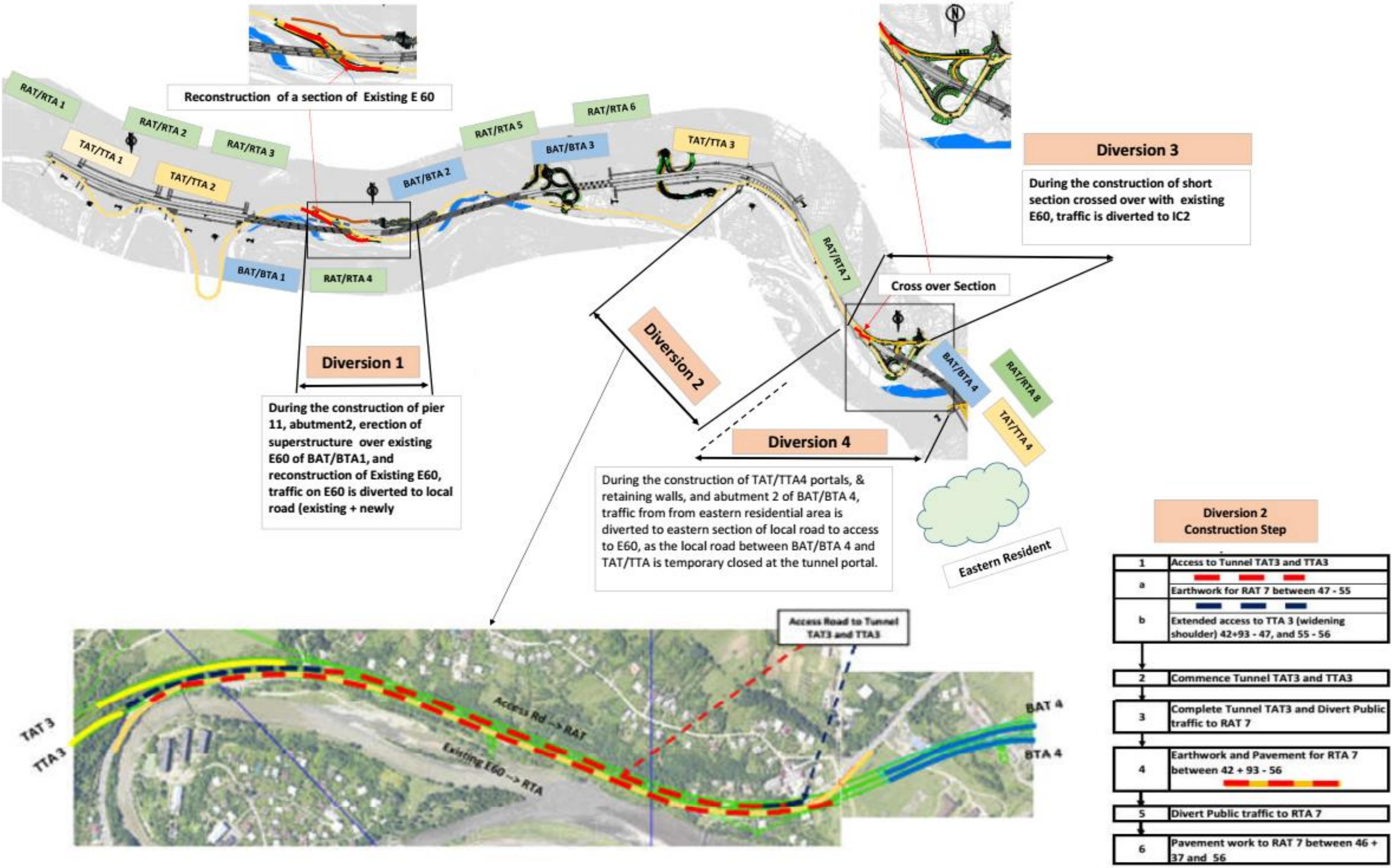
A possible stockpile area extending from River Chishura towards east along southern side of the proposed bypass alignment, approximately 2.5 km in length and 100-200 m width was confirmed by the study team.



Note; Cut & Fill Static Balance obtained by D/D Consultant
Numbers of Daily average truck from F2 and F3 are obtained assuming excavation period of 2 years (600 days)

Source: JICA Survey Team based on cut & fill statistic balance obtained from D/D consultant.

Figure 6-6: Anticipated Average Daily Truck Traffic during the Construction of Tunnels



Source: JICA Survey Team based on D/D drawing CM PHA 4000 GE PL 1002 Rev0

Figure 6-7: Locations of Traffic Diversion

6.4.3 Temporary Works

Temporary works include;

- Temporary yards for tunnel sites,
- Temporary plants, such as concrete bathing plant, crushing plant,
- Access roads and ramps for the construction of substructures, assembling and erection of superstructures of bridges,
- Temporary structures for bridge erections,
- Protection of traffic and railways,
- Traffic diversion roads,
- Haulage roads,
- Restoration of all roads utilized during the works,

Some of above temporary works are indicated in D/D as follows;

- Work site and Service roads (CM-WSI-0000-GE-PL-3001~3006)
- Local road No 2 (SR-RDE-4602-GE-PL-0201/0202),
- BoQ No 1 General Item, Item No 101 “Contractor's mobilisation and site installations”,
- BoQ No 3 Earthworks, Item No 315 “Mechanical crushing of oversized stones to be used in fill”,
- BoQ No 3 Earthworks, Item No 318 “Construction of protection barriers of prefabricated concrete cubes during cut excavation”, and
- BoQ No 5-1 TA/AT Bridge, Item No 502 “Preparatory works”

Table 6-11 summarise the temporary works required for the Project and items included in D/D.

Table 6-11: Temporary Works and D/D

Temporary Works		Description	D/D		Comments
			Drawings	BoQ	
All tunnels	Temporary Yards for Tunnel works	JST believes that temporary yard (100 m × 300 m) to accommodate facilities including power, concrete facilities, water treatment, storages, workshop at each tunnel site is required.	N/A	Bill No 1 General Item, 101 "Contractor's mobilization and site installations" may include some cost for this work. No details provided.	It is highly likely that BoQ includes only partial cost of the work, or excludes entirely.
Tunnels	Service Roads	D/D indicates provision of service roads 1,2,9, and 12 for Tunnel 1,2,4,5 and 6	CM –WSI-000-GE-PL-3001/3002/30033004/3005	N/A	Most likely excluded from BoQ
All Bridges	Working platform for erection of superstructure	IRD considers all erection works by cranes. JST believes that substantial and secure working platform for assembling of structure and erection work by crane is required at each bridge site.	Service roads, and crossing river roads are indicated for Bridge 1, 2, 3,4, 5, 6, and 7 in CM – WSI-000-GE-PL-3001/3002/30033004/3005/3006	Bill No 5.1 Bridge-502, "Construction of temporary roads and sites for the installation of piers and abutments"	BoQ No 5.1 for TA and AT Allocates only 64,000 GEL for all works. It appears significantly insufficient.
All Bridges	Temporary Bents for erection of Superstructures	D/D considers all erection works by cranes. JST believes that temporary bent are required during the erection of superstructure.	N/A	Bill No 1 General Item, 101 "Contractor's mobilization and site installations" may include some cost for this work. No details provided	It is highly likely that BoQ includes only partial cost of the work, or excludes entirely.
Road	Traffic Diversion 1	IRD considers traffic diversion during construction of P11, abutment 2 of Bridge 2 and erection of superstructure over E60 (Refer Section 6.4.2)	Local road 2 is newly constructed (SR-RDE-4602-GE-PL-0201/0202) to divert the traffic on E60	Bill No 3 Earthwork, 301-310 "Local Roads"	Drawings and quantities are included in D/D
On – Line Upgrading Section	Protection of live traffic	JST believes that protection of traffic during construction of On line upgrading section (km 4.6- km 5.6) addition to concrete barriers, such as rubber net over the rock surface and protection wall is required.	N/A	BoQ allocates, Bill No 3 Item 318 "Construction of protection barriers of prefabricated concrete cubes during cut excavation"	Controlled blasting, and walls are required for rock excavation in height more than 5 m.

Temporary Works		Description	D/D		Comments
			Drawings	BoQ	
Bridge 4 and Tunnel 4	Access Ramp and Protection of Georgian Railways	Temporary access ramp from local road is required for the works for abutments of Bridge 4, Temporary protection works for Georgian rails along above access ramp is also required.	Service road 7 (CM-WSI-0000-GE-PL-3003), no protection measures provided.	Bill No 1 General Item, 101 "Contractor's mobilization and site installations" may include some cost for this work. No details provided. Bill No 5.1 Bridge-502, "Construction of temporary roads and sites for the installation of piers and abutments"	It is highly likely that the cost in BoQ include only minimal works for service road, and excludes the works for protection of Georgian railways
Road	Traffic Diversion Road 4	D/D considers traffic diversion of local road during construction of portals for Tunnel 4 and abutment 2 of Bridge 4 (refer Section 6.4.2) The diversion road has a new bridge to cross River Kvirila	N/A	Bill No 1 General Item, 101 "Contractor's mobilization and site installations" may include some cost for this work. No details provided.	It is highly likely that BoQ excludes the cost.
Tunnel 4 and 5	Hauling Road for Tunnel 4 and 5	D/D suggested that existing local road is utilised to transport material excavated from Tunnel 4 and 5 to existing E60 (refer, Figure 6.5 in Section 6.4.2), require widening of the local road for traffic by dump trucks.	Service road 9 (CM-WSI-0000-GE-PL-3004)		It is highly likely that cost for the widening works and maintenance, and restoration upon completion are excluded.
Road	Fill material	Approximately 1.5 million m^3 of fill material is required for embankment Material excavated from tunnels is temporarily stockpiled and processed for fill material for embankment. Extensive stockpile area and crushing & screening plants and storage yard are required.	N/A	Bill No 3 Earthworks-315, "Mechanical crushing of oversized stones to be used in fill"	Quantity and rate allocated in the bill item appears insufficient.
Road	E60 Rehabilitation	JST believes that rehabilitation of E60 including the section in Zestafoni is required.	N/A	N/A	

Source: JICA Survey Team based on D/D as of 25 December 2017

6.4.4 Source of Major Material and Plant

Major materials and plant required for the Project and their sources are listed in Table 6-12.

Table 6-12: Source of Major Material and Plant

Item	Source		Note
	Georgia	Overseas	
Cement	Agent		
Re bar	Rustavi, Agent	Turkey, Ukraine	
Steel Fabrication	yes	Turkey	
Rock bolts		Turkey, Italy	
Shaped steel	Agent	Turkey	
Wire mesh	Agent	Turkey	
Stressing cable, bar		Turkey	
U Drain, Pipes	yes	Turkey	
Colgate pipes		Turkey	
Membrane and drainage pipe for tunnel		Turkey	
Gabion and slope protection	Agent	Turkey	
Asphalt (Bitumen)	Agent	Iran, Azerbaijan	
Road Furniture		Mostly (80%) from Turkey	
Pre stressed concrete girders	Locally manufactured		
Rational Steel Girders		Japan	STEP
Rock fall protection net		Japan	
All Ground Fastening (AGF) - Tunnel reinforcement		Neighboring Countries	
Large size Roadheader		Neighboring Countries	

Source: JICA Survey Team

6.4.5 Local Contractors

There are several Georgian general contractors and steel fabricators who have experience in road, bridge and tunnel constructions, the JICA study team conducted hearings from those contractors, it appears that none of them has enough resources to perform the Project of this magnitude. However, those companies can be utilized as subcontractors. List of major local contractors and their speciality are summarized in Table 6-13.

Table 6-13: Local Contractors

Name of Contractor	Speciality and Experience
Zemo	General Contractor
Caucasus Road Project	General Contractor
Khidmsheni -99 LLC	Bridge contractor
Elita Burji	Steel Fabricator
Rustavi Metallurgical Plant	Steel Fabricator, Reinforcing bars

Source: JICA Survey Team

6.4.6 Construction Programme

RDMRDI envisages the completion of the Project by the end of Year 2020, this means that the construction period of just over 2 years is allowed for the Project. Although the Contractor is able to proceed the works at multiple work fronts to shorten the construction period if he allocates enough resources to do so.

It is generally accepted idea that shorter the project duration becomes, require more resources, hence the more cost. There is a construction period which is optimal both from cost and construction period point of views. Relation between construction cost and construction period is analysed first to find the Optimum Construction Period, then 2.5 Years Construction is holistically assessed.

(1) Optimum Construction Period

Following 3 construction periods are considered;

- Very Tight schedule – 2.5 Years
- Moderate Schedule – 5 Years
- Relaxed Schedule – 7 Years

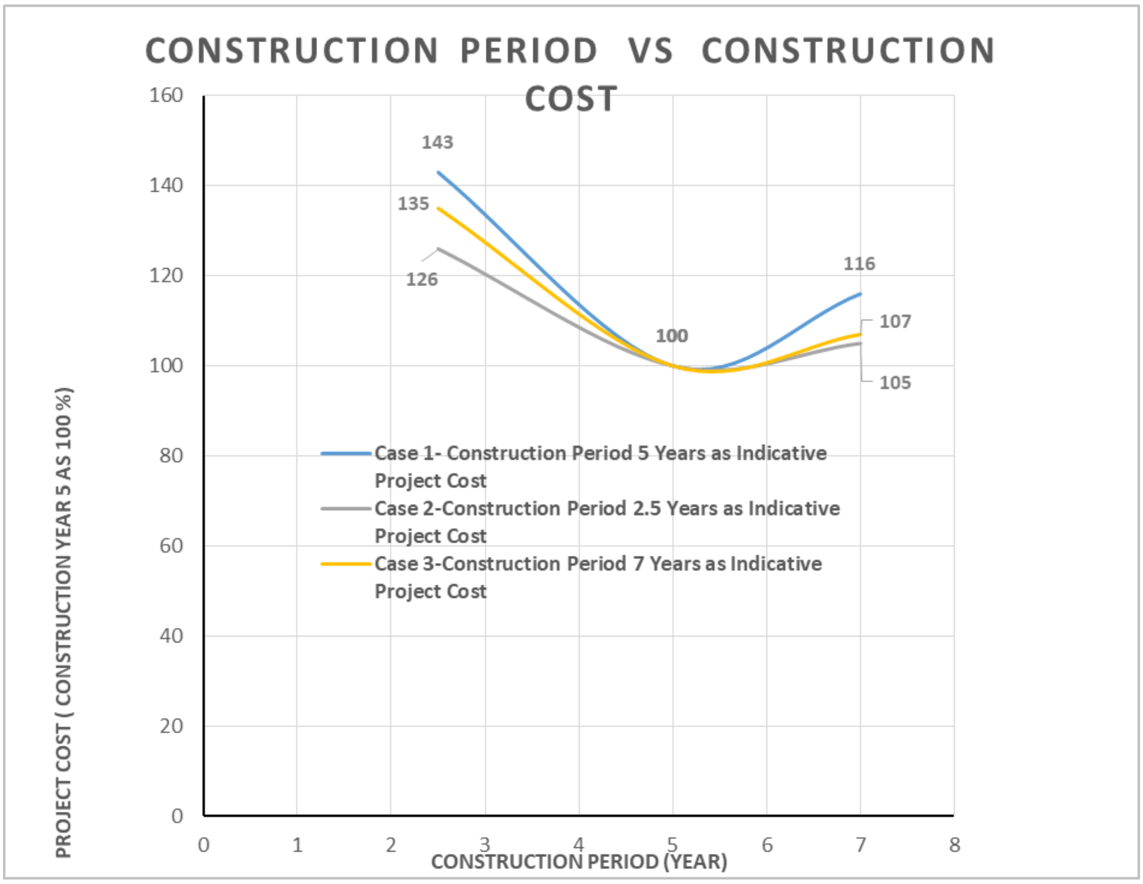
Overall project schedules, indicative cost and the method to obtain the cost for above 3 schedules are presented in Appendix 6.1,

Figure 6-8 shows the result of the analysis “Relation between construction period and construction cost”.

- Case 1 – “5 Years Construction being the Indicative Construction Cost,
- Case 2 – “2.5 Years Construction being the Indicative Construction Cost” and
- Case 3 – “7 Years Construction being the Indicative Construction Cost”

The relation obtained from the analysis indicates;

i. Optimum construction period appears between 4-6 years,
ii. Shorter the construction period than the Optimum construction period, higher the cost, longer the construction period than the Optimum construction period, higher the cost. This represents general relation between Construction Period and Construction Cost well,
iii. Cost of “2.5 Years Construction” appears 24 – 36 % higher than the cost of “5 Years Construction” which seems to be a schedule close to the Optimum Construction Period, and
iv. Additional cost for the project management is not considered in above analysis, this will increase overall project cost for “2.5 Years Construction”



Source: JICA Survey Team

Figure 6-8: Relation between Construction Period and Construction Cost

(2) 2.5 Years Construction and its Viability

The JICA study team strongly recommended “5 Years Construction” option, as it is close to the Optimum Schedule, 5 Years Construction can be shorten further by introducing multiple packages, most likely up to 4 years.

“2.5 Years Construction” is possible only when;

a) above additional cost, which is more than 30 % higher than the cost of “5 Years Construction”, is justified, and
b) likelihood of project risk associated with the schedule “2.5 Years Construction” is accepted and managed.

Project Management of “2.5 Years Construction” is much more difficult than “5 Years Construction”, as critical construction activities, such as Bridge 1,2, and 4, Tunnels 3,4, and 5 take place in every work fronts at the same time. Even slight deviation from the original plan in single activity has compound effects on the overall schedule. The Contractor, the Engineer and the Employer requires additional resources to manage the risk, hence the cost.

Following conditions need to be fulfilled;

Contractor

- Enough resources, at least (in case of single package)
- 9 bridge parties,
- 9 tunnel parties
- 6 road parties,
- Substantial financial cash flow capacity, most likely, US$20-30 million

The Employer

- 100% Site Access upon Signing of the Contract,
- Clear all Environmental and Social Issues prior to the commencement of works,
- Speedy decisions, especially on unforeseeable events,

(3) Anticipated "2.5 Years Construction Schedule"

The JICA survey team prepared an anticipated construction program for "2.5 Years Construction" as presented in Figure 6-9.

Immediately after the initial mobilization of resources, the Contractor needs to commence works at almost every work fronts to achieve the Schedule. This is achievable provided that the Contractor can allocate enough resources, as interactions of each work are minimal.

Bridge 1, 2 and 4, Tunnel 3, 4 and 5 are on critical pass, Bridge 3, Tunnel 1 and 2 are considered as sub-critical works.

As critical construction activities take place simultaneously in every work fronts, even slight deviation from the original plan in single activity has compound effects on the overall schedule.

The contractor shall plan and coordinate miscellaneous works including retaining walls, culverts, relocation of utilities

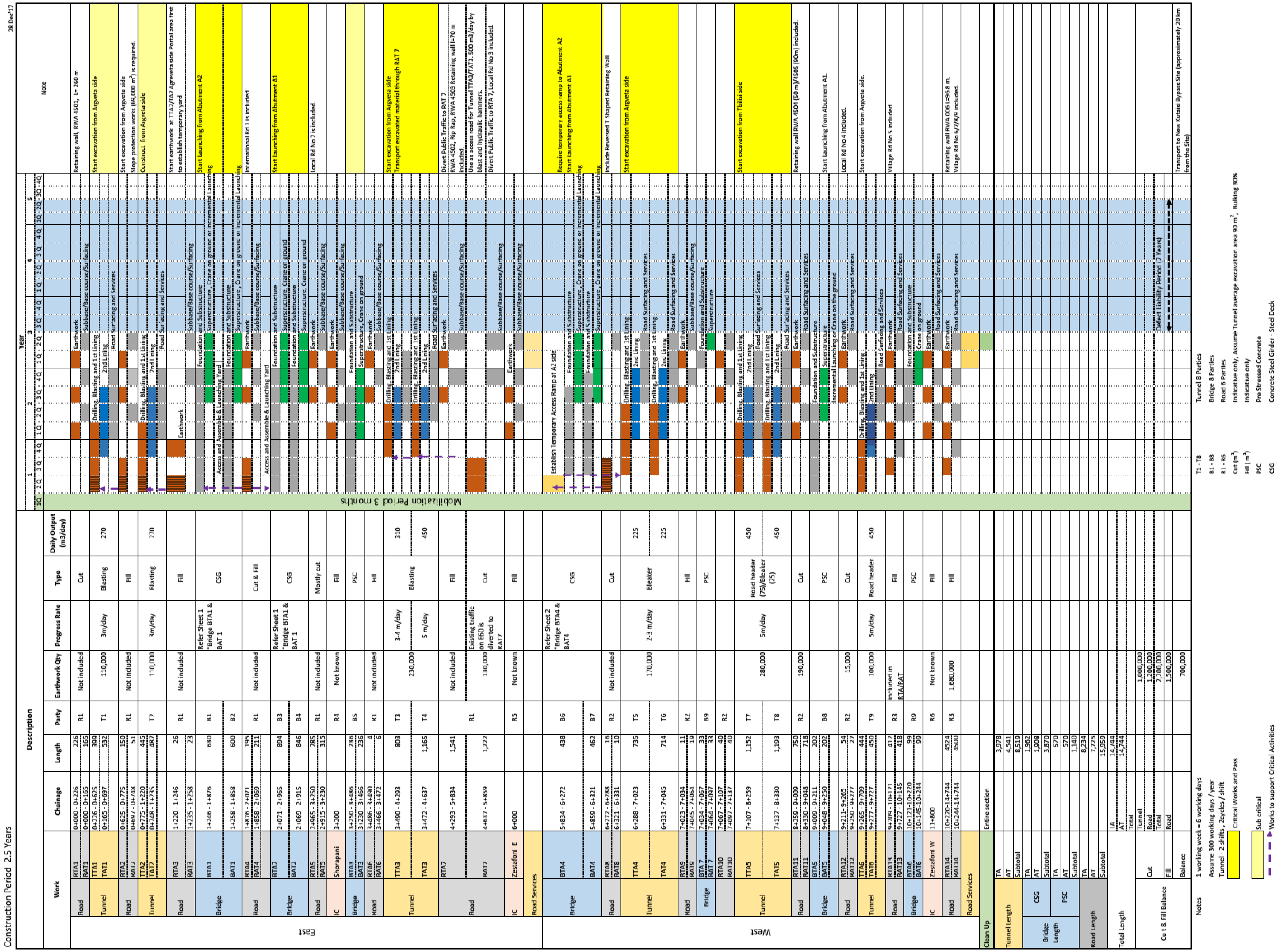
The Program developed by D/D consultant (drawing reference; CM-WBS-4000-GE-PL-4000, Diagram of the Works) is similar to the JICA survey team's schedule except work items as summarized in Table 6-14.

Table 6-14: D/D Consultant's Schedule and Comments by the JICA Survey Team

No	Works	D/D Consultant's Schedule (DDC)	Comments by JST
1	Overall	DDC considers 2 .5 years construction is very tight, but possible. DDC considers crane erection for all bridges.	JST considers that 2.5 years construction is possible, however it is extremely tight schedule. JST has recommended 4-5 years construction period based on the result of cost -construction period analysis. JST considers incremental launching method for Bridge 1 and 4 is more appropriate. Methods applied for tunnel construction are more or less same.
2	Tunnel 1 TA & AT	DDC allows 15.5 months construction period for tunnel TA & AT including excavation of total 931 m and 4 portals by single party. DDC assumed that lining and pavement works follows immediately after excavation, the works are completed 1 month after completion of excavation.	JST recommends immediate start of the work and to allow more time lag between excavation, lining and pavement. JST allows 18 months for tunnel TA & AT by single party.
3	Tunnel 2 TA & AT	DDC allows 15.5 months construction period for tunnel TA & AT including excavation of total 932 m and 4 portals by single party. DDC assumed that lining and pavement works follows immediately after excavation, the works are completed 1 month after completion of excavation.	JST recommends immediate start of the work and to allow more time lag between excavation, lining and pavement. JST allows 18 months for tunnel TA & AT by single party.
4	Bridge 1 TA & AT	DDC allows only 19 months for TA & AT by 2 parties, and considers erection by crane on river bed.	JST considers 27 months construction period by 2 parties, at least 24 months. Incremental launching erection is considered, as crane lifting from river bed is difficult due to lifting weight and lifting height more than 20 m. steel assembling yard can be secured in the area between Bridge 1 and 2.
5		DDC allows 9 months for piers and abutment.	It appears too tight. Requires 1.2- 1.5 years at least by two separate parties.
6		DDC allows 13 months for construction of all piers and superstructure by 2 parties for TA and AT.	It appears too tight. Requires 2 years at least by two separate parties.
7	Bridge 3 TA & AT	DDC allows 11 months for all substructure by single party and all superstructure by 2 parties.	It appears too tight. Requires 20 months at least by single party.
8	Tunnel 3 TA & AT	DDC allows construction period of 18 months by 2 parties. Consider access to portals at Argveta side from E60.	18 months construction period appears reasonable, Access from E60 seems to be very tight, JST recommends excavation of RAT 7 first and use the RAT 7 as the access to both portal (refer Figure 6.7 in Section 6.4.2).
9	Road 7	Start excavation of AT from beginning of 4^{th} month.	JST recommends immediate start of this section to provide access to portals for AT and TA and hauling road.

No	Works	D/D Consultant's Schedule (DDC)	Comments by JST
10	Bridge 4 TA & AT	DDC allows 16 months for the bridge works including temporary roads, foundation and substructure by single party and superstructure by 2 parties, consider erection of superstructure by crane on river bed. Introduce reversed T shaped retaining wall between abutments and tunnel portals to allow relocation of local road (refer MA-TUN-4004-GE-TB-4312). Closed the local road at portals and abutments area, divert traffic from nearby village to E60 through a temporary bridge built eastern side of Shorapani Station.	Consider at least 24 months by 2 separate parties, and application of incremental launching due to undulating river bed and lifting height over 20 m. Considers access ramp to Abutment 2, the ramp shall have protection wall to prevent falling of material in Georgian railway's right of way. Introduction of the Reversed T shaped retaining wall and the diversion seems workable.
11	Tunnel 4 TA & AT	DDC considers excavation from Argveta side, allows 21 months by 2 parties. Establish temporary yard in the area between Tunnel 4 and Tunnel 5 and provide access to the yard through existing local road,	JST also consider excavation from Argveta side, allow 24 months to complete Tunnel TA & AT, therefor DDC's construction period appears reasonable. JST also locate temporary yard in the area between Tunnel 4 and Tunnel 5 and an access to the yard using the existing local road (refer Figure 6.5 in Section 6.4.2).
12	Tunnel 5 TA & AT	DDC considers 27 months to complete tunnel TA & AT by 2 parties.	JST allows 24 months to complete TA & AT by 2 parties using roadheader for 75% of tunnel excavation and remaining by blast.
13	Bridge 5 TA & AT	DDC allows 12 months to complete all works including foundation and substructure by single party for 8 months and superstructure by 2 parties for 6 months.	JST considers 12 months proposed by IRD too tight and allow 21 months by single party.
14	Tunnel 6 TA & AT	DDC considers 26 months to complete tunnel TA & AT by 2 parties.	JST allows 21 months to complete TA & AT by 2 parties using road header.

Source: JICA survey team



Source: JICA Survey Team

Figure 6-9: Anticipated Construction Program "Construction Period 2.5 Years" Prepared by the JICA Study Team

6.5 Project Risks and Mitigation Measures

There are a number of different types of construction contracts, and project risk depends on the type of contract adapted by the Employer. RDMRDI employs JICA Harmonized Edition of FIDIC Construction Contract for the Project.

Table 6-15 lists conceivable risk under the Contract, likelihood, severity and possible mitigation measure for each risk.

Following risk especially need attention:

a) ROW:
Non-access to the site by the Contractor due to outstanding land acquisitions delays the Project and result in additional cost, every effort shall be made to achieve 100% land acquisition prior to the Contract Agreement,

b) Environment clearance:
In order not to hinder the construction progress, it is necessary to acquire environment clearance. Regarding the ROW, the Employer initiates its acquisition. On the other hand, regarding the temporary land which is necessary for the Contractor outside the ROW such as temporary facilities and material storage, it is obligated to obtain under the initiative and responsibility of the Contractor. For contractors, it is desirable to prepare for acquisition of environment clearance in advance so that it would not be delayed in the construction period.

c) Relocations of utilities and Installation of new utilities:
Relocation of existing utilities has a significant impact on both the Project cost and duration of the works.

d) Georgia Rail (GR), railway overpass at St 42:
Contractor to prepare detail construction method, safety control measures in satisfaction of GR and the Engineer

e) In case of multiple Contractors, certain activities adversely impact on other party's activities, for example, prolonged traffic restriction by the Contractor working for one Package may delay and disrupt the progress of other package by another Contractor.

Table 6-15: Conceivable Risk and Mitigation Measures

Risk		Consequence Severity		
		L (Minor)	M (Moderate)	H (Major)
Probability	H (Easily happen)	Low	High	Extreme
	M (Could happen)	Low	Moderate	High
	L (Extreme occasion)	Low	Low	High

Potential project risks	Assessment					
	Probability	**Impact**	**Analysis of Probability and Impact**	**Mitigation Measures**	**Action during the implementation**	**Contingency plan (if applicable)**
1. Stakeholder Risk						
1.1 Georgia Railways (GR)						
Interference of the proposed road alignment with the existing railway structures and future plan	L	H	Details of the existing railway structures and future plan are available during design stage and these conditions can be fully incorporated into the road design, therefore, probability of the event is low. Should the event occur, significant design change including realignment is required, which will cause major impact on time and cost.	Thorough investigation of existing railway structures and future plan of GR	Maintain communication with GR and ensure that GR is notified of the construction timing, period and methods.	
1.2 Ministry of Environment and Natural Resource Protection						
Regulations set by the Authority are not met in Design and/or during construction	L	H	Environmental requirements set by the Authority are fully considered in the design and construction activities, therefore, probability of the event is low. Major impact, as remedial measure delays the project in significant way.	Incorporate environmental requirement in the design and contract conditions. Design auditing specifically focus on environment by a 3rd party.	Request the Contractor to prepare environment management plan complying the requirement and the Engineer to strictly monitor the plan and report to the Employer.	

Potential project risks	Assessment					
	Probability	**Impact**	**Analysis of Probability and Impact**	**Mitigation Measures**	**Action during the implementation**	**Contingency plan (if applicable)**
1.3 Utility Providers (Power/Gas Pipe/Fiber Optic/Water & Sewer)						
Interference of the proposed road alignment with the existing utility lines	L	H	Details of the existing utility lines and future plan are available during design stage and these conditions can be fully incorporated into the road design, therefore, probability of the event is low. Should the event occur, significant design change including realignment is required, which will cause major impact on time and cost.	Thorough investigation of existing utilities structures and future plan of utilities	Maintain communication with utility providers and ensure that they are notified of the construction timing, period and methods. Joint inspection to be conducted.	D.D includes relocation plan for powerline, gas line, fiber optical cable and water & sewer, and their relocation cost. Allocate contingency.
1.4 Landowners (farmers, grazers, etc.)						
Outstanding land acquisition. Additional works during construction to minimize damage caused by changes in land use, for example, water flow and access.	M	M - H	It is likely for the Employer not to be able to complete all land acquisition prior to the commencement of works (the Employer intends to acquire at least 50% of ROW prior to the signing of the Contract, remaining will be available during the mobilization period. Moderate – Major impact on cost and the progress of the work	The Employer to complete all land acquisition prior to the signing of the Contract. This is absolutely necessary if 2.5 year construction is go ahead.	Change sequence of works if possible to avoid the suspension of work due to the access issue. Periodical consultation with farmers and grazers during the construction as needed.	Allow time and cost if outstanding land acquisition will most likely remain by the time of commencement of the work.
Additional works during construction to minimize damage caused by changes in land use, for example, water flow and access.	M	M	It is possible that the original land use is unexpectedly affected by the Project.	Detailed design requires thorough investigation of existing land use and identify possible impact on the land use caused by the proposed road.	Periodical consultation with farmers and grazers during the construction as needed.	

Potential project risks	Assessment					
	Probability	**Impact**	**Analysis of Probability and Impact**	**Mitigation Measures**	**Action during the implementation**	**Contingency plan (if applicable)**
2. Executing Agency Risk						
2.1. Capacity Risk						
Shortage of human resources hinder the project.	L	M	The Employer (Road Department) has completed a number of road projects funded by international assistant agencies including WB, ADB, and JICA, therefore they are familiar with requirements of international assistant agencies. Minimum probability.	Discuss lessons learned from previous projects to develop effective measures for smooth implementation of the Project.	Earlier consultation with JICA.	
2.2. Governance Risk						
The Employer does not have established policies and regulations to deliver the project with this size funded by international assistant agencies, the progress of the Project is hindered.	L	M	The Employer (Road Department) has completed a number of road projects funded by international assistant agencies including WB, ADB, and JICA, the Employer has policy and regulation applied for those projects. Minimum probability.	Discuss lessons learned from previous projects and effective measures to improve the outcome.	Earlier consultation with JICA.	
2.3. Fraud and Corruption Risk						
The Employer's staff committed fraudulent and corrupted acts in relation to the Project.	L	M	The Employer (Road Department) has completed a number of road projects funded by international assistant agencies including WB, ADB, and JICA, and is fully aware of the consequence of the event. Minimum probability.	Check mechanism such as periodical audits by 3rd party such as National Forensic Bureau and an auditor appointed by JICA.	JICA hotline to be informed to concerned parties and people.	

Potential project risks	Assessment					
	Probability	Impact	Analysis of Probability and Impact	Mitigation Measures	Action during the implementation	Contingency plan (if applicable)
3. Project Risk						
3.1. Design Risk						
Considerable number of design changes, Disruption and delay of the Project as the result	M	H	Due to complex geological conditions along the road, it is highly likely that the Project encounters unforeseeable ground conditions, which normally result in design changes. Special attention to slope protections and potential landslides. Medium probability.	Identify areas with complex subsurface condition, apply moderate design (between conservative and lean design).	Minimize the disruption of the work by altering the original sequence of the works	Allocate contingency both in construction schedule and budget.
3.2. Construction Risk						
Rock fall in the area between Tunnel 1 and Tunnel 2	M	H	Observation of ground suggests possible landslide in the area. Significant impact.	Further investigation through borings, monitoring by inclinometer etc. detail site survey. Protection net to prevent falling rock is included in the detailed design.	Contractor to monitor the ground daily, installation of temporally wall may be required.	
Change in underground water level in Tunnels 4 and 5 area	M	M	Due to large excavation activity, ground water level in Tunnels 4 and 5 areas is significantly lowered and it may affect livelihood of residents	Monitor ground water level, lower the tunnel alignment.	Regularly consult with residents in the area most likely affected.	
Noise, Vibration, and Dust	M	M	Resident in certain area, such as Zestafoni, will be constantly disturbed by noise, vibration and dust caused by dump trucks hauling excavated material to stockpile. Some resident may bring the matter to relevant authority, which may result in delay of the works	Avoid planning of temporary access road in residential area as much as possible. Provide dust cover to trucks. Regular service by watercart during dry season. Avoid hauling operation during night time.	Regularly consult with residents in the area most likely affected. Monitoring to be conducted by the Contractors and reported to the Engineer and the Employer.	

Potential project risks	Assessment					
	Probability	Impact	Analysis of Probability and Impact	Mitigation Measures	Action during the implementation	Contingency plan (if applicable)
Georgian Railways	M	H	The works for portals for Tunnel 4, abutment 2 of Bridge 4 and reversed T shaped retaining walls between the portals and the abutments are located adjacent to Georgian railways. Falling of excavated rock or construction material and equipment to the railway line result in catastrophic event.	Prior to any works in the area, the contractor to prepare work plan indicating protection plan and discussed with technical department of GR and the Engineer to receive their approval. Installation of temporary wall along the railways. Place very experienced safety officer on the site and strictly follows the work plan.	Restrict blasting, heavy excavation, lifting activities, etc. at non-operational period (GR has 2 live lines, one on higher elevation, and another on lower elevation). Railway on higher elevation has 4 trip/day, lower line has approximately 40 trip/day. Contractor to negotiate timing of their work and inform GR accordingly.	
3.3. Program & Donor Risk						
Disturbance of the Project due to dispute over the evaluation of design changes	H	H	As mentioned in Section 3.1, High probability of design changes due to complex geology. Dispute over the evaluation of extension of time and additional cost and time due to the design changes are highly likely and cost would be significant.	Include an experienced contract administrator and a scheduler in project management team. Inform and engage Dispute Board from early stage of events which will be likely developed to dispute in the future.	Monitor and analyze construction schedule throughout the Project by critical pass based software, particularly when design change takes place. Fully inform DB of development of design changes during site visits and meetings.	Allocate contingency both in construction schedule and budget.

Potential project risks	Assessment					
	Probability	**Impact**	**Analysis of Probability and Impact**	**Mitigation Measures**	**Action during the implementation**	**Contingency plan (if applicable)**
Construction Schedule and Delay	H	H	2.5 years Construction for the magnitude of this project appears so tight, activities at every work front are happening simultaneously, any delay at single point has domino effect on the rest of activities immediately. Significant impact.	Cooperative approach between the Employer, the Engineer and the Contractor, focus on site activities rather than the contractual issues. Use DB effectively.	Identify any issue which may have impact on the progress of work as early as possible and notify other parties and take actions to minimize possible delay.	Allocate contingency in the budget.
3.4. Delivery Quality Risk						
New technology/ construction method/ material for Georgia in areas of slope protection, bridge, and tunnel are included in the design, defective construction and remedial works due to lack of experience and supervision by the Contractor.	L - M	M - H	Low probability provided that experienced international contractor strictly follows the relevant specifications and the quality control system approved by the Engineer.	Restrict the use of new construction application unless justified. Nominate specialists for the new construction applications in the Contract.	Establish clear holding points critical to quality of the structure, examination and test by qualified supervisors and engineers in accordance with the relevant specs and the quality control system.	
Defective work due to short construction period	M	M	The contractor cut corner to meet construction milestones, this result in poor workmanship and defective works. The project may be delayed due to significant number of remedial works	Contractor to have enough resources to be able to achieve quality standard including lab, material engineers, quality engineers. The Engineer also needs enough staff to supervise the contractor.	Strict supervision of quality control in accordance with specification in the Contract.	

Potential project risks	Assessment					
	Probability	**Impact**	**Analysis of Probability and Impact**	**Mitigation Measures**	**Action during the implementation**	**Contingency plan (if applicable)**
3.5. Contractor Financial Risk						
Contractor experiences financial difficulty during the Project, progress of the work is affected significantly. Possible termination of the Contract.	L	H	Experienced in the East-West Highway Improvement Project, Zestafoni – Kutaisi – Samtredia. Both parties need to spend significant time and effort on the event. Major impact on both cost and time.	Rigorously check the financial status of tenderers. JV agreement shall include a clause dealing with the replacement of the lead member with other member in case of the lead member being financially disable.	Monitor financial status of the Contractor, specifically payments to its subcontractors, suppliers and labor.	
4. Other Risk						
4.1 Traffic Control during Construction						
Hindrance of work progress due to traffic accidents	H	M	Approximately one third of the Proposed road locates in mountainous region and form very narrow and winding alignment. Most of local drivers tend to ignore traffic rules and speeding. Probability of traffic accident during construction will be high. Reinstatement of accident site, investigation disturb construction activities and delay the progress.	Effective and strict traffic control. For critical areas, police presence may be required	Preparation of standard emergency procedure.	
5. Overall Assessment	M	M	2.5 years construction period, which seems quite tight, may have significant impact on project cost, quality and safety unless it is managed with cooperative approach, ample resources and good working practices. Project Cost Overrun and Prolonged Construction Period	Refer 3.1, 3.2, 3.3, and 3.4	Refer 3.1, 3.2, 3.3, and 3.4	Allocate contingency both in construction schedule and budget.

Provability (Likelihood) - L= Low, M= Medium, H= High
Impact (Consequence) - L= Not significant, M= Medium, H= Significant
Source: JICA Survey Team

Chapter 7 Preliminary Project Cost Estimation

(This chapter has been removed because of confidential information.)

Chapter 8 Environmental and Social Considerations

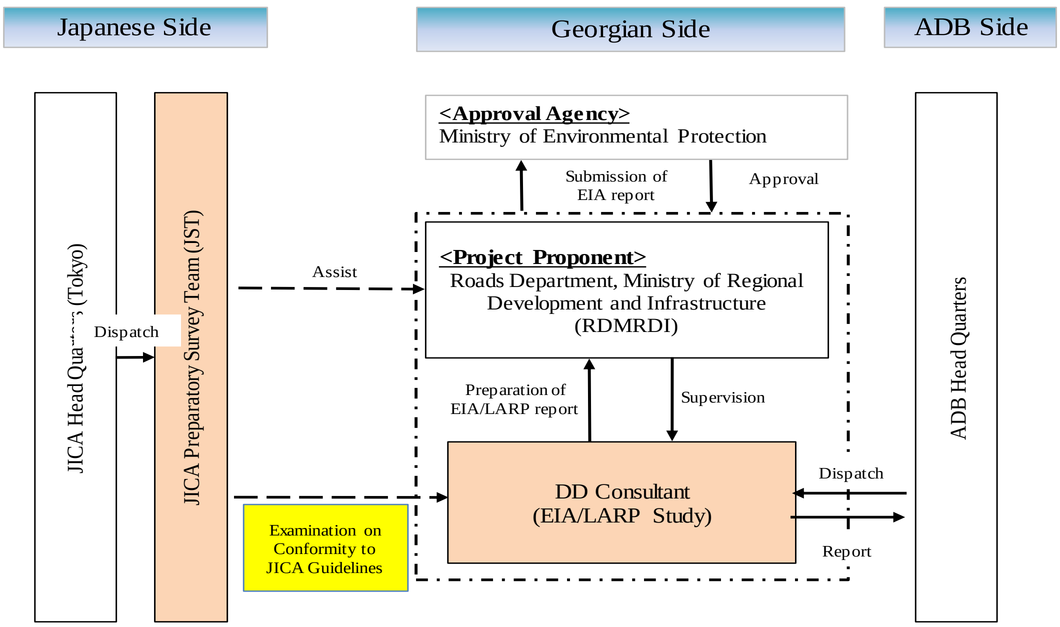
8.1 General

The objectives of this survey are to conduct necessary studies for a Japanese Loan Project of the East-west Highway Development Project (Phase 2), including a review of the Detailed Design (DD) being conducted by the Asian Development Bank (ADB) and an examination of possible applications of Japanese technology.

The target section of the Project is approximately 14.7 km of the existing E60 between Shorapani and Argveta of Imereti State. The feasibility study (FS) funded by the World Bank (WB) on the section of 81 km between Zemo Osiauri and Argveta, which includes this section, was conducted in 2015. The “Report of Environmental Analysis” and “Resettlement Policy Framework” were prepared during the FS in the course of discussion on environmental and social considerations.

The Project has been categorized as “category A” based on the JICA Guidelines for Environmental and Social Considerations (April 2010), hereinafter referred to as the “JICA Guidelines”. The draft Environmental Impact Assessment (EIA) and Land Acquisition and Resettlement Plan (LARAP) were prepared by the DD consultant hired by ADB. The JICA Survey Team (JST) reviewed the drafts for conformity with Georgian legislation and the JICA Guidelines.

During the review, JST maintained close communication with related parties including the counterpart and ADB to ensure that the produced reports will meet the requirements of the JICA Guidelines as much as possible. JST remained in close contact with the DD consultant and requested for them to revise the draft reports if necessary. JST also confirmed the necessary procedures for the EIA approval process and provided assistance to the counterpart for the process to proceed on schedule. The implementation structure for the study is shown in Figure 8-1.



Source: JICA Survey Team

Figure 8-1: Implementation Structure of the Survey

8.2 Environmental Considerations

This section gives an overview of environmental assessment regulations under the legislation of Georgia and the guidelines of JICA (and ADB/WB, where relevant), including their comparisons, and a summary of the EIA report.

8.2.1 Legal Framework on Environmental Impact Assessment

(1) Legal Framework on Environmental Impact Assessment in Georgia

Two pieces of legislation provide the basic framework for conducting an environmental impact assessment (EIA) in Georgia:

- “Law of Georgia on Environmental Impact Permits” (2007)
- “Regulation on the Environmental Impact Assessment” (2013)

The “Law of Georgia on Environmental Impact Permits” defines activities within the borders of Georgia that are subject to mandatory ecological examination and permit issuance (environmental impact permit). According to article 4, sub-paragraph j) of the Law, “construction of international and intrastate highways and railways, and bridges and underway crossings over them, as well as structures for engineering protection of highways, railways and their territories” is subject to ecological examination, thereby including this Project in its scope. This Law also defines the permit application/issuance procedure for the planned development, including timeframes for information disclosure and public review. It should be noted that although a revised version of this law will become effective after 1 January 2018, this project will follow the existing (old) legislation, under which its application was started.

The Law requires developers to conduct an EIA and submit the report, which is then subject to state ecological examination. Procedures and requirements of an EIA are specified in the “Regulation on the Environmental Impact Assessment.” Assuming the state review is favorable, an environmental impact permit is issued by the Ministry of Environmental Protection and Agriculture of Georgia[1], which is a pre-requisite for obtaining a construction permit. To obtain a permit, the project proponent must submit a written application to the Ministry with the following documents:

a) an EIA report prepared according to the standards set by the legislation of Georgia;
b) a layout plan of the intended activity site;
c) volume and types of anticipated emissions;
d) an abstract of activities; and
e) a statement on confidential parts of the submitted application.

Article 10, paragraph 4 of the Law further stipulates that the required procedures and content of an EIA report shall be established by the “Regulation on the Environmental Impact Assessment”. According to the Regulation, principles of EIA include:

a) comprehensive consideration of technical, technological, social and economic characteristics of design decisions of the planned activity;
b) consideration of alternative design decisions to meet the requirements of environmental standards;
c) comprehensive consideration of local factors;
d) publicity and public participation; and
e) appropriateness of methods applied during EIA and reliability and validity of obtained information and conclusions.

[1] Ministry of Environment, Natural Resources and Protection (MoENRP) until November 2017

(2) JICA Guidelines on Environmental Considerations

The objectives of JICA's guidelines are to encourage Project proponents etc. to have appropriate consideration for environmental and social impacts, as well as to ensure that JICA's support for and examination of environmental and social considerations are conducted accordingly. JICA recognizes the following seven principles to be very important:

1. A wide range of impacts must be addressed.
2. Measures for environmental and social considerations must be implemented from an early stage to a monitoring stage.
3. JICA is responsible for accountability when implementing cooperation projects.
4. JICA asks stakeholders for their participation.
5. JICA discloses information.
6. JICA enhances organizational capacity.
7. JICA makes serious attempts at promptness.

JICA also requires their projects to not deviate significantly from the World Bank's Safeguard Policies.

(3) Comparison between Georgian Legislation and JICA/WB Guidelines

There are no significant difference between JICA, WB, and ADB guidelines on environmental assessment. Some gaps exist, however, between the requirements of these guidelines and those of the Georgian legislation on environmental assessment. An overview of the gap analysis between the requirements of JICA and the Georgia are given in Table 8-1. However, for this project, which is being funded by various international donor organizations, the client has confirmed that they will follow the guidelines of the relevant funding organizations, especially when they have stricter requirements than the Georgian legislation.

Table 8-1: Gap Analysis between JICA Guidelines and Georgian Legislation

Item	JICA (WB/ADB)	Georgia	Harmonized Measures
Scoping	• Describes scoping and EIA preparation procedures in detail.	• Scoping not considered by the national legislation.	• JICA and ADB guidelines will be followed
EIA Approval	• Projects are assigned as A, B or C categories by considering ecological impact and other factors. EIA required for A and possibly also for B category projects.	• No A/B/C categorization. Activities requiring an EIA are defined in the Law of Georgia on Environmental Impact Permits.	• JICA and ADB guidelines will be followed
EIA Disclosure	• JICA: EIA is to be disclosed after governmental approval and 120 days before loan agreement • WB/ADB: draft EIA is disclosed	• Draft EIA is disclosed before application for approval to the Ministry for 45-60 days	• JICA guidelines will be followed
Environmental Management and Monitoring Plan	• Environmental Management and Monitoring Plan required for category A and B projects	• No specific management/monitoring plan requirements	• JICA guidelines and suggestions will be followed

Item	JICA (WB/ADB)	Georgia	Harmonized Measures
Consideration of Alternatives	• Mitigation measures and alternatives (including "No Project" scenario) are considered	• Alternative location, technology, etc. are considered	• Multiple alternatives are considered
Stakeholder Consultation	• Stakeholder consultation conducted at least twice and continuously during project implementation if needed • Keep record of discussions and include in project plan	• Conduct a public review of draft EIA and consider stakeholder opinion in project planning	• 2 stakeholder consultations were held in addition to public review, and their opinion was reflected in project planning

Source: JICA Survey Team

In addition, to harmonize the EIA disclosure process between ADB and JICA, which was under discussion at the time of DFR, it was confirmed that only JICA's disclosure (120 days) would be applies to this project. The Ministry of Environmental Protection and Agriculture of Georgia issued an ecological expertise on 26 March 2018 and approved for the RD to proceed with the project.

8.2.2 Summary of the Environmental Impact Assessment

The first draft EIA for this project, prepared by a DD consultant hired by ADB, was submitted at the end of November 2017. JST reviewed the report and, also considering comments from JICA, requested revisions including confirmation of potential impact to protected areas, further clarification about the State Forest Fund system, confirmation about environmental management cost, and updating of various maps. JST held discussions with RD and the DD Consultant particularly regarding the treatment of potentially contaminated soil behind the GAA Factory and the proposed installation of noise barriers during the operational phase. The second draft EIA reflecting the result of these requests and discussions was submitted in mid-January. In reviewing the second draft EIA, JST further requested revisions and clarifications on issues such as sources for water and air quality standards, mitigations measures (e.g. replanting and monetary compensation) of cutting rare species of trees, compensation for drawdown in wells, and ecosystem and protection measures of the Eurasian otter. The final EIA was submitted in March 2018.

Potential impacts from the Project were assessed and screened comprehensively by category. Low to medium impacts are expected in most areas. Potentially high impact during the construction phase is expected from loss of land and property due to the new road, accidents and injuries to workers, and damage to properties caused during blasting and piling. Section below gives an overview of the final EIA. Refer to the EIA report for details (Appendix 8.1).

(1) Description of the Environment

Air Quality

Within the Project area the main sources of air emissions are from transport, including vehicles on the existing Project road and large scale industrial facilities including the Georgian American Alloys (GAA) manganese processing plant which is located almost adjacent to the southern boundary of the Project road. Air quality monitoring was carried out at nine different locations during August 2017, and the results show that in most instances the parameters monitored were below national, and where applicable, IFC standards. The exception was NO_2 exceeding the national limit for 30 minutes average in two locations. Overall the most noticeable factor was the higher levels of PM recorded at the first four monitoring stations which are adjacent to the existing road, suggesting that these levels of PM10 and PM2.5 are attributable to vehicle movements on the existing road.

Table 8-2: Ambient Air Quality Monitoring Results

#	Time	Wind speed, m/s	Wind direction	CO, µg/m³	NO_2, µg/m³	SO_2, µg/m³	PM10, µg/m³	PM 2.5, µg/m³	TSP, µg/m³
NVA-1									
1	12:30 -13:50	1.3	W	<1,000	376	<500	28	26	<100
2	19:30-19:50	1.4	W	<1,000	<200	<500	91	61	200
3	01:30-01:50	1.0	W	<1,000	<200	<500	18	15	<100
4	06:55–07:15	1.0	W	<1,000	<200	<500	10	9	<100
NVA-2									
1	13:00-13:20	2.0	SW	<1,000	550	<500	48	32	120
2	18:50-19:10	1.6	SW	<1,000	376	<500	72	39	170
3	01:00 -01:20	1.0	SW	<1,000	<200	<500	18	15	<100
4	06:50-07:10	1.0	SW	<1,000	<200	<500	10	9	<100
NVA-3									
1	10:30 -10:50	2.0	SW	<1,000	<200	<500	12	9	<100
2	18:20-18:40	1.6	SW	<1,000	<200	<500	29	21	<100
3	00:30-00:50	1.2	SW	<1,000	<200	<500	10	7	<100
4	06:20 -06:40	1.0	SW	<1,000	<200	<500	5	4	<100
NVA-4									
1	12:00-12:20	2.0	W	<1,000	<200	<500	36	24	110
2	17:50-18:10	1.2	W	<1,000	<200	<500	35	25	120
3	24:00-24:20	1.1	W	<1,000	<200	<500	11	8	<100
4	05:50-06:10	1.0	W	<1,000	<200	<500	<1.0	<1.0	<100
NVA-5									
1	10:00 -10:20	1.6	NW	<1,000	<200	<500	5	4	<100
2	17:20-17:40	1.2	NW	<1,000	<200	<500	25	16	<100
3	23:30-23:50	1.1	NW	<1,000	<200	<500	<1.0	<1.0	<100
4	05:20-06:40	1.0	NW	<1,000	<200	<500	<1.0	<1.0	<100
NVA-6									
1	09:10-09:30	1.0	SW	<1,000	<200	<500	<1.0	<1.0	<100
2	16:40-17:00	1.0	SW	<1,000	<200	<500	16	11	<100
3	23:10-23:30	1.2	SW	<1,000	<200	<500	<1.0	<1.0	<100
4	04:10-04:30	1.0	SW	<1,000	<200	<500	<1.0	<1.0	<100
NVA-7									
1	08:30-08:50	1.5	NW	<1,000	<200	<500	9	6	<100
2	16:10-16:30	1.1	NW	<1,000	<200	<500	16	12	<100
3	22:50-23:10	1.0	NW	<1,000	<200	<500	<1.0	<1.0	<100
4	04:10-04:30	1.1	NW	<1,000	<200	<500	<1.0	<1.0	<100
NVA-8									
1	07:30-07:50	2.2	S	<1,000	<200	<500	12	8	<100
2	15:30-15:50	1.1	S	<1,000	<200	<500	26	19	<100
3	22:30-22:50	1.1	S	<1,000	<200	<500	<1.0	<1.0	<100
4	03:30-03:50	1.3	S	<1,000	<200	<500	<1.0	<1.0	<100

#	Time	Wind speed, m/s	Wind direction	CO, $\mu g/m^3$	NO_2, $\mu g/m^3$	SO_2, $\mu g/m^3$	PM10, $\mu g/m^3$	PM 2.5, $\mu g/m^3$	TSP, $\mu g/m^3$
NVA-9									
1	07:00-07:20	2.0	SW	<1,000	<200	<500	17	15	<100
2	15:00-15:20	1.1	SW	<1,000	<200	<500	21	10	<100
3	22:10-22:30	1.0	SW	<1,000	<200	<500	16	10	<100
4	03:00-03:20	1.2	SW	<1,000	<200	<500	<1.0	<1.0	<100
	MPC/guideline values/limits		**Aver. period**	**CO, $\mu g/m^3$**	**NO_2, $\mu g/m^3$**	**SO_2, $\mu g/m^3$**	**PM10, $\mu g/m^3$**	**PM 2.5, $\mu g/m^3$**	**TSP, $\mu g/m^3$**
1	National limit – max. permissible one time (volley) concentration (MPC), $\mu g/m^3$		24 h	3,000	40	50	n/a	n/a	150
			30 min	5,000	200	500	n/a	n/a	500
2	IFC/WHO (updated 2016) – guideline value, $\mu g/m^3$		1 year	n/a	40	50	20	10	n/a
			8 h	10,000	n/a	n/a	n/a	n/a	n/a
			24 h	n/a	n/a	20	50	25	120
			1 h	30,000	200	n/a	n/a	n/a	n/a
			30 min	60,000	n/a	n/a	n/a	n/a	n/a
			10 min	100,000	n/a	500	n/a	n/a	n/a
3	EU limit, $\mu g/m^3$		1 year	n/a	40	n/a	40	25	n/a
			8 h	10,000	n/a	n/a	n/a	n/a	n/a
			24 h	n/a	n/a	125	n/a	n/a	n/a
			1 h	n/a	200	350	n/a	n/a	n/a

Source: final EIA (March 2018)

Topography

While the DD consultant considered the risk of landslides to be very low, JST was of the opinion that the possibility of landslides cannot be ignored and that additional survey is necessary. Through discussion between the DD consultant, RD, and JST, it was decided to incorporate basic mitigation measures into the detailed design such as safety nets, and also to conduct an additional geological survey.

Surface Water

Two main rivers can be found within the Project area, the Kvirila and the Dzirula, along with other small tributaries. The results of the water quality monitoring in September 2017 show that both rivers meet the national Maximum Allowable Concentrations (MACs) for surface water quality. Two samples were taken at Bridge BRI 4.1.01-AT/TA, Dzirula River, and at BRI 4.1.04-AT/TA, Kvirila River.

Table 8-3: 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

#	Parameter	Units	SW-1 (Dzirula)	SW-2 (Kvirila)	Method/standard	National, maximum allowable concentration
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
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	100 ml	680	800	ISO 9308-1:2014	≤10,000

Source: final EIA (March 2018)

The soils in the Project area are very productive and range of crops are grown in the region. However, hazardous wastes generated by the GAA plant and other small-size smelters operating in various settlements of Imereti may be sources of soil pollution. To assess the status of soil quality in the Project area, specifically around the Georgian American Alloys Plant (GAA) plant, soil samples were taken and analyzed. The results of the sampling show that all parameters are within the current Georgian limits with the exception of Arsenic and Lead. However, these limits are considered outdated, stemming from old regulations developed during Soviet times. Assessing the results against EU limits (Italy and the UK), the results of all parameters sampled are well within the limits for residential areas. In addition, the results are also well within the proposed Georgian maximum allowable concentrations recently developed by the Ministry of Environmental Protection and Agriculture which should come into force in 2018. Most importantly, all parameters are also below the proposed Georgian preventive limits of risk elements in agricultural soil.

Table 8-4: 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
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)	

Source: final EIA (March 2018)

Groundwater

A total of two groundwater samples were collected from two wells behind the GAA plant to assess the baseline groundwater quality in the Project area. Because groundwater quality standards are not set under Georgian law, drinking water quality standards are commonly used instead as assessment criteria for groundwater. 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 8-5: 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	1,946.7	Calculated	1,000-1,500	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	Sulphates	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*

Source: final EIA (March 2018)

Ecological Resources

The project corridor crosses forest areas, agricultural land plots, hilly forest slopes, residential areas and riparian ecosystems. Due to human pressures natural vegetation has mostly been taken over by agricultural crops and other human development. Animals currently found in this area are those that can tolerate presence of humans. A biodiversity study was carried out based on two aspects: first existing data was collected and analyzed in the form of a ‘desk-top’ study. This was then followed by field surveys carried out in August and September 2017.

According to available information there are two species considered ‘vulnerable’ on Georgian Red List, Eurasian otter and Caucasian squirrel, which may be found within the Project area. Areas of bridge construction were surveyed carefully but no record of otter presence was registered. Likewise, trees within the Right of Way of the new alignment were checked, but no squirrels or burrows were registered. The review of the habitat along the alignment indicates that it is not optimum for existence of the Caucasian squirrel.

A study of flora in this EIA showed that the Project corridor could be split into six habitats types based on collection of desk-top data and also field surveys, most of which were classified as 'low' conservation status due to the absence of any unique flora and the generally degraded nature of the landscape due to human interference. One section around Argveta was classified as 'high' conservation status in this EIA, primarily due to the presence of two 'vulnerable' (on Georgian Red List) tree species, the Persian walnut and the Elm Zelkova.

The nearest protected area to the Project road is the Ajameti Managed Reserve, approximately 5 km southwest of the end point of the road, and this is unlikely to be impacted by Project works.

Economic Development

Viticulture is the main economic activity in the municipality of Zestafoni, providing 80% of agricultural output. Other than grapes, melon and maize are predominant crops grown in the region. The Georgian American Alloys Plant (GAA) is the largest company in Zestafoni. Zestafoni is not considered a significant area for tourism and recreation.

The road network in the Project area is dominated by the existing E-60 which links Tbilisi with Batumi. The main line from Tbilisi to Batumi runs broadly parallel with the Project road until it reaches Zestafoni.

Networked water supply and sewage systems only exist within the main towns and cities, including Zestafoni. Villages mainly use groundwater resources for potable and home use. The housing stock in the Project area mainly comprises one or two story houses that are distributed mainly along the local roads.

Social and Cultural Resources

According to the social survey undertaken for this Project, it is found that the average monthly wage of the population in the target villages is 650 GEL. The majority (70%) states 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. A number of physical cultural resources have been identified along the Project corridor, but none are located close enough to be impacted by Project works or where construction workers may come in contact with them. However, as an extra protection measure, the two cultural resources located relatively close to the Project area, the cemetery and natural spring, will be fenced off during construction works and monitored on a weekly basis.

Noise and Vibration

According to noise and vibration monitoring, vibration values in the monitoring locations are currently too low to cause any structural or cosmetic damage and/or cause nuisance to the residents. According to the national standard the values are ranked as weak and non-perceptible. Noise 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 Zestafoni noise levels get lower and are within IFC guideline limits for daytime and nighttime noise.

Alternatives

The "No Action" alternative would result in the continued deterioration of the road, bridges and drainage structures along the RoW. The relatively minor environmental impacts (such as noise and short-term air quality impacts due to maintenance activities) and inconveniences (such as traffic diversions) would be avoided in the short-run. In the long run, however, the steadily declining state of the roadway would severely hamper economic development in the Project Area and the Imereti region. Renovation of the road section between the Shorapani and Argveta is considered necessary given that the traffic volume of this section is expected to more than double by 2040 compared to 2017. Given the complex topography of the region and Georgia in general, there are no other feasible alternative corridors that would be able to compete with the existing corridor in terms of travel times. In addition, the Project forms part of the overarching program to upgrade the E-60 motorway which includes many sections that have recently been upgraded, or are in the process of upgrading (or detailed design). JST confirmed that during the detailed design phase a number of factors were taken into account to determine the final alignment, including the consideration of potential resettlement issues and social aspects such as access and noise.

(2) Potential Environmental Impacts

This section summarizes the potential environmental impacts from the Project.

Air Quality

During construction air quality is likely to be temporarily degraded by a range of operational activities including exhaust emissions from the operation of construction machinery; open burning of waste materials; and dust generated from quarries, borrow pits, haul roads, etc. Dust is the major air quality problem from construction sites. The main source of air pollution during the operational phase will be vehicles moving on the highway. The main pollutants would be: CO; NO_X; hydrocarbons (HC); SO_2; carbon dioxide (CO_2); and particulate matter (PM). An air dispersion model prepared for this EIA suggests that not only will the maximum allowable limits not be surpassed but also that 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, as a resulting benefit of smoother drive and optimized alignment.

Soils

Potential impacts to soil during the construction phase include: loss of topsoil, erosion, and contamination due to spills or hazardous materials, in case that proper and adequate protection measures are not taken. Soil samples taken to the north of the GAA plant have indicated that this area does not comprise levels of soil contamination above Dutch Intervention Levels or Italian standards for residential areas. Arsenic and Lead were identified in the samples above the current national limits, but within proposed new national limits and other international limits (UK and Italy).

However, only two soil samples were taken in this location and it is possible that soil contamination could still exist in the area north of the GAA, thus based on a request from JICA/JST, DD Consultant will do additional sampling of 4 locations and submit the result as an addendum to the EIA. The Project road runs parallel to the GAA plant for approximately 1.3 kilometres, but the potential for any additional pollution is considered to be confined to a smaller area, around 500 meters in length, and is focused around large two piles of waste material sited on the northern boundary of the GAA. Although the two soil samples taken as part of this EIA did not show significant levels of contamination, it was agreed with JICA/JST that it would be prudent to undertake additional sampling of these soils to determine if any additional actions for soil monitoring and disposal would be needed during the construction phase. Therefore, an additional four samples will be taken as part of this EIA and the results presented as an addendum to this report. If the results show that the monitored parameters are within the proposed national limits and the Dutch target values no further soil sampling will be considered necessary. Should the results of the monitoring indicate any elevated levels of contamination, further testing of the excavated soils in this area will be required during the construction phase by the Contractor as follows (further details in EIA).

The Contractor shall identify a temporary storage area comprised of an impermeable surface, strip the topsoil in batches of 5,000 m^2 and store the mixed material in the temporary storage area (the stockpile). Stockpile will be divided into quadrants of 250 m^3. The Engineer will hire a certified laboratory to take a soil sample from each of the quadrants for further chemical analysis (a stockpile of 2,500 m^3 would require 10 samples). The Engineer will be present during the sampling to confirm that the correct number of samples were taken and that the sampling was undertaken in line with the relevant national legislative requirements. If any of the samples show elevated levels of contamination the material from the respective contaminated quadrants of 250 m^3 will be disposed of as hazardous waste. Any other non-contaminated quadrants may be disposed of as non-hazardous waste. Final disposal of any contaminated soil must be undertaken at a waste management facility licensed to handle such wastes. As with normal waste materials, the Contractor will be obliged to keep records of any hazardous materials removed from the site.

Hydrology

If proper construction supervision is not provided, bridge construction activities may increase silt load in the river or result in accidental spillage of concrete and liquid waste into the river. Spills and contamination of groundwater and soils from fuel and lubricant and other hazardous liquids is possible without standardized materials handling and storage protocol in place.

Flora and Fauna

The road on this area passes mainly through agricultural land and some forested areas. Potential impacts to fauna include habitat loss/deterioration, migration, poaching, and road kill, but no significant impact is expected, as the area is mostly already developed. Some of the trees cut may be the ‘vulnerable’ Persian walnut or Elm Zelkova, but mitigation measures have been proposed for anticipated loss of trees, and otherwise, no significant impacts to flora are anticipated. Regarding trees that will need to be cut, some are on private land, and some are located in State Forest Fund, explained in detail below.

State Forest Fund is not recognized as protected area in Georgian legislation but established as a measure to avoid unauthorized deforestation and excessive use of natural resources in forests. SFF may be used for the purposes of construction of motorways, as well as for other activities which are deemed as special use of forest lands. If the activity that is deemed as special use of forest land and is subject to Ecological Expertise, then the Client (in this case the RD) is obliged to apply to remove all trees identified in the affected SFF area from the SFF registry or “de-list” them before they can be cut. The decision to de-list trees and plants from the State Forest Fund of Georgia is issued by the National Forest Agency excepting the vegetation species protected by the Red List of Georgia, which will be approved by MoENRP. The client must apply to the MoENRP in writing regarding the presence of the Red-Listed species in the project area. For this Project a total of 7,232 trees have been identified in State Forest Fund areas, and RD is already applying to have these trees de-listed.

Transportation, Utilities

The main impacts resulting from Project works will be road diversions and some temporary blocking of access routes. However, impact upon the existing road or other local roads will be relatively little due to the fact that it is a new alignment often passing through tunnels and over bridges. Medium and low voltage power lines, water supply, and gas pipes may need to be temporarily removed during construction.

Tunnels

The main typical environmental problems linked to the construction of underground works include: triggering of surface settlements, structures collapses and slope instabilities; drying up of springs and groundwater alterations; storage and use of excavated materials; noise; and vibrations.

Community Health and Safety

Construction activities may result in an increase in road traffic accidents between vehicles, pedestrians and vehicles and livestock and vehicles. There will also be short term impacts to noise and air quality, which may impact upon health.

Noise and Vibrations

Noise levels along the Project corridor is expected to increase during the operational phase of the Project, especially in the Zestafoni bypass area. A noise model developed for the EIA shows that there are many locations where IFC guideline limits for daytime and nighttime noise could be exceeded in 2037 even with the installation of noise abatement in the form of a 4 meter high solid noise barrier, particularly the strict 45 dBA nighttime limit. The model is however, based on a range of variables that may change in the future. Accordingly, a noise barrier of 5,950 m in maximum length has been incorporated in the detailed design, but installation will only be determined after operational phase begins, based on monitoring results and discussions with the affected residents. Regarding vibration, it is likely that construction works will impact upon structures within the Project area, potentially causing structural or cosmetic damage. Highway traffic is not likely to have any measurable impact on the structures or on comfort.

(3) Environmental Management Plan and Monitoring Plan

Table 8-6, Table 8-7 and Table 8-8 give a summary of mitigation measures with management plans for the Project during the pre-construction, construction and operational phases. For all details, refer to the final EIA.

Table 8-6: Environmental Management Plan - DD/Pre-Construction Phase

Subject	Potential Impact/Issue	Mitigation Measures	Responsibilities
Air Quality	Construction impacts	Preparation of an Air Quality Plan (AQP) including the locations of haul routes	Contractor to prepare AQP, and Engineer to review and approve.
	Air quality impacts from stationary sources	Locations for borrow pits and concrete batching plants require approval from the Engineer and MoENRP and all necessary permits. All of the above facilities will also have the appropriate GoG permits and licenses. No plant within 500 m of any urban area or sensitive receptor.	Contractor to select sites. Engineer and MoENRP to approve sites.
Land Use	Loss of land and Property	Before the commencement of the construction works, RD must prepare the LARP, obtain the approval of JICA, and then implement the plan.	RD to prepare the RAP. JICA to approve the RAP. RD to implement the Plan.
	Tree cutting	The LARP shall contain the compensation methods and payments for loss of trees on private land.	
Climate Change	Damage to roads/ drainage due to increased flooding and rainfall	As part of DD: Increase ditch and culvert capacity and ensure that all embankments are seeded to help increase stability, etc.	Engineer to review design documents prior to the start of construction and make any additions as necessary.

Subject	Potential Impact/Issue	Mitigation Measures	Responsibilities
Soils	Loss of Agricultural Soils	Before the commencement of the construction works, RD must prepare the LARP, obtain the approval of JICA, and then implement the plan.	RD to prepare the RAP. JICA to approve the RAP. RD to implement the Plan.
	Soil contamination	Analysis of four additional soil samples taken close to the GAA. Addendum to this EIA including the results of the additional soil samples.	DD Consultant to hire a licensed laboratory for the analysis. DD Consultant to provide the results in an addendum to this EIA
Borrow Pits and Quarry's	New Quarry Sites	Any new quarries must obtain the required permits prior to commencement of works at these sites, this shall include approval from MoENRP and the Engineer.	Contractor to select sites and apply for approval from MoENRP and other regulatory agencies as necessary. Engineer to review quarry locations, licenses and approvals from MoENRP.
	Existing Borrow Pits	Due diligence review to determine suitability. Review shall be undertaken before the Contractor signs any contract with the existing borrow pit owner.	Engineer to undertake due diligence review and present results to RD and Contractor, clearly stating the reasons for any rejection of the site.
	New Borrow Pits	Obtain all necessary permits from the regulatory authorities. Prepare a Borrow Pit Action Plan (BAP).	Contractor to select sites and apply for approval from MoENRP and other regulatory agencies as necessary. Engineer to review quarry locations, licenses and approvals from MoENRP.
Hydrology	Bridge Construction	All new bridges shall be designed for the life expectancy of 100 years, a design discharge of 100 years return period. Bridge designs should ensure that drainage from bridge decks over 50 m does not discharge directly to the watercourses beneath the bridges. The bridge run-off waters should lead to an interceptor tank, or filter pond to prevent pollution. Bridge design and layout must be aesthetically pleasing and in harmony with existing environment.	DD Consultants Engineer to review design documents prior to the start of construction.
		Establish the fish spawning period to minimize effect to the fish spawning period.	Contractor to consult with MoENRP regarding fish spawning periods.
	Culverts	A design discharge of 50 years return period is considered for culverts.	DD Consultants/Engineer to review design documents prior to start of construction.
	Tunneling	Contractor to develop a ground water management plan for each tunnel to be submitted for approval.	Contractor to prepare plan. Engineer to review and approve plan.
	Siting of facilities	No construction camp within 500 m of any river or irrigation channel.	Contractor to select sites. Engineer/ MoENRP to approve sites.

Subject	Potential Impact/Issue	Mitigation Measures	Responsibilities
Flora & Fauna	Land clearance	The Contractor shall prepare a Clearance, Re-vegetation and Restoration Management Plan for prior approval by the Engineer. Prior to the commencement of works Contractor shall undertake a survey to identify if any Georgian red-list species are located within this zone. All temporary construction facilities should be located on already heavily disturbed ground.	Contractor to prepare and implement Plan. Engineer to review and approve plan. Contractor to survey trees for vulnerable species.
	State Forest Fund	Prior to cutting trees in the State Forest Fund trees must be de-listed and compensation payments to be made.	RD to obtain permit and submit to Engineer for review. RD to make compensation payments.
	Impacts to Protected Areas	No haul route, borrow pits or quarries will be allowed in a protected area.	Contractor to implement mitigation. Engineer to approve Borrow Pit/ Traffic Management Plans.
	Impacts to birds from street lighting	Ensure that lower wattage lamps are used in street lights which direct light downwards to reduce glare.	DD Consultant to incorporate the measures.
Construction Camps	Selection of Construction Camp Site	Preparation of a Construction Camp Site Plan and a Spills Response Plan. Construction camps shall not be located within 1 km of an urban area and at least 50 meters from any surface water course and not within 2 km of a protected area. Coordinate all construction camp activities with neighboring land uses.	Engineer to review/ approve Plans. Engineer and RD to approve camp locations.
Transportation and Utilities	Damage to roads	Prior to the commencement of works: a road condition survey to record the condition of access roads to borrow pits, asphalt plants, camps, etc.	Engineer to complete road condition survey. Contractor to review and agree to the findings of the road condition survey.
	Traffic management	Preparation of a traffic management plan as part of the SSEMP.	Contractor to prepare plan. Engineer to review and approve plan.
Occupational Health and Safety	Worker Health and Safety	Prepare an Occupational Health and Safety Plan (OHS Plan). Ensure that sub-contractors are provided with copies of the SSEMP.	Contractor to prepare OHS Plan and provide copies of the SSEMP to sub-contractors prior to site access. Engineer to review and approve OHS Plan.
	Traffic Safety	Submit a Traffic Management Plan (TMP) to local traffic authorities prior to mobilization.	Contractor to prepare TMP. Engineer to approve TMP.
Emergency Response	Explosions, fires, etc.	Preparation of an Emergency Response Plan (ERP).	Contractor to prepare ERP. Engineer to review and approve.
Waste Management	Management of waste materials	Preparation of a waste management plan and construction camp management plan to manage liquid wastes.	Contractor to prepare Plans Engineer to review and approve Plans.
	Tunnel and Embankment Spoil	Consultations between Kutaisi Bypass Contractor and RD to determine if the static balance from F4 can be re-used as embankment material for Kutaisi Bypass. Preparation of a Spoil Re-use and Disposal Plan	Contractor to consult with RD and Kutaisi Bypass Contractor. Contractor to prepare plan. RD and Engineer to review and approve the plan.

Subject	Potential Impact/Issue	Mitigation Measures	Responsibilities
PCR	Chance Finds	The Contractor shall prepare a chance find procedure in line with the requirements of the GoG.	Contractor to prepare Plans. Engineer to review and approve.
Noise	Noise Barriers	Include areas for the installation of the identified noise barriers in the detailed design.	Detailed Design Consultant
Vibration	Construction vibration	The Contractor will develop a detailed Tunnel Blasting Plan (TBP).	Contractor to prepare Plans. Engineer to review and approve.
SSEMP Requirement	Preparation of SSEMP	Prepare SSEMP.	Contractor to prepare SSEMP. Engineer to review and approve.
	Incorporation into Bid Documents	Specific environmental and social section included in the main Bid Documents indicating Contractor's responsibility for conforming to EMP requirements.	RD to ensure EMP is included within Bid Documents.

Source: final EIA (March 2018)

Table 8-7: Environmental Management Plan - Construction Phase

Subject	Potential Impact /Issue	Mitigation Measure	Responsibilities	Monitoring	Monitoring Responsibility & Schedule
Air Quality	Open burning of waste materials	No burning of debris or other materials will occur on the at any camp or construction site.	Contractor to implement mitigation.	Engineers NES	Daily site inspections throughout construction period
	Rock-crushing plant	Water sprinklers will run continuously while the plant is operational. Water run-off from the sprinkler system shall not discharge directly to surface water courses.	Contractor to implement mitigation. Engineer to routinely monitor Contractors activities.	Engineers NES	Daily site inspections throughout construction period
	Exhaust emissions from the operation of construction machinery	No equipment that may produce air pollutants will be installed without prior written consent of the Engineer. Construction equipment will be maintained to a good standard.	Contractor to implement mitigation. Engineer to routinely monitor Contractors activities.	Engineers NES	Daily site inspections throughout construction period
	Emissions from construction vehicles	Emissions from on/off-road vehicles should comply with national or regional programs. Implement a regular engine/vehicle maintenance and repair program. Instruct drivers on driving practices.	Contractor to implement mitigation. Engineer to routinely monitor Contractors activities.	Engineers NES	Daily site inspections, throughout construction period
	Fugitive emissions	All trucks used for transporting materials will be covered. Carry out watering for dust control. Earthwork operation to be suspended if too windy.	Contractor to implement mitigation. Engineer to routinely monitor Contractors activities.	Engineers NES	Daily site inspections, throughout construction period
Soils Erosion and Soil Contamination	Contamination of Soils	All fuel and chemical storage will be sited on an impervious base within a bund and secured by fencing. The storage area will be located away from any watercourse or wetlands. Filling and refueling will be strictly controlled. Waste oils will be stored and disposed of by a licensed contractor. All valves and trigger guns will be resistant to unauthorized interference.	Contractor to implement mitigation. Engineer to review and approve bunding prior to the start of construction. Engineer to review and approve vehicle fueling area prior to the start of construction.	Engineers NES	Daily site inspections, throughout construction period

Subject	Potential Impact /Issue	Mitigation Measure	Responsibilities	Monitoring	Monitoring Responsibility & Schedule
	Loss of topsoil	Locate topsoil stockpiles outside drainage lines. Construct diversion channels and silt fences around the topsoil stockpiles to prevent erosion and loss of topsoil.	Contractor to implement mitigation.	Engineers NES	Daily site inspections, throughout construction period
	Soil Erosion	Selection of material that is less susceptible to erosion. Re-vegetation of exposed areas. The Engineer and the Contractor will both be responsible for ensuring that embankments are monitored continuously during construction for signs of erosion.	Contractor to implement mitigation.	Engineers NES	Daily site inspections, throughout construction period
	Contaminated Land	Should the results of the additional soil sampling in the pre-construction phase indicate any elevated levels of contamination, further testing of the excavated soils in this area will be required as follows. The Contractor shall identify a temporary storage area comprised of an impermeable surface, strip the topsoil in batches of 5,000 m^2 and store the mixed material in the temporary storage area (the stockpile). Stockpile will be divided into quadrants of 250 m^3. The Engineer will hire a certified laboratory to take a soil sample from each of the quadrants for further chemical analysis (a stockpile of 2,500 m^3 would require 10 samples). The Engineer will be present during the sampling to confirm that the correct number of samples were taken and that the sampling was undertaken in line with the relevant national legislative requirements. If any of the samples show elevated levels of contamination the material from the respective contaminated quadrants of 250 m^3 will be disposed of as hazardous waste. Any other non-contaminated quadrants may be disposed of as non-hazardous waste. Final disposal of any contaminated soil must be undertaken at a waste management facility licensed to handle such wastes. As with normal waste materials, the Contractor will be obliged to keep records of any hazardous materials removed from the site.	Contractor to implement mitigation. Engineer to hire certified laboratory and review results. Engineer to undertake periodic inspections of the stockpiles to ensure the correct procedures are being followed.	Engineers NES	Weekly inspections of stockpiles.
Hydrology	Ground and surface water pollution	Implementation of the specific mitigation measures outlined under Construction Camps and Soil Contamination. Provide portable toilet facilities for workers at road work sites.	Contractor to implement mitigation.	Engineers NES	Daily site inspections, throughout construction period

Subject	Potential Impact /Issue	Mitigation Measure	Responsibilities	Monitoring	Monitoring Responsibility & Schedule
	Groundwater depletion	Routine monitoring of groundwater levels in well in line with groundwater management plan. If drawdown levels are significant temporary source of potable water will be provided to the affected persons until the groundwater levels are recharged. Monitoring shall continue for a two month period after the completion of the tunnels.	Contractor to implement mitigation	Engineers NES	Weekly review of groundwater monitoring reports.
	Bridges	Divert the water flow near the bridge piers. Prevent migration of silt during construction. Ensure no waste materials are dumped in the river. Place generators more than 20 m from the river. Ensure that no concrete waste from concrete mixers is dumped in the river. Ensure that no hazardous liquids are placed within 10 m of the river. Provide portable toilets at bridge construction sites. Ensure that workers are provided with correct PPE.	Contractor to consult with MoENRP and provide copies of letters confirming construction periods to the Engineer.	Engineers NES	Routine monitoring of bridge works to ensure they are in compliance with MoENRP guidelines.
	Drainage and Flooding	Construct, maintain, remove and reinstate as necessary temporary drainage works and take all other precautions necessary for the avoidance of damage to properties and land by flooding and silt washed down from the works. Ensure that no construction materials or waste block existing drainage channels.	Contractor to implement mitigation.	Engineers NES	Monitor drainage channels on a weekly basis.
	Dewatering of tunnels	The Contractor will pass all drainage water from the tunnel through a settlement tank and monitored for pollution. If the drainage water meets drinking water standards it can be considered for re-use in any potentially depleted wells during the construction phase.	Contractor to implement mitigation. Engineer to review and approve settlement tank locations and designs.	Engineers NES	Review of weekly water monitoring results. Weekly inspection of settlement tanks.
	Water Supply	Only legally permitted water resources shall be used for technical water supply, including rivers.	Contractor to implement mitigation. Engineer to review all water extraction permits.	Engineers NES	Weekly inspections, throughout construction period. Annual review of permits.
Flora & Fauna	Tree cutting	Trees cleared from private land plots will be compensated in accordance with the LARP.	GoG to implement the LARP	According to the LARP	According to the LARP

Subject	Potential Impact /Issue	Mitigation Measure	Responsibilities	Monitoring	Monitoring Responsibility & Schedule
	State Forest Fund	The Contractor will be provided with plans indicating the areas of State Forest Fund. Tree-cutting works in the State Forest Fund areas shall be implemented under the supervision of specialists of the National Forestry Agency. Contractor to remove the trees to a location specified by the National Forest Agency.	RD to provide plans to Contractor. Contractor to undertake tree cutting. Contractor to remove trees.	National Forestry Agency	None
	Tree Re-planting	Coordinate with the National Forest Agency to identify a site, or sites, within the Project area where 615 red-list species can be re-planted. Plant maintenance will be carried out for at least two years. Monthly monitoring of the re-planted areas and report on the success rate of the re-planted trees, which should be above 80%. If the success rate falls below 80% re-plant on a 1:1 basis to compensate for losses.	Contractor to coordinate with NFA. Contractor to purchase, plant and maintain the seedlings. Contractor to plant additional seedlings if success rate not met.	Engineer to monitor success rate (NFA to determine success rate criteria).	Monthly monitoring of success rate.
	Protection of Vulnerable Species	The Contractor will place protective wood fencing around the any Georgian red-list species identified within 5 meters of the site boundary in the pre-construction survey in order to protect the tree during construction works, including its root zones.	Contractor to implement mitigation.	Engineers NES	Daily site inspections, throughout construction period.
	Vegetation clearance	No chemicals shall be used to clear vegetation.	Contractor to implement mitigation.	Engineers NES	Daily site inspections, throughout construction period.
	Fish Spawning	The Contractor shall consult with the MoENRP to determine when works in rivers should be ceased in order to limit impacts to fish spawning periods.	Contractor to implement mitigation.	Engineers NES	Review of documentation provided by MoENRP.
	Impacts to habitat	Prior to the start of construction in river beds, or close to river embankments (within 10 m), undertake a site survey to ensure that there are no otter burrows in these areas. If burrows are found prepare a method statement for the management of these areas which will be sent to the Engineer for review and approval.	Contractor to implement mitigation.	Engineers NES	Review method statement and periodically monitor works in this area.
	Poaching	Poaching of wildlife shall be strictly prohibited.	Contractor to implement mitigation.	N/A	N/A

Subject	Potential Impact /Issue	Mitigation Measure	Responsibilities	Monitoring	Monitoring Responsibility & Schedule
Waste Management and Spoil	Recycling and re-use	Where possible, surplus materials will be reused or recycled. Used oil and grease shall be removed from site and sold to an approved used oil recycling company.	Contractor to implement mitigation.	Engineers NES	Monthly review of waste manifests to determine if wastes are being recycled.
	Spoil	Under no circumstances shall the Contractor dump excess materials on private lands. Excess spoil shall not be dumped or pushed into any river at any location. Spoil re-use and disposal haul routes shall be included within the TMP. The Contractor will be responsible for upgrading and maintenance of any local roads used for the transport of spoil materials. Transport of spoil material from tunnels on local roads shall be prohibited between 10pm and 6am. Routine spraying of haul routes during dry periods.	Contractor to implement mitigation.	Engineers NES	Daily site inspections, throughout construction period.
	Inert Solid & Liquid waste	Provide refuse containers at each worksite. Maintain all construction sites in a cleaner, tidy and safe condition. Waste storage containers shall be covered, tip-proof, weatherproof and scavenger proof. Train and instruct all personnel in waste management practices and procedures. Collect and transport non-hazardous wastes to all approved disposal sites. Keep copies of waste manifests on site. Keep a record of waste on-site and waste removed.	Contractor to implement mitigation and conduct training. Engineer to approve any waste disposal site.	Engineers NES	Daily site inspections, throughout construction period. Regular review of Contractors training sessions.
	Asphalt and Concrete	Waste asphalt will be recycled where possible for base and shoulder material. Unused or rejected tar or bituminous products shall be returned to the supplier's production plant. Waste concrete shall be crushed and re-used as fill or base material where possible. Under no circumstances should concrete mixers be washed out onto open ground at construction sites, such as bridges.	Contractor to implement any recommendations for re-use of asphalt. Contractor to implement mitigation.	Engineers NES	Daily site inspections, throughout construction period.

Subject	Potential Impact /Issue	Mitigation Measure	Responsibilities	Monitoring	Monitoring Responsibility & Schedule
	Hazardous Waste	Store hazardous waste in secure locations as identified by the waste management plan. Hazardous liquids must be stored within impermeable bunds. Collect and temporarily store used hazardous waste separately in specialized containers and place in safe and fire-free areas with impermeable floors roofs, at a safe distance from fire sources and according to the requirements of their MSDS. Provide training and suitable PPE to all relevant personnel. Disposal of waste materials shall be undertaken by a licensed waste management company. Keep records of the types and volumes of waste removed from the site on a weekly basis. Keep copies of waste manifests.	Contractor to implement mitigation. Engineer to approve any waste disposal site. Engineer to review waste manifests.	Engineers NES	Daily site inspections, throughout construction period. Monthly review of waste manifests.
	Spoil from tunnels and bridges	Disposal of spoil material according to the approved Spoil Disposal Plan.	Contractor to implement mitigation.	Engineers NES	Daily site inspections, throughout construction period.
Transport and Utilities	Transportation	Provide information to the public at least 24 hours before the disruptions about the scope and schedule of construction activities and expected disruptions and access restrictions. Allow for adequate traffic flow around construction areas via diversions or temporary access roads. Access roads for will be rehabilitated at the end of construction.	Contractor to implement mitigation.	Engineers NES	Weekly inspections, throughout construction period.
	Working Close to Railways Lines	The Contractor will be responsible for the preparation of an Environmental, Health and Safety Method Statement for working in the area above the railway line at KM 6.3 and at Bridge BR 4.0.1.AT/TA.	Contractor to prepare method statements. Engineer to review and approve method statements.	Engineers NES	Weekly monitoring of works in these areas.
	Utilities	Liaise with the relevant utilities operators to ensure all utilities remain operational particularly during the winter months. Should utilities need relocating the Contractor will consult with the relevant utilities and local community to ensure that there is no change in supply as a result of these changes.	Contractor to implement mitigation.	Engineers NES	Weekly inspections, throughout construction period.

Subject	Potential Impact /Issue	Mitigation Measure	Responsibilities	Monitoring	Monitoring Responsibility & Schedule
Borrow Pits and Quarry's	New Borrow Pits	Before the materials extraction the layer of top-soil will be removed to the side of excavation area and kept until the area works will be finalized. Top-soil stockpiles will be located at least 50 m from any watercourses. Provide access road to the borrow site. If the Engineer deems the site to be hazardous to the local community he will request the Contractor to fence the site and provide warning signs. Full site reinstatement will be undertaken. Additional borrow pits will not be opened without the restoration of those areas no longer in use.	Contractor to select borrow sites and apply for approval from MoENRP and any other regulatory agencies. Engineer to review borrow locations, licenses and approvals from MoENRP. Engineer to determine if the site requires fencing.	Engineers NES Engineers NES and IES to ensure reinstatement of borrow pits are completed satisfactorily	Monthly inspections of borrow pits. Final inspection of reinstatement activities.
	Existing Borrow Pits	Due diligence review of borrow pit A copy of the agreement between the operator and the Contractor will be provided to the Engineer.	Engineer to undertake due diligence review. Contractor to provide agreement to Engineer.	N/A	N/A
	New Quarry Sites	Any new quarries must obtain the required permits prior to commencement of works at these sites, this shall include approval from MoENRP and the Engineer. No quarry shall be located within 1 km of any urban area or sensitive receptor and not within 1 km of a protected area.	Contractor to select quarry sites and apply for approval from MoENRP and any other regulatory agencies. Engineer to review quarry locations, licenses and approvals from MoENRP.	N/A	N/A
Asphalt Plants	Emissions & Noise	Asphalt plants will be located downwind of urban areas and not within 1 km of any urban area. Adequate PPE will be provided to staff. Storage and use of hazardous materials: ensure all hazardous materials are stored, handled and disposed of according to their MSDS; copies of MSDS will be kept on site; keep a log of the type and volume of all hazardous wastes on site; keep a plan of site indicating where all hazardous materials are stored.	Contractor to implement mitigation.	Engineers NES	Daily site inspections, throughout construction period. Monthly review of hazardous waste log.
	Vehicle Movement	The Contractor will include the asphalt plant in his Traffic Management Plan, including haul routes from the plant.	Contractor to implement mitigation.	Engineers NES	Daily site inspections, throughout construction period.

Subject	Potential Impact /Issue	Mitigation Measure	Responsibilities	Monitoring	Monitoring Responsibility & Schedule
	Health and Safety	Workers handling hot bitumen must wear full-body protection. All transportation, handling and storage of bitumen will be handled safely by experienced personnel. Protective air mask will be provided to the operators for the loading and unloading of aggregates. Ear-muffs will be provided those working on the plant. First Aid kit will be available on site. MSDS for each chemical product will be made accessible onsite and displayed.	Contractor to implement mitigation.	Engineers NES	Daily site inspections, throughout construction period.
Construction Camps	Pollution and Emissions	Rain-water run-off arising on the site will be collected and removed properly. Provide on-site wastewater treatment facilities as needed. No direct discharge of untreated sanitary or oily wastewater to surface water bodies. Licensed contractors will be required to collect and disposal of liquid waste from the septic tanks on regular basis. Lubricating and fuel oil spills will be cleaned up immediately. Construction and work sites will be equipped with sanitary latrines. Sediment laden construction water must be discharged into settling lagoons or tanks prior to final discharge. Regarding fuel and chemical storage: Fueling operations will occur only within containment areas. All fuel and chemical storage will be sited on an impervious base within a bund and secured by fencing away from any watercourse or wetlands. All valves and trigger guns will be resistant to unauthorized interference and vandalism. The contents of any tank or drum will be clearly marked. Maintain and cleanup campsites and respect the rights of local landowners.	Contractor to implement mitigation.	Engineers NES	Daily site inspections, throughout construction period.

Subject	Potential Impact /Issue	Mitigation Measure	Responsibilities	Monitoring	Monitoring Responsibility & Schedule
Concrete Batching Plants	Pollution and Emissions from Concrete Batching Plants	Batching plants will be located not within 1 km of urban area. The area traversed by vehicles will be paved with impervious material. Sand and aggregates will be delivered in a dampened state, using covered trucks. Sand and aggregates will be stored in a hopper or bunker which shields the materials from winds. Protect the opening of the overhead bin from winds. Conveyor belts which are exposed to the wind, conveyor transfer points and hopper discharge areas will be effectively enclosed. All hatches, inspection points and duct work will be dust-tight. Contaminated storm water and process wastewater will be captured and recycled.	Contractor to implement mitigation.	Engineers NES	Daily site inspections, throughout construction period.
Community Health and Safety	Blasting	Blasting will be conducted using standard mining industry practices and procedures.	Contractor to implement mitigation.	Engineers NES	Daily site inspections, throughout construction period.
	HIV / AIDS	Subcontract with an Approved Service Provider to provide an HIV Awareness Program to the Contractor's Personnel and the Local Community.	Contractor to implement mitigation. Service Provider to implement training. Engineer to review program.	Engineers NES	Annual review of awareness program activities.
	Code of Conduct	Develop an induction program, including a Code of Conduct, for all workers directly related to the Project. A copy of the Code of Conduct is to be presented to all workers and signed by each worker.	Contractor to implement mitigation.	Engineers NES	Routine assessment of workers staff to determine if the code of conduct has been presented.
	Monthly Meetings	The Contractor will be responsible for holding monthly community meetings within the Project area throughout the construction period.	Contractor to implement mitigation.	Engineers NES	Engineers NES to attend all community meetings.

Subject	Potential Impact /Issue	Mitigation Measure	Responsibilities	Monitoring	Monitoring Responsibility & Schedule
Occupational Health and Safety	Worker Health & safety	Initial Safety Induction Course: All workmen will be required to attend a safety induction course before they are allowed access to the Site. Develop a Safety Training Program. Conduct Safety Meetings on a monthly basis. Regularly inspect, test and maintain all safety equipment. A fully equipped first aid base shall be provided at the Construction Camp and Asphalt Plant. Coordinate with local public health officials to reach a documented understanding with regard to the use of hospitals and other community facilities. Provide appropriate PPE at no cost to the workers.	Contractor to implement mitigation. Engineer to review and approve training program.	Engineers NES	Daily site inspections, throughout construction period. Periodic attendance of training sessions to determine quality and numbers in attendance.
	Sub-contractor H&S	All sub-contractors will be supplied with copies of the SSEMP. Provisions to be incorporated into all sub-contracts to ensure the compliance with the SSEMP. All sub-contractors will be required to appoint a safety representative who shall be available on the Site.	Contractor to provide SSEMP. Sub-contractors to ensure compliance with SSEMP	Engineers NES	Routinely monitor sub-contractors activities.
	Noise	Zones with noise level above 80 dBA must be marked with safety signs and appropriate PPE must be worn by workers.	Contractor to implement mitigation.	Engineers NES	Daily site inspections and monitoring
PCR	Impacts to Cemetery	During the construction phase the northern boundary of the cemetery shall be fenced off to ensure that there is no encroachment into this area by construction workers or equipment.	Contractor to implement mitigation.	Engineers NES	Weekly site inspections of the fencing.
	Natural Spring	Noise barrier and fencing d around the natural spring to the north of the GAA to prevent construction works impacting upon the spring.	Contractor to implement mitigation.	Engineers NES	Weekly site inspections of the fencing.
	Impacts to Historical and archeological areas	In the event of any chance finds procedures shall apply that are governed by GoG legislation and guidelines and as outlined in the Contractors Chance Find Procedure.	Contractor to implement mitigation.	Engineers NES	Daily site inspections throughout construction period.
Noise	Construction noise	Time and Activity Constraints. Describe activities and time expected. Within normal working hours, where reasonable: Schedule noisy activities for less sensitive times. Provide periods of respite. Use best current technology. Maintain mechanical plant, tools, machines and equipment in good conditions. Follow OHS requirements. Provide noise protection kits for workers.	Contractor to implement mitigation.	Engineers NES	Daily site inspections throughout construction period.

Subject	Potential Impact /Issue	Mitigation Measure	Responsibilities	Monitoring	Monitoring Responsibility & Schedule
Vibration	Tunneling Vibration	The Contractor shall follow the procedures outlined in EIA.	Contractor and Engineer to implement mitigation.	N/A	N/A
	Piling Vibrations	Condition surveys of all properties within 50 meters of bridge piles.	Engineer	N/A	N/A
	Blasting	No blasting within 100 m of the portal of the tunnel. Blasting during the day only. Local communities will be informed of timetable in advance.	Contractor and Engineer to implement mitigation.	Engineers NES	Routine inspections of blasting activities.

Source: final EIA (March 2018)

Table 8-8: Environmental Management Plan – Operational Phase

Subject	Potential Impact / Issue	Mitigation Measure	Responsibilities	Monitoring	Monitoring Responsibility & Schedule
Tree re-planting	Tree maintenance	If tree maintenance extends beyond the construction period the Contractor shall continue maintenance of the trees to complete the two-year maintenance period.	Contractor (during defects liability period)	N/A	N/A
Noise	Traffic and road noise	Based on the results of the annual noise monitoring, construct the noise barriers or develop other noise mitigation measures, such as sound proof windows, in consultation with affected receptors.	Engineer (during defects liability period)	N/A	N/A

Source: final EIA (March 2018)

To ensure that all of the above mitigation actions are completed according to the requirements of the EIA, both observational monitoring and instrumental monitoring of Project works will be undertaken by the Engineer and by independent monitoring specialists. Below tables summarize monitoring plans during the construction and operational phases.

Table 8-9: Construction Phase Instrumental Monitoring

Issue	Mitigation	Locations	Schedule	Responsibilities	Reporting
Air Quality	Establish routine ambient air quality monitoring throughout the construction period. The following parameters shall be monitored: Particulate Matter (PM_{10} & $PM_{2.5}$).	KM 4.4 KM 5.8 KM 6.4 KM 9.2 KM 12.6 KM 13.3	Monitoring to be undertaken monthly during construction period (30 months)	Engineer shall hire certified laboratory to perform the monitoring activities.	The certified laboratory shall provide the results to the Engineer within three days of the monitoring activity.
Noise	Ensure that routine noise monitoring is undertaken throughout the construction period. Parameters to be monitored include: Laeq 1 h (dBA)	KM 4.4 KM 5.8 KM 6.4 KM 9.2 KM 12.6 KM 13.3	Monitoring to be undertaken monthly both daytime and night-time measurements during construction period (30 months)	Engineer shall hire certified laboratory to perform the monitoring activities.	The certified laboratory shall provide the results to the Engineer within three days of the monitoring activity.
Vibration	Vibration sensors for PPV monitoring.	At each tunnel location	Throughout tunnel blasting period.	Contractor to purchase, install and monitor vibration.	Weekly reporting of vibration results to the Engineer.
Surface Water Quality	Establish routine water quality monitoring throughout the construction period. The following parameters shall be monitored: pH; Suspended Solids; BOD5; COD; Coliforms; Nitrate (NO3); Phosphate (PO4); Oil and Grease	50 m upstream from all bridge sites crossing rivers (3 locations) during construction; 50 m downstream of the bridge site	Monitoring to be undertaken monthly during bridge construction works	Engineer shall hire certified laboratory to perform the monitoring activities.	The certified laboratory shall provide the results the Engineer within seven days of the monitoring activity.
Tunnel water	Monitoring of water from tunnel dewatering settlement tanks. Parameters will include all required to meet Georgian drinking water standards.	At all settlement tanks.	Weekly	Engineer shall hire certified laboratory to perform the monitoring activities.	The certified laboratory shall provide the results to the Engineer within 5 days of the monitoring activity.
Ground water	Monitoring of groundwater levels.	Selection of ten sites	Weekly	The Engineer shall perform the monitoring activities.	Weekly reporting by the Engineer to affected parties.

Issue	Mitigation	Locations	Schedule	Responsibilities	Reporting
Soils	If required, undertake a soil sampling program on the stockpiles of excavated material to the north of the GAA.	Contractor to divide the stockpiles into ten quadrants of mixed soil.	Monitoring to be completed before materials can be removed from the stockpile site.	The Engineer shall hire certified laboratory to perform the monitoring activities.	The certified laboratory shall provide the results to the Engineer within 20 days of the monitoring activity. The Engineer will immediately provide the results to the Contractor for disposal as hazardous or non-hazardous materials.

Source: final EIA (March 2018)

Table 8-10: Operational Phase Instrumental Monitoring

Issue	Mitigation	Locations	Schedule	Responsibilities	Reporting
Air Quality	Air quality monitoring of PM_{10}, $PM_{2.5}$, NO_X, SO_X and CO.	Same as during the construction phase.	Bi-annually during DLP	Engineer (during defects liability period)	Bi-annual submission of results to JICA.
Noise	Noise monitoring - Laeq 1h (dBA) both daytime and nighttime periods.	At all receptors within Project corridor	Twice per year during DLP	Engineer (during defects liability period)	Annual submission of results to JICA for two years after the completion of the project.
Final noise barrier monitoring	Undertake noise monitoring at sensitive receptors behind finished noise barriers to ensure the barriers are functioning according to their design.	At all identified receptors.	Once, daytime and nighttime	Contractor	Provide final results to RD within one month of the completion of construction of any noise barrier.

Source: final EIA (March 2018)

Table 8-11 lists the anticipated EMP costs, and Table 8-12 lists the anticipated instrumental monitoring costs.

Table 8-11: EMP Costs

Activity	Item	Number of Units / Unit cost	Cost estimate / US$	Responsibility	Source: JICA	Source: RD
Pre-construction						
SSEMP	SSEMP and associated plans	Included in Project Construction costs	-	Contractor	X	
Approval of Camp locations	Approval	Included in Project Construction costs	-	Engineer	X	
Incorporation of Environmental Items into Bid Documents	Item in Bid Document	Included in Detailed Design Budget.	-	RD		X
Obtain permits	Permits	Included in Project Construction costs	-	Contractor	X	

Activity	Item	Number of Units / Unit cost	Cost estimate / US$	Responsibility	Source: JICA	Source: RD
SFF	Compensation	Approx. 4,200	Approx. 4,200	Contractor		X
Pre-construction costs						$4,200
Construction						
Standard site management Additional environmental measures	Septic Tanks	Included in Project Construction costs	-	Contractor	X	
	Spill Kits	20 / US$200	4,000	Contractor	X	
	Bunds for fuel and oil storage	Included in Project Construction costs	-	Contractor	X	
	Waste containers	Included in Project Construction costs	-	Contractor	X	
	Waste Storage areas	Included in Project Construction costs	-	Contractor	X	
	Waste collection and disposal	Included in Project Construction costs	-	Contractor	X	
	Storage areas for hazardous materials	Included in Project Construction costs	-	Contractor	X	
	Sprinklers for rock crushing plant	Included in Project Construction costs	-	Contractor	X	
	Drainage (including oil and grease interceptors)	Included in Project Construction costs	-	Contractor	X	
	Vehicle washing bay	Included in Project Construction costs	-	Contractor	X	
	Fire safety	Included in Project Construction costs	-	Contractor	X	
	PPE	Included in Project Construction costs	-	Contractor	X	
	Impervious hardstanding (for maintenance yards, bitumen storage, etc.)	Included in Project Construction costs	-	Contractor	X	
	First aid facilities	Included in Project Construction costs	-	Contractor	X	
	Animal Crossings	Included in Project Construction costs	-	Contractor	X	
	Fencing around borrow pits	8 / $,2000	$16,000	Contractor	X	
	Fencing around PCR	2 / $1,000	$2,000	Contractor	X	
	Water bowsers	Included in Project Construction costs	-	Contractor	X	
	Water sprinklers (rock crushing plant)	Included in Project Construction costs	-	Contractor	X	

Activity	Item	Number of Units / Unit cost	Cost estimate / US$	Responsibility	Source: JICA	Source: RD
	Dust control measures (rock crushing and batching plants)	Included in Project Construction costs	-	Contractor	X	
	Tarpaulins	Included in Project Construction costs	-	Contractor	X	
SFF Tree Cutting and tree removal	Labour	Included in Project Construction costs	-	Contractor	X	
Fencing around red-list species (over 8 cm in diameter)	Fencing	Approximately 200 / $50	10,000	Contractor	X	
Re-planting of red-list species	Seedlings	615 / $10	6,150	Contractor	X	
Tunnel Excavation	Pre-condition surveys	Approximately 200 / $100	20,000	Contractor	X	
Tree / Vegetation maintenance	Labour and water	Included in Project Construction costs	-	Contractor	X	
Embankment vegetation and soil erosion measures	Vegetation, Labor and maintenance	Included in Project Budget	-	Contractor	X	
Potentially Contaminated Soil	Disposal of soil.	TBD	TBD	Contractor	X	
Training & Awareness Programs	Safety Training	Included in Project Budget	-	Contractor	X	
	HIV/AIDS Training	4 / US$1,000	4,000	Contractor	X	
	Toolbox Training	Included in Project Budget	-	Contractor	X	
	Construction orientation meetings	Included in Project Budget	-	Contractor	X	
	Periodic meetings with stakeholders	Included in Project Budget	-	Contractor	X	
Clean-up of construction sites.	Labor, waste disposal	Included in Project Budget	-	Contractor	X	
Environmental Staff	EO	30 / US$ 2,000	60,000	Contractor	X	
	IES	5 / US$ 20,000	100,000	Engineer	X	
	NES	30 / US$ 1,500	45,000	Engineer	X	
Construction Costs						US$267,150
Operation						
Noise	Noise Barriers	5,950 m / $1,352 m	8,044,440	Contractor	X	
	Noise Barrier foundations	4,822 m / $200 m	964,400	Contractor	X	
	Resettlement	Maximum 120	See RAP for costs	RD		X
	Other noise mitigation (noise proof windows, etc)	Maximum 120 receptors / US$2,000	240,000	Contractor	X	
Operation Costs						US$9,248,840
Total Cost						**US$9,520,190**

Source: final EIA (March 2018)

Table 8-12: Construction Phase Instrumental Monitoring Costs

Activity / Item	Frequency / Responsibility	Unit Cost	Cost /USD
Air Quality Monitoring	Monthly (six sites) / Engineer to hire certified laboratory.	200 per site	36,000
Soil Sampling	Ten samples from each of the eight stockpiles (2,500 m^3) / Engineer to hire certified laboratory.	400 per sample	32,000
Noise Monitoring	Monthly (six sites) / Engineer to hire certified laboratory.	200 per site	36,000
Surface Water Quality Monitoring	Weekly during construction period at the bridge sites crossing rivers (three sites) / Engineer to hire certified laboratory.	200 per site	28,800
Groundwater levels	Weekly during construction period of each tunnel / Engineer to hire certified laboratory.	20 per site	2,880
Tunnel dewatering	Weekly during construction period of each tunnel / Engineer to hire certified laboratory.	200 per site	41,600
Vibration Monitoring	Continuous during blasting in the vicinity of tunnels. One sensor for each cluster of house within the risk zones. At least 5 sensors within 100 m and 5 beyond. 10 sensors in total / Contractor	800	8,000
Total			**185,280**

Source: final EIA (March 2018)

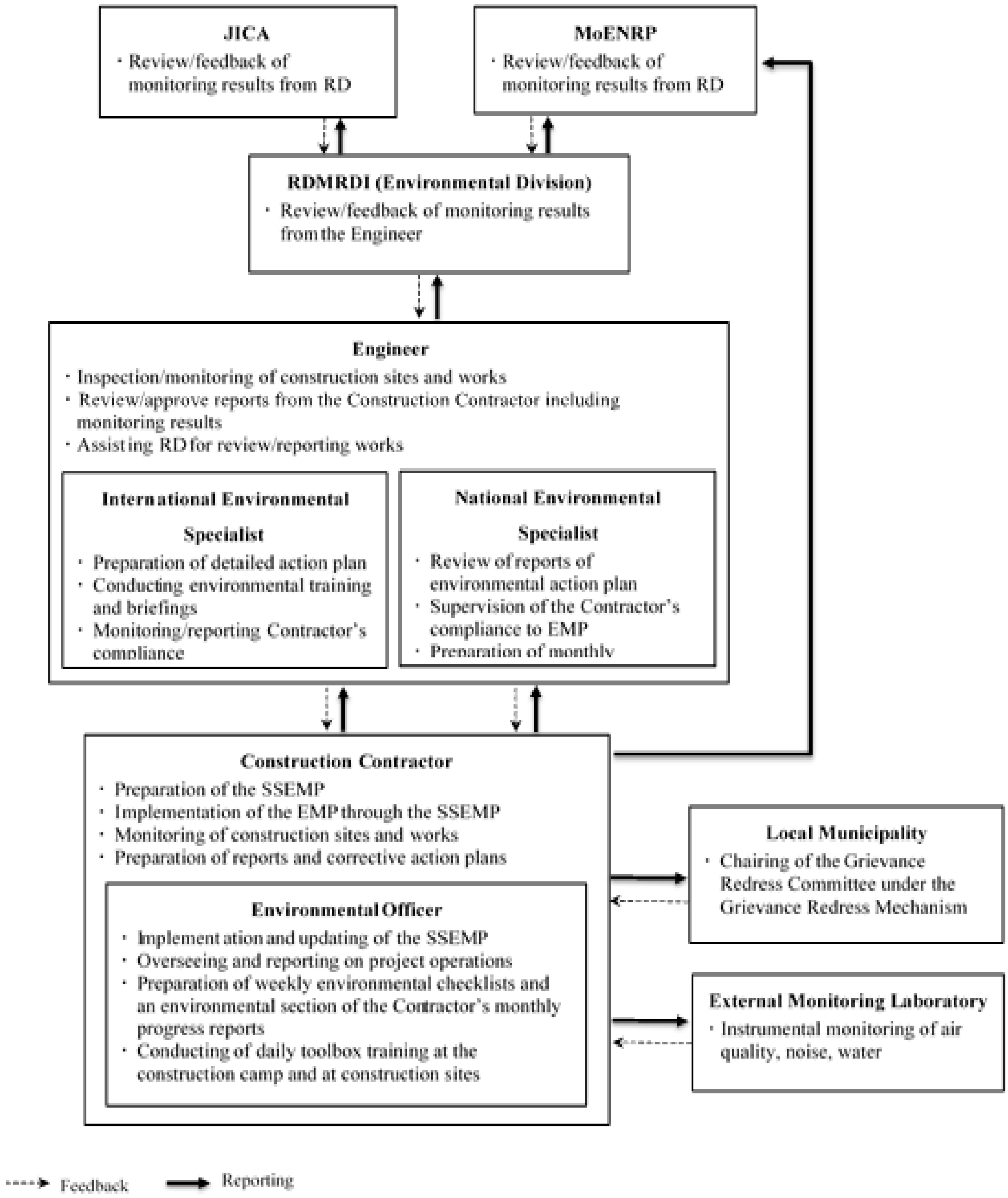
Table 8-13: Operational Phase Instrumental Monitoring Costs

Activity / Item	Frequency / Responsibility	Unit Cost	Annual Cost /USD
1. Air Quality Monitoring to JICA	Bi-annually (six locations) for two years / Engineer (during DLP)	200 per site	2,400
2. Noise Monitoring for Noise Mitigation.	Twice per year (all affected receptors) / Engineer	200 per site	Maximum 80,000
Total			**82,400**

Source: final EIA (March 2018)

(4) Institutional Requirements/Implementation Structures

Figure 8-2 shows the implementation structure during the construction phase.



Implementation and reporting/feedback structure of EMP (construction stage)

Source: JICA Survey Team

Figure 8-2: Implementation Structure of EMP (Construction Stage)

(5) Public (Stakeholder) Consultations

The first stakeholder consultation was undertaken on 7 June 2017 in Zestafoni (scoping consultation). The results were included to determine survey area, items, and methodology. While there was no major opposition to the project, a number of issues were raised, such as disposal of tunnel spoil material, tree cutting and replanting, access to properties during construction and identification of sites of cultural heritage. All of the issues identified in the consultations are included in the EIA and where practical, mitigation measures are proposed. The second consultation was held on 17 January 2018 in Zestafoni. Draft EIA had been disclosed to the public beforehand, but at the consultation also an overview of the project with a visual presentation was given, and public opinion was sought. As regards to environmental issues, questions on topics such as groundwater depletion near tunnel construction and the possibility of impacts of street lights on migratory birds were raised, but no concern or opposition to the project was expressed.

8.2.3 Conclusions and Recommendations

JST reviewed the final EIA submitted in March 2018 after numerous revisions and confirmed that discussion results between JICA/JST/RD were properly reflected, including issues that were pending such as potential soil contamination and mitigation measures for noise impact. No major revision request was made by MoENRP as a result of ecological expertise.

Potential Soil Contamination

Should the results of additional sampling indicate any elevated levels of contamination, further testing of the excavated soils in this area will be required during the construction phase by the Contractor, and a proper mitigation measure for soil removal should be considered.

Mitigation Measures for Noise Impact

Maximum of 5,950 m of noise barrier is recommended in the final EIA based on the model prediction for 2037, and this is incorporated into the detailed design. In reality, however, based on discussions with JICA/JST, these barriers are to be constructed after operation begins if it is considered necessary based on noise monitoring and if the affected persons want the noise barrier to be constructed. When operation is about to begin, we recommend JICA to confirm that the implementing agency has a system in place to conduct monitoring, evaluation, and planning/implementation of mitigation measure.

8.3 Involuntary Resettlement

This chapter outlines the legal framework on involuntary resettlement in Georgia and the requirements of related donors on involuntary resettlement. It also describes the policies on land acquisition and resettlement for the Project.

8.3.1 Legal Framework on Involuntary Resettlement of Georgia

In Georgia, the legislative acts given below regulate the issues of obtaining State ownership rights to privately owned land parcels, based on the necessary public needs established due to road construction activities:

- The Constitution of Georgia, August 24, 1995
- The Civil Code of Georgia, June 26, 1997
- Law on Public Health 27 June 2007
- The Law of Georgia on Ownership Rights to Agricultural Land, March 22, 1996
- Law on Compensation of Land Substitute Costs and Damages due to Allocating Agricultural Land for Non-Agricultural Purposes 1997
- The Law of Georgia on Recognition of the Property Ownership Rights Regarding the Land Plots Owned (Used) by Physical Persons or Legal entities; 11 June 2007
- Law on state property 2010
- The Law of Georgia on Public Register- No820 –IIs; December 19 of 2008
- In frames of national project, the Law of Legal Power of Land Parcels Systemic and Sporadic Registration and Improvement of Quality of Cadastral Data. June 17 of 2016.

- The Law of Georgia on the Rules for Expropriation of Ownership for Necessary Public Need, July 23, 1999
- The Civil Procedural Code of Georgia, November 14, 1997
- Labor Code, May 25, 2006

Overall, the above laws/regulations provide that the principle of compensation at full replacement cost is reasonable and legally supported. The laws also identify the types of conditions eligible for compensation and indicate that compensation is to be given both for loss of physical assets and for loss of income. Finally, these laws place a strong emphasis on consultation and notification to ensure that the project affected persons (PAPs) participate in the process. Income loss due to loss of harvest and business closure will be compensated to cover net loss.

8.3.2 The Requirements of Related Donors on Involuntary Resettlement

The requirements of related donors such as ADB, WB and JICA on involuntary resettlement are as follows. It should be noted that they have similar principles for main items mentioned below.

- LARAP Preparation
- Eligibility for Compensation
- Compensation Price
- Information Disclosure
- Income Restoration Programme
- Public Consultation

(1) ADB Safeguard Policy Statements (2009)

The summary on policies regarding involuntary resettlement is as follows.

- To avoid or minimize involuntary resettlement wherever possible by exploring project and design alternatives.
- To enhance, or at least restore, the livelihoods of all displaced persons in real terms relative to pre-project levels.
- To conduct meaningful consultation with PAPs, their host communities, and civil society for every project and subproject identified as having involuntary resettlement impacts.
- To prepare a resettlement plan if the proposed project will involve involuntary resettlement.
- To provide adequate and appropriate replacement land, structures or cash compensation at full replacement cost for lost land and/or structures.
- To conceived of and execute involuntary resettlement as part of a development project or program.
- To apply ADB’s policy persons inclusive of those with no formal legal rights to the lands they occupied.
- To improve the standards of living of any affected poor and other vulnerable groups.
- All costs of compensation, relocation, and livelihood rehabilitation will be considered as project costs.
- To conduct a socioeconomic survey to identify all persons who will be displaced by the project and to assess the project’s socioeconomic impact on them.
- Preference will be given to land-based resettlement strategies for displaced persons whose livelihoods are land-based.

(2) JICA policies on Land Acquisition and Resettlement

JICA stipulates the policies on land acquisition and resettlement in the guidelines as follows.

- Involuntary resettlement and loss of means of livelihood are to be avoided when feasible by exploring all viable alternatives.
- When, after such an examination, avoidance is proved unfeasible, effective measures to minimize impact and to compensate for losses must be agreed upon with the people who will be affected.
- People who must be resettled involuntarily and people whose means of livelihood will be hindered or lost must be sufficiently compensated and supported, so that they can improve or at least restore their standard of living, income opportunities and production levels to pre-project levels.
- Compensation must be based on the full replacement cost as much as possible.
- Compensation and other kinds of assistance must be provided prior to displacement.
- For projects that entail large-scale involuntary resettlement, resettlement action plans must be prepared and made available to the public. It is desirable that the resettlement action plan include elements laid out in the World Bank Safeguard Policy, OP 4.12, Annex A.
- In preparing a resettlement action plan, consultations must be held with the affected people and their communities based on sufficient information made available to them in advance. When consultations are held, explanations must be given in a form, manner, and language that are understandable to the affected people.
- Appropriate participation of affected people must be promoted in planning, implementation, and monitoring of resettlement action plans.
- Appropriate and accessible grievance mechanisms must be established for the affected people and their communities.

Above principles are complemented by World Bank OP 4.12, as stated in JICA Guideline that "JICA confirms that projects do not deviate significantly from the World Bank's Safeguard Policies". Additional key principle based on World Bank OP 4.12 is as follows.

- Affected people are to be identified and recorded as early as possible in order to establish their eligibility through an initial baseline survey (including population census that serves as an eligibility cut-off date, asset inventory, and socioeconomic survey), preferably at the project identification stage, to prevent a subsequent influx of encroachers of others who wish to take advance of such benefits.
- Eligibility of Benefits include, the PAPs who have formal legal rights to land (including customary and traditional land rights recognized under law), the PAPs who don't have formal legal rights to land at the time of census but have a claim to such land or assets and the PAPs who have no recognizable legal right to the land they are occupying.
- Preference should be given to land-based resettlement strategies for displaced persons whose livelihoods are land-based.
- Provide support for the transition period (between displacement and livelihood restoration.
- Particular attention must be paid to the needs of the vulnerable groups among those displaced, especially those below the poverty line, landless, elderly, women and children, ethnic minorities etc.
- For projects that entail land acquisition or involuntary resettlement of fewer than 200 people, abbreviated resettlement plan is to be prepared.

In addition to the above core principles on the JICA policy, it also places emphasis on a detailed resettlement policy inclusive of all the above points: project specific resettlement plan; institutional framework for implementation; monitoring and evaluation mechanism; time schedule for implementation; and detailed Financial Plan.

The results of comparative analysis on policies on land acquisition and resettlement among related donors are shown in the Table 8-14.

Table 8-14: Comparative Analysis on Policies on Land Acquisition and Resettlement among Related Donors

Item	ADB	JICA Guidelines(WB)	Identified Gap
LARP Preparation	To prepare a resettlement plan if the proposed project will involve involuntary resettlement	For projects that entail large-scale involuntary resettlement, resettlement action plans must be prepared and made available to the public.	No significant gap
Eligibility for Compensation	To apply ADB's policy persons inclusive of those with no formal legal rights to the lands they occupied.	Eligibility of Benefits include, the PAPs who don't have formal legal rights to land at the time of census	No significant gap
Compensation Price	To provide cash compensation at full replacement cost for lost land and/or structures	Compensation must be based on the full replacement cost as much as possible.	No significant gap
Income Restoration Programme	To improve the standards of living of any affected poor and other vulnerable groups	People who must be resettled involuntarily and people whose means of livelihood will be hindered or lost must be sufficiently compensated and supported.	No significant gap
Public Consultation	To conduct meaningful consultation with PAPs, their host communities, and civil society for every project and subproject identified as having involuntary resettlement impacts.	In preparing a resettlement action plan, consultations must be held with the affected people and their communities based on sufficient information made available to them in advance.	No significant gap

Source: JICA Survey Team

(3) Comparison of Relevant Georgian Laws and the JICA Guidelines

Overall, the legislation of Georgia adequately reflects the major provisions of the JICA Guidelines but a few differences are to be noted. The most significant of these differences is that under Georgian legislation/regulation, emphasis is put on the definition of formal property rights and on how the acquisition of properties for public purposes is to be implemented and compensated while in the case of JICA guidelines emphasis is put both on the compensation of rightfully owned affected assets and on the general rehabilitation of the livelihood of Affected People (AP) and Households (AH). Because of this, JICA policy complements the Georgian legislation/regulation with additional requirements related to (i) the economic rehabilitation of all AP/AH (including those who do not have legal/formal rights on assets acquired by a project); (ii) the provision of indemnities for loss of business and income, (iii) and the provision of special allowances covering AP/AH expenses during the resettlement process or covering the special needs of severely affected or vulnerable AP/AHs.

To reconcile the gaps between Georgia laws/regulations and JICA Policy, RDMRDI has adopted the JICA policies for the Project, ensuring compensation at full replacement cost of all items, the rehabilitation of informal settlers, and the provision of subsidies or allowances for AHs those will be relocated, suffer business losses, or will be severely affected. The differences between Georgia law/regulation and JICA policies are outlined in Table 8-15.

Table 8-15: Comparative Analysis of Georgian Law/Regulation and JICA Guidelines

No.	Items	Georgian Laws	JICA Guidelines	Gap between JICA Guidelines and Georgian Laws	Corrective Action
1	Avoidance of involuntary resettlement and loss of means of livelihood	No provision for avoidance of involuntary resettlement and loss of means of livelihood	Involuntary resettlement and loss of means of livelihood are to be avoided when feasible by exploring all viable alternatives.	Laws of Georgia have no provision for avoidance of involuntary resettlement and loss of means of livelihood	During DD there was made some changes to avoid involuntary resettlement.
2	Preparation of effective measures to minimize impact, when population displacement is unavoidable	No provision for minimization of impact caused by population displacement	When population displacement is unavoidable, effective measures to minimize impact and to compensate for losses should be taken	Laws of Georgia have no provision for minimization of impact caused by population displacement	For minimize impact PAPs will be given full replacement cost for assets and allowances for severely affected HH, vulnerable HH and relocation/shifting allowances.
3	Requirement of sufficient compensation to People who must be resettled involuntarily and people whose means of livelihood will be hindered or lost.	Loss of income is considered for compensation but no provision for income/livelihood rehabilitation, allowances for severely affected or vulnerable APs, or resettlement expenses	People who must be resettled involuntarily and people whose means of livelihood will be hindered or lost must be sufficiently compensated and supported, so that they can improve or at least restore their standard of living, income opportunities and production levels to pre project levels.	Laws of Georgia have no provision for income/livelihood rehabilitation, allowances for severely affected or vulnerable APs, or resettlement expenses	To improve or at least restore their standards of living APs will be given compensation for severely affected HH, vulnerable HH and relocation/shifting allowances.

No.	Items	Georgian Laws	JICA Guidelines	Gap between JICA Guidelines and Georgian Laws	Corrective Action
4	Compensation Price	No specific provision for compensation based on the full replacement cost	Compensation must be based on the full replacement cost as much as possible.	Laws of Georgia have no provision for compensation based on the full replacement cost	Compensation will be given in full replacement cost.
5	Timing of provision of compensation and other kinds of assistance	No specific provision for timing of provision of compensation and other kinds of assistance	Compensation and other kinds of assistance must be provided prior to displacement	Laws of Georgia have no provision for timing of provision of compensation and other kinds of assistance	Compensation and other kinds of assistance will be provided prior to displacement
6	LARP Preparation	No provision for preparation of resettlement action plans for the projects that entail large-scale involuntary resettlement	For projects that entail large-scale involuntary resettlement, resettlement action plans must be prepared and made available to the public.	Laws of Georgia have no provision for preparation of resettlement action plans	LARP will be disclosed on the website of RD.
7	Consultations during preparation of a resettlement action plan	There is provision for consultation with APs but there is no specific plan for public consultation under the Georgian laws	In preparing a resettlement action plan, consultations must be held with the affected people and their communities based on sufficient information made available to them in advance	Laws of Georgia have no provision for specific plan for public consultation	During the DD two public consultations was held and also individual consultations with stakeholders
8	Explanation method in consultation	No provision for giving explanations in a form, manner, and language that are understandable to the affected people	When consultations are held, explanations must be given in a form, manner, and language that are understandable to the affected people.	Laws of Georgia have no provision for giving explanations in a form, manner, and language that are understandable to the affected people	During Public consultation fully explanation was given in language that was understandable for PAPs. Also they were given informational leaflets.

No.	Items	Georgian Laws	JICA Guidelines	Gap between JICA Guidelines and Georgian Laws	Corrective Action
9	Appropriate participation of affected people	No provision for promotion of appropriate participation of affected people in planning, implementation, and monitoring of resettlement action plans	Appropriate participation of affected people must be promoted in planning, implementation, and monitoring of resettlement action plans.	Laws of Georgia have no provision for promotion of appropriate participation of affected people in planning, implementation, and monitoring of resettlement action plans	RDMRDI will follow the JICA GL.
10	Grievance mechanisms	Land Acquisition Committee is the only pre-litigation final authority to decide disputes and address complaints regarding quantification and assessment of compensation for the affected assets.	Appropriate and accessible grievance mechanisms must be established for the affected people and their communities.	Laws of Georgia have provision of Land Acquisition Committee as pre-litigation final authority to decide disputes and address complaints regarding quantification and assessment of compensation for the affected assets.	Complaints & grievances are resolved informally through community participation in the Grievance Redress Committees (GRC), Local governments, and NGO and/or local-level community based organizations (CBOs)
11	Requirement of identification and record of affected people in early stage	No provision for requirement of identification and record of affected people in early stage to establish their eligibility through an initial baseline survey	Affected people are to be identified and recorded as early as possible in order to establish their eligibility through an initial baseline survey, preferably at the project identification stage, to prevent a subsequent influx of encroachers of others who wish to take advance of such benefits.	Laws of Georgia have provision or requirement of identification and record of affected people in early stage	Affected identified during DMS. Cutoff-date was declared as start date of DMS

No.	Items	Georgian Laws	JICA Guidelines	Gap between JICA Guidelines and Georgian Laws	Corrective Action
12	Eligibility for Compensation	- Compensation for land is conducted only for titled landowners. - Only registered houses/buildings are compensated for damages/demolition caused by a project. - Crop losses compensation provided only to registered Landowners	Eligibility of benefits includes, the PAPs who have no formal legal rights to land	Laws of Georgia accept compensation only on titled landowners, registered houses/buildings and registered landowners(crops)	- Lack of title should not be a bar to compensation and/or rehabilitation. - Non-titled landowners receive rehabilitation assistance. - All affected houses/buildings are compensated for buildings damages/demolition caused by a project. - Crop losses compensation provided to landowners and sharecrop/lease tenants whether registered or not
13	Land-based resettlement strategies	No provision for preference on land-based resettlement strategies for displaced persons whose livelihoods are land-based.	Preference should be given to land-based resettlement strategies for displaced persons whose livelihoods are land-based. (WB OP4.12 Para. 11)	Laws of Georgia have no provision for preference on land-based resettlement strategies	Compensation to PAPs will be given in cash.
14	Support for the transition period	No provision for provision of support for the transition period	Provide support for the transition period (between displacement and livelihood restoration).	Laws of Georgia have no provision for provision of support for the transition period	RD will provide support during and displacement.
15	Paying attention to the vulnerable groups	No provision for particular attention on vulnerable groups	Particular attention must be paid to the needs of the vulnerable groups among those displaced, especially those below the poverty line, landless, elderly, women and children, ethnic minorities etc.	Laws of Georgia have no provision for particular attention on vulnerable groups	RD will pay attention to the needs of vulnerable people during implementation of LARP throughout appropriate measures.

No.	Items	Georgian Laws	JICA Guidelines	Gap between JICA Guidelines and Georgian Laws	Corrective Action
16	Abbreviated resettlement plan	No provision for preparation of abbreviated resettlement plan for the projects that entail land acquisition or involuntary resettlement of fewer than 200 people	For projects that entail land acquisition or involuntary resettlement of fewer than 200 people, abbreviated resettlement plan is to be prepared. (WB OP4.12 Para. 25)	Laws of Georgia have no provision for preparation of abbreviated resettlement plan	Fully LARP is applied.

Source: JICA Survey Team

8.3.3 Policies on Land Acquisition and Resettlement for the Project

The resettlement policy for the project has been designed to (a) cover all APs irrespective of their title to land, (b) provide replacement cost compensation for lost assets, and (c) restore or enhance the livelihoods of all categories of APs. The households/persons affected by the project interventions will receive cash compensation for land and other assets at full replacement cost as per market price at the time of dispossession. Additional measures will be taken to ensure minimum disruption during the project construction period. Physically and economically affected households will receive due compensation, relocation assistance, and allowances in accordance with the following guidelines and policies:

- Land acquisition, and other involuntary resettlement impacts will be avoided or minimized exploring all viable alternative project designs.
- Where unavoidable, a time-bound LARP will be prepared and APs will be assisted in improving or at least regaining their pre-program standard of living.
- Land will be acquired through a contract agreement to the extent possible. Expropriation process will be sought only as the last resort when all possibilities of negotiation fail.
- Vulnerable and severely APs will be provided special assistance.
- Non-titled APs will receive a livelihood allowance in lieu of land compensation and will be fully compensated for losses other than land.
- Legalizable APs (APs possessing ownership documents but with title formalization pending) will be legalized and fully compensated for land losses.
- The land users who are not registered but legitimately use agricultural land not adjacent to residential plots will be provided with cash compensation at full replacement cost, according to the Decree of the Government of 2011. The payments will be executed without registration in NAPR.
- Provision of income restoration and rehabilitation compensation will be made.
- The LARP will be disclosed to the APs in the local language which is Georgian.
- Payment of compensation, resettlement assistance and rehabilitation measures the rates set in this LARP will be fully provided prior to the commencement of any construction activities on a particular package.
- Compensation will be provided at least at the rates detailed in this LARP although some modification in excess will be possible during the discussions preceding the signing of the contract
- Complaints will be reviewed using the existing grievance redress mechanisms.

- For projects that entail large-scale involuntary resettlement, resettlement action plans must be prepared and made available to the public. It is desirable that the resettlement action plan include elements laid out in the World Bank Safeguard Policy, OP 4.12
- Appropriate participation of affected people must be promoted in planning, implementation, and monitoring of resettlement action plans.
- Preference should be given to land-based resettlement strategies for displaced persons whose livelihoods are land-based.
- Provide support for the transition period (between displacement and livelihood restoration).
- In preparing a resettlement action plan, consultations must be held with the affected people and their communities based on sufficient information made available to them in advance. When consultations are held, explanations must be given in a form, manner, and language that are understandable to the affected people.

8.3.4 Summary of the LARP for the Project

JST obtained the first draft of the Land Acquisition and Resettlement Plan (LARP) for the Project in November 2017 and reviewed it. The comments on the first draft of LARP prepared by JST were combined with those of JICA HQs and sent to RD/DD consultant for their revision.

The draft of LARP was revised three times based on the comments of JICA/JST and the Final LARP was submitted to RD by DD consultant in February 2018. The Final LARP was approved by RD in March 2018. Note that the results of the second stakeholders meeting held in January 2018 are incorporated into the Final LARP.

In this chapter, the summary of the LARP has been described based on the information of the Final Draft of LARP for the Project. For full details see Final LARP (Appendix 8.2).

(1) Affected Land Plots

According to the preliminary data, the mentioned road section will affect 609 land plots. From the mentioned 609 land plots, 32 are in state ownership, and 577 are in private ownership.

Project affected land plots have been grouped in following categories according to ownership types, based on legal right on ownership:

I category: Project affected private land plots, registered in Public Register: 381 with total affected area of 378,749 m^2.
II category: Legalizable project affected land plots: 194 land plot with affected area of 150,965 m^2.
III category: Non legalizable; ownership is not subject for legalization- 2 land plot, with total area of 11,956 m^2
IV category: State land (is not occupied arbitrarily by population) 32 plot with affected area 101,155 m^2.

The information on usage types of affected land plots is given in Table 8-16 below.

Table 8-16: Type of Land

Type of land	Number
Agricultural	493
Residential area	50
Non-agricultural	66

Source: Final LARP (March 2018)

(2) Impact on Agricultural Crops

Impact from the project includes arable land plot where populations have planted corn etc. There is 1,003,602 m^2 of corn, beans and other vegetables under the project impact zone.

(3) Impact on Trees

According to preliminary data under the project impact zone there is 14,552 trees on 301 land plots.

(4) Impact on Structures

Under the impact of the project there are 21 residential house, 115 auxiliary buildings and 30 commercial structures.

(5) Impact on Business

According to the survey the project impact on 14 business facilities out of which there are 4 restaurants, 2 is little shops and other 8 little factories or other industrial facilities. This means that 41 people will lose their job.

(6) Socio-economic Characteristics

The project impact area covers Zestafoni municipality and its villages: Ilemi, Argveta, Futi, Tseva, Shoropani, Dzirula, Zemo Sakara, Kvemo Sakara and Zestaphoni city. The characteristics of the impact area are as followed.

Population and Demography

As for official data of January 2016, the populations of Zestafoni municipality comprise 58,041 people. Table 8-17 shows the population in villages, boroughs and Zestafoni city within the project affected zone.

Table 8-17: Population in Villages, Boroughs and Zestafoni City within the Project Affected Zone

Location	Population	Man	Woman
Zestafoni municipality	58,041	37,124	209,17
Zestafoni city	20,814		
Shoropani Borough	1,258	596	662
Argveta	1,329	652	677
Dzirula	84	37	47
Ilemi	525	253	272
Puti	1,564	780	784
Kveda Tseva	178	91	87
Kveda Sakara	1,989	944	945
Zeda Sakara	2,099	1,008	1,091

Source: Final LARP (March 2018)

Natural Resources and Agriculture

Agriculture is the main source of income for population. Agricultural land plots cover 7027 ha of the municipality area that is only 46% of the whole territory. 5159 ha out of the abovementioned area is arable lands. As for greenhouse areas, it totals as 6 ha. Detailed information on Imereti region and Zestafoni Municipality is given in Table 8-18.

Table 8-18: Natural Resource and Agriculture

Land Use	Zestafoni municipality (ha)
Total agricultural	7,027
Arable	5,159
Mowing	363
Green house	6

Source: Final LARP (March 2018)

Economy

Viticulture is the leading economy in the municipality, making up 80% of the produced agricultural products. Its development is supported by favourable soil-climatic conditions. Vineyards occupy 5,000 ha area. There are two active wine producing factories in the municipality. Maize is the main crop culture; feed and vegetable crops are also grown.

Healthcare

Five hospitals, several clinics and medical emergency centers operate in the municipality. The population of remote villages, who live far from the center, face some problems in relation to the distance. Unfortunately there is no helicopter in the region, for provision of transportation of patients to hospitals in case of necessity.

Education and Culture

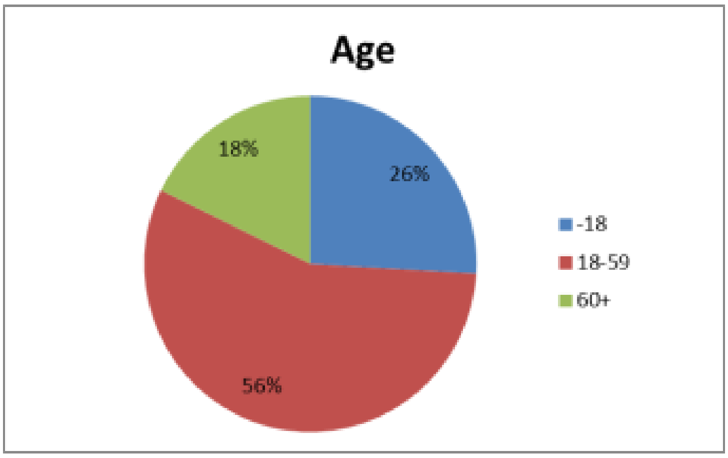
There are 33 public schools in Zestafoni municipality, with 8 700 pupils, 2 vocational education centers, 4 private schools, 42 libraries, 1 theatre and a Zestafoni Local Museum. The newspaper "Zestaponis Moambe" is distributed throughout the municipality. There are up to 50 orthodox churches in the municipality. There is no higher education institution in the municipality and accordingly youth have to leave for Tbilisi and other large cities of the country to receive higher education.

(7) Socio-Economic Survey for the Target Community

The socio-economic survey for the target community was conducted to grasp the effects and impacts on the local people caused by the Project through interview to 20% of related households (1,500HHs) in the community. The sample households were selected by sampling method. The results of the survey are as follows.

Age Distribution

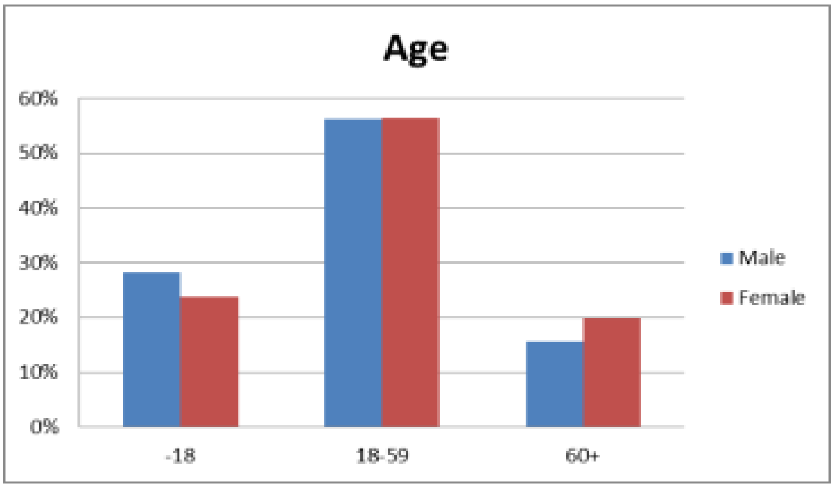
As for the age distribution, as shown in the Figure 8-3, 26% of them are 18 years old, 56% - from 19 to 59 years old, 18% - 60 years old or more.



Source: Final LARP (March 2018)

Figure 8-3: Age Distribution

Figure 8-4 shows the age distribution by age and sex.



Source: Final LARP (March 2018)

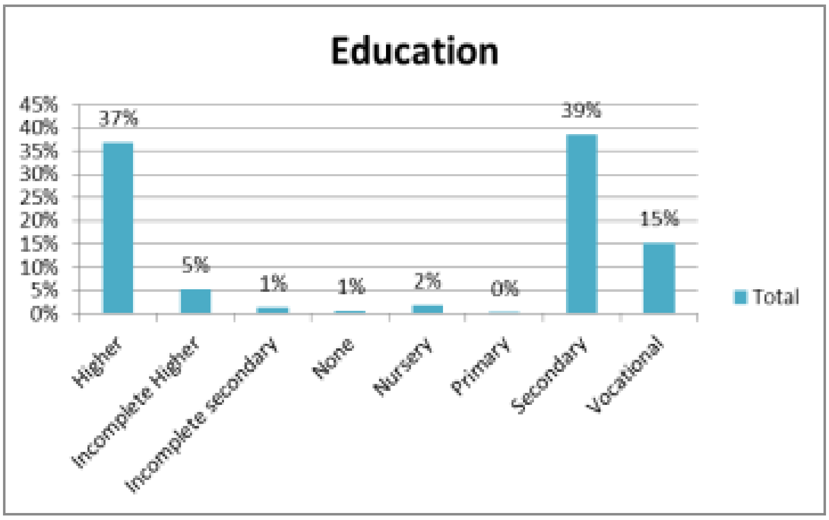
Figure 8-4: Age Distribution by Age and Sex

Marital Status

6% of population aged over 18 years is married. 1% is divorced and 9% is widow.

Education Level

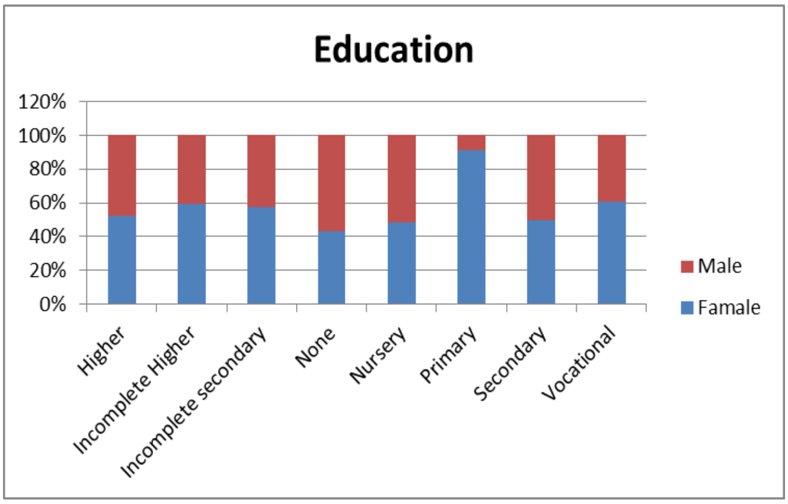
Figure 8-5 shows education level in the project affected area. 39% has secondary education, 37% - higher education and 15% - vocational education.



Source: Final LARP (March 2018)

Figure 8-5: Education Level

Figure 8-6 shows population distribution by education and sex in the project affected area. 52% of interviewed populations with higher education are woman, but in case of population with secondary education it is 50%. Majority of population with vocational education are woman (61%)

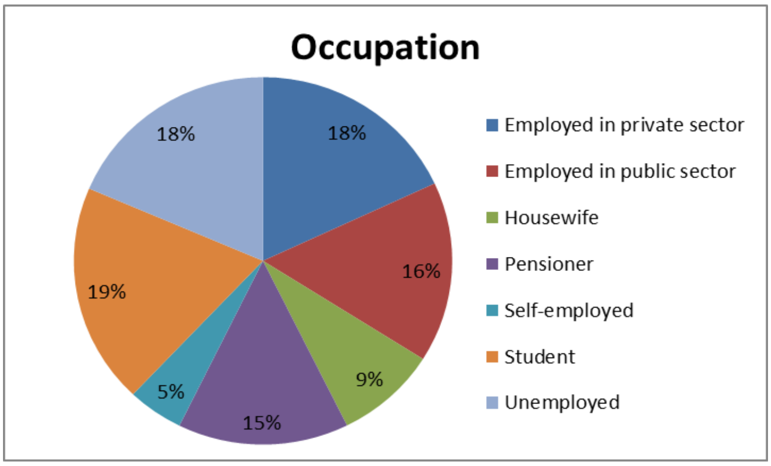


Source: Final LARP (March 2018)

Figure 8-6: Population Distribution by Education and Sex

Employment Status

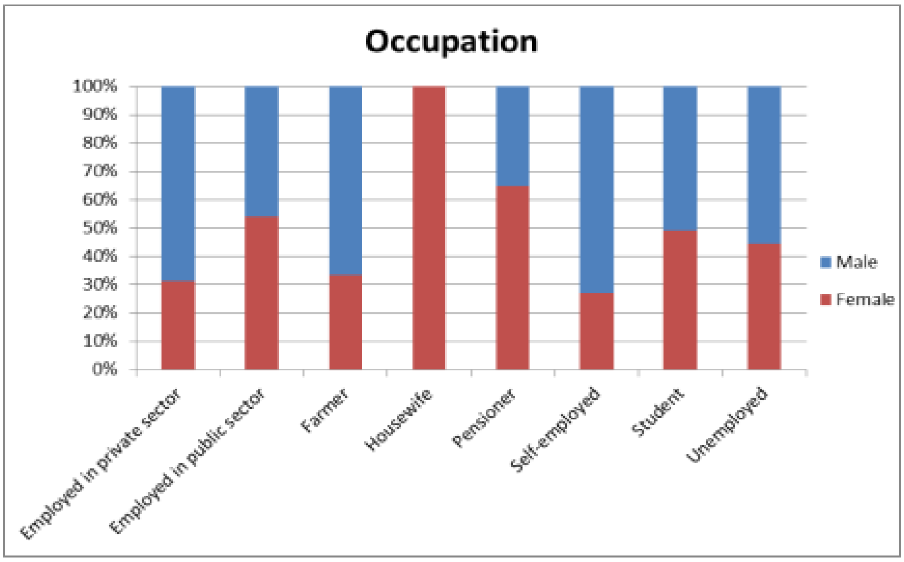
Figure 8-7 shows employment status in the project affected area. 34% of surveyed people are employed, almost 18% is unemployed, 9% - housewives, 19% - students or pupils, 15% - pensioners.



Source: Final LARP (March 2018)

Figure 8-7: Employment Status

As shown in Figure 8-8, the majority of employed people in private sector are men (68%), but in case of public sector women (54%).



Source: Final LARP (March 2018)

Figure 8-8: Employment Status by Sex

Table 8-19 shows Occupation and Education Level.

Table 8-19: Occupation and Education Level

Occupation	Higher	Secondary	Vocational
Employed in private sector	28%	30%	28%
Employed in public sector	42%	10%	18%
Housewife	8%	19%	18%
Self-employed	6%	7%	13%
Unemployed	16%	35%	24%
Total	100%	100%	100%

Source: Final LARP (March 2018)

Household Assets

Table 8-20 shows the present condition of household assets.

Table 8-20: Household Assets

Household Assets	Percentage
Refrigerator	95%
Television	96%
Gas	88%
Gas Heater	69%
Computer	65%
Mobile phone/telephone	95%
Washing machine	80%
Car	39%

Source: Final LARP (March 2018)

Agriculture

Table 8-21, Table 8-22, Table 8-23 shows the present condition of agriculture of the area.

Table 8-21: No. of HHs Cultivating One Year Crop

Crops	Zestaphoni city	Villages	Total
Corn	20	297	317
Fruit	24	285	309
Potatoes	6	171	177
Vegetables	14	209	223
Walnut/Hazelnut	20	277	297
Grapes	20	283	303
Hay	0	85	85

Source: Final LARP (March 2018)

Table 8-22: No. of HHs Keeping Livestock

Livestock	Zestaphoni city	Villages	Total
Cow, Ox and Buffalo	5	195	200
Horse or Donkey	2	3	5
Pigs	4	36	40
Sheep	3	7	10
Chicken or Turkey	11	236	247

Source: Final LARP (March 2018)

Table 8-23: No. of HHs of Product Sell

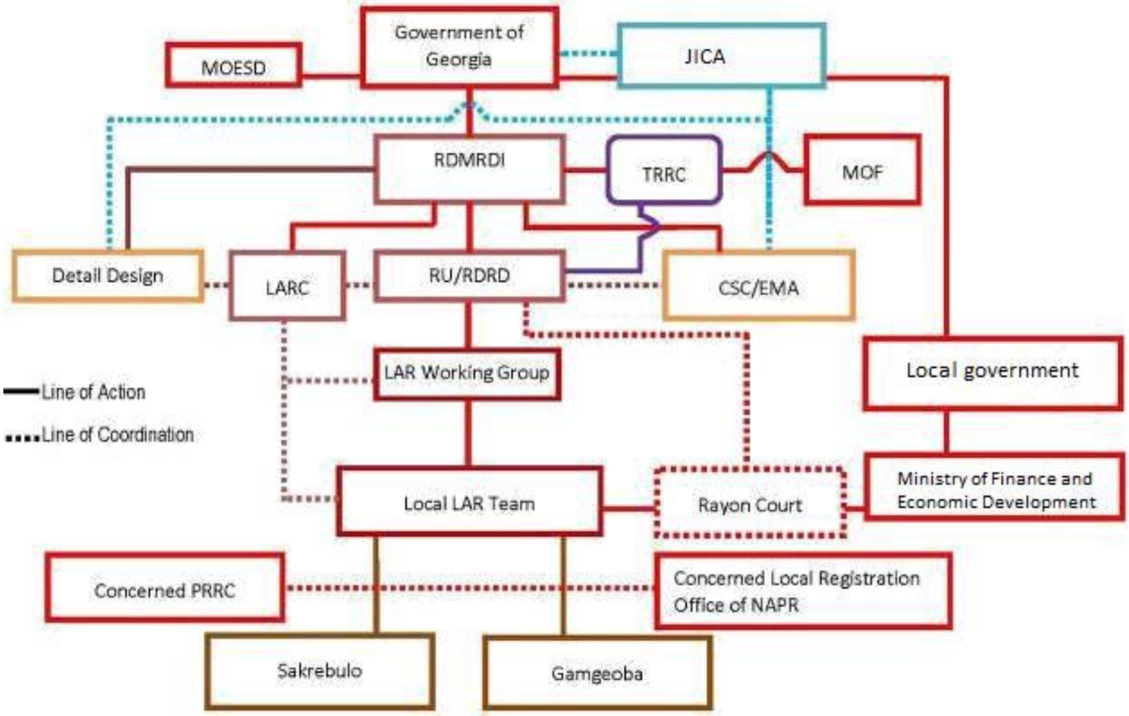
Product Sell	Zestaphoni city	Villages	Total
Dairy Product	2	75	77
Honey	1	6	7
Handmade items	1	1	2
Fruit	4	4	8
Vegetables	2	1	3
Flour	1	2	3
Other	0	6	6

Source: Final LARP (March 2018)

(8) Institutional Arrangement

The Roads Department of the Ministry of Regional Development and Infrastructure of Georgia (RDMRDI) will be the Executing Agency (EA) having the lead responsibility for road construction, as well as the implementation of the LARP. RDMRDI with the assistance of the consultants will develop and implement the LARP. In addition to the RDMRDI, a number of other government departments and private agents will play an instrumental role in the design, construction and operation of the project. The Ministry of Natural Resources and Environmental Protection is responsible for environmental issues. The Ministry of Justice is responsible for legal matters regarding land ownership, and National Agency of Public Registry (NAPR) within the Ministry of Justice is in charge of the registration of land ownership and its transfer through purchase agreement from landowners to the Roads Department.

The organization chart for land acquisition and resettlement is as shown in Figure 8-9.



Source: Final LARP (March 2018)

Figure 8-9: Organization Chart for Land Acquisition and Resettlement

(9) Eligibility (Entitlement Matrix)

The compensation entitlement depending on the type of loss is shown in the Table 8-24.

Table 8-24: Entitlement Matrix

Type of Loss	Application	AH/APs	Compensation Entitlement
Land			
Permanent loss of all types of land	All land losses independent from impact severity	PAPs (with fully registered title)	PAPs will receive cash compensation at full replacement cost at current market value. If any remaining part of the land owned by the registered owners is no longer appropriate for use, such remaining part will also be purchased subject to the agreement with the owner.

Type of Loss	Application	AH/APs	Compensation Entitlement
		PAPs (possessors of legalizable land parcel)	Assistance to PAPs in the process of legalization of project affected land parcel being under their possession. Once legalization and registration of ownership title is accomplished, land acquisition will be undertaken and PAP will receive cash compensation at full replacement cost at current market value at unit rate proposed in approved LARP. If any remaining part of the land owned by the registered owners is no longer appropriate for use, such remaining part will also be purchased subject to the agreement with the owner.
		Leaseholder of private or public lands	Free of charge renewal of lease in other plots of equal value/productivity of affected land parcel or cash compensation equivalent to market value of gross yield of affected land for the remaining lease years (up to a maximum of 3 years). In addition, cash compensation to reimburse the proven investments incurred by the Leaseholder to improve the leased land.
		Leaseholder (not registered)	Cash compensation equivalent to market value of gross yield of affected land for the remaining lease years (up to a maximum of 3 years).
		Non-titled, non-legalizable land users/Squatters	Non-legalizable APs losing agricultural land plot, which is the only land plot owned by AH and provides main source of income for AH, will be compensated with one-time self-relocation allowances in cash equal to 3 months of minimum subsistence income.
Permanent loss of community land (pastures, grazing land)	Community land	Local community losing access to pasture, grazing land	Affected community will be free of charge allocated replacement land of similar size, productivity, and location acceptable to affected community by the local government. If such replacement is not possible, Livelihood Restoration Plan will be prepared and implemented to address the needs of affected community and preserve their livelihood at least similar to pre-project level.
Structures			
Residential house	Project affected residential dwellings subject to partial/full demolition	All PAPs	All impacts will be considered as full impacts disregarding the actual impact percentage. Impacts will be compensated in cash at full replacement costs free of depreciation and transaction costs. In addition, Livelihood Restoration initiatives will be provided to PAPs that may face deterioration of livelihood through indirect impact of proposed road project. (E.g. project impact is extended only on residential dwelling subject to full cash compensation at replacement costs and additional one-time allowances to transport salvaged materials and personal belongings. However, other income generating assets (agricultural land/private commercial facilities) may remain outside of project impact; correspondingly, these assets may not be included in the suggested compensation package. PAPs after moving and settling down to a new location may at least temporarily lose income due to lack of access

Type of Loss	Application	AH/APs	Compensation Entitlement
			(increased travel time, complicated accessibility) to the above mentioned income generating assets
		Residential tenants/rent errs	One-time allowance equals monthly rental fee (specified in the lease agreement) multiplied by 3; if Lease agreement is not available, minimum monthly salary multiplied by 3; In addition one-time technical assistance for transportation personal belongings to a new location; or one-time cash allowance to cover costs for transportation personal belongings. LARP developer consultant will determine reasonable amount depending on the project nature and specificity
Commercial Structure	Project affected commercial facilities subject to partial/full demolition	Titleholder	Cash compensation at replacement cost at current market value calculated for project affected structure and other fixed assets free of salvageable materials, depreciation and transaction costs. If partial demolition threats deterioration of structure or raises safety and security concerns the cash compensation, will apply to the full structure.
		Tenant of commercial facility	One-time allowance equal to monthly rental fee (specified in the lease agreement) multiplied by 3; if Lease agreement is not available, minimum monthly salary multiplied by 3
State/Municipality owned buildings affected by project	Project affected state/Munici pality owned buildings subject to partial/full demolition	Refugees, squatters occupying facilities for residential purposes	Accommodation in a government resettlement area or a self-relocation allowance as stipulated in the approved LARP.
Fences/Walls	Affected Fences/Walls	All PAPs	Cash compensation at replacement cost according to the material and linear meter length of affected fence/wall.
Annual Crops	Crops affected	All PAPs (including squatters)	Crop compensation in cash at gross market value of actual or expected harvest. Compensation for this item will be provided even in case if the crops were harvested. Crop compensation will be paid to landowners, land users, tenants or other users based on their specific sharecropping agreements being made between these parties, if any.
Perennials standing on private land parcels	Project affected Fruit bearing perennials	All PAPs (including squatters)	Cash compensation at market value on the basis of type, age, and productive value of fruit tree; Each fruit bearing tree in addition shall be compensated for purchase of saplings. PAPs will be eligible to dispose logged trees themselves. Construction company ensures free logging and delivery of timber to the residence of PAPs.
	Project affected nonfruit bearing perennials.	All PAPs (including squatters)	No cash compensation will be issued for perennials not bearing fruits. PAPs will be eligible to dispose logged trees themselves.

Type of Loss	Application	AH/APs	Compensation Entitlement
Perennials (on public/State land)	Standing trees	Perennials standing outside of private land	Construction Company will deliver logged down trees and transfer to the Municipality. Municipality may later distribute to local population below poverty levels.
	Standing non fruit trees	Perennials standing outside of private land	The legal implementation of the mentioned activity requires, that Perennials standing on the forestry land must be delisted from the State Forest Fund in accordance with the corresponding Decrees of Government of Georgia. Construction Company will deliver logged down trees and transfer to the Municipality. Municipality may later distribute to local population below poverty levels.
Income Loss			
Lessors/landlords	Loss of income through termination of Lease agreements	All PAPs holding lease/rental agreement	One-time allowance equal to monthly rental fee (specified in the lease agreement) multiplied by 3; if Lease agreement is not available, minimum monthly salary multiplied by 3.
Business Employment	Temporary or permanent loss of business or employment	All PAPs (including squatters)	All kind of running business (officially registered or not-vendors etc.) will be compensated in cash equal to 1 year based on tax declaration or, if unavailable (Loss of income from both formal and informal economic activities) based on the official minimum substance income. All kind of unofficial business (e.g. street venders) will compensate based on official minimum substance income multiple on active period up to 1 year. Worker/employees: Indemnity for lost wages for the period of business interruption. In cases where tax declaration reports are unavailable, then official minimum monthly salary multiplied to the number of months of actual stoppage of business
		Agricultural workers losing their contract	Cash indemnity corresponding to their salary for the remaining part of the agricultural year, and where needed livelihood restoration measures
Additional Rehabilitation Measures			
Technical assistance in legalization, registration procedures		All PAPs with registered title/possessors of legalizable land parcels	Free of charge technical assistance to PAPs during legalization, sub-division of project affected parcel, registration of corrections and/or sales transaction. Project related State taxes, official fees and transactions costs if not waived will be covered by the GOG.
Relocation /Shifting allowance	Transport and transitional livelihood allowances	All PAPs affected by relocation	Provision of equal allowance for 3 months of consumer basket for family of five members, plus 200 Gel for transportation.
Community Resources			Access shall be maintained or reinstated; Rehabilitation/substitution of the affected structures/utilities (i.e. bridges, roads, schools, health-centers, potable water supply systems, irrigation channels, etc.)
Vulnerable PAPs		PAPs below poverty line etc.	Allowance equivalent to 3 months of minimum subsistence income and employment priority in project-related jobs.

Type of Loss	Application	AH/APs	Compensation Entitlement
Severely Affected		APs who will lose more than 20% of land plot.	Severely AH will receive an allowance equivalent to 3 months minimum subsistence for a family of 5 person
Temporary impact	Loss of access to land parcel	Owners/Users	Temporary access will be set up by Construction Company. In cases of temporary loss of access to land parcel results in loss to crops, the construction company will compensate APs. All losses and amount of due compensation shall be determined according to the principles of compensation entitlements provided under the LARP.
	Avoidance of interruption of temporary access road to the business activity	Business units	Temporary access will be set up by Construction Company.
	Temporary loss of income caused by occupying land parcels for the camps and quarries	Owners/Users	During camps' site selection process, Construction Company should coordinate with relevant state agencies and give priority to vacant lands not used for agricultural /residential purposes. In case the land parcels selected for camps and quarries will have private land-users, all losses and amount of due, compensation shall be determined according to the principles of compensation entitlements provided under the LARP.
Any other unforeseen Impacts	As required	Any	Road Department and the construction contractor will address and mitigate/compensate unforeseen resettlement impact during project.

Source: Final LARP (March 2018)

(10) Stakeholder Meeting

The stakeholder meetings for the LARP of the Project were held twice at Zestaphoni City. Note that individual stakeholder meetings were conducted for the PAPs who were absent from the meeting.

The summary of the meeting is as follows.

<1st Stakeholders Meeting>

- Date and Venue: 20th December 2017 at Zestaphoni City
- Number of Attendants: 25 persons
- Agenda
  - Information about the project aliment
  - Land registration and legalisation
  - Rights of APs
  - Discussion

- Discussion Summary

Content of comments and suggestions	Response
Will the Project facilitate employment?	The civil works contractor contract will envisages the prioritized employment of the locals.
Can the civil works contractor dispose the remained soil materials on the private land plots adjacent to the project? And if they will, will the land owners compensated for the inflicted damage?	Temporal disposal of the soil materials on the private land plots is admissible only following the negotiations between the building company and the land owner.
Will be the local roads and infrastructure damaged during project implementation and then restored?	On the sites where the Project envisages such damages, the infrastructure will be moved after finishing the construction period. In case of unforeseen damage RD will impose control over the civil works company to ensure rehabilitation of all damaged infrastructure.
What is the land compensation price?	Evaluation methodology implies identification of market price on the basis of data on executed transactions related to land sale/purchase; published proposals of land sellers; real negotiations with potential sellers of land plots. Final individual prices will be presented to each AH when the representative of RD will come to affected landowner to sign the contract. However the rates of price (per sq.m) for different types of land will be disclosed with the LARP earlier.
For those of us, who does not have a new registration on the lands, shall we do it ourselves or will you help us?	For everyone who needs new registration we will make cadastral drawings and help to register lends.
Inventory of my property has already taken place. I want to know whether I can arrange a roof, and whether I will receive a compensation for the roofing?	Anything done after inventory will not be compensated.
I want to ask better access roads for Shorapani village, to be either for population to go to the direction of Zestaphoni or Tbilisi.	Project engineers will be informed about request.

<2nd Stakeholders Meeting>

- Date and Venue: 24th January 2018 at Zestaphoni City
- Number of Attendants: 48 persons
- Agenda
  - Information about the project and responsible institution
  - Presentation of the movies and drawings of project
  - Discussion
- Discussion Summary

Content of comments and suggestions	Response
We live on a territory where a highway will be constructed and part of our vineyard is under the project impact and remaining land is too small. How can I continue agricultural activities?	According the entitlement matrix developed for the project you will receive compensation for land and perennials as well as for harvest and annual corps. Also in case if PAPs are losing more than 20% of their lands they will receive one time allowances, which equals 3 month minimum subsistence for family from 5 persons. With this amount you can buy the land for agricultural activities.
What is the source of financing this project?	The government of Georgia is getting the loan from JICA to finance this project civil works. However, the RAP expenses are paid from national budget.
My house is under the project impact, but the yard is not within the construction territory. I would like to know whether the house and the yard will be fully compensated, or the compensation only covers the house.	If residential building is under impact of project, full residential land will be compensated.
What will be your comment regarding the damaged houses? Will not the construction worsen their condition?	In the areas where vibration can cause damage of the building. Prior of civil works condition of the buildings in those areas will be described and documented. In case if constructions will cause some damage it will be compensated.
Will we have bus stop areas near the village?	Bus stops areas will be included in the project of access roads.
Is it possible to relocate a public center from its current location to the center of Shorapani, namely an old administrative building?	The request will be transferred to the RD for further consideration.
How will be compensated annual crop? Do we have possibility to harvest crops this year?	In any case, crop compensation for 1 year will be given to APs in cash at market rate by default at the gross crop value of expected harvest, even in case if you already have taken this year crop before starting the land acquisition process. The start of land acquisition is expected from spring of this year.
Who is paying registration fees?	Government will cover land registration fees in case if registration will be required.
How will be compensated impact on houses and axillary buildings?	The impact on structures will be compensated at replacement cost, taking into account current prices on materials, transportation, workforce etc.
What is the land compensation rate?	Independent auditors are fixing the land market price at the moment based on relevant research of land market and valuation of your land plots.


< Individual consultation>

Individual consultations with stakeholders who didn't attend on first Public Consultation were conducted as follows. During the consultations, Stakeholders was given information leaflets and information about project impact.

- Date and Venue: 25th and 26th January 2018 at Zestaphoni City
- Number of Attendants: 8 persons
- Discussion Summary

Content of comments and suggestions	Response
Can we sow harvest this year? Will we be able to take the harvest this year?	The start of civil works is planned in January of 2019. In this case you can harvest as it was planned.
How much time we will have for physical relocation?	After signing of the contract you will have as minimum 3 months to find or build new place to live, before construction will start.
How will be calculated compensation for the loss of business?	Cash compensation equal to one year declared income.
Can we use materials after house demolishing?	After signing of the contract you will be able to demolish buildings and reuse materials.
How will be calculated compensation for fruit trees?	Cost of perennial plants is determined in accordance with their age and productivity.
When is the starting date for civil work?	The start of civil works is planned in January of 2019.
How will be calculated compensation for loss of employment?	Official minimum monthly salary multiplied to the 3 months will be paid.
How will be calculated price of buildings?	Structures will be cash compensated at replacement cost. Replacement cost calculation considers market cost of the materials to build a replacement structure with an area and quality similar to or better than those.
Will you provide assistance during the registration of land plots?	RD will assist you with providing cadastral maps and which will be provided for the land registration.


(11) Grievance Redress Mechanism

Complaint & Grievances related the Project will be addressed through the process described below in Table 8-25.

Table 8-25: Grievance Resolution Process

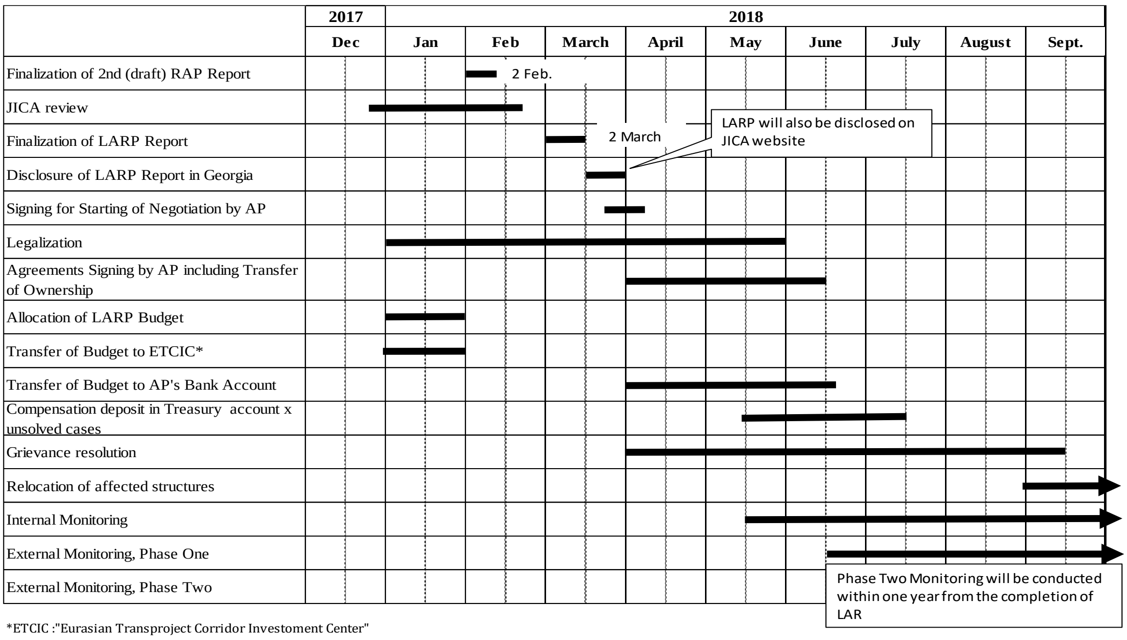
Steps	Action Level	Process
Step 1	Negotiations with APs	The complaint is informally reviewed by the grievance redress committee (GRC), which takes all necessary measures to resolve the dispute amicably. GRC is an informal, project-specific grievance redress mechanism, established to administer the grievances at Step 1. This informal body will be established at community level in each affected Municipality.
Step 2	GRC Resolution	If the grievance is not solved during the negotiations, the GRC will assist the aggrieved APs to formally lodge the grievances to the GRC. The aggrieved APs shall submit their complaints to the GRC within 1 week after completion of the negotiations at the village level.
Step 3	Decision from central RDMRDI	If any aggrieved AP is unsatisfied with the GRC decision, the next option will be to lodge grievances to the RDMRDI at the national level. The RDMRDI shall review the complaint in compliance with the procedures specified in the Administrative Code of Georgia.
Step 4	Court decision	If the RDMRDI decision fails to satisfy the aggrieved APs, they can pursue further action by submitting their case to the appropriate court of law (Rayon Court).

Source: Final LARP (March 2018)

(12) Implementation Schedule

The implementation schedule for land acquisition and resettlement for the Project is as shown in the Table 8-26.

Table 8-26: Implementation Schedule



*ETCIC :"Eurasian Transproject Corridor Investoment Center"

Source: JICA Survey Team

(13) Cost and Budget

The cost and budget for land acquisition and resettlement for the Project is as shown in the Table 8-27.

Table 8-27: Cost and Budget

Name	Unit cost	Amount	Total cost (Gel)
Land parcels	Various	642,825 m^2	6,729,884
Structures	Various	-	7,345,760
Trees	Various	14,552	1,404,733
Crop	Various	1,003,602 m^2	355,343
Fences and Gates	Various	-	161,134
Other assets	Various	-	37,420
Severe impact allowance	Subsistence minimum for 3 months (349.5 GEL × 3)	379HHs	397,381.5
Relocation/Shifting allowance	Subsistence minimum for 3 months (349.5 GEL × 3) + Transportation cost (200 GEL)	21HHs	26,218.5
Vulnerability allowance	Subsistence minimum for 3 months (349.5 GEL × 3)	36HHs	37,746
Business and employment compensation	-	-	316,078
Rent/Lease	Various	3	3,600
External and Internal monitoring	-		120,000
Sum			16,935,298
Unexpected costs 10%			1,693,530
Total			18,628,828

Source: Final LARP (March 2018)

(14) Monitoring and Reporting

Internal Monitoring

Internal monitoring will be carried out routinely by RDMRDI either directly or through the services of a consultant. The results will be communicated to JICA through the quarterly project implementation reports.

Specific monitoring benchmarks will include:

- Timeliness, information campaign, quality of information and consultation with APs;
- Status of land acquisition and payments on land compensation;
- Compensation for affected structures and other assets;
- Relocation of APs;
- Payments for loss of income;
- Selection and distribution of replacement land areas; and
- Income restoration activities
- Results of income restoration activities and compensation provided in terms of measuring extent to which affected livelihoods were restored, identifying gaps, which affected livelihoods were not satisfactory restored

External Monitoring

External Monitoring for phase 1 will be carried out in parallel with the implementation of a LARP and will be concluded after the LARP is fully implemented.

In the meantime, external monitoring for phase 2 will be conducted within one year from the completion of LAR to assess the whole of LARP implementation. The supervision consultant will hire external monitoring agency/consultant for external monitoring for phase 2.

The following are main indicators for the investigations to be carried out in this external Monitoring phase:

Socio-economic conditions of the APs in the post-resettlement period;

- Communications and reactions from APs on entitlements, compensation, options, alternative developments and relocation timetables etc.;
- Changes in housing and income levels;
- Rehabilitation of informal settlers;
- Effectiveness of property valuation for rehabilitation purposes;
- Effectiveness of Grievance procedures;
- Level of satisfaction of APs in the post resettlement period

8.3.5 Conclusion

The JST confirmed the appropriateness of the LARP in terms of the conformity with the requirements of Georgian laws and JICA Guidelines. Note that the conformity was considered for the below items.

- **Eligibility for Compensation**
  Lack of title should not bar people from receiving compensation and/or rehabilitation.
- **Compensation Price**
  Compensation for loss of assets is based on market value without taking into account depreciation.
- **Income Restoration Programme**
  JICA Guidelines requires rehabilitation for income/livelihood.
- **Public Consultation**
  Public consultation and participation is the integral part of JICA Guidelines.

Chapter 9 Economic Analysis

(This chapter has been removed because of confidential information.)

Chapter 10 Project Evaluation

10.1 Project Description

Georgia with approximately 3.7 million (in 2015) people is in a geopolitically important location as an energy and commodities transport corridor between Europe, Asia, Russia and Middle Eastern countries. This corridor becomes more and more important for providing transport of oil and gas products from Caspian Sea to European countries and logistic bases between Central Asia and Caucasian countries. Thus, the East-west Highway Development is the Georgia's highest priority projects under these circumstances. The World Bank (WB), Asian Development Bank (ADB), and European Investment Bank (EIB) as well as JICA have co-financed and provided assistance towards project development starting from the eastern side. This highway section of 67 km that is so far left undeveloped goes through narrow mountainous topographies that would need urgent construction.

JICA provided approximately 17.7 billion yen of assistance to Georgia for the East-west Highway Development (Phase 1) in 2010 and additional 4.4 billion yen in 2016 for development of 59 km of Samtredia-Kutaisi-Argveta section, which was opened to traffic in July 2017. This project section goes from Shorapani to Argveta, of which currently operated as a two-way two-lane E-60 highway going through narrow mountainous terrain. Providing a 4-lane International Standard highway would need tunnels and bridges for efficient travel, which would need higher construction costs compared with a flat terrain. In addition, safety measures against falling rocks, slope failures, and landslides are crucial for the prevention of road blocks caused by disasters to ensure reliable and safe transport.

WB has completed the Feasibility Study (F/S) of Argveta to Shorapani, Shorapani to Khevi, and Khevi, Chu-mateleti and Zemo Osiauri sections of 78 km in 2015. The Khevi to Chu-mateleti section will be financed by WB. ADB will prepare the Environmental Impact Assessment (EIA) and conduct the Detail Design (D/D) of the Argveta-Khevi section of E60; including the Argveta-Shorapani section of the highway which the Georgian Government applied for financing from the Japanese Government (East-west Highway Development Project Phase II) based on the F/S by WB.

10.2 Project Evaluation

10.2.1 Relevance of the Design

(1) Route Description

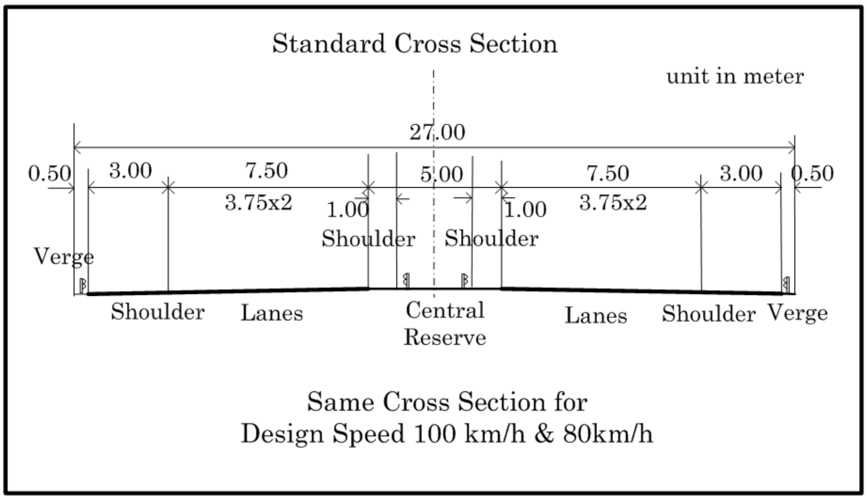
This 14.7 km section of Shorapani to Argveta is designed to go along very steep valleys until Zestafoni, bypass Zestafoni town and go through relatively flat hill reaching Argveta location where a new IC is under construction. Due to steep topography the highway section includes more tunnels and bridges. The geometry designed in the F/S was mostly minimum requirements based on TEM Standards, which D/D consultant was aware. Usually the design by D/D is based on F/S, however from traffic safety point of view JICA Study Team suggested to use desirable minimum standards as much as possible and after discussion with RDMRDI the detail design is based on the minimum horizontal radius of curvature of 400 m for design seed of 80 km/h is applied.

(2) Applied Standards

TEM（Trans European Motorway）is used for the geometric design of the highway in principle. GS (Georgian Standard), AASHTO of USA, Japanese Standards could be used if there are no items in TEM to apply. Snip could be used only for examining the existing road designed by SNIP. The alignment of mainline of the highway near IC for the design speed of 80 km/h by the Japanese

Standards stipulates minimum radius of 1,100 m for general conditions and 700 m for difficult to follow general case. IC-2 (Shorapani West) previously used 500 m radius but later modified to 750 m suggested by JICA Survey Team.

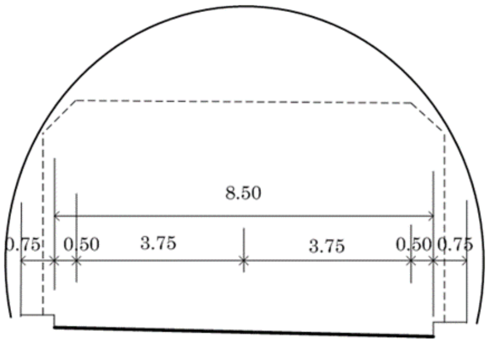
The standard cross section is based on TEM and RDMRDI policy as follows.



Source: JICA Survey Team based on RDMRDI

Figure 10-1: Standard Cross Section

Shoulders used in F/S was 0.25 m and very narrow. JICA Survey Team initially suggested to used much wider shoulders based on the Japanese experiences. However, RDMRDI denied this application because of cost involved instead the cross section below was decided to use.



Unit: m

Source: JICA Survey Team based on RDMRDI

Figure 10-2: Tunnel Cross Section

RDMRDI intended to minimize cost increase for a new tunnel construction by increase of cross section area. The new proposed cross section is wider than the past tunnel, which slightly contribute safety and comfort of traffic. Besides, the selection of the cross section for F4 influence other sections.

It is generally understood that Georgian government officials, contractors and scholars are influenced by Russian technologies and systems for bridge design of the standard of Snip and Gost. However, AASHTO and BS are widely used for international bidding in harmonized with Snip, which is considered to be non-practical. For bridge designs of F4 section by ADB D/D consultant uses Eurocode (EN). Steel super structures to be applied STEP is designed by the Japanese Standards, which is not familiar among Georgia engineers.

(3) Road Design

Tunnel length is predominant among other structures such as bridges or embankment in this section.

a) Five tunnel locations with ten tunnels of 6,775 m were planned in FS. Whereas, due to review of alignment the total number of tunnels are 12 (6 locations) with 8,515.09 m.
b) Additional two tunnels at the final stage (T-TA-6, T-AT-6) were originally designed as cut sections in FS but later modified to shallow tunnels by NATM method.
c) Tunnel excavation methods are generally divided into by blasting or by machinery depending on rocks and its environment. Machinery excavation could be applied to shallow tunnels under residences or buildings where noise and vibration would be a problem.

The design standards of steel super structures (STEP application) are exclusively Japanese Standards, which also cover Eurocode as a result. Thus, the bridges are designed based on the Japanese Standards. Bridge 4001 and Bridge 4002 cross the winding portion of Dzirula with a gentle curve crossing existing E-60 at the both ends of the bridges. Round shaped piers are used in the river where the direction of current of winding parts is not uniform depending on the amount of water in the river. On the other hand, the obstruction rate to the current (total pier width/design river width in %) would be maximum 6% compared with allowable limit of 7% of the Japanese expressway case when round shaped piers of 3.0 m diameter are built in the stream of the river of which width varies from 50 m to 100 m.

Geology of the site by found by JICA Survey Team are mainly composed of coarse-grained sandstone, volcano history tuff, tuff breccia and andesite of which simple strata direction is west-north-west to east-south-east and flat toward south 5 to 15 degrees. Right bank of the Dzirula river is dip slope and left bank is stratum of opposite dip from the relationship position between geological structures and the direction of the river. Generally, cut slope of the planned highway is the stratum of opposite dip because of the location of the highway. From the geological distribution, most of the cut slope belongs to hard rocks and some are soft rocks. The standard slope gradient for Japanese is 1: 0.3 to 1: 0.8 (73.3° to 51.3°) for hard rock and 1: 0.5 to 1: 1.2 (63.43° to 39.8°) for soft rock. Cut slope of hard rocks is very steep and slope protection is not necessary except for tunnel entrances where the slope is steep and shot-crete protection is needed.

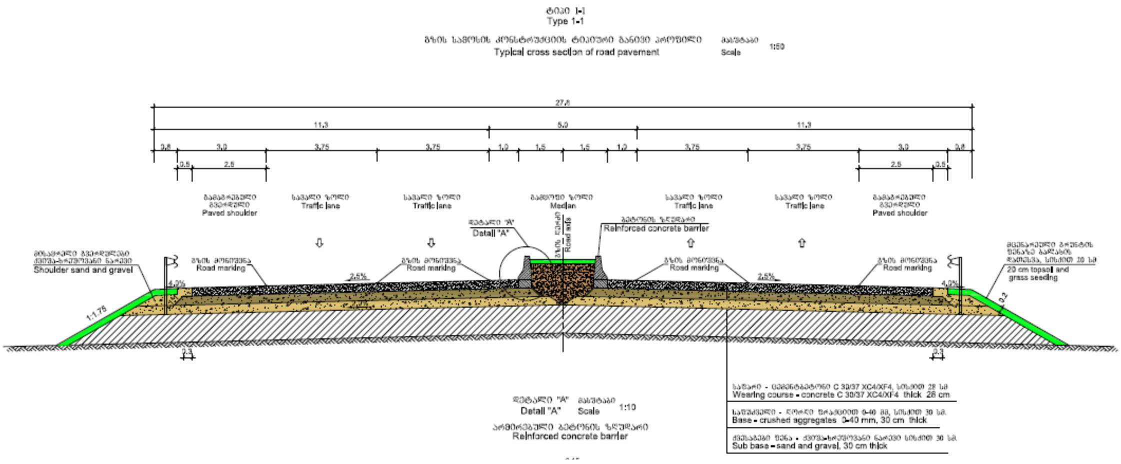
When the boring test results show that higher water table of the weathered rock surface, protection measures with drainage of water is crucial. If falling rocks outside of right-of-way is expected the protection by steel net is considered.

The F/S compared the AASHTO and the RStO (German Standard: Richitlinien fur die Standardisherung des Ober-baues von Verkersflachen) based on Equivalent Single Axle Loading (ESAL) for 20 years for each section (shown in the table below). The highway pavement is generally classified by a flexible and rigid pavement. The rigid pavement (concrete pavement) needs higher initial investment but poor riding quality. Despite, Georgian Government decided to use concrete pavement for the East-west Highway because cement is locally obtained and thus economical and less maintenance required. There might be some differences of traffic volume among sections, the pavement is designed as the concrete slab surface course of 28 cm, crushed aggregates base course of 30 cm and sand-gravel mix sub-base course of 30 cm is used for the Phase 2 section. The Figure 10-3 shows the cross section of the concrete pavement of the main line.

Table 10-1: Each Layer of the Concrete Pavement

N	Pavement layers	Thicknesses of layers mm
1	Cement concrete (pavement)	280
2	Crushed aggregates (base course)	300
3	Sand-gravel mix (underlying layer)	300

Source: JICA Survey Team based on RDMRDI



Source: JICA Survey Team based on RDMRDI

Figure 10-3: Cross Section of the Concrete Pavement Structures

Construction periods of tunnels are the key to the overall construction schedule of the section. The total number of tunnels of 12 with 8.5 km of which an average length of 700 m needs time for more access to each entrance and slow speed at the beginning of the start of tunnel excavation. Speedy preparation and efficient works are required. There are factors to influence schedule such as transport of dug soils and temporary stock piling if necessary. Especially the construction between the section from the start point to Zestafoni bypass is under difficult conditions such as transportation of construction machines and equipment and excavated soils in a narrow yard keeping the safety of existing traffic. Well prepared and planned traffic control at site is also important.

This project is classified as category A based on the JICA Guidelines for Environmental and Social Considerations (April 2010) (hereinafter referred to as the "JICA Guidelines"), being a road sector project likely to cause environmental and social impacts. The draft Environmental Impact Assessment (EIA) and the Land Acquisition and Resettlement Action Plan (LARAP) for this project were prepared by the DD consultant hired by ADB. The JICA Survey Team (JST) reviewed the draft EIA and LARAP for conformity with relevant laws and regulations of Georgia and the JICA Guidelines, and confirmed that necessary investigations were conducted. For the review, JST maintained close communication with related parties and requested modifications as needed including during draft preparation.

10.2.2 Relevance of the Project

The East-West Highway development is part of the TRACECA network and is very important not only for Georgia, but also for neighbouring countries as an international corridor for transportation of goods and passengers, the project section from Argveta to Shorapani is a bottleneck for transport on the East-West Highway, going through narrow mountainous topographies that would need tunnels and bridges for efficient travel.

The National Development Plan (Georgia 2020) emphasizes the importance of road development including the East-West Highway as a priority project to streamline domestic and international transport, increase road network safety/convenience, and strengthen economies of the region. In such situation, the Road Department of Georgia has decided the construction of E-60 as a key developmental action based on the priorities of road development.

The project follows these upper level plans and the results of the economic analysis say that the calculated value of EIRR is 13.03% for the basic case, which is over the range of 10-12% that is generally regarded as the opportunity cost of capital for the economic evaluation of public investment in developing countries. The development of the highway, therefore, is considered feasible from the national economy's point of view.

10.2.3 Effectiveness of the Project

(1) Quantitative Effect

The quantitative effect of the development of the highway was evaluated as follows. The value for performance indicators were estimated for the base year (2017) and the target year 2023, two years after the project completion.

Table 10-2: Targeted Outcome for the Project

Performance Indicators	Section/Location	Baseline (2016) Value	Target Year (2023) Value
Annual Average Daily Traffic (vehicles/day)	Dzirula (km 188)	14,489	18,589
	Argveta (km 200)	17,060	18,938
Average Travel Time (minutes/vehicle)	Shorapani ~ Argveta	20.64	11.03
Average Travel Speed (km/hour)	Shorapani ~ Argveta	50	80

Source: JICA Study Team

(2) Qualitative Effect

The impact to existing villages would be minimum because road of this section is designed to be away from existing E-60 Highway and most of the sections are designed as tunnels. On the other hand, the accessibility to the new highway would be poor due to the nature of the roadway designed as an access-controlled highway. The new highway has a better riding quality because of smooth alignment, less operation costs and higher traffic safety compared to the existing E-60 highway. It is expected to have higher growth of logistic movement in the future, too.

Construction of the Zestafoni bypass detours built-up areas of the town and would improve living environment of noise, air quality and vibration. It is expected that a higher traffic growth especially of heavy traffic on the new expressway also improve traffic safety and traffic congestion of the existing E-60 due to increased number of heavy traffic, which is currently going through city areas.

However, there would be some adverse impacts to residences of surrounding areas of new bypass compared with the present environmental conditions. Countermeasures would be necessary if the environment impacts exceed a necessary standard based on the monitoring of the environment. The adverse impact would be possible near tunnel entrances and bridge joints such as air pollution and vibration after opening of traffic. Heavy construction trucks especially transport of tunnel excavated soils and rocks might expect adverse impact to living and traffic environment of surrounding areas during construction. Thus, careful management of construction is crucial for minimizing social losses of people.

Chapter 11 Conclusions and Recommendations

(1) The Project is Relevant and Effective

As evaluated in Chapter 10, despite being an important route for the Government of Georgia, the construction of the corresponding section was delayed due to severe topography and weather conditions. The current road, E-60, has been an important community road for the surrounding residents. At the same time, the road has been utilized for domestic and international transits. The current road also faced safety issues such as severe horizontal/vertical alignment, terrain subject to disaster, and snowfall during the winter.

In such circumstances, even at a high cost, the new highway is worth constructing as the highway would provide higher quality of traveling performance and safety. Its effectiveness has been confirmed through the quantitative and qualitative effects discussed in the previous chapter and therefore, it is concluded that the project is effective and valid.

(2) Necessity of Operation and Maintenance

The section around the Rikoti tunnel including the F4 section is a section with severe topography conditions and high possibility of disaster such as rock falls and landslides caused by heavy rains during rainy season. The main possible causes for disaster include winter road conditions and avalanche, which would cause traffic disturbance. Although the Road Department is currently considering the development of the improved organizational structure, equipment/personnel, technology for road maintenance and management as these are common issues for the East-West Highway, further enhancement of traffic management, including information collection and dissemination is desirable. Especially, as there are many tunnels in the F4 section, proper usage of equipment and daily training of staff to respond to fire and accidents inside the tunnels are necessary. From such point of view, a visit to Japan to understand the maintenance and management state of the Japanese roads would be effective, in order to strengthen the management structure in Georgia. If necessary, the possibility for technical cooperation should also be explored, through reviewing the technical content for assistance.