

# Basic Survey on East-West Highway in Georgia

Final Report

January 2010

JAPAN INTERNATIONAL COOPERATION AGENCY

PADECO Co., Ltd.  
EXe•Idea Ltd.  
Oriental Consultants Co., Ltd.

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# Summary

## Basic Survey on East–West Highway in Georgia (Summary)

### Chapter 1 Introduction

#### 1.1 Background

Georgia attained its independence in 1991 after the collapse of USSR. As a result of the economic chaos, loss of the market and ethnic conflicts after the collapse, the GDP of 2000 fell to 30% of the one in 1990. Georgia is a small country with a population of around 4 million, but it holds politically and economically important and the shortest line to connect Central Asia and the Black Sea. The national policy to become much closer to NATO and to promote being one of the EU member countries after the rose revolution made the relationship with Russia worse, who were the trade partner with more than 20% of the whole Georgia exports, and lead to the ban of all the trade in 2006 except the natural gas.

The arterial highway development is one of the important policies for the economic recovery of Georgia as recognized in the National Development Plan. The East–West Highway development is one of them and has been implemented from Tbilisi toward the west with state and other donors such as the World Bank finance. On the other hand there have been no F/S financial sources for implementation from Rikoti located in the central region toward the west.

Under these circumstances, former JBIC carried out the study for project formulation for highway improvement project (hereinafter call JBIC Study) from 2007 to 2008, and formulated the ODA loan project for the East–West Highway development which is the most important road in Georgia. The purpose of the study was to find a priority section for the Japanese ODA loan and promote project formation.

#### 1.2 Objective of the Basic Survey

As a result of the discussion with Georgia government after the JBIC Study, the yen loan was finally agreed to be provided for the route connecting Kutaisi–Samtredia by building a new highway. At the time of JBIC Study, basic selection of the route, basic design, and preliminary cost estimate was carried out mainly from Kutaisi to the east of Samtredia. Since there was a lack of detail study around Samtredia, further study needed to be carried out including alternative selection. The existing East–West Highway (S-01, E-60) is going through the urban area, and the bypass is required for the high standard highway. However, there are many restrictions on the route selection and the road design due to the Rioni River flowing just southeast of the city, and additional study for this area was necessary.

The objective of this survey is to make clear of the background of this project, the condition of the site, and existing plan etc, (by reviewing the results of the previous project), and to carry out a technical study of the East–West Highway development for Samtredia city and its surrounding areas in order to implement a yen loan project.

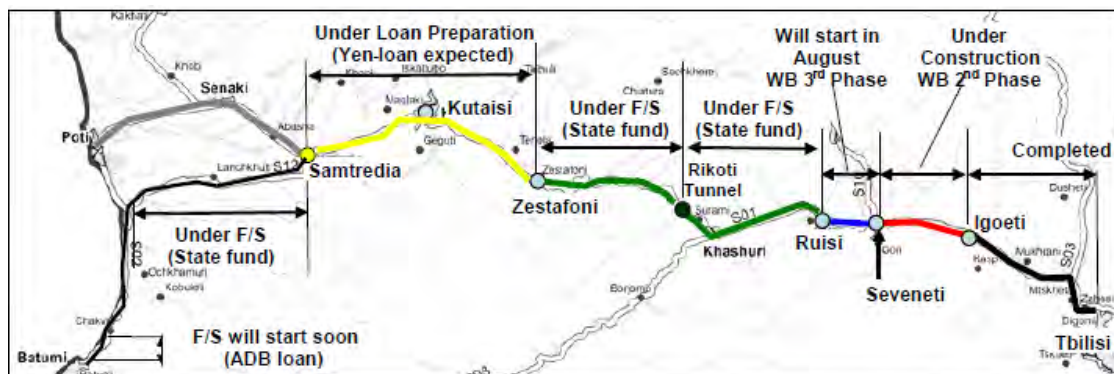
#### 1.3 East–West Highway Plan

##### 1.3.1 Current Status of the East–West Highway Development

The East–West Highway is one of the important arterial highways in Georgia. There are two routes, one of which starts from Azerbaijan border and reaches Poti, the Black Sea port, via Tbilisi. The other route starts from Armenia and joins the East–West Corridor. This corridor is not only important for transportation of goods in Georgia but also connects to Iran via

Azerbaijan in the east and central Asian countries via the Caspian Sea. This corridor connects further to European countries (via the Black Sea) in the west and goes down to the south to reach Turkey.

EU started the TRACECA (Transport Corridor Europe Caucasus Asia) program in 1993 as an economic cooperation program of the Black Sea area, Caucasus, and Central Asia. The East–West Corridor was taken as an important major corridor in Georgia, being included Feasibility Study (hereinafter call FS) of the program. A pre-FS was conducted to analyze the economic feasibility of motorways in Georgia. The government began implementation of the project financed by the World Bank from Tbilisi toward the west based on the FS results.



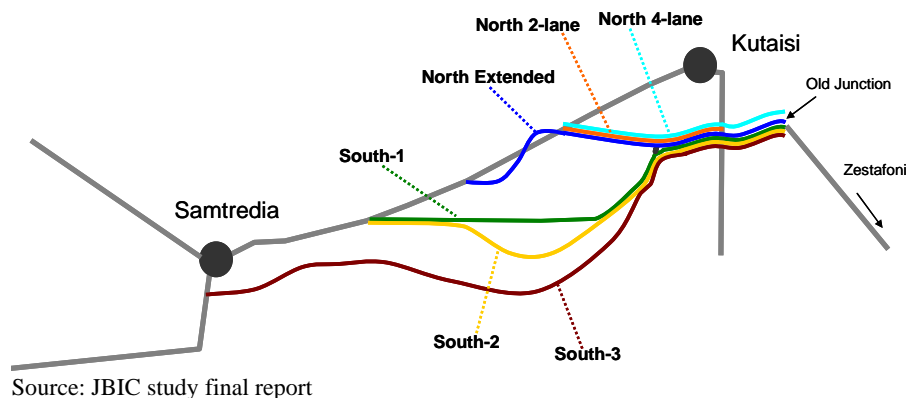
Source: JBIC study final report

**Figure 1 Highway Improvement of the East–West Corridor**

### 1.3.2 Development Section by ODA Loan

As mentioned previously, the feasibility study was carried out by the JBIC study for the improvement and upgrading of the road between Zestafoni–Samtredia section. In the study, the Kutaisi bypass was recommended to be a high priority (it was very economically effective), but there were several alternatives in the section between Kutaisi–Samtredia (this section includes the Kutaisi bypass). Each alternative has advantages and disadvantages, and the comparison of six alternatives (shown in Figure 2) was carried out. Among the six alternatives, the North 2-lane option seemed economically effective but the traffic will nearly reach capacity in the morning and evening. The North-extended alternative was proposed, but it was noted that all of the North alternatives will go through residential areas and as such will worsen the environment. Finally, a North-extended alternative which can make use of the existing road and can develop gradually from 2 lanes to 4 lanes, and South 2 alternative were selected as the most appropriate routes.

However, as a result of the discussions with the Georgian government after the JBIC study, the yen loan was finally agreed to be provided for South 3 alternative, which is the route to connect Kutaisi–Samtredia by building a new highway.



**Figure 2 Alternatives between Kutaisi–Samtredia Section**

### 1.3.3 Outline of Kutaisi–Samtredia Section

The planned East–West Highway of the Kutaisi–Samtredia section under the Georgian Government scheme starts from the Kutaisi Bypass. The highway passes the intersection of the two-lane local road which connects the Kutaisi center to Bagdadi, goes to the west and crosses the Rioni River by a bridge (as in the JBIC Study). There is an interchange to connect a local road leading to Kutaisi center on the right bank of the Rioni River. The route further goes to the west crossing the railway and local roads and crossing down the alluvial fan hills formed by the river sedimentation. The major land use is for farm land and unused lots. There are scattered houses in the area. The number of houses to be relocated will be minimal. The route reaches the Samtredia section of the East–West Highway after going south of the military airport.

## Chapter 2 Survey Area

### 2.1 Target Area

The survey area is located between the 255 km and 266 km posts from Tbilisi along the S-01 route, which is about 12 km. The planned route is in the south of Samtredia and near the Rioni River. The route either goes along the vacant strip or meadow located between residential areas to the south of the railway and the Rioni River (right bank route) or along the left bank of the river which is a flood plain currently used as farm land.

The followings are the special features of the area along the route and the points to pay attention for the design of the roadway.

- The Rioni River runs to the south of the residential areas. This river is winding and the river course is repeatedly changing in the long time period.
- The erosion is moving to the north according to the aerial photos and old map. The distance between the south of the residential areas developing toward south and the river is getting shorter. Therefore, it might be possible that the route goes in the river course or flood plain.
- There are many utility lines buried in the ground along the route. The high voltage power transmission line also exists near the route.
- There might be relocation of houses in the south, which would be influenced by the highway depending on the route design.

## 2.2 Outline of the Route

### 2.2.1 Alternative Routes

As alternatives two major options were considered: on the right bank of the river and the left bank of the river (R-option, L-option). Moreover, several options were studied for each alternative as shown in Figure 3.

- Option R-1: The route goes over Gubistskali River and passes to the south of Ianeti Village. Then it runs on a proposed landfill of a bend toward the right bank and continues back to the right bank to the west to join the road from Samtredia to Batumi.
- Option R-2: The route is similar to Option R-1, but with the sacrifice of the radius of the road between the west of the Gubistskali River and the western end of Akhalsopepli Village, the resettlement and relocation of gas pipe lines are minimized.
- Option R-3: The route is similar to Option R-1 but slightly shifted towards the north to avoid the proposed landfill of the Rioni River to minimize the interference with the river hydrology.
- Option L-1: The route starts at the south of the military airstrip, and crosses the discharge channel of a hydropower station located upstream of the Rioni. Then it crosses the northward stream of the Rioni and passes through the flood plain to the west. It crosses again the southward stream of the Rioni. Then it joins the same junction at the road from Samtredia to Batumi. This option limits the bridge crossings to a minimum.
- Option L-2: The route itself is exactly the same as Option L-1, but the entire span of first crossing of the Rioni through the second will be connected by the long span bridge, limiting the impact of potential course changes of the Rioni River.

The comparison has been made among above alternatives based on the results of the survey with regard to relocation of houses, social/environmental impacts, utility relocation, impact to the river, and geometries/costs.

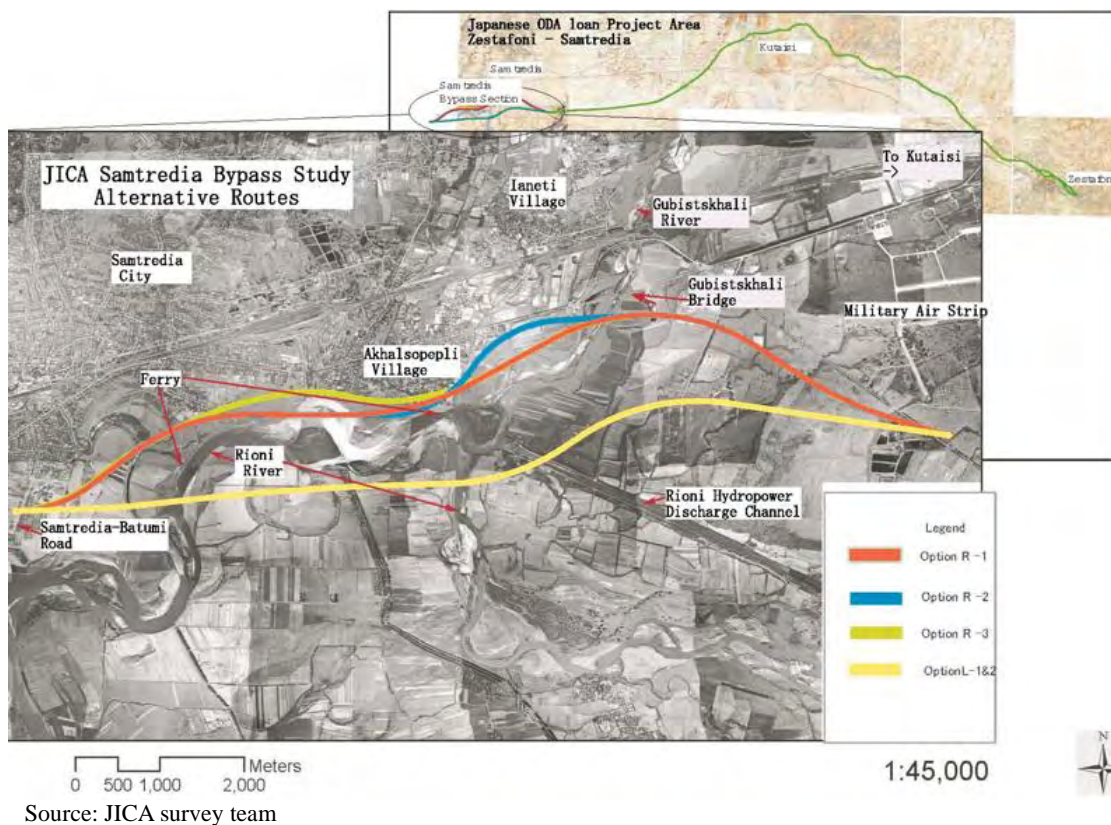


Figure 3 Alternative Routes

## Chapter 3 Site Survey

### 3.1 Survey Flow

The survey of this area has two stages; the first stage of which was to examine which side of the river, left or right, was preferable for the route and for detailed surveys. The second stage was to determine the recommended route locations among the alternatives mentioned in chapter 2.2.1 after discussion with relevant government organizations based on the results of the site survey.

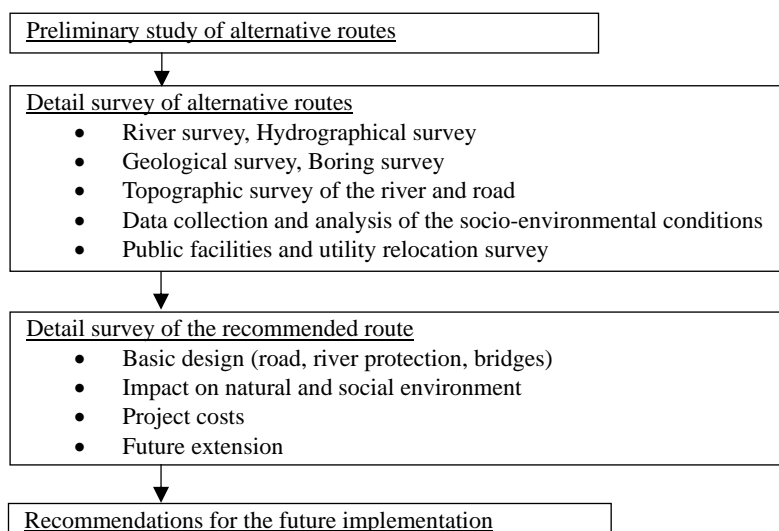


Figure 4 Survey Flow



## 3.2 River and Hydrological Survey

### 3.2.1 Data Collection on River and Hydrological Conditions

The data collection was carried out for the selection of East–West Highway routes and its detailed design. The following data was collected from the agencies and site investigations.

- (1) Climate parameters near by the study area (Rainfall, temperature, humidity, wind speed)
- (2) Daily rainfall data
- (3) Water level and discharge of the Rioni and Gubistskali Rivers
- (4) River characteristics of the Rioni and Gubistskali Rivers
- (5) Regulation/Code on River Improvement

### 3.2.2 Characteristics of the Rioni River

The Rioni River is the second largest after Kura River in the country. The total river length is 327 km with catchment area of 13,400 km<sup>2</sup>. The River originated at Pash Mountain (MSL 2,620 m) of watershed of Caucasus mountains and flow down north west and join its main tributary of the Kvirila and flow to Kolkheti lowland to the Black Sea near by Poti town. The Rioni River in the study area is located in flat plain area in altitude of 20 m and flow with 0.125% riverbed slope. The left bank area is situated as floodplain area with many traces of old river course. Accordingly it is judged that the river course has big tendency of meandering.

In order to understand the characteristic of river, river cross section, riverbed material and site investigation were carried out. The river course was characterized in: riverbed slope of 1/400 to 1/5,000, alternate layer of gravel, silt with sand, meandering is great and average water depth varies 4 to 6 m.

### 3.2.3 Characteristics of the Gubistskali River

The Gubistskali River is one of tributaries of the Rioni River and characterized as a mountain river having river length 36 km, with catchment area of 442 km<sup>2</sup>. The river joins the Rioni at the eastern part of Samtredia. There are railway bridge and two road bridges in the lower reach of the Gubistskali River. The river course lower section is restricted by those structures and no big meandering has been occurred. However, local bank erosion at left bank of the old road bridge and right bank of gas pipe river crossing structures has been progressed. The river course was characterized in: riverbed slope of 1/60 to 1/400, alternate layer of gravel, silt with sand, meandering is in lower river section from the railway bridge and average water depth of 1 to 2 m.

## 3.3 Geological Investigation

### 3.3.1 Geological Investigation Plan

- (1) Location and Quantities of Investigation

Geological investigations were carried out in the area of the right and left bank of the Rioni River near Samtredia along the planned highway route. The location map of the investigations area is shown in Figure 3.3.1 of the main volume. Items and quantities of the investigations are shown in Table 1.

**Table 1 Items and Quantities of Investigation**

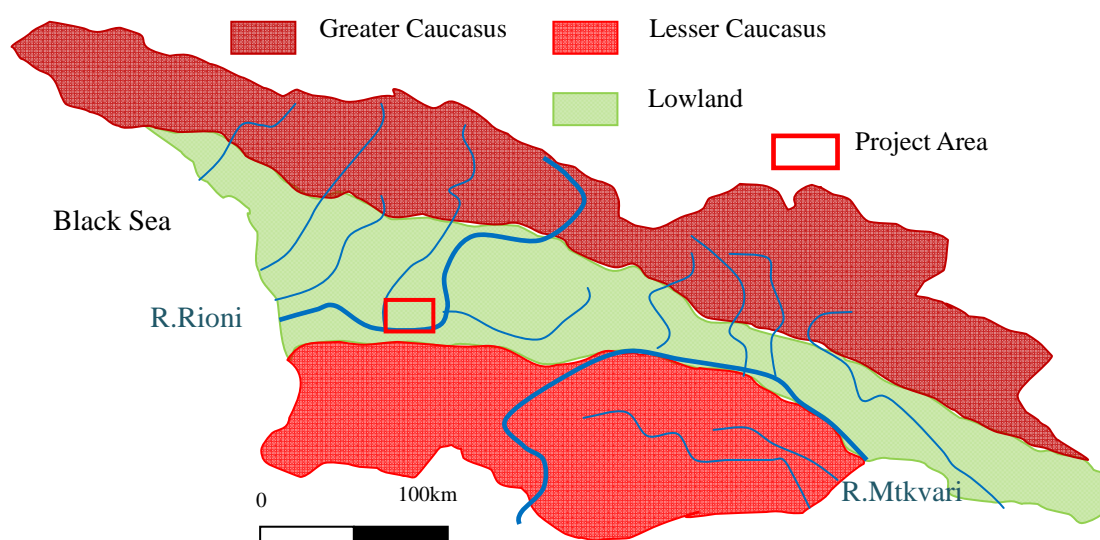
Items and Quantities of Geological Investigation		
Standard Penetration Test	12 points	142 nos
Laboratory Test	12 points	
Grain Size Analysis		40 samples
Unit Weight		40 samples
Dry Density		45 samples
Natural Water Content		43 samples

Source: JICA survey team

**(2) Topography and Geology**

The project area is located in the western Georgia and Rioni River flows in the southern part of the city. The Rioni River is meandering in the flat lowland near Samtredia. Samtredia is situated around 100 km upstream from the river-mouth and its elevation ranges from 20 to 50 m in general. The topography of Georgia and project area is shown in the Figure 5.

Cenozoic formation including Holocene (Alluvium) and Pleistocene (Diluvium) deposits are widely distributed in the plain along Rioni River, and they are underlain by sedimentary rocks of Mesozoic era. The hills and terrains, which are distributed in the area between Poti and Samtredia, consist mainly of Mesozoic sedimentary rocks.

**Figure 5 Topography of Georgia and Project Area****3.3.2 Results of Investigation****(1) Standard Penetration Test**

The Standard Penetration Tests aims to determine the SPT N value, which gives an indication of the soil stiffness and can be empirically related to many engineering properties. This test can be applied various kinds of soils except boulders. Majority of the surveyed points from BH-1 to BH-11 showed the average N-value of 30 in 20 m deep points except one location where soft ground is assumed. The N-value of boring points where bridge structures are expected exceeded 50.

## (2) Engineering Geology

The geology of the project area is mainly divided into three formations: Holocene deposits (Alluvium), Pleistocene deposits (Divilium) and bed rock. Each formation is analyzed as follows.

### Holocene Deposits

This formation consisting mainly of sand and gravel supplied from present Rioni River is soft and loose. As such, the improvement of its mechanical strength may be required if it is used as the foundation of structures. Drawing down of groundwater level can be proposed for improvement of mechanical strength of the layer. Holocene deposits are divided into two types of sandy layer (As) and sand & gravel layer (Asg) in this report, however thin layers of clay, as well as silt are seen in the sandy layer (As), and clayey layers are locally distributed in the sand & gravel layer (Asg).

### Pleistocene Deposits

This formation is composed mainly of gravel, sand and clay, is relatively consolidated and seems to be formed of horizontal layers of deposits. This formation seems to have sufficient strength for the foundations of any structures except large scale structures such as dams and the main piers of large scale bridges. This formation is underlain by basement rock, and in most cases it can serve as the foundation of the road. Pleistocene deposits are also classified into two types: relatively consolidated sand & gravel layers (Dsg-1) and consolidated sand & gravel layers (Dsg-2).

### Bed Rock

Bed rock is composed of Cenozoic to Mesozoic sedimentary rocks and it is overlain by said Holocene and Pleistocene deposits. This formation is very stable and it suitable as the foundation of any structures.

## (3) Seismic Risk

The Caucasus Mountains, located in the middle of the Eurasian plate, has been known to experience various tectonic processes associated with lithospheric plate motion. Recent geodynamics of the region is largely determined by its position between the still converging Eurasian and Africa–Arabian plates. As a result of the continuing northward displacement of the Africa–Arabian plate in Oligocene and post-Oligocene time, the region turned into the intra-continental mountain-fold construction.

However, no major earthquakes have been recorded near the project area. According to the recent seismic zoning under the Ministry of Architecture and Building of the Republic of Georgia in 1991, the probability of occurrence of the earthquake is as low as twice every 1,000 years.

## 3.4 Topographic Survey

The topographic maps along the studied routes were made for the alternatives of the right bank and left bank of the Rioni River. The first step of the survey was to determine the tentative horizontal alignment of the routes and then survey topography using total stations, levelling equipment and GPS surveys. Control points along the survey area were identified to determine the horizontal alignment of the road based on the topographic survey results. Major control points were crossing of roads, rivers, water channels, public buildings, houses, and utilities (including buried cable lines).

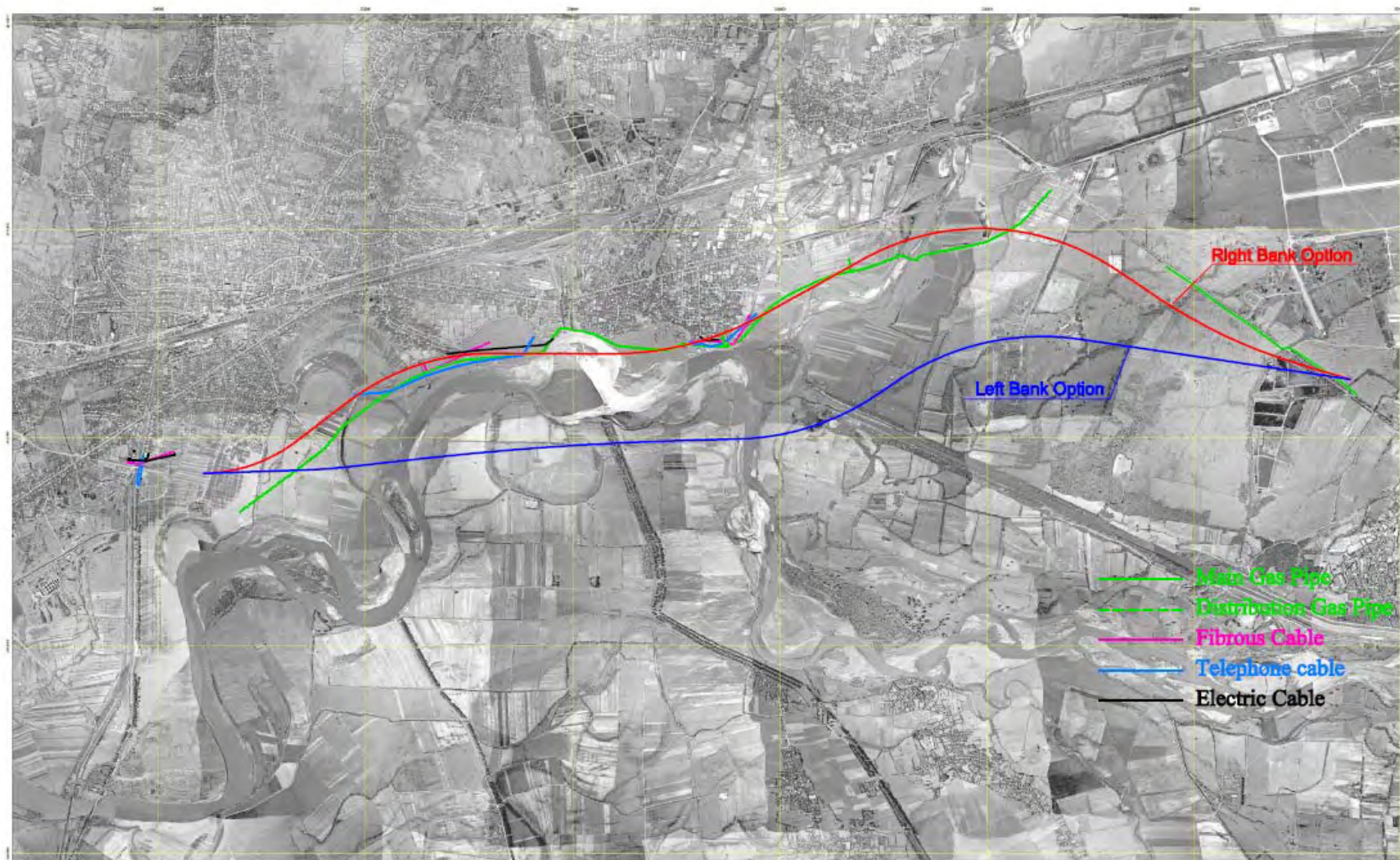
### **3.5 Site Survey on Utility Lines**

It was identified that there are various utility cable lines either exposed or buried in the vacant land between residential areas and the Rioni River for the right bank route (as shown in Figure 6). In order to reconfirm locations and kinds of utility lines, the meeting of organizations concerned was held at the Samtredia city.<sup>1</sup>

Among all of the utility lines, the gas pipeline was the most influential located in the grazing area between houses and the river. The relocation seems to take a longer time and higher costs. Other facilities include the telephone cable, optical fiber cable and power transmission line.

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<sup>1</sup> The meeting was held on October 22, 2009 in Samtredia City Hall with the chairman of Mr. Emzar Shubladze (Chairman Council).



Source: JICA survey team

Figure 6 Existing Utility Locations



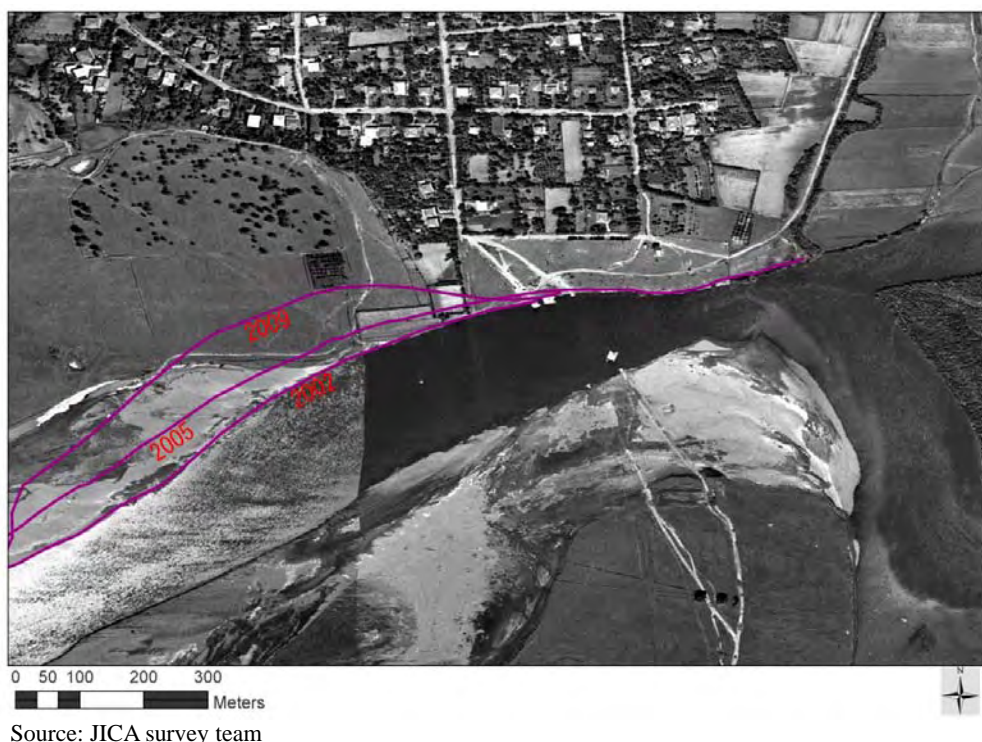
## Chapter 4 Social and Environmental Impact Assessment

### 4.1 Current Status of EIA and Objective of Study

An Environmental Impact Assessment study was completed in March 2009, titled as “Project ‘Reconstruction of the Zestafoni–Kutaisi–Samtredia Section of the E-60 Highway’ Environmental and Social Assessment and Analysis of Alternatives”. According to Georgian law, public disclosure of the EIA has already been completed. The final EIA will be approved after the final Samtredia Bypass alignment is selected during the detail design based on the proposed alternative alignment and additional baseline information. If a new alignment that is different from the original route at JICA approval is selected, the EIA will be modified based on the social/environmental assessment of this survey and/or additional survey. The final EIA will be approved after the additional public hearing of Samtredia and EIA approval process.

### 4.2 Baseline Information

In this area, two additional streams, the Gubistskali River from the north and the discharge channel from the Rioni Hydropower Station from the southeast, join Rioni River, forming a delta at the junction. Given this hydrological characteristics, the space left for a bypass construction on the right bank of the Rioni River has about 70 meters of space between the river and the residential area near the ferry terminal and no space left between the river and the residential area where the Rioni bends to change its direction from northward to southward.



**Figure 7 Changes in Coastline Due to the Rioni River Erosion**

On the right hand bank of the Rioni River, there are gas pipes, power transmission lines, optical fiber and telecommunication lines. When the new bypass crosses these facilities or comes closer than the regulated margin of distance, it becomes mandatory to relocate the existing facilities to a new location without disrupting the services. For gas pipes, there are special safety measures to be provided for the crossing of pipes under the road.

### 4.3 Estimation of Social Impacts

The necessity of relocation of houses was examined for the five options as mentioned in Section 2.2.1. The relocation is required on the right bank route while no relocation is required on the left bank route where the route goes mainly through the farm land.

Starting from the east, the right bank options first encounter the community of Akhalsopepli Village. At around the milestone of 6 km + 700, the Option R-1 (yellow) touches on two houses. The Option R-2 (red), with a minimal radius, crosses one house while Option R-3 (green) necessitates the resettlement of 8 houses at the section between 6 km + 500 m and 6 km + 900 m. The Option R-3 also isolates 5 households on the southern side of the planned bypass while leaving the majority of them on the northern side.

### 4.4 Outline of Alternative Routes

#### 4.4.1 Alternative Routes

Three alternatives on the right bank of the Rioni River and two alternatives on the left bank were studied. Details of each alternative are as described in Section 2.2.1.

#### 4.4.2 Evaluation of Alternatives

The proposed alternatives were evaluated according to the parameters of hydrological risks, social impacts, relocation of utility infrastructures and construction costs as shown in Table 2.

**Table 2 Alternative Evaluation**

Alternative evaluation						
Alternatives		Option R-1	Option R-2	Option R-3	Option L-1	Option L-2
Features		Right bank standard design	Right bank relocation minimize by smaller curve	Right bank minimize disturbance to the River	Left bank Embankment & bridges	Left bank bridges in the flood plain
Sector	Item					
Environment	River risk	L	L	L	M	L
Social	House relocation (no)	2	1	20	0	0
	Land acquisition (ha)	52.9	53.5	56.3	67.5	61.7
	Noise	M	M	M	L	L
	Landscape	M	M	M	H	H
	Traffic safety	M–H	M	M–H	H	H
	Utilities (Gas pipeline relocation km)	3.554	2.457	0.71	–	–
Economic	Cost (USD million)	66	65	63	100	129
	Maintenance Cost (USD million)	0.3	0.3	0.3	0.8	0.6
	Obstruction to local economy	M	M	M–H	L	L
Overall evaluation		○	△	△	X	X

Note) H: high, M: medium, L: low, ○: recommended, △: medium, x: not recommended

Source: JICA survey team

## Chapter 5 Study on Highway Structures

### 5.1 Highway Design

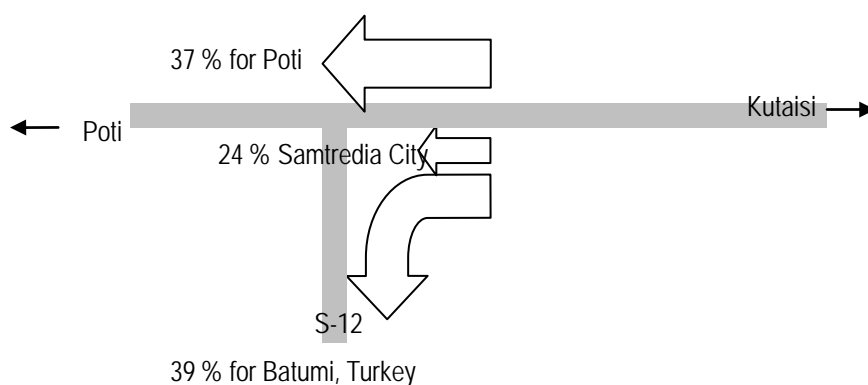
#### 5.1.1 Design Traffic Volume

##### (1) Present Traffic Volume

The Road Department of Georgia carries out traffic count surveys three times a year for major highways and roads using automatic counting equipment. The current traffic volumes and growth for the national highway No.1 (S-01) are summarized as shown in Table 5.1.1. The traffic volume of the Kutaisi–Samtredia section was about 6,000 vpd (vehicle per day) with the growth rate of 3% to 6% until 2007 and it exceeded 8,000 vpd after 2008.

##### (2) Traffic Flow

National Highway No. 1 (S-01) branches off to Poti and Batumi (S-12) directions at Samtredia. The directional splits of traffic volume are shown in Figure 8. These are according to the OD survey on the East–West Corridor at the east of Samtredia (conducted by the JBIC Study). The ratio of the traffic in the directions of Poti and Batumi were each about 40 % whereas the local traffic was 20%.



Source: JBIC Study final report

**Figure 8 Traffic Flow near Samtredia**

##### (3) Traffic Volume Forecast

Currently the FS is being carried out for other sections<sup>2</sup> of the East–West Corridor. The traffic forecast has been made for the Rikoti Tunnel based on the reviewed growth in consideration of the world economic crisis in 2008. The comparison between the new traffic forecast of the Rikoti Tunnel by the JBIC Study and that by above mentioned FS were made. Based on the actual traffic volume surveyed by the Road Department and the JBIC Study, a traffic forecast of the Kutaisi–Samtredia section, with a modified new growth rate, is as shown in Table 3.

<sup>2</sup> FS Sections: 3 sections of East–West Corridor (1. Ruisi–Rikoti, 2. Rikoti–Shorapani, 3. Samtredia–Grigoleti), Study period: Dec. 2009, Implementation: Kocks (German consultant) by RD budget



**Table 3 Traffic Volume Forecast of Kutaisi–Samtredia Section**

Item	Unit: vehicles /day							
	Year	2007	2008	2009	2010	2015	2020	2025 2030
JBIC Pilot Study		(6,262)	—	—	8,248	11,662	15,182	18,665 22,866
Other FS Growth Rate		—	(38%)	(–3%)	3%	31%	25%	— 46%
Reviewed Traffic Volume		—	8,642	8,382	8,576	11,234	14,043	— 20,503

( ): Traffic count

Source: Study team

The reviewed traffic volumes for 2020 and 2030 are about 1,000 to 2,000 vpd lower than those of the JBIC Study estimates.

### 5.1.2 Road Class and Design Standard

#### (1) Design Standard

In principle, the European Motorway Standard is the basis of highway design because the Samtredia section of the East–West Corridor is a part of the European Motorway Corridor (E-60). However, it was confirmed that the Road Department of Georgia determined its own Highway Design Standard in February 2009; thus, the highway design was carried out according to the Georgian Design Standard as much as possible.

#### (2) Classification of Roads

The road section near Samtredia is classified as an international trunk highway with limited access by the Georgian Design Standard as shown in the Table 4. The design speed of each class and by terrain is 120 km/h.

**Table 4 Design Conditions of the Samtredia Section**

Class of Highway	Topography	Design traffic volume	Design speed	# of lanes	Cross section
International Trunk Highway	Flat	16,400 <sup>3</sup> vpd	120km/hr	4 lanes (2 lanes at the start)	Standard cross section by RD of Georgia

Source: JICA Survey team

### 5.1.3 Number of Lanes and Cross Section

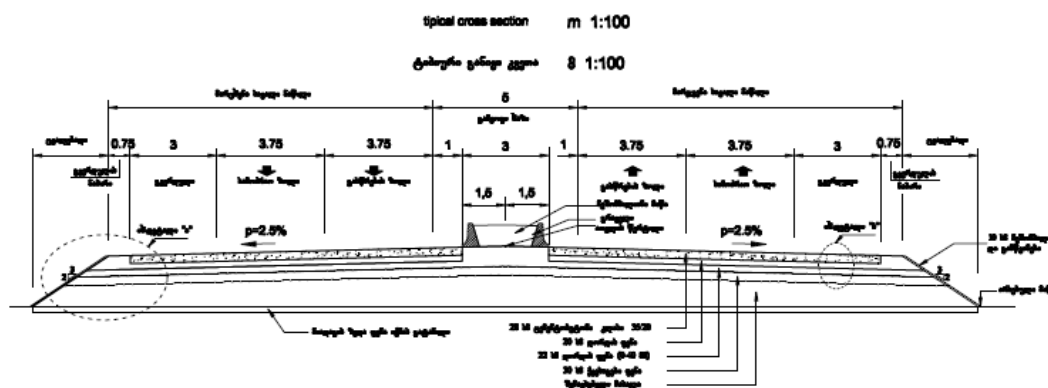
#### (1) Traffic Lanes

The design year of 2030 and design traffic volume of 16,400 vpd was selected for the design of this section. The International Trunk Highway should have at least four lanes according to the Georgian Standard. The Japanese Design Standard also stipulates that the number of lanes with a traffic volume above 14,000 vpd needs four. Thus, the number of lanes for this traffic volume will be four. However, since the expected traffic volume will be 6,860 (8,570 x 0.8) in 2010 and 8,990 vpd (11,234 x 0.8) in 2015, it is proper to start from two lanes to minimize the initial investment, with the widening to four lanes in the future. According to this traffic forecast, the period for the 2-lane operation would be about 10 years after the opening. The year when the traffic reaches 14,000 vpd would be 2025. The widening should start roughly 3 years earlier than this.

<sup>3</sup> Table 3 Design traffic volume of Kutaisi–Samtredia was set based on the assumption that the switch factor of 80% and the estimated traffic volume of 20,503 vpd in 2030.

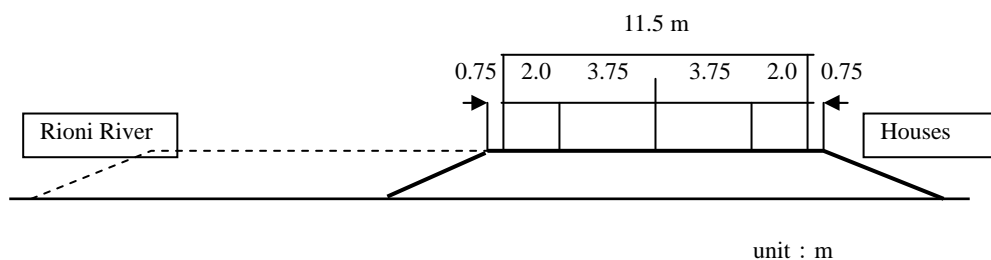
## (2) Standard Cross Section

The standard cross section is determined by both European and Georgian Design Standards. However, slightly different cross sections are proposed by the Road Department to coordinate with other sections already completed in Georgia. The cross sections for embankment (both completed and temporary) are shown in the Figure 9 and Figure 10 respectively.



Source: JICA survey team

**Figure 9 Standard Cross Section (Completed, Earthwork Section)**



Source: JICA survey team

**Figure 10 Standard Cross Section (Temporary, Earthwork Section)**

### 5.1.4 Horizontal and Vertical Alignment

The final horizontal alignment was determined using various control points, geometric design standards, and topographic maps with reference to the initial alternative routes used for the different kinds of site surveys of this project. The main control points are the starting and end points of the route, river improvement plan, revetment, impact to houses, and public utilities including buried lines. The start and end points of the route are shown in the Table 5.

**Table 5 Start and End Points**

Kind	Location	Factors to determine the location
Start	East (South of the airport)	The end point of the New Kutaisi Bypass shown in the JBIC Pilot Study
End	S-12 junction	Tentative end point connects to S-12 at grade

Source: JICA survey team

### 5.1.5 Interchange

Two interchange locations were examined with discussion with the R D: Samtredia East and West. The alternatives of locations, size, shape and type were compared. Probable interchange locations and types are shown in the Table 6.

**Table 6 Outline of Proposed Interchanges**

Name	Location	Access road	Type
Samtredia East IC	2.7 km from the starting point	Regional road leading to Bashi and S-01	Trumpet (At grade intersection of the regional road)
Samtredia West IC	West end of the section	S-12	At grade intersection of S-12 (Future connection to Poti is considered)

Source: JICA survey team

### 5.1.6 Road Structure

#### (1) Earthwork Section

The majority of the road structure is an embankment with an exception of the Gubistskali River Bridge and Ochopa River Bridge. The determining factors of the embankment height were the design high water level of the Rioni and crossing structures. Reduction of the earth work volume was important for cost minimization and efficient construction because the required soils for embankment construction should be taken from borrow pits which are quite distant from the site.

The boring results of the soil survey showed that there are soft ground layers (10 or less N value) near the surface as shown in the Table 7. It seems necessary to reduce differential settlement of the embankment after opening by replacing soft materials, and applying geotextile, as an example, before embankment construction.

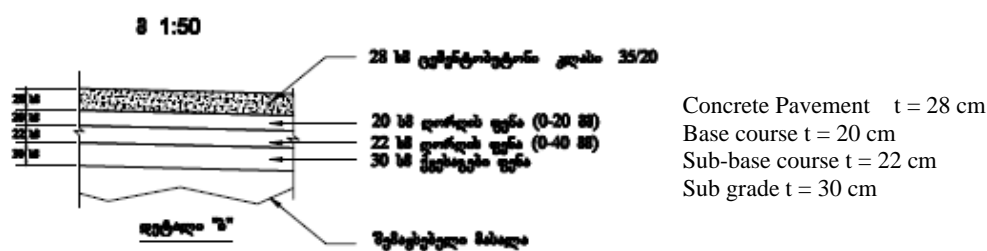
**Table 7 Soft Ground Thickness Based on the Soil Survey**

Boring points	BH-01	BH-02	BH-03	BH-04	BH-05	BH-06	BH-07	BH-08	BH-09	BH-10	BH-11	BH-12
Thickness of layer with N-value < 10	0.6	1.5	0	0	1.6	2.0	0	1.5	3.6	3.0	0	0

Note: Refer to the Figure 3.3.1 of the main volume for the soil survey location

Source: JICA Survey team

The pavement structure for this section is designed as the same structure as the other sections of the highway of the East–West Corridor. The pavement structure is shown in the Figure 10.



Source: Highway standard of Georgia

**Figure 11 Pavement Structure**

#### (2) Bridge Section

There are bridges at Samtredia IC, Gubistskali River and Ochopa River bridges. The Gubistskali River bridge is a long bridge while the other two are short.

### (3) Others

#### Culverts

The locations and dimensions of crossing roads and water channels along the proposed route were identified. The location and size of the culverts were determined and designed. The standard size of the culverts is based on the JBIC Study.

#### Drainage

The size and location of drainages listed below were designed based on the Georgian Road Standard and water related data such as catchment area, precipitation, probability period (year), coefficient of flow and topographic condition.

- Pavement surface drainage
- Slope drainage
- Other drainage facilities

The drainage will be designed in more detail later during the detail design stage.

#### Traffic Safety Equipment

The crush barriers, pavement markings, road signs, and delineators are the safety facilities to be applied for the East–West highway.

### **5.1.7 Bridge Design**

#### (1) Bridge Structure

The general plan of the bridges has been drawn regarding length, span, superstructures, substructures and foundations. Rough construction costs were also estimated.

### **5.1.8 Basic Design of Dike and Revetment**

#### (1) Basic Concept

The design of dikes and revetments should be carried out taking into consideration the river character, flood velocity and scouring conditions of the river bed. The structure shall be safe and economical. The dike shall be constructed together with a revetment structure, since the proposed road is designed to pass in the flood plain area.

#### (2) Design Conditions (Water Level and Discharge)

The design high water level for the bridge and dike in the Georgia are set at the discharges of 300-year and 100-year return period. The design water level for bridges, dikes and revetment of the study section is calculated by means of non-uniform flow based on the survey results of water level and discharge conducted at the Rioni railway bridge and river cross section survey by JICA survey team. The estimated deepest riverbed is calculated based on discharge of 5-year return period and sandbar height about 5 m. The calculation conditions of water level are as follows:

- Water Level
  - Bridge design: EL. 18.66 m
  - Earth dike and revetment: EL. 16.70 m
  - Deepest riverbed: EL. 16.45 m
- Discharge
  - Bridge design: Rioni river — 5,418 m<sup>3</sup>/s, Gubistskali river — 675 m<sup>3</sup>/s

- Earth dike & revetment: Rioni river — 3,214 m<sup>3</sup>/s, Gubistskali river — 555 m<sup>3</sup>/s
- Deepest riverbed: Rioni river — 1,830 m<sup>3</sup>/s, Gubistskali river — 316 m<sup>3</sup>/s

### (3) Design Water Level and Velocity

The water level and velocity are calculated based on the above conditions. As a result, the velocity reached 6.5 m/s at confluence of the Gubistskali River. This velocity is too high for the design. As countermeasures for this, river improvement to induce lower velocity was considered. The study suggests improvements at certain sections of the river, by which the velocity was reduced to 4.2 m for ordinal design level.

### (4) Design of Dike

An earth dike was planned along the proposed road on the right bank of the Rioni and Gubistskali Rivers. This dike will have a function for revetment maintenance as well as to protect the road from floods. The dike elevation was designed at design water levels calculated by design discharges plus 1.2 m and 1.0 m for Rioni and Gubistskali rivers respectively.

### (5) Selection of Revetment Type

The extent of design revetment was decided considering the route of the proposed road, the alignment of the river and the scouring conditions. As a result, the revetment was designed 6.2 km long on the right bank running from Gubistskali river to Rioni river. The applicable revetment type considering available materials at site are stone type, concrete block type and gabion type. The stone type revetment was selected considering the construction cost and maintenance.

## 5.2 Project Cost Estimate

The expected project costs of all the alternative routes are shown in Table 8.

**Table 8 Total Project Costs**

Unit: x 1,000 USD

Cost Estimate Summary						
No.	Item	Option R-1 Cost	Option R-2 Cost	Option R-3 Cost	Option L-1 Cost	Option L-2 Cost
<b>I</b>	<b>Preparatory works</b>	<b>5,326</b>	<b>4,280</b>	<b>3,468</b>	<b>1,499</b>	<b>1,499</b>
I-a	Land Acquisition and Resettlement	1,301	1,265	2,293	1,134	1,134
I-b	Other preparatory works	4,025	3,015	1,175	365	365
<b>II</b>	<b>Earthworks</b>	<b>19,163</b>	<b>19,379</b>	<b>18,211</b>	<b>46,577</b>	<b>32,459</b>
<b>III</b>	<b>Pavement</b>	<b>11,546</b>	<b>11,652</b>	<b>11,556</b>	<b>8,096</b>	<b>8,096</b>
<b>IV</b>	<b>Facilities</b>	<b>18,138</b>	<b>18,430</b>	<b>17,280</b>	<b>33,198</b>	<b>76,006</b>
IV-a	Bridges	5,030	5,030	5,030	15,416	67,034
IV-b	Revetment	9,660	9,660	8,510	16,100	8,372
IV-c	Others	3,448	3,740	3,740	1,682	600
<b>V</b>	<b>Junctions #1, #2</b>	<b>1,575</b>	<b>1,575</b>	<b>1,575</b>	<b>1,575</b>	<b>1,575</b>
<b>VI</b>	<b>Interchange</b>	<b>2,626</b>	<b>2,626</b>	<b>2,626</b>	<b>224</b>	<b>224</b>
<b>VII</b>	<b>Safety measures and Social Considerations</b>	<b>4,212</b>	<b>4,256</b>	<b>5,140</b>	<b>3,671</b>	<b>3,293</b>
<b>VIII</b>	<b>Contingencies</b>	<b>3,129</b>	<b>3,110</b>	<b>2,993</b>	<b>4,742</b>	<b>6,158</b>
	<b>Total</b>	<b>65,715</b>	<b>65,308</b>	<b>62,850</b>	<b>99,582</b>	<b>129,310</b>

Note: Option R denotes the right bank side route and Option L denotes the left bank side route.

Option R-1 is a recommended option, R-2 is a variation to minimize relocation of houses using small radius of curvature, R-3 is trying to avoid impact on the river, L-1 is on the left bank side with embankment, and L-2 is on the left bank side with long bridges.

Source: JICA survey team

## **Chapter 6 Recommendations for Project Implementation**

### **6.1 Road Design**

The road design satisfied required design standards and necessary control points. The issues to be considered in the next stage are:

- Whether to proceed with reclaiming a part of the river for construction of the road (engineers in the Road Department accept this);
- Although the existing utility lines and relocation plan were studied, more detailed investigation will be necessary;
- A large amount of soil is necessary for the embankment from borrow pits.

Construction work in the river such as revetment, bridge and reclamation must be done during low water periods. The efficient survey and design will be required to minimize construction schedule. The construction period must be carefully planned.

### **6.2 Bridge Design**

The geological conditions have been investigated within the scope of the basic survey along the assumed alignment of the highway (which later was slightly changed). Additional soil investigations for bridge design based on the exact location of the abutment and piers will be necessary at the detail design stage. The type and span of the bridge may be modified depending on the results of the soil investigation. New technology for cost reductions may also be considered

### **6.3 River and Revetment Plan**

#### **(1) Water Code and Revetment Plan**

The Water Code of Georgia was prepared during USSR period and has not been changed since then, even after independence in 1991. However, the effectiveness of the code is questionable and the local experts have the same opinion that the code is not valid any more as well. In any case, the explanations to the concerned agencies and people are necessary before starting the project. Therefore, it is recommended to assign a river and hydrological expert during the detail design stage who will explain the Rioni River hydrologic conditions and impacts on the river environment caused by the river improvement work, revetment and embankment.

#### **(2) Detail Design of Embankment and Revetment**

The basic design for embankment and revetment was carried out based on the water level and discharge measured at the Rioni Railway Bridge. However the information was limited and the assignment period was short. Therefore during detail design stage, more detail survey, collection of hydrological information and analysis are required. The study of rehabilitation of the existing dikes may also be required.

#### **(3) Observation of Water Level**

Water level observation has not been carried out since 1961 and the existing data is not reliable. Therefore, the water level observation will be needed to collect effective information during detail design stage in order to plan the construction program.

## 6.4 Geological Investigation

Alluvium deposits and upper parts of Divilium deposits were surveyed in this study. However lower parts of Divilium deposits as well as bed rocks are insufficient to assume the typical value of the layer. They shall be determined by execution of laboratory tests of core samples in the detail design stage.

Site investigations for construction materials shall be performed in detail at a later stage. Laboratory tests as well as field tests such as a trial embankment are proposed to be executed at the detailed design stage. Additional geological investigations at the sites of structures like bridges shall also be performed.

## Chapter 7 Conclusions

The basic survey for the East–West Highway Project near Samtredia area has been carried out and the basic design and cost estimates have been prepared. Surveys include topography, river investigation, geological survey, and socio-environmental study. The following conclusions can be drawn from the basic survey.

- The characteristics of the Rioni River are key to the road planning and design
- The option on the right bank of the Rioni River is more advantageous than the left bank
- The right bank option involves the relocation of various public facilities and utility lines and thus will take long time because of necessary negotiations
- The cost for the relocation of such facilities on the right bank option will come to a significant amount
- Options on both the right and left bank sides will have a certain impact on the Rioni River structure and stream
- Countermeasures against erosion from the Rioni River are important for both options

The qualitative characteristics of each alternative, according to the overall evaluation based on the environmental, social and economic points of view as well as the technical aspect are summarized in the Table 9.

**Table 9 Comments on Overall Evaluation of Each Alternative**

Option	Features	Advantages	Concerns	Evaluation
Right bank (Option R-1)	Standard design	<ul style="list-style-type: none"> <li>• Reclaim a part of the river flood plain</li> <li>• Some relocation of houses</li> <li>• Better traffic safety (well balanced road design)</li> </ul>	<ul style="list-style-type: none"> <li>• Reclamation might be a problem</li> <li>• Relocation costs and time</li> <li>• Highest construction costs among right bank options</li> <li>• Relocation costs and time of public utilities</li> </ul>	○
Right bank (Option R-2)	Relocation minimizing	<ul style="list-style-type: none"> <li>• Reclaim a significant part of the river flood plain</li> <li>• Minimum relocation of houses</li> </ul>	<ul style="list-style-type: none"> <li>• Reclamation might be a problem</li> <li>• Creating traffic hazard (poor alignment in a short section)</li> <li>• More relocation costs and time of public utilities</li> </ul>	△
Right bank (Option R-3)	River encroaching minimizing	<ul style="list-style-type: none"> <li>• No reclamation of the river</li> <li>• Some relocation of houses</li> <li>• Less relocation costs and time of public utilities</li> </ul>	<ul style="list-style-type: none"> <li>• More relocation of houses need more money and time</li> <li>• Creating traffic hazard (poor alignment in a short section)</li> <li>• More land acquisition</li> </ul>	△

Option	Features	Advantages	Concerns	Evaluation
Left bank (Option L-1)	Embankment & bridge combination	<ul style="list-style-type: none"> <li>• Minimum impact to residences</li> <li>• Minimum relocation of public utilities</li> </ul>	<ul style="list-style-type: none"> <li>• Subject to river erosion in the future</li> <li>• River analysis and negotiation would require long time</li> <li>• Bridge crossing the canal for the power plant needs a large scale construction</li> <li>• More construction costs</li> <li>• Inconvenient to local users of the highway</li> </ul>	X
Left bank (Option L-2)	Bridge option	<ul style="list-style-type: none"> <li>• Minimum impact to residences</li> <li>• Minimum relocation of public utilities</li> <li>• Less influence by the river compared with Option L-1</li> </ul>	<ul style="list-style-type: none"> <li>• River analysis and negotiation would require long time</li> <li>• Bridge crossing the canal for the power plant needs a large scale construction</li> <li>• More construction costs</li> </ul>	X

The overall evaluation of the Option L-1 and L-2 seems unfavourable for implementation due to several reasons. These include high construction costs, the risks of being influenced by river erosion, and the fact that the future river direction is not predictable. Options R-2 and R-3 have some advantages for specific purposes such as minimizing relocations or river intrusion, but at the same time there are many concerns such as adverse impacts on the river caused by reclamation and more relocation of houses (Option R-3). The most significant concern among them is the traffic safety due to introducing small radius of curvature. On the other hand, Option R-1, which has a slightly higher construction cost than the other “R” options, is considered, among these options, to be well balanced in terms of route location and impact to the river. Therefore, R-1 option is recommended for implementation because there are less adverse impacts on the relocation, costs and reclamation of the river, as well as traffic safety.

However, as mentioned earlier there are still some concerns, even with the recommended option. It seems necessary to seek best road alignment taking the advantages found for the Option R-2 and R-3 during the detail design stage into consideration. In view of all the above, river investigation and revetment plans and design, and relocation planning and the negotiation of houses, public facilities and utilities, must be done as quickly as possible to minimize the overall implementation period.





## **Chapter 1 Introduction**

### **1.1 Background**

Georgia attained its independence in 1991 after the collapse of the USSR. As a result of the economic chaos, loss of markets and ethnic conflict after the collapse, the GDP of 2000 is said to have fallen to 30% of that of 1990, creating more than thirty thousand refugees. The restructuring of the economy began in 21<sup>st</sup> century, and after the Rose Revolution in 2003, the economy has grown at a rate of 5% to 10% owing to the enhancement of democratization and market economy, and political reconstruction such as eradication of corruption.

Georgia is a small country with a population of around 4 million, but it has some political and economical instability because of its location on the shortest line connecting Central Asia and the Black Sea. After the Rose Revolution, the policy towards the West has been to seek affiliation with NATO and the EU, and this has soured relationships with Russia (which was a trade partner accounting for more than 20% of Georgia exports), leading to a ban in 2006 of all trade except natural gas. Thereafter, military conflicts over South Ossetia and other areas occurred between Georgia and Russia in August, 2008.

Georgia is located in the Caucasus region between the Black Sea and the Caspian Sea and it is geopolitically very important, with access both to Europe and Asia. Furthermore, Georgia is very important from an energy security point of view for being the relay point of the BTC pipeline, which runs through Azerbaijan to Turkey, as well as from the “arc of freedom and prosperity” approach which Japan is advocating. It is expected that Georgia will recover from the damage of the conflict and return to stability and growth, leading to the prosperity and stability of the region by democratization and market economics in the whole Caucasus region.

The former JBIC carried out the study for project formulation for highway improvement project (hereinafter call JBIC study) from 2007 to 2008, and formulated a yen loan project for East–West Highway development (considered the most important road in Georgia). After the completion of the study, the military conflict with Russia took place, and, in a conference after the conflict, Japan pledged a maximum of 200 million US dollars. The largest amount pledged was 1 billion US dollars by the United States, the second largest was 500 million Euro by the EU, and Japan was the third largest. Japan has promised to provide yen loan for the East–West Highway development to enable infrastructure reconstruction.

### **1.2 Objective of the Study**

Arterial highway development is one of the most important projects in the national development plan of Georgia, and it has been implemented using increased state budget for the road sector as well as by funds from international donors, such as the World Bank. Among all the arterial highways, the East–West Highway from the border of Azerbaijan through Tbilisi to Poti is one of the highest priorities.

While the development of the East–West Highway westwards from Tbilisi is in progress using the State budget and funding from the World Bank, no feasibility study (FS) was carried out for the area west of Rikoti (central Georgia), and no budget for FS was assured. Considering these situations, JBIC carried out a study from 2007 in order to specify priority sections to be developed and to formulate a project, which would stimulate the Georgian government to apply for a yen loan.

Through this JBIC study, the situation of the East–West Highway development was made clear and the most appropriate development plan as a yen loan project was proposed. Afterwards, the discussions with the Georgia government were held on the basis of the JBIC study, and the section between Kutaisi to Samtredia was selected as a yen loan project.

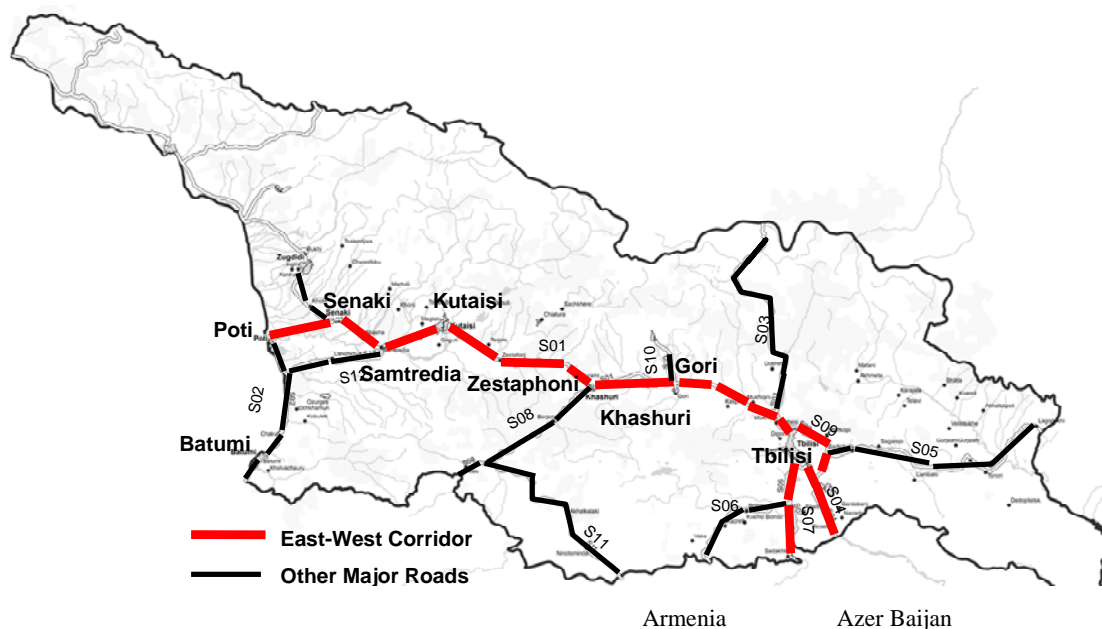
At the time of the JBIC study, basic selection of the route, basic design, and preliminary cost estimates were carried out from Kutaisi to the east of the Samtredia (not including the Samtredia city). Since Samtredia city was finally included in the project scope during discussions with the Georgian government, further study was needed. The existing East–West Highway (S-01, E-60) runs through urban areas, and a bypass is required for a high standard highway. However, there are many restrictions on the route selection and road design due to the river Rioni flowing just south-east of the city, and additional study for this area was necessary.

The objectives of this study are to make clear of the background of this project, the conditions of the site, existing plans etc. (by reviewing the results of the previous project), and to carry out a technical study of the East–West Highway development for Samtredia city and its surrounding area in order to implement a yen loan project.

### 1.3 East–West Highway Plan

#### 1.3.1 Current Status of the East–West Highway Development

The major road network in Georgia is shown in Figure 1.3.1. The East–West Highway is one of the important arterial highways in Georgia. There are two routes, one of which starts from the Azerbaijan border and reaches Poti, the Black Sea port, via Tbilisi. The other route starts from Armenia and joins the East–West Corridor. This corridor is not only important for transportation of goods in Georgia but also connects to Iran via Azerbaijan in the east and central Asian countries via the Caspian Sea. This corridor connects further to European countries (via the Black Sea) in the west and goes down to the south to reach Turkey.



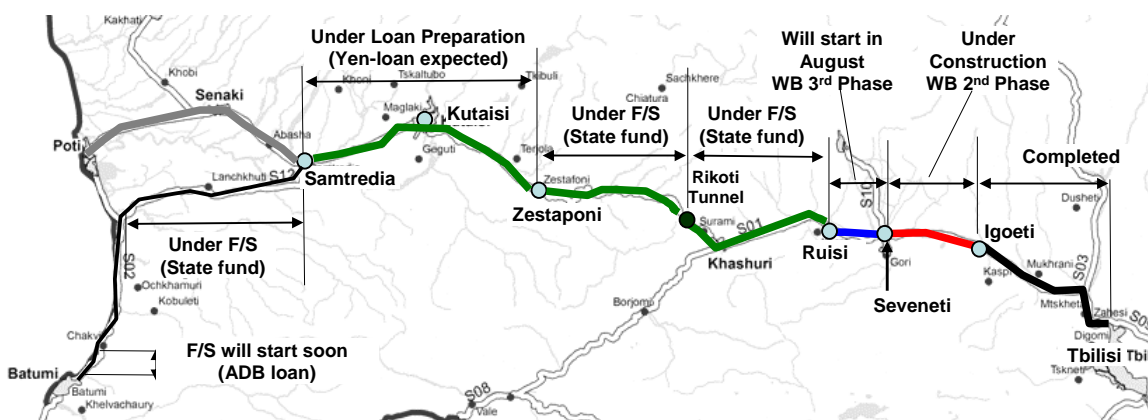
Source: JBIC study final report

**Figure 1.3.1 Trunk Highways of Georgia**

The traffic volume of the East–West Highway from Tbilisi and Gori (80 km, 2 and 4 lanes) section is over 10,000 vehicles/day (vpd) according to the traffic data from 2008. Smooth traffic flow has often been hindered by slow moving vehicles in 2 lane sections because overtaking is difficult under this traffic volume. The west section of Gori to Kashuri (45 km), of which traffic volumes reach almost 10,000 vpd, also shows the same traffic conditions. The sections further to the west of Zestafoni to Kutaisi (46 km) and Kutaisi to Samtredia (34 km) have about 8,600 vpd. These two sections also show similar traffic conditions because of the lack of capacity of 2 lane roads. According to the JBIC Study, it is expected that forecast traffic of Zestafoni to Samtredia in 2030 reaches between 23,000 vpd and 27,000 vpd. The Georgian government, under these circumstances, has begun improving the existing East–West Highway to a motorway that fits the Trans European Motorway (TEM) standards: four lanes and access controlled motorway with a design speed of 120 km/h in flat terrain.

EU started the TRACECA (Transport Corridor Europe Caucasus Asia) program in 1993 as an economic cooperation program of the Black Sea area, Caucasus, and Central Asia. The East–West Corridor was taken as an important major corridor in Georgia, being included in Feasibility Study (Hereinafter called FS) of the program. A pre-FS was conducted to analyze the economic feasibility of motorways in Georgia. The government began implementation of the project from Tbilisi based on the FS results. The section Tbilisi and Igoeti (56 km) is completed and open to traffic. The section between Igoeti and Seveneti (entrance to Gori, 24 km) is, as of July 2009, under construction financed by the World Bank. Preparation for construction has been made for the section to the west.

However, the JBIC Study proposes the section from Zestafoni to Samtredia as a higher priority section. This section starts from Zestafoni towards the east and connects Kutaisi and Samtredia. The through traffic on the corridor goes into the Kutaisi city area because the bypass is only partially completed. Improvement is required for this section in the areas of transportation efficiency, traffic safety and the environment. The Asian Development Bank (ADB) is assisting the Ajhara Bypass of the section between Poti and Batumi, which is a part of the East–West Corridor. This section is also an important connection from Georgia to Turkey.



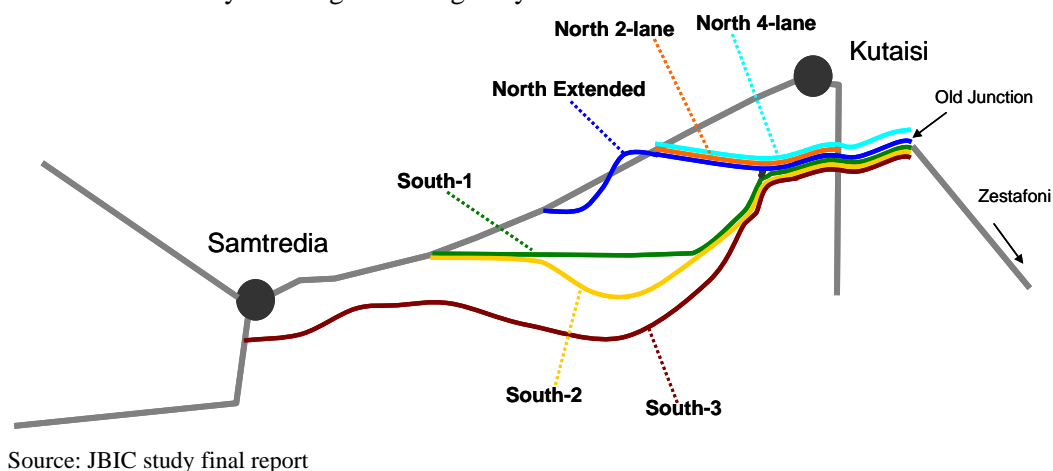
Source: JBIC study final report

**Figure 1.3.2 Highway Improvement of the East–West Corridor**

### 1.3.2 Section for Development by ODA Loan

As mentioned previously, the feasibility study was carried out by the JBIC study for the improvement and upgrading of the road between Zestafoni–Samtredia section. In the study, the Kutaisi bypass was recommended to be a high priority (it was very economically effective), but there were several alternatives in the section between Kutaisi–Samtredia (this section includes the Kutaisi bypass). Each alternative has advantages and disadvantages, and the comparison of six alternatives (shown in Figure 1.3.3) was carried out. Among the six alternatives, the North 2-lane option seemed economically effective but the traffic will nearly reach capacity in the morning and evening. The North-extended alternative was proposed, but it was noted that all of the North alternatives will go through residential areas and as such will worsen the environment. Finally, a North-extended alternative which can make use of the existing road and can develop gradually from 2 lanes to 4 lanes, and South 2 alternative were selected as the most appropriate routes.

However, as a result of the discussions with the Georgian government after the JBIC study, the yen loan was finally agreed to be provided for South 3 alternative, which is the route to connect Kutaisi–Samtredia by building a new highway.



**Figure 1.3.3 Alternatives between Kutaisi–Samtredia Section**

### 1.3.3 Outline of Kutaisi–Samtredia Section

The East–West Corridor (S-01, E-60) starts from Tbilisi heading west, reaches the entrance of Kutaisi after going along Zestafoni and the plateau between the hills and the Kvirila River. The highway becomes the Kutaisi Bypass before Kutaisi, diverting from the old road that goes directly into the city area. Most traffic uses the bypass because the old road is narrow and the pavement condition is very bad due to poor maintenance. Usually a bypass is designed to divert through traffic from going into the city center. However, the traffic on the East–West Corridor goes along the bypass but then into the city area because the Kutaisi Bypass is partially completed and passes through the edge of the city in the direction of Samtredia.

The traffic going along the Kutaisi City area comes back to the urban section of the East–West Corridor. This section from Kutaisi to Samtredia (about 40 km) is surrounded by farm land where sporadic houses are located along the highway and other roads. The highway that approaches to Samtredia goes along farm land and forest or unused areas. The corridor reaches the south of the Samtredia city area and branches off to Poti or Batumi directions. The traffic volume of the Samtredia–Kutaisi section was 8,600 vpd (vehicle per day) in 2008 (according to the traffic count). This traffic volume on the inter-urban highway is quite normal for two-lane highways, and does not interrupt smooth traffic flow. However, where a fair amount of heavy

and through traffic goes on city streets (the JBIC study shows the forecasted traffic volume of between 23,000 vpd and 27,000 vpd in 2030) this traffic may create traffic congestion, safety hazards and environmental nuisances unless some countermeasures are taken in the future.

The planned East–West Highway of the Kutaisi–Samtredia section under the Georgian Government scheme starts from the Kutaisi Bypass. The highway passes the intersection of the two-lane local road which connects the Kutaisi center to Bagdadi, goes to the west and crosses the Rioni River by a bridge (as in the JBIC Study). There is an interchange to connect a local road leading to Kutaisi center on the right bank of the Rioni River. The route further goes to the west crossing the railway and local roads and crossing down the alluvial fan hills formed by the river sedimentation. The major land use is for farm land and unused lots. There are scattered houses in the area. The number of houses to be relocated will be minimal. The route reaches the Samtredia section of the East–West Highway after going south of the military airport.



## Chapter 2 Survey Area

### 2.1 Target Area

#### 2.1.1 Survey Area

The survey area is located between the 255 km and 266 km posts from Tbilisi along the S-01 route, starting from the south of the military airport and ending at the connection to the National Highway No.12. The total length is about 12 km. This area has a humid climate in Georgia due to its location, south of Rikoti. The planned route is in the south of Samtredia and near the Rioni River. The route either goes along the vacant strip or meadow located between residential areas to the south of the railway and the Rioni River (right bank route) or along the left bank of the river which is a flood plain currently used as farm land.

#### 2.1.2 Outline of the Project Area

The project area is located to the south of Samtredia which is developed in the hill and plateau formed as a part of the Caucasian mountains. The south of the residential areas has been suffering from river erosion in recent years. The Rioni River flows to the west from Kutaisi. The river is wide due to the nature of its winding and unstable flow. The project area is on both banks of the current river where water runs. The elevation of the residential areas located at the edge of the plateau is higher than the current water level. However there are still possibilities of floods due to the winding nature of the river and especially during high water periods in spring when a lot of water flows from melting snow. On the other hand, the left bank of the river in the project area is basically a flood plain; there are also possibilities of flooding during the high water season.

The followings are the special features of the area along the route and the points to pay attention for the design of the roadway.

- The Rioni River runs to the south of the residential areas. This river is winding and the river course is repeatedly changing in the long time period.
- The erosion is moving to the north according to the aerial photos and old map. The distance between the south of the residential areas developing toward south and the river is getting shorter. Therefore, it might be possible that the route goes in the river course or flood plain.
- There are many utility lines buried in the ground along the route. The high voltage power transmission line also exists near the route.
- There might be relocation of houses in the south, which would be influenced by the highway depending on the route design.

### 2.2 Outline of the Route

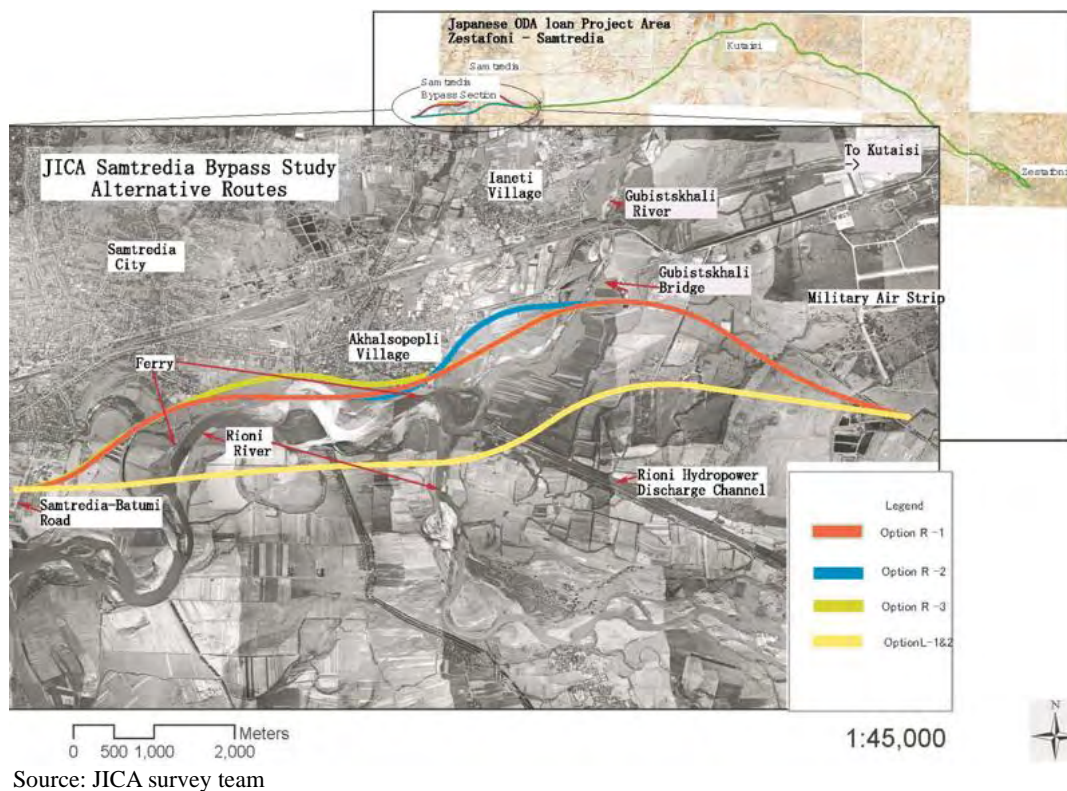
#### 2.2.1 Alternative Routes

As alternatives two major options were considered: on the right bank of the river and the left bank of the river (R-option, L-option).

- Option R-1: The route goes over Gubistskali River and passes to the south of Ianeti Village. Then it runs on a proposed landfill of a bend toward the right bank and continues back to the right bank to the west to join the road from Samtredia to Batumi.
- Option R-2: The route is similar to Option R-1, but with the sacrifice of the radius of the road between the west of the Gubistskali River and the western end of Akhalsopepli Village, the resettlement and relocation of gas pipe lines are minimized.



- Option R-3: The route is similar to Option R-1 but slightly shifted towards the north to avoid the proposed landfill of the Rioni River to minimize the interference with the river hydrology.
- Option L-1: The route starts at the south of the military airstrip, and crosses the discharge channel of a hydropower station located upstream of the Rioni. Then it crosses the northward stream of the Rioni and passes through the flood plain to the west. It crosses again the southward stream of the Rioni. Then it joins the same junction at the road from Samtredia to Batumi. This option limits the bridge crossings to a minimum.
- Option L-2: The route itself is exactly the same as Option L-1, but the entire span of first crossing of the Rioni through the second will be connected by the long span bridge, limiting the impact of potential course changes of the Rioni River.

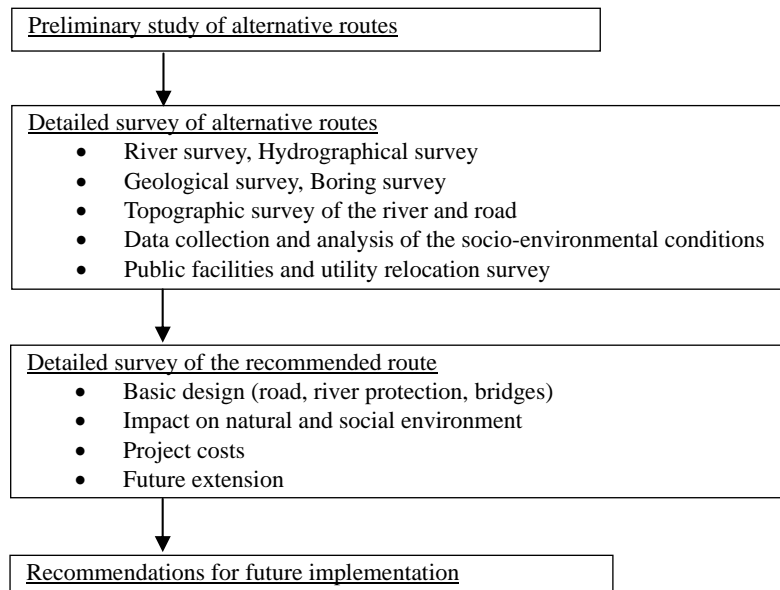


**Figure 2.2.1 Alternative Routes**

## Chapter 3 Site Survey

### 3.1 Survey Flow

The survey of this area had two stages, the first of which was to examine which side of the river, left or right, was preferable for the route and for detailed surveys. The second stage was to determine the recommended route locations among the alternatives mentioned in Section 2.2.1 in Chapter 2, “Alternative Routes” after discussion with relevant government organizations based on the results of the site survey.



**Figure 3.1.1 Survey Flow**

Survey items necessary for the basic design and project cost estimation are as follows. The details of the survey are mentioned in the following sub-sections.

- River survey, Hydrographical survey
- Geological survey, Boring survey
- Topographic survey
- Public facilities and utility survey
- Natural and social environment survey
- Road design

### 3.2 River and Hydrological Survey

#### 3.2.1 Data Collection on River and Hydrological Conditions

The data collection was carried out for the selection of East–West Highway routes and its design. The following data was collected from agencies and site investigations:

- (1) Climate parameters around the study area (Rainfall, temperature, humidity, and wind speed)
- (2) Daily rainfall data
- (3) Water level and discharge of Rioni River

- (4) River characteristics of Rioni River
- (5) Water level and discharge of Gubistskali River
- (6) River characteristics of Gubistskali River
- (7) Regulations/Codes on River Improvement

### 3.2.2 Survey Results

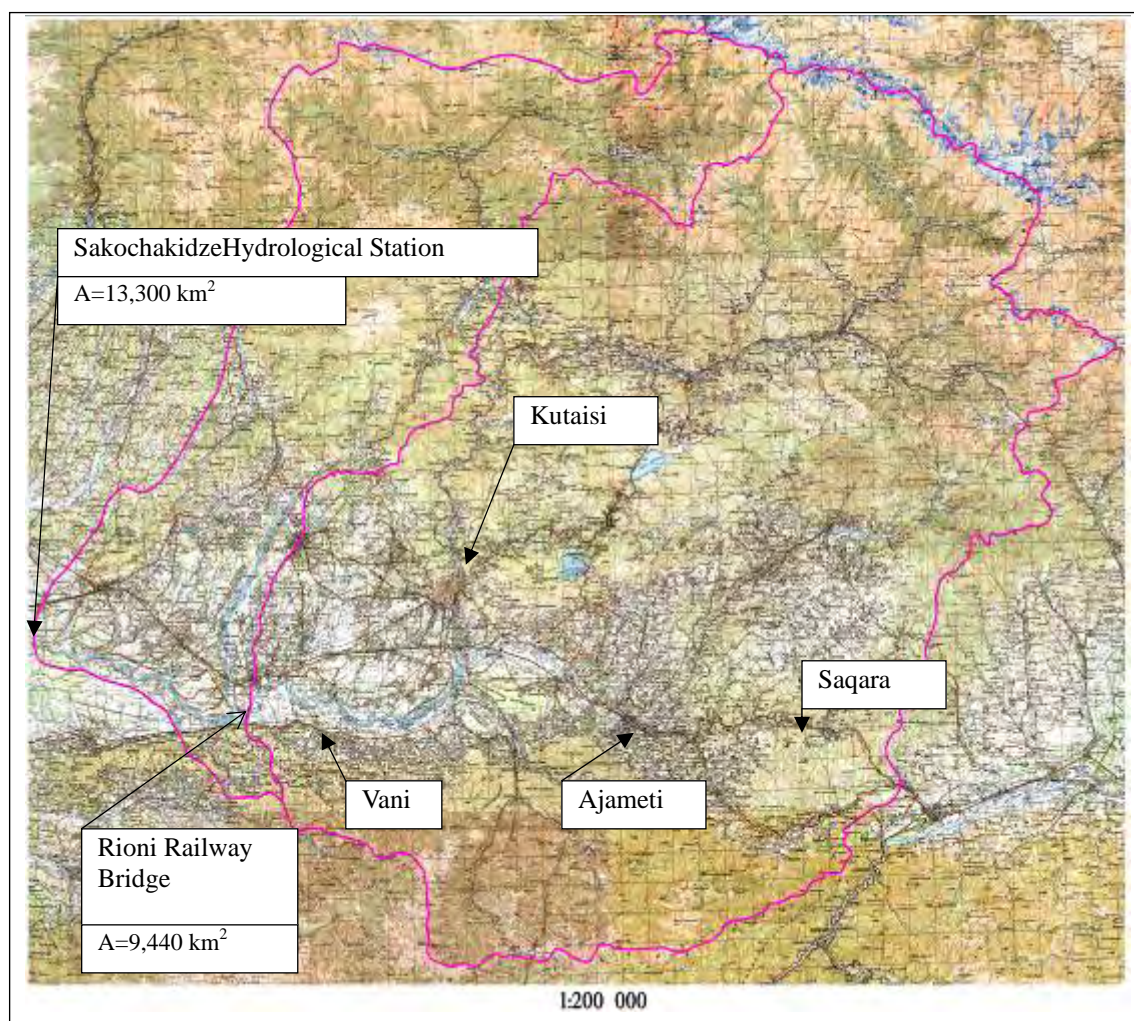
Hydrological observations for the Rioni River have not been carried out since 1987 due to domestic turmoil following independence from the USSR. Due to this it was judged that extensive data collection could be too time-consuming for the period of the study, and therefore only available data and the essential required conditions were collected.

#### (1) Climate in the Study Area

The study area is situated nearby Samtredia in West Georgia and categorized as a damp, subtropical climate zone. Topographically the area is positioned in Kolkheti lowland and is surrounded by Caucasus mountains to the north and south. This area has large amounts of precipitation compared with eastern parts of Georgia because of unstable damp air masses flowing up from the Black Sea. The annual precipitation at Samtredia is about 1,300 mm and the monthly rainfall varies from 160 mm to 400 mm.

The annual average temperature is 14 degrees centigrade. The minimum and maximum temperatures drops are recorded in January and August, and are 5 and 14 degrees respectively. Humidity varies little, from 72% to 81% throughout the year. Eastern winds are dominant throughout the year although the wind speed is relatively small, varying from 1.8 m/s to 3.6 m/s.

The gauging stations near the study area and the data collected are shown in Figure 3.2.1 and Table 3.2.1



Source: JICA survey team

**Figure 3.2.1 Rioni River Catchment Basin and Climate Gauging Stations**

**Table 3.2.1 Climate Conditions****(1) Air temperature (C)**

Meteorological Station	Months												Annual Average
	Jan	Feb.	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Samtredia	4.7	5.6	8.8	13.0	18.0	21.0	23.2	23.5	20.4	16.2	11.2	7.0	14.4
Vani	4.1	4.8	8.2	12.6	17.6	20.7	23.0	23.4	20.0	15.6	10.8	6.3	13.9
Kutaishi	5.2	5.8	8.4	12.9	17.9	21.0	23.2	23.6	20.5	16.4	11.5	7.5	14.5
Ajameti	4.3	5.0	8.1	12.7	17.0	20.8	23.2	23.6	20.3	16.0	10.8	6.3	14.0
Saqura	3.7	4.5	7.8	12.8	18.0	21.2	23.6	23.9	20.3	15.5	10.1	5.7	13.9

**(2) Air Humidity (%)**

Meteorological Station	Months												Annual Average
	Jan	Feb.	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Samtredia	76.0	75.0	73.0	72.0	73.0	75.0	78.0	80.0	81.0	79.0	72.0	72.0	76.0
Vani	77.0	74.0	73.0	69.0	71.0	72.0	76.0	76.0	78.0	77.0	75.0	74.0	74.0
Kutaishi	68.0	68.0	69.0	66.0	69.0	72.0	76.0	75.0	74.0	71.0	65.0	64.0	70.0
Saqura	75.0	75.0	72.0	68.0	70.0	71.0	73.0	72.0	75.0	76.0	73.0	72.0	73.0

**(3) Average Monthly Wind Speeds (m/s)**

Meteorological Station	Months												Annual Average
	Jan	Feb.	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Samtredia	3.2	3.4	3.6	3.4	2.8	2.3	1.8	1.8	1.8	2.3	3.6	3.6	2.8
Vani	2.9	3.3	3.5	3.3	2.6	2.2	1.8	1.9	1.7	2.2	3.2	3.3	2.7
Kutaishi	5.6	5.6	5.9	5.7	4.6	3.7	3	3.4	3.6	4.8	7.2	6.7	5.0
Ajameti	3.5	3.5	3.5	3.2	2.5	2.2	1.8	2.2	2.2	2.5	3.4	3.6	2.8
Saqura	1.9	2.1	3.1	3	2.6	2.4	2.3	2.2	1.8	1.5	2.2	1.8	2.2

**(4) Average Monthly Precipitation (mm)**

Meteorological Station	Months												Annual
	Jan	Feb.	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Samtredia	142	130	102	78	64	90	11	93	130	150	146	149	1285
Vani	129	120	94	72	58	82	94	86	121	137	134	137	1264
Kutaishi	136	131	113	99	84	97	110	91	116	131	131	141	1380
Ajameti	111	110	90	75	63	71	56	53	75	101	116	119	1040
Saqura	127	126	104	86	72	81	64	61	85	116	132	136	1190

**(5) Monthly Maximum Precipitation (mm)**

Meteorological Station	Months												Maximum
	Jan	Feb.	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Samtredia	347	375	251	196	161	195	287	200	287	402	378	374	402
Saqura	307	384	245	208	159	174	193	143	187	326	483	353	483

**(6) Daily maximum Precipitation (mm)**

Meteorological Station	Months												Maximum
	Jan	Feb.	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Samtredia	73	60	62	58	76	103	98	87	97	111	111	73	145
Saqura	77	62	94	79	87	60	56	74	72	92	91	120	120

**Condition of Meteorological Stations**

	Samtredia	Vani	Kutaishi	Ajameti	Saqura
Altitude (A.S.L)	25	46	114	107	148
Operation Period	1923–60	1936–58	1935–60	1922–35	1892–1960

Source: Ministry of justice

**(2) Daily Rainfall Data**

Rainfall observation at Samtredia Hydrometeorological Station has been carried out since 1936. The daily rainfall data from 1946 was recommended for use by the observation agency. The total amount of annual rainfall was 1,468 mm, 183 mm higher than the annual average rainfall amount of 1,285 mm. The daily maximum rainfall in 1946 was 63 mm. This amount is less than the annual average precipitation of 111 mm. 158 rainfall days was recorded. The details are shown in Table 3.2.2

**Table 3.2.2 Daily Rainfall (1946)**

(1) Daily Precipitation (mm)													Unit :mm
Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Remarks
1	6.4	0.0	0.0	24.1	0.0	0.2	32.2	0.0	0.0	0.0	0.0	0.0	
2	7.2	0.0	0.0	58.3	11.0	0.0	62.8	0.0	0.0	12.7	0.0	0.0	
3	0.5	0.0	5.1	5.6	0.0	0.0	6.3	0.0	1.9	0.9	0.0	0.0	
4	0.0	0.0	0.8	1.0	2.8	0.0	1.4	1.7	0.0	5.0	0.0	0.0	
5	0.0	0.0	0.0	0.0	0.0	0.0	4.4	0.0	0.3	24.7	0.0	0.0	
6	0.0	0.0	0.0	0.0	0.0	0.0	31.7	0.0	20.0	0.4	0.0	0.0	
7	0.0	0.0	0.0	0.0	0.5	0.7	4.5	0.1	0.0	0.0	0.0	0.0	
8	0.3	17.3	0.8	0.0	1.0	0.0	4.9	0.0	0.0	0.0	0.0	0.0	
9	3.5	3.3	0.0	0.0	12.7	3.3	0.0	0.0	0.0	7.6	0.0	0.0	
10	0.0	0.1	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
11	0.0	0.1	0.0	0.0	16.3	21.2	2.0	0.0	0.0	4.9	0.0	0.0	
12	8.9	0.0	0.0	0.0	0.0	0.0	3.2	0.0	0.0	23.2	0.0	0.0	
13	0.0	0.0	9.8	0.1	0.0	0.0	0.0	18.2	0.0	26.7	7.5	0.0	
14	0.0	2.0	1.9	21.1	0.0	2.3	0.0	0.0	34.9	22.3	45.5	0.1	
15	0.0	2.6	7.2	0.2	0.0	0.0	0.0	0.0	0.0	37.8	0.3	41.1	
16	0.0	7.7	2.4	0.0	0.0	13.1	0.0	0.0	0.0	0.0	0.0	16.2	
17	40.1	6.0	0.0	0.0	0.0	0.0	0.3	0.0	4.7	0.9	19.9	25.3	
18	17.3	2.3	0.0	0.0	0.0	0.0	0.0	0.0	3.3	1.3	0.0	8.5	
19	7.0	1.5	3.1	0.0	0.0	29.7	0.0	0.0	0.0	7.8	0.0	3.6	
20	2.5	20.4	0.9	0.0	0.0	22.3	0.0	0.0	0.0	15.4	21.8	26.3	
21	12.7	1.0	0.0	0.0	0.0	8.6	0.3	0.0	0.0	3.5	23.6	3.9	
22	8.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
23	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.1	0.0	0.0	
24	3.5	0.0	0.0	0.0	1.6	0.0	0.0	4.6	12.2	0.7	0.0	0.0	
25	0.0	3.5	10.3	0.0	3.7	0.0	0.2	0.3	0.9	0.0	0.0	0.0	
26	0.0	6.5	24.8	3.0	0.0	0.0	7.1	0.0	0.3	9.3	0.0	6.1	
27	0.0	21.1	40.1	12.9	0.3	0.0	1.0	0.0	16.6	9.9	0.0	1.1	
28	0.0	5.4	3.0	0.0	0.0	0.0	0.2	0.0	16.3	18.8	0.0	3.1	
29	0.0		0.4	0.0	4.8	0.0	0.0	2.3	1.2	0.0	0.0	1.3	
30	0.0		29.6	0.0	0.0	1.8	0.3	3.3	0.2	0.0	0.0	0.9	
31	0.0		5.6		2.0		2.1	4.6		0.0		12.2	
Total	118.9	100.8	145.8	126.5	56.7	103.2	164.9	35.8	112.8	233.9	118.6	149.7	1,467.6

(2) Yearly rainfall days

Months	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Remarks
	14	16	16	10	11	10	18	9	13	21	6	14	158

Source: Meteorological department, Ministry of environment protection and natural resources

### (3) Water Level of Rioni River

#### Water Level

According to local people in the study area, the highest water stage in normal seasons is in April to May, due to snow melt, and the lowest is January to February. According to information from local residents, annual high water level at ferry terminal in upper stream is about E.L 25 m, while water level during the survey period was E.L. 21 m.

#### Design High Water Level of Railway Bridge

Regarding the design high water level for the study area, a design water level for the Railway Bridge located downstream of the Rioni River was obtained. According to the designer of the bridge, the Design High Water Level is E.L. 18.66 m for 300-year return period scale, and E.L. 16.70 m for 100-year return period scale (refer to Appendix A1).

#### Maximum High Water Level by Observation

The flood markings at the piers of the railway bridge indicated by railway staff is E.L. 16.45 m and is considered relatively low compared with the design high water level (refer to Appendix A2).



#### (4) Discharge Record of Rioni River

Discharge data was obtained from the local construction firm. Based on the data, a 300-year return period of design discharge 5,418 m<sup>3</sup>/s was adopted for the Railway Bridge, while discharge for a 100-year return period is mentioned to be 3,214 m<sup>3</sup>/s. According to Mr. Baadur Ukleba, a prominent hydrologist in Georgia, a reliable gauging station is located at Sakochakidze which is 52 km down stream from the railway bridge. The discharge observation by means of river section and flow velocity was carried out intermittently from 1928 to 1987. The data is shown in Table 3.2.3.

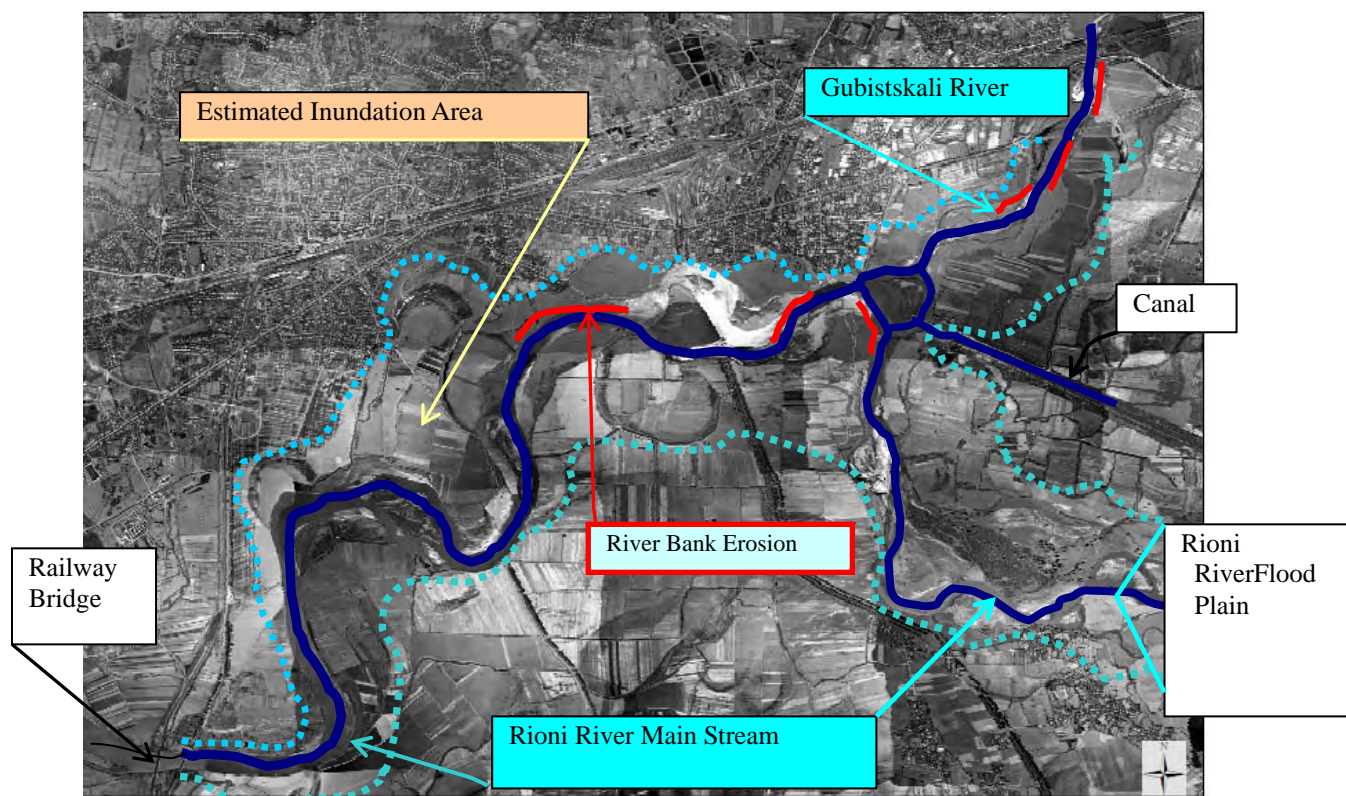
**Table 3.2.3 Flow Rate at Sakochakidze Hydrological Station**

			(F=13,300 km <sup>2</sup> )		
#	Years	Q m <sup>3</sup> /sc	#	Years	Q m <sup>3</sup> /sc
1	1928	1,020	31	1961	2,030
2	1929	952	32	1962	2,520
3	1930	1,130	33	1963	3,000
4	1931	1,200	34	1964	1,850
5	1932	1,070	35	1965	1,290
6	1933	1,210	36	1966	2,330
7	1934	1,200	37	1967	2,250
8	1935	1,160	38	1968	2,280
9	1936	1,040	39	1969	1,310
10	1937	1,140	40	1970	2,240
11	1938	1,310	41	1971	1,650
12	1939	1,520	42	1972	1,480
13	1940	1,670	43	1973	1,440
14	1941	1,920	44	1974	2,280
15	1942	1,190	45	1975	1,780
16	1943	979	46	1976	2,830
17	1947	1,400	47	1977	3,520
18	1948	1,150	48	1978	3,510
19	1949	1,250	49	1979	2,260
20	1950	1,930	50	1980	2,720
21	1951	1,740	51	1981	3,330
22	1952	1,520	52	1982	4,650
23	1953	1,790	53	1983	2,670
24	1954	1,490	54	1984	2,040
25	1955	1,530	55	1985	1,590
26	1956	2,850	56	1986	1,590
27	1957	1,720	57	1987	4,850
28	1958	2,280	Total		109,661
29	1959	1,820	Average		1,924
30	1960	2,190			

Source: Hydrologist of Georgia, Mr Baadur Ukleba

#### (5) Condition of Rioni River

The Rioni River is the second largest river in the country after the Kura river. The total river length is 327 km with a catchment area of 13,400 km<sup>2</sup>. The river originates at Pash Mountain (MSL 2,620 m), the watershed of the Caucasus mountains and flows down north west, joins its main tributary (Kvirila) and flows to the Kolkheta lowland and reaches the Black Sea near by the town Poti. The river is fed by glaciers, snow, rain and groundwater, and characterized as having spring floods. Its water resources are mainly utilized for power generation and irrigation purposes. A dam for a power plant was constructed at the confluence of Kvirila River in 1977 and a canal joins at the Rioni river at the confluence with the Gubistskali River. The condition of the river course is shown in Figure 3.2.2



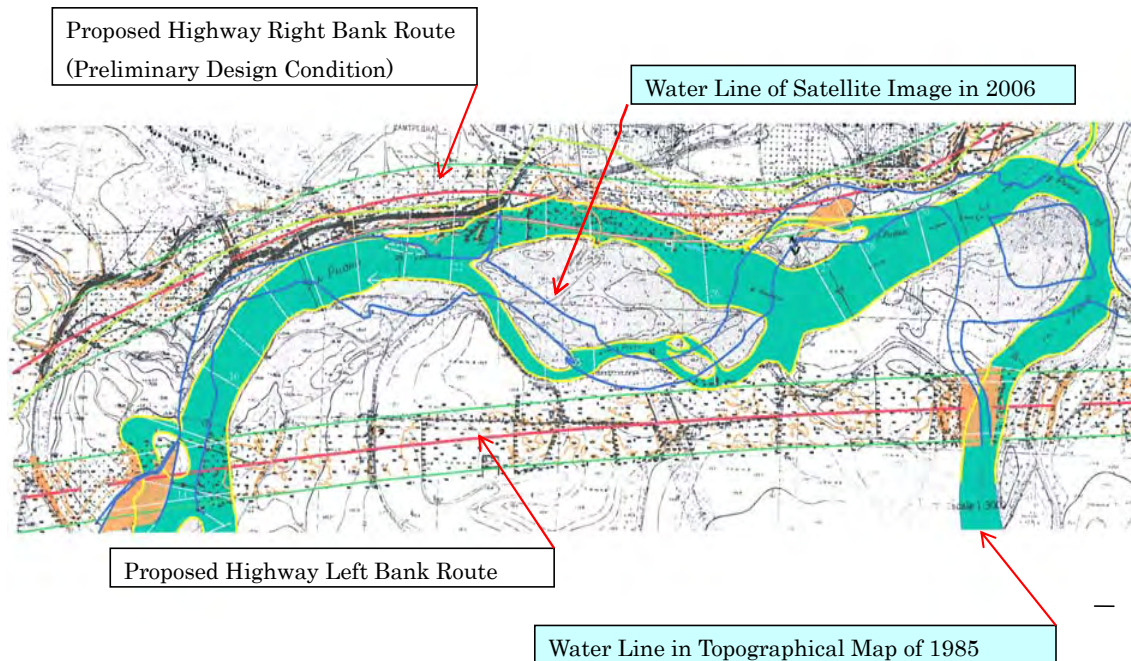
Source: JICA survey team

**Figure 3.2.2 Rioni River Condition and Inundation Area**

#### Change of River Course

The part of the Rioni River in the study area is located in a flat plain area with an altitude of 20m and flows with a 0.125% riverbed slope. The left bank area is situated as a floodplain area with many traces of old river courses. Accordingly it is judged that the river course has a considerable tendency to meander. Based on the topographic map prepared in 1958 and satellite images in 2006, it is found that the erosion and meandering to the right bank has progressed considerably (refer to Figure 3.2.3).





Source: JICA survey team

**Figure 3.2.3 Change of the Rioni River Course**

### Inundation

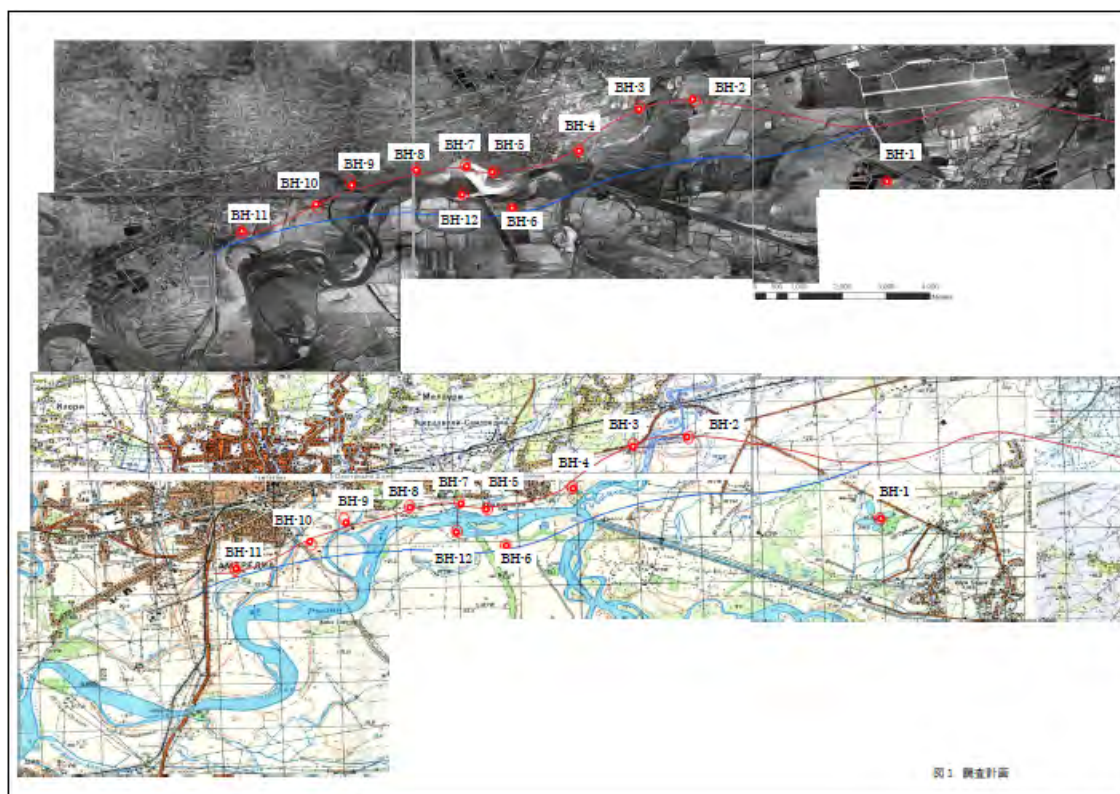
The average river width of the Rioni River varies from 150 m to 200 m in the study area. The water level changes from 17 m to 22 m of mean sea level from the winter to spring. During times of flooding caused by snow melt and rainfall, a part of the agricultural area in the left bank is submerged under the flow water. About 350 m<sup>3</sup>/s of discharge water from the canal for the power plant flow into the Rioni River throughout the year. The inundation area based on the site information is shown in Figure 3.2.2

### Characteristics of River Course

In order to understand the characteristics of the river and riverbed materials, river cross sections and site investigations were carried out. The river course was characterized using the “river course category by segment” method as follows:

- Longitudinal Profile: Segment 2 (Riverbed slope 1/400 to 1/5,000)
- Topographic feature: plain in a valley
- Riverbed material: D<sub>60</sub> = 20–35 mm
- Riverbank materials: alternate layer of gravel and silt with sand
- Meandering: meandering is great and sandbars are found in wider river sections
- Bank erosion: erosion of the right bank dominates
- Average water depth: varies from 4 to 6 m

The locations of geological survey and grain size analysis are shown in Figure 3.2.4 and Table 3.2.4.



Source: JICA survey team

**Figure 3.2.4 Location of Geological Survey**

Table 3.2.4 Riverbed Material

Ref. No.  Elevation	Depth  (m)		Physical Characteristics				Remarks	
			N value	Layer	Specific Gravity $\rho_s$ (g/cm <sup>3</sup> )	Unit Weight		D <sub>60</sub> (mm)
A. Gubistskali River								
BH-02								
	1.10	1.50	3	Ac	2.670			
	3.50	5.50	37	Ag		22.5000		
	7.00	9.00	45	Dg-1	2.690	1.970	25.5000	Riverbed Layer
	18.00	20.00	50	Dg-2			31.0000	
	21.00	22.00	50	Dg-2	2.610	2.020		
BH-03								
	2.00	3.00	35	Ag	2.680			
	4.00	5.00	19	Ag			25.0000	
	6.00	7.00	21	Ag	2.620	1.980	27.5000	Riverbed Layer
	9.00	10.00	26	Ag	2.650	2.000		
	13.00	14.00	37	Dg-1			41.0000	
	14.25	14.45	37	Dg-1				
	15.00	17.00	50	Dg-2			36.0000	
B. Rioni River								
BH-05	1.30	1.60	5	Ac	2.680			
	4.00	6.00	50	Dg-1	2.590			
	4.50	5.60	50	Dg-1		1.950	10.0000	
	8.20	9.70	50	Dg-2			20.0000	Riverbed Layer
	11.00	12.00	50	Dg-2	2.660	2.010		
	12.00	13.00	50	Dg-2			25.0000	
BH-06								
	1.50	2.00	7	Ac				
	6.00	8.00	39	Dg-1			35.5000	Riverbed Layer
	10.00	12.00	49	Dg-1	2.650	1.970	14.0000	
	13.00	14.00	50	Dg-2	2.620	2.030		
	16.00	17.00	50	Dg-2			36.0000	
BH-07								
	0.70	1.00	15	Ac,Ag	2.730		0.0038	
	1.50	2.00	16	Ag	2.600	1.970	30.0000	
	4.00	5.00	21	Ag			30.0000	Riverbed Layer
	7.00	8.00	28	Ag	2.590	1.960		
	9.00	10.00	31	Dg-1			11.0000	
	11.50	12.80	39	Dg-1		1.960		
BH-08								
	0.80	1.00	3	Ac	2.690	1.850	0.0087	
	1.30	1.50	5	Ac	2.730	1.820		
	4.00	5.00	36	Ag	2.640	1.990	28.0000	Riverbed Layer
	8.10	8.70	30	Dg-1	2.660	2.000		
	10.00	11.00	50	Dg-2	2.660		11.5000	
	13.00	14.00	50	Dg-2	2.660	1.990		

Source: JICA survey team

Major River Structures

An earth dike located on the right bank was constructed to protect the Samtredia city and the agricultural area in 1980s. However the dike was partly destroyed and now it is not expected to function entirely effectively. Recently the gas pipe line was damaged significantly due to the erosion of the river. As a countermeasure, stone revetments were constructed to protect replaced gas pipe lines. There are two ferry facilities for transportation of people and agriculture products from Samtredia to the villages located at the left bank. There are many small drainage flows into the Rioni River in the study area as well.

#### (6) Water Level and Discharge Data of Gubistskali River

There were no observation activities on water level and discharge. No reliable information on highest water level was obtained during site investigation. Based on hydraulic analysis by Mr. Baadur, the estimated discharges for 300 and 100 year return periods are 675 m<sup>3</sup>/s and 555 m<sup>3</sup>/s respectively.

#### (7) Characteristics of Gubistskali River

Gubistskali River is one of the tributaries of the Rioni river and is characterized as a mountain river having a length of 36km and a catchment area of 442 km<sup>2</sup>. The river joins the Rioni at the eastern part of Samtredia and the riverbed slope in the lower section is about 1/360.

##### River Course Change

There is one railway bridge and two road bridges in the lower reach of Gubistskali River. The river course is restricted by those structures and no significant meandering has occurred. However, local bank erosion on the left bank of the old road bridge and right bank of the gas pipe river crossing structures have progressed (refer to Figure 3.2.2).

##### Inundation Area

The low water river channel varies from 100 m to 150 m. However the water surface width in the winter season is only 20m to 30m and the water depth is measured at only about 1m. There is an earth dike in the lower reach of the railway bridge, but the dike has no function due to damage. As such, some inundation is expected in the protected inland area. The inundation area based on site survey is shown in Figure 3.2.2.

##### Characteristics of River Course

In order to understand the characteristics of the river and riverbed materials, river cross sections and site investigations were carried out. The river course was characterized, in referring to “river course category by segment” method as follows:

- Longitudinal Profile: Segment 1 (Riverbed slope 1/60 to 1/400)
- Topographic feature: alluvial fan
- Riverbed material: D60 = 26 mm
- Riverbank materials: alternate layer of gravel and silt with sand
- Meandering: meandering is in lower river section from railway bridge
- Bank erosion: erosion at lower section of bridge and gas pipe line
- Average low water depth: varies from 1 to 2 m

The locations of the geological survey and grain size analysis are shown in Figure 3.2.4 and Table 3.2.4.

##### Major River Structures

There is a railway bridge, road bridge and gas pipe line, and no other big structures are found in the section.

##### Regulations/Codes on the River

There were some technical standards for river structures under the USSR, however nowadays, no strict observation on the standards is said to exist. The government is taking the standpoint to apply any foreign standards if it is reasonable. For the design of the river structures, uniform technical standards do not exist.

There is a Water Code which aims to protect water resources and the environment. In the water code river areas are not clearly defined, however it is requested to explain any activities on the river to the concerned committee. The concerned articles on river improvement 18, 19 and 20 are shown in Appendix A3.

### 3.3 Geological Investigation

#### 3.3.1 Geological Investigation Plan

##### (1) Location and Quantities of Investigation

Geological investigations were carried out in the areas of the right and left bank of the Rioni River near Samtredia along the planned highway route. A location map of the investigations area is shown in Figure 3.3.1. Items and quantities of the investigations are described in Table 3.3.1.

**Table 3.3.1 Items and Quantities of Investigation**

<b>Items and Quantities of Geological Investigation</b>		
Standard Penetration Test	12 points	142 nos
Laboratory Test		
Grain Size Analysis		40 samples
Unit Weight		40 samples
Dry Density		45 samples
Natural Water Content		43 samples

Source: JICA survey team



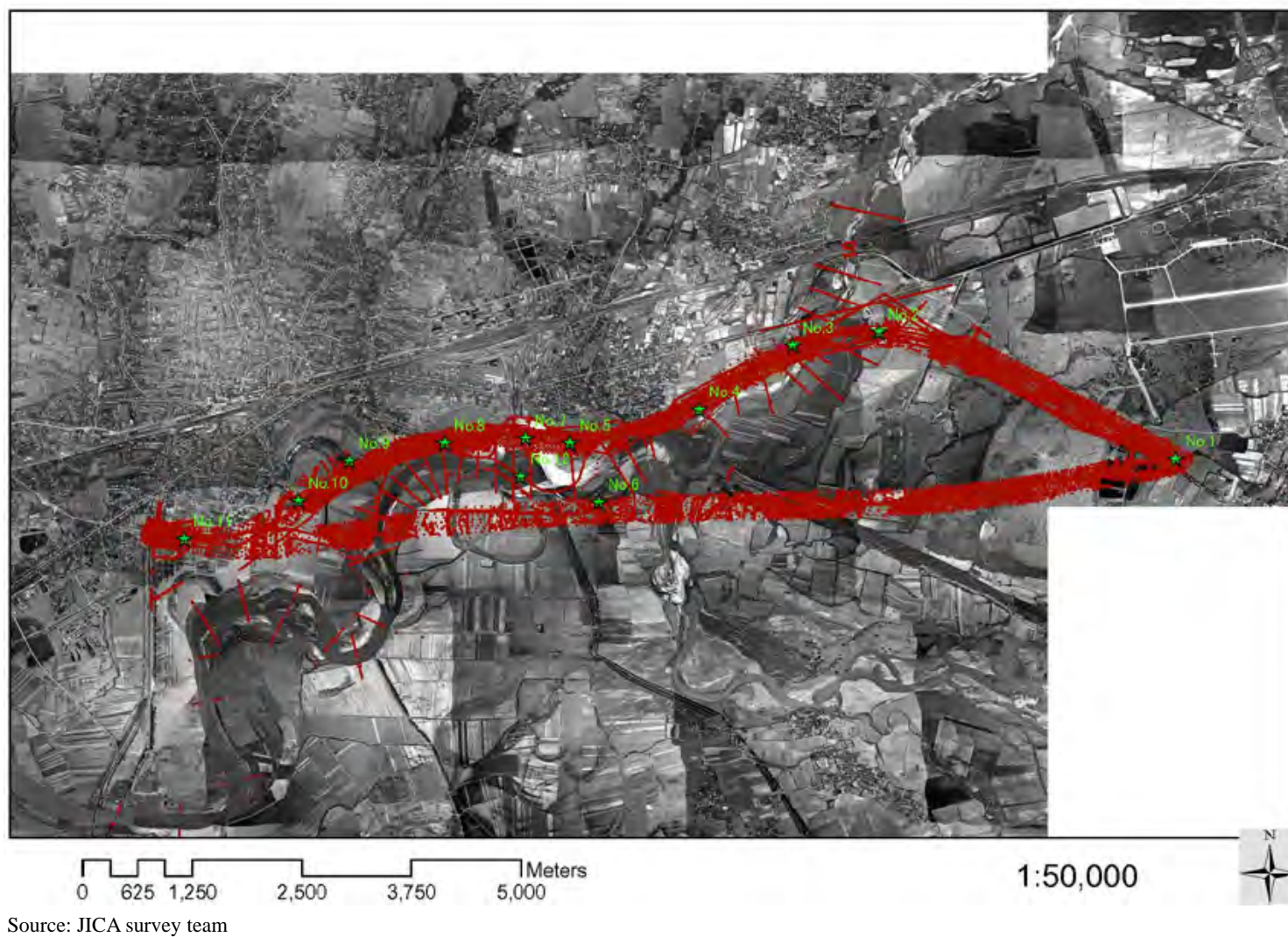


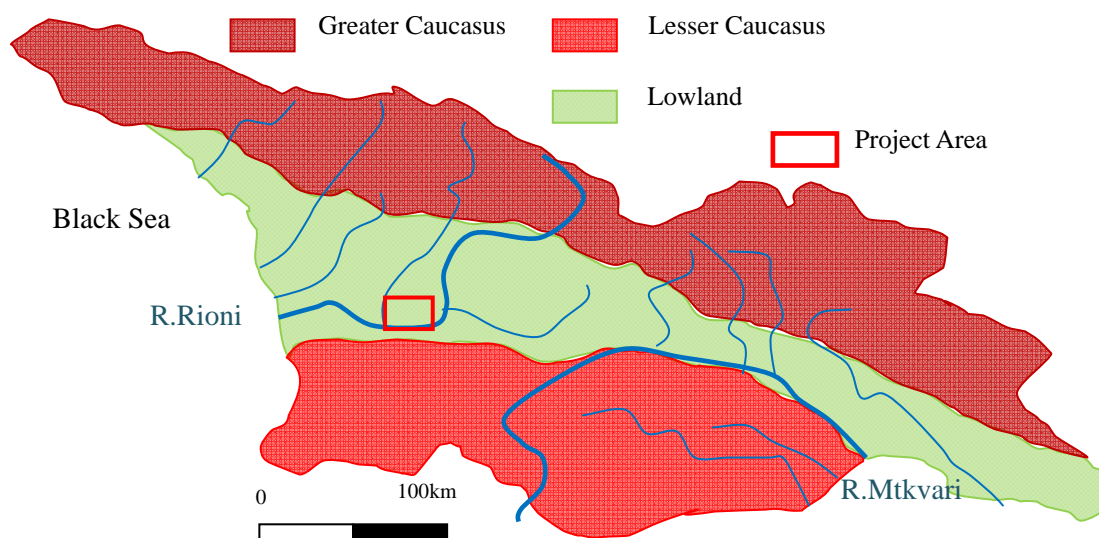
Figure 3.3.1 Location Map of Geological Investigations

## (2) Topography and Geology

Georgia is located in the region between the Greater and Lesser Caucasus Mountains running west to east and the depression (lowland) is between the two mountain ranges. Caucasus is a mountainous region stretching along the borders of several countries, including Georgia. The mountainous and high land of the Greater and Lesser Caucasus expand in the region between the Black Sea and the Caspian Sea.

Around 25,000 rivers drain into the Black Sea and the Caspian Sea (through Azerbaijan). The rivers form the hydrographical network and a large amount of sediment is transported from mountains to lowland areas by the rivers. The Mtkvari River, formerly known as the Kura River, flows from northeast Turkey across the plains of Eastern Georgia, through Tbilisi, and into the Caspian Sea. The Rioni River, the largest river in Western Georgia, originates in the Greater Caucasus and empties into the Black Sea at the port of Poti.

The project area of Samtredia city is located in Western Georgia and the Rioni River flows in the southern part of the city. The Rioni river originates from the Greater Caucasus and runs along a narrow and rather deep canyon which in the upstream has a high gradient. It changes its river-bed gradient and becomes gentler and enters into flat lowland near Kutaisi. The Rioni River meanders in the flat lowland near Samtredia, which is located on the plain running east to west in the Western part of the country (See Figure 3.3.2). The Rioni River, with a total length of 327 km, which originates from the North Caucasus plateau, flows from east to west in the project area. Samtredia is situated around 100 km upstream from the river-mouth and its elevation ranges from 20 to 50 m in general.



Source: JICA survey team

**Figure 3.3.2 Topography of Georgia and Project Area**

The region of Greater Caucasus is mainly dominated by Early to Middle Jurassic slates, which are part of the continental margin from late Palaeozoic to Jurassic. The slates were subsequently intruded by Middle to Late Jurassic and Neogene granitoids respectively. Quartz veins in the more carbonaceous slate units are most consistently enriched and show mineralization of most consistent with typical orogenic deposits.

The Lesser Caucasus Mountains on the other hand, are largely of volcanic origin. The Javakheti Volcanic Plateau in Georgia and the surrounding volcanic ranges (which extend well into central Armenia) are some of the youngest features of the region.

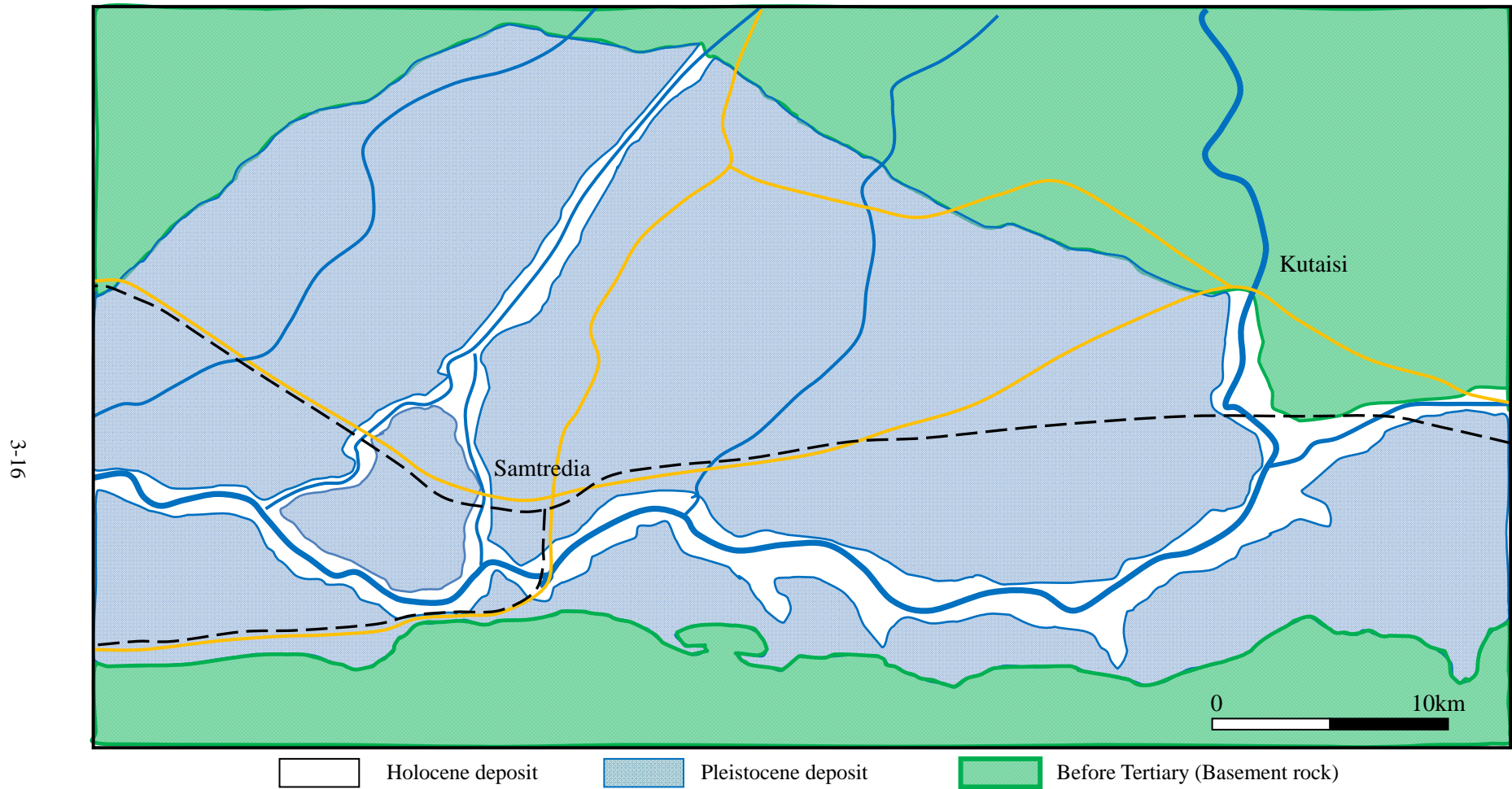
Cenozoic formation including Holocene (Alluvium) and Pleistocene (Diluvium) deposits are widely distributed in the plain along the Rioni River, and they are underlain by sedimentary rocks of the Mesozoic era. The hills and terrains, which are distributed in the area between Poti and Samtredia, consist mainly of Mesozoic sedimentary rocks. The regional geology of Southern West of Georgia is shown in Figure 3.3.3 The stratigraphy of the geological map of Figure 3.3.3 is described as below Table 3.3.2.

**Table 3.3.2 Stratigraphy around Project Area**

Era (Ma)		Period		Rocks & Deposits	Distribution
Cenozoic	1.75	Quaternary	Holocene	Bolder, gravel, sand, silt, clay. Loose and non-consolidated in general.	Mainly along present rivers
			Pleitocene	Bolder & Gravel in consolidated sandy & clayey matrix. Consolidated in general.	Almost entire project area
		Tertiary	Neogene	Sandstone, Marl, Mudstone, Conglomerate, and Limestone at some localities.	In south & north of project area.
			Paleogene	Limestone, Marls intercalated with sandstone and conglomerates	Mainly in north of project area.
Mesozoic	65	Cretaceous	Late	Reddish and yellowish Tuff, Tuffbreccia, Tuffaceous sandstone, Sandstone, Limestone	Mesozoic formations are mainly confirmed in the north of project area.
			Early	Limestone, Dolomite.	
	Jurassic	Late			
		Middle	Porphyrites, Tuff, Tuffbreccia, Tuffaceous sandstone, Sandstone.		
		Early	Crystal complex		
	203	Triassic		Jurassic formation is assumed to be oldest in the area.	

Source: JICA survey team





Source: JICA survey team

**Figure 3.3.3 Geological Map around Project Area**

### 3.3.2 Results of Investigation

#### (1) Standard Penetration Test

The test is conducted inside a borehole. A ‘split spoon’ sampler is attached to the bottom of a core barrel and lowered into position at the bottom of the borehole. The sampler is driven into the ground by a drop hammer weighing 63.5 kg falling from a height of 75 cm. The number of hammer blows is counted. The number of the blows required to drive the sampler three successive 300mm increments is recorded.

The Standard Penetration Test aims to determine the SPT N value, which gives an indication of the soil stiffness and can be empirically related to many engineering properties.

N value defined on the basis of the number of hammer blows is often considered to be a subject to modification when the depth of the test section exceeds a certain depth of 20 m below ground surface (e.g. N value of 29 is calculated after modification when N value of 30 is recorded in the section of 30 m below the ground surface.) However, little modification is made due to the site conditions of this study area. The number of hammer blows of more than 30 (N value of over 30) was generally recorded in sections of more than 30 m below the ground surface, and blows of more than 50 (N value of over 50) were recorded immediately below that depth. A lower number of hammer blows seems to be recorded due to the existence of thick sedimentation in the bottom of the drill holes caused by the sandy geological condition of the area. The difference between the recorded hammer blows and modified number of blows appears to be negligible considering these conditions. N value estimated on the basis of recorded hammer blows is applied in this report.

**Table 3.3.3 Result of Standard Penetration Test**

Bore Holes	SPT	N values		
	(times)	Minimum	Maximum	Mean
BH-1	10	8	>50	36.7
BH-2	16	3	>50	41.0
BH-3	17	8	>50	30.5
BH-4	12	16	>50	30.3
BH-5	12	5	>50	37.3
BH-6	14	7	>50	40.9
BH-7	12	15	>50	28.0
BH-8	12	3	>50	32.8
BH-9	13	7	>50	28.2
BH-10	13	7	>50	26.3
BH-11	9	5	7	5.8
BH-12	–	–	–	–
Total	142	–	–	–

\* Mean N value is calculated when maximum N value of 50.

Source: JICA survey team

#### (2) Laboratory Test

Laboratory tests of the following items were performed in this study.

Grain size analysis	40 samples
Unit weight	40 samples
Specific gravity	45 samples
Natural water content	43 samples

In the course of laboratory tests, experiments are generally executed three times for one sample to ensure the test result. The entirety of the recorded data, including additional tests, was utilized for statistical analysis. The detailed data of each item are summarized and shown in Table 3.3.9.

### Grain Size Analysis

Grain-size analysis, also known as particle-size analysis or granulometric analysis, is the most basic technique to characterize sediments. Grain-size measurements were carried out by means of the classical sieve-pipette technique. The grain-size distributions are generally shown as a cumulative frequency curve. The results of grain size analysis were utilized in classification of soils and detailed data are shown in Table 3.3.9.

### Unit Weight

The unit weight of samples is measured during the course of laboratory tests. Data obtained as a result of laboratory tests are summarized in Table 3.3.4. Unit weights of soils of different classification are generally said to be as shown in Table 3.3.5. As shown in Table 3.3.5, smaller unit weights show less consolidated status in general.

In the result of the tests, the unit weights of some samples shows such a low value that humus rich soil is likely to exist in the study area.

**Table 3.3.4 Data of Unit Weight**

Unit weight (kN/m <sup>2</sup> )	
Minimum Value	18.20
Maximum Value	20.50
Average Value	18.68
Number of Data Items	40

Source: JICA survey team

**Table 3.3.5 Typical Unit Weight of Soils**

Soil Type		Unit Weight $\gamma_t$ (kN/m <sup>2</sup> )
Alluvium	Clay	12–18
	Sand	16–20
Diluvium	Clay	16–20
Humus (rich) soil		8–13

Source: JICA survey team

### Specific Gravity

The Specific Gravity is a dimensionless unit defined as the ratio of density of the material to the density of water at a specified temperature. Since specific gravity can be changed depending on the temperature of the material, temperature should be kept unchanged during the testing.

The specific gravity of the samples is shown in Table 3.3.6.

**Table 3.3.6 Data of Specific Gravity**

Specific Gravity (g/cm <sup>3</sup> )	
Minimum Value	2.590
Maximum Value	2.740
Mean Value	2.662
Number of Data Items	45

Source: JICA survey team

### Natural Water Content

Natural water content of soil is estimated as the ratio of water quantity to the specific gravity of the soil at the temperature of 110°C (degrees centigrade). The natural water content indicates the shear strength, plasticity and grain size distribution of soils. The natural water content of the

samples are shown in Table 3.3.7 and the typical values of natural water contents of soils are generally said to be as mentioned in Table 3.3.8.

**Table 3.3.7 Data of Natural Water Content**

Natural Water Content (%)	
Minimum Value	0.900
Maximum Value	45.00
Average Value	14.82
Number of Data Items	45

Source: JICA survey team

**Table 3.3.8 Typical Natural Water Content of Soils**

Soil Type		Natural Water Content w (%)
Alluvium	Clay	30–150
	Sand	10–30
Diluvium	Clay	20–40
Humus (rich) soil		80–200

Source: JICA survey team

Table 3.3.9 Results of Laboratory Tests

Borehole No	Depth		N value	Layer	Specific	Unit	Water	Grain Size Analysis					
					Gravity $\rho_s$	Weight $(\text{Mg}/\text{m}^3)$	Content $W_n$	$D_{10}$	$D_{30}$	$D_{50}$	$D_{60}$	Uc $(D_{60}/D_{10})$	U'c $(D_{60} \times D_{30}) / (D_{10} \times D_{50})$
	(m)	( $\text{Mg}/\text{m}^3$ )			( $\text{Mg}/\text{m}^3$ )	(%)							
BH-01	0.40	- 0.60	8	Ac	2.740	1.840	29.60	-	-	0.00	0.00		
	2.70	- 3.00	25	Ag	2.630	1.990		0.30	10.00	23.00	30.00	100.00	11.11
	4.00	- 5.00	32	Dg-1			3.80						
	6.00	- 7.00	50	Dg-2			4.40	0.40	17.00	30.00	33.50	83.75	21.57
	8.00	- 9.00	50	Dg-2	2.640	2.000							
BH-02	1.10	- 1.50	3	Ac	2.670		22.60						
	3.50	- 5.50	37	Ag				0.17	2.15	17.00	22.50	132.35	1.21
	7.00	- 9.00	45	Dg-1	2.690	1.970	6.20	0.16	6.00	18.50	25.50	159.38	8.82
	18.00	- 20.00	50	Dg-2			6.50	0.40	10.00	22.00	31.00	77.50	8.06
	21.00	- 22.00	50	Dg-2	2.610	2.020							
BH-03	2.00	- 3.00	35	Ag	2.680		2.40						
	4.00	- 5.00	19	Ag			5.80	0.30	9.30	18.00	25.00	83.33	11.53
	6.00	- 7.00	21	Ag	2.620	1.980	5.40	0.25	6.80	20.00	27.50	110.00	6.73
	9.00	- 10.00	26	Ag	2.650	2.000							
	13.00	- 14.00	37	Dg-1				1.40	14.00	31.00	41.00	29.29	3.41
BH-04	14.25	- 14.45	37	Dg-1			20.70						
	15.00	- 17.00	50	Dg-2				0.16	13.00	28.00	36.00	225.00	29.34
	1.40	- 1.70	26	Ag	2.680	1.970	4.40						
	2.30	- 3.00	21	Ag	2.630	1.990	4.50	0.30	8.00	20.00	27.50	91.67	7.76
	3.50	- 4.00	20	Ag	2.650	2.010	6.00	0.22	7.00	18.00	23.00	104.55	9.68
BH-05	6.70	- 7.00	32	Ag	2.650	2.050							
	8.20	- 9.00	32	Dg-1			5.20	0.06	0.60	10.00	16.00	266.67	0.38
	10.60	- 11.00	36	Dg-1	2.650	2.010							
	12.20	- 13.00	50	Dg-2			4.40	0.30	13.00	23.00	31.00	103.33	18.17
	1.30	- 1.60	5	Ac	2.680		19.40						
BH-06	4.00	- 6.00	50	Ag	2.590		4.90						
	4.50	- 5.60	50	Ag		1.950		0.07	0.52	4.20	10.00	151.52	0.41
	8.20	- 9.70	50	Dg-2			4.70	0.20	4.00	15.50	20.00	100.00	4.00
	11.00	- 12.00	50	Dg-2	2.660	2.010							
	12.00	- 13.00	50	Dg-2				0.21	6.20	19.00	25.00	119.05	7.32
BH-07	1.50	- 2.00	7	Ac			25.20						
	6.00	- 8.00	39	Dg-1				0.40	15.50	30.00	35.50	88.75	16.92
	10.00	- 12.00	49	Dg-1	2.650	1.970	4.00	0.01	0.60	7.00	14.00	2800.00	5.14
	13.00	- 14.00	50	Dg-2	2.620	2.030							
	16.00	- 17.00	50	Dg-2				0.30	11.50	26.50	36.00	120.00	12.25
BH-08	0.70	- 1.00	15	Ac, Ag	2.730		25.80	-	0.00	0.00	0.00		
	1.50	- 2.00	16	Ag	2.600	1.970		0.18	1.65	20.00	30.00	166.67	0.50
	4.00	- 5.00	21	Ag			6.10	0.80	15.00	22.00	30.00	37.50	9.38
	7.00	- 8.00	28	Ag	2.590	1.960							
	9.00	- 10.00	31	Dg-1			6.70	0.08	0.60	6.00	11.00	146.67	0.44
BH-09	11.50	- 12.80	39	Dg-1		1.960							
	0.80	- 1.00	3	Ac	2.690	1.850	32.70	-	0.00	0.01	0.01		
	1.30	- 1.50	5	Ac	2.730	1.820	45.00						
	4.00	- 5.00	36	Ag	2.640	1.990	5.60	0.22	2.10	16.00	28.00	127.27	0.72
	8.10	- 8.70	30	Dg-1	2.660	2.000							
BH-10	10.00	- 11.00	50	Dg-2	2.660			0.00	0.42	5.90	11.50	2875.00	3.83
	13.00	- 14.00	50	Dg-2	2.660	1.990	4.00						
	0.70	- 1.00	7	Ac		1.830	23.20						
	3.30	- 3.60	8	As	2.730			0.00	0.04	0.05	0.06	26.09	13.40
	5.00	- 5.80	27	Ag			12.20						
BH-11	7.00	- 8.00	28	Ag			5.00	0.08	0.60	12.50	21.00	262.50	0.21
	10.20	- 10.50	50	Dg-1	2.600	2.000							
	12.00	- 13.00	37	Dg-1			6.80	0.06	1.20	17.50	38.00	633.33	0.63
	14.20	- 15.00	49	Dg-1	2.640	2.010							
	1.80	- 2.00	7	As		1.880	31.10	-	0.00	0.00	0.00		
BH-12	2.80	- 3.00	7	Ac	2.680	1.970	28.10	0.00	0.00	0.04	0.05	25.00	0.18
	4.50	- 4.80	23	Ds	2.690	1.900	27.70	0.00	0.05	0.07	0.09	24.44	7.89
	5.30	- 5.50	36	Ds	2.690	1.970	26.50						
	8.00	- 9.00	44	Dg-1	2.600	1.980	12.10						
	10.00	- 10.50	25	Dg-1	2.600	2.010	16.20						
BH-13	12.00	- 13.00	37	Dg-1	2.670			0.00	0.22	5.00	11.00	3055.56	1.22
	14.00	- 14.50	50	Dg-2	2.600	1.970							
	1.60	- 2.00	7	Ac	2.730	1.920	34.40	-	0.00	0.00	0.00		
	2.00	- 2.60	7	Ac	2.670	1.960							
	5.80	- 6.00	5	As	2.730	1.990	33.50	-	0.00	0.00	0.00		
BH-14	9.50	- 10.00	5	As	2.720		30.90	-	0.00	0.00	0.00		
	1.50	- 1.80		Ac	2.740		23.70	0.00	0.01	0.02	0.04	14.81	0.42
	2.50	- 3.50		Ag	2.670			0.00	0.01	9.00	13.00	3250.00	0.00
	4.50	- 6.00		Ag		2.030	0.90						
	7.00	- 8.50		Dg-1	2.670	1.980		0.07	0.52	1.20	5.00	76.92	0.83
BH-15	9.30	- 10.00		Dg-1	2.670	1.990	9.00						

Source: JICA survey team

### 3.3.3 Engineering Study of Geology

#### (1) Geological Condition

Geological investigation has been carried out on the right and left banks of the Rioni River along the planned highway route in Samtredia. The quantities of each investigation item and location map of the investigations are shown in Table 3.3.1 and Figure 3.3.1 respectively. The geology of the project area is mainly divided into three formations: Holocene deposits (Alluvium), Pleistocene deposits (Divilium) and bedrock. Each formation is analyzed in Table 3.3.10.

**Table 3.3.10 Result of Geological Investigation**

Period	Epoch	Geology		Engineering Geology		
		Description	Classified	Description	Suitability for foundation	N value
Quaternary	Pliocene	Loose sand & gravel layer with some contents of silt and clay. Mainly present river deposits.	Clayey sand rich layer (As)	Soft and loose with high water content	Not suitable for foundation of structures except embankment in general. Foundation treatment probably required.	Less than 10
			Sand & gravel layer (Asg)	Loose in general, Not only gravel but boulders observed at some localities.		Less than 30
	Pleistocene	Consolidated and relatively consolidated soil consisting of gravel, sand, silt and clay.	Sand & gravel layer (Dsg-1)	Relatively consolidated.	Suitable for any structures except large structures like dams. Detailed study required for large structures.	More than 30
			Consolidated sand & gravel layer (Dsg-2)	Consolidated in general.		More than 50
Unknown		Bedrock appears to be Cenozoic or Mesozoic sedimentary rocks.	Bedrock	Hard & compact in fresh condition. Top portion seems to be weathered.	Suitable for any structures.	More than 50

Source: JICA survey team

The geological profile of the area is shown in Figure 3.3.4. The distribution of physical values including N values assumed on the basis of the standard penetration test is shown in Figure 3.3.5.

#### Holocene Deposits

This formation consisting mainly of sand and gravel supplied from the present Rioni River is soft and loose. As such, the improvement of its mechanical strength may be required if it is used as the foundation of structures. Drawing down of the groundwater level can be proposed for improvement of the mechanical strength of the layer. Holocene deposits are divided into two types, which are the sandy layer (As) and sand & gravel layer (Asg). However, thin layers of clay, as well as silt are seen in the sandy layer (As), and clay-like layers are locally distributed in the sand & gravel layer (Asg).

#### Pleistocene Deposits

This formation is composed mainly of gravel, sand and clay, is relatively consolidated and seems to be formed of horizontal layers of deposits. This formation seems to have sufficient strength for the foundations of any structures except large scale structures such as dams and the main piers of large scale bridges. This formation is underlain by basement rock, and in most cases it can serve as the foundation of the road. Pleistocene deposits are also classified into two

types: relatively consolidated sand & gravel layers (Dsg-1) and consolidated sand & gravel layers (Dsg-2).

#### *Bed Rock*

Bed rock is composed of Cenozoic to Mesozoic sedimentary rocks and it is overlain by Holocene and Pleistocene deposits. This formation is very stable and is suitable as the foundation of any structures.

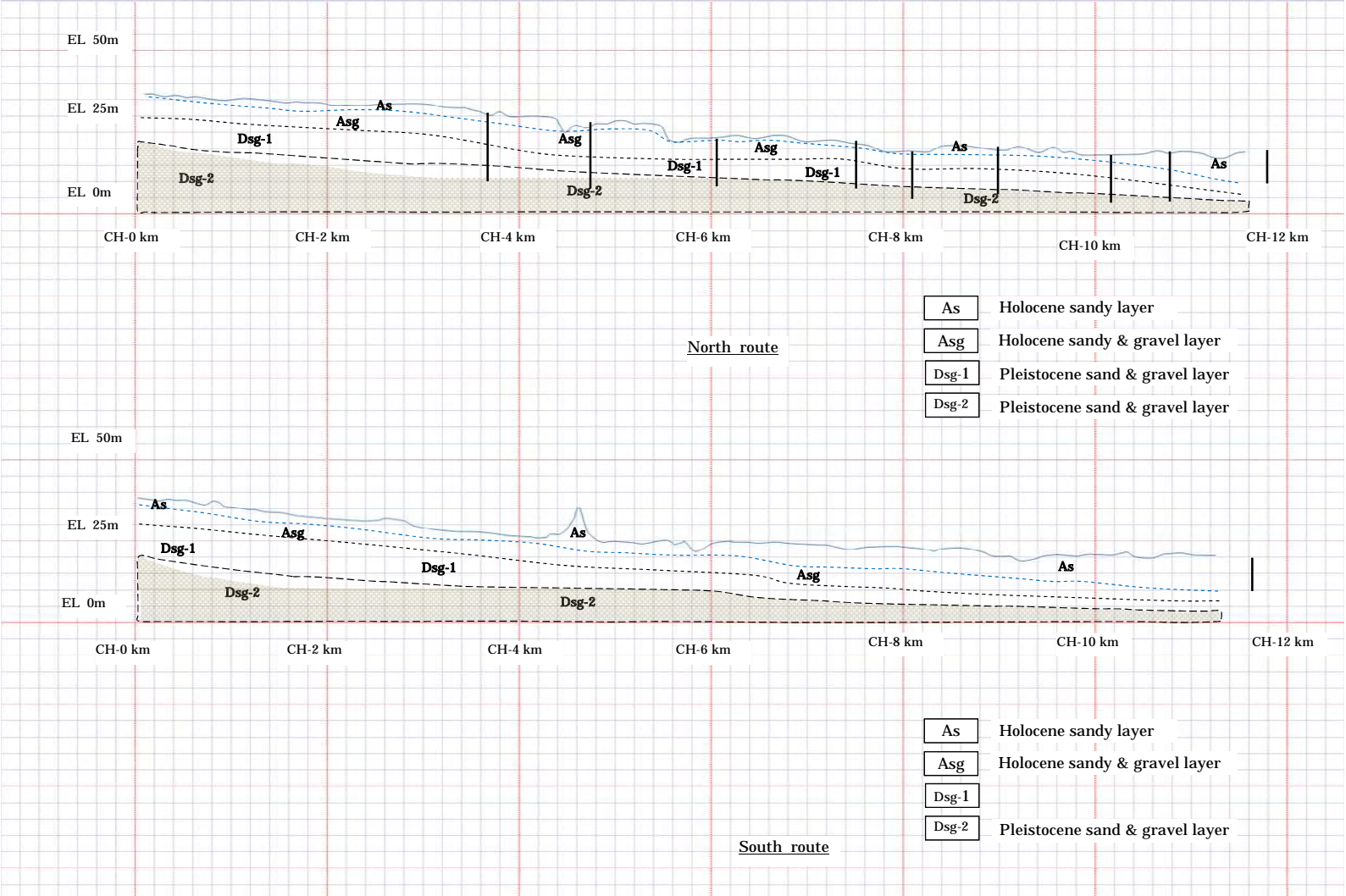


Figure 3.3.4 Geological Profiles in Project Area



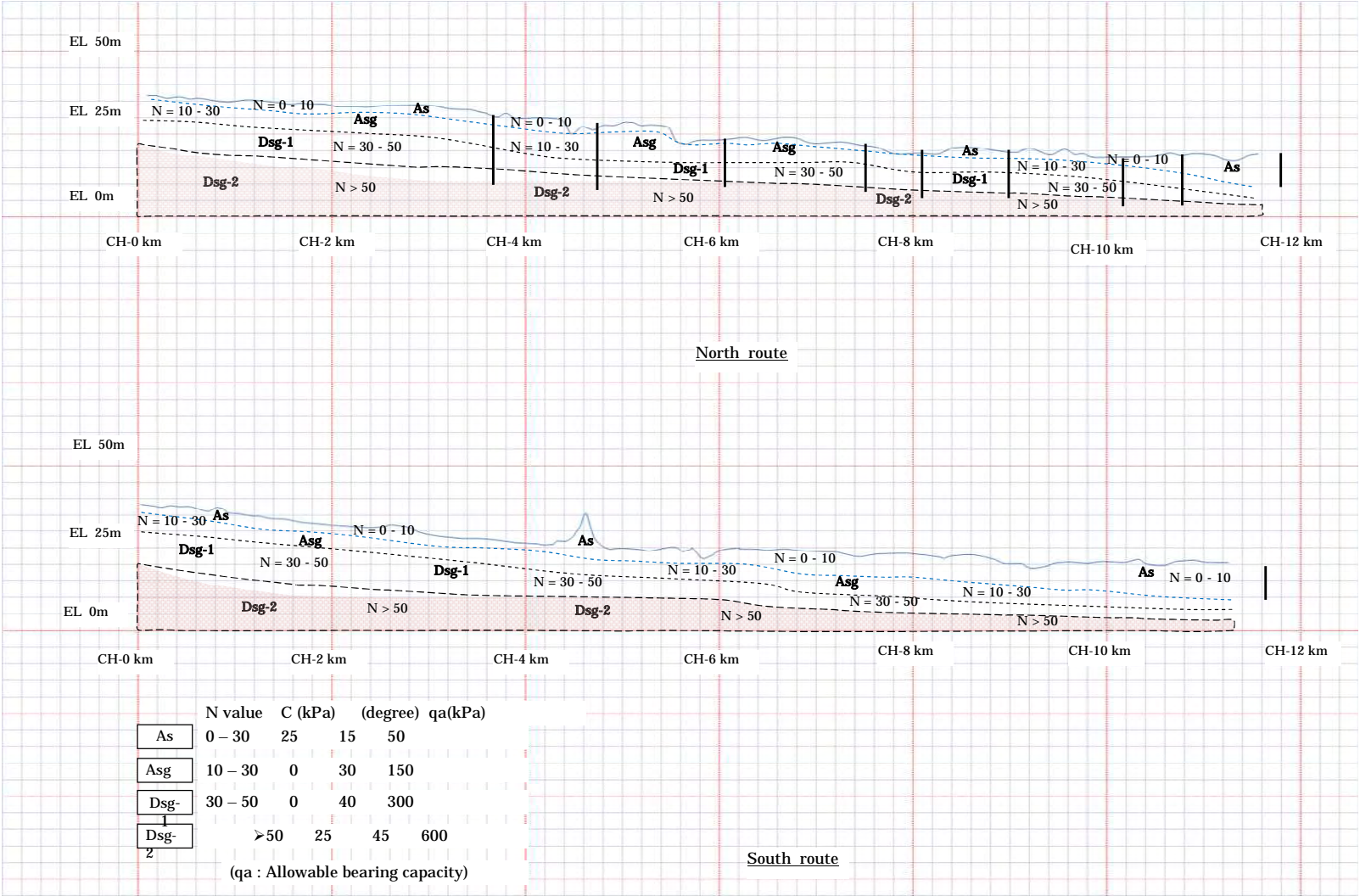


Figure 3.3.5 Distribution of Physical Values along Geological Profiles

### Engineering Properties

The engineering properties of layers have been obtained as a result of standard penetration and laboratory tests and summarized for each layer as shown in Table 3.3.11.

In general, the mean value of test results can be applied to represent each layer. However, the discrepancy of test data should be carefully studied when the data is applied to design work due to the non-uniform distribution of the soils in each layer.

**Table 3.3.11 Physical Properties of Layers**

Layer	Value of Test results	N value	Specific Gravity ( $Mg/m^3$ )	Unit Weight ( $Mg/m^3$ )	Water Content (%)	Uc ( $D_{60}/D_{10}$ )	U'c ( $(D_{30} \times D_{30}) / (D_{10} \times D_{60})$ )
As	Minimum	3	2.67	1.82	19.40	14.81	0.18
	Maximum	8	2.74	1.99	45.00	26.09	13.40
	Mean	5.9	2.71	1.90	29.20	21.97	4.67
	Nos of Data	10	12	9	13	3	3
Asg	Minimum	15	2.59	1.96	0.9	37.5	0.00
	Maximum	37	2.73	2.03	25.8	3250.00	11.53
	Mean	24	2.65	1.99	6.7	420.32	5.86
	Nos of Data	14	12	10	10	10	10
Dsg-1	Minimum	25	2.59	1.95	3.80	29.29	0.21
	Maximum	50	2.69	2.05	20.70	3055.56	16.92
	Mean	38	2.64	1.99	8.68	462.95	3.49
	Nos of Data	22	22	10	13	8	11
Dsg-2	Minimum	50	2.60	1.97	4.00	77.50	3.83
	Maximum	50	2.66	2.03	6.50	2875.00	29.34
	Mean	50	2.64	2.00	4.80	462.95	13.07
	Nos of Data	14	7	6	5	8	8

\*(qa : Allowable bearing capacity, Uc: Coefficient of uniformity, U'c: Coefficient of curvature)

Source: JICA study team

### Seismic Risk

The Caucasus Mountains, located in the middle of the Eurasian plate, have been known to experience various tectonic processes associated with lithospheric plate motion.

Georgia, a part of the Caucasus, is situated in the vast zone of Late Alpine continental collision. During the pre-collisional (Late Proterozoic–Early Cenozoic) stage, the region belonged to the continuously developing oceanic basin (Tethys) and its continental framing – Africa–Arabian and Eurasian.

The recent geodynamics of the region are largely determined by its position between the still converging Eurasian and Africa–Arabian plates.

As a result of the continuing northward displacement of the Africa–Arabian plate in the Oligocene and post-Oligocene time, the region turned into the intra-continental mountain-fold construction.

This process formed the present-day structure and relief such as high-mountain ranges – fold-thrust belts of the Greater and Lesser Caucasus, the Rioni and Mtkvari intermountain depressions of the Transcaucasia.

The Caucasus Mountains formed largely as the result of a tectonic plate collision between the Arabian plate moving northward with respect to the Eurasian plate. The entire region is regularly subject to strong earthquakes from this activity.

Earthquakes and landslides due to earthquakes in mountainous areas present a significant threat to life and property.

However, no major earthquakes have been recorded near the project area. According to the recent seismic zoning under the Ministry of Architecture and Building of the Republic of Georgia in 1991, the probability of occurrence of the earthquake is as low as twice every 1,000 years.

### 3.4 Topographic Survey

Topographic maps of 200 meter width along the studied routes, as well as the profile and cross sections, were made for the alternatives of the right bank and left bank of the Rioni River. The first step of the survey was to determine the tentative horizontal alignment of the routes and then survey topography using total stations, levelling equipment and GPS surveys. The details of the survey were the profile along the center of each alternative and the cross section of 100 meters on each side of the centreline. Control points along the survey area were identified to determine the horizontal alignment of the road based on the topographic survey results. Major control points were crossing of roads, rivers, water channels, public buildings, houses, and utilities (including buried cable lines).

The finalization of the horizontal alignment was carried out by examining social and natural control points to avoid; control points of buildings and facilities shown by the topographic survey; and concentrations of houses. The main investigation items for the route alignment were as the following:

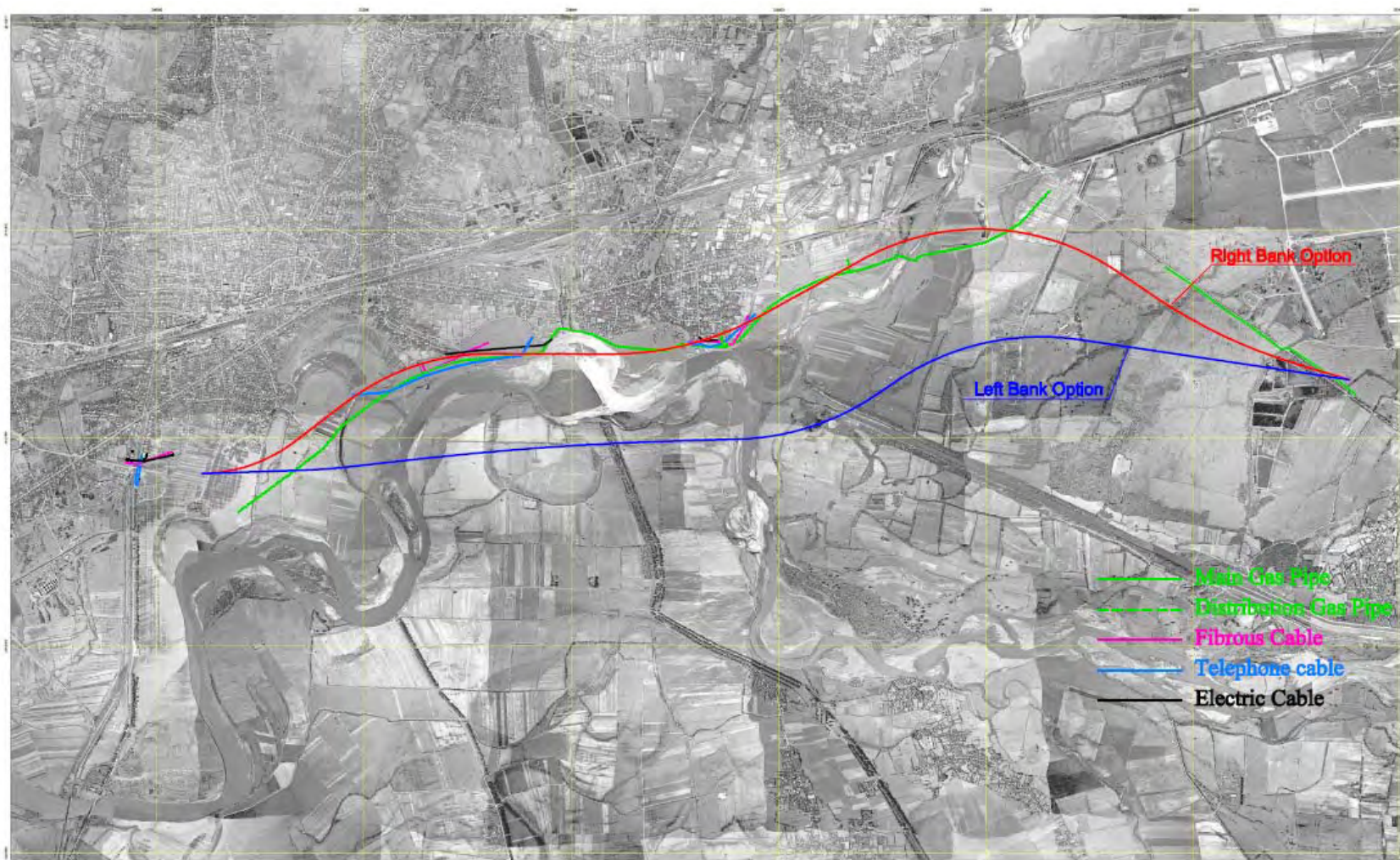
- Ground and soil conditions, public facilities including buried lines, interchange locations and types and possible environmental impacts.

Finalization of the profile was carried out using the topographic survey results, high water level based on the river analysis, harmonization with the horizontal alignment, and rough estimates of soil volume for the embankment. The following were the main items to investigate:

- The height when crossing roads and water channels, high water level of the river, elevation of the revetment, design bridge height, and elevation of the connecting roads.

Public facilities and utilities have been identified by the topographic survey as shown in Figure 3.4.1. The required procedures to relocate utility lines are shown in Table 3.4.1.





Source: JICA survey team

**Figure 3.4.1 Utility Locations According to the Topographic Survey Result**

Table 3.4.1 Relocation Procedures of Utility Lines

No.	Kind of utility lines	Location (Chainage)	Relocation length (m)	Administrator	Relocation procedures		Relocation work		
					Order of procedure	Term (month)	Implementation procedure	Term (procedure + Construction)	Rough cost estimates (unit cost/m)
O-1	Optical Cable	CH6353.3 – 6922.2	568.9 m	Telecommunication & Technology Group “T&T”	<ul style="list-style-type: none"> <li>• Submit relocation plan and drawings to T&amp;T</li> <li>• Three party site confirmation for relocation (T&amp;T, RD, and Land owner)</li> <li>• Approval by T&amp;T</li> </ul>	4	<ul style="list-style-type: none"> <li>• Cost estimate from T &amp; T</li> <li>• Contract signing</li> <li>• Relocation</li> </ul>	1 month (2 weeks for procedures, 2 weeks for relocation)	¥ 2,789 /m (41.5 GEL/m)
O-2	Optical Cable	CH12358.9 – 12529.2	170.3 m	„	„	„	„	„	„
T-1	Telephone cable	CH6322.9–6945.9 Or Crossing x 2	623 m	United Telecom of Georgia (UTG)	<ul style="list-style-type: none"> <li>• Submit relocation plan and drawings to UTG</li> <li>• Three party site confirmation for relocation (UTG, RD, and Land owner)</li> <li>• Approval by UTG</li> </ul>	1	<ul style="list-style-type: none"> <li>• Bidding</li> <li>• Contractor selection</li> </ul>	2 months (2 weeks for procedures, 6 weeks for relocation)	¥ 1,828 /m (27.2 GEL/m)
T-2	Telephone cable	CH8529.2 Crossing x 1	Crossing	„	„	„	„	3 weeks (2 weeks for procedures, 1 week for relocation)	„
T-3	Telephone cable	CH9324.0–9932.8	608.8 m	„	„	„	„	2 months (2 weeks for procedures, 6 weeks for relocation)	„
T-4	Telephone cable	CH12500 at Samtredia Interchange West (Along S12)	350 m	„	„	„	„	1.5 months (2 weeks for procedures, 4 weeks for relocation)	„

No.	Kind of utility lines	Location (Chainage)	Relocation length (m)	Administrator	Relocation procedures		Relocation work		
					Order of procedure	Term (month)	Implementation procedure	Term (procedure + Construction)	Rough cost estimates (unit cost/m)
G-1	Gas Pipe Line φ700 (main)	CH3487.4–3782.0	294.6 m	Georgia Gas and Oil Company (GOGC)	<ul style="list-style-type: none"> <li>• Submit a letter and drawings to GOGC</li> <li>• Approval form GOGC unless socio-environmental problems are foreseen, which requires government approval</li> <li>• Relocation contract (GOGC or another contractor)</li> <li>• Detailed survey and design</li> <li>• Approval from the government concerned</li> </ul>	12	<ul style="list-style-type: none"> <li>• Bidding</li> <li>• Contractor selection</li> </ul>	2 months for procedure and 5 km/month for relocation	¥ 76,000 /m (800 USD/m)
G-3	Gas Pipe Line φ700 (main)	CH5109.0–6410.8	1301.8 m	„	„	„	„	„	„
G-4	Gas Pipe Line φ700 (main)	CH6756.8–7746.0	989.2 m	„	„	„	„	„	„
G-5	Gas Pipe Line φ700 (main)	CH8258.1–10506.0	2247.9 m	„	„	„	„	„	„
GD-1	Gas Pipe Line φ150 (distributor)	CH62.0–402.1	340.1 m	Samtredia Gas Ltd. (SG) and Auto Gas Ltd.(AG)	<ul style="list-style-type: none"> <li>• Submit a letter and drawings to Transportation Company (GTC)</li> <li>• Approval from GTC</li> <li>• Contract out to a relocation contractor</li> </ul>	3	<ul style="list-style-type: none"> <li>• Bidding</li> <li>• Contractor selection</li> </ul>	2 months for procedure and 10 km/month for relocation	¥ 1,960 /m (35 GEL/m)

Source: JICA survey team

### 3.5 Site Survey of Utility Lines

It was identified that there are various utility cable lines either exposed or buried in the vacant land between the residential areas and the Rioni River for the right bank route. In order to reconfirm locations and kinds of utility lines, a meeting of organizations concerned was held in Samtredia city.<sup>1</sup> The attendance of the meeting is shown in Table 3.5.1.

**Table 3.5.1 Utility and Related Organizations at the Meeting**

No.	Kind of Facilities	Administrator	Contact in Attendance
1	Communication Cable Optical cable	Optical Telecommunication Network Ltd.	Mr. Omar Shilakadze (Site Manager) / 16 Jikja St. (877 98 2821) Mr. Kote Samushia (Executive Director) / (877 40 1740)
2	Telecommunication Cable	United Telecom JSG	Mr. Nugzar Meparishvili (Head of Technical) / Magistral Telecom Branch / Site of Samtredia (877 18 8046)
3	Gas Pipeline	Samtredia Gas Ltd.	Mr. Vazha Kantaria (Chief Engineer) / (899 95 1132)
4	Embankment	Samtredia–Khoni– Martvili–Vani	Mr. Lio Geguchadze (Head of Melioration System) / (895 90 4852)

Source: JICA study team

During the meeting it was pointed out that although it was possible to identify the location of the utility lines from the existing maps, it was decided to have site investigations presented by administrators of each utility line and topographic surveyors to reconfirm the exact locations. The results of the site investigations held in October 2009 were reflected in the topographic survey drawings.

Prior to road design the survey team carried out a site investigation along the expected routes. The main items investigated were terrain, public facilities, utility lines and housing development. More specific descriptions of the investigation are shown in Table 3.5.2.

**Table 3.5.2 Site Investigation Outline**

No.	Item	Contents
1	Purpose	Site identification, data collection for route selection and design
2	Locations	Locations which affect technical design in relation to topography, soft ground area, bridge sites and utility locations
3	Methods	Identify and confirm by observation at site
4	Contents	The number of houses and conditions, crossing roads/water channels, terrain, soft ground, soil and rocks on the surface and the interchange locations along the route.

Source: JICA study team

<sup>1</sup> The meeting was held on October 22, 2009 in Samtredia City Hall with the chairman of Mr. Emzar Shubladze (Chairman Council).

## Chapter 4 Social and Environmental Evaluation

### 4.1 Current Status of EIA and Objective of Study

An Environmental Impact Assessment study was completed in March 2009, titled as “Project ‘Reconstruction of the Zestafoni–Kutaisi–Samtredia Section of the E-60 Highway’ Environmental and Social Assessment and Analysis of Alternatives”. According to Georgian law, public disclosure of the EIA has already been completed. The final EIA will be approved after the final Samtredia Bypass alignment is selected during the detail design based on the proposed alternative alignment and additional baseline information. If a new alignment that is different from the original route at JICA approval is selected, the EIA will be modified based on the social/environmental assessment of this survey and/or additional survey. The final EIA will be approved after the additional public hearing of Samtredia and EIA approval process.

The main additional baseline information needed for the EIA is limited to hydrological data on the Rioni and Gubistskali Rivers, geological data for bridge foundation as well as social data on Samtredia communities. Furthermore, the exhaustive comparison of alternative bypass routes is crucial in determining the final alignment. The five alternative routes are evaluated on the basis of road design properties, social impact including resettlement, construction cost, hydrological risks, and magnitude of relocation of other infrastructure facilities.

### 4.2 Baseline Information

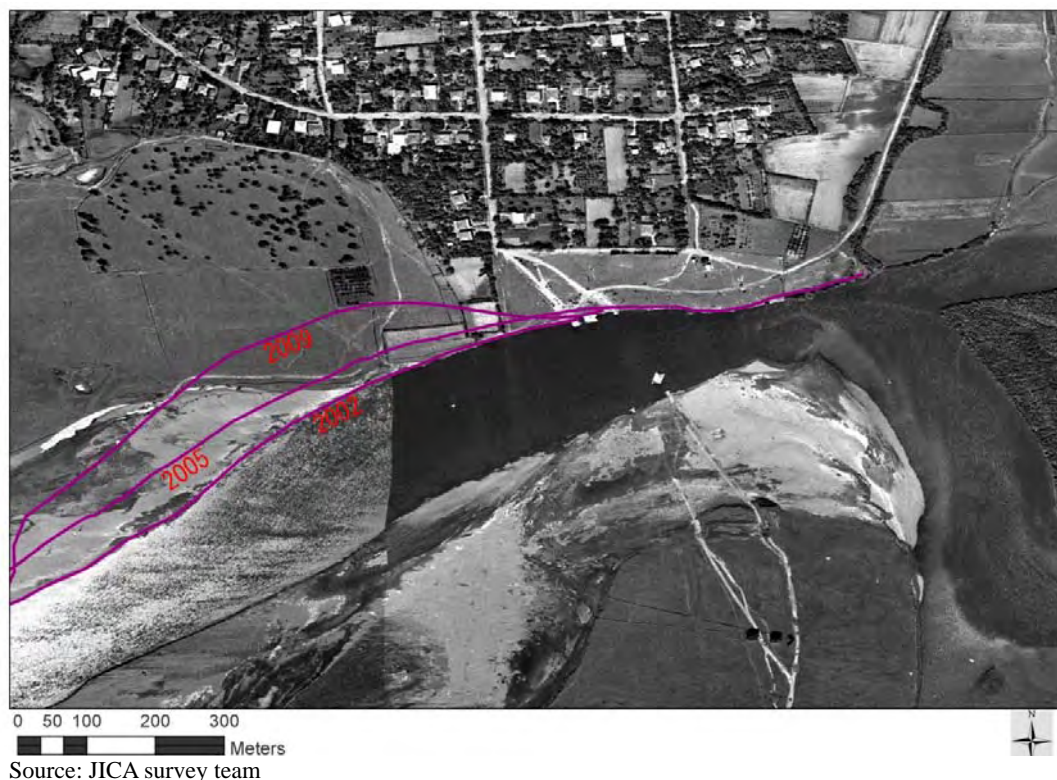
#### 4.2.1 Hydrology

The baseline data related to hydrology is described in Section 3.2 in Chapter3, “River and Hydrological Survey”. It is important to note that the Rioni River in the project area has an average discharge of around 2,000 m<sup>3</sup>/sec, and an average flow velocity of around 2.0 m/sec. The river is now eroding the right bank to the southern periphery of Samtredia City, and is rapidly changing its river channel to the North. In this area, two additional streams, the Gubistskali River from the north and the discharge channel from the Rioni Hydropower Station from the Southeast, join to the Rioni River, forming a delta at the junction. Given these hydrological characteristics, the space left for a bypass construction on the right bank side of the Rioni River is about 70 meters between the river and the residential area of Samtredia near the ferry terminal, while there is no space left between the river and the residential area where the Rioni bends to change its direction from northward to southward.

According to some residents, the northward migration of the Rioni River became conspicuous after the construction of the discharge channel. Within the limited space left on the right bank of the Rioni, there is other infrastructure already in place, including gas, telecommunications, optical fiber and power transmission lines. Gas pipelines were exposed to the river course due to lateral erosion and this made it necessary to construct revetments to the right bank immediately.

The magnitude of erosion is most conspicuous at the area where the new revetment was constructed near the junction of the Gubistskali River. Figure 4.2.1 shows an aerial photo taken in 2002, and the riverbank lines that existed in the years of 2005 and 2009. Obviously, the line has moved to the Northwest as far as 150 meters during the period. The revetment is now provided along the coast to stop further coastline recession. However, this has left very limited space for the bypass construction without intruding into residential areas.



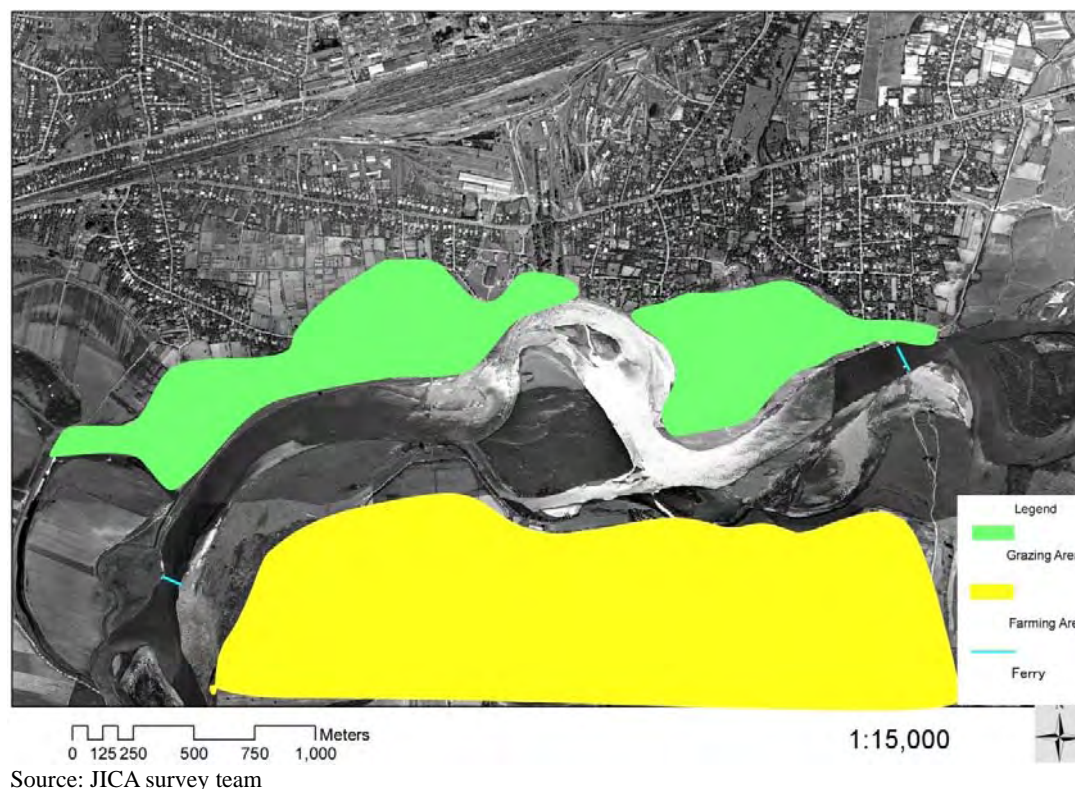


**Figure 4.2.1 Changes in Riverbanks Due to Rioni River Erosion**

#### **4.2.2 Land Use**

Most of the residents that would be significantly affected by the proposed Samtredia Bypass are engaged in farming for their livelihood. They also own cattle as an invaluable source for dairy products. Since cattle is raised on free range grazing, it is always more convenient to keep cattle close to the residence. As Figure 4.2.2 shows, despite fertile soil property, the areas adjacent to the residential area in the south and north to the Rioni River are dedicated to grazing. Thus farming is conducted in the areas on both sides of the Rioni River. The residents need to use the two ferries indicated by the blue lines in Figure 4.2.1 to commute to these farms. The ferries transport large-scale tractors and trucks required for farming. Situated within a floodplain, the farm lands in these areas are quite fertile and allow the cultivation of corn and soybeans.

The design of a new road should incorporate special measures so as not to disrupt the economic and social activities of the local residents, and should take special care to the alignment as well as the provision of adequate service roads and local crossings.



**Figure 4.2.2 Agricultural Land Use**

### 4.2.3 Utility Lines

On the right hand bank of the Rioni River, there are gas pipes, power transmission lines, optical fiber and telecommunication lines. When the new bypass crosses these facilities or comes closer than the regulated margin of distance, it becomes mandatory to relocate the existing facilities to a new location without disrupting the services. For gas pipes, there are special safety measures to be provided for the crossing of pipes under the road (for details, please refer to the Section 3.5 in Chapter 3, “Site Survey of Utility Lines”).

### 4.2.4 Current Situation of Cadastral Registration

According to the “law on land privatization”, which came into effect on January 1, 1992, most parcels of land were granted to local inhabitants in the following manner:

- 1) Members of collective farms received 1 ha and 2,500 m<sup>2</sup>;
- 2) Helpers of farmers received 7,500 m<sup>2</sup>;
- 3) Permanent inhabitants of villages who did not use to take part in collective farming – 0.5 ha;
- 4) People, who did not live permanently in villages, received 2,500 m<sup>2</sup>.

Some of the parcels were purchased by the respective owners according to the law on paid privatization in 2006 and 2009. The privatization process is still ongoing. After the privatization, there were some transactions of land. Although the owners hold paper-based land titles, the Civil Registry Office does not yet maintain all the records. Figure 4.2.3 shows the current status of land registration. The green line indicates registration prior to the year 2006 and the red line indicates registration after the year 2006. Obviously only a fraction of lands are registered. Therefore it is necessary to register land holdings prior to land acquisition. In general, the project owner has to hire a surveyor to undertake all the registration by surveying the exact extent of land holdings for the concerned parcels. The survey should commence right after the

final determination of the route alignments based on detail design work. Actual negotiation for land acquisition will only start after the completion of cadastral registration.



Source: Samtredia City

**Figure 4.2.3 Current Situation of Cadastral Registration**

### 4.3 Outline of Alternative Routes

According to the agreement reached between the Georgian and Japanese governments, the bypass from Kutaisi to Samtredia will be built continuously from the proposed Kutaisi Bridge toward Samtredia as an entirely new bypass and connect to the road from Samtredia to Batumi. The study section is limited to the last 12 km section of this continuous bypass from the south of the military airstrip to the road from Samtredia to Batumi. Poti and Batumi are the two major gateway ports in Georgia. While Poti serves container cargoes, Batumi serves bulk cargoes. Batumi is also the largest beach resort in Georgia facing the Black Sea.

#### 4.3.1 Alternative Routes

There are three alternatives on the right bank of the Rioni River and two alternatives examined on the left bank of the Rioni River. The alignment of the bypass itself is dependent on the plans of the continuing sections from the starting point of the entire Kutaisi–Samtredia Bypass Project. The overall project alternatives are as follows:

**Option R-1:** The route that goes over Gubistskali River and passes to the south of Ianeti Village and then runs on a proposed landfill of a bend toward the right bank and continues back on the right bank to the west to join the road from Samtredia to Batumi.

**Option R-2:** The route is similar to Option R-1, but, at the sacrifice of road design parameter of its radius between the west of the Gubistskali River and the western end of Akhalsopepli Village, the resettlement and relocation of gas pipe lines are minimized.

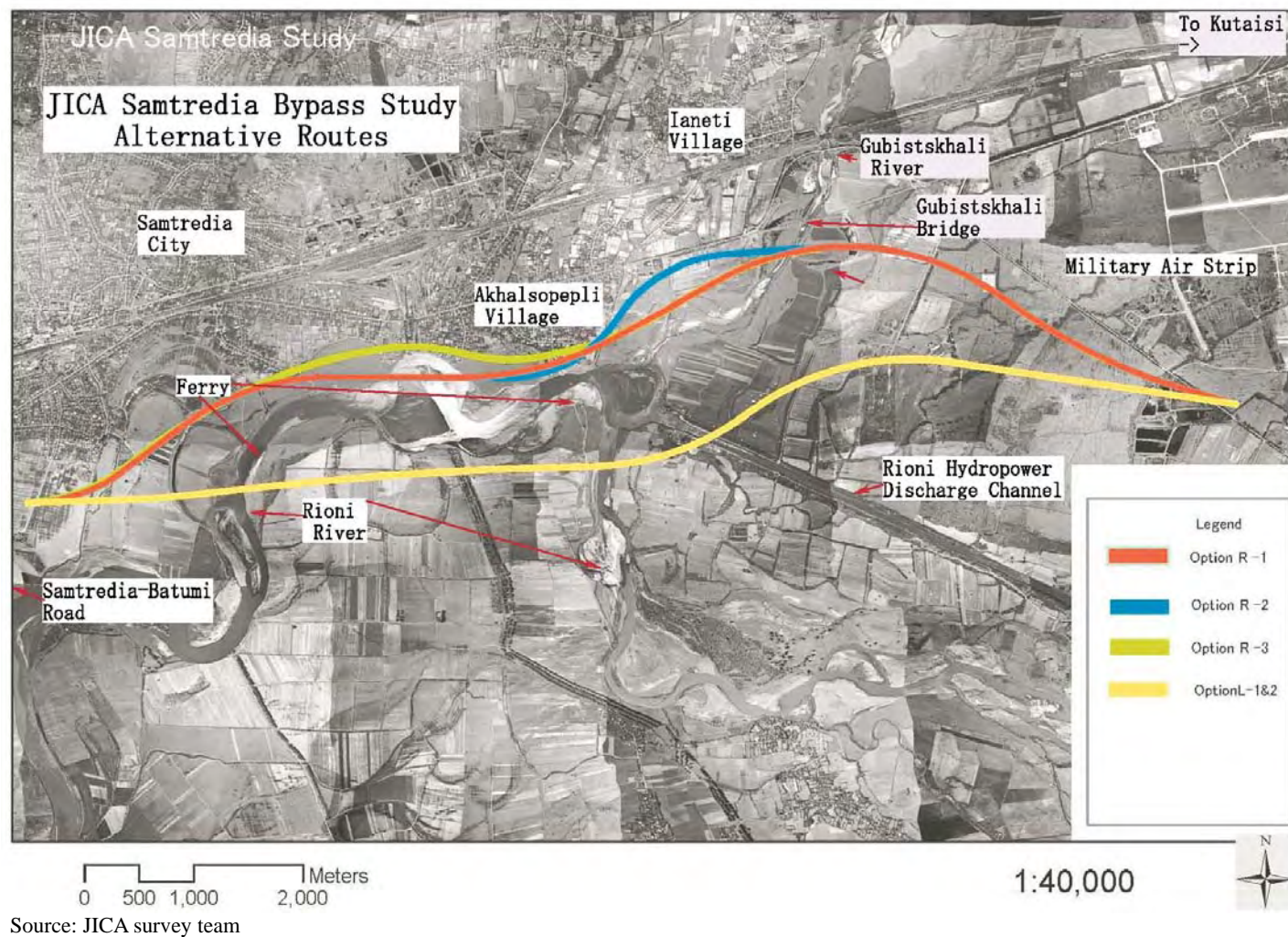
**Option R-3:** The route is similar to Option R-1 but slightly shifted towards the north to avoid the proposed landfill of the Rioni River to minimize interference with the river hydrology.

**Option L-1:** The route starts at the south of the military airstrip and crosses the discharge channel of a hydropower station located upstream of the Rioni. Then it crosses the northward stream of the Rioni and passes through the flood plain to the west. It crosses again the southward stream of the Rioni. Then it joins the same junction at the road from Samtredia to Batumi. This option limits bridge crossings to a minimum.

**Option L-2:** The route itself is exactly the same as Option L-1 but from the entire span of the first crossing of the Rioni through to the second will be connected as one continuous bridge, limiting the impact of potential course changes of the Rioni River.

Figure 4.3.1 shows the above alternative routes.





**Figure 4.3.1 Alternative Route Alignments**

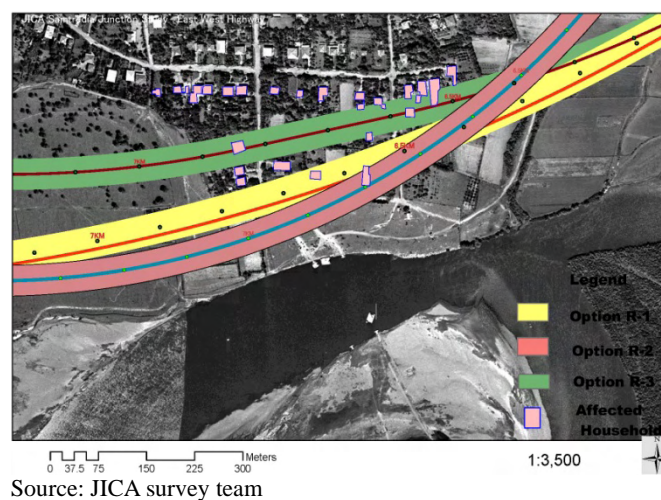
**Table 4.3.1 Planning Parameters for Alternative Routes**

Basic Design Parameters							
No.	Item	Unit	Option R-1	Option R-2 (min. radius)	Option R-3	Option L-1	Option L-2
1	Characteristics		Right Bank Standard Design	Right Bank Minimum Resettlement w/mini. Radius	Right Bank No Interference to River	Left Bank Standard Design with Embankment and Revetment	Left Bank Standard Design with Bridge Span over Flood Plain
2	Length of route	m	11,950	12,084	11,964	11,327	11,327
3	Design speed	km/h	120	120	120	120	120
4	Minimum horizontal radius	m	1,500	1,175	1,500	2,500	2,500
5	Bridge Length	m	370.46	370.46	370.46	906.85	3943.2
6	Revetment Length	m	5,800	5,800	5,300	7,000	3,640
7	Resettlement of households	Nos	2	1	21	-	-
8	Gas Pipe Line Relocation	km	3.554	2.457	0.71	-	-
9	Construction Cost	USD million	63	62	60	95	123

Source: JICA survey team

## 4.4 Estimation of Social Impacts

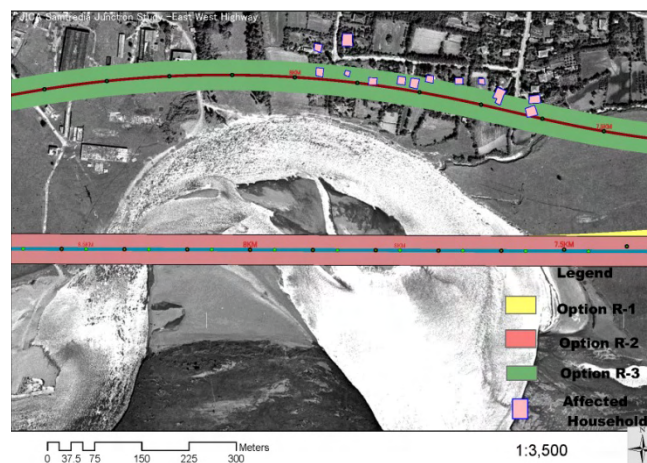
### 4.4.1 Resettlement Needs

**Figure 4.4.1 6 km + 500 m Section**

The requirement of resettlement is analyzed according to the alternative routes described in the previous section. The left bank options do not have resettlement requirements as they pass through predominantly agricultural lands. The right bank options require resettlement while the left bank options require none.

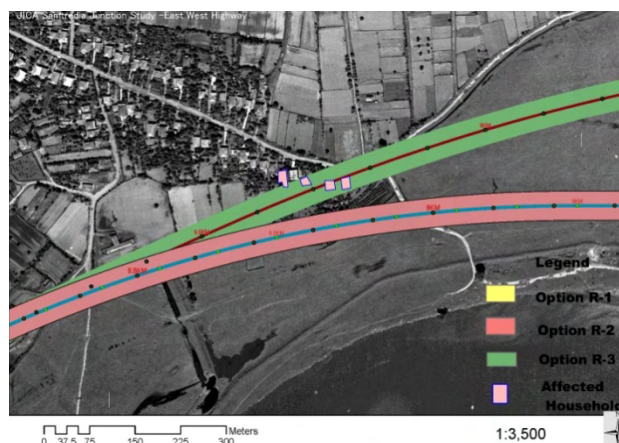
Starting from the east, the right bank options first encounter the community of Akhalsopepli Village as shown at around 6 km + 500 m in Figure 4.4.1. At around the milestone of 6 km+ 700, the Option R-1 (yellow) touches on two houses. The Option R-2 (red), with a minimal radius,

crosses one house while Option R-3 (green) necessitates the resettlement of 8 houses at the section between 6 km + 500 m and 6 km + 900 m. The Option R-3 also isolates 5 households on the southern side of the planned bypass while leaving the majority of them on the northern side.



**Figure 4.4.2 7 km–8 km Section**

In the middle section between 7 km + 600 m and 8 km + 500 m, both the Option R-1 and R-2 are designed to cross over the planned landfill at the sharp bend where there is little water flow during dry seasons, as well as dredging the delta immediately in the south. Thus there will be no resettlement in this area. The Option R-3 avoids interference with the river such as land-filling and cuts into the village of Akhalsopepli and necessitates the resettlement of 9 houses. This area is subject to dramatic lateral erosion. As a result, the gas pipes were exposed, and the gas company had to relocate the pipeline within the premises of the residential areas.



**Figure 4.4.3 9 km Section**

As Option R-3 is shifted northward, at the section between 9 km + 200 m and 9 km + 400 m, the option cuts at the southern edge of Samtredia City, necessitating the relocation of 4 households.



#### 4.4.2 Land Acquisition Requirements

##### (1) Right Of Way

In order to estimate land acquisition requirements, it is necessary to set the width of right-of-way. It is the government decision to acquire the right-of-way required for future full-scale development of four-lane road construction. The top width of four lane road would be 27.5 meters wide. With a slope gradient of 1:1.5, the bottom width will be determined by the height of a particular section of the proposed road. The average embankment heights for the alternatives on the right bank are estimated to be 4.6 meters for the right bank options and 9.6 meters for the left bank options. Furthermore, it would be necessary to add another 6 meters for the provision of local service roads and crossings. In summary, the right bank routes would require an average of 24 meters and the left bank routes 31 meters to each side from the center of the road.

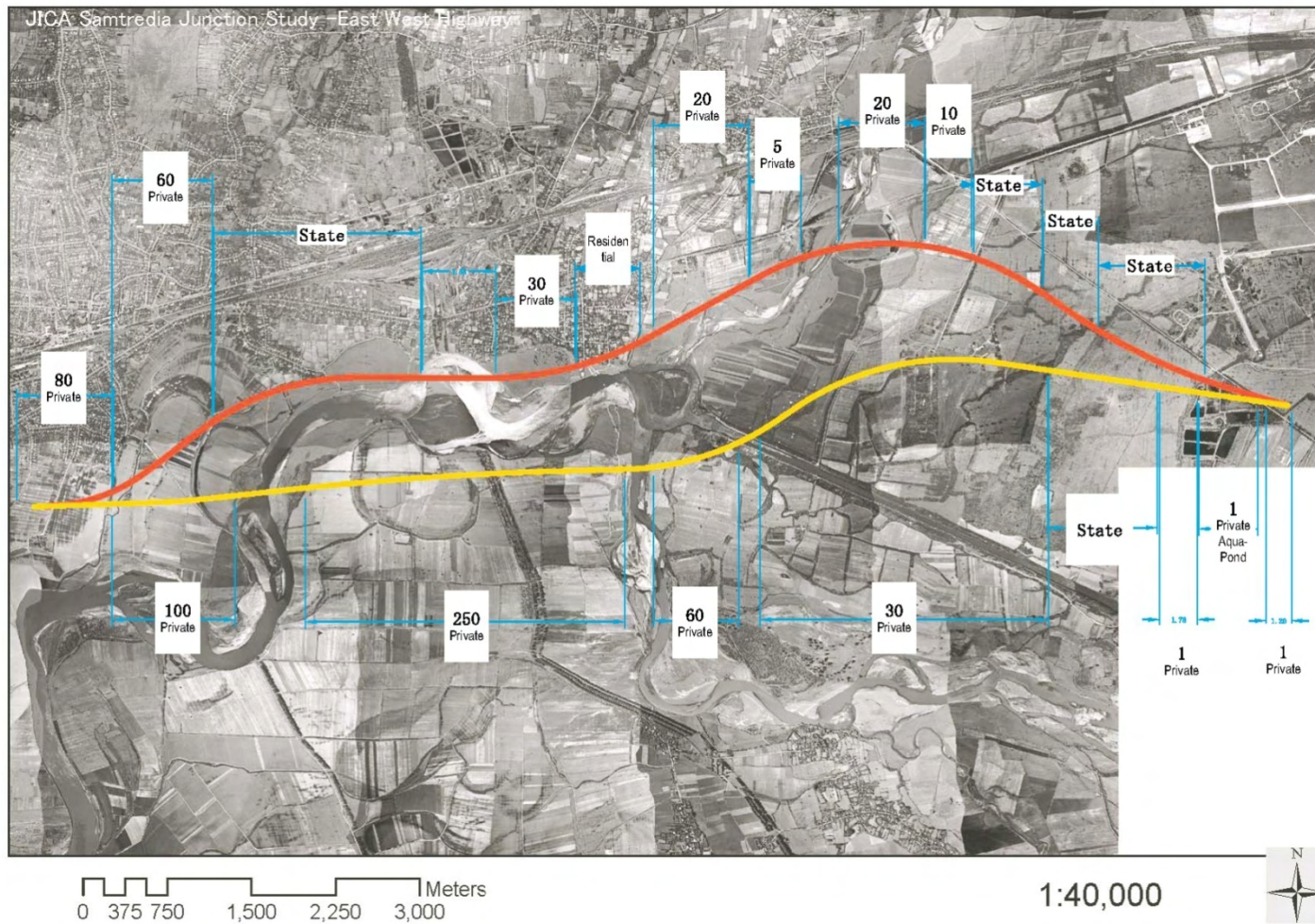
##### (2) Number of Land Owners

The agricultural landholdings were divided into oblong thin parcels. Usually, the land plots connect to the access road perpendicularly. However, actual shape and divisions need to be clarified by a detailed survey. In the case of a new bypass crossing these landholdings at a sharp angle, the number of affected landowners would become large. Conversely, in the case of crossing more in parallel, the number of landowners would be limited.

The number of land owners estimated in Figure 4.4.4 is based on the information from local authorities without precise investigation. The exact number needs to await a full-scale cadastral survey. At a maximum, the right bank options will require land acquisition negotiations with between 200–250 land owners and the left bank options will require negotiations with more than 500 land owners. There are more landowners since agricultural landholdings by the residents of Samtredia are concentrated in the left bank of the Rioni River. The actual number of landowners would most likely reduce by half after a detailed survey.

##### (3) Estimation of Land Acquisition Requirement

As discussed in the previous section on “Current Situation of Cadastral Registration”, the majority of land holdings belong to private citizens (farmers). There remain some state-owned lands. However, these lands are mostly leased for cattle grazing. Private lands to be acquired will be compensated according to the standard procedures. The exact procedure of land acquisition is not clear for state-owned but privately utilized land. However, based on the equal-or-better compensation principle, the compensation for leased land of its use value or the finding of other alternative land should be pursued by the project owner. The most prevalent land use is agricultural cultivation followed by cattle grazing and residential. Table 4.4.1 shows the current land use and ownership for each route option.



Source: Interviews with the Municipality of Samtredia

Figure 4.4.4 Estimate of Number of Landowners



Table 4.4.1 Land Acquisition Requirements by Current Land Use

Option		R-1		R-2		R-3		L-1		L-2	
Ownership and Land Use		No. Of Owners	Areas (ha)	No. Of Owners	Areas (ha)	No. Of Owners	Areas (ha)	No. Of Owners	Areas (ha)	No. Of Owners	Areas (ha)
Private	Private Agricultural	206	29.0	206	29.8	207	31.0	532	60.7	532	50.4
	Private Grazing	30	3.6	30	4.8	30	3.2	0	0.0	0	0.0
	Private Pond (Aquaculture)	1	1.9	1	1.9	1	1.8	1	3.4	1	3.4
	Private Residential	8	2.7	5	1.1	22	4.5	0	0.0	0	0.0
	Sub-total	235	32.6	232	33.0	250	35.9	523	59.6	523	53.8
Public	State Owned Agricultural	1	11.2	1	11.3	1	11.2	1	6.1	1	6.1
	State Owned Grazing	1	9.1	1	9.2	1	9.2	1	1.7	1	1.7
	Road	1	0.3	1	0.3	1	0.4	2	0.9	2	0.9
	Water Course	2	4.7	2	4.9	1	1.3	3	2.7	3	2.7
	Sub-total	5	25.4	5	25.6	4	22.2	7	11.5	7	11.5
Total		240	58.0	237	58.7	254	58.1	530	71.1	530	71.1
Overall Land Acquisition Needs*		237	52.9	234	53.5	252	56.3	525	67.5	525	61.7

Note: Overall needs include state grazing and agricultural land

Source: JICA survey team

## 4.5 Evaluation of Alternatives

The proposed alternatives were evaluated according to the parameters of hydrological risks, social impacts, relocation of utility infrastructures and construction costs as described in the following sections.

### 4.5.1 Hydrological Risks

The construction of the bypass in Samtredia may incur two types of hydrological risks. The first type of the risks is concerned with changes in river course or lateral erosion resulting in damages to the constructed facilities. Another risk is a possibility of affecting suspended sediment balance within water, resulting in scouring of footings of river structures such as bridges.

The Rioni River is a powerful river with a discharge level around 2,000 m<sup>3</sup>/sec and a flow velocity of over 2 m/sec; thereby the risk of erosion and consequential damages should be regarded as serious threats. The river course in the project area meanders from south to north and then back to south precipitously. Recent history shows the gradual northward migration of the river course. However, it is not certain the trend will continue or suddenly change its direction to the south. Adequate revetments and embankments should be constructed to avoid all the possible incidents. Amongst all, the left bank routes are positioned in its middle part within the floodplain of the Rioni River. Therefore, the hydrological risks would be even greater and the maintenance costs may be higher. Option L-2 minimizes the hydrological risks by traversing the entire floodplain with a continuous bridge. Naturally the construction costs are much higher as well. As far as scouring is concerned, the requirement of dredging and reclamation at the section between 7 km + 600 m–8 km + 500 for the Option R-1 and R-2 may have some impact on downstream structures. However, the overall effect is deemed to be minor.

### 4.5.2 Social Impact

As far as social impacts are concerned, the left bank options have far less impacts compared to the right bank options. The right bank options require some resettlement, and cause traffic noise and disturbances to the local movement of residents and cattle, as well as the deterioration of landscape. The left bank options, on the other hand, will not cause such social inconveniences. Amongst the right bank options, Option R-3 cuts in the middle of Akhalsopepli Village with a resettlement of at least 21 households while leaving 5 households separated by the bypass from the rest of the community on the river side. Within the right bank options, Option R-2 minimizes the resettlement requirement by downgrading the road alignment by adopting curves of smaller diameters than those of other options, while clearing the TEM standard of minimum 650m in radius. However, the sacrifice of road design property has a possibility of damaging traffic safety at the same time.

### 4.5.3 Relocation of Utility Lines

The issues of relocation of utility lines are an integral part of construction costs. However, the relocation of utilities would require negotiation with many external organizations such as gas, power, telephone and communications companies as well as complicated design work. Prolonged negotiation may entail the extension of the construction schedule.

### 4.5.4 Construction Cost

Simple comparison of the construction costs between the alternatives shows that the right bank options will cost around USD 60 million while the least expensive left bank Option L-1 embankment costs USD 30 million more than the right bank options. Amongst the right bank options, the Option R-3 shows the least cost. However, the route intersects with power

transmission line routes at two points. Depending on the final alignment decided by the detailed design work, it may become necessary to relocate a portion of the transmission lines. In such a case, the relocation costs are expected to be quite large.

The evaluation result of all the alternatives is summarized in Table 4.5.1.

**Table 4.5.1 Evaluation of Alternative Options**

		Alternative Evaluation				
		Option R-1	Option R-2	Option R-3	Option L-1	Option L-2
Characteristics	Element	Right Bank Standard Design	Right Bank Minimum Resettlement w/mini. Radius	Right Bank No Interference to River	Left Bank Standard Design with Embankment and Revetment	Left Bank Standard Design with Bridge Span over Flood Plain
Environment	Hydrological Risk	L	L	L	M	L
Social	Resettlement of households	2	1	21	0	0
	Land Acquisition (ha)	52.9	53.5	56.3	67.5	61.7
	Noise	M	M	M	L	L
	Aesthetic Impression	M	M	M	H	H
	Traffic Safety	M–H	M	M–H	H	H
	Utility Relocation (Gas Pipe Relocation km)	3.554	2.457	0.71	–	–
Economics	Construction Cost (USD Million)	63	62	60	95	123
	Maintenance Cost (USD Million)	0.3	0.3	0.3	0.8	0.6
	Local Economic Interruption	M	M	M–H	L	L
<b>Overall Evaluation</b>		H	H–M	H–M	L	L

Note) H: high, M: medium, L: low

Source: JICA survey team

## 4.6 Procedure for Land Acquisition and Resettlement

### 4.6.1 Laws Governing Land Acquisition and Resettlement

Laws pertaining to land acquisition in Georgia are the following:

The Constitution of Georgia, August 24, 1995

- The Law of Georgia on the rules for expropriation of ownership for necessary public needs, July 23, 1999
- The Law of Georgia on ownership rights to agricultural land, March 22, 1996
- The Law of Georgia on registration ownership rights to immovable property, December 28, 2005
- The Civil code of Georgia, June 26, 1997
- The Civil Procedural Code of Georgia, November 14, 1997
- Law of Georgia “On Privatization of State-Owned Agricultural Land, July 8, 2005.

#### 4.6.2 Procedure and Principles for Land Acquisition and Resettlement

In general, Georgian laws require the compensation of acquired land on a market-value basis, without amortization. However, through working with the World Bank on road projects, the World Bank's Guidelines on land acquisition principles, which are more stringent to the project owner, are applied. The basic tenet of the project stipulates the restoration or improvement of the current living standards of the affected people.

The project executing agency will undertake the negotiation for land acquisition directly. If the negotiation fails, the concerned agency should seek a Presidential order on the use of eminent domain for expropriation. The regional court would assess the order of the President and if it deemed it necessary for public needs, it would approve the President's order. Then it would assign a third party, who would assess the market value of lost property and loss of income generation, and compensation would be granted to the relevant land owners.

The principles on land acquisition, and resettlement have been developed through working with the World Bank. The main purpose of the principles is to restore and compensate to have the affected people regain the current level of living standards. The principles of land acquisition are summarized as follows:

1. Avoid relocation of people as much as possible;
2. Minimize the restrictions of land use in the adjoining areas;
3. Follow fair procedures for determining the compensation for temporary and permanent loss of property;
4. Purchase the land through negotiation contracts; if it is possible one should try to avoid the eminent domain;
5. Reinstatement of the area as much as possible after the construction;
6. Inform people fully about the project and possible results;
7. Illegal owners of lands will not be compensated for the loss of land, but will receive compensation for loss of other assets which they acquired themselves and for loss of income to help them to maintain their livelihoods;
8. Project Affected People (PAP) should be aware of the project implementation schedule and the principles of land acquisition, loss or damage;
9. Damages to assets such as standing crops including loss of harvest, trees, garages, sheds and other agricultural buildings and fences should be minimized, and if unavoidable, should be compensated;
10. During the detail design a Resettlement Action Plan will be developed that defines detailed compensation packages and an implementation schedule;
11. The market prices of land, construction materials for affected structures, crops and other relevant items should be identified based on market survey;
12. Loss of income and assets should be compensated without tax, depreciation or any other deduction;
13. The final Resettlement Action Plan (RAP) should be submitted to and cleared by JICA prior to the execution of civil works for relevant sections;
14. Grievances and complaints by the affected people should be properly recorded and be made readily available to inquiries by JICA.

## 4.7 Recommendations for EIA Approval

So far the Road Department has not yet obtained an EIA license. This is because the law related to EIA requires the submission of the detail design of the planned road, which is yet to be finished. Therefore, the EIA submission should await the appointment of the detail design consultant and their completion of the design. On the other hand, the current Study has clarified that there are at least five alternative route options for the Samtredia Bypass, each with pros and cons from social, environmental and economic viewpoints. It is desirable to establish the consensus of the affected communities and people at an early stage through public consultation and other dialogue methods. Therefore, communication with local people should start before the completion of the detailed design. The detail design team should finalize the alternative options and their evaluations and immediately communicate with the local people. Based on their finally agreed option, the team should develop the detail design of one final route. The Study Team suggests the following actions and schedule as shown in the following figure.

**Table 4.7.1 Recommended Actions for EIA Finalization**

	2010											
	3 月			4 月			5 月			6 月		
Appointment of Detail Design Consultant	↔											
Finalization of Alternative Routes and Evaluations	↔											
Public Consultation and Dialog				↔								
Consensus of Affected Communities and People							↔					
Detailed Design of the Agreed Route									↔			
EIA Approval												↔

Source: JICA survey team

## Chapter 5 Study on Highway Structures

### 5.1 Highway Design

#### 5.1.1 Design Traffic Volume

##### (1) Present Traffic Volume

The Road Department of Georgia carries out traffic count surveys three times a year for major highways and roads using automatic counting equipment. The current traffic volumes and growth for the national highway No.1 (S-01) are summarized as shown in Table 5.1.1. The traffic volume of the Kutaisi–Samtredia section was about 6,000 vpd (vehicle per day) with the growth rate of 3% to 6% until 2007 and it exceeded 8,000 vpd after 2008.

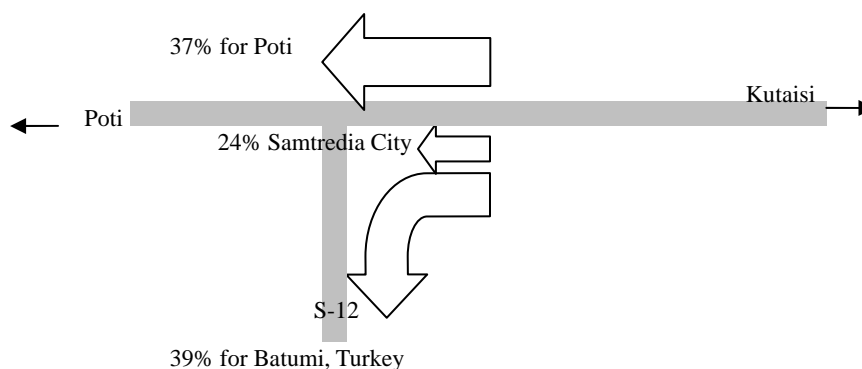
**Table 5.1.1 Present Traffic Volume on S-01**

		Unit: vehicles/day								
Year	Items	Km 140	Km 179	Km 215	Km 249	Km 288	Km 20	Km 64	Km 95	Km 115
2005	Average	4,035	4,464	5,466	5,701	2,411	2,009	2,481	6,135	3,368
	Growth	—	—	—	—	—	—	—	—	—
2006	Average	5,083	4,493	6,129	5,887	2,609	2,393	2,908	7,041	3,401
	Growth	26%	1%	12%	3%	8%	19%	17%	15%	1%
2007	Average	6,140	5,917	7,039	6,262	2,738	3,005	3,343	8,946	4,871
	Growth	21%	32%	15%	6%	5%	26%	15%	27%	43%
2008	Average	5,831	7,325	8,588	8,614	3,073	3,174	4,282	10,162	4,848
	Growth	–5%	24%	22%	38%	12%	6%	28%	14%	0%
2009	April	4,790	6,753	8,515	5,882	2,903	3,921	3,836	10,114	5,165
	July	7,331	7,075	9,117	10,789	3,907	4,406	5,353	11,740	7,073
	Average	6,061	6,914	8,816	8,336	3,405	4,164	4,595	10,927	6,119
	Growth	4%	–6%	3%	–3%	11%	31%	7%	8%	26%

Source: Road Department of Georgia

##### (2) Traffic Flow

National Highway No. 1 (S-01) branches off to Poti and Batumi (S-12) directions at Samtredia. The directional splits of traffic volume are shown in Figure 5.1.1. These are according to the OD survey on the East–West Corridor at the east of Samtredia (conducted by the JBIC Study). The ratio of the traffic in the directions of Poti and Batumi were each about 40 % whereas the local traffic was 20%. It seems necessary to identify the present and future traffic volume and directional splits in Samtredia at the detail design stage because the tendency observed at the JBIC Study was before the military conflict with Russia. This traffic forecast determines the design of interchanges.



Source: JBIC Study Final Report

**Figure 5.1.1 Traffic Flow near Samtredia**

### (3) Traffic Volume Forecast

Currently the FS is being carried out for other sections<sup>1</sup> of the East–West Corridor. The Road Department of Georgia requested the JICA survey team to ensure consistency of the future traffic volume with the one used by the FS team. In above mentioned FS, the traffic forecast has been made for the Rikoti Tunnel based on the reviewed traffic volume growth in consideration of the world economic crisis in 2008. This traffic growth rate result is shown in Table 5.1.2. The traffic volume growth rate in the JBIC study is shown in Table 5.1.3. The comparison between the new traffic forecast of the Rikoti Tunnel by the JBIC study and that by the FS mentioned is shown in Table 5.1.4. Based on the actual traffic volume surveyed by the Road Department and the JBIC Study, a traffic forecast of the Kutaisi–Samtredia section, with a modified new growth rate, is shown in Table 5.1.5.

**Table 5.1.2 Traffic Growth of Other Sections of FS (%)**

Year	National Economy			Passenger Cars			Freight		
	Low	Best	High	Low	Best	High	Low	Best	High
2009	1.5	2.5	4.00	1.8	3	4.8	1.5	2.5	4
2010	4	5	6	4.8	6	7.2	4	5	6
2011	4	5	6	4.8	6	7.2	4	5	6
2012	5	6	7	6	7.2	8.4	5	6	7
2013	3	4	5	3.6	4.8	6	3	4	5
2014	3	4	5	3.6	4.8	6	3	4	5
2015	3	4	5	3.6	4.8	6	3	4	5
2016	3	4	5	3.6	4.8	6	3	4	5
2017	3	4	5	3.6	4.8	6	3	4	5
2018	3	4	5	3.6	4.8	6	3	4	5
2019	3	4	5	3.6	4.8	6	3	4	5
2020	3	4	5	3.6	4.8	6	3	4	5
2021	2.5	3.5	4.5	3	4.2	5.4	2.5	3.5	4.5
2022	2.5	3.5	4.5	3	4.2	5.4	2.5	3.5	4.5
2023	2.5	3.5	4.5	3	4.2	5.4	2.5	3.5	4.5
2024	2.5	3.5	4.5	3	4.2	5.4	2.5	3.5	4.5
2025	2	3	4	2.4	3.6	4.8	2	3	4
2026	2	3	4	2.4	3.6	4.8	2	3	4
2027	2	3	4	2.4	3.6	4.8	2	3	4
2028	2	3	4	2.4	3.6	4.8	2	3	4
2029	2	3	4	2.4	3.6	4.8	2	3	4
2030	0.5	1.5	2.5	0.6	1.8	3	0.5	1.5	2.5
2031	0.5	1.5	2.5	0.6	1.8	3	0.5	1.5	2.5
2032	0.5	1.5	2.5	0.6	1.8	3	0.5	1.5	2.5
2033	0.5	1.5	2.5	0.6	1.8	3	0.5	1.5	2.5
2034	0.5	1.5	2.5	0.6	1.8	3	0.5	1.5	2.5
2035	0.5	1.5	2.5	0.6	1.8	3	0.5	1.5	2.5
2036	0.5	1.5	2.5	0.6	1.8	3	0.5	1.5	2.5
2037	0.5	1.5	2.5	0.6	1.8	3	0.5	1.5	2.5
2038	0.5	1.5	2.5	0.6	1.8	3	0.5	1.5	2.5
2039	0.5	1.5	2.5	0.6	1.8	3	0.5	1.5	2.5
2040	0.5	1.5	2.5	0.6	1.8	3	0.5	1.5	2.5

Source: Feasibility Study and Alternative Analysis for Upgrading the Section between Rikoti, km144 and Shorapani, km 188 of the E60 Highway

<sup>1</sup> FS Sections: 3 sections of East–West Corridor (1. Ruisi–Rikoti, 2. Rikoti–Shorapani, 3. Samtredia–Grigoleti), Study period: Dec. 2009, Implementation: Kocks (German consultant) by Road Department budget.

**Table 5.1.3 Traffic Growth in JBIC Pilot Study (%)**

Year	Cars	Growth in other FS	Minibus	Light Truck	Large Bus	Medium Truck	Heavy Truck	Articulated Truck	Growth in other FS
2008	13.40	—	7.70	7.50	7.70	7.50	7.50	7.50	—
2009	10.70	3.00	5.20	7.00	5.20	7.00	7.00	7.00	2.50
2010	10.30	6.00	4.50	7.00	4.50	7.00	7.00	7.00	5.00
2011	10.50	6.00	4.30	7.00	4.30	7.00	7.00	7.00	5.00
2012	9.60	7.20	4.90	5.00	4.90	5.00	5.00	5.00	6.00
2013	7.60	4.80	2.80	5.00	2.80	5.00	5.00	5.00	4.00
2014	7.60	4.80	2.60	5.00	2.60	5.00	5.00	5.00	4.00
2015	7.70	4.80	2.40	5.00	2.40	5.00	5.00	5.00	4.00
2016	7.20	4.80	2.80	4.00	2.80	4.00	4.00	4.00	4.00
2017	6.20	4.80	1.70	4.00	1.70	4.00	4.00	4.00	4.00
2018	6.30	4.80	1.50	4.00	1.50	4.00	4.00	4.00	4.00
2019	6.30	4.80	1.40	4.00	1.40	4.00	4.00	4.00	4.00
2020	6.40	4.80	1.20	4.00	1.20	4.00	4.00	4.00	4.00
2021	5.80	4.20	1.80	3.00	1.80	3.00	3.00	3.00	3.50
2022	4.80	4.20	0.70	3.00	0.70	3.00	3.00	3.00	3.50
2023	4.80	4.20	0.50	3.00	0.50	3.00	3.00	3.00	3.50
2024	4.80	4.20	0.40	3.00	0.40	3.00	3.00	3.00	3.50
2025	4.90	3.60	0.20	3.00	0.20	3.00	3.00	3.00	3.00
2026	4.90	3.60	0.10	3.00	0.10	3.00	3.00	3.00	3.00
2027	4.90	3.60	−0.10	3.00	−0.10	3.00	3.00	3.00	3.00
2028	4.90	3.60	−0.30	3.00	−0.30	3.00	3.00	3.00	3.00
2029	5.00	1.80	−0.50	3.00	−0.50	3.00	3.00	3.00	1.50
2030	5.00	1.80	−0.70	3.00	−0.70	3.00	3.00	3.00	1.50

Source: JBIC Study Final Report, June 2008

**Table 5.1.4 Comparison of Traffic Volume Forecast at the Rikoti Tunnel**

Year	Growth in other FS		JBIC Study	
	Traffic volume (vpd)	Growth rate (%)	Traffic volume (vpd)	Growth rate (%)
2009	5,505	—	—	—
2010	5,664	3%	7,902	—
2015	7,423	31%	11,393	44%
2020	9,312	25%	15,068	32%
2030	13,563	46%	23,281	55%
2040	16,124	19%	—	—

Source: Feasibility Study and Alternative Analysis for Upgrading the Section between Rikoti, km144 and Shorapani, km 188 of the E60 Highway

**Table 5.1.5 Traffic Volume Forecast of Kutaisi–Samtredia Section (vpd)**

Year	2007	2008	2009	2010	2015	2020	2025	2030
Item								
JBIC Pilot Study	(6,262)	—	—	8,248	11,662	15,182	18,665	22,866
Other FS Growth Rate	—	(38%)	(−3%)	3%	31%	25%	—	46%
Reviewed Traffic Volume	—	8,642	8,382	8,576	11,234	14,043	—	20,503

( ): By actual traffic count

Source: JICA survey team

The reviewed traffic volumes for 2020 and 2030 are about 1,000 to 2,000 vpd lower than those of the JBIC Study estimates.

## 5.1.2 Road Class and Design Standard

### (1) Design Standard

In principle, the European Motorway Standard is used as the basis of highway design because the Samtredia section of the East–West Corridor is a part of the European Motorway Corridor



(E-60). However, it was confirmed that the Road Department of Georgia determined its own Highway Design Standard in February 2009; thus, the highway design was carried out according to the Georgian Design Standard as much as possible. Standard cross sections for embankment and bridge sections were presented by Road Department.

## (2) Classification of Roads

Roads in Georgia are classified by the Georgian Design Standards as shown in Table 5.1.6. The design speed of each class and by terrain is shown in Table 5.1.7.

**Table 5.1.6 Road Classification in Georgia**

Features	Class		
	International Trunk Highways	Domestic Trunk Highways	Regional Roads
Access control	Fully access controlled	Partially access controlled	No control of access
Purpose	Connecting the political, industrial and cultural centers of Georgia and neighbouring countries.	Connecting the capital and political and industrial centers of Georgia. Or, internationally important highways connecting such centers in Georgia.	Connecting regional political centers. International and domestic roads connecting regional centers.
Design speed	60–120 km/h	40–100 km/h	30–80 km/h
Cross section	2 lanes and more	2 lanes (multi-lanes in some cases)	2 lanes (1 lane exceptional)

Source: Highway standard of Georgia

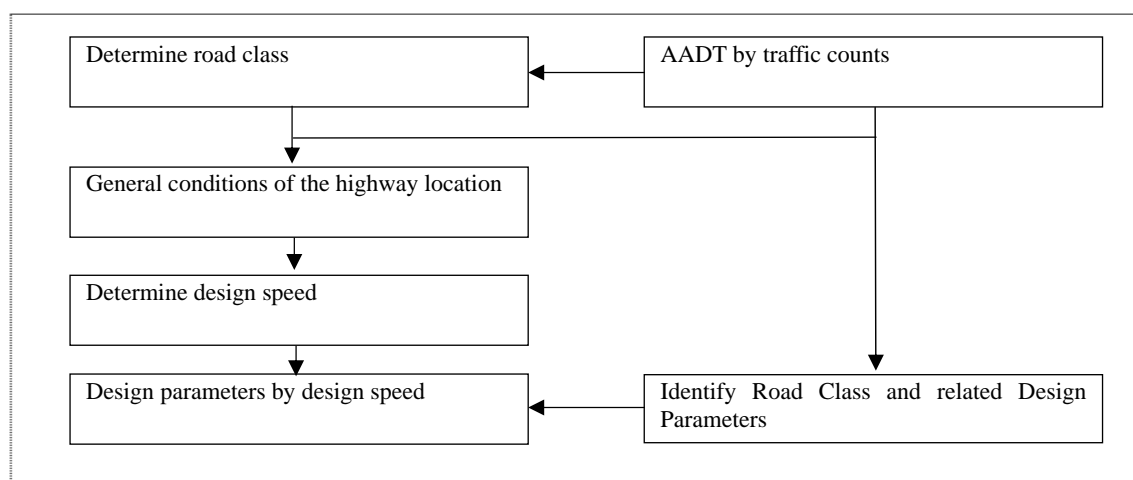
**Table 5.1.7 Design Speed by Highway Classification (km/h)**

Terrain	International trunk highways		Domestic trunk highways			Regional roads		
Traffic Volume	T>8,000	T<8,000	T>5,000	5,000–1,000	T<1,000	T>2,000	2,000–500	T<500
Flat	120	100	100	90	80	80	70	60
Rolling	100	80	80	70	60	60	50	40
Mountain	80	60	60	50	40	40	30	30

Note: Traffic volume is vehicles/day.

Source: Highway standard of Georgia

The design flow, according to the Georgian Design Standards, is as shown in Figure 5.1.2, and the design conditions for the JICA survey are summarized in Table 5.1.8.



Source: Highway standard of Georgia

**Figure 5.1.2 Design Flow**

**Table 5.1.8 Design Conditions of the Samtredia Section**

Class of Highway	Topography	Design traffic volume	Design speed	# of lanes	Cross section
International Trunk Highway	Flat	16,400 vpd <sup>2</sup>	120 km/hr	4 lanes (2 lanes at the start)	Standard cross section by RD of Georgia

Source: JICA Survey team

The design speed of 120 km/h is applied to the geometric design of the complete 4-lane highway. The geometric design of the temporary 2-lane highway remains the same as the complete highway of which the design speed is 120 km/h. There are many cases where the operating speed (or regulatory speed) and design speed is different depending on the various road conditions.

### (3) Road Design Parameters

The design parameters for this section are based on Georgian standards whereas the European Motorway Standard will supplement design practices when it is necessary. Design parameters of each standard are shown in the Table 5.1.9.

**Table 5.1.9 Design Parameters of the Samtredia Section**

No	Main Parameters	Unit	Flat		
			Georgian Standard	European Standard	
1	Design speed	km/h	120	120	
2	Number of lanes	Nos	4	4	
3	Lane width	M	3.75	3.75	
4	Shoulder width	M	3.75	3.5	
5	Minimum width of central reserve	M	4	4	
6	Hard shoulder width for emergency stops	M	2.5	2.5	
7	Verge for central reserve	M	1.5	0.25	
8	Maximum longitudinal gradient	%	4	4	
9	Minimum horizontal curvature at 7% cross fall	M	700	650	
10	Minimum radius of convex vertical curves	M	—	12,000	
11	Width of acceleration and deceleration lane	M	—	3.5	
12	Minimum stopping distance for straight section	M	250	200	
13	Normal cross fall of carriageway	%	2.5	2	
14	Maximum gradient of super elevation	%	7	7	
15	Design clearance of bridges and overpasses	Horizontal	M	—	12x2
		Vertical	M	5	4.5+ 0.20
16	Design clearance of tunnels	Vertical	M	—	4.5
		Service walkway width	M	—	0.75
17	Technical parameters of interchanges and junctions	Design speed	km/h	50	40
		Min. horizontal curves	M	80	50
18	Pavement structure		—	Concrete	

Source: JICA Survey team

## 5.1.3 Number of Lanes

### (1) Traffic Lanes

The number of traffic lanes is determined by the forecast volume for the design year. The traffic volume forecast is made based on the present traffic and estimated future growth. A design year of 20 years from the planning stage is usually taken. The design year of 2030 and design traffic volume of 16,400 vpd were selected for the design of this section. The number of lanes for this traffic volume is four, which coincides with the number of lanes in the category of the highway

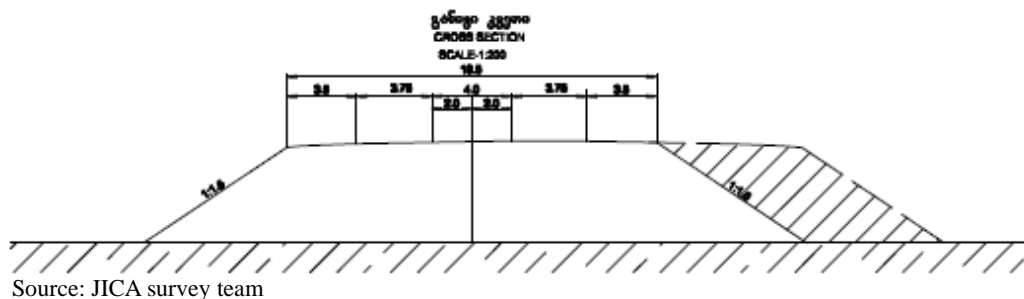
<sup>2</sup> Table 5.1.5 Design traffic volume of Kutaisi-Samtredia was set based on the assumption that the switch factor of 80% and the estimated traffic volume of 20,503 vpd in 2030.

with 14,000 vpd or more according to Japanese Design Standards. However, it seems proper for economic efficiency that the initial number of lanes is two, to minimize initial investment, with widening to four lanes in the future when the traffic reaches 14,000 vpd (traffic in the year 2010 would be 6,860 vpd ( $8,570 \times 0.8$ ) and 8,990 vpd ( $11,234 \times 0.8$ ) in 2015). According to this traffic forecast, the period for the 2-lane operation would be about 10 years after the opening. The year when the traffic reaches 14,000 vpd would be 2025. The widening should start roughly 3 years earlier than this.

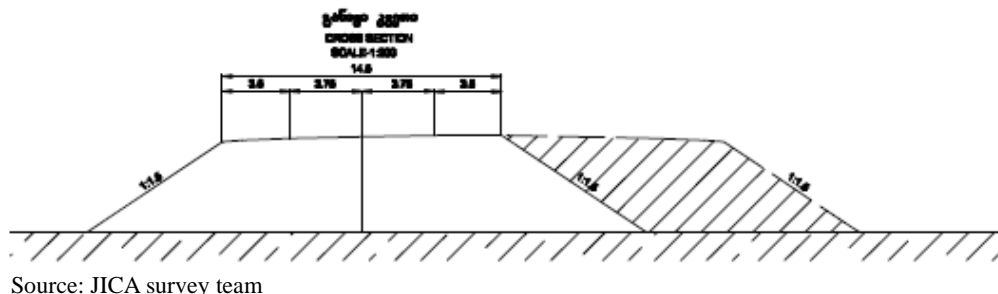
There are two methods of temporary construction of two-lane highways:

- Plan 1: Median strip will be installed for safety of traffic (Figure 5.1.3)
- Plan 2: Two-way traffic without median to minimize costs (Figure 5.1.4)

Plan 2 was selected after discussion with RD to minimize initial investment and future widening costs. Safety measures will be considered after the opening to traffic.



**Figure 5.1.3 Plan 1: Temporary 2 Lane Road with Median**



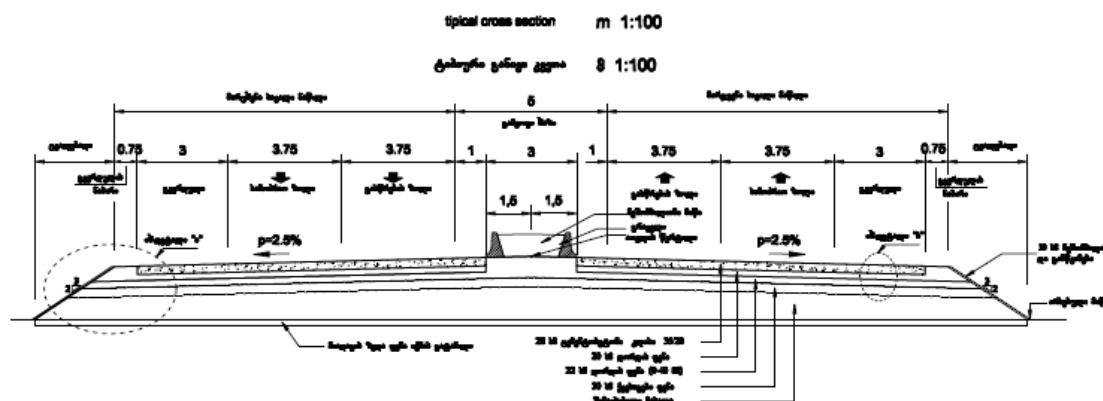
**Figure 5.1.4 Plan 2: Temporary 2 Lane Road without Median**

## (2) Right of Way

Although the initial construction is for two lanes, the land acquisition should be based on the full ROW width from the beginning.

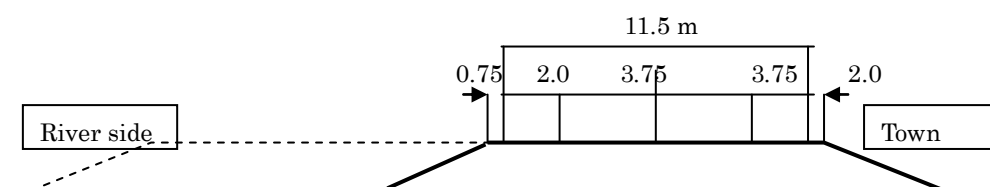
## (3) Standard Cross Section

The standard cross section is determined by both European and Georgian Design Standards. However, slightly different cross sections are proposed by the Road Department to coordinate with other sections already completed in Georgia. The cross sections for embankment (completed and temporary) and bridges are as shown in Figures 5.1.5 to 5.1.8.



Source: JICA survey team

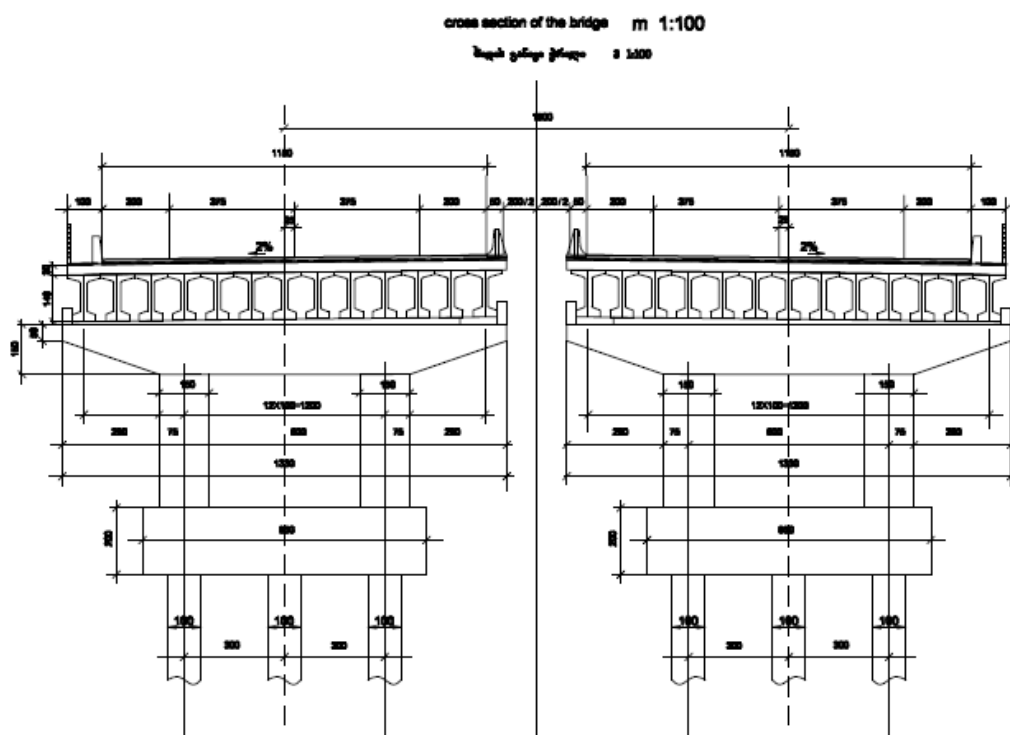
Figure 5.1.5 Standard Cross Section (Completed, Earthwork Section)



Unit : m

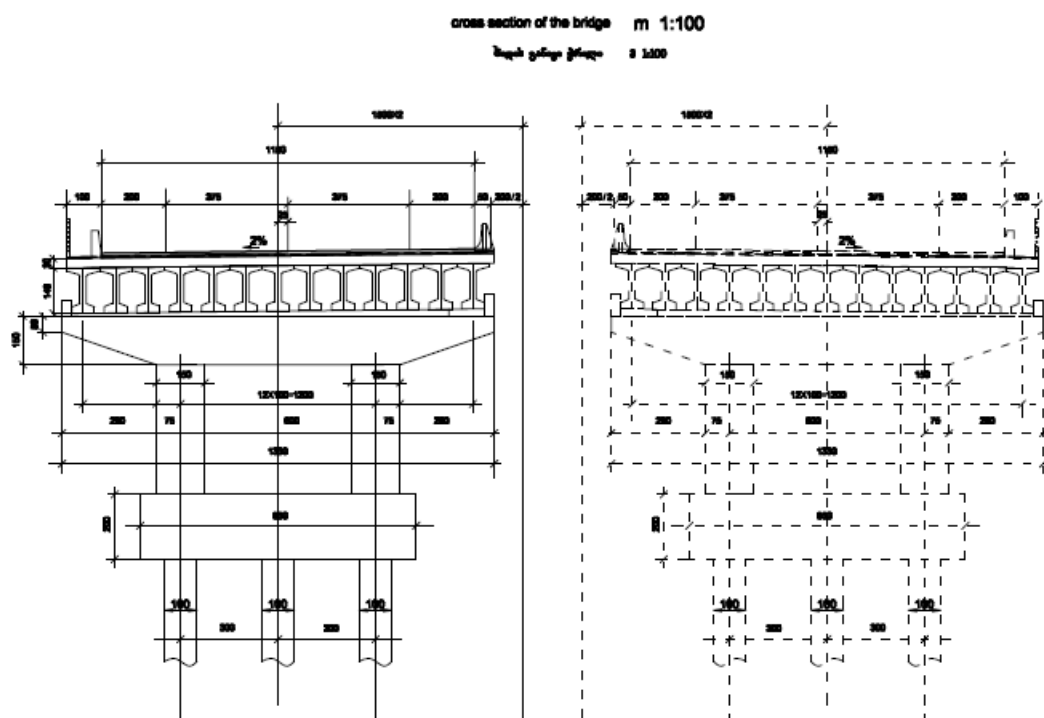
Source: JICA survey team

Figure 5.1.6 Cross Section (Temporary)



Source: JICA survey team

Figure 5.1.7 Standard Cross Section (Bridge Section – Completed)



Source: JICA survey team

**Figure 5.1.8 Standard Cross Section (Bridge Section – Temporary)**

## 5.1.4 Horizontal and Vertical Alignment

### (1) Horizontal Alignment

The final horizontal alignment was determined using various control points, geometric design standards, and topographic maps with reference to the initial alternative routes used for the different kinds of site surveys of this project. The main control points are the starting and end points of the route, river improvement plan, revetment, impact to houses, and public utilities including buried lines. The start and end points of the route are shown in Table 5.1.10. The horizontal alignment after examining those control points is shown in Appendix B.

**Table 5.1.10 Start and End Points**

Kind	Location	Factors to determine the location
Start	East (South of the airport)	The end point of the New Kutaisi Bypass shown in the JBIC Study
End	S-12 junction	Tentative end point connects to S-12 at grade

Source: JICA survey team

### (2) Vertical Alignment




The final vertical alignment was again determined using various control points, geometric design standards, and topographic maps after the final horizontal alignment was determined. The main control points are the height of starting and end points, the height of revetment based on the river improvement plan, bridge height, the height of other crossing structures including irrigation channels, pedestrian paths and road crossings. The vertical alignment after examining those control points are shown in Appendix B.

## 5.1.5 Interchanges

Two interchanges, Samtredia East and West, were proposed by the Road Department and their locations and structure types were examined. The alternatives of locations, size, shape and type

were compared. Detail plans and designs should be done during the detail design stage, but the comparison of interchange locations and types are shown in Table 5.1.11.

**Table 5.1.11 Comparison of Interchange Alternatives**

Name	Option	Location	Access road	Remarks
Samtredia East IC	Option 1	2.7 km from the starting point 	Regional road leading to Bashi and S-01	Service of both S-01 and regional road is possible. Less flood damage with a better ground. Access road improvement would be necessary.
	Option 2	5.2 km from the starting point 	S-01	The loop ramp of the trumpet IC would be eroded by the river. Flood damage would be possible in the future.
Samtredia West IC		West end of the section (S-12) 	Samtredia–Batumi Road (S-12)	At grade intersection of S-12 (Future connection to Poti is considered). Utilizing the existing row for the new IC (semi-clover type)

Source: JICA survey team

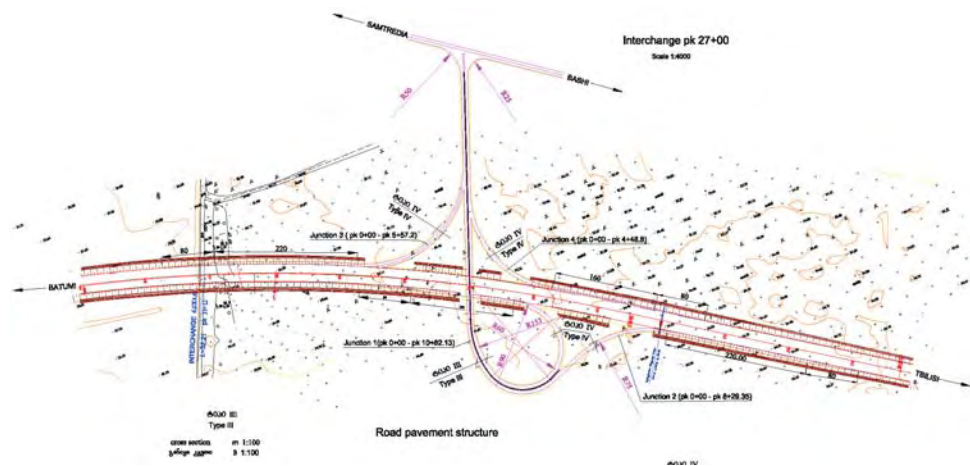
As shown in the table above, the comparison was made among two locations for the Samtredia East interchanges. The IC location of Option 1 is recommended due to the problem of the loop ramp of Option 2. The tentative type of trumpet shape is considered for comparison purposes. The detailed investigation of the site and geometric designs based on costs and safety will be necessary during the detail design stage.

The location of the Samtredia West IC or connection is automatically determined considering the future possible connection to Poti and extension of the East–West Highway mainline to Batumi direction. Cost reduction is possible by utilizing already acquired land for the IC ramp, which would be an at grade junction to the access road (as a temporary connection). The final and detailed geometrics of the IC should be determined based on the overall information of the highway such as traffic volumes and directional splits during detail design stage.

The determinant of the interchange locations and types were control points, easy construction, convenience, and social/natural environment. The following are the descriptions of each interchange candidate selection and comparison.

#### Samtredia East IC

The proposed interchange location will be on the left bank of the Gubistskali River but moved slightly Eastward to avoid an area of soft ground. Access to S-01 will be via the regional road which provides reasonable distant access to the National Highway without spoiling convenience to users. This access will provide services both to Samtredia and Bashi villages. A sketch of the interchange is shown in Figure 5.1.9.



Source: JICA survey team

**Figure 5.1.9 Samtredia East IC**

#### Samtredia West IC

The temporary connection to S-12 was determined at the Samtredia West IC. The route aims for the abandoned bridge location for future extension to Poti. The shape of the IC was planned to make full use of the reserved land space for the future extension as an at grade junction. A sketch of the interchange is shown in Figure 5.1.10.



Source: JICA survey team

**Figure 5.1.10 Samtredia West IC**

### **5.1.6 Road Structure**

#### **(1) Earthwork Section**

##### Embankment

The majority of the road structure is an embankment with the exception of the Gubistskali River Bridge and Ochopa River Bridge. The determining factors of the embankment height are the design high water level of the Rioni River and crossing structures. The embankment structures are based on the Georgian Road Design Standards. The standard slope gradient of 1:1.5 with sod slope protection is used.



Reduction of the earth work volume was important for cost minimization and efficient construction because the required soils for embankment construction have to be taken from borrow pits which are quite distant from the site. Nearby farmers said that the height of two culvert boxes designed at the ferry sites for use by ordinary automobiles is crucial when deciding the profile. Therefore, the embankment height of other sections without culvert boxes is designed as a low embankment structure wherever possible. Further soil reduction measures should be examined at the detail design stage.

### Construction Materials

A construction material survey was carried out during the site reconnaissance. Holocene as well as Pleistocene deposits of sand and gravel with boulders appear to be suitable for concrete aggregates and materials for gabion works and wet masonry, and they are currently used for such purposes locally. Embankment materials for the road will be obtained from weathered portions of Cenozoic and partly Mesozoic sedimentary rocks distributed in the north and south hills around the project site.

The soil layers containing the materials that can be used for concrete aggregates are sand and gravel layers (Asg, Dsg) along the river. Some materials can be used as they are, but usually they are crushed from large boulders to aggregates suitable for the purpose. Sand can be produced during the crushing process. The crushing plants near Samtredia produce aggregates for concrete in this way.

### Measures for Soft Foundation

The boring results of the soil survey showed that there are soft ground layers (N value of 10 or less) near the surface as shown in Table 5.1.12. It seems necessary to reduce differential settlement of the embankment after opening by replacing soft materials, and applying geo-textile, as an example, before embankment construction. It is necessary to decide the kinds of countermeasures and areas to be improved after a detailed geo/soil survey at the detail design stage.

It is important to determine the countermeasures against soft ground by detail soil and geological investigation, such as a soil consolidation test and sieve test during the detail design stage. The expected soft soil ground would be between BH-8 and BH-10 on the flat area of the previous flood plain.

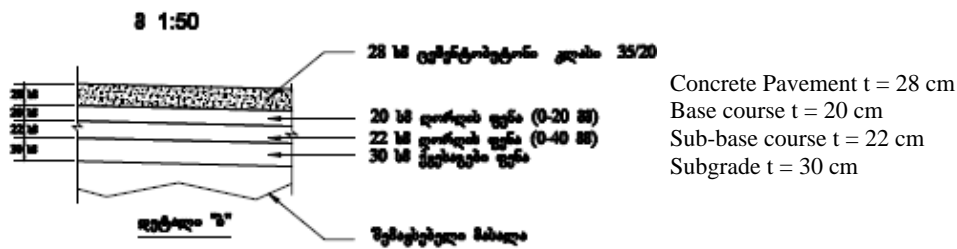
**Table 5.1.12 Soft Ground Thickness Based on the Soil Survey**

Boring No.	BH-01	BH-02	BH-03	BH-04	BH-05	BH-06	BH-07	BH-08	BH-09	BH-10	BH-11	BH-12
Thickness of N-value below 10	0.6m	1.5m	0m	0m	1.6m	2.0m	0m	1.5m	3.6m	3.0m	0m	0m

Source: JICA survey team

### Pavement

The pavement structure for this section is designed to be the same as the other sections of the highway of the East–West Corridor. The pavement structure is shown in Figure 5.1.11.



Source: Highway standard of Georgia

**Figure 5.1.11 Pavement Structure**

The basic pavement selection method is written in the European Motorway Design Standards. The pavement design (type, structure) will, at the detail design stage, be based on the cumulative heavy traffic volume.

## (2) Bridge Section

The location and the size of crossing roads, rivers, and water channels along the final horizontal alignment and topographic maps are shown in Table 5.1.13. The structures of bridges, culverts for road traffic, and drainage culverts are determined. The necessary bridges for rivers and IC are shown in Table 5.1.14.

**Table 5.1.13 List of Crossing Roads, Rivers, Water Channels**

	Chainage	Crossing facility	Type of facility	Size	Length	Bridge length	Note
1	3+55	Regional Road	Culvert	6X4.6	32.21		
2	7+55	Canal	R/C box culvert	4X2.5	46.76		
3	8+63	Canal	R/C pipe culvert	d=1.5	38.63		
4	18+57	Canal	R/C box culvert	4X2.5	31.50		
5	24+00	Lowland	R/C pipe culvert	d=1.5	37.60		
6	27+00	Ramp	IC Bridge		L-24m	L-24m	
7	31+12	Road	Culvert for people and livestock	6X4.6	32.21		
8	36+16	Ravine	R/C box culvert	4X2.5	40.63		
9	36+66	Canal	R/C pipe culvert	d=1.5	39.62		
10	38+30	Canal	R/C pipe culvert	d=1.5	42.67		
11	45+18	Riv. Gubistskali	Bridge	-		L-338.26	
12	48+13	Lowland	R/C pipe culvert	d=1.5	51.82		
13	56+00	Lowland	R/C pipe culvert	d=1.5	50.83		
14	63+61	Ravine	R/C box culvert	4X2.5	44.73		
15	68+31	Road	Culvert for people and livestock	6X4.6	32.21		
16	81+90	Riv. Cherokhe	R/C box culvert	6X4.6	32.21		
17	84+28	Road	Culvert for people and livestock	4X2.5	33.52		
18	90+70	Lowland	R/C pipe culvert	d=1.5	43.70		
19	91+38	Road	Culvert for people and livestock	4X2.5	33.52		
19	93+30	Lowland	R/C pipe culvert	d=1.5	41.70		
20	98+90	Lowland	R/C pipe culvert	d=1.5	41.70		
21	102+36	Ravine	R/C pipe culvert	d=1.5	45.72		
22	107+90	Lowland	R/C pipe culvert	d=1.5	44.73		
23	108+36	Road	Culvert for people and livestock	6X4.6	32.21		
24	111+24	Riv. Ochopa	Bridge			L-32.2m	
25	113+30	Ravine	R/C pipe culvert	d=1.5	40.65		
26	118+40	Lowland	R/C pipe culvert	d=1.5	41.68		

	Chainage	Crossing facility	Type of facility	Size	Length	Bridge length	Note
26	118+82	Road	Culvert for people and livestock	4X4,6	32.21		
27	121+57	Canal	R/C pipe culvert	d=1,5	17.0		At the junction

Source: JICA survey team

**Table 5.1.14 List of Bridges**

No.	Chainage	Crossing Road/River, Channel	Type of Bridge	No. Lanes	Length (m)
1	27+00	IC	PC Girder	4	24
2	45+18	Gubistskali	PC Girder	2	338
3	111+00	Ochopa	PC Girder	2	32

Source: JICA survey team

### (3) Others

#### Culvert

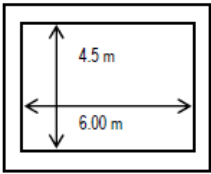
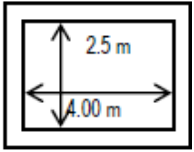
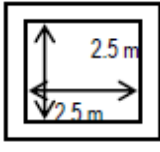

The locations and dimensions of crossing roads and water channels along the proposed route were identified as shown in Table 5.1.13. The location and size of the culverts were determined and designed as shown in Table 5.1.15. The size of the culverts is based on the standard size in the JBIC Study as shown in Table 5.1.16.

**Table 5.1.15 List of Culverts**

Chainage	Crossing facility	Type of facility	Size	Length
3+55	Regional road	Culvert	6X4.6	32.21
7+55	Canal	R/C box culvert	4X2.5	46.76
18+57	Canal	R/C box culvert	4X2.5	31.50
31+12	Road	Culvert for people and livestock	6X4.6	32.21
36+16	Ravine	R/C box culvert	4X2.5	40.63
63+61	Ravine	R/C box culvert	4X2.5	44.73
68+31	Road	Culvert for people and livestock	6X4.6	32.21
81+90	Riv. Cheroke	R/C box culvert	6X4.6	32.21
84+28	Road	Culvert for people and livestock	4X2.5	33.52
91+38	Road	Culvert for people and livestock	4X2.5	33.52
108+36	Road	Culvert for people and livestock	6X4.6	32.21
118+82	Road	Culvert for people and livestock	4X4,6	32.21

Source: JICA survey team

**Table 5.1.16 Type of Culvert**

Item	Type 1	Type 2	Type 3	Type 4
Size				
Purpose/usage	Vehicles (2 lanes) and pedestrians	Vehicles (1 lane) and pedestrians	Pedestrians and animals	Water channel

Source: JBIC Study final report

#### Drainage

The size and location of drainage structures were designed based on the Georgian Road Standards and the following water related data:

- Catchment area
- Precipitation
- Probability period (year)
- Coefficient of flow
- Topographic conditions

The following drainage systems and facilities were designed based on the rain data above:

- Pavement surface drainage
- Slope drainage
- Other drainage facilities

### Traffic Safety Equipment

The crash barriers used in Georgia as traffic safety equipment according to the Design Standards are classified into two types as shown in Table 5.1.17.

**Table 5.1.17 Crash Barrier Classification**

Classification	Purpose of installation
Group 1	a) To prevent vehicles entering railways and waterways out of the highway b) To protect structures located at road side against collision c) To prevent vehicles going out of the highway
Group 2	d) To separate traffic lanes if necessary

Source: Highway standard of Georgia

The European Highway Standard stipulates the following traffic safety facilities:

- Pavement marking
- Signs
- Delineators
- Emergency telephones, control center
- Anti-glare facilities
- Fence to prevent animals from entering
- Traffic control facilities
- Lighting

Thus, it is important to design traffic safety facilities properly during the detail design stage as instructed by Road Department and based on the Georgian and European Design Standards.

### **5.1.7 Bridge Design**

#### (1) Information Collection on Bridge Structure Design

The river plan for the Gubistskali river is mentioned in the following Section 5.1.8 “Basic design of dike and revetment”. The design conditions for bridge design are summarized in Table 5.1.18.

**Table 5.1.18 Design Conditions for Bridge Design**

Bridge name	High water level	Clearance	Scouring depth
Gubistskali River Bridge	29.6 m	2.0 m	3.5 m

Source: JICA survey team

## (2) Bridge Structure

Basic design has been conducted based on the conditions in Table 5.1.18. The general plan of the bridges has been drawn regarding length, span, superstructures, substructures and foundations. Rough construction costs were also estimated. The general characteristics of the Gubistskali River Bridge are shown in Figure 5.1.12.



Source: JICA survey team

**Figure 5.1.12 Gubistskali River Bridge**

### 5.1.8 Basic Design of Dike and Revetment

#### (1) Basic Concept

The design of dikes and revetments should be carried out taking into consideration the river character, flood velocity and scouring conditions of the river bed. The structure shall be safe and economical. The dike shall be constructed together with a revetment structure, since the proposed road is designed to pass in the flood plain area.

The design of dikes and revetments are conducted referring to Japanese Design Standards “Engineering Standards of River and Sediment Control” and “Dynamic Design Approach on Revetments”. Selection of revetment structures is decided considering material availability and economical efficiency. The characteristics of the Rioni and Gubistskali rivers, as well as their riverbed materials, are described in Section 3.2.2 in Chapter 3.

#### (2) Design Conditions (Water Level and Discharge)

The design high water level for the bridge and dike in Georgia are set at the discharges of 300-year and 100-year return period. In this study, the design water level and discharge are justified considering past high water observation, water levels in upper reaches at the ferry terminal (refer to Section 3.2.2 in Chapter 3) and recent climate change conditions.

The design water level for the study section is calculated by means of non-uniform flow based on the survey results conducted by the JICA survey team. The estimated deepest riverbed is calculated based on discharge of 5-year return period and sandbar height of about 5 m. The calculation conditions of water level are as follows:

- Water Level
  - Bridge design: EL. 18.66 m
  - Earth dike and revetment: EL. 16.70 m
  - Deepest riverbed: EL. 16.45 m
- Discharge
  - Bridge design: Rioni river — 5,418 m<sup>3</sup>/s, Gubistskali river — 675 m<sup>3</sup>/s
  - Earth dike & revetment: Rioni river — 3214 m<sup>3</sup>/s, Gubistskali river — 555 m<sup>3</sup>/s
  - Deepest riverbed: Rioni river — 1830 m<sup>3</sup>/s, Gubistskali river — 316 m<sup>3</sup>/s
- Roughness Coefficient:
  - Low water channel section: 0.030
  - High water channel section: 0.055

#### (3) Design Water Level and Velocity

The water level and velocity are calculated based on the above conditions. As a result, the velocity reached 6.5 m/s at confluence (Section No. 29) of the Gubistskali River. This velocity is too high for the design. As countermeasures for this, river improvement to induce lower velocity was considered. The study suggests improvements at river sections No. 28 and 29, with the velocity reduced to 4.2 m for ordinal design level. The calculation of water level and velocity are conducted based on the above conditions.

#### (4) Design of Dike

An earth dike about 7.3 km long was planned along the proposed road on the right bank of Rioni and Gubistskali Rivers. This dike will have a function for revetment maintenance as well as to protect the road from floods. The dike elevation was designed at design water levels calculated by design discharges plus 1.2 m and 1.0 m for the Rioni and Gubistskali rivers respectively. The crown width and their slope are 5.0 m and 4.0 m (minimum) according to the



design discharges and bank slope 1:2. The design dike elevation and water levels for the bridge and road are shown in Tables 5.1.19 and 5.1.20. The extent of the earth dike is shown in Figure 5.1.13.

**Table 5.1.19 Reference Level for Bridge and Highway Design  
(300-year Return Period)**

Sec. No.	Accum. Distance	Distance	Calculated Water Level	Design High Water Level	Minimum Required Road Surface	Ground Level of Right Bank	Remarks
	(m)	(m)	(EL m)	(EL m)	(EL m)	(EL m)	
1	0	0	18.66	18.66	19.66	19.4	Rioni River (No.1–29)
(F1)	37	37	20.05	20.05	21.05	23.7	Railway Bridge
(F2)	294	257	20.29	20.23	21.23	24.5	Road Bridge
2	1,007	713	20.74	20.74	21.74	18.2	
3	2,000	993	21.73	21.45	22.45	19.6	
4	2,998	998	22.00	22.16	23.16	19.3	
5	3,510	512	22.30	22.52	23.52	20.5	
6	4,010	500	22.88	22.88	23.88	19.7	
7	4,516	506	22.95	23.06	24.06	21.0	
8	5,013	497	23.06	23.23	24.23	20.2	
9	5,650	637	23.14	23.46	24.46	18.4	
10	6,043	393	23.19	23.60	24.60	18.2	
11	6,531	488	23.46	23.77	24.77	19.5	
12	7,043	512	23.62	23.95	24.95	21.6	Existing Levee
13	7,404	361	23.77	24.08	25.08	21.4	High Ground
14	7,666	262	23.73	24.17	25.17	21.7	Existing Levee
15	7,889	223	23.84	24.25	25.25	21.9	Existing Levee
16	8,149	260	23.97	24.34	25.34	22.7	Existing Levee
17	8,329	180	24.15	24.41	25.41	23.2	Existing Levee
18	8,542	213	24.24	24.48	25.48	23.8	Existing Levee
19	8,734	192	24.35	24.55	25.55	23.5	Existing Levee
20	8,934	200	24.62	24.62	25.62	23.6	Existing Levee
21	9,135	201	24.68	24.79	25.79	23.8	Existing Levee
22	9,335	200	24.78	24.95	25.95	24.1	Existing Levee
23	9,540	205	25.01	25.12	26.12	24.9	Existing Levee
24	9,743	203	25.00	25.29	26.29	24.9	Towhead
25	9,942	199	25.18	25.46	26.46	23.6	Towhead
26	10,442	500	25.48	25.88	26.88	22.8	
27	10,942	500	25.77	26.29	27.29	24.1	
28	11,154	212	25.86	26.47	27.47	24.4	
29	11,441	287	25.29	26.71	27.71	25.9	
31	12,153	712	27.30	27.30	28.30	24.1	Gubistskali River (No.31–
32	12,558	405	27.31	27.68	28.68	27.9	High Ground
33	12,951	393	27.34	28.04	29.04	29.0	High Ground
34	13,356	405	27.41	28.42	29.42	29.9	High Ground
35	13,559	203	27.63	28.61	29.61	29.5	High Ground
(F4)	13,660	101	28.05	28.70	29.70	29.0	Gaspipe line Bridge
36	13,754	94	28.15	28.79	29.79	28.2	
37	13,951	197	28.97	28.97	29.97	30.9	Existing Levee
38	14,151	200	28.91	29.60	30.60	31.1	Existing Levee
(F5)	14,270	119	30.05	29.97	30.97	33.2	Road Bridge
39	14,450	180	30.19	30.53	31.53	30.9	Existing Levee
40	14,748	298	30.63	31.47	32.47	34.0	Existing Levee
(F6)	14,975	227	30.76	32.18	33.18	37.5	Old Road Bridge
(F7)	15,094	119	32.55	32.55	33.55	36.7	Railway Bridge
41	15,553	459	33.28	33.28	34.28	34.5	

Source: JICA survey team

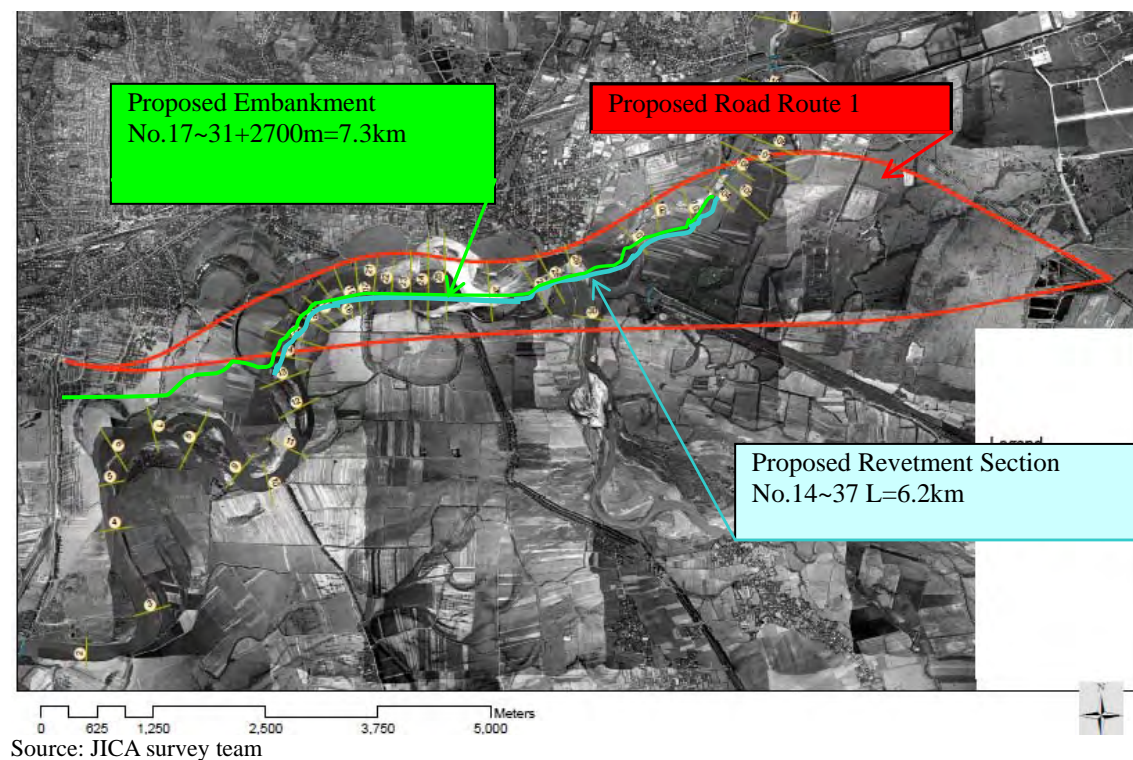
Table 5.1.20 Design Bank Level

Sec. No.	Accum. Distance	Distance	Calculated Water Level	Calculated Velocity	Design High Water Level	Design Bank Level	Lowest Riverbed Elevation	Ground Level of Right Bank	Remarks
	(m)	(m)	(EL m)	m/s	(EL m)	(EL m)	(EL m)	(EL m)	
1	0	0	16.70	5.53	16.70	17.90	11.480	19.4	Rioni River (No.1–29)
(F1)	37	37	18.08	2.55	18.08	19.28	8.680	23.7	Railway Bridge
(F2)	294	257	18.26	2.66	18.25	19.45	9.310	24.5	Road Bridge
2	1,007	713	18.63	3.29	18.73	19.93	12.079	18.2	
3	2,000	993	19.59	2.04	19.39	20.59	13.401	19.6	
4	2,998	998	19.94	2.84	20.06	21.26	12.575	19.3	
5	3,510	512	20.27	2.84	20.41	21.61	11.452	20.5	
6	4,010	500	20.74	1.31	20.74	21.94	10.956	19.7	
7	4,516	506	20.82	1.37	20.97	22.17	13.164	21.0	
8	5,013	497	20.93	1.38	21.20	22.40	12.135	20.2	
9	5,650	637	21.06	1.71	21.49	22.69	13.085	18.4	
10	6,043	393	21.14	2.15	21.67	22.87	13.707	18.2	
11	6,531	488	21.44	1.76	21.90	23.10	15.050	19.5	
12	7,043	512	21.68	1.68	22.13	23.33	15.610	21.6	Existing Levee
13	7,404	361	21.84	1.30	22.30	23.50	14.620	21.4	High Ground
14	7,666	262	21.81	2.33	22.42	23.62	14.510	21.7	Existing Levee
15	7,889	223	21.91	3.11	22.52	23.72	14.870	21.9	Existing Levee
16	8,149	260	22.27	2.43	22.64	23.84	14.330	22.7	Existing Levee
17	8,329	180	22.42	2.37	22.72	23.92	14.260	23.2	Existing Levee
18	8,542	213	22.57	2.57	22.82	24.02	15.570	23.8	Existing Levee
19	8,734	192	22.72	2.67	22.91	24.11	15.900	23.5	Existing Levee
20	8,934	200	23.00	1.85	23.00	24.20	16.610	23.6	Existing Levee
21	9,135	201	23.09	2.30	23.16	24.36	16.046	23.8	Existing Levee
22	9,335	200	23.20	2.06	23.32	24.52	16.284	24.1	Existing Levee
23	9,540	205	23.38	1.79	23.48	24.68	16.717	24.9	Existing Levee
24	9,743	203	23.38	2.44	23.64	24.84	16.297	24.9	Towhead
25	9,942	199	23.59	2.30	23.80	25.00	17.196	23.6	Towhead
26	10,442	500	23.89	2.16	24.20	25.40	17.033	22.8	
27	10,942	500	24.26	2.12	24.60	25.80	18.903	24.1	
28	11,154	212	24.43	1.96	24.77	25.97	18.646	24.4	
29	11,441	287	24.19	4.17	24.99	26.19	14.556	25.9	
31	12,153	712	25.56	0.77	25.56	26.56	20.895	24.1	Gubistskali River (No.31–41)
32	12,558	405	25.61	0.85	26.27	27.27	21.954	27.9	High Ground
33	12,951	393	25.75	1.78	26.97	27.97	23.480	29.0	High Ground
34	13,356	405	26.77	1.93	27.68	28.68	24.496	29.9	High Ground
35	13,559	203	27.27	2.96	28.04	29.04	25.203	29.5	High Ground
(F4)	13,660	101	27.84	1.95	28.22	29.22	24.894	29.0	Gaspipe line Bridge
36	13,754	94	27.90	3.22	28.38	29.38	24.979	28.2	
37	13,951	197	28.73	2.05	28.73	29.73	25.646	30.9	Existing Levee
38	14,151	200	28.72	4.10	29.19	30.19	26.057	31.1	Existing Levee
(F5)	14,270	119	29.66	1.46	29.46	30.46	25.799	33.2	Road Bridge
39	14,450	180	29.79	1.94	29.87	30.87	26.587	30.9	Existing Levee
40	14,748	298	30.51	1.49	30.55	31.55	27.697	34.0	Existing Levee
(F6)	14,975	227	31.17	3.54	31.07	32.07	26.938	37.5	Old Road Bridge
(F7)	15,094	119	31.34	2.52	31.34	32.34	24.439	36.7	Railway Bridge
41	15,553	459	32.49	1.23	32.49	33.49	30.350	34.5	

Note:

1. Rioni River Proposed Embankment is Right Bank Only
2. Gubistskali River : Proposed Embankment is Right Bank and Bridge Section of Right and Left Bank
3. Section No: Refer to Survey Section, (F No) indicate Facility No. in Survey Drawings
4. Design Bank Level for Rioni River =High Water Level +1.2m
5. Design Bank Level for Gubistskali River =High Water Level +1.0m
6. Bank Elevation of Bridges means Bottom Surface of bridge slab.

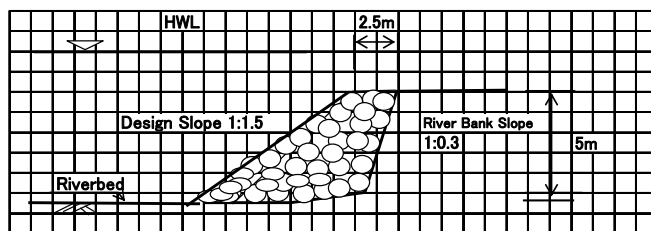
Source: JICA survey team



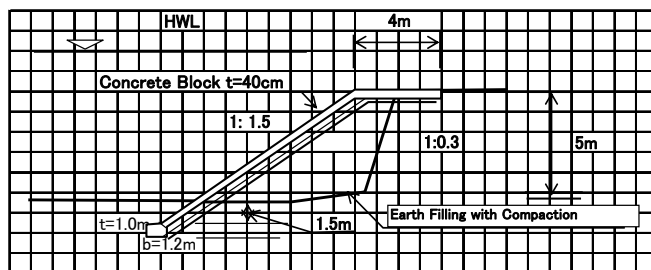
**Figure 5.1.13 Extent of Earth Embankment and Revetment**

#### (5) Selection of Revetment Type

The extent of revetment was decided considering the route of the proposed road, the alignment of the river and the scouring conditions. As a result, the revetment was designed to be 6.2 km long on the right bank running from section No.14 of the Rioni river to section No. 37 of the Gubistskali river. Considering the available materials at the site, the appropriate revetment types are stone, concrete block and gabion types. The stone type revetment was selected considering the construction cost and maintenance considerations (refer to Figure 5.1.14). With reference to the revetment at the ferry facilities, further study should be conducted in the detailed design stage based on detailed topographical data. Special revetment structures may be required to take the change of water level into consideration.

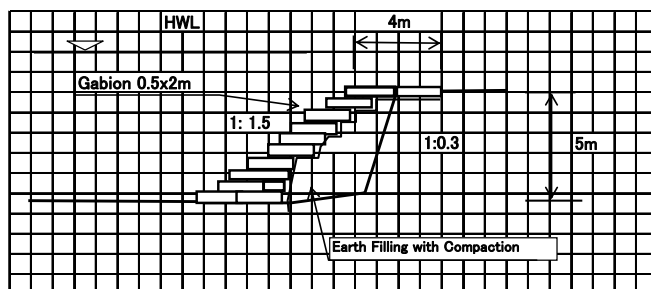
**1 Stone Type Revetment**

1 Stone Volume per unit=	Unit Volume	
	27.5	m3
1 Cost (GEL)=Unit Cost x Volume	Unit Cost	Cost
	70	1,925

**2. Concrete Type Revetment**

1 Concrete Volume per unit = 2 Earthfilling 3 Excavation 4 Preparatory Works	Unit Volume	
	7.49	m3
	22.5	m3
	12.5	m3
	1	LS

1 Cost=Unit Cost x Volume = 2 Earthfilling 3 Preparatory Works (Direct Cost x20%) Cost (GEL)	Unit Cost	Cost
	210	1,572
	14	315
	377	2,265

**3. Gabion Type Revetment**

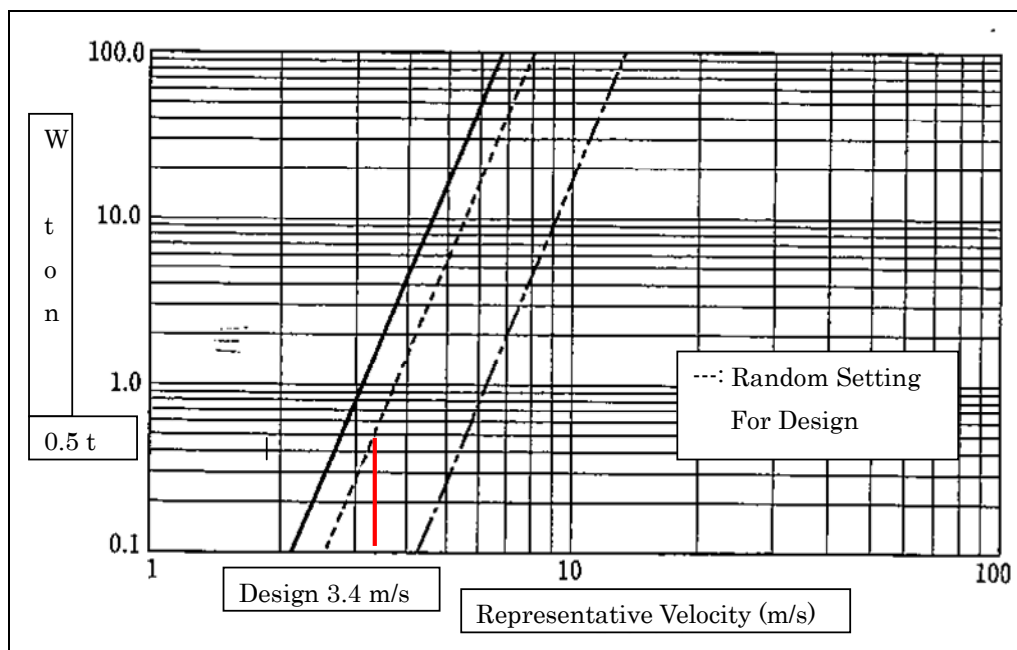
1 Gabion Volume per unit = 2 Earthfilling 3 Preparatory Works (Direct x20%)	Unit Volume	
	23.5	m3
	7.5	m3
	1	LS

1 Cost=Unit Cost x Volume= 2 Earthfilling 3 Preparatory Works (Direct Cost x20%) Cost (GEL)	Unit Cost	Cost
	77	1,810
	14	105
	383	2,297

Source: JICA survey team

**Figure 5.1.14 Selection of Revetment Type**Design of Stone Type Revetment

The design velocity for the revetment design was set at 3.4 m/s referring to the average velocity in the proposed road section. The design stone weight of the revetment was set at 0.5 tons per piece referring to the diagram shown in Figure 5.1.15. For the revetment at the proposed bridge section of the Gubistskali, a minimum length of 30m up and down from the bridge is recommended according to Japanese Standards.



Source: JICA survey team

**Figure 5.1.15 Design Weight of Revetment Stone**

Regarding the foot protection of the revetment, the estimated maximum riverbed depth was calculated from the 5-year discharge. River curvature was also considered. The calculated maximum riverbed depth ranges from 1 to 1.5 m from the lowest riverbed. The study classified the revetment type with foot protection as A, B and C (please see Table 5.1.21 and Figure 5.1.16). The type and section of the revetment, as well as its total length for each section, are summarized in Figure 5.1.16.

**Table 5.1.21 Design Revetment Top Level and Expected Lowest Riverbed**

Sec. No.	Accum. Distance	Distance	1) Expected Lowest Riverbed (EL m)	2) Lowest Riverbed Elevation (EL m)	Depth: 2)–1) (m)	3) Design Top of Revetment (EL m)	4) Riverbed EL (EL m)	Remarks
1	0	0	10.37	11.480	1.112			Rioni River (No.1–29)
(F1)	37	37	7.70	8.680	0.981			Railway Bridge
(F2)	294	257	8.23	9.310	1.077			Road Bridge
2	1,007	713	10.16	12.079	1.921			
3	2,000	993	11.94	13.401	1.465			
4	2,998	998	11.25	12.575	1.329			
5	3,510	512	12.31	11.452	–0.863			
6	4,010	500	12.32	10.956	–1.364			
7	4,516	506	12.28	13.164	0.880			
8	5,013	497	13.05	12.135	–0.913			
9	5,650	637	12.84	13.085	0.246			
10	6,043	393	12.84	13.707	0.864			
11	6,531	488	14.04	15.050	1.011			
12	7,043	512	13.58	15.610	2.035			
13	7,404	361	13.37	14.620	1.247			
14	7,666	262	14.08	14.510	0.429	20.4	17.3	Design Revetment Section (No.14–37)
15	7,889	223	15.42	14.870	–0.554	20.4	17.3	
16	8,149	260	14.94	14.330	–0.608	20.4	15.2	
17	8,329	180	15.54	14.260	–1.279	20.4	15.6	
18	8,542	213	15.58	15.570	–0.006	20.4	16.7	
19	8,734	192	15.66	15.900	0.244	20.4	16.9	
20	8,934	200	15.16	16.610	1.448	21.8	16.9	
21	9,135	201	14.84	16.046	1.210	21.8	20.1	
H.W.R.B						20.1	17.7	
22	9,335	200	15.28	16.284	1.007	21.8	20.1	
H.W.R.B						20.1	16.4	
23	9,540	205	15.31	16.717	1.409	21.8	17.4	
24	9,743	203	16.14	16.297	0.160	22.8	21.0	
H.W.R.B						21.0	16.6	
25	9,942	199	15.71	17.196	1.486	23.1	21.8	
H.W.R.B						21.8	17.3	
26	10,442	500	16.77	17.033	0.267	23.1	21.8	
H.W.R.B						21.8	20.3	
27	10,942	500	17.25	18.903	1.653	23.3	19.5	
28	11,154	212	16.86	18.646	1.781	23.9	19.7	
29	11,441	287	13.96	14.556	0.594	25.5	20.9	
31	12,153	712	18.10	20.895	2.791	25.5	22.2	Gubistskali River (No.31–41)
32	12,558	405	19.32	21.954	2.629	27.7	23.5	
H.W.R.B						23.5	22.0	
33	12,951	393	20.72	23.480	2.756	28.8	25.0	
34	13,356	405	21.31	24.496	3.188	29.8	24.6	
35	13,559	203	21.92	25.203	3.287	29.8	25.3	
(F4)	13,660	101	22.14	24.894	2.750	29.8	25.3	Gaspipe line Bridge
36	13,754	94	22.44	24.979	2.541	30.4	25.1	
37	13,951	197	22.98	25.646	2.664	30.3	25.6	
38	14,151	200	22.75	26.057	3.305			
(F5)	14,270	119	22.64	25.799	3.160			Road Bridge
39	14,450	180	23.71	26.587	2.876			
40	14,748	298	24.92	27.697	2.782			
(F6)	14,975	227	25.28	26.938	1.658			Old Road Bridge
(F7)	15,094	119	25.16	24.439	–0.718			Railway Bridge
41	15,553	459	27.18	30.350	3.166			

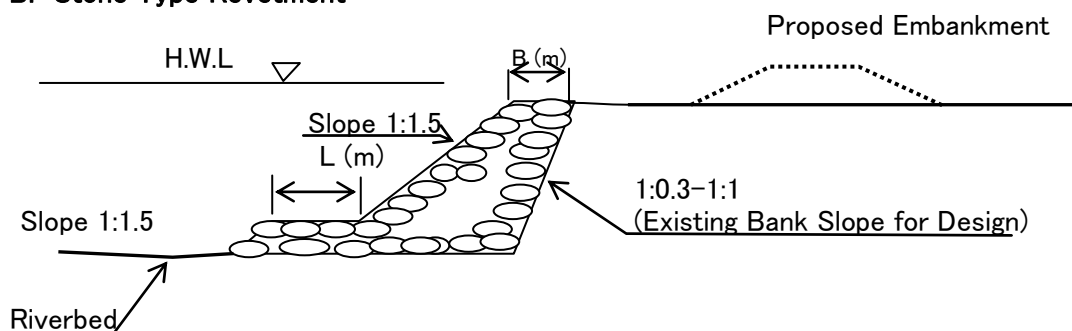
Note:

H.W.R.B: Revetment for High Water River Bank

Source: JICA survey team

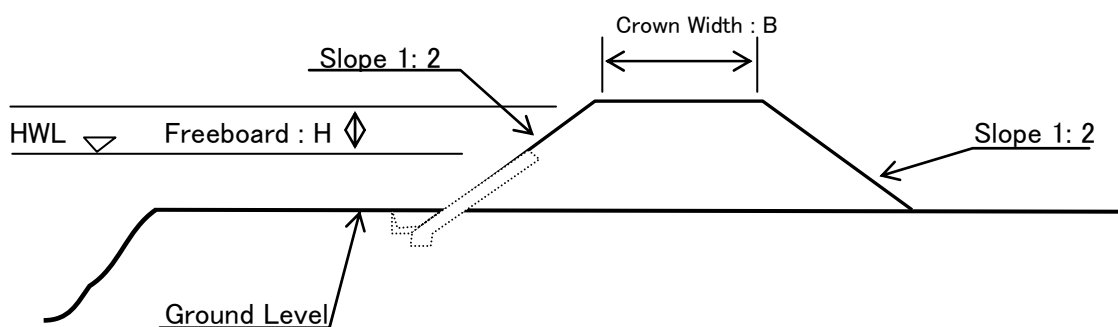
**A. Revetment Type and Section**

Type	L	B	Section	Distance	Remarks
	(m)	(m)	(Sta.No)	(m)	
Type A	4.0	2.5	No.14–22, No27–29	2,800	
Type B	3.0	2.5	No.22–23, No29+200–No.36	2,200	
Type C	2.0	2.0	No.23–27	1,200	
Total Length (m)				6,200	

**B. Stone Type Revetment****C. Designed Embankment**

Embankment Dimension

River	B	H	Slope	Remarks
	(m)	(m)		
Rioni River	5.0	1.2	1: 2	Minimum requirements
Gubistskali River	4.0	1.0	1: 2	Minimum requirements



Note: Drawing is Conception Only

Source: JICA survey team

**Figure 5.1.16 Standard Section of Revetment Type and Earth Embankment****(6) Scouring at Bridge Piers and Countermeasures**

Bridge construction is proposed at river section No. 37 between the existing gas pipe crossing, the road bridge over the Gubistskali and local drainage flowing to the Rioni at No.9. Judging from the site conditions, the scouring problem occurs only for the Gubistskali river bridge. The scouring depth is estimated at 3.5 m according to the applicable approaches assuming the pier ( $D=1.5$  m), water depth 5m and design velocity 4 m/s (please see Table 5.1.22)

**Table 5.1.22 Scouring Depth at Bridge Section**

			<u>Conditions of Calculation</u>		
			Zs:	Depth of Erosion	
			h:	Water Depth	5 m
			D:	Width of Pier	1.5 m
			V:	Velocity	5 m/s
<u>Approach</u>					
1	Andru	$Z_s/h=0.8$	$Z_s=$	4.0	m
2	Neil, Cunha	$Z_s/D = 1.5 \cdot (h/D)^{0.3}$	$Z_s=$	3.2	m
3	Tarapore	$Z_s/h = 1.17$	$Z_s=$	5.9	m
4	Larras	$Z_s = 1.05 \cdot D^{0.75}$	$Z_s=$	1.4	m
5	Breusers	$Z_s = 1.4 \cdot D$	$Z_s=$	2.1	m
6	Shen	$Z_s = 0.00022 \cdot Re^{0.619}$ $Re = u \cdot D \cdot 1000000$	$Z_s=$	4.0	m
7	Japan Railway Ltd	$Z_s/D = 1.6$	$Z_s=$	2.4	m
		1) Average Depth		2.9	m
		Design Depth :1)x1.2		3.5	m

Source: JICA survey team

**(7) Quantity of Dikes and Revetments**

Preliminary estimates of the quantities of dikes and revetments are summarized in Table 5.1.23. The basic conditions for the quantity calculation are as follows:

- **Embankment Volume**

Embankment Section: Trapezoid (Ref. Figure 5.1.16)

Height of Embankment (m) = Design EL of Dike-Ground Level (Ref. Table 5.1.20)

Embankment Volume (m<sup>3</sup>) = Distance x Sectional Area

Note: Embankment height between the junction to Rioni No.17, about 2,700 m, is assumed to be 1.5m high.

- **Revetment Volume**

Revetment Section: Trapezoid (Ref. Figure 5.1.16)

Height of Revetment (m) = Design EL of Revetment-Riverbed Level (Ref. Table 5.1.21)

Design slope of Revetment = 1:1.5

Slope of Existing River Bank = 1:0.3–1:1 (Ref. Table 5.1.23)

Revetment Volume (m<sup>3</sup>) = Distance x Sectional Area

- **Foot Protection Volume**

Section: Trapezoid (Ref. Figure 5.1.16)

Foot Protection Volume (m<sup>3</sup>) = Distance x Sectional Area



Table 5.1.23 Quantity of Embankment and Revetment

Sec. No.	1) A ccum. Distance	Embankment	3) Embankment Volume	Revetment	Existing River Bank Slope	Type	Revetment Volume		Remarks
		2) Height of Dike(H)		4) Height (H)			5) Revetment Volume	6) Foot Protection	
	(m)	(m)	(m3)	(m)			(m3)	(m3)	
		Junction to River Sta. No.14=2700m, Have=1.5m  V (m3)= 32,400							
14	0	2.92	10,909	3.1	1:0.5	B	4,331	1,553	
15	345	3.32	11,016	3.1	1:0.5	B	3,578	1,283	
16	630	3.94	11,417	5.2	1:0.3	B	6,575	1,013	
17	855	4.82	16,949	4.8	1:0.3	B	6,198	1,080	
18	1,095	3.02	8,002	3.7	1:0.3	B	4,191	1,080	
19	1,335	3.51	9,485	3.5	1:0.5	B	3,347	1,013	
20	1,560	3.40	8,425	4.9	1:0.3	B	5,598	945	
21	1,770	3.06	7,145	1.7	1:0.5	C	1,017	630	
H.W.R.B	1,770			2.4	1:0.5	C	1,613	630	
22	1,965	2.32	4,358	1.7	1:0.5	C	945	585	
H.W.R.B	1,965			3.7	1:0.5	C	2,778	585	
23	2,145	2.28	4,256	4.4	1:0.5	C	3,326	540	
24	2,340	1.64	2,656	1.8	1:0.5	C	1,018	585	
H.W.R.B	2,340			4.4	1:0.5	C	3,604	585	
25	2,535	1.40	2,133	1.3	1:0.5	C	672	585	
H.W.R.B	2,535			4.5	1:0.5	C	3,729	585	
26	3,000	2.50	11,620	1.3	1:0.5	C	1,602	1,395	
H.W.R.B	3,000			1.5	1:0.5	C	1,918	1,395	
27	3,375	1.68	5,280	3.8	1:0.3	C	6,099	1,125	
28	3,600	1.77	3,389	4.2	1:1	A	3,355	1,350	
29	3,900	1.09	2,358	4.6	1:1	A	5,037	3,960	
31	4,560	2.56	15,409	3.3	1:0.5	B	9,039	2,970	
32	5,010	0.00	0	4.2	1:0.5	B	8,694	2,025	
H.W.R.B	5,010	0.00	0	1.5	1:0.5		2,194	2,025	
33	5,400	0.00	0	3.8	1:0.5	B	7,084	1,080	
34	5,640	0.00	0	5.2	1:0.5	B	7,014	1,080	
35	5,820	0.00	0	4.5	1:0.5	B	4,212	810	
(F4)	5,910	0.00	0	4.5	1:0.5	B	2,106	405	Gas Pipeline
36	6,000	0.00	0	5.3	1:0.5	B	2,720	405	
37	6,180	0.00	0	4.7	1:0.5	B	4,501	810	Proposed Bridge
Quantity									
	1.Embankment Total Volume (m3)		167,206	2. Revetment & Foot Protection (m)			118,095	23,310	
	Length: Junction to No.31(m)=		7,260	Length (m)=			6,180		
	3. Excavation and Filling (m3)								
	(River Sta.No.28`29)		300,000						
Note:									
H.W.R.B: Revetment for High Water River Bank									

Source: JICA survey team

## 5.2 Project Cost Estimate

The rough project costs have been estimated based on each cost item from the basic design results. Cost items were determined by the basic design and by the results of the JBIC Study. The project costs were estimated by the breakdown of items multiplied by the unit costs. The unit costs were estimated by market research, and hearings with contractors, because there were no standard unit costs provided by the Road Department of Georgia. The total project costs are shown in the following table:

**Table 5.2.1 Total Project Costs**

No.	Item	Cost Estimate Summary				
		Option R-1 Cost	Option R-2 Cost	Option R-3 Cost	Option L-1 Cost	Option L-2 Cost
<b>I</b>	<b>Preparatory works</b>	<b>5,326</b>	<b>4,280</b>	<b>3,468</b>	<b>1,499</b>	<b>1,499</b>
I-a	Land Acquisition and Resettlement	1,301	1,265	2,293	1,134	1,134
I-b	Other preparatory works	4,025	3,015	1,175	365	365
<b>II</b>	<b>Earthworks</b>	<b>19,163</b>	<b>19,379</b>	<b>18,211</b>	<b>46,577</b>	<b>32,459</b>
<b>III</b>	<b>Pavement</b>	<b>11,546</b>	<b>11,652</b>	<b>11,556</b>	<b>8,096</b>	<b>8,096</b>
<b>IV</b>	<b>Facilities</b>	<b>18,138</b>	<b>18,430</b>	<b>17,280</b>	<b>33,198</b>	<b>76,006</b>
IV-a	Bridges	5,030	5,030	5,030	15,416	67,034
IV-b	Revetment	9,660	9,660	8,510	16,100	8,372
IV-c	Others	3,448	3,740	3,740	1,682	600
<b>V</b>	<b>Junctions #1, #2</b>	<b>1,575</b>	<b>1,575</b>	<b>1,575</b>	<b>1,575</b>	<b>1,575</b>
<b>VI</b>	<b>Interchange</b>	<b>2,626</b>	<b>2,626</b>	<b>2,626</b>	<b>224</b>	<b>224</b>
<b>VII</b>	<b>Safety measures and Social Considerations</b>	<b>4,212</b>	<b>4,256</b>	<b>5,140</b>	<b>3,671</b>	<b>3,293</b>
<b>VIII</b>	<b>Contingencies</b>	<b>3,129</b>	<b>3,110</b>	<b>2,993</b>	<b>4,742</b>	<b>6,158</b>
	<b>Total</b>	<b>65,715</b>	<b>65,308</b>	<b>62,850</b>	<b>99,582</b>	<b>129,310</b>

Note: Option R denotes the right bank side route and Option L denotes the left bank side route.

Option R-1 is the recommended option, R-2 is a variation to minimize relocation of houses using small radius of curvature, R-3 tries to avoid impacts on the river, L-1 is on the left bank side with embankment, and L-2 is on the left bank side with long bridges.

Source: JICA survey team



## **Chapter 6 Recommendations for Project Implementation**

### **6.1 Road Design**

The road design satisfied the required design standards and necessary control points. The issues to be considered in the next stage are:

- Whether to proceed with reclaiming a part of the river for construction of the road (engineers in the Road Department accept this);
- Although the existing utility lines and relocation plan were studied, more detailed investigation will be necessary;
- A large amount of soil is necessary for the embankment from borrow pits;
- Construction work in the river such as revetment, bridge and reclamation must be done during low water periods.

An efficient survey and design will be required to the minimize construction schedule. The construction period must be carefully planned.

### **6.2 Bridge Design**

The geological conditions have been investigated within the scope of the basic survey along the assumed alignment of the highway (which later was slightly changed). Additional soil investigations for bridge design based on the exact location of the abutment and piers will be necessary at the detail design stage. The type and span of the bridge may be modified depending on the results of the soil investigation. New technology for cost reductions may also be considered.

### **6.3 River Improvement and Design of Revetment**

#### **(1) Assignment of River Expert**

The Water Code of Georgia was prepared during USSR period and has not been changed since then, even after independence in 1991. The basic concept of the water code is to protect water resources and their environmental conditions and to ensure clarification about the contents of proposed project. According to the code, any river improvement work must be approved by a committee consisting of relevant organizations, but there is no such organization at present and the effectiveness of the water code is questionable. However, project information regarding hydrology and river improvements, including dike and revetment works, need to be explained to the concerned agencies and people. Accordingly it is recommended to assign a river expert during the detailed design stage

#### **(2) Detailed Design of Dike and Revetment**

The basic design was prepared based on limited survey data, hydrological data and a short assignment period. Therefore the detailed design should be carried out with more detailed survey works, and hydrological information/studies. The major items to be newly included are ferry facilities, local drainage and some compensation works related to the project.

#### **(3) Observation of Water Level**

Water level observation has not been carried out since 1961. Water level gauging at the site, including during the detailed design stage, is recommended for a minimum of one year.

## **6.4 Geological Investigation**

Alluvium deposits and the upper parts of Divilium deposits were surveyed in this study. The engineering properties of Alluvium and upper parts of Divilium deposits can be determined on the basis of obtained data, however the data of engineering properties obtained from lower parts of Divilium deposits and bed rocks appears to be insufficient to determine the typical value of the layer. The engineering properties of lower layers of Dsg-2 and basement rock should be determined by execution of laboratory tests etc. of core samples at the detail design stage.

Site investigations for construction materials shall be performed in detail at a later stage. Laboratory tests, as well as field tests such as a trial embankment are proposed to be executed at the detailed design stage. Additional geological investigations at the sites of structures like bridges should also be performed.

The following are additional tests recommended to be carried out on site:

- Test for concrete aggregates: Density test, Water absorption test, Sieve analysis, Unit weight test, Organic Impurity test, Exfoliation damage test, Stability test, Compression test, Alkali-Silica reactivity test etc.
- Test for embankment (earth) material: Sieve analysis, Water content test, Tri-axial compression test etc.

## Chapter 7 Conclusions

The basic survey for the East–West Highway Project near Samtredia area has been carried out and the basic design and cost estimates have been prepared. Surveys conducted cover topography, river investigation, geological characteristics and socio-environmental study. The following conclusions can be drawn from the surveys:

- The characteristics of the Rioni River are key to the road planning and design
- The option on the right bank of the Rioni River is more advantageous than the left bank
- The right bank option involves the relocation of various public facilities and utility lines and thus will take long time because of necessary negotiations
- The cost for the relocation of such facilities on the right bank option will come to a significant amount
- Options on both the right and left bank sides will have a certain impact on the Rioni River structure and stream
- Countermeasures against erosion from the Rioni River are important for both options

The overall evaluation based on environmental, social, economic and technical factors is summarized in the Table 7.1.1.

**Table 7.1.1 Comments on Overall Evaluation of Each Alternative**

Option	Features	Advantages	Concerns	Evaluation
Right bank (Option R-1)	Standard design	<ul style="list-style-type: none"> <li>• Reclaim a part of the river flood plain</li> <li>• Some relocation of houses</li> <li>• Better traffic safety (well balanced road design)</li> </ul>	<ul style="list-style-type: none"> <li>• Reclamation might be a problem</li> <li>• Relocation costs and time</li> <li>• Highest construction costs among right bank options</li> <li>• Relocation time and costs of public utilities</li> </ul>	○
Right bank (Option R-2)	Relocation minimizing	<ul style="list-style-type: none"> <li>• Reclaim a significant part of the river flood plain</li> <li>• Minimum relocation of houses</li> </ul>	<ul style="list-style-type: none"> <li>• Reclamation might be a problem</li> <li>• Creating traffic hazard (tight curve in a short section)</li> <li>• More relocation time and costs of public utilities</li> </ul>	△
Right bank (Option R-3)	River encroaching minimizing	<ul style="list-style-type: none"> <li>• No reclamation of the river</li> <li>• Some relocation of houses</li> <li>• Less relocation costs and time of public utilities</li> </ul>	<ul style="list-style-type: none"> <li>• More relocation of houses – need more money and time</li> <li>• Creating traffic hazard (tight curve in a short section)</li> <li>• More land acquisition</li> </ul>	△
Left bank (Option L-1)	Embankment & bridge combination	<ul style="list-style-type: none"> <li>• Minimum impact to residences</li> <li>• Minimum relocation of public utilities</li> </ul>	<ul style="list-style-type: none"> <li>• Subject to river erosion in the future</li> <li>• River analysis and negotiation would take a long time</li> <li>• Bridge crossing the canal for the power plant would need large scale construction</li> <li>• More construction costs</li> <li>• Inconvenient to local users of the highway</li> </ul>	X

Option	Features	Advantages	Concerns	Evaluation
Left bank (Option L-2)	Bridge option	<ul style="list-style-type: none"> <li>• Minimum impact to residences</li> <li>• Minimum relocation of public utilities</li> <li>• Less influence by the river compared to Option L-1</li> </ul>	<ul style="list-style-type: none"> <li>• River analysis and negotiation would take a long time</li> <li>• Bridge crossing the canal for the power plant would need large scale construction</li> <li>• More construction costs</li> </ul>	X

The overall evaluation of the Option L-1 and L-2 seems unfavourable for implementation due to several reasons. These include high construction costs, the risks of being influenced by river erosion, and the fact that the future river direction is not predictable. Options R-2 and R-3 have some advantages for specific purposes such as minimizing relocations or river intrusion, but at the same time there are many concerns such as adverse impacts on the river caused by reclamation and more relocation of houses (Option R-3). The most significant concern among them is the traffic safety due to introducing small radius of curvature. On the other hand, Option R-1, which has a slightly higher construction cost than the other “R” options, is considered, among these options, to be well balanced in terms of route location and impact to the river. Therefore, R-1 option is recommended for implementation because there are less adverse impacts on the relocation, costs and reclamation of the river, as well as traffic safety.

However, as mentioned earlier there are still some concerns, even with the recommended option. It seems necessary to seek best road alignment taking the advantages found for the Option R-2 and R-3 during the detail design stage into consideration. In view of all the above, river investigation and revetment plans and design, and relocation planning and the negotiation of houses, public facilities and utilities, must be done as quickly as possible to minimize the overall implementation period.

# **Appendix A**



Technical drawing of a bridge structure, showing a plan view and a cross-section.

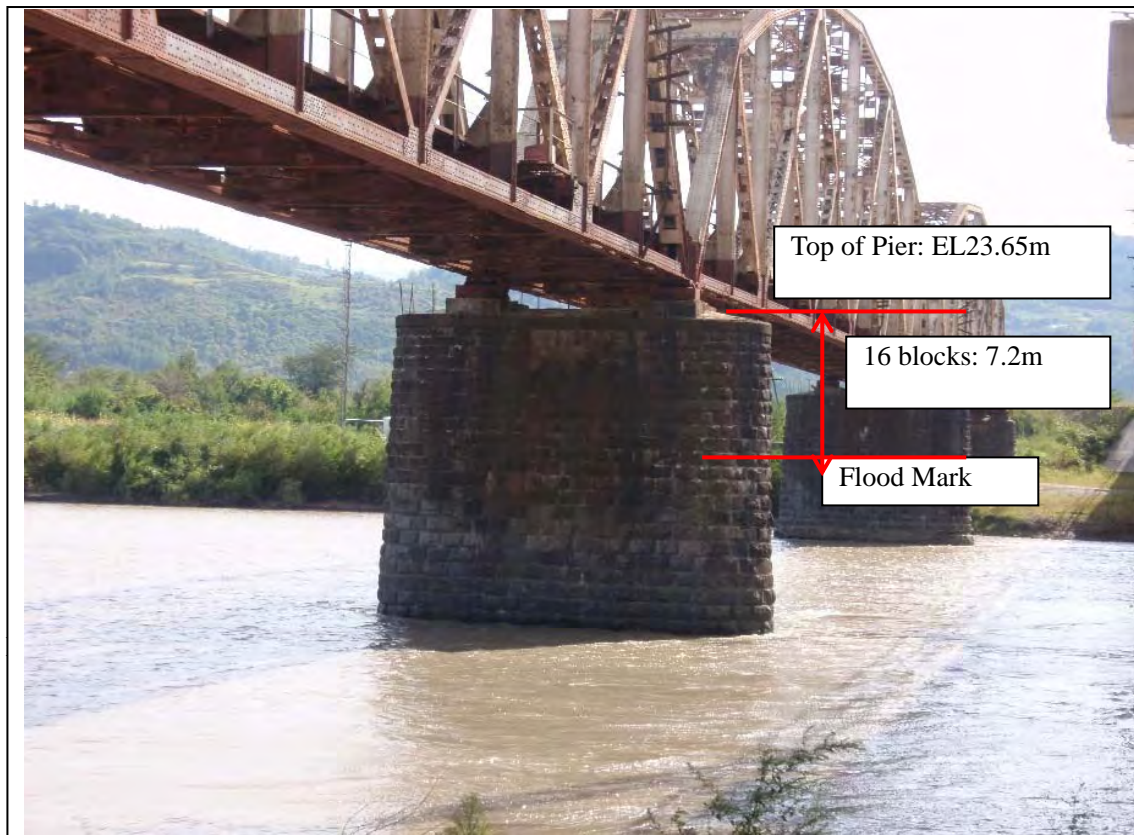
**Plan View (Top):**

- Central span: 7700
- Side spans: 27658
- Bridge width: 26.5
- Dimensions: 19.0, 12.0

**Cross-Section (Bottom):**

- Bridge width: 26.5
- Central span: 19.0
- Side span: 12.0
- Dimensions: 12.01, 12.51, 11.91, 10.50, 9.87
- Structural details: Truss, supports, and internal components.

## A2 Maximum High Water Level by Observation of Railway Bridge on Rioni River



## A3 Extract of Water Code

### 1. Preface

#### THE WATER ACT OF GEORGIA

Water is a unique and primary natural resource being of vital importance for humans, the animal kingdom and vegetative cover as well as for the Georgian economy development.

In order to secure the safe for the human health environment under the Constitution of Georgia, in compliance with the ecological and economic interests of society, with regard for the interests of the present and future generations, the state shall ensure protection of the environment and, correspondingly, the protection of water - its main component.

All residents of Georgia are obliged to ensure the rational and sustainable use and protection of water, not to allow its contamination, pollution and depletion.

Water available on the land area of Georgia, in its entrails, in the continental shelf, territorial waters and within a special economic zone is the national wealth of Georgia and is protected by the state.

### 2. Articles Concerned with River Improvement

#### *Article 18. Location, Design, Construction and Commission of an Enterprise, Structure and other Facility Affecting the State of Water*

1. When locating, designing, constructing and commissioning a new or reconstructed enterprise, structure and other facility, as well as in introducing new technological process that affect the state of water, the rational water use shall be secured with due regard for population's health care requirements and the first-priority satisfaction of drinking and household water needs. At the same time, due attention shall be given to the measures ensuring accounting of the water abstracted from and returned to water bodies, the protection of water from contamination, pollution and depletion, the avoidance of the unfavourable water impact, the restriction of land flooding up to the minimum necessary level, the protection of land from silting, swamping or drying up, as well as the environmental protection and landscape preservation.
2. When locating, designing, constructing and commissioning a new or reconstructed enterprise, structure and other facility on fish ponds, the measures ensuring conditions for the protection and reproduction of fish, other objects and plants of the wildlife shall be carried out together with the meeting of the requirements stipulated by the first paragraph of this Article.
3. When designing, constructing and operating a new or reconstructed enterprise, structure and other facility, as well as in introducing new technological processes, the following conditions shall be observed:
  - a) the purification of waste water to be discharged in a water body up to the fixed standard;
  - b) a natural reservoir may not be used for effluent dilution;
  - c) the wastewater irrigation may not be applied to the land devoid of the underground water regime and composition monitoring network.
4. The following may not be commissioned:
  - a) a new or reconstructed enterprise, ship, terminal, set, municipal and other facilities, unless they are properly equipped to prevent water pollution or its adverse impact;
  - b) the irrigation and water supply system, water basin and canal, unless the project-stipulated measures for preventing land swamping, water stagnation and alienation, soil erosion are carried out;
  - c) drainage systems - unless the water-inlet header and other structures are ready in accordance with the approved projects;

- d) the water intake works - unless, pursuant to the approved projects, they are equipped with a fish facility;
  - e) hydraulic structures - unless, pursuant to the approved projects, the flood protection, fish conservation work and river beds are ready, as well as the Black Sea coast-protecting measures are secured;
  - f) underground water intake works and wells - devoid of water-regulating and monitoring equipment and without the defined sanitation zones, where appropriate;
  - g) oil pipeline and terminal - devoid of water-protecting, oil-leak detecting, control, measuring, oil trapping facilities and devices, the emergency (including information) service;
  - h) self-propelled vessels and barges devoid of the on-board service and sewage water collectors.
5. A water reservoir shall not be filled, unless the project-stipulated measures for its bed preparation are carried out.
6. The site of an enterprise, structure and other project affecting the state of water shall be coordinated with the Ministry, the State Geology Department, the State Sanitary Supervision, local self-government and administration bodies, as well as other bodies in the cases and under the procedure established by Georgian legislation.

#### ***Article 19. Water-protecting Strip***

- 1. Water-protecting strips include the coastal (bank) strips of rivers, lakes, reservoirs, the right of way of main and other canals, as well as other strips stipulated by laws.
- 2. The construction, deepening of the bottom and blasting operations, the extraction of mineral resources, peat, sapropel, sunk wood, the laying out of a cable, pipeline and other communications, wood cutting, drilling and other activity in water bodies and water-protecting strips shall be carried out on the basis of an environmental permit for a concrete activity and under the license and procedure established by the laws of Georgia.
- 3. The procedure for fixing the limits of a water-protecting strip, a list of the permitted in the strip operations, their conditions and regime are defined under the Statute "On a Water-protecting Strip" to be worked out by the Ministry in coordination with the Ministry of Health, the State Department for Land Management and Forestry of Georgia and approved by the Ministry.

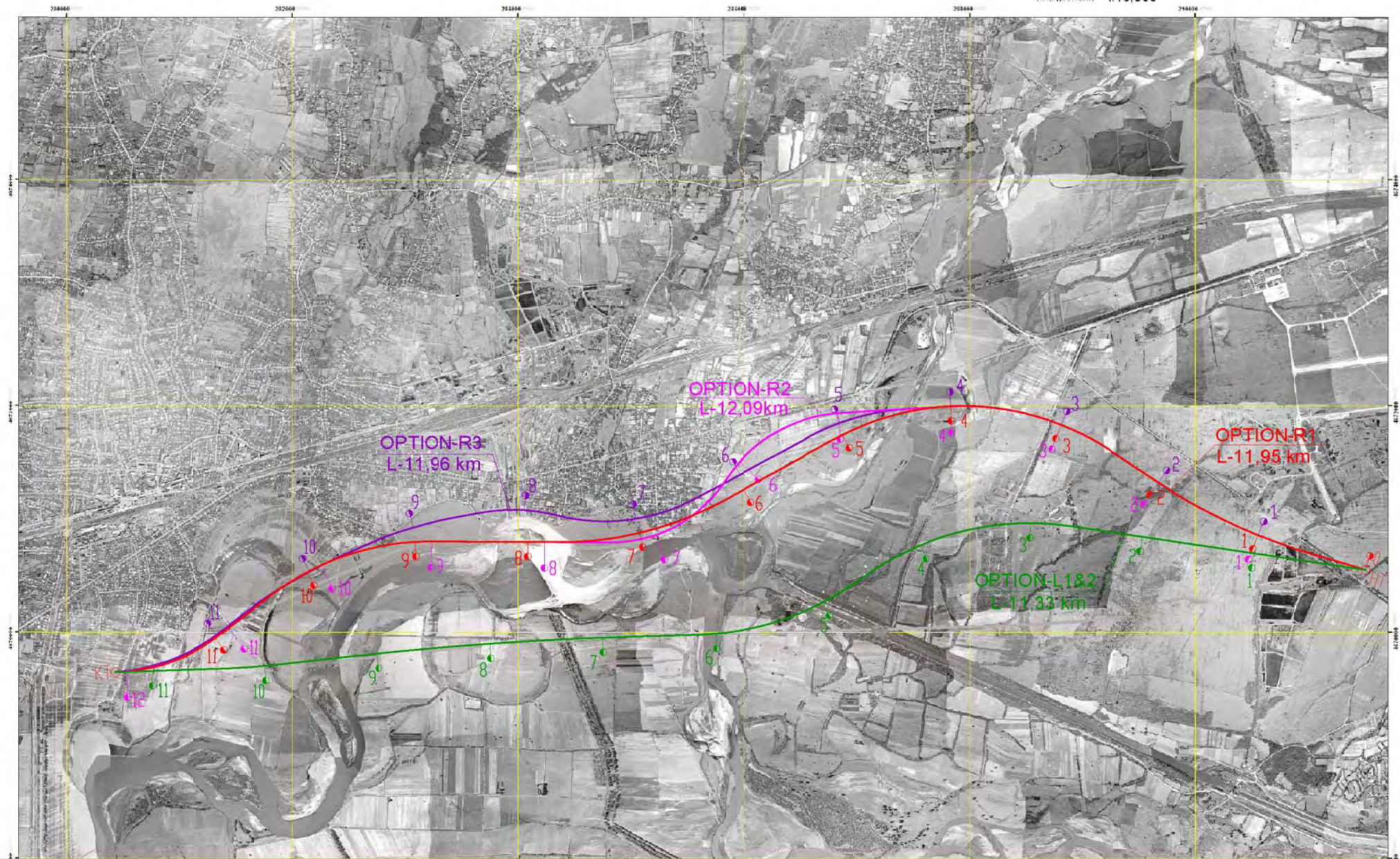
#### ***Article 20. Water-protecting Strip of a River***

- 1. The water-protecting strip of a river is its adjacent territory, wherein a special regime to protect water resources from pollution, sitting and depletion is established.
- 2. The water-protecting strip may include the dry river bed, its adjacent terraces, the elevated and sloppy banks, as well as the ravine immediately abutting upon the river banks.
- 3. The river water-protecting strip's width is counted off from the river-bed edge to both sides in meters under the following procedure:
  - a) for a river with a length of up to 25 km - 10 meters;
  - b) for a river with the length up to 50 km - 20 meters;
  - c) for a river with the up to 75 km length - 30 meters;
  - d) for a river with the length of over 75 km - 50 meters.
- 4. The following is prohibited within this strip:
  - a) the construction or expansion and reconstruction of the operating enterprises, except for the cases directly provided by law;
  - b) the application of pesticides upon perennial plants, crops and forests through aerial spraying;
  - c) the accumulation, storage or burial of pesticides and mineral fertilizers, as well as various household, economic and industrial wastes.
- 5. Hydraulic works located in the water-protecting strip shall generally be equipped with the appropriate technical facilities to completely exclude a possibility of the river pollution and contamination.

# **Appendix B**



Scale 1:18,000



VICTORIA LTD.

MINISTRY OF REGIONAL DEVELOPMENT AND INFRASTRUCTURE  
ROAD DEPARTMENT, GEORGIA  
BASIC SURVEY ON EAST-WEST HIGHWAY IN GEORGIA  
FINANCED BY JICA  
JV OF PADECO CO.LTD.EXEIDEA  
AND ORIENTAL CONSULTANT CO.LTD.

EAST-WEST HIGHWAY IN GEORGIA  
Samtredia bypass

No 1  
2009

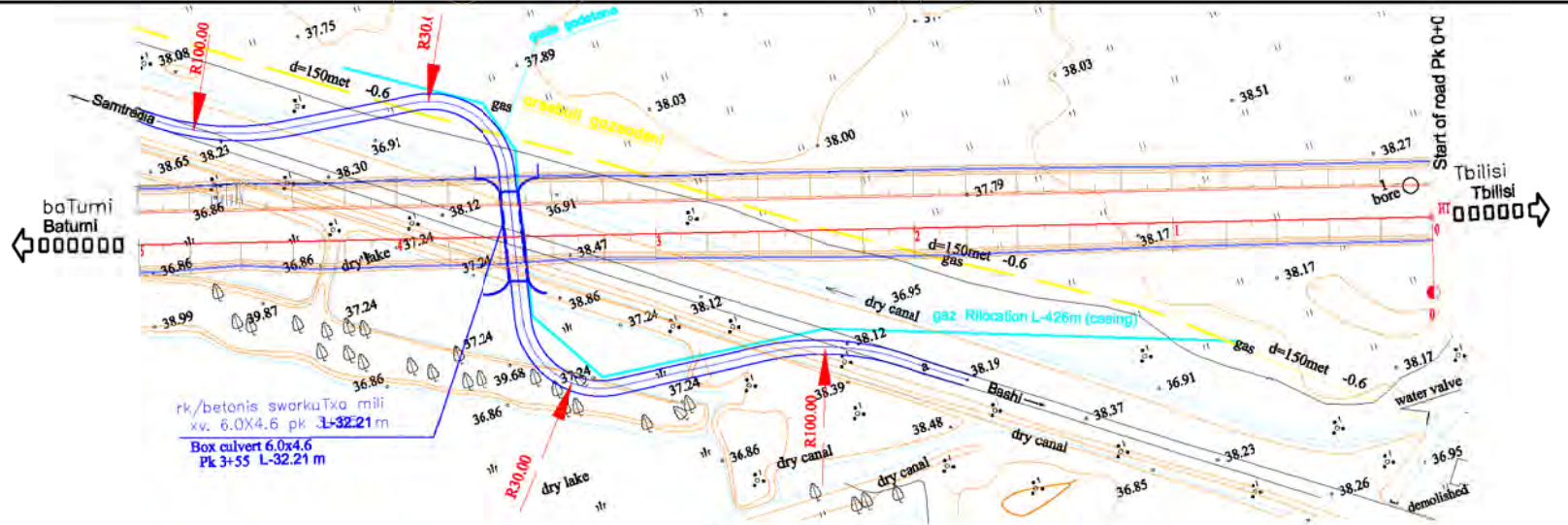
Sections location of options  
Scale 1:40 000



Start of road Pk 0+00

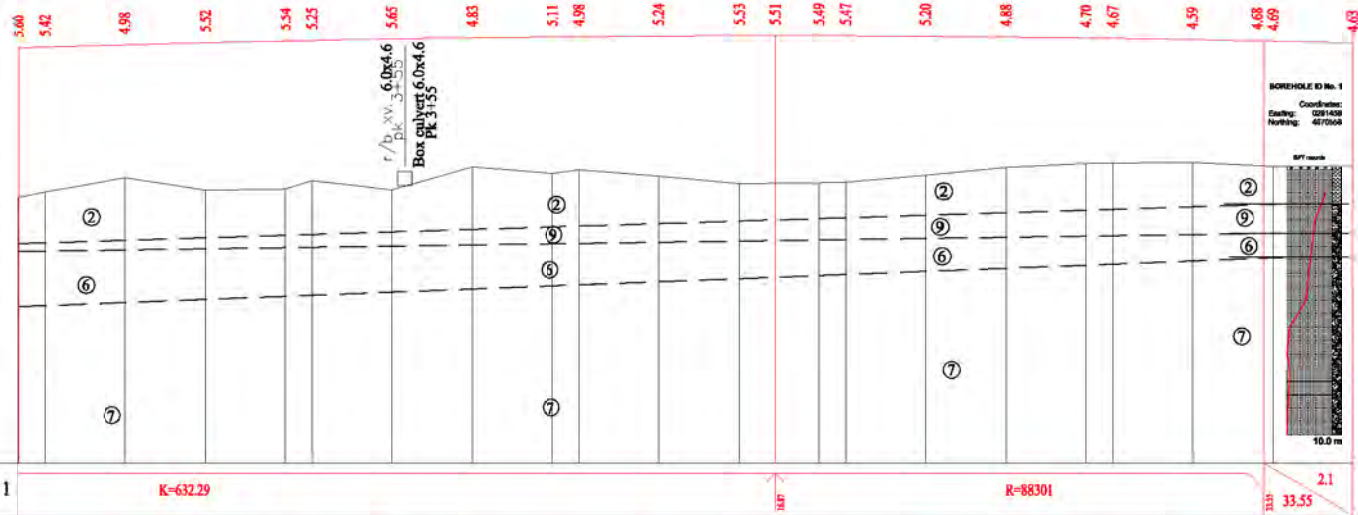
Coordinates:  
Easting: 0291505,566  
Northing: 4670555,003

baTumi  
Batumi  
0000000



Legend			
Soil Group	Index and Color Mark	Typical Description of Soils	Origin
Fine Soils	①	Clayey SILT	Alluvial Deposit
	②	Stiff CLAY	Alluvial Deposit
	③	Firm CLAY	Alluvial Deposit
	④	Silty SAND	Alluvial Deposit
Coarse Soils	⑤	SAND	Alluvial Deposit
	⑥	GRAVEL with clayey sand matrix	Alluvial Deposit
	⑦	GRAVEL with sand matrix	Alluvial Deposit
	⑧	GRAVEL with silty sand matrix	Alluvial Deposit
	⑨	GRAVEL with clay matrix	Alluvial Deposit

horizontaluri m 1:2000  
vertikaluri m 1:200  
HORIZONTAL SCALE 1:2000  
VERTICAL SCALE 1:200



saprocto monocemebi PROJECT DATA	qanobebi da vertikaluri mrudebi GRADIENT AND VERTICAL CURVE	1	K=632.29																		R=88301		2.1
	sovali nawilia RerZis niSnulebi ROADWAY AXIS LEVEL	2	42.54	42.57	42.66	42.74	42.81	42.83	42.88	42.92	42.96	42.97	42.99	43.00	43.00	43.00	42.99	42.98	42.95	42.92	42.91	42.86	42.83
faqturni monocemebi ACTUAL DATA	miwis niSnulebi GROUND LEVEL	3	36.94	37.15	37.69	37.22	37.26	37.58	37.23	38.10	37.85	37.99	37.75	37.47	37.50	37.52	37.78	38.08	38.22	38.24	38.26	38.11	38.11
	marZilebi DISTANCE	4	10.00	30.00	30.00	30.00	10.00	30.00	30.00	30.00	10.00	30.00	30.00	30.00	10.00	30.00	30.00	30.00	10.00	30.00	30.00	30.00	
piketebi CHAINAGE		5	4 3 2 1 0																				
swori da mrudi gegmaSi STRAIGHT SECTION AND CURVE IN PLAN		6																					

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MINISTRY OF REGIONAL DEVELOPMENT AND INFRASTRUCTURE  
ROAD DEPARTMENT, GEORGIA  
BASIC SURVEY ON EAST-WEST HIGHWAY IN GEORGIA  
FINANCED BY JICA  
JV OF PADECO CO.LTD, EXEIDEA  
AND ORIENTAL CONSULTANT CO.LTD.

EAST-WEST HIGHWAY IN GEORGIA  
Sambredia bypass

No 2/1  
2009

Plan and longitudinal profile  
PK 0+00 - PK 5+00





An 1 Pk 12+82.37

Coordinates:  
Easting: 0290276.618  
Northing: 4670921.289

baTumi  
Batumi  
←

Tbilisi  
Tbilisi  
→

Legend			
Soil Group	Index and Color Mark	Typical Description of Soils	Origin
Fine Soils	①	Clayey SILT	Alluvial Deposit
	②	Soft CLAY	Alluvial Deposit
	③	Firm CLAY	Alluvial Deposit
	④	Silty SAND	Alluvial Deposit
Coarse Soils	⑤	SAND	Alluvial Deposit
	⑥	GRAVEL with clayey sand matrix	Alluvial Deposit
	⑦	GRAVEL with sand matrix	Alluvial Deposit
	⑧	GRAVEL with silty sand matrix	Alluvial Deposit
	⑨	GRAVEL with clay matrix	Alluvial Deposit

horizontaluri m 1:2000  
vertikaluri m 1:200  
HORIZONTAL SCALE 1:2000  
VERTICAL SCALE 1:200

approqetbi მონაცემები PROJECT DATA	qanobebi da vertikaluri mrdebi GRADIENT AND VERTICAL CURVE	1	<div><div>0.7</div><div>199.74</div><div>42.33</div><div>R=201470 K=881.31</div></div>																									
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fakturi მონაცემები ACTUAL DATA	miwis niSnulebi GROUND LEVEL	3	35.54	35.55	35.57	35.59	35.60	35.61	35.67	35.72	35.77	35.79	35.83	35.81	35.80	35.80	35.87	36.04	36.20	36.26	36.39	36.50	36.62	36.66	36.78	36.88	36.87	
	manZilebi DISTANCE	4	100	30.00	30.00	30.00	100	30.00	30.00	30.00	100	30.00	30.00	30.00	30.00	100	30.00	30.00	100	30.00	30.00	30.00	30.00	100	30.00	30.00	30.00	
p i k e t e b i CHAINAGE		5	17	16				15				14				13				12				11				
swori da mrudi gegnaSi STRAIGHT SECTION AND CURVE IN PLAN		6	Y=17°8.6' R=5000 T=754 K=1496																									

VICTORIA LTD.

MINISTRY OF REGIONAL DEVELOPMENT AND INFRASTRUCTURE  
ROAD DEPARTMENT, GEORGIA  
BASIC SURVEY ON EAST-WEST HIGHWAY IN GEORGIA  
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AND ORIENTAL CONSULTANT CO.LTD.

EAST-WEST HIGHWAY IN GEORGIA  
Sambredia bypass  
Plan and longitudinal profile  
PK 11+00 - PK 17+00

No 2/3  
2009

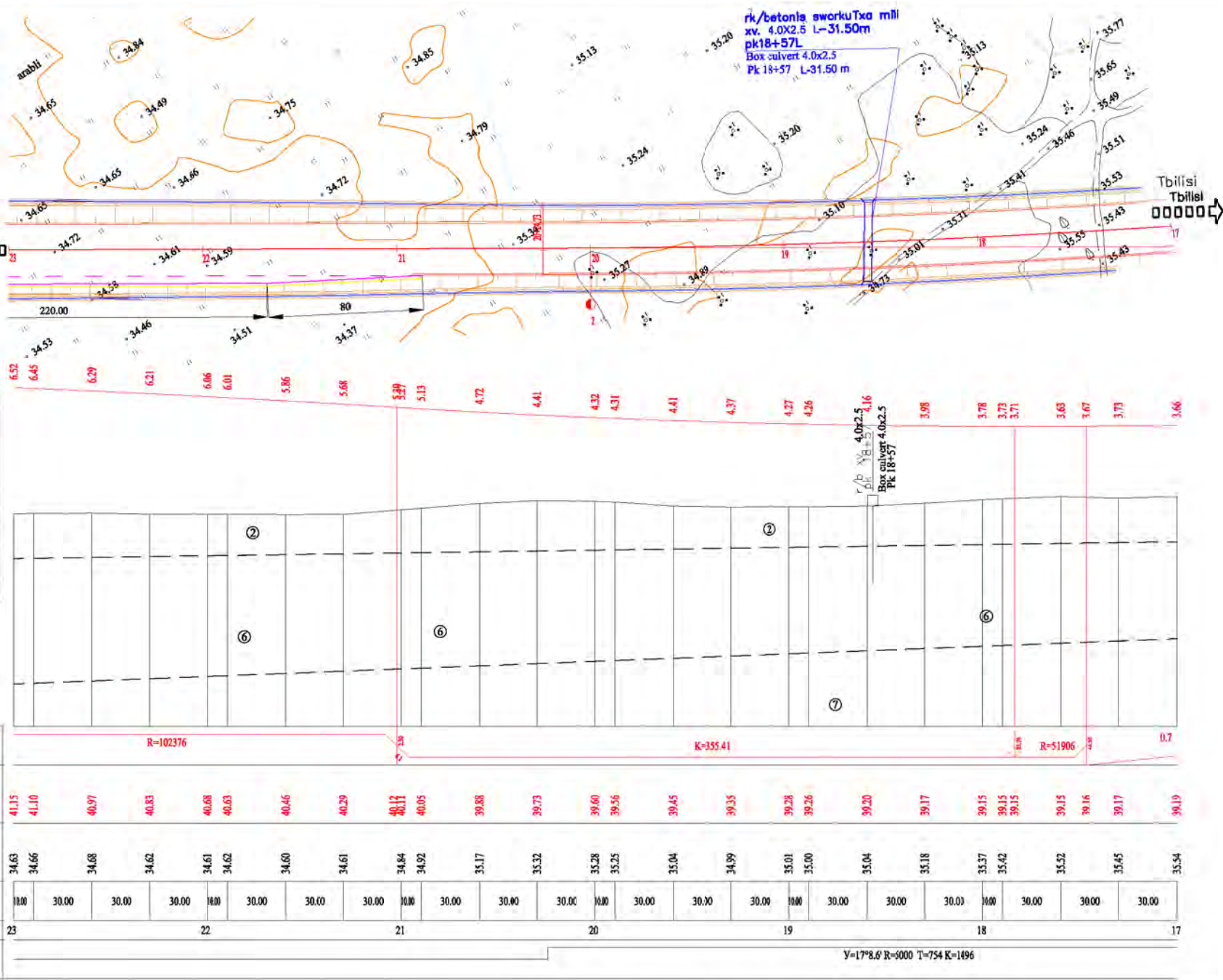
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Batumi

თბილისი  
Tbilisi

რკ/ბეტონის სვორკუთხა მლი  
xv. 4.0x2.5 L=31.50m  
pk18+57L  
Box culvert 4.0x2.5  
Pk 18+57 L=31.50 m

Legend			
Soil Group	Index and Color Mark	Typical Description of Soils	Origin
Fine Soils	①	Clayey SILT	Alluvial Deposit
	②	Stiff CLAY	Alluvial Deposit
	③	Firm CLAY	Alluvial Deposit
	④	Silty SAND	Alluvial Deposit
Coarse Soils	⑤	SAND	Alluvial Deposit
	⑥	GRAVEL with clayey sand matrix	Alluvial Deposit
	⑦	GRAVEL with sand matrix	Alluvial Deposit
	⑧	GRAVEL with silty sand matrix	Alluvial Deposit
	⑨	GRAVEL with clay matrix	Alluvial Deposit

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vertikaluri m 1:200  
HORIZONTAL SCALE 1:2000  
VERTICAL SCALE 1:200



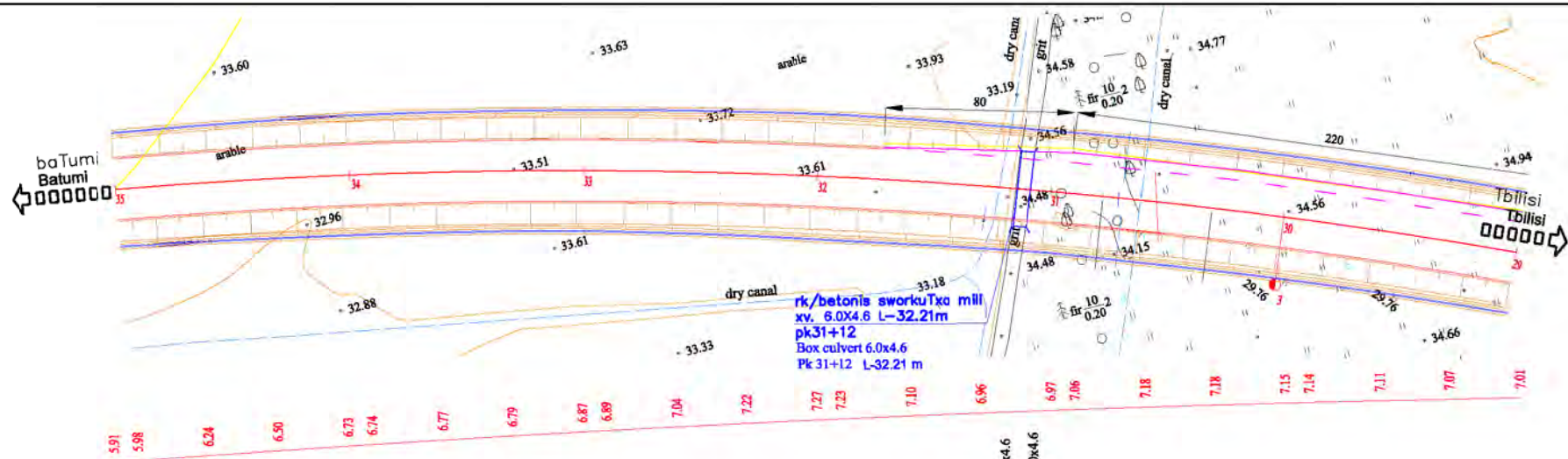
ასპროექტის მონაცემები PROJECT DATA	qanabebi da vertikaluri mrudebi GRADIENT AND VERTICAL CURVE	1	
	savali nawilis RerZis nISnulebi ROADWAY AXIS LEVEL	2	41.15 41.10 40.97 40.83 40.68 40.63 40.46 40.29 40.12 40.05 39.88 39.73 39.60 39.56 39.45 39.35 39.28 39.26 39.20 39.17 39.15 39.15 39.15 39.15 39.16 39.17 39.19
faktური მონაცემები ACTUAL DATA	მიწის nISnulebi GROUND LEVEL	3	34.63 34.66 34.68 34.62 34.61 34.62 34.60 34.61 34.64 34.62 35.17 35.32 35.28 35.25 35.04 34.99 35.01 35.00 35.04 35.18 35.37 35.42 35.52 35.45 35.54
	მანძილები DISTANCE	4	10.00 30.00 30.00 30.00 10.00 30.00 30.00 30.00 10.00 30.00 30.00 30.00 10.00 30.00 30.00 30.00 10.00 30.00 30.00 30.00 10.00 30.00 30.00 30.00
პიკეტაჟი CHAINAGE		5	23 22 21 20 19 18 17
სწორი და მრუდი გეგმა STRAIGHT SECTION AND CURVE IN PLAN		6	Y=17°8.6' R=5000 T=754 K=1496

VICTORIA LTD.	MINISTRY OF REGIONAL DEVELOPMENT AND INFRASTRUCTURE ROAD DEPARTMENT, GEORGIA BASIC SURVEY ON EAST-WEST HIGHWAY IN GEORGIA FINANCED BY JICA JV OF PADECO CO.LTD.EXEIDEA AND ORIENTAL CONSULTANT CO.LTD.	EAST-WEST HIGHWAY IN GEORGIA Samtredia bypass	No 2/4 2009
		Plan and longitudinal profile PK 17+00 - PK 23+00	



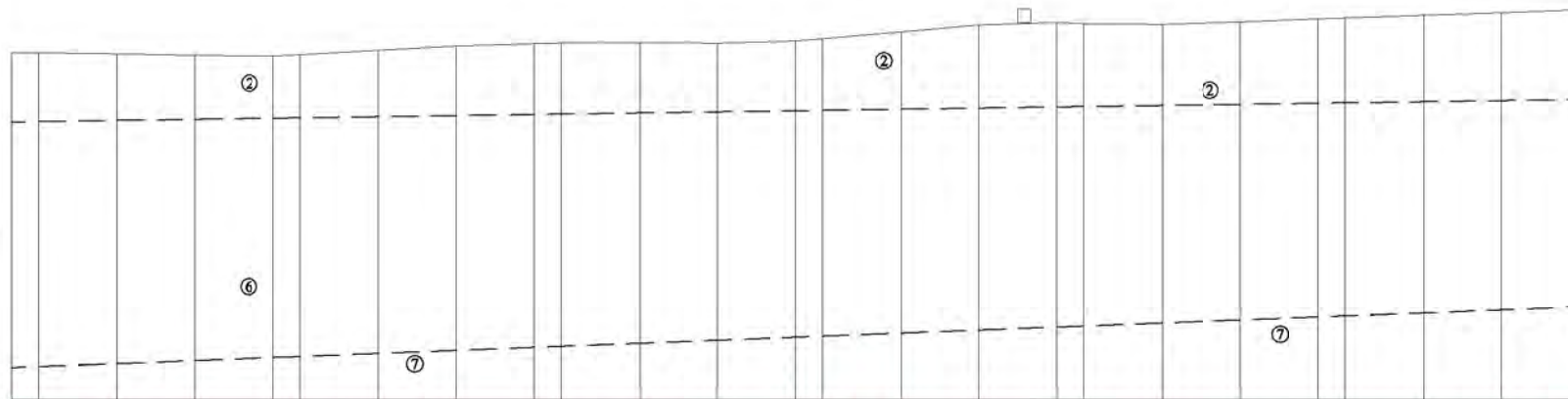


VICTORIA LTD.	MINISTRY OF REGIONAL DEVELOPMENT AND INFRASTRUCTURE ROAD DEPARTMENT, GEORGIA BASIC SURVEY ON EAST-WEST HIGHWAY IN GEORGIA FINANCED BY JICA JV OF PADECO CO.LTD.EXEIDEA AND ORIENTAL CONSULTANT CO.LTD.	EAST-WEST HIGHWAY IN GEORGIA Samtredia bypass	No 2/5 2009
		Plan and longitudinal profile PK 23+00 - PK 29+00	



Legend			
Soil Group	Index and Color Mark	Typical Description of Soils	Origin
Fine Soils	①	Clayey SILT	Alluvial Deposit
	②	STIFF CLAY	Alluvial Deposit
	③	Firm CLAY	Alluvial Deposit
	④	Silty SAND	Alluvial Deposit
Coarse Soils	⑤	SAND	Alluvial Deposit
	⑥	GRAVEL with clayey sand matrix	Alluvial Deposit
	⑦	GRAVEL with sand matrix	Alluvial Deposit
	⑧	GRAVEL with silty sand matrix	Alluvial Deposit
	⑨	GRAVEL with clay matrix	Alluvial Deposit

horizontaluri m 1:2000  
 vertikaluri m 1:200  
 HORIZONTAL SCALE 1:2000  
 VERTICAL SCALE 1:200

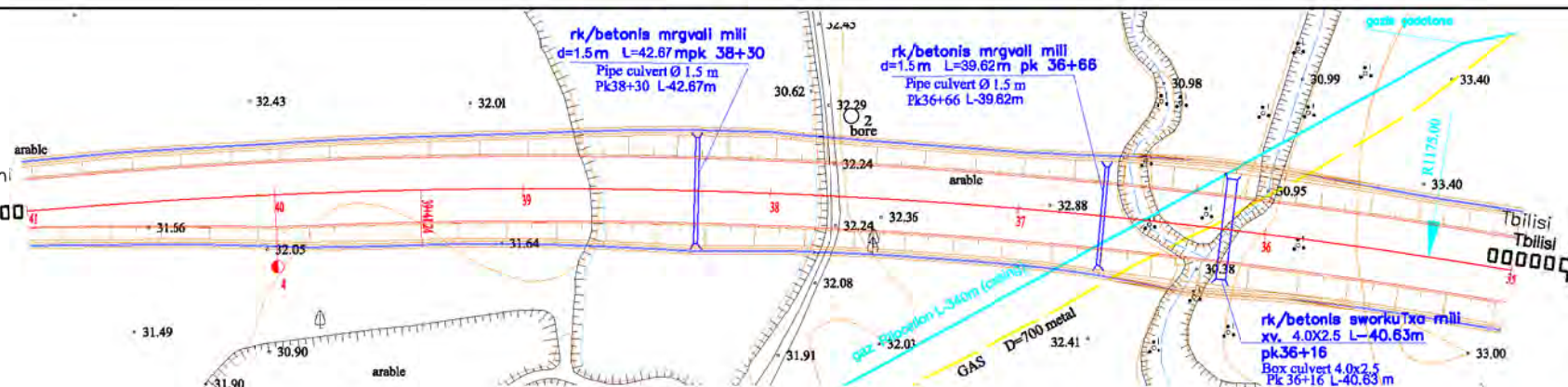


suproektis matsnebi PROJECT DATA	qonebebi da vertikaluri mdubebi GRADIENT AND VERTICAL CURVE	1	
	savali nawilis RerZis niSnubebi ROADWAY AXIS LEVEL	2	39.16 39.24 39.45 39.66 39.86 39.93 40.12 40.30 40.47 40.52 40.68 40.83 40.98 41.02 41.15 41.27 41.39 41.42 41.52 41.61 41.70 41.72 41.80 41.86 41.91
fakturi matsnebi ACTUAL DATA	miwis niSnubebi GROUND LEVEL	3	33.25 33.26 33.21 33.16 33.13 33.18 33.35 33.51 33.60 33.63 33.65 33.62 33.71 33.79 34.05 34.31 34.42 34.36 34.34 34.43 34.55 34.58 34.69 34.79 34.90
	manZilebi DISTANCE	4	100 30.00 30.00 30.00 100 30.00 30.00 30.00 100 30.00 30.00 30.00 100 30.00 30.00 100 30.00 30.00 30.00 30.00 100 30.00 30.00 30.00
p i k e t e b i CHAINAGE		5	35 34 33 32 31 30 29
swori da mudi gegmaSi STRAIGHT SECTION AND CURVE IN PLAN		6	Y=62°41.8' R=2350 L=120 T=1492 K=2692

VICTORIA LTD.	MINISTRY OF REGIONAL DEVELOPMENT AND INFRASTRUCTURE ROAD DEPARTMENT, GEORGIA BASIC SURVEY ON EAST-WEST HIGHWAY IN GEORGIA FINANCED BY JICA JV OF PADECO CO.LTD.EXEIDEA AND ORIENTAL CONSULTANT CO.LTD.	EAST-WEST HIGHWAY IN GEORGIA Sambredia bypass	No 2/6 2009
		Plan and longitudinal profile PK 29+00 - PK 35+00	

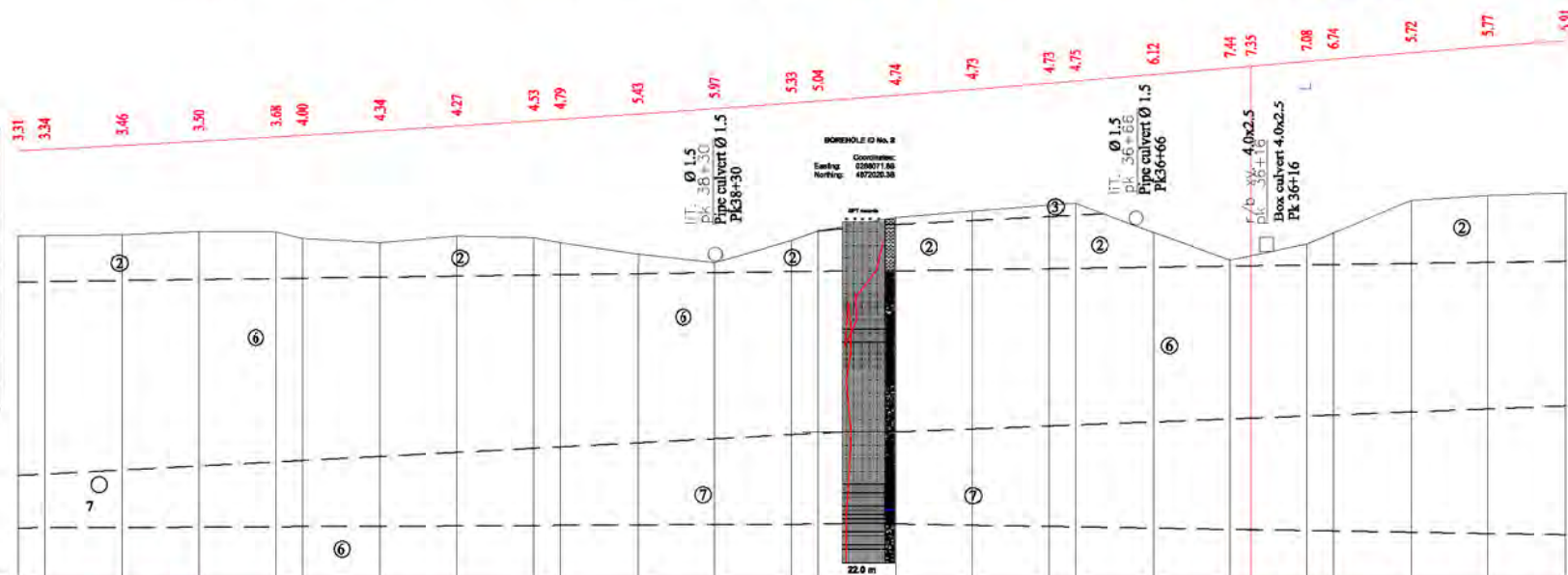


**Coordinates:**  
Easting: 0288056.208  
Northing: 4672404.316



Legend			
Soil Group	Index and Color Mark	Typical Description of Soils	Origin
Fine Soils	①	Clayey SILT	Alluvial Deposit
	②	Stiff CLAY	Alluvial Deposit
	③	Firm CLAY	Alluvial Deposit
	④	Silty SAND	Alluvial Deposit
Coarse Soils	⑤	SAND	Alluvial Deposit
	⑥	GRAVEL with clayey sand matrix	Alluvial Deposit
	⑦	GRAVEL with sand matrix	Alluvial Deposit
	⑧	GRAVEL with silty sand matrix	Alluvial Deposit
	⑨	GRAVEL with clay matrix	Alluvial Deposit

horizontaluri m 1:2000  
 vertikaluri m 1:200  
 HORIZONTAL SCALE 1:2000  
 VERTICAL SCALE 1:200

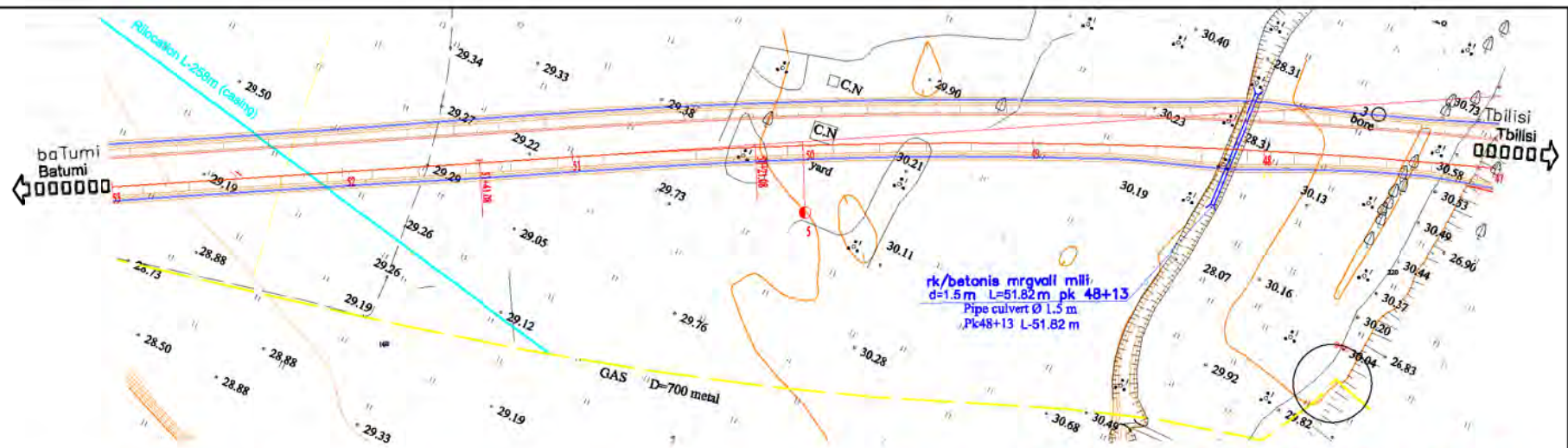


საპროექტო მონაცემები PICTURE DATA	კანონები და ვერტიკალური მრუდები GRADIENT AND VERTICAL CURVE	1	R=129502 K=873.74																								
	სავალი ნაწილის RerZis-ის ნიშნულები ROADWAY AXIS LEVEL	2	34.89	34.94	35.10	35.26	35.43	35.49	35.67	35.86	36.05	36.11	36.32	36.53	36.74	36.82	37.04	37.28	37.52	37.60	37.85	38.10	38.17	38.36	38.45	38.69	38.93
ფაქტური მონაცემები ACTUAL DATA	მიწის ნიშნულები GROUND LEVEL	3	31.59	31.60	31.64	31.76	31.75	31.49	31.33	31.59	31.52	31.33	30.89	30.56	31.41	31.78	32.30	32.55	32.78	32.85	31.73	30.66	31.28	31.71	32.97	33.16	33.25
	მანძილები DISTANCE	4	10.00	30.00	30.00	30.00	10.00	30.00	30.00	30.00	10.00	30.00	30.00	30.00	10.00	30.00	30.00	30.00	10.00	30.00	30.00	30.00	10.00	30.00	30.00	30.00	30.00
პიკეტაჟი CHAINAGE		5	41	40				39				38				37				36				35			
სწორი და მრუდი გეგმაში STRAIGHT SECTION AND CURVE IN PLAN		6	Y=62°41.8' R=2350 L=120 T=1492 K=2692																								

VICTORIA LTD.	MINISTRY OF REGIONAL DEVELOPMENT AND INFRASTRUCTURE ROAD DEPARTMENT, GEORGIA BASIC SURVEY ON EAST-WEST HIGHWAY IN GEORGIA FINANCED BY JICA JV OF PADECO CO.LTD.EXEIDEA AND ORIENTAL CONSULTANT CO.LTD.	EAST-WEST HIGHWAY IN GEORGIA Samtredia bypass	No 2/7 2009
		Plan and longitudinal profile PK 35+00 - PK 41+00	

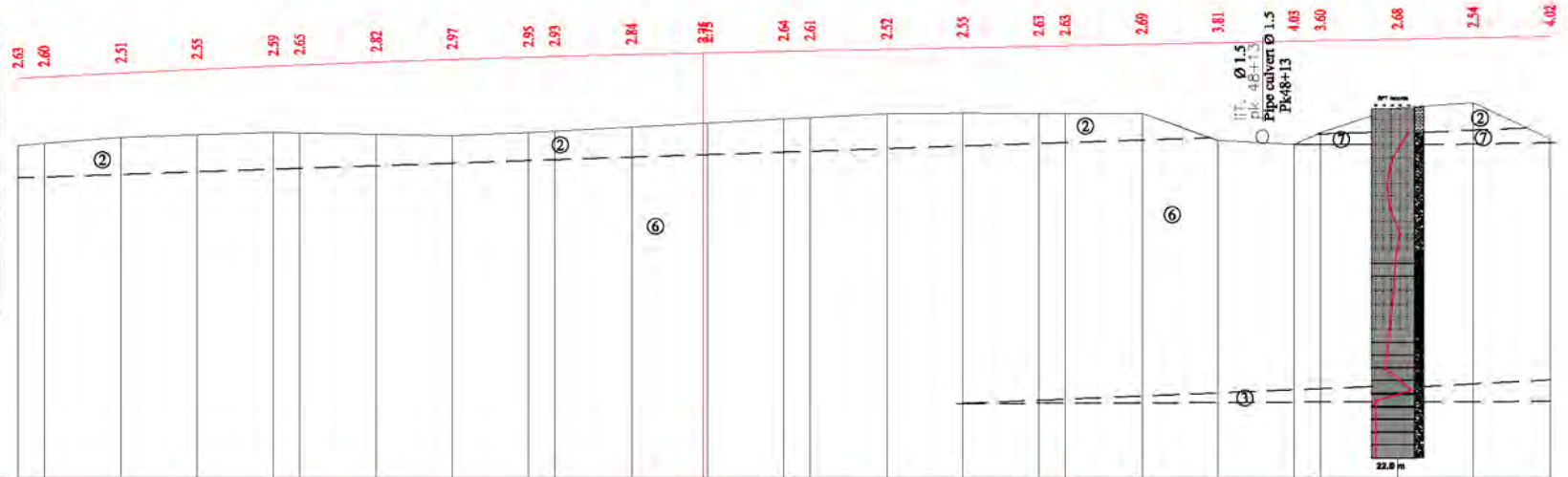






Legend			
Soil Group	Index and Color Mark	Typical Description of Soils	Design
Fine Soils	①	Clayey SILT	Alluvial Deposit
	②	Stiff CLAY	Alluvial Deposit
	③	Firm CLAY	Alluvial Deposit
	④	Silty SAND	Alluvial Deposit
Coarse Soils	⑤	SAND	Alluvial Deposit
	⑥	GRAVEL with clayey sand matrix	Alluvial Deposit
	⑦	GRAVEL with sand matrix	Alluvial Deposit
	⑧	GRAVEL with silty sand matrix	Alluvial Deposit
	⑨	GRAVEL with clay matrix	Alluvial Deposit

horizontaluri m 1:2000  
 vertikaluri m 1:200  
 HORIZONTAL SCALE 1:2000  
 VERTICAL SCALE 1:200



saproqta mshvrebis PROJECT DATA	qanobebi da vertikaluri mudebi GRADIENT AND VERTICAL CURVE	1	
	savali nawile RerZie niSnulebi ROADWAY AXIS LEVEL	2	31.46 31.52 31.67 31.81 31.94 31.98 32.10 32.20 32.29 32.32 32.40 32.46 32.52 32.54 32.60 32.66 32.72 32.74 32.80 32.85 32.91 32.93 32.99 33.05 33.11
faguri mshvrebis ACTUAL DATA	miwis niSnulebi GROUND LEVEL	3	28.83 28.92 29.16 29.26 29.35 29.33 29.28 29.23 29.34 29.40 29.55 29.72 29.88 29.93 30.08 30.10 30.09 30.10 30.10 29.04 28.88 29.33 30.31 30.51 29.09
	manZilebi DISTANCE	4	100 30.00 30.00 30.00 100 30.00 30.00 30.00 100 30.00 30.00 30.00 100 30.00 30.00 100 30.00 30.00 30.00 100 30.00 30.00 30.00
p i k e t a b i CHAINAGE		5	53 52 51 50 49 48 47
swori da mrudi gegnoSi STRAIGHT SECTION AND CURVE IN PLAN		6	Y=62°41.8' R=2350 L=120 T=1492 K=2692

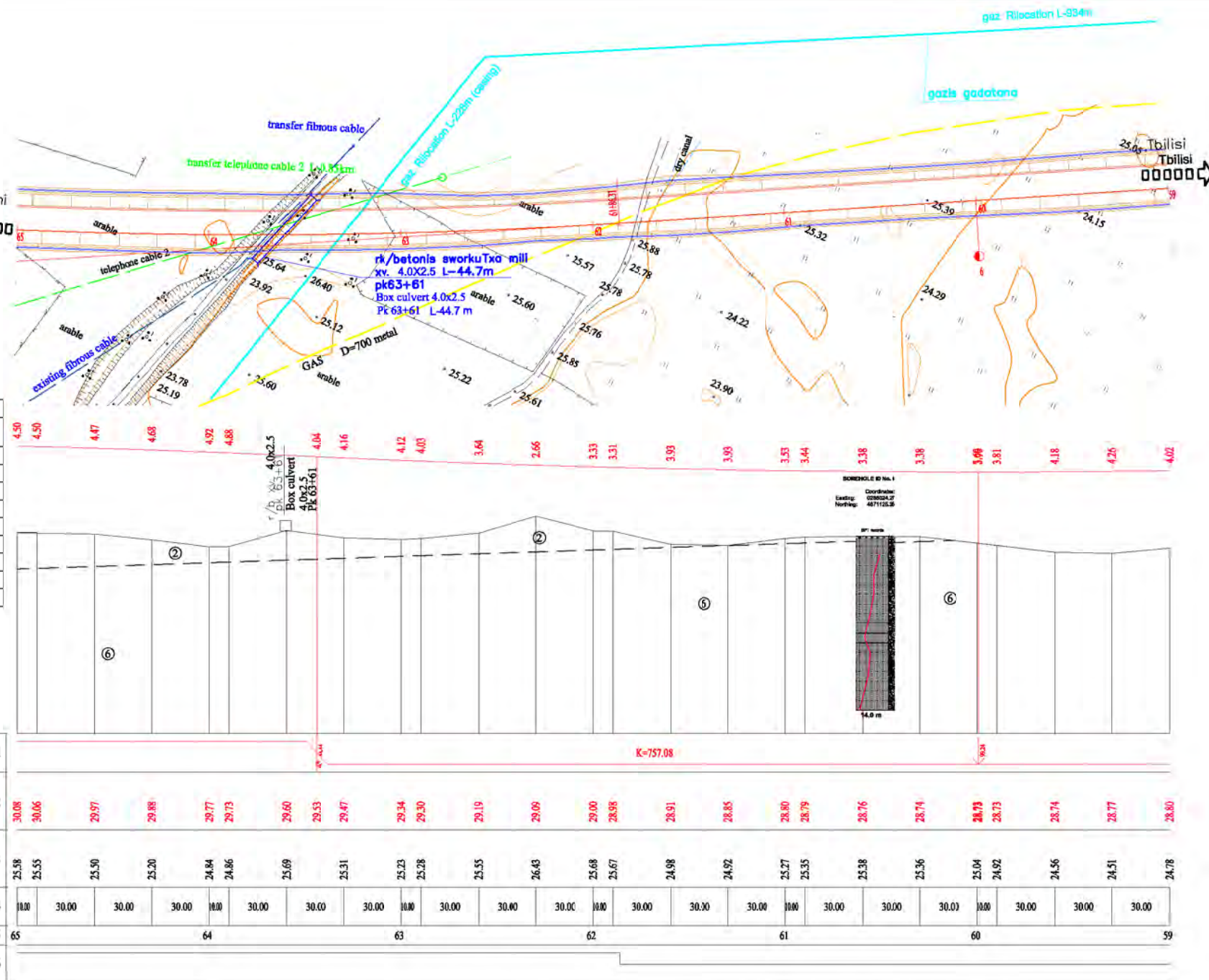




Legend			
Soil Group	Index and Color Mark	Typical Description of Soils	Origin
Fine Soils	①	Clayey SILT	Alluvial Deposit
	②	Stiff CLAY	Alluvial Deposit
	③	Firm CLAY	Alluvial Deposit
	④	Silty SAND	Alluvial Deposit
Coarse Soils	⑤	SAND	Alluvial Deposit
	⑥	GRAVEL with clayey sand matrix	Alluvial Deposit
	⑦	GRAVEL with sand matrix	Alluvial Deposit
	⑧	GRAVEL with silty sand matrix	Alluvial Deposit
	⑨	GRAVEL with clay matrix	Alluvial Deposit

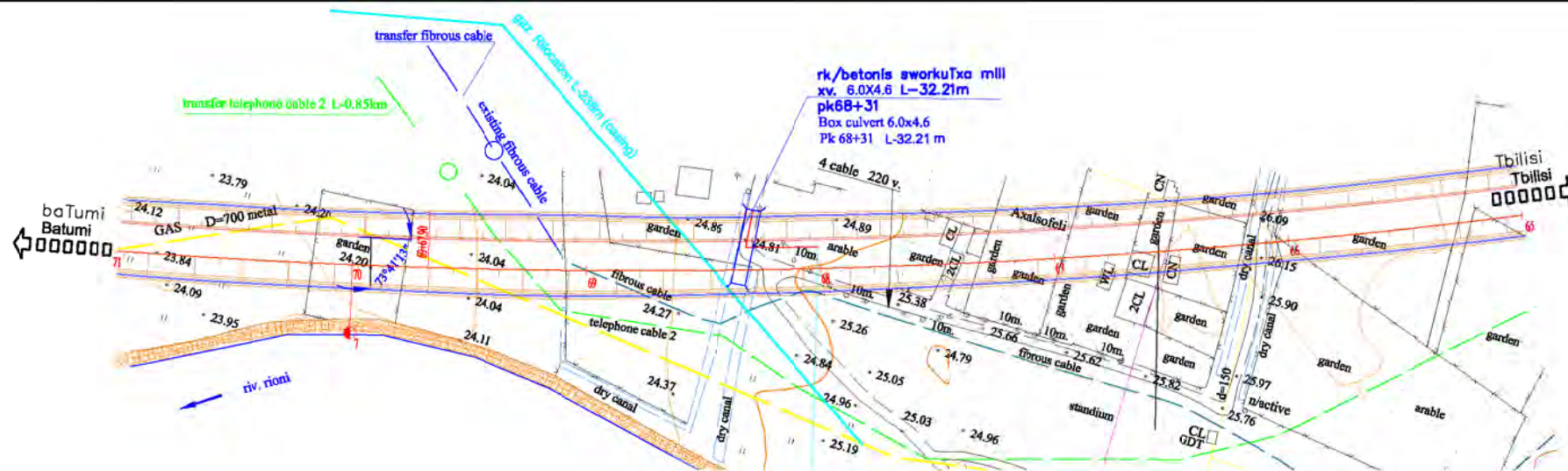
horizontaluri m 1:2000  
 vertikaluri m 1:200  
 HORIZONTAL SCALE 1:2000  
 VERTICAL SCALE 1:200

suproaqta maqsadmebi PROJECT DATA	qanobebl da vertikaluri mrudebl GRADIENT AND VERTICAL CURVE	1	
	savali nawilis RerZis niSnulebi ROADWAY AXIS LEVEL	2	
faghuri maqsadmebi ACTUAL DATA	miwis niSnulebi GROUND LEVEL	3	
	manZilebi DISTANCE	4	
p i k e t a b i CHAINAGE		5	65 64 63 62 61 60 59
swori da mrudi gegmaSi STRAIGHT SECTION AND CURVE IN PLAN		6	



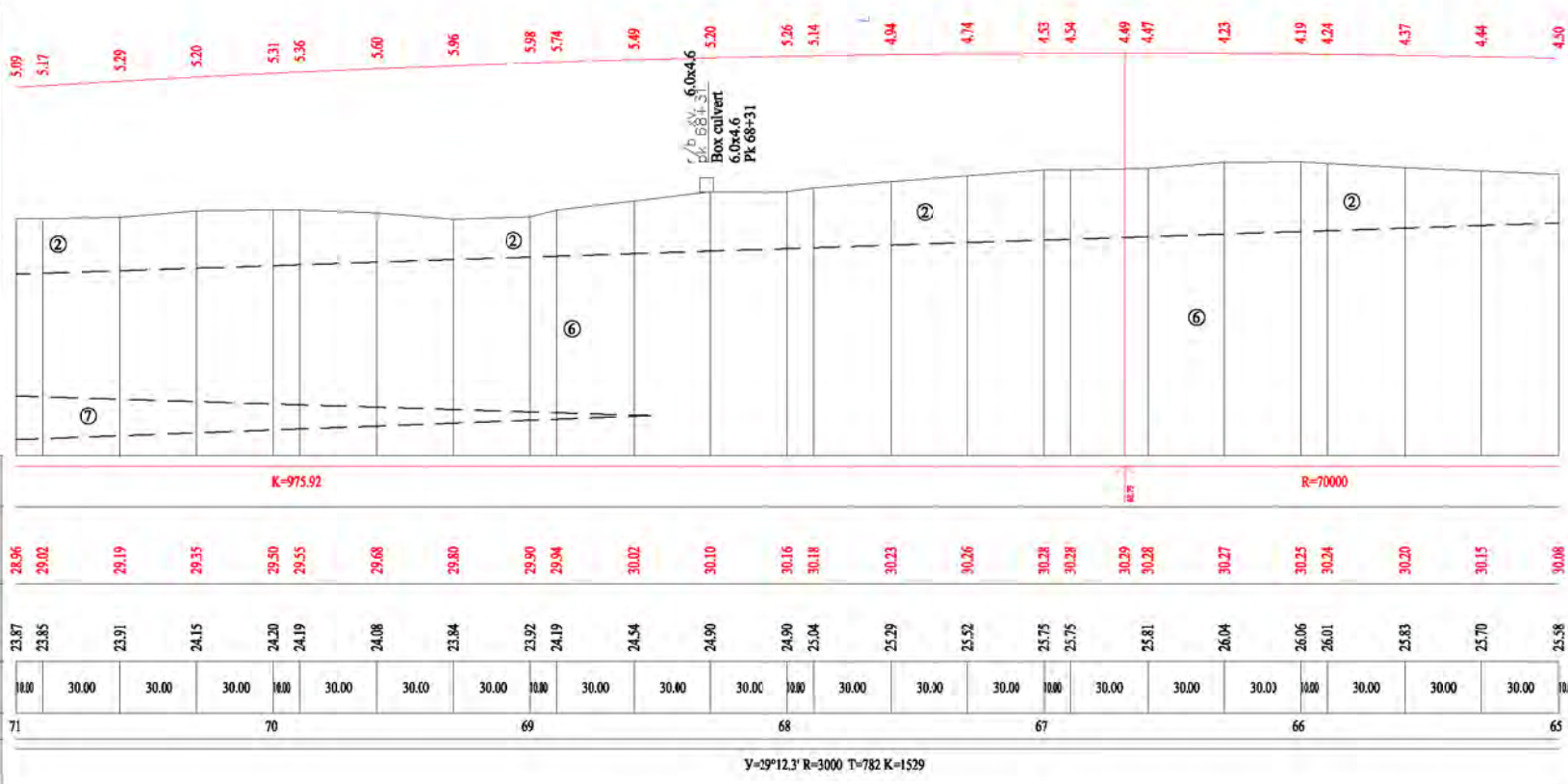
An 3 Pk 69+67.9

Coordinates:  
Easting: 0285152.576  
Northing: 4670797.579



Legend			
Soil Group	Index and Color Mark	Typical Description of Soils	Origin
Fine Soils	①	Clayey SILT	Alluvial Deposit
	②	Stiff CLAY	Alluvial Deposit
	③	Firm CLAY	Alluvial Deposit
	④	Silty SAND	Alluvial Deposit
Coarse Soils	⑤	SAND	Alluvial Deposit
	⑥	GRAVEL with clayey sand matrix	Alluvial Deposit
	⑦	GRAVEL with sand matrix	Alluvial Deposit
	⑧	GRAVEL with silty sand matrix	Alluvial Deposit
	⑨	GRAVEL with clay matrix	Alluvial Deposit

horizontaluri m 1:2000  
verikaluri m 1:200  
HORIZONTAL SCALE 1:2000  
VERTICAL SCALE 1:200

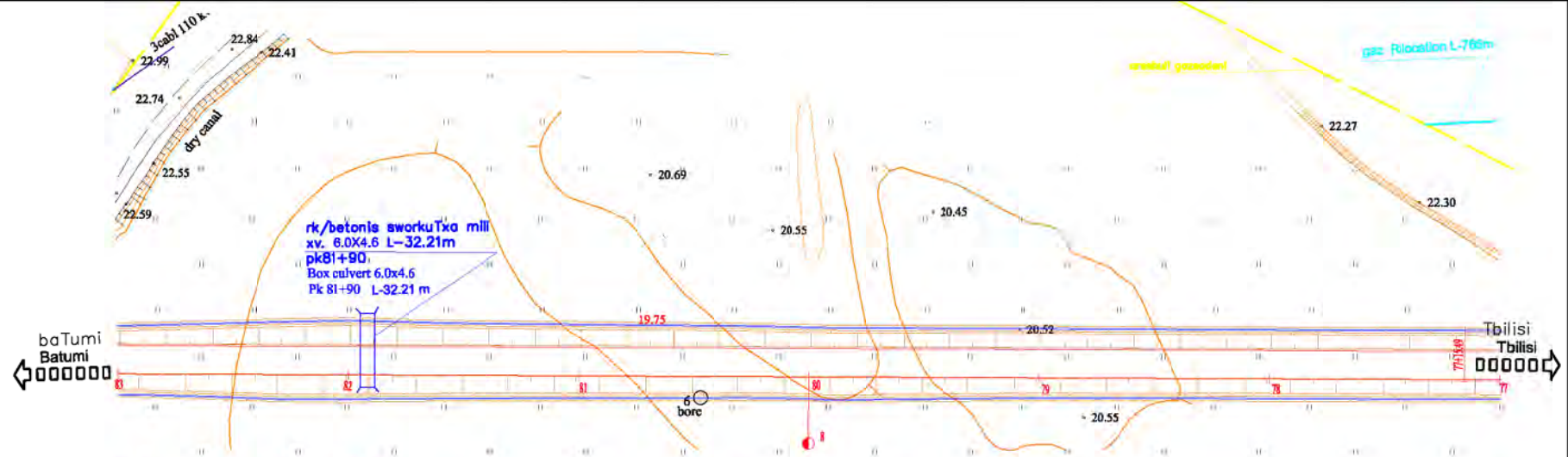


suproektis maqsadmebi PROJECT DATA	qonobebl da vertikaluri mudebi GRADIENT AND VERTICAL CURVE	1
	savali nawilis RerZis niSnulebi ROADWAY AXIS LEVEL	2
facturi maqsadmebi ACTUAL DATA	miwls niSnulebi GROUND LEVEL	3
	manZilebi DISTANCE	4
	piketebl CHAINAGE	5
	swori da mudi gegmaSi STRAIGHT SECTION AND CURVE IN PLAN	6

VICTORIA LTD.	MINISTRY OF REGIONAL DEVELOPMENT AND INFRASTRUCTURE ROAD DEPARTMENT, GEORGIA BASIC SURVEY ON EAST-WEST HIGHWAY IN GEORGIA FINANCED BY JICA JV OF PADECO CO.LTD.EXEIDEA AND ORIENTAL CONSULTANT CO.LTD.	EAST-WEST HIGHWAY IN GEORGIA Samtredia bypass	No 2/12 2009
		Plan and longitudinal profile PK 65+00 - PK 71+00	

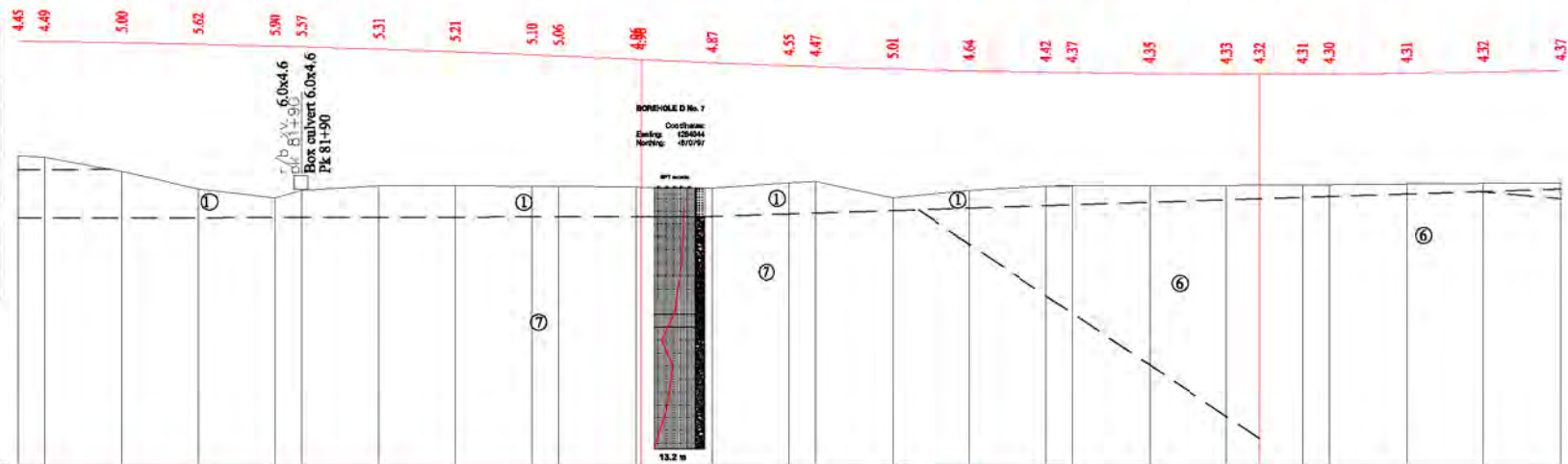






Legend			
Soil Group	Index and Color Mark	Typical Description of Soils	Origin
Fine Soils	①	Clayey SILT	Alluvial Deposit
	②	Stiff CLAY	Alluvial Deposit
	③	Firm CLAY	Alluvial Deposit
	④	Silty SAND	Alluvial Deposit
Coarse Soils	⑤	SAND	Alluvial Deposit
	⑥	GRAVEL with clayey sand matrix	Alluvial Deposit
	⑦	GRAVEL with sand matrix	Alluvial Deposit
	⑧	GRAVEL with silty sand matrix	Alluvial Deposit
	⑨	GRAVEL with clay matrix	Alluvial Deposit

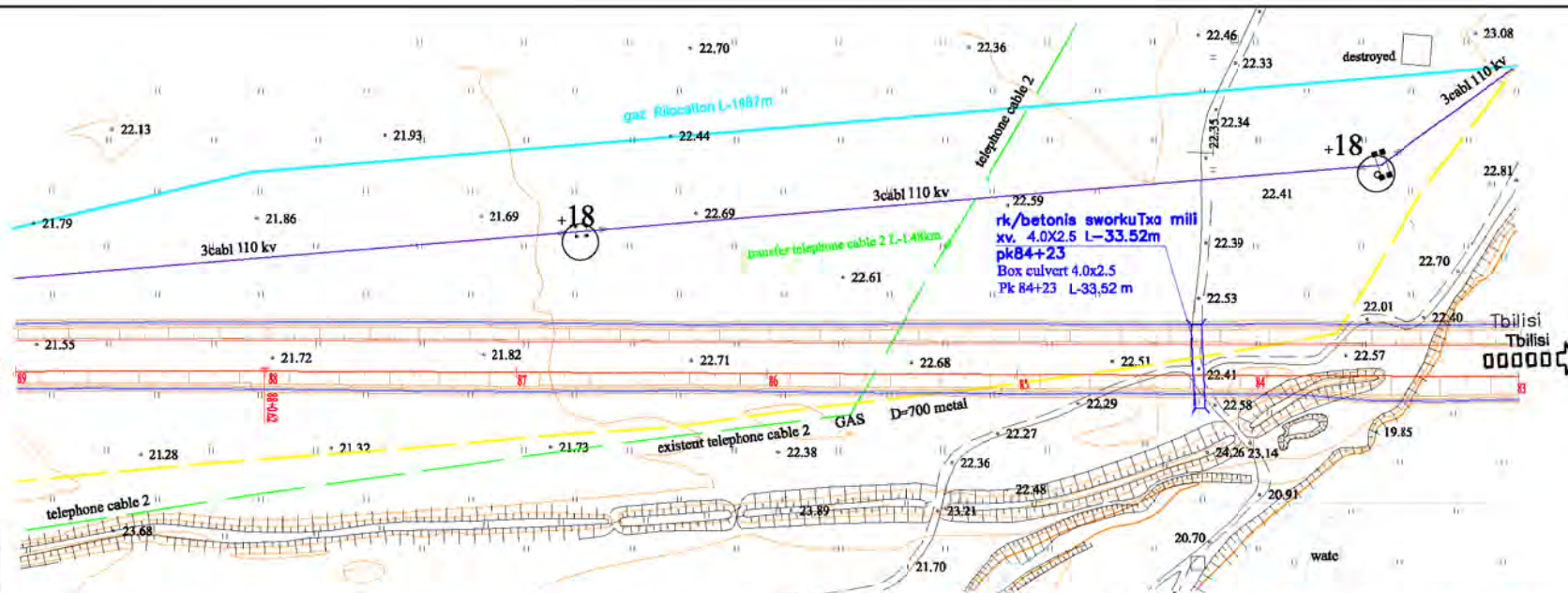
horizontaluri m 1:2000  
 vertikaluri m 1:200  
 HORIZONTAL SCALE 1:2000  
 VERTICAL SCALE 1:200



საპროექტო მონაცემები PROJECT DATA	განახების ვერტიკალური მრუდი GRADIENT AND VERTICAL CURVE	1
საპროექტო მონაცემები PROJECT DATA	საქონლის ნიშნის ნიშნული ROADWAY AXIS LEVEL	2
ფაქტური მონაცემები ACTUAL DATA	მიწის ნიშნული GROUND LEVEL	3
ფაქტური მონაცემები ACTUAL DATA	მანძილის DISTANCE	4
პიკეტაჟი CHAINAGE		5
სწორი და მრუდი გეგმა STRAIGHT SECTION AND CURVE IN PLAN		6

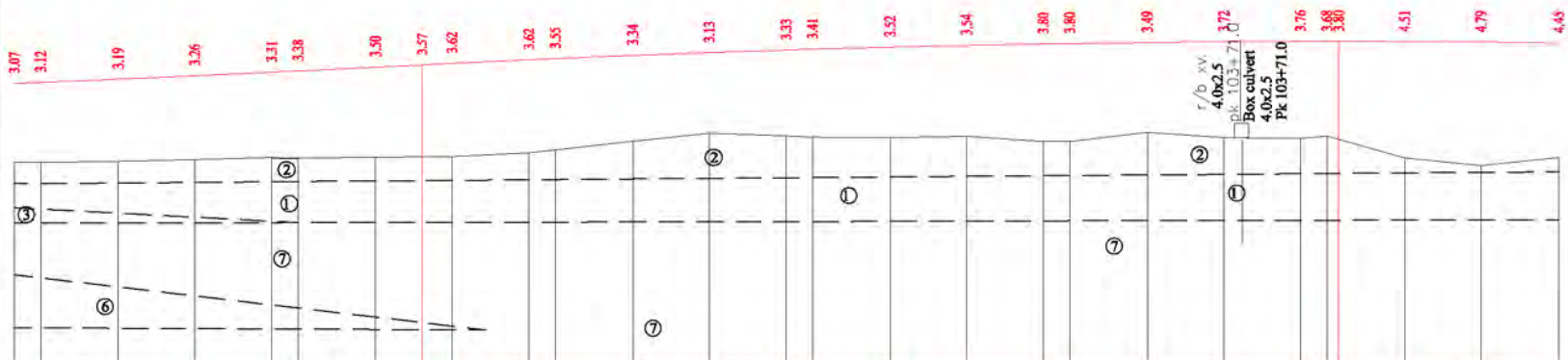


ბათუმი  
Batumi  
←

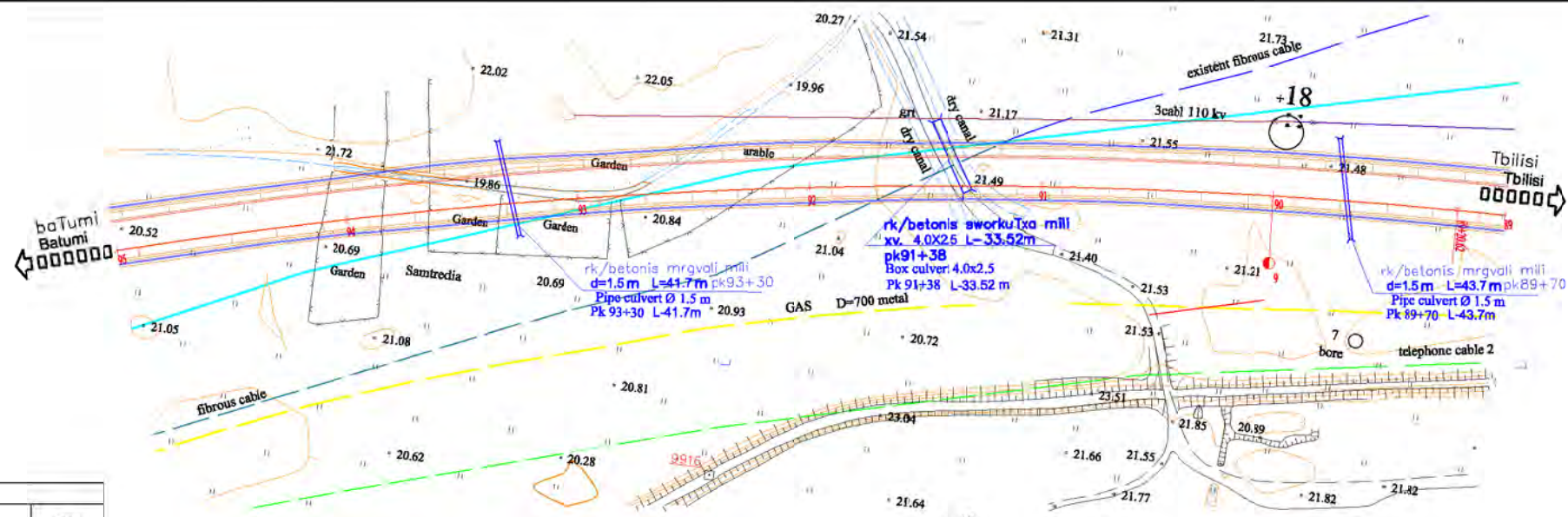


horizontaluri m 1:2000  
vertikaluri m 1:200  
HORIZONTAL SCALE 1:2000  
VERTICAL SCALE 1:200

Legend			
Soil Group	Index and Color Mark	Typical Description of Soils	Origin
Fine Soils	①	Clayey SILT	Alluvial Deposit
	②	Stiff CLAY	Alluvial Deposit
	③	Firm CLAY	Alluvial Deposit
	④	Silty SAND	Alluvial Deposit
Coarse Soils	⑤	SAND	Alluvial Deposit
	⑥	GRAVEL with clayey sand matrix	Alluvial Deposit
	⑦	GRAVEL with sand matrix	Alluvial Deposit
	⑧	GRAVEL with silty sand matrix	Alluvial Deposit
	⑨	GRAVEL with clay matrix	Alluvial Deposit

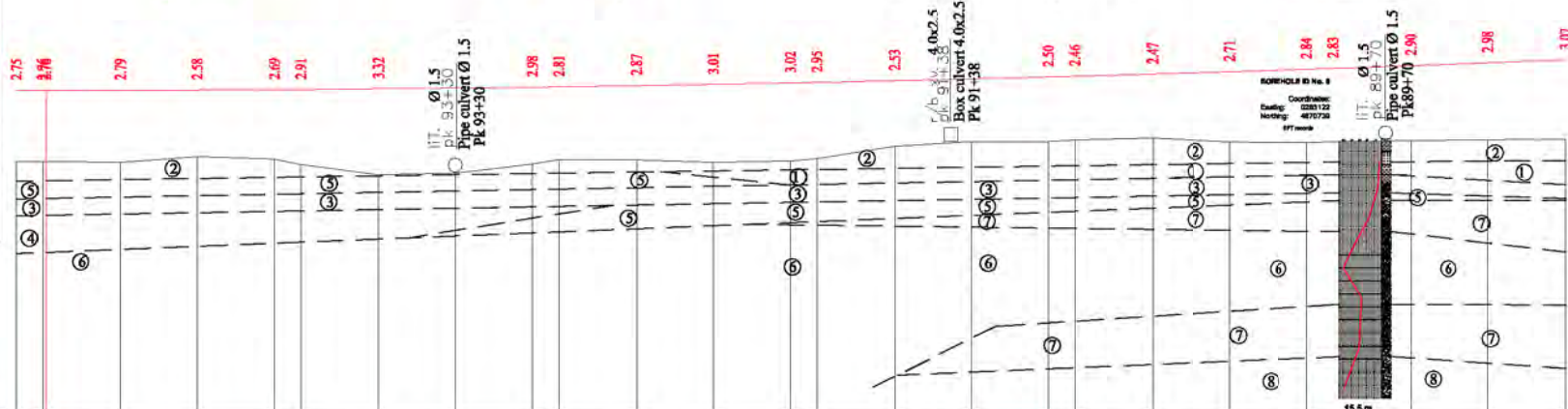


ასპექტის მონაცემები PROJECT DATA	განაბრების და ვერტიკალური მრუდები GRADIENT AND VERTICAL CURVE	1	
	სავალი ნაწილის მონაცემები ROADWAY AXIS LEVEL	2	24.56 24.60 24.73 24.86 24.99 25.04 25.19 25.28 25.34 25.48 25.52 25.65 25.76 25.86 25.89 25.97 26.04 26.09 26.11 26.15 26.17 26.18 26.19 26.18 26.16 26.13
ფაქტური მონაცემები ACTUAL DATA	მიწის ნიშნები GROUND LEVEL	3	21.49 21.48 21.53 21.60 21.69 21.66 21.69 21.72 21.86 21.97 22.31 22.63 22.53 22.47 22.45 22.50 22.30 22.31 22.66 22.45 22.42 22.51 21.67 21.37 21.69
	მანძილები DISTANCE	4	10.00 30.00 30.00 30.00 10.00 30.00 30.00 30.00 10.00 30.00 30.00 30.00 10.00 30.00 30.00 30.00 10.00 30.00 30.00 30.00 10.00 30.00 30.00 30.00
პიკეტაჟი CHAINAGE		5	89 88 87 86 85 84 83
სწორი და მრუდი გეგმა STRAIGHT SECTION AND CURVE IN PLAN		6	



Legend			
Soil Group	Index and Color Mark	Typical Description of Soils	Origin
Fine Soils	①	Clayey SILT	Alluvial Deposit
	②	Soft CLAY	Alluvial Deposit
	③	Firm CLAY	Alluvial Deposit
	④	Silty SAND	Alluvial Deposit
	⑤	SAND	Alluvial Deposit
Coarse Soils	⑥	GRAVEL with clayey sand matrix	Alluvial Deposit
	⑦	GRAVEL with sand matrix	Alluvial Deposit
	⑧	GRAVEL with silty sand matrix	Alluvial Deposit
	⑨	GRAVEL with clay matrix	Alluvial Deposit

horizontaluri m 1:2000  
 vertikaluri m 1:200  
 HORIZONTAL SCALE 1:2000  
 VERTICAL SCALE 1:200



saproqta mshvrebelsi PROJECT DATA	qanobebi da vertikaluri mudebi GRADIENT AND VERTICAL CURVE	1	
	savali nawile RerZie niSnulebi ROADWAY AXIS LEVEL	2	23.38 23.38 23.38 23.39 23.40 23.41 23.43 23.46 23.50 23.51 23.56 23.61 23.66 23.68 23.75 23.82 23.89 23.92 24.00 24.10 24.19 24.23 24.33 24.44 24.56
fagituri mshvrebelsi ACTUAL DATA	miwis niSnulebi GROUND LEVEL	3	20.63 20.62 20.59 20.81 20.72 20.50 20.11 20.18 20.52 20.70 20.69 20.60 20.64 20.73 21.21 21.40 21.39 21.46 21.53 21.38 21.36 21.39 21.43 21.46 21.49
	manZilebi DISTANCE	4	100 30.00 30.00 30.00 100 30.00 30.00 30.00 100 30.00 30.00 30.00 100 30.00 30.00 30.00 100 30.00 30.00 30.00 100 30.00 30.00 30.00
p i k e t a b i CHAINAGE		5	95 94 93 92 91 90 89
swori da mrudi gegnoSi STRAIGHT SECTION AND CURVE IN PLAN		6	Y=3°36.7' R=2300 L=120 T=843 K=1630

VICTORIA LTD.

MINISTRY OF REGIONAL DEVELOPMENT AND INFRASTRUCTURE  
 ROAD DEPARTMENT, GEORGIA  
 BASIC SURVEY ON EAST-WEST HIGHWAY IN GEORGIA  
 FINANCED BY JICA  
 JV OF PADECO CO.LTD.EXEIDEA  
 AND ORIENTAL CONSULTANT CO.LTD.

EAST-WEST HIGHWAY IN GEORGIA  
 Samtredia bypass

Plan and longitudinal profile  
 PK 89+00 - PK 95+00

No 2/16  
 2009



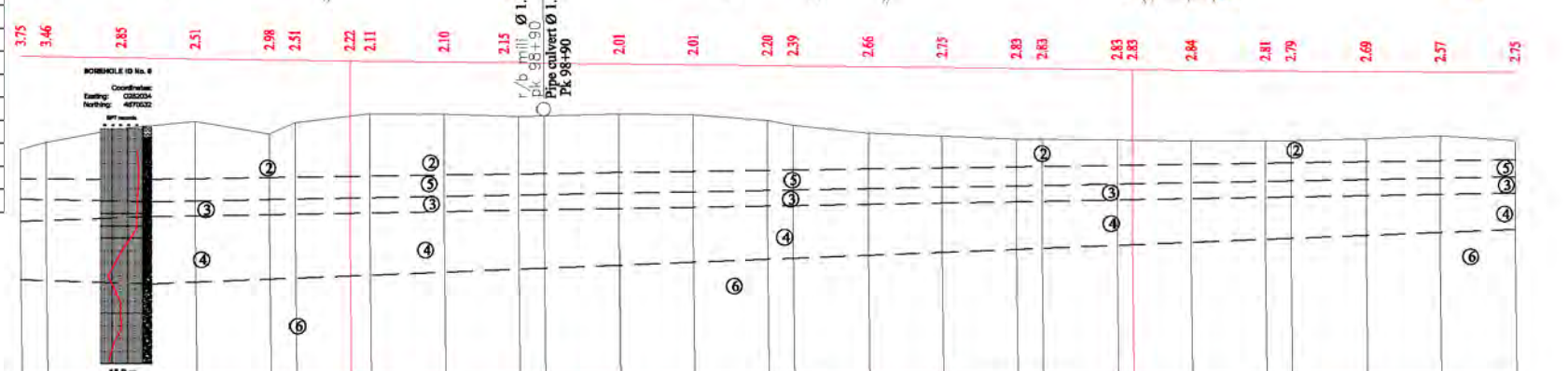
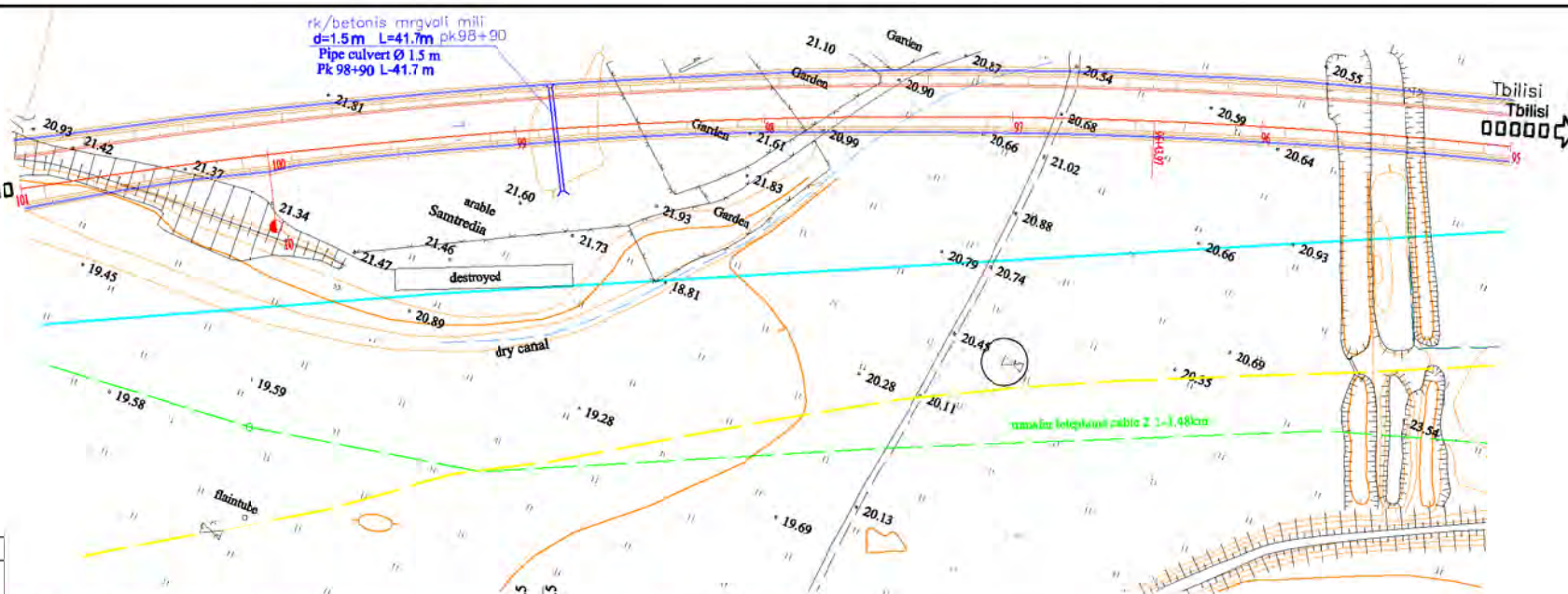
ბათუმი  
Batumi  
000000


An 4 Pk 96+43.97

Coordinates:  
Easting: 0282442.540  
Northing: 4670809.265

Legend			
Soil Group	Index and Color Mark	Typical Description of Soils	Origin
Fine Soils	①	Clayey SILT	Alluvial Deposit
	②	Stiff CLAY	Alluvial Deposit
	③	Firm CLAY	Alluvial Deposit
	④	Silty SAND	Alluvial Deposit
Coarse Soils	⑤	SAND	Alluvial Deposit
	⑥	GRAVEL with clayey sand matrix	Alluvial Deposit
	⑦	GRAVEL with sand matrix	Alluvial Deposit
	⑧	GRAVEL with silty sand matrix	Alluvial Deposit
	⑨	GRAVEL with clay matrix	Alluvial Deposit

horizontaluri m 1:2000  
vertikaluri m 1:200  
HORIZONTAL SCALE 1:2000  
VERTICAL SCALE 1:200



საპროექტო მონაცემები PROJECT DATA	გონახები და ვერტიკალური მრუდები GRADIENT AND VERTICAL CURVE	1																										
	სავალი ნაწილის RerZia niSnulebi ROADWAY AXIS LEVEL	2	24.03	24.01	23.95	23.91	23.86	23.85	23.82	23.82	23.78	23.75	23.74	23.70	23.67	23.64	23.62	23.59	23.56	23.52	23.51	23.48	23.47	23.45	23.42	23.41	23.40	23.38
ფაქტური მონაცემები ACTUAL DATA	მიწის niSnulebi GROUND LEVEL	3	20.28	20.55	21.11	21.39	20.89	21.34	21.70	21.68	21.60	21.62	21.70	21.66	21.44	21.24	20.93	20.81	20.69	20.68	20.65	20.61	20.61	20.61	20.62	20.70	20.82	20.82
	მანძილები DISTANCE	4	10.00	30.00	30.00	30.00	10.00	30.00	30.00	30.00	10.00	30.00	30.00	30.00	10.00	30.00	30.00	30.00	10.00	30.00	30.00	30.00	30.00	10.00	30.00	30.00	30.00	30.00
პიკეტაჟი CHAINAGE		5	101	100				99				98				97				96				95				
სწორი და მრუდი გეგმა STRAIGHT SECTION AND CURVE IN PLAN		6	Y=37°36.7' R=2300 L=120 T=843 K=1/30																									

VICTORIA LTD.

MINISTRY OF REGIONAL DEVELOPMENT AND INFRASTRUCTURE  
ROAD DEPARTMENT, GEORGIA  
BASIC SURVEY ON EAST-WEST HIGHWAY IN GEORGIA  
FINANCED BY JICA  
JV OF PADECO CO.LTD.EXEIDEA  
AND ORIENTAL CONSULTANT CO.LTD.

EAST-WEST HIGHWAY IN GEORGIA  
Samtredia bypass

Plan and longitudinal profile  
PK 95+00 - PK 101+00

No 2/17  
2009

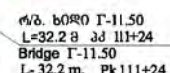


VICTORIA LTD.	MINISTRY OF REGIONAL DEVELOPMENT AND INFRASTRUCTURE ROAD DEPARTMENT, GEORGIA BASIC SURVEY ON EAST-WEST HIGHWAY IN GEORGIA FINANCED BY JICA JV OF PADECO CO.LTD.EXEIDEA AND ORIENTAL CONSULTANT CO.LTD.	EAST-WEST HIGHWAY IN GEORGIA Samtredia bypass	No 2/18 2009
		Plan and longitudinal profile PK 101+00 - PK 107+00	





კრთიმის ტანსაცმელი 8 12000  
 მისი ტანსაცმელი 8 1200  
 HORIZONTAL SCALE 1:2000  
 VERTICAL SCALE 1:200



ഭവനം രൂപം വെക്കുന്നതിനായി

An 5 PK 114+45.3

Coordinates:  
Easting: 0283965.698  
Northing: 4669681.551

End of road Pk 119+50.23

Coordinates:  
Easting: 0280434.418  
Northing: 4669650.041

rk/betonis sworkuTxa mli  
xv. 6.0x4.6 L=32.21m  
pk118+82  
Box culvert 6.0x4.6  
Pk 118+82 L=32.21 m

rk/betonis mrgvali mli  
d=1.5m L=41.68 m pk118+40  
Pipe culvert Ø 1.5 m  
Pk 118+40 L=41.68 m

rk/betonis mrgvali mli  
d=1.5m L=40.65 m pk113+30  
Pipe culvert Ø 1.5 m  
Pk 113+30 L=40.65 m

Legend			
Soil Group	Index and Color Mark	Typical Description of Soil	Origin
Fine Soils	①	Clayey SILT	Alluvial Deposit
	②	Stiff CLAY	Alluvial Deposit
	③	Fine CLAY	Alluvial Deposit
	④	Silty SAND	Alluvial Deposit
Coarse Soils	⑤	SAND	Alluvial Deposit
	⑥	GRAVEL with clayey sand matrix	Alluvial Deposit
	⑦	GRAVEL with sand matrix	Alluvial Deposit
	⑧	GRAVEL with silty sand matrix	Alluvial Deposit
	⑨	GRAVEL with clay matrix	Alluvial Deposit

horizontaluri m 1:2000  
vertikaluri m 1:200  
HORIZONTAL SCALE 1:2000  
VERTICAL SCALE 1:200

approximate monocameral PROJECT DATA	qanobebl da vertikaluri mrudebl GRADIENT AND VERTICAL CURVE	1	594.00																	
	savali novlis RerZis niSnulebl ROADWAY AXIS LEVEL	2	26.82	26.70	26.54	26.48	26.31	26.14	25.97	25.92	25.75	25.58	25.41	25.36	25.19	25.02	24.85	24.79	24.63	24.46
fakturi monocameral ACTUAL DATA	miwis niSnulebl GROUND LEVEL	3	20.33	20.40	20.55	20.60	20.38	20.16	20.46	20.53	20.53	20.56	20.63	20.66	20.72	20.67	20.61	20.53	20.32	20.21
	monZilebl DISTANCE	4	20.23	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
p i k e t a b i CHAINAGE		5	119 118 117 116 115 114 1																	
swori da mrudi gegmaSi STRAIGHT SECTION AND CURVE IN PLAN		6	Y=33°58.3' R=1500 L=130 T=523 K=1019																	

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MINISTRY OF REGIONAL DEVELOPMENT AND INFRASTRUCTURE  
ROAD DEPARTMENT, GEORGIA  
BASIC SURVEY ON EAST-WEST HIGHWAY IN GEORGIA  
FINANCED BY JICA  
JV OF PADECO CO.LTD.EXEIDEA  
AND ORIENTAL CONSULTANT CO.LTD.

EAST-WEST HIGHWAY IN GEORGIA  
Sambredia bypass

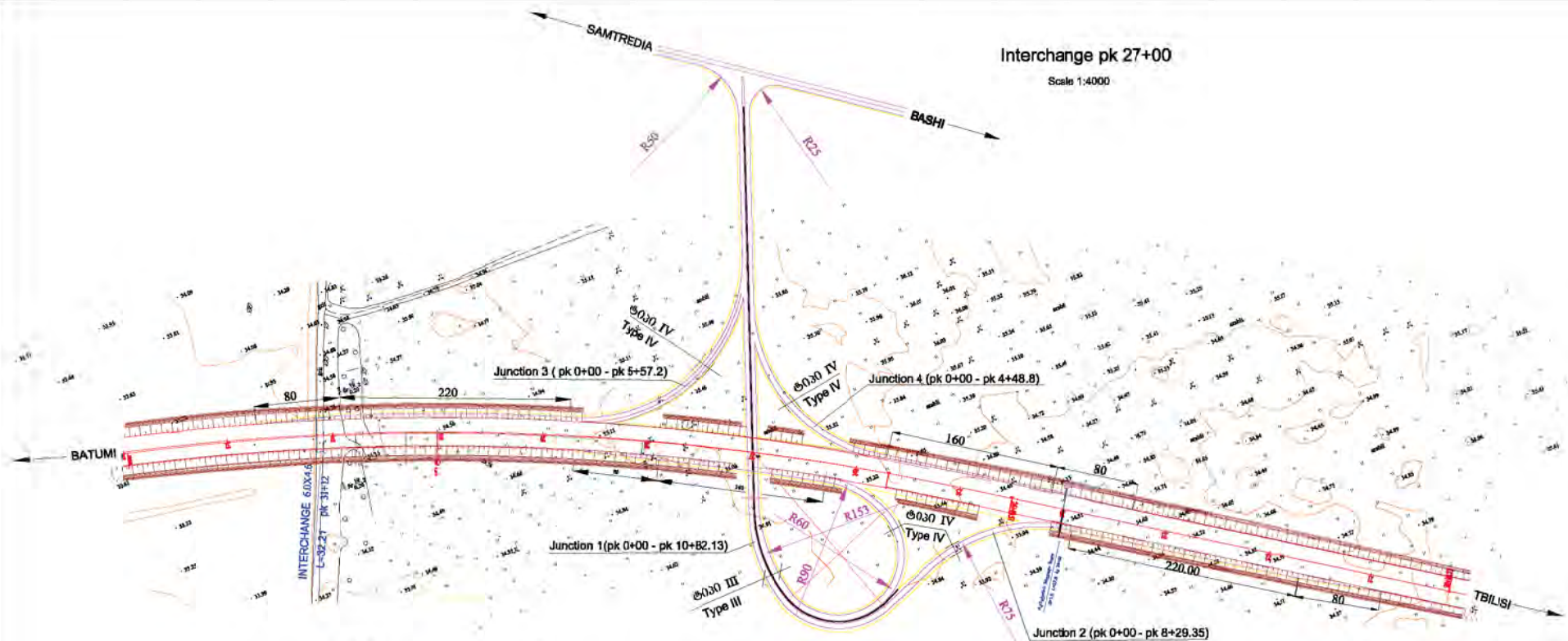
Plan and longitudinal profile  
PK 113+00 - PK 119+50.2

No 2/20  
2009



# Interchange pk 27+00

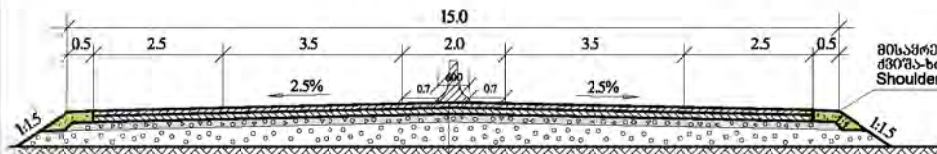
Scale 1:4000



ტიპი III  
Type III

cross section m 1:100  
ჯანგა ქვემოთ 8 1:100

## Road pavement structure



80სანტომეტრიანი გზისკენ  
შებენი ნაგებობა  
Shoulders sand and gravel

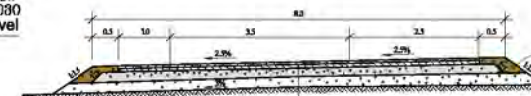
საშარის ზედა ფენა-ფორმირებადი მკვრივი ღორღოვანი  
ასფალტბიტუმის ცხელი ნარევი სისქით 4 სმ ტიპი II  
Wearing course layer-fine graded dense asphalt concrete hot mix, 4 cm thick, Type B, Class II

საშარის შუა ფენა-ფორმირებადი მკვრივი ღორღოვანი  
ასფალტბიტუმის ცხელი ნარევი სისქით 6 სმ ტიპი II, მარკა II  
binder course layer-fine graded dense asphalt concrete hot mix, 6 cm thick, Type B, Class II

საშარის - ღორღი ფრამიით 0-40 მმ. სტაბილიზებული,  
ცემენტის (5%) დანამატით, სისქით 20 სმ.  
Base-crushed aggregates (0-40 mm), stabilized with  
addition cement (5%), 20 cm thick

შუბანები ფენა-ფორმირებადი ნარევი, სისქით 30 სმ.  
Subbase- sand and gravel 30 cm thick

ტიპი IV  
Type IV



80სანტომეტრიანი გზისკენ  
შებენი ნაგებობა  
Shoulders sand and gravel

საშარის ზედა ფენა-ფორმირებადი მკვრივი ღორღოვანი  
ასფალტბიტუმის ცხელი ნარევი სისქით 4 სმ ტიპი II, მარკა II  
Wearing course layer-fine graded dense asphalt concrete hot mix, 4 cm thick, Type B, Class II

საშარის შუა ფენა-ფორმირებადი მკვრივი ღორღოვანი  
ასფალტბიტუმის ცხელი ნარევი სისქით 6 სმ ტიპი II, მარკა II  
binder course layer-fine graded dense asphalt concrete hot mix, 6 cm thick, Type B, Class II

საშარის - ღორღი ფრამიით 0-40 მმ. სტაბილიზებული,  
ცემენტის (5%) დანამატით, სისქით 20 სმ.  
Base-crushed aggregates (0-40 mm), stabilized with  
addition cement (5%), 20 cm thick

შუბანები ფენა-ფორმირებადი ნარევი, სისქით 30 სმ.  
Subbase- sand and gravel 30 cm thick

VICTORIA LTD.	MINISTRY OF REGIONAL DEVELOPMENT AND INFRASTRUCTURE ROAD DEPARTMENT, GEORGIA BASIC SURVEY ON EAST-WEST HIGHWAY IN GEORGIA FINANCED BY JICA JV OF PADECO CO.LTD.EXEIDEA AND ORIENTAL CONSULTANT CO.LTD.	EAST-WEST HIGHWAY IN GEORGIA Samtredia bypass	
		No 8/1 2009	Interchange pk 27+00 and road pavement structure

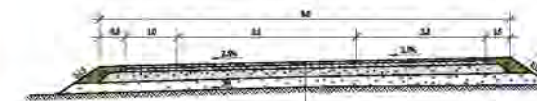




Road pavement structure  
Scale 1:50

ბოძო IV  
Type IV

მისამართი გზისპირა  
მინერალური ნივთიერების  
შებენი ნივთიერება  
Shoulders sand and gravel



საშპს-ის ზედა ფენა-ფინიშინგის ფენის მქონე მკვდრი ფენის ფენის  
საშპს-ის ფენის ფენის ფენის ფენის ფენის ფენის ფენის ფენის  
Wearing course layer-fine graded dense asphalt concrete hot mix, 4 cm thick, Type B, Class II

საშპს-ის ფენის ფენის ფენის ფენის ფენის ფენის ფენის ფენის  
binder course layer-fine graded dense asphalt concrete hot mix, 6 cm thick, Type B, Class II

საშპს-ის ფენის ფენის ფენის ფენის ფენის ფენის ფენის ფენის  
Base-crushed aggregates (0-40 mm), stabilized with  
addition cement (5%), 20 cm thick

ფენის ფენის ფენის ფენის ფენის ფენის ფენის ფენის  
Subbase- sand and gravel 30 cm thick

VICTORIA LTD.

MINISTRY OF REGIONAL DEVELOPMENT AND INFRASTRUCTURE  
ROAD DEPARTMENT, GEORGIA  
BASIC SURVEY ON EAST-WEST HIGHWAY IN GEORGIA  
FINANCED BY JICA  
JV OF PADECO CO.LTD.EXEIDEA  
AND ORIENTAL CONSULTANT CO.LTD.

EAST-WEST HIGHWAY IN GEORGIA  
Samtredia bypass  
Junctions pk 119+00 - pk 126+70.1  
No 9/1  
2009

Plan and road pavement structure  
Scale 1:4000

# **Appendix C**

Basic Design Parameters													
No.	Item	Unit	Option R-1		Option R-2(min. radius)		Option R-3		Option L-1		Option L-2		
1	Characteristics		Right Bank Standard Design		Right Bank minimum resettlement w/mini. Radius		Right Bank No Interference to River		Left Bank Standard Design with Embankment and Revetment		Left Bank Standard Design with Bridge Span over Flood Plain		
2	Length of route	m	11950		12084		11964		11327		11327		
3	Design speed	km/h	120		120		120		120		120		
4	Minimum horizontal radius	m	1175		1175		1500		2500		2500		
5	Bridge Length	m	370.46		370.46		370.46		906.85		3943.2		
6	Revetment Length	m	5800		5800		5300		7000		3640		
7	Resettlement of households	Nos	2		1		20		-		-		
8	Gas Pipe Line Relocation	km	3.554		2.457		0.71		-		-		
Cost Estimate													
No.	Item	Unit	Cost €23 thousand USD	Option R-1		Option R-2(min. radius)		Option R-3		Option L-1		Option L-2	
				Quantity	Cost €23 thousand USD	Quantity	Cost €23 thousand USD	Quantity	Cost €23 thousand USD	Quantity	Cost €23 thousand USD	Quantity	Cost €23 thousand USD
	1	2	3	4	5	6	7	8	9	10	11	12	13
I	Preparatory works												
1	Route development	km	32.2	11.95	385	12.084	389	11.964	385	11.327	365	11.327	365
2	Resettlement of households	No	55	2	110	1	55	20	1,100	-		-	
3	Land Acquisition	ha	21	56.7	1,191	57.6	1,210	56.8	1,193	54	1,134	54	1,134
4	Gas Pipeline	km	609.8	3.554	2,167	2.457	1,498	0.71	433	-		-	
	Gas Pipeline crossing	No	355.2	4	1,421	3	1,066	1	355	-		-	
5	Fiber cable relocation	km	2.9	0.85	2	0.85	3	0.5	2	-		-	
6	Telephone cable relocation	km	33.9	1.48	50	1.48	59	-	-	-		-	



Cost Estimate													
No.	Item	Unit	Cost € thousand USD	Option R-1		Option R-2(min. radius)		Option R-3		Option L-1		Option L-2	
				Quantity	Cost € thousand USD	Quantity	Cost € thousand USD	Quantity	Cost € thousand USD	Quantity	Cost € thousand USD	Quantity	Cost € thousand USD
	1	2	3	4	5	6	7	8	9	10	11	12	13
<b>II</b>	<b>Earthworks</b>												
1	Earth works – flat terrain	1000m3	17.6	1082.25	19,048	1094	19,261	1028	18,095	2643	46,515	1842	32,419
	Installing side drains	1000m3	9.9	11.632	115	11.842	117	11.7	116	6.25	62	4.0	40
<b>III</b>	<b>Pavement</b>												
1	Pavement with cement concrete cover h-28cm	1000m2	68.3	169.05	11,546	170.6	11,652	169.2	11,556	118.531	8,096	118.531	8,096
<b>IV</b>	<b>Facilities</b>												
1	Reinforced concrete bridge on piles on Gubistskali River CH 45+18.4 section - 6X36 width-11.5m	m	13.7	338.26		338.26		338.26		-		-	
					4,634		4,634		4,634		-		-
		m2	1.1	4397.38		4397.38		4397.38					
2	Culvert on piles CH 27+00 section - 12X24X12 width-2X11.5m+3.75m	m	28.3	52.2		52.2		52.2		-		-	
		/			1,477		1,740		1,740		-		-
		m2	0.9	1552.96		1552.96		1552.96					
3	Reinforced concrete bridge on piles on the Ochopa River CH 111+34 section 1X24 width-11.5m	m	12.3	32.2		32.2		32.2		-	-	-	-
		/		/	396	/	396	/	396	/	/	/	/
		m2	0.9	418.6		418.12		418.12					
4	Revetment works on Gubistskali River with rocks d-0.6m weight-0.3t	m	0.7	2300		2300		2300					
					1,610		1,610		1,610	-	-	-	-
		m3		38870		38870		38870					
5	Revetment works on Rioni River with rocks d-1.2m weight-2.5t												
		m	2.3	3500		3500		3000		7000		3640	
					8,050		8,050		6,900		16,100		8,372
		m3		185,500		185,500		162,562		371,000		192,920	
6	Pipe culverts d-1.5m	m	0.5	578.08	289	578.08	318	578.08	318	-	-	-	-
7	Box culverts 6.0X4.5	m	5.6	193.26	1,082	193.26	1,082	193.26	1,082	193.26	1,082	-	-
8	Box culverts 4.0X2.5	m	2.6	230.65	600	230.65	600	230.65	600	230.65	600	230.65	600

Cost Estimate													
No.	Item	Unit	Cost € thousand USD	Option R-1		Option R-2(min. radius)		Option R-3		Option L-1		Option L-2	
				Quantity	Cost € thousand USD	Quantity	Cost € thousand USD	Quantity	Cost € thousand USD	Quantity	Cost € thousand USD	Quantity	Cost € thousand USD
	1	2	3	4	5	6	7	8	9	10	11	12	13
9	Steel reinforced concrete bridge on Hydropower Plant Discharge Canal CH 49+60 Section 6X63 width-11.5m	m	17	-	-	-	-	-	-	197.2	-	197.2	-
		/	-	-	-	-	-	-	-	-	3,352	-	3,352
		m2	1.300	-	-	-	-	-	-	2563.6	-	2563.6	-
10	Steel reinforced concrete bridge on Rioni River CH 57+80 section 6X63 width-11.5m	m	17	-	-	-	-	-	-	323.3	-	3746	-
		/	0	-	-	-	-	-	-	-	5,496	-	63,682
		m2	1.300	-	-	-	-	-	-	4202.9	-	4202.9	-
11	Steel reinforced concrete bridge on Rioni River CH 91+40 section 6X63 width-11.5m	m	17	-	-	-	-	-	-	386.35	-	-	-
		/	-	-	-	-	-	-	-	-	6,568	-	-
		m2	1.300	-	-	-	-	-	-	5022.55	-	-	-
V	Junctions #1,#2												
1	Earth works – flat terrain	1000m3	17.6	67.89	1,195	67.89	1,195	67.89	1,195	67.89	1,195	67.89	1,195
2	Installing side drains	1000m3	9.9	0.723	7	0.723	7	0.723	7	0.723	7	0.723	7
3	Double asphalt concrete pavement on the base of 20cm crushed rock	1000m2	39.8	9.372	373	9.372	373	9.372	373	9.372	373	9.372	373
VI	Interchange			Ch 3+55; CH 27+00		Ch 3+55; CH 27+00		Ch 3+55; CH 27+00		CH 2+53;CH 91+53		CH 2+53;CH 91+53	
1	Earth works	1000m2	17.6	101.964	1,795	101.964	1,795	101.964	1,795	1.15	20	1.15	20
2	Installing side drains	1000m3	9.9	0.877	9	0.877	9	0.877	9	0.236	2	0.236	2
3	Double asphalt	1000m2	39.8	20.668	823	20.668	823	20.668	823	5.072	202	5.072	202

Cost Estimate													
No.	Item	Unit	Cost € thousand USD	Option R-1		Option R-2(min. radius)		Option R-3		Option L-1		Option L-2	
				Quantity	Cost € thousand USD	Quantity	Cost € thousand USD	Quantity	Cost € thousand USD	Quantity	Cost € thousand USD	Quantity	Cost € thousand USD
	1	2	3	4	5	6	7	8	9	10	11	12	13
<b>VII</b>	<b>Safety measures and Social Considerations</b>												
1	Installing steel guardrails	km	167	11.95	1,996	12.084	2,018	11.964	1,998	11.327	1,892	11.327	1,892
2	Concrete parapets	km	28.8	11.95	344	12.084	348	11.964	345	11.327	326	11.327	326
3	Road signs	km	16.4	11.95	196	12.084	198	11.964	196	11.237	184	11.237	184
4	Road marking	km	12.5	11.95	149	12.084	151	11.964	150	11.237	140	11.237	140
5	Local Service Road	km	42.4	10.8	456	10.9	461	10.8	457	10.2	432	6.8	290
6	Local Access Passage	Nos	169	4	676	4	676	6	1,014	3	507	2	338
7	Anti-noise measure	m	0.19	439	83	496	94	2045	389		0		0
8	Environmental mitigation	%		0.5	311	0.5	309	1	593	0.2	189	0.1	123
<b>VIII</b>	<b>Contingency</b>	%		5	3,129	5	3,110	5	2,993	5	4,742	5	6,158
	<b>Total</b>				<b>65,716</b>		<b>65,308</b>		<b>62,849</b>		<b>99,582</b>		<b>129,310</b>