Environmental Impact Assessment

December 2018
First Draft

GEO: North–South Corridor (Kvesheti-Kobi) Road Project

Part 2 (Sections A-C)

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A. Introduction

A.1 General

112. This section of the report; a) provides an overview of the Project, b) outlines the purpose of the EIA; and c) describes the scope of the EIA.

A.2 Overview

113. Due to its geographic location Georgia’s role as a major transit country is significant. Transport of goods into and through Georgia has increased over the past 10-15 years. Almost two-thirds of goods in Georgia are transported by road, and haulage by domestic and international truck companies is very evident on the country’s highways. Many of the roads are however poorly equipped to cope with the volume of traffic and the proportion of heavy vehicles, and factors such as insufficient dual carriageways, routing through inhabited areas and inadequate maintenance and repair, hinder throughputs and increase transit times. This creates difficulties for haulage companies and their clients, truck drivers, Georgian motorists and local residents.

114. The Government of Georgia (GoG) has launched a program to upgrade the major roads of the country. The program is managed by the Roads Department (RD) of the Ministry of Regional Development and Infrastructure (MRDI) and aims to improve transportation and transit of goods in Georgia and to surrounding countries. The World Bank, Japanese International Cooperation Agency (JICA), European Investment Bank (EIB) and the Asian Development Bank (ADB) have already provided series of loans to the state for construction/rehabilitation of the road infrastructure.

115. As a part of the program, upgrading Jinvali-Larsi section of the Mtskheta-Stephantsminda-Larsi Road is planned which connects Georgia to Russian Federation. The road starts from Mtskheta, follows the E-60 highway before heading north bypassing Jinvali reservoir from the west, crossing Gudauri winter resort via the Jvari Pass located at 2,400 meters above sea level (masl) and ending at the border to Russian Federation.

116. Various portions of the road are currently being rehabilitated or are in the process of feasibility study or detailed design. The Project, which is the subject of this EIA, focuses on the portion of road between Kvesheti and Kobi which is shown by Figure 3.

117. The existing road between Kvesheti and Kobi (approximately 34 km) is characterized by difficult geographical and problematic winter maintenance conditions. During the winter, the height of snow at Jvari Pass (2,379 meters above sea level) is 3-5 meters in depth. Snow drifts due to high wind conditions compound the problems in the winter and often lead to closures of the Jvari Pass which can be anytime between November and April.

118. Avalanche protection tunnels are located in portions of the existing road however, they are not wide enough for safe bidirectional traffic. This results in queuing of trucks and passenger cars caused by regulation of the traffic flow by road police. In these areas vehicles have to wait until the snow is cleared or, in best case – until the traffic flow from opposite direction stops to allow the queue to move.

119. Based on the calculation of the average number of hours with prohibited movements the portion of annual demand affected by restriction of traffic by vehicle type has been estimated by the Project’s Feasibility Study.
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Figure 3: Project Road Location Map

Administrative Boundary (left side Dusheti, right side Kazbegi)
Table 5. Percentage of annual demand affected due to prohibition of traffic

<table>
<thead>
<tr>
<th>Kvesheti-Kobi</th>
<th>Bus</th>
<th>Heavy vehicles</th>
<th>Light vehicles</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012-2016 annual average delay (hr)</td>
<td>2,351</td>
<td>2,384</td>
<td>1,096</td>
</tr>
<tr>
<td>% of the annual demand affected</td>
<td>34.6%</td>
<td>35.1%</td>
<td>16.1%</td>
</tr>
</tbody>
</table>

120. Given the issues identified above a new alignment has been proposed that bypasses the problematic areas mainly through a 9km tunnel.

121. The importance of the project is conditioned by the fact that the road is a strategic project in the Government’s effort of transforming Georgia into a transport and logistics hub for trade between Central Asia and the Far East on the one hand, and Turkey and Europe on the other. Connecting the East-West Highway to the main border crossing points via the Project road is becoming a critical part of Georgia to enhance its role as a transit country along the Silk Road.

122. The project will have multiple benefits including a) improving operational continuity of the road even during winter time, b) improving safety, including reduction in fatality, injury and accident rates especially in the winter when tourist traffic heading to Gudauri will be separated from vehicles in transit to Kobi and beyond, and c) travel time savings for passengers and freight transport. At the same time the existing road will be kept operational thereby acting almost exclusively as access to Gudauri.

A.3 Purpose of the EIA Report

123. This Environmental Impact Assessment (EIA) is part of the process of compliance with the ADB Safeguard Policy Statement (2009) and EBRD’s Environmental and Social Policy (2014) in relation to the construction of the Kvesheti – Kobi Road Section or more simply, the “Project”.

124. The EIA provides a road map to the environmental measures needed to prevent and/or mitigate negative environmental effects associated with the Project. The EIA provides a detailed description of the direct and indirect environmental effects associated with the proposed Project during key periods of work.

125. More specifically, the EIA:

(i) Describes the existing socio-environmental conditions within the Project area;
(ii) Describes the project design, construction activities and operational parameters;
(iii) Describes the extent, duration and severity of potential impacts;
(iv) Analyzes all significant impacts; and
(v) Formulates the mitigation actions and presents it all in the form of an Environmental Management Plan (EMP).

A.4 Category of Project

126. Based on the existing ADB Environmental Safeguards Policy (2009), this Project falls under ADB’s project Category A as the project is considered to have significant diverse impacts over a wide area, such as noise impacts, significant quantities of spoil disposal, road safety impacts, and vibration. The Project is also classified as a Category A Project according to EBRD E&S Policy, Appendix 2 which classified construction, realignment or widening of motorways as Category A projects.

A.5 Structure of the Report

6 According to ADB “A proposed project is classified as category A if it is likely to have significant adverse environmental impacts that are irreversible, diverse, or unprecedented. These impacts may affect an area larger than the sites or facilities subject to physical works. An environmental impact assessment is required.”
Section A: Introduction – The section in hand provides the introductory information.

Section B: Description of the Project – Section B describes the Project need and its environmental setting. A scope of works is also provided indicating the type of engineering works required.

Section C: Analysis of Alternatives – This portion of the report provides an analysis of alternatives, including the ‘no project’ option.

Section D: Legal, Policy and Administrative Framework - This section presents an overview of the policy/legislative framework as well as the environmental assessment guidelines of Georgia that apply to the proposed project. The overview is based on recent EIA reports prepared for the previous East West Highway Improvement Projects (EWHIPs).

Section E: Description of the Environment – This section of the report discusses the regional and local environmental baseline conditions. This section is divided into subsections relating to:

(i) Physical: geology; topography; soils; climate; air quality; noise; surface water; groundwater; seismicity and natural hazards.

(ii) Biological: flora and fauna; rare and/or endangered species (Red List species); critical habitats and ecosystems; protected areas. Particular attention shall be given to the presence of land plots registered as the State Forest Fund.

(iii) Human: population; communities; demographics; employment and socio-economics; land use; infrastructure (including local access roads); transport; public health; cultural heritage; archaeology; waste management; tourism.

Surveys have been conducted to address important gaps in the existing data and to collect up-to-date information on topics and areas where significant negative impacts are expected, specifically, flora, fauna, noise, air quality and water quality.

Section F: Environmental Impacts and Mitigation Measures – Section F outlines the potential environmental impacts and proposes mitigation measures to manage the impacts. This has included numerical modeling of noise, vibration and air quality to assist in predicting impacts and planning mitigation in these fields.

Section G: Environmental Management Plan – This section comprises an Environmental Mitigation Plan and an Environmental Monitoring Plan.

The Environmental Mitigation Plan:

(i) Clearly identifies what specific potential impacts various types of works may have on the sensitive receptors;

(ii) Provides concrete actions prescribed for managing these impacts, including location and timing of these actions;

(iii) Provides cost estimates for the main discrete mitigation measures (those that are unlikely to be part of a construction company’s corporate policy and will not necessarily be included into general pricing of the contract); and

(iv) Specifies responsibility for the implementation of each mitigation activity.

The Environmental Monitoring Plan:

(i) Lists all prescribed mitigation measures by types of construction activities;

(ii) Provides selected criteria of monitoring implementation of mitigation measures;

(iii) Specifies methods for measuring outcomes of applied mitigation measures (visual, instrumental, survey, etc.);

(iv) Identifies location and timing/frequency of monitoring mitigation measures by the prescribed criteria.
(v) Gives cost estimates of monitoring mitigation measures by the prescribed criteria; and
(vi) Specifies responsibility for tracking each monitoring criterion.

Section H: Public Consultation, Information Disclosure & Grievance Mechanism – Section H provides a summary of all of the stakeholder consultation activities undertaken. The section also describes the grievance redress mechanism, setting out the mechanisms for resolving complaints about environmental performance.

Section I: Conclusions and Recommendations – The final section of the report provides the report conclusions and recommendations, including a description of any residual impacts.
B. Project Description

B.1 Section Layout

127. This section of the EIA provides the Project description. More specifically it provides; a) Summary of the type and location of the Project, including detailed site location maps, b) summary of each of the two lots including maps of each lot, c) overview of the road design, including all structures, d) summary of the construction process and activities, and e) and overview of road safety issues.

B.2 Type and Location of project

128. The Project is a road construction project. The project is located in Dusheti and Kazbegi municipalities, Mtskheta-Mtianeti region. The Project comprises the Kvesheti – Kobi section of Mtskheta-Stephantsminda-Larsi Road. The length of the new alignment is 22.7 km and will be divided into two construction packages, or ‘Lots’ as follows:

- Lot 1: Tskere – Kobi: Chainage KM 12.7 – KM 22.7 (10 km)
- Lot 2: Kvesheti – Tskere: Chainage KM 0.0 – KM 12.7 (12.7 km)

129. Figure 4 provides a map of the entire Project road and Figure 5 to

130. Figure 19 provides a set of fifteen detailed maps of both Lots including locations of tunnels and bridges.

B.3 Summary of Lots

B.3.1 Lot 1 Summary

131. The Tskere-Kobi portion of the Project road, also referred to as ‘Lot 1’, includes a 8.86 km long tunnel with two cut and cover sections and a junction connecting to the existing road near Kobi. More specifically Lot 1 includes:

- 178m long section of road from Tskere to the south portal of Tunnel 5;
- Tunnel 5 - 8.86 km long bidirectional, 2 lane tunnel (max. gradient 2.35%);
- Two cut and cover (C&C) sections of Tunnel 5 (200m –south portal and 8m – north portal) to protect from avalanches and move entrance portal farther from the Tskere;
- 9.062 km emergency gallery parallel to Tunnel 5 and 17 connections to the main tunnel (6.4 meters wide);
- Technical buildings next to the north and south portals – the buildings include facilities building, pumping station and ventilation room;
- 0.8km long section of road connecting the north portal of the tunnel with existing road. The alignment has been adapted to the current road with a maximum gradient of 4.2 % to keep on using the existing bridge (bridge length 42m, height 6m); and
- 214m long local road diversion.

Cut and cover: the basic concept involves the digging of a trench, the construction of a tunnel, and then returning the surface to its original state.
Figure 4: Project Road (KM 0 – KM 22.7)

Lot 2

Lot 1

Kvesheti

Kobi
Figure 6: LOT 2 Plans (KM 1.5 – KM 2.5)
Figure 7: LOT 2 Plans (KM 2.5 – KM 4.0)
Figure 8: LOT 2 Plans (KM 4.0 – KM 7.5)
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Figure 9: LOT 2 Plans (KM 7.0 – KM 8.9)
Figure 10: LOT 2 Plans (KM 8.5 – KM 10.2)
Figure 11: LOT 2 Plans (KM 10.1 – KM 11.5)
Figure 12: LOT 2 Plans (KM 11.5 – KM 12.7)
Figure 13: LOT 1 Plans (KM 12.7 – KM 14.0)
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Figure 14: LOT 1 Plans (KM 14.0 – KM 15.4)
Figure 15: LOT 1 Plans (KM 15.4 – KM 16.8)
Figure 16: LOT 1 Plans (KM 16.8 – KM18.2)
Figure 17: LOT 1 Plans (KM18.2 – KM 19.7)
Figure 18: LOT 1 Plans (KM 19.7 – KM 21.1)
1. Lot 1, which is located predominantly within Tunnel 5, starts around 200m south of Tskere. Figure 20 provides an aerial image of the start section of Lot 1 and Figure 21 depicts Tskere village. There will be a minor realignment of the existing road approaching Tskere and prior to the tunnel’s technical buildings. Access from the north to the south will also be provided via an underpass just before the immediate start of Lot 1 as shown on the figure below (underpass is located in Lot 2). This will enable villagers to access the cemetery located to the north of the cut and cover portion of Tunnel 5.

**Figure 20: Start section of the design alignment**

![Start section of the design alignment](image1)

2. Lot 1 ends near Kobi, about 176m from the existing bridge over the Narvani river. This area is illustrated by Figure 22 and Figure 23. No new access roads are required in this area.
B.3.2 Lot 2 Summary

132. The Kvesheti – Tskere section, or ‘Lot 2’ includes 2.5 km of tunnels and 1.5 km of bridges. The main elements of this section are:

- Kvesheti bypass road (length 3.2 km),
• Bridge 1 (length 27.8m, height 14m, 2 lane)
• Bridge 2 over the Aragvi river (length 435.28m, height 62m, 3 lanes)
• Tunnel 1 (length 1540.64m, 2 lanes) with gallery (1092m) (New Austrian tunnelling method-NATM)
• Bridge 3 - Arch bridge over the River Khadistskali (length 426m, height 164m, 3 lane)
• Tunnel 2 (length 193.42m, C&C, 3 lane)
• Bridge 4 over the left tributary of River Khadistskali river (length 147.80m, height 26m, 3 lane)
• Tunnel 3 (length 388.38m)
• Bridge 5 (length 322m, height 55m, 3 lane)
• Tunnel 4 (length 299m, C&C, 3 lane)
• Bridge 6 (length 218m, height 48m, 3 lane)
• Five grade junctions are planned (KM0.3, KM1.7, KM3.1, KM7.7, KM10,5) and 3 service roads.

133. The starting section of Lot 2 coincides with the existing road and then bypasses Kvesheti from the east and connects back to the existing road (see Figure 24). Two access roads (length 240m and length 405m) are planned as well as two underpasses allowing access to the river.

134. The new alignment then follows existing alignment up to Arakveti village. Just before reaching the village a small bridge, Bridge 1, is planned (see Figure 25). In Arakveti connection to the existing local road is provided via a junction and two service roads.

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8 The NATM integrates the principles of the behaviour of rock masses under load and monitoring the performance of underground construction during construction. The NATM has often been referred to as a "design as you go" approach, by providing an optimized support based on observed ground conditions. More correctly it can be described as a "design as you monitor" approach, based on observed convergence and divergence in the lining and mapping of prevailing rock conditions. It is not a set of specific excavation and support techniques.
From Arakveti the alignment curves to cross the Tetri Aragvi River with a three lane, 435.38m long bridge, Bridge B2. Beyond the bridge there is the entrance portal for Tunnel 1, see Figure 26.

The alignment then enters Tunnel 1 curving and climbing towards the top of the plateau where it exits the tunnel and bends back along the edge of the plateau towards Zakatkari (see Figure 27). Note, there are plans to connect this portion of the road to Gudauri in the future via a new local road. Tunnel 1 is a three-lane tunnel, consisting of two short cut and cover sections at the portals and the main tunnel. At the north end of tunnel technical service buildings for the tunnel are planned.
137. At Zakatkari connection to the village is provided via an access road. After Zakatkari, the new alignment crosses the Khadistskali river with 426m long, 164m high three lane arch bridge, Bridge 3 (Figure 28).

138. After Bridge 3, on the left bank of the Khadistskali river Tunnel 2 and Bridge 4 is planned. Bridge 4 will connect to Tunnel 3 in Bedoni area. Tunnel 3 has been proposed to go across the mountainous terrain where landslides and avalanches are to be avoided. The new alignment bypasses the village of Sviana-Rostiani from the east to minimize disturbance to the local population as far as possible. The sequence of new tunnels-bridges allows to minimize the geotechnical risks of this area. The axis of the new alignment has been moved away from the edge of the cliff (minimum guard of 5 m) and by providing a minimum radius of 350 m. (see Figure 29).
139. In the Sviana-Rostiani area Tunnel 3 connects to Bridge 5, that ends at an interchange providing access to the villages of Gomurni and Benian-Begoni. (see Figure 30 & Figure 31).
140. After KM 12 local access roads and a cut and cover three lane tunnel, Tunnel 4, are planned. Tunnel 4 will connect with Bridge 6. A local access road under the bridge is planned. Lot 2 ends at KM 12+720, where it joins Lot 1 alignment.

**Figure 32. Alignment in Mughure Village Area**

### B.4 Design

#### B.4.1 General

141. The main technical characteristics of the design road sections are given below.

**Table 6: Design Horizontal and Vertical Parameters and Values**

<table>
<thead>
<tr>
<th>DESIGN PARAMETERS</th>
<th>DESIGN VALUES ADOPTED</th>
</tr>
</thead>
<tbody>
<tr>
<td>Road class</td>
<td>International</td>
</tr>
<tr>
<td>Design speed</td>
<td>80 km/h</td>
</tr>
<tr>
<td>Horizontal alignment</td>
<td></td>
</tr>
<tr>
<td>Min horizontal radius</td>
<td>250m</td>
</tr>
<tr>
<td>Min length for min radius</td>
<td>45m</td>
</tr>
<tr>
<td>Min radius</td>
<td>2500m</td>
</tr>
<tr>
<td>Superelevation min</td>
<td>2.5%</td>
</tr>
</tbody>
</table>
### DESIGN PARAMETERS

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Design Values Adopted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Superelevation max</td>
<td>7%</td>
</tr>
<tr>
<td>Min Stopping sight distance</td>
<td>140m</td>
</tr>
<tr>
<td>Vertical alignment</td>
<td></td>
</tr>
<tr>
<td>Max grade</td>
<td>6%</td>
</tr>
<tr>
<td>Max length max gradient</td>
<td>3000</td>
</tr>
<tr>
<td>Min grade (exceptional)</td>
<td>0.50%</td>
</tr>
<tr>
<td>Max grade tunnel</td>
<td>5%</td>
</tr>
<tr>
<td>Min vertical crest curve</td>
<td>5000m</td>
</tr>
<tr>
<td>Min vertical sag curve</td>
<td>3200m</td>
</tr>
<tr>
<td>Vertical clearance (structures)</td>
<td>5.2m</td>
</tr>
<tr>
<td>Vertical clearance (tunnel)</td>
<td>5m</td>
</tr>
</tbody>
</table>

### B.4.2 Tskere-Kobi (Lot 1) – Design Cross Section Parameters and Main Structures

142. The cross sections of the road section and the tunnel are described below:

#### Table 7: Cross Section Parameters (road and tunnel)

<table>
<thead>
<tr>
<th>Road</th>
<th>Tunnel 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of lanes – 2;</td>
<td>Number of lanes – 2;</td>
</tr>
<tr>
<td>Total width of the structure – 15m;</td>
<td>Tunnel total width – 12.5m</td>
</tr>
<tr>
<td>Total width paved – 12m;</td>
<td>Roadway width – 11m</td>
</tr>
<tr>
<td>Width of traffic lane - 3.5 m;</td>
<td>Lane width – 3.5m</td>
</tr>
<tr>
<td>Min shoulder - 2.5 m;</td>
<td>Min shoulder – 1.5+1m median</td>
</tr>
<tr>
<td>Min roadside – 1.0 m;</td>
<td>Min wayside – 0.75m</td>
</tr>
<tr>
<td>Min wayside – 1.5m</td>
<td>Wayside elevation – 7.5cm</td>
</tr>
<tr>
<td>Vertical clearance – 5m</td>
<td>Vertical clearance – 5m</td>
</tr>
</tbody>
</table>

#### Figure 33: Cross Section of the Main Road (2 lane)

Lot 1 Tunnel 5

143. Tunnel 5 will consist of three portions:

- A 200m long C&C section in Tskere.
- An 8m long C&C section in Kobi.
- The main tunnel and an emergency gallery.
144. The C&C tunnel section consists of a reinforced concrete vault with a radius of 7m and vertical walls of 3m height.

145. An Emergency gallery runs parallel to the main tunnel. Connections between the emergency gallery and the main tunnel are provided every 500m.

146. 80% of the alignment of the tunnel is straight. The elevation profile of the tunnel is: 2.35% uphill gradient from the south covers 7.3 km and 1.6% uphill gradient from the north covers 1.6 km. A climbing lane in Lot 1 is not required.

147. Along the main tunnel niches for SOS posts will be provided.

148. Cross-sections of the tunnel and the emergency gallery are provided in Appendix G.

Lot 1 Tunnel Ventilation

149. The tunnel will be equipped with transversal mechanical ventilation.

150. The system will work in impulsion mode during normal operation to control pollution and it will work in extraction mode in case of fire. The main tunnel ventilation system comprises two large ventilation rooms near the tunnel portals and ventilation ducts both over the road and below it. The air is injected and extracted from the tunnel through the over-road ducts. Fresh air will always be sent into the tunnel from upper part.

151. The system includes a range of sensors that allow monitoring air quality and speed:

- Anemometers.
- CO detectors.
- NOx detectors.
- Opacimeters.

152. The parallel emergency gallery is equipped with five jet fans — equivalent to the ones located in the main tunnel—in order to guarantee minimum air renewals and provide the air flow required for the vestibule ventilations.

Lot 1 Tunnel Lighting

153. Gradual reduction of luminance will be used to enables the driver's eyes reaction to cope with the transition from daylight levels to the tunnels, lower interior levels. To allow visual adaptation the lighting of a tunnel is divided into specific 'zones'.

154. A control system will be provided to easily integrate extra features like adapting the lighting according to traffic density, pollution environment adjustment, dynamic lighting evacuation systems and more. Monitoring and reporting the energy consumption and failures of luminaires, meters or other systems, provides tunnel managers with additional information and visibility concerning the network.

155. In addition to the mentioned above the tunnel will be equipped with:

- safety lighting powered by uninterruptable power supply unit (UPS); and
- evacuation lighting situated on both sides of the tunnel. The lamps will be places 1m above the carriageway in every 10m. (Capacity – 16W.)

Lot 1 Tunnel Fire fighting

156. The tunnel will be equipped with a manual extinguishing system. Hydrants, fitted with isolation valves, will be installed outside each tunnel portal and inside every 250m as maximum. Next to each hydrant inside the gallery, a cabinet equipped with hoses and other ancillary elements (jet-flows, torches, etc.) will be installed.

157. Design flow will be, at least, two consecutive hydrants working simultaneously (typically a total flow of 120 m³/h is considered). The fire water tank and fire pumps will be located in...
facility building at the tunnel portals within technical buildings area. Water for the fire water tanks will be supplied by tanker trucks.

158. Due to the large length of the tunnel and its height difference between the tunnel portals, the tunnel has been divided in two parts, each equipped with separate independent systems (hydrants, pumping rooms, water tanks, piping, etc.).

159. In addition to the system mentioned above, portable fire extinguishers will be provided.

160. Fire-fighting run-off water will be managed according to the requirements outlined below under Lot 1 and 2 Drainage.

Lot 1 Tunnel Power Supply

161. Energy will be supplied by 10 kV underground line by means of a corresponding Switching Substation. The installation of this Switching Substation and the underground line extension, are subjected to a separate project.

162. Three independent power sources have been designed for this installation:

- Medium Voltage line from the electricity supply in single grid (Main source).
- Stand-by diesel generator, which will automatically start in the event of failure of the main source. The diesel generator shall have the sufficient capacity to power all essential components and equipment. Diesel containers will be stored within a bunded area.
- Uninterruptible Power Supply (UPS) facility, which stores power to be used when all other sources fail. It would also cover any transition period and ensure that emergency systems remain operable.

163. More precisely, one Transformer Centre will be installed on each of the tunnel entrances. In addition to these two transformers, five more Transformer Centers will be installed inside the tunnel. The various transformers will be connected with each other by means of a Medium Voltage line that will pass through the emergency gallery in conduits specifically installed for Medium Voltage circuits. Oil used in the transformers will be PCB free.

164. Furthermore, next to the Transformer Centers, Technical Rooms for Low Voltage Switchboards will be implemented, in order to supply electricity to all the equipment in the tunnel. All Low Voltage cables that feed emergency systems (emergency ventilation, emergency lighting, detection equipment, etc.) shall be fire resistant (AS+).

165. On each entrance of the tunnel, next to the Transformer Centre, a stand-by diesel generator will be installed (diesel containers will be stored within a bunded area). The generator will supply all preference loads that are not supplied from UPS and which are fed from the Transformer Centers of the tunnel's entrances.

166. All Technical Rooms will have an uninterruptible power supply in case of power supply failure. Most critical electronic equipment will be fed from the UPS, such as, certain lighting and fire control. Power will be ensured for, at least, sixty (60) minutes.

Lot 1 Tunnel Safety

167. Safety will be ensured by availability of:

- Emergency walkways,
- Emergency gallery with cross connections in every 500 m.
- Lay-bays every 1,000 m (required if the total tunnel width that is accessible to vehicles, excluding elevated parts and normal traffic lanes, is less than the width of one normal traffic lane)
- Drainage system for flammable and toxic liquids
- Normal lighting, safety lighting & evacuation lighting
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- Emergency stations SOS post and SOS/PCI in every 125m and 250m respectively
- Water supply & hydrants in every 250 m
- Road signs showing exit positions, distance and direction to safe area, location of firefighting equipment, etc. (Maximum distance between evacuation signs - 25 m)
- Control center
- Video monitoring & Automatic Incident Detection
- Tunnel closing equipment
- Radio re-broadcasting equipment for emergency service
- Public Address System in shelters and exits
- Emergency power supply

Consultations on Tskere C&C

As a result of visiting the site several times, not only for the surveys but also for gathering the best input for the design, the Detailed Design held discussions with local people to understand their expectations for the project and also to listen their proposals. These meetings were informal ones but were also attended in some instances by World Bank staff (managing the design process).

Regarding Tskere, the tunnel portal design is focused on limiting geological and technical issues while at the same time limiting impacts to the population in Tskere. In this sense, the C&C was lengthened as much as possible to move the tunnel portal south further from Tskere. In addition, the cuts are proposed to be cladded with local stones and slim trees (Populus nigra) to minimize the visual impact.

Another request from local people was to prevent the existing cemetery at Tskere from any damage during the construction period. The temporary cuts at the tunnel portal were reinforced and their location and slope were modified in order to ensure a safety corridor. Also, temporary accesses to the cemetery during the construction period has been adopted at the design.

Lot 1 Technical Buildings

168. There will be technical buildings at the tunnel portals. The technical buildings will accommodate:

- Pump room with fire water tank - below ground structure entirely designed with in-situ reinforced concrete. The room accommodates fire pumps, water tank with capacity sufficient for 1 hour.
- Facilities Building - below ground structure (level of 35 m length, 23 m width and 4 m depth) for ventilation utilities. Above ground part of the structure consists of 9m wide and 6m high section to accommodate ventilation utilities and lateral electrical building (width 7 m, length 18 m).

B.4.3 Kvesheti - Tskere (Lot 2) – Design Cross Section Parameters and Main Structures

169. The cross sections of the road section and the tunnel are similar to those given in Table 7.

170. A climbing lane has been located in lot 2 from KM3.4 up to chainage KM12.7 before the main tunnel, Tunnel 5 in Lot 1.
171. The following cross section is proposed for this project where a clearance 0.30 m width for a double line is added to separate both ways and the shoulder on the right is reduced to 0.70 m:

**Figure 34: Proposed Cross Section of Climbing Lane**

Lot 2 Bridges

172. Lot 2 comprises six bridges as shown in Table 8.

<table>
<thead>
<tr>
<th>#</th>
<th>Chainage start</th>
<th>Chainage end</th>
<th>Total length, m</th>
<th>Max. height, m</th>
<th>Width, m</th>
<th>Number of lanes</th>
<th>Number of spans</th>
<th>Span length, m</th>
<th>Number of Piers in riverbed</th>
<th>Bridge type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2+216.100</td>
<td>2+243.9</td>
<td>27.8</td>
<td>14</td>
<td>15</td>
<td>2</td>
<td>1</td>
<td>30</td>
<td>0</td>
<td>Precast beams</td>
</tr>
<tr>
<td>2</td>
<td>3+437.225</td>
<td>3+872.34</td>
<td>434</td>
<td>62</td>
<td>18.2</td>
<td>3</td>
<td>5</td>
<td>53, 70, 93, 135, 83</td>
<td>1, partially Balanced cantilever</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>8+575.092</td>
<td>9+007.09</td>
<td>432</td>
<td>164</td>
<td>18.2</td>
<td>3</td>
<td>22</td>
<td>19</td>
<td>0</td>
<td>Arch bridge</td>
</tr>
<tr>
<td>4</td>
<td>9+366.562</td>
<td>9+514.33</td>
<td>147.8</td>
<td>26</td>
<td>17</td>
<td>3</td>
<td>5</td>
<td>28.9; 3x30, 28.9</td>
<td>0</td>
<td>Precast beams</td>
</tr>
<tr>
<td>5</td>
<td>10+171</td>
<td>10+493</td>
<td>322</td>
<td>55</td>
<td>3</td>
<td>7</td>
<td>38; 4 x 55; 38; 26</td>
<td>0</td>
<td>Movable scaffolding</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>12+470</td>
<td>12+688</td>
<td>218</td>
<td>48</td>
<td>17</td>
<td>3</td>
<td>5</td>
<td>26; 38; 2x55, 44</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

173. The cross section of the 6 bridges is as wide as the approach road. Table 9 indicates the parameters of each bridge.

<table>
<thead>
<tr>
<th>Lane width</th>
<th>Bridge 1</th>
<th>Bridge 2</th>
<th>Bridge 3, 4, 5, 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.5 m</td>
<td>3.90 m</td>
<td>3.5m</td>
<td></td>
</tr>
<tr>
<td>Lanes</td>
<td>2</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Side piece (left)</td>
<td>2.5 m</td>
<td>2.5 m</td>
<td>2.5m</td>
</tr>
<tr>
<td>Side piece (right)</td>
<td>2.5 m</td>
<td>0.7 m</td>
<td>0.7m</td>
</tr>
<tr>
<td>Wayside</td>
<td>1.5 m</td>
<td>1.5 m</td>
<td>1.5m</td>
</tr>
<tr>
<td>Clearance</td>
<td>0</td>
<td>0</td>
<td>0.3m</td>
</tr>
</tbody>
</table>
Except for small bridge in Kvesheti-Arakveti area all other bridges along the design alignment are three lane (have climbing lines). Plans and cross sections of all Lot 2 bridges are provided in Appendix G.

Lot 2 Tunnels

174. **Lot 2 Tunnel 1** - The tunnel consists of two Cut and Cover sections at entrance (length 11m) and exit (length 155m) of the tunnel and the main tunnel body. At each portal a section 10 m long is designed at variable height in order to integrate the portals into the existing landscape (see Figure 36).

<table>
<thead>
<tr>
<th></th>
<th>Tunnel cross section recommended according to “Cross section design for Bi-directional road tunnels” developed by World Road Association (PIARC)</th>
<th>Curved section of Tunnel 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of lanes</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Roadway width</td>
<td>14.3 m</td>
<td>15.2 m</td>
</tr>
<tr>
<td>Lane width</td>
<td>3.5 m</td>
<td>3.9 m</td>
</tr>
<tr>
<td>Shoulder</td>
<td>2.5 m</td>
<td>2.5 m</td>
</tr>
<tr>
<td>Shoulder reduced</td>
<td>0.7 m</td>
<td>1 m</td>
</tr>
<tr>
<td>Median</td>
<td>0.3 m</td>
<td>0.3 m</td>
</tr>
<tr>
<td>Walkway elevation</td>
<td>7 cm</td>
<td>7 cm</td>
</tr>
<tr>
<td>Walkway width</td>
<td>0.75 m</td>
<td>0.75 m</td>
</tr>
<tr>
<td>Vertical clearance</td>
<td>5m</td>
<td>5m</td>
</tr>
</tbody>
</table>

175. There will be 11 SOS niches, 10 SOS+PCI niches and 3 emergency exits.

**Figure 35. Lot 2 Tunnel 1 Main Tunnel Cross Section**
176. As the tunnel is more than one kilometer long an emergency gallery is required. The cross section of the gallery is similar to one designed for Lot 1 tunnel (see Appendix G). Three connections between emergency gallery and main tunnel are provided at less than 500m between connections or portals.

177. **Lot 2 Tunnel 2 (Cut and Cover)** - The tunnel is a 193m long Cut and Cover structure. At each portal a section 10 m long is designed at variable height in order to integrate the portals into the existing landscape. In the last 139 meters (between chainages KM9.1 and KM9.24), due to site conditions and to prevent snow avalanches, a protection gallery has been designed. The C&C was selected for Tunnel 2 due to the following design constraints:

- Type of soil – the rock is not good quality.
- Length (193 m) – short length.
- Overburden (less than 12 m in the worst section and less than 4 m in the main part of the tunnel).

178. The vegetation on top of the tunnel will be fully reinstated.

179. **Lot 2 Tunnel 3 (Cut and Cover sections, drill and blast tunnel)** - The tunnel consists of two Cut and Cover sections at entrance (length 4.1m) and exit (length 50m) of the tunnel. A variable section of 10 m length is designed in each structure as outlet in order to integrate the portals into the existing landscape.

180. Main tunnel cross section is similar to the plateau Lot 2 Tunnel 1, but lanes width are 3.5m. The main tunnel is less than one kilometer long so no emergency gallery is needed and, as the tunnel is also less than 500m no niches for SOS or PCI are needed.

**Table 11: Summary of Lot 2 Tunnel 3**

<table>
<thead>
<tr>
<th>Roadway width</th>
<th>14.3 m</th>
</tr>
</thead>
</table>
Tunnel cross section recommended according to “Cross section design for Bi-directional road tunnels” developed by World Road Association (PIARC)

<table>
<thead>
<tr>
<th></th>
<th>Lane width</th>
<th>Shoulder</th>
<th>Shoulder reduced</th>
<th>Median</th>
<th>Walkway elevation</th>
<th>Walkway width</th>
<th>Vertical clearance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lane width</td>
<td>3.5 m</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>5 m</td>
</tr>
<tr>
<td>Shoulder</td>
<td>2.5 m</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shoulder reduced</td>
<td>0.7 m</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Median</td>
<td>0.3 m</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Walkway elevation</td>
<td>7 cm</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Walkway width</td>
<td>0.75 m</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

181. **Lot 2 Tunnel 4 (cut and cover)** - Tunnel 4 is a 299 m long buried gallery located at chainage KM11.99. A variable section of 10 m length is designed at both sides of the C&C as outlet, in order to integrate the portals into the existing landscape.

182. **Lot 2 Tunnel Ventilation** - The length of the tunnels is different; therefore, their ventilation necessities are completely different. Lot 2 Tunnels 2, 3 and 4 do not need mechanical ventilation system. In Lot 2 Tunnel 1 there are two main zones that require independent mechanical ventilation:

- Traffic circulation area in the main tunnel.
- Emergency exits, which comprises the parallel gallery and the connections with the main tunnel.

183. The main tunnel ventilation system and the emergency gallery ventilation present a double objective- provide adequate air quality during normal operation and removal of exhaust and smoke from the main tunnel, emergency gallery and connections during fire.

184. Similar to Lot 1 Tunnel 5, the system includes anemometers, CO detectors, NOx detectors and opacimeters that allow monitoring air quality and speed.

**Lot 2 Tunnel Lighting**

185. Similar to Lot 1 Tunnel 5 permanent, reinforcement and evacuation lighting will be provided.

**Lot 2 Tunnels Firefighting**

186. Firefighting system along the tunnel comprises the following elements: manual extinction systems and fire detection systems. All the tunnels will be equipped with portable fire extinguishers. In addition, Tunnel 1, due to its long length, will be equipped with a firefighting hydrant network.

187. In addition to the hydrant systems, portable fire extinguishers shall be provided. In Lot 2 Tunnel 1 they should be installed next to each emergency call points and at gallery connections. In Lot 2 Tunnels 2, 3 and 4, they should be installed in each entrance and exit of the tunnel. In addition, all technical rooms should be equipped with portable fire extinguishers.

**Lot 2 Technical Buildings**

188. In order to house the installations required for the different tunnels, different groups of buildings have been planned close to each tunnel portal. These building include: Electrical Building the Pumping Station. The location of these buildings is the following:

- Tunnel 1 entrance and exit (KM3.9, KM5.5): electrical building and pumping station.
- Tunnel 2 entrance (KM8.5): electrical building.
- Tunnel 3 exit (KM10.0): electrical building.
- Tunnel 3 exit (KM12.2): electrical building.

189. Electrical buildings house the power supply facilities:
• Medium Voltage Room where a group of medium voltage cells and a transformer centre are located.
• Generator Room where a stand-by-diesel will be installed (diesel containers will be stored within a bunded area).
• Low voltage Room for low voltage switchboards and UPS.
• Facilities Room where racks are located.

190. Electricity will be supplied in Medium Voltage to the different Transformer Centres located along the road, and later transformed to Low Voltage in each Transformer Centre, to finally supply the equipment in the tunnel.

Lot 2 Underpasses

191. According to the original design two underpasses were considered for access (see Figure 24: Kvesheti bypass):

• Underpass KM0.9 - box type (length 20.31m, width 14m, height 6.65m).
• Underpass KM0.7 - box type (length 45.08m, width 14m, height 5.50m).

Consultations on Underpasses

As part of the consultation process for this Project some changes to the underpasses have been made. These changes are discussed below.

Underpass KM0.9 - This proposed underpass affects some land plots and buildings, and local people (and the owners of these properties) complained about it during the public meetings for this EIA. At the same time, because of the height of the embankments for the new alignment (above of the existing ground), some buildings were affected regarding their sights to the Aragvi river and the valley. Considering this, when developing the survey on site, the resettlement team decided to extend the buffer at this location (see A, Figure 37: Buffer, Kvesheti, Figure 38: Properties Affected by Embankment), in order to include these properties (see [1] and [2], Figure 38).
Accordingly, the design team developed a new alignment for the Khada valley road from Kvesheti and moved the underpass to a new location which connects an existing pedestrian path (see [ACL-1.06], Figure 39).

**Figure 39: New Khada Valley Access Road and Underpass**

Arakveti underpass - As a result of the public consultations in Arakveti, a new underpass (see [UP-2.6], Figure 40) both for pedestrians and cattle, has been adopted. Even though the access to the river side was provided by a new local road which avoids crossing the new road, this underpass ensures a shorter path to some plots and also to an existing shop. The project team met with the woman in charge of this shop, explaining her the design criteria regarding safety, both for traffic road and pedestrians. Also, attending the demands from some local residents, some accesses to plots were provided.

**Figure 40: Arakveti Underpass**
Cattle underpass at the Plateau - Considering the requests from the social meetings, regarding the Plateau area which is used for cattle grazing, and also in order to prevent from accidents from cattle crossings and to allow a better access to the whole area, a new underpass was adopted (see [UP-5.9], Figure 41).

Lot 2 Retaining Walls

193. A group of protection wall will be arranged to retain the terrain at different levels as described in the table below.

Table 12: Lot 2 Retaining Walls
Environmental Impact Assessment for the Kvesheti-Kobi Road Section

| Cantilever concrete walls | are entirely cast on site with reinforced concrete and its height varies from 2 m to 10 m. | • Max height 6m, length 110m  
• Max height 6m, length 130m  
• Max height 3m, length 170m  
• Max height 10m, length 50m  
• Max height 10m, length 80m  
• Max height 10m, length 65m |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Reinforced earth walls</td>
<td>are built on site using terrain, steel anchors and concrete shells.</td>
<td>• Max height 14m, length 180m</td>
</tr>
</tbody>
</table>
| Rockery walls            | are built on site using rock elements that allows to stabilize terrain slope effects. | • Max height 2m, length 40m  
• Max height 10m, length 35m |
| Anchored concrete walls  | are established in general in order to permit excavation throughout the Project area of main road, anchored walls are cast on site reinforced concrete (shells elements) with individualized anchors dimensioned to control terrain stability. | • Max height 10m, length 260 |

B.4.4 Lot 1 and Lot 2 Shared Design Characteristics

Drainage

194. Longitudinal drainage, e.g. side drains – consists mainly in platform ditches and guard ditches.

- Platform ditches drain the water of the road platform and the water of the cut slopes. They are triangular ditches, disposed along the road platform, with side slopes of 2H:1V.
- Guard ditches: These are trapezoidal ditches, located along the head of cuts and the foot of embankments. They drain the runoff water, preventing that this water reaches the road platform.

195. The longitudinal ditches connect to transversal drainage (culverts), which are composed of circular pipes or box culverts depending on the maximum discharge. In this section some bridges allow to pass the main flow of incoming water as well as the main transversal drainage pipes.

196. Along the alignment (Lot 1 and Lot 2) there are 7 bridges that allows the passing of the main flow of incoming water. In addition, three culverts are designed in Lot 1 at KM 12.73, KM 12.86 and KM 22.00 and nine culverts in Lot 2 at KM 3.20, KM 3.43, KM 5.69, KM 5.79, KM 6.10, KM 7.70 (2 units), KM 8.20 and KM 11.09. For drainage 1200mm and 1800mm pipes will be provided. The diameters/capacity of the pipes have been estimated based on 100-year recurrence discharge.

197. All bridges include oil-interceptor tanks to collect oil and grease run-off from the bridge decks. Figure 42 illustrates an example of where an oil interceptor tank has been included in the design, in this instance at the start of Bridge 2. The effluent from the tanks will discharge directly to the surrounding environment. On steep slopes erosion protection will be provided at the discharge points (planting of native wetland plant species in discharge locations to remediate the water and provide some soil stability is also recommended). All other above ground portions of the Project road will have the drainage system connected to settlement tanks.

Figure 42: Oil Interceptor Tank, Bridge 2
198. In the tunnels, where the transport of dangerous goods is permitted, the drainage of flammable and toxic liquids is considered. Additionally, the drainage system is designed to prevent fire and flammable and toxic liquids from spreading inside and between the tubes.

**Figure 43: Tunnel and C&C Platform Drainage**

199. The system platform drainage designed consists of a slotted precast chainage and a longitudinal pipe 300 mm diameter, in addition siphon manholes (600 x 800 mm) each 60 m prevent from the fire propagation (coordinated with the rest of facilities located in the tunnel).

200. The effluent collects in a storage tank of 120 m$^3$, these tanks are located in the technical building areas. The tank shall be fitted with an interceptor tank to filter out any oil and grease run-off within the tunnel. Water discharge from the tank shall be tested when the tank is full to ensure effluent discharge is compliant with national and IFC standards. In the event that a spill of toxic or hazardous liquid occurs the liquid shall be stored within the tank until they can be removed by a licensed contractor.
201. In the emergency gallery, infiltration water is collected and drained by means of a longitudinal pipe 250 mm diameter and manholes each 60 m apart.

**Pavement**

202. The pavement consists of asphalt base course and crushed rock base course. In order to reduce the negative effect of ice in pavement durability, it has been designed a dense-graded asphalt surface course, meaning it is relatively impermeable. As it can be observed, the thickness of the frost blanket course depends on the frost class:

<table>
<thead>
<tr>
<th>Table 13: Proposed Pavement Structure</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>OPTION A: ASPHALT BASE COURSE AND CRUSHED ROCK BASE COURSE</strong></td>
</tr>
<tr>
<td><strong>(RStO 12 Plate 1, Line 3)</strong></td>
</tr>
<tr>
<td><strong>LOAD CLASS BK32</strong></td>
</tr>
<tr>
<td><strong>FROST CLASS</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>ASPHALT SURFACE COURSE</td>
</tr>
<tr>
<td>ASPHALT BASE COURSE</td>
</tr>
<tr>
<td>CRUSHED ROCK BASE COURSE</td>
</tr>
<tr>
<td>FROST BLANKET COURSE</td>
</tr>
</tbody>
</table>

203. The pavement design of the structures is designed with two layers of dense asphalt with a thickness of 3 cm and 5 cm respectively and a tack coat (350 g/m²) between them. In the tunnel sections, the pavement design follows the same structure as the general outside sections. The pavement of the emergency galleries is composed of a concrete layer of 20 cm since the traffic along the gallery will be circumstantial. For main local road diversions where the traffic will be lower than for the main section (particularly the Mleta junction, Kobi junction (Lot1)), a traffic category of BK 10 has been considered, resulting in the following pavement design (Local Road Type 1):

<table>
<thead>
<tr>
<th>Table 14: Pavement structure Local Road Type 1</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ASPHALT SURFACE COURSE</strong></td>
</tr>
<tr>
<td><strong>ASPHALT BASE COURSE</strong></td>
</tr>
<tr>
<td><strong>CRUSHED ROCK BASE COURSE</strong></td>
</tr>
<tr>
<td><strong>FROST BLANKET COURSE</strong></td>
</tr>
</tbody>
</table>

204. For the other local roads, for example at Kvesheti, Bedoni or the new Gudauri access road, designs for the lowest traffic category, BK 0.3, are considered as follows:

<table>
<thead>
<tr>
<th>Table 15: Material specifications for Local Road Type 2 and Type 3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Layer Material</strong></td>
</tr>
<tr>
<td>Asphalt concrete type B, on viscous bitumen 60/90</td>
</tr>
<tr>
<td>Tack Coat</td>
</tr>
<tr>
<td>Asphalt concrete porous coarse, on a viscous bitumen 60/90</td>
</tr>
<tr>
<td>Prime Coat</td>
</tr>
<tr>
<td>Crushed mix with continuous granulometry C6</td>
</tr>
<tr>
<td>Gravel mixture with continuous granulometry C3</td>
</tr>
</tbody>
</table>

205. The same consideration applies for operation area at tunnel portals where the technical buildings are placed.
206. Where the slope is high in these areas (higher than 12%), a concrete surface course has been selected due to the constructive limitations to asphalt on high slopes.

Junctions

207. In Lot 2 five junctions have been considered, these junctions allow the connection to existing populations, existing roads or existing facilities improving the driving conditions of the proposed road. The junctions are shown in Figure 24 to Figure 28.

208. The first junction is located at KM 0.3, it is a three-leg intersection (T Junction) with extra lanes for left turns, it links to Kvesheti where there is a new access to Khada valley. The next junction is located at KM 1.7, it is other three leg intersection with extra lanes for left turns, it links to an urban area between Kvesheti and Arakveti on the left side where there is no other access. The third junction is located at KM 3.1, it is a three-leg intersection with extra lanes for left turns, it links to the existing road on the left side that goes towards Gudauri before Bridge 3 that rises to the plateau. The fourth junction is located at KM 7.7, it is a three-leg intersection with extra lanes for left turns, it links to Zakatkari on the left side. The final junction of Lot 2 is at KM 10.5, it is a diamond intersection for four possible movements, it links to Begoni and to the existing road along the Khada river. It is the last junction before the main tunnel and it is at 1,700 meters above sea level.

Figure 44: Diamond Intersection at KM 10.5

Lighting Specification

209. Lamps are Light Emitting Diode (LED) type and produced so that maximum durability and best performance is ensured. Luminaires are made of die cast aluminum alloy enclosure, sealed to IP66. Luminaires are mounted on galvanized steel columns with a 12 m height. The supports of outdoor lighting shall comply with the applicable regulations. The supports, anchorages and foundations, are sized to withstand the mechanical stresses, particularly considering the wind, with a safety factor not less than 2.5.

Fencing
210. Fencing has been only adopted for tunnel portals and operational areas. It is a simple twisted (diamond mesh) electro welded metal fence, with the corresponding tension posts, anchored to the ground by concrete cubes.

Local Road Diversions

211. According to the detailed design twelve road diversions are planned.

Table 16: Local road diversions

<table>
<thead>
<tr>
<th>#</th>
<th>Id</th>
<th>Description</th>
<th>Type</th>
<th>Length</th>
<th>Max slope</th>
<th>Current conditions</th>
<th>New pavement</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>LDR 09</td>
<td>Kvesheti</td>
<td>1</td>
<td>242/633</td>
<td>5.5%/7%</td>
<td>Gravel secondary road</td>
<td>Asphalt</td>
</tr>
<tr>
<td>2</td>
<td>LDR 1.6</td>
<td>Kvesheti</td>
<td>4</td>
<td>158</td>
<td>14%</td>
<td></td>
<td>Concrete</td>
</tr>
<tr>
<td>3</td>
<td>LRD 3.1 (*)</td>
<td>Arakveti</td>
<td>2</td>
<td>390</td>
<td>3.5%</td>
<td></td>
<td>Asphalt</td>
</tr>
<tr>
<td>4</td>
<td>LRD 3.5</td>
<td>Plateau</td>
<td>5</td>
<td>251</td>
<td>6%</td>
<td></td>
<td>Gravel</td>
</tr>
<tr>
<td>5</td>
<td>LRD 5.3</td>
<td>Plateau, T1 exit</td>
<td>5</td>
<td>261</td>
<td>2.5%</td>
<td></td>
<td>Asphalt</td>
</tr>
<tr>
<td>6</td>
<td>LRD 7.7(*)</td>
<td>Future access to Gudauri</td>
<td>3</td>
<td>328</td>
<td>4%</td>
<td></td>
<td>Asphalt</td>
</tr>
<tr>
<td>7</td>
<td>LRD 10.5(*)</td>
<td>Begoni access</td>
<td>4</td>
<td>531</td>
<td>10%</td>
<td></td>
<td>Asphalt &amp; concrete</td>
</tr>
<tr>
<td>8</td>
<td>LRD 11.5</td>
<td></td>
<td>5</td>
<td>344</td>
<td>7%</td>
<td></td>
<td>Gravel</td>
</tr>
<tr>
<td>9</td>
<td>LRD 11.9</td>
<td>After Begoni</td>
<td>5</td>
<td>370/68</td>
<td>9%/5%</td>
<td></td>
<td>Gravel</td>
</tr>
<tr>
<td>10</td>
<td>LRD 12.0</td>
<td>Before the end of Lot 2</td>
<td>3</td>
<td>549</td>
<td>6%</td>
<td></td>
<td>Asphalt</td>
</tr>
<tr>
<td>11</td>
<td>LRD 12.7</td>
<td>Mughure access</td>
<td>4</td>
<td>167</td>
<td>12.5%</td>
<td></td>
<td>Concrete</td>
</tr>
<tr>
<td>12</td>
<td>LRD 12.9</td>
<td>KM 12+920</td>
<td>3&amp;3</td>
<td>214</td>
<td>≤10%; &gt;10%</td>
<td></td>
<td>Asphalt &amp; concrete</td>
</tr>
</tbody>
</table>

B.5 Construction

B.5.1 Construction Process

212. During the construction phase the following activities will be undertaken:

(i) **Land Acquisition** - Under the terms of the Loan of the ADB and EBRD, before the commencement of the construction works at any part of the site, the Employer must prepare the Land Acquisition and Resettlement Plan (the LARP), obtain the approval of ADB and EBRD and then implement the plan and acquire the land.

(ii) **Specific Environmental Management Plan (SEMP)** - Ensure that the SEMP is submitted to the Engineer for review at least 30 days before taking possession of any work site. No access to the site will be allowed until the SEMP is reviewed by the Engineer and approved by the RD / PIU.

(iii) **Site Clearing Works** - The Works include the following site clearing works within or adjacent to the RoW (within the Project buffer) of the Project Road, in accordance with the Drawings or instructions of the Engineer:

(a) Clearing and grubbing.
(b) Removal and disposal of any existing traffic signs, sign posts and their foundations.
(c) Demolition, removal and disposal of any existing culverts, inlet and outlet structures, headwalls, concrete drains, channel lining, and erosion protection works.
(d) Removal of any other natural or artificial objects within the RoW.
(e) Removal and disposal of all vegetation and debris within the designated limits of the Right-of-Way.

---

9 Buffer refers to the land that is required for the construction and operation of the road. The buffer, in its entirety will be the property of the GoG and as such all properties, or land not belonging to the GoG must be procured as part of the LARP before works can commence in this area.
(f) Removal of any existing pavement in the Kvesheti and Kobi areas of the Project area. Recycling of this material is described further below.

(iv) **Relocation of Existing Services** - The Works include the relocation of all services affecting the construction of the Project Road within the Right-of-Way. The services include the following:
   - (a) water mains
   - (b) overhead electric supply lines
   - (c) gas pipelines
   - (d) underground telephone cables
   - (e) sewer mains

(v) **Construction Activities** – The main construction phase aspects are described in detail below.

**Tunnels**

**Tunnel Boring Machine (TBM)**

213. Due to the length of Lot 1 Tunnel 5, the type of ground, time restraints and the evaluation of costs, a simple shield TBM is considered the best option for this tunnel. The suggested TBM type is primarily intended for use in rock with a short stand-up time and fractured rock.

![Figure 45: Example of a TBM](image)

214. The TBM is fitted with a shield skin. The shield skin extends from the cutter head over the entire machine. The lining is installed in the projection of the shield tail, with a support consisting of reinforced concrete segments. To obtain the thrust necessary to excavate the full-face section and the advance rates required, the TBM is equipped with telescopic hydraulic cylinders which rest on the tunnel lining rings which are displayed in the previous phases. The shield forms an integral protection system, formed by a steel-sheeted structure. Its aim is to guaranty the temporary support of the terrain while the excavation process is advancing, and the lining is not placed. In order to install the lining segments a hydraulic erector is installed at the back of the TBM. This erector is in charge of the final placing of the lining.

215. As in this case presence of water inflows has been foreseen, special attention must be paid to the joints between the metallic shield and the lining finally placed. The lining segments are disposed inside the shield, so when the machine moves forward, a gap is left between the lining and the surrounding soil. This gap must be filled with grout.

216. The working cycle of a Simple Shield TBM is as follows:
   - **Excavation.**
- Removal of the thrust hydraulic cylinders.
- Placement of the lining segments.
- Adjustment of the thrust hydraulic cylinders to their new position.
- Starting the next excavation stage.

217. The estimated time for TBM tunnel construction without manufacturing, transportation, assembly and dismantling is expected to take 22 months.

218. The disc cutters excavate the rock in a continuous way. The buckets collect the loosened rock and are tipped onto the conveyor belt intermittently. Buckets are constructed as slots around the perimeter of the cutter head and deliver the excavated rock to the conveyor belt while the cutter head rotates.

219. Waterproofing system will include:
- Sealing bands.
- Injected grout between the segment and the ground.

220. Another way to ensure waterproofing, is reducing the inflowing geological water by filling the gap with the surrounding rock by injecting grout mixture. Injecting by itself does not constitute and effective waterproofing layer, it is an additional way of decreasing the water pressure that the sealing band has to face. The whole gap between the segments and the ground will be filled with a concrete grout.

### Emergency Gallery

221. The emergency gallery is going to be built using New Austrian Technology Method (NATM). Depending on the size of the tunnel and the quality of the terrain, it can be possible to excavate the full face of the tunnel in one or in two phases. The construction process involves:
- Excavation (blasting).
- Removal of spoil.
- Construction of the support (using robots equipped with concrete guns, hydraulic jumbos and platform lifts).
- Waterproofing.
- Positioning of the formwork and concreting of the lining.

222. Post blasting, ventilation of the excavation face area is required due to firing fumes, gases and dust. High temperatures and the concentration of harmful gasses (e.g. Carbon Monoxide CO, Carbon Dioxide CO\(_2\), Nitrogen Dioxide NOx etc.) shall be decreased. The ventilation during construction will be done with simple jet fans installed outside the tunnel in the portal area. Through the pipe (installed in the upper part of the top heading) fresh air is pressed into the tunnel to the working face.

223. The spoil removal procedure can be divided into the loading, transport and disposal phases. The loading of the material can be completed with wheeler loaders.

224. The advance rates depend on the quality and the kind of terrain to be excavated. Excavation will start from both portals of the tunnel. Construction of the two portals will take up 2 months.

### Bridges

225. The construction of the new bridges includes but is not limited to the following parts of the structures and associated works:

(i) Foundations.
(ii) Substructure including bridge bearings.
(iii) Superstructure, including construction of expansion and deformation joints and footpaths.
(iv) Deck pavement including hydro isolation, drainage, hand railing, and conduits for services.
(v) Approach slabs.
(vi) Slope treatments in front and around the abutments.
(vii) Construction and maintenance of traffic detours.
(viii) Scour and erosion protection of the waterway areas and river bank protection upstream and downstream of the bridge crossing, and removal of old foundations and substructure from the waterways.
(ix) All necessary and incidental items required for a complete bridge.
(x) All new bridges will be designed for the life expectancy of 100 years.
(xi) Oil and grease interceptor tanks.

Culverts

226. Project works include the construction of culverts and underpasses, including inlet and outlet structures and associated works in accordance with the Specification. The scope of the cross drainage works includes:
(i) Complete replacement of existing culverts which are old, structurally deficient or undersized;
(ii) Construction of new culverts at locations where no cross-drainage structure existed before;
(iii) Cleaning of existing culverts which are partially or completely silted;
(iv) Miscellaneous repair of the existing culvert joints, headwalls, wing walls, and scour and erosion protection works; and
(v) Construction of new scour protection and channel lining works.

Other Drainage Structures

227. Surface runoff from the carriageway and all other pavements, and any cut and embankment slopes must be discharged through longitudinal drains designed for adequate cross section, bed slopes, invert levels and the outfalls. The Works include construction of the drainage system components in urban and rural areas according to the types, dimensions, classes and material requirements for this work.

Earthworks

228. The Works include the following types of earthworks necessary for the construction of the Project Road and all associated works:
(i) Removal of topsoil.
(ii) Construction of embankments.
(iii) Construction of subgrade.
(iv) Excavation and removal of the existing pavement materials and the existing road embankment.
(v) Removal and replacement of unsuitable materials.
(vi) Structural excavation.
(vii) Excavation for the construction of side drainage and cross-drainage works.
(viii) Excavation for the removal and relocation of the existing utilities.
(ix) All backfilling necessary for the construction of bridges, retaining walls or other earth retaining structures, cross drainage structures and associated works, side drains and erosion protection work.
(x) Preparation of beddings and filters for all structural, cross drainage, side drains or pavement works.
(xi) Excavation, filling or backfilling necessary for the execution of any other incidental works.
Removal of Asphalt

There is some small section of the existing pavement (both Lot 1 and Lot 2) which will need to be removed to make way for the new alignment. The Contractor shall remove the existing bituminous pavement layers in these areas and stockpile this material at locations that will be specified by the RD and instructed by the Engineer. The asphalt will be re-used, where practical, for access roads and temporary roads, and if not suitable will be re-used for shoulder material.

B.5.2 Construction Equipment and Staff

Construction Equipment

Table 17 provides indicative lists of the key equipment required in the construction phase.

<table>
<thead>
<tr>
<th>No.</th>
<th>Equipment Type and Characteristics</th>
<th>Minimum Number required</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Bulldozer (&gt;245HP)</td>
<td>4</td>
</tr>
<tr>
<td>2</td>
<td>Excavator (&gt;100HP)</td>
<td>12</td>
</tr>
<tr>
<td>3</td>
<td>Crushing and screening plant – mobile type at least 150 m3/h including rock material washing machinery</td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td>Concrete Paving Machinery width not less than 9.0 m for 2-layer concrete placing including film-forming machinery</td>
<td>2</td>
</tr>
<tr>
<td>5</td>
<td>Small Concrete Paving Machinery width not more than 5.0 m including film-forming machinery</td>
<td>1</td>
</tr>
<tr>
<td>6</td>
<td>Front Loader (&gt;135HP)</td>
<td>15</td>
</tr>
<tr>
<td>7</td>
<td>Concrete batching plant (&gt;150m3/hr)</td>
<td>2</td>
</tr>
<tr>
<td>8</td>
<td>Motor grader (&gt;135HP)</td>
<td>10</td>
</tr>
<tr>
<td>9</td>
<td>Vibratory roller (&gt; 13T)</td>
<td>8</td>
</tr>
<tr>
<td>10</td>
<td>Tipper truck (10T)</td>
<td>30</td>
</tr>
<tr>
<td>11</td>
<td>Tipper truck (16T)</td>
<td>30</td>
</tr>
<tr>
<td>12</td>
<td>Mobile concrete carriers (&gt;25T)</td>
<td>25</td>
</tr>
<tr>
<td>13</td>
<td>Transit mixer (&gt;6m3)</td>
<td>6</td>
</tr>
<tr>
<td>14</td>
<td>Crane (100 tons)</td>
<td>4</td>
</tr>
<tr>
<td>15</td>
<td>Crane (250 tons)</td>
<td>2</td>
</tr>
<tr>
<td>16</td>
<td>Rotary drilling Machine</td>
<td>8</td>
</tr>
<tr>
<td>17</td>
<td>Roadheader</td>
<td>2</td>
</tr>
<tr>
<td>18</td>
<td>Excavator Hammer</td>
<td>8</td>
</tr>
<tr>
<td>19</td>
<td>Jack Hammer</td>
<td>8</td>
</tr>
<tr>
<td>20</td>
<td>Pusher Leg</td>
<td>4</td>
</tr>
<tr>
<td>21</td>
<td>Truck mixer concrete pump</td>
<td>10</td>
</tr>
<tr>
<td>22</td>
<td>TBM</td>
<td>1</td>
</tr>
</tbody>
</table>
Environmental Impact Assessment for the Kvesheti-Kobi Road Section

Personnel

231. The construction phase will last approximately 36 and 48 months for Lot 2 and Lot 1 respectively and it is expected that approximately 600 direct employment opportunities will be available during the peak of construction. This may be divided between two construction ‘Lots’. It is estimated that around 70% of staff will be locally employed and 30% will be international staff. It is estimated that around 20-30 female staff for each lot, around 10% of the total staff for each Lot. The breakdown of skills required during the construction phase will be as follows:

(i) Skilled labour: 58%;
(ii) Semi-skilled labour: 20%; and
(iii) Unskilled labour: 22%.

B.5.3 Construction Program and Schedule

232. The proposed works schedule is as follows:

Lot 1

233. The layout of this section, mainly with a long tunnel and its parallel emergency gallery, provides only two main areas of work, located close to the portals, in which are concentrated the more important activities.

234. The work schedule establishes the main activities involved in the works, their duration and the relations between the activities. It is divided in five groups of actuations:

1. Access preparation 2 months.
2. Works from T5 entrance.
3. Works from T5 exit.
4. Works in tunnel and emergency gallery.
5. Other works.

235. The total duration expected for the Lot 1 works is 4 years.

Lot 2

236. The layout of this section (Lot 2) provides three main areas of work:

1. KM 0.0 – KM3.9 - Outside road works from Kvesheti to Arakveti.
2. KM 3.9 – KM 8.7 - Tunnel/outside road works at Plateau.
3. KM 8.75 – 12.72 - Tunnel/outside road works at Begoni plateau.

237. The total duration expected for the Lot 2 works is 3 years. The three different areas of works can act simultaneously with small interferences. As the cross section is composed of 3 lanes, the first portion along the existing road will develop works on one lane and allow crossing traffic at the other two. Bridge 2 should be totally completed from the existing road by a temporary river cross. Tunnel 1 is the main task for portion 2 – Plateau and the longer activity (31 months) and it is considered to drill only one side (top to down) because of the difficulties of accesses to the south portal (close to the riverside). In any case, earthworks for all this portion are related to the Plateau spoil disposal site. The arch bridge abutment, Bridge 3, must be completed from this side of the gorge. Portion 3 – Begoni plateau is the most limiting work area, because of the interferences with Lot 1 and local traffic, the distance to the spoil disposal site (potentially located at Kvesheti or the Plateau) and mainly because completing Tunnel 3 provides the access to bridges (for the precast beams), C&C tunnels (earthworks and transport of remaining material to the spoil disposal site) and abutment of the Arch bridge, Bridge 3.
B.5.4 Access to Site / Temporary Roads

238. The following section provides a summary of the access to site proposed as part of the Detailed Design. These roads have been represented in the project for the sole purpose of indicating possible access routes and to evaluate the cost of construction within the Bill of Quantities (BoQ). These schemes of design are indicative and not mandatory, although suggested: The Contractors, according to their working methods, available machinery and experience, can change them and must in any case submit to the Employer, or his Engineer, a detailed plan for such access roads and will also have to provide for the temporary acquisition of the relevant areas.

239. Such plan must be complete with detailed drawings of the elements that make up the road, the areas and the properties affected by possible occupation outside the areas owned by the administration, calculation reports if necessary. In addition, in this plan the existing traffic affected by the passage of construction vehicles must be shown and the Contractor will be responsible for requesting authorization from the Authority managing the use of the same infrastructure.

240. In addition, the EIA states (in Sections F and G) that specific environmental and social method statements shall be prepared for all temporary roads (and temporary river crossings and storage areas) in order to adequately assess the potential environmental and social impacts of these areas and the measures to manage any potential impacts. These method statements shall be prepared with the oversight of the Contractors Ecological Clerk of Works and then reviewed and approved by the RD and Engineer before any works can commence in these areas.

241. Access to the site is discussed below in detail, but broadly includes:

- **Lot 1:**
  - Portion 1: Access to Kobi and Tunnel 5 northern portal
  - Portion 2: Access to Tunnel 5 southern portal

- **Lot 2:**
  - Portion 1: Kvesheti
  - Portion 2: Plateau and Potential Spoil Disposal Sites
  - Portion 3: Begoni Plateau

242. Figure 46 illustrates the three potential access roads up to Tskere.
243. **Access for Portion 1**: The first portion relates to; a) the development of the northern portal of Tunnel 5 (where the TBM will be launched), b) the northern half of the excavation of the emergency gallery, c) all the works in the operation area of the exist of Tunnel 5 (including technical and service buildings and cut & cover structures), and d) the junction with the existing road at Kobi.

244. **Access for Portion 2**: Relates to the southern portal of Tunnel 5 in Tskere. In order to quickly initiate the tunnel excavation, the existing access road at the Khada valley should be used (Figure 46 – Blue line). The distance from the main road at Kvesheti junction to Tskere through this way is around 7 kilometers.

245. The current condition of this route will allow it to be used for the initial delivery of tunneling equipment. But it will be necessary to enhance and enforce it so that it may be used as the main access for all construction equipment (Lot 1 and 2).

246. For this access route it has been planned to bypass Bedoni to the north because of the narrow existing road and to not to disturb the villagers. Consultations undertaken as part of this EIA have indicated that trucks currently using this route to access the Khada valley are causing some noise and vibration impacts. The change of the layout solves the problem of space in the existing route, were the houses are close to the pavement, and there is not enough space for a
regular traffic of construction vehicles and machinery. However, it is also noted that this route requires temporary land access across some of the fenced agriculture areas of the village, which can be reinstated at the completion of construction.

247. To use this route the Contractor will need to reinforce or to build up a new bridge over the Aragvi river, because of the bad condition of the existing one. The existing bridge is not suitable for a regular traffic of construction vehicles and machinery.

248. The Contractor will be required to improve the access road by spreading (regularly during the construction period) compacted crushed stone. Some transversal drainage pipes will be also required for the winter-spring time (small crossing streams appears because of snow melting). Even though no risk of rock falls has been detected during the Project construction phase, it is recommended to have regular inspections all the way up to Begoni. Special passing areas should be provided every 250 m in order to facilitate the movement of heavy traffic (construction) and also the local traffic.

Lot 2

249. The objective is to provide access to all the work areas and also to the spoil disposal areas. The priority is to start as soon as possible with the activities which are the critical path for finishing the works, but specifically must be considered to minimize interferences with Lot 1 works and not to disturb existing traffic (main road to Gudauri and all local roads).

250. **Access to Portion 1:** The access to the first portion – Kvesheti and the associated embankment are proposed from the existing road. As the embankment at the riverside (KM 0.2 to KM 1.4) is constructed, it will be possible to provide an alternative track for construction equipment. For the whole stretch, as 3 lanes are proposed, it is recommended to build one of them and, at the same time, to use the other two for the existing traffic.

251. **Access to Portion 2:** Access to the Plateau and the associated potential spoil disposal sites (indicated as LFL-5.8, LFR-5.8 and LFL-7.5 on Figure 47) have been proposed by the design team from the existing road or Path 1 (point B) and by using the existing track (Path 2). However, due to the steep gradient of this path it is unlikely that Path 2 will be used. Accordingly, access to the plateau will be via Gudauri (White Line - Figure 46: Roads to access Tskere during construction). It is planned that the access road from Gudauri will now be a permanent road and as such it is discussed in more detail below under **Section B.5.5.**
252. **Portion 3:** Begoni Plateau proposes to use the existing access road (Path 1, Figure 48: Lot 2 Work Sites / Blue Line, Figure 46: Roads to access Tskere during construction) in the Khada valley (shared with Lot 1).

253. The design team recommended that this road is upgraded by spreading (regularly during the construction period) compacted crushed stone layers. Some transversal drainage pipes would be also required for winter-spring time (small crossing streams appears because of snow melting). Even though no risk of rock falls has been identified in this area, the design team recommended to have regular inspections at the way up to Begoni. However, consultations undertaken as part of this EIA have identified this route as having potentially negative impacts on local residents in this area and as such changes to the alignment of this route are recommended and discussed further in the impact assessment section of this report, **Section F**.
254. Notwithstanding the above, all access road or temporary roads must be removed at the end of their use, unless otherwise notified by the Employer, or if at the end of the construction phase consultation with local residents has determined if they wish the temporary road to remain in place.

255. The Contractors, according to their working methods, available machinery and experience, can determine different access roads to those suggested above and must in any case submit to the Employer, or his Engineer, a detailed plan for such access roads and will also have to provide for the temporary acquisition of the relevant areas.

256. Such plan must be complete with detailed drawings of the elements that make up the road, the areas and the properties affected by possible occupation outside the areas owned by the administration, calculation reports if necessary. In addition, in this plan the existing traffic affected by the passage of construction vehicles must be shown and the Contractor will be responsible for requesting authorization from the Authority managing the use of the same infrastructure.

257. The Contractor shall install tanks for washing the truck wheels at the access points to the work site in order to reduce the level of mud and dust leaving the sites. The Contractor will also provide for the restoration of the existing roads if the Employer ascertains that the passage of construction vehicles has deteriorated the level of service. This assessment will be done in the presence of the Contractor, the Engineer and the RD. Once ascertained, the costs for the restoration of such roads will be borne by the Contractor.

**B.5.5 Gudauri Road**

258. As part of the Project the access road from Gudauri will be made into a permanent road. The road will be approximately 4.9km long, its location shown by Figure 49. The potential impacts associated with the road will be studied further and this EIA updated accordingly.
B.5.6 Source of Construction Materials

Borrow Pits

259. Borrow pits for materials to build the embankments are initially not foreseen, because the potential reserves of spoil material from the tunnel excavation works is likely to satisfy the necessary amounts of fill material for creating embankments.

260. Should additional borrow material be required the Contractor will follow the borrow pit guidelines outlined in Appendix C.

Concrete Batching and Asphalt

261. Bitumen and bituminous products are not produced locally in Georgia and is mainly imported from Iran, Azerbaijan and Romania. Bituminous products, which are necessary for the project (production and construction) must be imported and comply with European standards.

262. There is an asphalt plant near the north portal of the main tunnel. The facility is owned by “GRG” Ltd. The plant produces about 100-120 tons asphalt per hour.

263. Cement is produced locally by companies such as Saqcementi and Kartuli Cementi in Kaspi (approximately 70 km east of the Project area), other sources of cement may also be found closer to the site.

264. In the event that the Contractor decides to operate his own asphalt production facility consultations must be undertaken with MoEPA as asphalt production belongs to activities listed in Annex II of the Environmental Assessment Code. MoEPA will make a decision in the need of...
Environmental Impact Assessment for the Kvesheti-Kobi Road Section

EIA for this activity based on the screening procedure (ref. Environmental Assessment Code (document code: 360160000.05.001.018492).

265. The Contractor will be responsible for ensuring the concrete batching facilities and asphalt plant comply with the conditions outlined in this EIA and that all necessary permits to operate are obtained from the MoEPA.

Technical and Potable water

266. Approximately 200 m$^3$ of technical water will be needed per day during the construction phase and around 15 m$^3$ of potable water per day. Most technical water will be sourced from the rivers adjacent to the construction sites, or from tunnel groundwater. Potable water will be provided to camps in reusable bottles – no single use bottles will be permitted. Potable water will be tested regularly throughout the construction period to ensure it meets the drinking water standards of GoG. There will be no supply of potable water to construction camps or sites from existing potable water supply lines in the villages as this may impact upon the availability of water to the local population. The final locations of the extraction points (for both technical and potable water) will require the approval of the Engineer and the RD prior to the start of extraction to ensure that over extraction of water resources does not happen. In addition, all relevant water abstraction and discharge permits will need to be in place and reviewed by the Engineer prior to the start of construction.

B.5.7 Disposal of Spoil Material

267. A large volume of spoil material will be generated by the Project works, mostly from the excavation of tunnels. The following table outlines the amount of spoil generated by each Lot that needs to be disposed of in spoil disposal sites (after subtraction of suitable fill material for road construction works).

Table 18: Spoil Volumes

<table>
<thead>
<tr>
<th>#</th>
<th>Lot</th>
<th>Volume (m$^3$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1 – Kobi Side</td>
<td>2,156,749</td>
</tr>
<tr>
<td>2</td>
<td>1 – Plateau Side</td>
<td>342,498</td>
</tr>
<tr>
<td>3</td>
<td>2</td>
<td>1,130,841</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>3,630,088</td>
</tr>
</tbody>
</table>

Potential Lot 1 Spoil Disposal Sites

268. For the works considered in Lot 1, there is a surplus of material, approximately 2.5 million m$^3$ (2.15 million m$^3$ from the Kobi side). Several spoil disposal zones have been identified by the Detailed Design team to manage the spoil on the Kobi side (spoil on the Tskere side will be sent to the spoil disposal sites discussed under Lot 2):

Table 19: Lot 1 Spoil Disposal Sites

<table>
<thead>
<tr>
<th>#</th>
<th>Reference</th>
<th>Approximate Area (m$^3$)</th>
<th>Approximate Volume Available (m$^3$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>SDL-22.0</td>
<td>63,000</td>
<td>215,609</td>
</tr>
<tr>
<td>2</td>
<td>SDL-22.3</td>
<td>65,500</td>
<td>465,100</td>
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<tr>
<td>3</td>
<td>SDR-22.1</td>
<td>6,324</td>
<td>17,766</td>
</tr>
<tr>
<td>4</td>
<td>SDR-22.3</td>
<td>31,500</td>
<td>104,119</td>
</tr>
<tr>
<td>5</td>
<td>SDL-22.7</td>
<td>97,000</td>
<td>1,042,750</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>1,845,344</td>
</tr>
</tbody>
</table>

269. The following figures illustrate the locations and layouts of these sites.
Figure 50: Lot 1 Spoil Disposal Locations

Figure 51: SDL-22.0
Figure 52: SDL-22.3, SDR-22.1, SDR-22.3

Figure 53: SDL-22.7
270. The profiles of the spoil disposal sites are presented in Appendix O.

271. These areas are designed to accommodate all the spoil material of Tunnel 5 and half of the excavation of Tunnel 5 emergency gallery, and the remaining material of the earthworks of the Tunnel 5 exit (north side), operation area Tunnel 5 exit (north side), and Junction of Kobi.

272. However, it is noted that there is a surplus of spoil material \( (2,156,794 - 1,845,344 = 311,450 \text{ m}^3) \)

273. The use of the material from excavations as aggregates for concrete or pavements, as well as other uses like gravel, slope protections (rockery and rip-rap) and construction paths maintenance, will decrease the spoil disposal (soil disposal) volume.

274. The estimation of concrete volume for outside works (C&C and technical buildings structures, drainage, lean concrete, etc.) and tunnel T5 where excavation aggregates may be used is around 250,000 m\(^3\).

275. The estimation of gravel volume for pavements is around 20,000 m\(^3\). The estimation for rockery/rip-rap protections is around 40,000 m\(^3\). Construction and local paths maintenance should be estimated around 40,000 m\(^3\). Accordingly, the approximate total of re-usable material would be 350,000 m\(^2\).

Lot 2 Potential Spoil Disposal Sites

276. A large amount of spoil will also be generated in Lot 2. The Detailed Design team have identified the following locations for the disposal of spoil material from Lot 2 (and the surplus 342,000m\(^3\) from Lot 1):

<table>
<thead>
<tr>
<th>#</th>
<th>Reference</th>
<th>Approximate Area (m(^2))</th>
<th>Approximate Volume Available (m(^3))</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>LFL-0.4</td>
<td>8,500</td>
<td>99,367</td>
</tr>
<tr>
<td>2</td>
<td>LFL-0.8</td>
<td>19,000</td>
<td>208,287</td>
</tr>
<tr>
<td>3</td>
<td>LFR-5.8</td>
<td>97,000</td>
<td>54,509 (partial)*</td>
</tr>
<tr>
<td>4</td>
<td>LFL-5.8</td>
<td>160,000</td>
<td>407,640</td>
</tr>
<tr>
<td>5</td>
<td>LFL-7.5</td>
<td>106,000</td>
<td>681,230</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>1,451,033</td>
<td></td>
</tr>
</tbody>
</table>

* - Partial meaning that more land is available in this area if required.

277. Locations within Khada valley have been avoided because of a high risk of instability. The following figure illustrates the locations of these spoil disposal locations. Profiles are provided in Appendix O.
Figure 54: LFL-0.4 and LFL-0.8

Figure 55: LFR-5.8 and LFL-5.8
278. It is noted that the total volume of spoil material would be around 22,000 m$^2$ more than the spoil disposal site volumes, but it should be pointed out that the LFR-5.8 is only partially filled in the above tables and that more room is available in this site, and also that this material can also be used for concrete, gravel, rip rap, etc., as per Lot 1.

**Transport of Material**

279. The potential material destinations are distributed according to three different stretches, in order to reduce as much as possible, the transport distances.

- **Stretch 1 (KM 0.0 to KM 3.9).** All the remaining materials (outside earthworks) to the Kvesheti bypass.
- **Stretch 2 (KM 3.9 to KM 8.75).** All the remaining materials (tunnel T1 and outside earthworks) to the Zakatkari fill area.
- **Stretch 3 (KM 8.75 to KM 12.72).** All the remaining materials (C&C T2 and T4, tunnel T3 and outside earthworks) will be sent to Kvesheti bypass; when this is completed, the remaining material will be sent to the Zakatkari fill area, and Plateau spoil site (LFL-5.8 and LFR-5.8).

280. An assessment of each of these sites has been undertaken as part of this EIA. The findings of the assessment and any necessary mitigation and management actions are outlined in Section F.7.5 – Spoil Disposal.

281. Notwithstanding the above, the final selection of spoil locations rests with the Contractor, who may wish to choose alternative locations to those listed above for cost reasons. In any case the sites used will have to be surveyed and permitted to ensure that no areas of particular ecological or social value are affected by the proposed spoil disposal. Critical actions that the Contractor must complete before using any spoil location, including the requirement to prepare an EIA to meet national requirements are outlined in Section F.7.5 – Spoil Disposal, below and also further assessment of the spoil sites per the Spoil Disposal Plan (Appendix F) which will require approval by the RD, Engineer and Lenders (further details outlined in Section F.7.5 – Spoil Disposal)
B.5.8 Camps and Storage Areas

Construction Camps

282. Camp sites will be selected keeping in view the availability of an adequate area for establishing campsites, including parking areas for machinery, stores and workshops, access to communication and local markets, and an appropriate distance from sensitive areas in the vicinity.

283. The area requirement for construction camps will depend upon the workforce deployed and the type and quantity of machinery mobilized. For example, the camps may include rock crushing plant and concrete batching facilities. In view of the area required, it will not be possible to locate campsites within the RoW and the contractors will have to acquire land on lease from private landowners. The construction camp will also have facilities for site offices, workshop and storage yard, accommodation areas and other related facilities including fuel storage.

284. The Contractor will provide the following basic facilities in the construction camps:

(i) Safe and reliable water supply.
(ii) Hygienic sanitary facilities and sewerage system.
(iii) Facilities for sewerage of toilet and domestic wastes.
(iv) Storm water drainage facilities.
(v) Sickbay and first aid facilities.
(vi) Recreational areas.

The camp sites will strictly follow the IFC/EBRD guidance note “Workers’ accommodation: processes and standards”.

285. Detailed criteria for siting of construction camps and establishment of facilities are given in Section F.7.6.

Storage Areas

286. Temporary storage areas will be required for certain activities, such as the storage of sand and gravels and construction equipment. These storage areas may range in size from anything between 50 m$^2$ to more than a hectare. The precise locations of these temporary facilities is not known at this stage, as such mitigation measures have been prepared as part of this EIA to ensure that these areas are sited in approved locations.

B.6 Accidents and Safety

B.6.1 Accidents

287. There is a database from 2012 to 2016 with the accident data between kilometers 25 and 137 of the Larsi - Jinvali road. The information is classified by type and reason of the accident. There is no specific data relating solely to the Project road itself.
288. The following images show the most critical points of the existing road according to:

- Number of accidents.
- Fatal accidents (8% of accidents have associated at least one death in the incident).
- Pedestrian accidents involved.
Figure 59: Accidents Occurred on the Existing Road (2012 – 2016)

Source: Road Department

Figure 60: Fatal Accidents on the Left and Accidents involving Pedestrians on the Existing Road (2012 – 2016)

Source: Road Department
B.6.2 Safety

Tunnels

289. Safety measures to be adopted in the Tunnel under study will be mainly based on the European Directive 2004/54/EC on minimum safety requirements for tunnels in the Trans-European Road Network (TERN).

290. This Directive establishes a set of organizational, technical and operational requirements for all tunnels measuring over 500 meters that are part of the trans-European Road Network.

Roadway

291. An important part of the safety offered to the driver by the technical characteristics of the roads is that the elements and protective facilities, function as devices that, in case of accident or emergency, prevent the vehicle from leaving the road and will help reduce the harmful consequences of this situation.

292. The measures that have been planned include two types: semi-rigid security barriers and rigid security barriers. The installation of the containment system will be justified when the distance from the edge mark of the exterior roadway to an obstacle or dangerous area is less than a certain one, admitting that the risk of accident is associated with the containment system that is going to be eliminated. The containment systems parallel to the road used are the following; metal crash barriers, metal parapets, concrete barriers and railings.

B.7 Traffic Forecasts

293. Traffic forecasts have been prepared by the design team and are shown in Table 22.

<table>
<thead>
<tr>
<th>Year</th>
<th>Car</th>
<th>Minibus</th>
<th>Van/pickup</th>
<th>Bus</th>
<th>2ax MGV</th>
<th>3ax HGV</th>
<th>T-T</th>
<th>Sum</th>
</tr>
</thead>
<tbody>
<tr>
<td>2017</td>
<td>2,396</td>
<td>191</td>
<td>191</td>
<td>112</td>
<td>144</td>
<td>81</td>
<td>316</td>
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<tr>
<td>2018</td>
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<td>203</td>
<td>203</td>
<td>119</td>
<td>154</td>
<td>86</td>
<td>337</td>
<td>3,649</td>
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<td>2019</td>
<td>2,705</td>
<td>216</td>
<td>216</td>
<td>127</td>
<td>164</td>
<td>92</td>
<td>359</td>
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<td>242</td>
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<tr>
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<td>267</td>
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<td>281</td>
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<td>387</td>
<td>241</td>
<td>313</td>
<td>175</td>
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<td></td>
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<td>459</td>
<td>426</td>
<td>269</td>
<td>348</td>
<td>195</td>
<td>762</td>
</tr>
<tr>
<td>Year</td>
<td>Car</td>
<td>Minibus</td>
<td>Van/pickup</td>
<td>Bus</td>
<td>2ax MGV</td>
<td>3ax HGV</td>
<td>T-T</td>
<td>Sum</td>
</tr>
<tr>
<td>--------</td>
<td>-------</td>
<td>---------</td>
<td>------------</td>
<td>------</td>
<td>---------</td>
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<td>-----</td>
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<td>590</td>
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<td>611</td>
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<td>1,093</td>
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<td>633</td>
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<td>699</td>
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<td>569</td>
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<td>Year 20</td>
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<td>764</td>
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<td>768</td>
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<td>625</td>
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</tr>
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<td></td>
<td>2048</td>
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<td>775</td>
<td>775</td>
<td>455</td>
<td>631</td>
<td>353</td>
<td>1,381</td>
</tr>
</tbody>
</table>

Source: ADB

Figure 61: Type of Traffic
C. Alternatives

C.1 General

294. One of the objectives of an EIA is to investigate alternatives to the Project. In relation to a proposed activity “alternatives” mean different ways of meeting the general purposes and requirements of the proposed activity. The following section provides an assessment of alternative corridors, alignments, transport modes and technologies, as well as the ‘no action’ alternative.

C.2 The No Action Alternative

295. The “No Action” Alternative in this instance is defined as a decision not to undertake the proposed construction of the Project Road. The “No Action” Alternative would see the continuation of the following issues:

- Deterioration of the existing road which is often closed due to snow fall during the winter months thereby impeding the economic development of the Project Area and the region in general.
- Significant increase in congestion on the existing road especially during the tourist season which leads to degradation of air quality in and around Gudauri.
- Difficulties maneuvering HGVs which leads to a high level of delays and demand affected.

<table>
<thead>
<tr>
<th>Kvesheti-Kobi</th>
<th>Bus</th>
<th>Heavy vehicles</th>
<th>Light vehicles</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012-2016 annual average delay (hr)</td>
<td>2,351</td>
<td>2,384</td>
<td>1,096</td>
</tr>
<tr>
<td>% of the annual demand affected</td>
<td>34.6%</td>
<td>35.1%</td>
<td>16.1%</td>
</tr>
</tbody>
</table>

296. In addition, and most importantly, the existing road has cannot ensure safety and is characterized by high accident rates due to the Narrow carriageway, geometry of the road (high gradient and sharp bends), inadequate technical parameters of avalanche protection tunnels and galleries and unprotected landslide prone sections along the road.

297. Table 24 provides a summary of the operational and construction impacts of the ‘no action’ alternative against the Project.
# Table 24: Comparison of No Action alternative and Alternative with a project

<table>
<thead>
<tr>
<th>Natural environment: ambient air</th>
<th>Alternative with project</th>
<th>No Action Alternative</th>
<th>Adverse factors</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Positive factors</strong></td>
<td><strong>Operation:</strong> An expected improvement of the road’s performance properties and traffic conditions will lead to a reduction in individual vehicle emissions against the no action alternative. Traffic will be smoother, no stop and go related emissions, no waiting with switched engine required, shorter distance - i.e less fuel consumption (less emissions)</td>
<td><strong>Construction:</strong> Temporal air pollution by exhaust gases from construction machinery. Contamination associated with vehicle engines and wear of tyres and the road during traffic and transportation of construction materials. <strong>Operation:</strong> Traffic related emissions during operation of the road</td>
<td><strong>Construction:</strong> There will be positive impacts for communities in the Khada valley along the proposed new alignment which will not be affected by vehicle emissions during operation.</td>
</tr>
<tr>
<td><strong>Adverse factors</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>construction</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>operation</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Acoustic impact</strong></td>
<td><strong>Operation:</strong> Noise levels in the Gudaun area, a significant tourist area, will be reduced. In addition, the proposed bypass around Kvesheti will reduce noise levels to an extent in the village.</td>
<td><strong>Construction:</strong> Short term localized noise impacts related to construction works will impact upon residents. However, many of these impacts can be mitigated by the measures outlined in this EIA, e.g. through correct siting of camps and time and activity restraints. <strong>Operation:</strong> Operational noise levels may increase in the valley area, but the number of receptors is low, and the mitigation measures proposed as part of this EIA should minimize impacts.</td>
<td><strong>Construction:</strong> There will be positive impacts for communities in the Khada valley along the proposed new alignment which will not be affected by noise during operation.</td>
</tr>
<tr>
<td><strong>Natural environment:</strong> soils, land resources, surface and ground water,</td>
<td><strong>Operation:</strong> Moving road farther from protected area boundaries.</td>
<td><strong>Construction and Operation:</strong> The no action alternative has significant benefits in the Khada valley in terms of biodiversity. The valley will remain, more or less untouched.</td>
<td></td>
</tr>
</tbody>
</table>
## Environmental Impact Assessment for the Kvesheti-Kobi Road Section

<table>
<thead>
<tr>
<th>Positive factors</th>
<th>Adverse factors</th>
<th>Positive factors</th>
<th>Adverse factors</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>vegetation/flora and fauna</strong></td>
<td>However, most of these impacts can be mitigated via the recommendations made in this EIA, e.g. the requirement for a biodiversity action plan. <strong>Operation</strong>: Disturbance of wildlife caused by increase noise and light pollution. Increased access to previously undisturbed areas may result in poaching of wildlife.</td>
<td>high noise levels and garbage which is scattered along the road.</td>
<td></td>
</tr>
</tbody>
</table>

### Socio-economic environment

<table>
<thead>
<tr>
<th>Positive factors</th>
<th>Adverse factors</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Construction</strong>: Creation of jobs in an economically depressed area. <strong>Operation</strong>: Reduced number of road accidents. Reduced travel time. Improvement of access to the villages that used to be cut off in winter. Development of roadside services and entrepreneurship. Creation of new jobs related to road maintenance services. Improvement of the region’s social and economic performance. Improved cargo traffic and traffic safety in particular in winter season.</td>
<td><strong>Construction</strong>: Short term noise, air quality and vibration related impacts during construction. Temporary deterioration of transport conditions during the construction phase. <strong>Operation</strong>: Landscape-visual impact, although this is subjective. Potential improved tourism potential in Khada valley for winter sports, use of the new bridge, mountain biking and hiking. Potential to make living in villages viable all year round.</td>
</tr>
</tbody>
</table>
C.3  Upgrading of the Existing Road (Alternative 0)

298. The existing road is 35 km long. Between Kvesheti and Kobi it runs through Gudauri ski resort and Jvari Pass (2,400 masl). The section is characterized with difficult geographical and winter maintenance conditions. The road for most of its extent is only 10m wide (including unpaved shoulders). The steep gradient of the road and the tight hairpins create traffic safety problems along the route, in particular for HGVs.

Figure 62. Existing Road Conditions

299. Safety problems exists irrespective of the weather conditions but is particularly the case in adverse weather conditions in the winter. Even with upgrading of the road to improve general safety conditions relating to road geometry the harsh winter conditions and high snowfall levels will mean that it is almost impossible to keep the road open and operational all year round without delays. In addition, around 8 km of Alternative 0 is in the limits of the SPA/IBA area (see Section E.2 for more details of these areas). The existing road is also located along a bird migration corridor, that goes along the Tetri Aragvi river. From a geological perspective the existing road is also located in areas of medium and significant geological risk along the alignment. Keeping the mentioned above in mind Alternative 0 has been considered as non-advisable and was excluded from further consideration during the Feasibility Study.
Figure 63: Geological Risks in the Project Area

Figure 64: Existing road vs protected areas (green shapes – boundaries of Kazbegi National Park and Emerald network sites, red highlighted areas – SPA/IBA areas)
C.4 Alternative Road Corridors and Alignments

Given the complex topography, presence of protected areas and geological conditions in the project area the number of feasible alternative corridors turned to be rather limited. At pre-feasibility stage of the project nine alternatives have been considered. Depending on the design speed, these options were classified into two groups:

<table>
<thead>
<tr>
<th>Alternative</th>
<th>Design speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternative 1, 2, 3, 6, 8</td>
<td>60 km/h</td>
</tr>
<tr>
<td>Alternative 4, 5, 7, 9</td>
<td>80 km/h</td>
</tr>
</tbody>
</table>

Figure 65: Alternatives (Lot 1 and Lot 2) for design speed 60 km/h
Table 26: Description of Alignment Alternatives

<table>
<thead>
<tr>
<th>Alternative</th>
<th>Description</th>
<th>Corridor</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Corridor 1 follows the river valley at its left side for a 60 km/h speed. The first stretch of the alternative consists of an upgrade of the existing road from Kvesheti to the zig-zag of Gudauri. From this point on, it is proposed a new alignment along the riverside, going ahead with 7% slope for 5 km and entering an 8.4-km length tunnel (level S portal 1930, N portal 2020). The main challenges are the landslides and the rock falls, and also the alluvial fans from the transversal valleys.</td>
<td>Corridor 1</td>
</tr>
<tr>
<td>2</td>
<td>Corridor 2 goes up to the Gudauri area by lifting to the Kvesheti plateau from the existing road. Both alternatives, 2 and 3, have the same alignment to access to the top of the plateau. According to the existing slopes of the plateau, the best way is continuing upstream along the current road and then cross the river and turn back downstream and going up in the slope at the same time. The access way to the plateau sums up the opposite slopes: alignment from 1.6% to 6.8% up and plateau 3.5% down. Once there, the alignment continues along the Gudauri area. Alternative 2 presents a shorter outside road and enters a 11.3-km long tunnel, S portal at level 1,860 m and N portal at 1,920 m, rounding to the left the volcanic cone and the contact aureole. The main challenge is to avoid the volcanic cone and the contact aureole. Starting from the same first stretch, Alternative 3 runs outside forward than 2, and because of that the tunnel for this proposal is shorter (10.0 km) and the portals higher (2,200 m), rounding the volcanic area to the right. Both alternatives, 2 and 3, are designed for 60 km/h</td>
<td>Corridor 2</td>
</tr>
<tr>
<td>3</td>
<td>Alternative bypasses Kvesheti by cutting the slopes and valleys behind the population (far from the river). On one hand this is a challenge from the geotechnical point of view, because of the landslides; but on the other hand, this allows the alignment to gain enough level to cross the river and enter the plateau. A 700-m long bridge with piers of height over 100 m would be required. Probably an arch bridge would fit for this situation. From the plateau on, the alignment remains at the same side of the Tskere valley, going up with a continuous slope of 7%. The high level of the</td>
<td>Corridor 3</td>
</tr>
</tbody>
</table>

Figure 66: Alternatives (Lot 1 and Lot 2) for design speed 80 km/h
### Alternative Description

#### 5
- Alternative is based on Alternative 4. Only differs for the Kvesheti bypass and the entrance to the south portal of the tunnel. The proposal crosses the river from the back of the population in a direct way by a 1-km long viaduct (high piers over 100 m). The slope of the elevation profile varies from 5% to 7%. The tunnel is 7.2-km long and the portal are located at levels 2,100 (South) and 1990 (North).

#### 6
- Alternative 6 continues upstream along the current road and after Kvesheti crosses the river and turns back downstream, lifting to the plateau (advantage of opposite slopes) and rounding it with an average slope of 6%. The alignment enters the Tskere valley crossing from one side to another to better adapt to the orography. Some bridges appear to be necessary, one of them around 0.5 km long and over 100 m of pier height; an arch seems to be a proper solution. The proposal finally enters an 8.2-km long tunnel, with a continuous slope. The South portal is located at level 1,870 m and the North at 1,980 m. Design speed 60km/h.

#### 7
- The alternative 7 avoids the population of Kvesheti by crossing in advance the river to the opposite side. The proposal is to gain enough elevation to jump to the plateau with a 550-m long bridge (height of piers around 80 m). The alignment connects to the Alternative 4 at the entrance of the Tskere valley. The proposed tunnel is 7.0-km long and the portals are located at level 2,100 (South) and 2,020 (North) respectively.

#### 8
- The corridor lifts the alignment to the Kvesheti plateau and from there enters to the Tskere valley. Located at the other side of the Corridor with a completely different approach to the Kvesheti plateau. Before entering this village, the alignment crosses the river and starts going up steeply (7%) surrounding the corner mountain; because of that it does not require significant bridges. Once in Begoni plateau, the proposal continues upstream forward than Alternative 6, to finally entering a 6.7-km long tunnel at level 2,000 m (South portal) and ending at level 1,970 m (North portal).

#### 9
- Alternative 9 bypasses Kvesheti close to the mountains, cutting the slopes and valleys behind the village. The alignment crosses the river upstream and turn back downstream at the other side, going up with an opposite slope to the plateau, which is an effective method to get the top. From the plateau on, the alignment enters the Tskere valley, changing from side to side in order to avoid the geotechnical problematic slopes. It would be required a 370-m long bridge (high piers over 120 m). An arch bridge is considered to suit for this proposal. The alignment continues for 5 km with a continuous slope of 7% to finally enter a 6.8-km long tunnel. The South portal is located at level 1,990 m and the North at 1,980 m.

301. After further consideration from a technical, environmental/social and economic point of view resulted in three alternatives being chosen for further assessment as part of the FS:

- Alternative 1: following the riverside, close to the existing road at a lower level; the tunnel would be located under the Jvari Pass;
- Alternative 2: going up to the Kvesheti plateau and connecting Gudauri area where it would be located the portal of the tunnel;
- Alternative 3: going up to the Kvesheti plateau and then entering the Khada valley.
Figure 67: Three Alternative Alignments Considered in Feasibility Study

Note: Green areas: Kazbegi National Park, Red Area: Khevi SPA

302. Information about the alternatives is given in below:

<table>
<thead>
<tr>
<th>Alternative #</th>
<th>Design speed, km/h</th>
<th>Road length, m</th>
<th>Tunnel length, m</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>60</td>
<td>23,628</td>
<td>8,347</td>
</tr>
<tr>
<td>2</td>
<td>80</td>
<td>25,040</td>
<td>11,440</td>
</tr>
<tr>
<td>3</td>
<td>60</td>
<td>23,704</td>
<td>7,986</td>
</tr>
</tbody>
</table>

303. The alignments were further assessed based on a multi-criteria analysis approach (MCA). International standards (such as UK DMRB\(^\text{10}\)) has been followed for route optioneering. Decisive factors in selection of preferable option were:

<table>
<thead>
<tr>
<th>Biodiversity</th>
<th>Alternative 1</th>
<th>Alternative 2</th>
<th>Alternative 3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Impact during vegetation clearance and disturbance of wildlife is expected.</td>
<td>Moderate to low impact on biodiversity in the sections where forest is crossed.</td>
<td>Moderate impact on biodiversity in the sections where forest is crossed.</td>
</tr>
</tbody>
</table>

\(^{10}\) [http://www.standardsforhighways.co.uk/ha/standards/dmrb/index.htm](http://www.standardsforhighways.co.uk/ha/standards/dmrb/index.htm)
Environmental Impact Assessment for the Kvesheti-Kobi Road Section

<table>
<thead>
<tr>
<th></th>
<th>Alternative 1</th>
<th>Alternative 2</th>
<th>Alternative 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amount of tunneling spoil, is impact on environment related to disposal of this material is slightly higher than for Alternative 3.</td>
<td>Longest tunnel i.e. amount of spoil is highest compared to other alternatives – i.e. the highest is impact on environment related to disposal of this material.</td>
<td>The tunnel is the shortest, i.e. amount of spoil is lower compared to other alternatives. This means – lowest scale impact on environment related to disposal of this material.</td>
<td></td>
</tr>
<tr>
<td>Protected areas</td>
<td>Alignment crosses protected area which is prohibited</td>
<td>The new section near Kobi will run close to protected area. The length of the section located in proximity of the Protected area is higher than in case of Alternative 3. Alignment runs close to protected area in the Kobi section of alignment.</td>
<td>Alignment uses existing road in the last section of alignment running parallel to the boundary of the Protected area. Alignment crosses PA via tunnel. The length of the crossing is 240m, overburden 200-300m.</td>
</tr>
<tr>
<td>Hazardous processes</td>
<td>Snow slide risk in 4 sections along alignment.</td>
<td>Snow slide risk in 6 sections along alignment.</td>
<td>Snow slide risk in 3 sections along alignment. Only safe corridor for the main tunnel and the rest of alignment.</td>
</tr>
<tr>
<td>Social impact – project related nuisance/disturbance Resettlement needs</td>
<td>Broad brush assessment with consideration of settlement pattern and available baseline cadastral information showed similar range/level of resettlement needs for all considered alternatives. Positive impact in case of Alternative 3 – related to improved access for Khadistskali community, possibility to revert seasonal migration.</td>
<td>304. Because of higher potential impacts to the Kazbegi National Park, Alternative 1 (corridor 1) was considered as not advisable. While selection of preferable option geological peculiarities in the main tunnel stretch have been considered. For the tunnel Corridor 3 (Alternative 3) proved to be advisable as it enables to avoid problematic areas. With consideration of geology and presence of natural hazards in the area main tunnel entrance (Tskere) and exit (Kobi) points have been fixed. Alignment connecting Tskere with Existing road in Kvesheti was specified considering the landform, geological conditions and risks. 305. At the detailed design stage, the alternative was developed further.</td>
<td></td>
</tr>
</tbody>
</table>
Some changes to alignment were made in order to; a) reflect new environmental legislation (Since 2014 environmental legislation has changed. Some of laws, regulations and policy documents in the area of biodiversity (listed in Annex II to the referred strategy document) have been updated, revised. As example - Environmental Assessment Code was adopted.), b) reduce risks and impacts, and c) improve the safety of the alignment. The main changes were made in Kobi-Tskere (Lot 2) section.

Kvesheti-Arakveti section

In the starting section of the road two options were considered:

- bypassing residential area closer to the mountains (not shown on the drawings given above)
- bypassing Kvesheti by diversion of the traffic to the strip between the settlement and the river.

The first option was discarded because of geological risks (sequence of landslides, debris deposits and non-stable hillsides). In addition to that, the need of heavy supports and retaining structures leading to significant visual impact backed the decision. Based on hydrological analysis carried out by the Design team alternative 2 was found to be feasible. The option allows to use the space between the residential area and the new road for spoil disposal. After planting of the area with vegetation 5ha of green new space will be created. This will provide better protection of the village from impact during high water events and, on the other hand, act as a green barrier reducing noise in the residential quarters. Note: implementation of flow modelling in this section is required to ensure that the change of hydrology after the change of the riverbed shape has no impact (does not cause scouring/erosion) on the area on the opposite side of the river.

Access to the plateau on the other bank of the river

Option including bridge and the road to access the plateau was ‘replaced’ with tunnel alternative (blue one) to ensure better safety in winter. The tunnel was considered preferable from the view of visual impact. Use of the tunnel will help to reduce: the need of deep cut slopes; the scale of the impact on vegetation; the length of the stretch where during operation of the road impact on soil quality may occur; as well as disturbance of wildlife (the blue one represents the final design).
Figure 69: Access to the Plateau

Note: alignment considered in Feasibility Stage (yellow line) vs Final Option (blue line)

Zakatkari section.

310. This realignment moves the road further from the protected areas and reduces the curves which may have safety impacts. (the blue one represents the final design).

Figure 70: Enhancing the Minimum Radius for Connection to Gudauri

Note: alignment considered in Feasibility Stage (yellow line) vs Final Option (blue line)
Begoni section

311. With consideration of the rugged terrain and risk of landslides and avalanches in the area cutting slope was considered as non-advisable. To minimize geotechnical risks, the option with a range of bridges was substituted with a sequence of tunnels.

Figure 71: Previous Version (left) and Proposed alignment (right) at "Begoni Curves"

312. The alignment has been shifted towards the border (minimum distance from the edge 5m) of the cliff to minimize disturbance of population.

Tskere section

313. Alternative bypassing Tskere farther from the west (yellow alternative) with tunnel starting north to the village is longer. Respectively higher is its visual impact and impact on Tskere residents caused by noise and emissions from the road. Besides, the ‘open’ road alignment is under higher risk of avalanches.
314. To minimize cut slopes and avoid the mention problems, tunnel entrance was moved away from the village. The tunnel will start with cut and cover section. The surface of the C&C tunnel will be replanted to merge with the background environment and minimize visual impact. Arrangement of the tunnel will reduce noise and emission related impacts on Tskere residents. Safety risks associated with avalanches will be avoided.

Figure 72: Tskere Area

Note: alignment considered in Feasibility Stage (yellow line) vs Final Option (blue line)

315. An alternative location of the junction closer to Mughure-Tskere was considered (see Figure 73). However, considering the landform, available space, technical requirements for the road, proximity to the residential areas and the expected scale of impact on environment, and despite the size of the junction, the current design was considered as preferable (see Figure 31 for the final design).

Figure 73: Junction alternative
Kobi section

316. The last stretch of the tunnel has been reshaped to reduce interference with gas pipelines. The alignment has been adapted to the current road with a maximum gradient of 4.2% to keep on using the existing bridge.

Figure 74: Kobi Area

Note: alignment considered in Feasibility Stage (yellow line) vs Final Option (blue line). Image is an old version which does not show the existing new road alignment as per Figure 19.

C.5 Alternative Transport Modes

317. The project is a part of Jinvali-Larsi road rehabilitation program, therefore no other transport modes can be considered as alternative.

C.6 Alternative Pavement Types

318. Asphalt and concrete pavement types have been considered. Priority was given to asphalt. This type of pavement has been chosen for the following reasons:

- less noise during operation – compared to concrete (less nuisance to the residents and wildlife);
- less vibration compared to the concrete (significant factor to consider, keeping in mind presence of the buildings construction without mortar);
- better visibility of horizontal marking on asphalt surface (safety consideration)
- better efficiency in snow/ice melt conditions;
- recyclability of material.

319. However, the other types of payment will also be used for other portions of the road:

- The pavement of the emergency galleries will be concrete, since the traffic along the gallery will be circumstantial.
- Concrete will be used on the high slopes (>12%) due to the constructive limitations to asphalt on high slopes.
For local diversions with very low traffic, that are nowadays paved with asphalt and gravel the same type pavement will be restored.

C.7 Alternative Construction Camps and Laydown Areas.

320. The locations of these facilities are not currently known. The Contractor will choose the sites which will need to follow the guidelines for siting and permitting as outlined in this EIA, including consultations with local residents. Employment of local labor force will reduce the need for construction camp size.

321. A range of auxiliary facilities during construction will include:

- Concrete batching plants and casting yard
- Pre-cast yard for piers and viaducts
- Laydown areas for tunneling and other equipment
- Materials storage areas
- Truck/vehicle parking areas
- Waste storage areas
- Construction Camps

322. The number, location, size and layout of these facilities will be specified by construction company. The EIA provides recommendations for site selection and mitigation of impacts. The Contractor will be responsible to prepare and submit Site installation layout plan, Construction camp layout plan and Construction Camp Management Plan for approval by RD, MoEPA and the Lenders. (See Section F for additional information).

C.8 Alternative Tunneling Techniques

323. Various tunneling option have been compared. The list includes:

- cut and cover,
- drill and blast,
- boring (using Tunnel Boring Machine (TBM)),
- NATM (sequential excavation – New Austrian Tunneling Method).

324. Advantages and shortcomings of methods are given below (Table 29). (Note: technical risks are not considered within this assessment).

<table>
<thead>
<tr>
<th>Method</th>
<th>Description of works</th>
<th>Disadvantage/shortcoming</th>
<th>Advantage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cut and Cover (C&amp;C)</td>
<td>Works include:</td>
<td>Dust along the C&amp;C alignment</td>
<td>Negligible vibration compared to other methods</td>
</tr>
<tr>
<td></td>
<td>trench excavation,</td>
<td>Noise along the C&amp;C alignment</td>
<td>Efficient for shallow tunnels</td>
</tr>
<tr>
<td></td>
<td>tunnel construction</td>
<td>Visual impact during construction</td>
<td></td>
</tr>
<tr>
<td></td>
<td>soil covering</td>
<td>Vegetation clearance required</td>
<td></td>
</tr>
<tr>
<td></td>
<td>excess material removal/disposal</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>reinstatement of the site</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NATM - Drill and Blast (D&amp;B)</td>
<td>Works include:</td>
<td>Dust in the portal area</td>
<td>Localized potential environmental impacts:</td>
</tr>
<tr>
<td></td>
<td>dividing excavation area in segments</td>
<td>Noise in the portal area</td>
<td>Dust, noise and visual impact mainly in the portal areas</td>
</tr>
<tr>
<td></td>
<td>drilling blast holes</td>
<td>Visual impact in the portal area during construction</td>
<td></td>
</tr>
</tbody>
</table>

Table 29: Comparison of Tunneling Methods
### Environmental Impact Assessment for the Kvesheti-Kobi Road Section

<table>
<thead>
<tr>
<th>Method</th>
<th>Description of works</th>
<th>Disadvantage/shortcoming</th>
<th>Advantage</th>
</tr>
</thead>
<tbody>
<tr>
<td>TBM</td>
<td>Works include:</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Excavation.</td>
<td>• High duration of vibration</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Placement of the lining segments.</td>
<td>• Requires space for assembling and dismantling – i.e. is related with higher impact on land</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• excess material removal/disposal</td>
<td>• Unexpected conditions tend to have bigger impact on the process than in case of D&amp;B</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hard rock can cause wearing of cutter and slow down the tunneling process or even make TBM inefficient</td>
<td>Localized potential environmental impacts as in case of D&amp;B and NATM</td>
</tr>
</tbody>
</table>

#### 325. There are some technical limitations related to the methods listed above:

- In relation to the curve radius for D&B there are normally no practical limitations, whereas for TBM, narrow curves may cause problems.
- TBM is unable to bore a niche.
- Cut and cover is not reasonable for long tunnels, besides, restriction related to landform are also worth to mention.

#### 326. It is important to highlight that the risk for accidents from handling explosives is eliminated by TBM tunneling. The risk of accidents related to stability of excavation face is also much lower with the TBM option since the machine works under the protection of a steel shield.

#### 327. Both operators of a TBM or drilling rig are exposed to noise and vibrations. This can be reduced to an acceptable level by installing an insulated and vibration dampened operator’s cabin. The problem for the crew occurs when additional tasks have to be done outside the operator’s cabin, like rock support, rail erections, charging during boring etc. The noise from a jumbo is still higher than from a TBM, but on the whole there is no significant difference between the methods (drill and blast vs TBM) regarding noise.

#### 328. Air pollution from the blasting is a problem in D&B tunnels, because of gas emissions and reduced sight. The main pollution problem in TBM tunnels is dust, especially if the quarts content in the rock is high. The content of fines in the muck is higher than in the D&B muck.

#### 329. Mucking in D&B tunnels is normally executed with diesel engine loaders. Loaders with electrical motors are an option. In TBM tunnels the mucking is carried out by the TBM itself and the TBM is always electrical driven.
330. With consideration of the length of the main tunnel (> 8 km), advancement rates of D&B and TBM, geotechnical characteristics of the rocks - use of a TBM for the main tunnel is considered as advisable.

331. In some sections, selection between mechanical and drill and blast excavation technique (in NATM tunnels) will be made on case by case basis. In case feasible mechanical excavation must be given priority in locations particularly sensitive to vibration.