ENVIRONMENTAL IMPACT STUDY FOR THE RUMICHACA – PASTO DUAL CARRIAGEWAY ROAD PROJECT, PEDREGAL – CATAMBUCO SECTION, UF 4 AND UF 5.1, CONCESSION CONTRACT UNDER SCHEME APP NO. 15 OF 2015

Géminis Consultores Ambientales SAS

Chapter 3. Project Description

San Juan de Pasto, April 2017

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3. PROJECT DESCRIPTION

3.1. Location

The "Rumichaca - Pasto" Road Project runs in the east-central and central-southern area of the department of Nariño approximately parallel to the existing Rumichaca - Pasto road, which is part of the Pan American Highway and National highwigh 25. This road corridor is the international hub linking Colombia with Ecuador and also connecting development cores in the south.

The Rumichaca - Pasto road has an Origin - Destination length of approximately eighty point two ninety-one kilometers (82.91 Km), with the northern part, consisting of thirty-two point seven kilometers (32.7 Km.) running between the towns of Pedregal and Catambuco are of interest for this EIA.

The primary purpose of the Rumichaca - Pasto Dual Carriageway Road Project, Pedregal - Catambuco Section is to improve mobility conditions transforming the existing infrastructure in a dual carriageway road with better specifications for traffic, contributing to improving communication throughout the southwest, mainly between Cali, Popayan, Pasto and Ecuador. At present, the road has sections with pronounced longitudinal slopes, small bending radii and poor visibility, which is detrimental to flow velocity and increases the risk of accidents.

The new project subject matter of the EIA and environmental licensing process is the section between the towns of Pedregal and Catambuco, which is divided into Functional Unit 4 (UF-4) and subsector 1 of Functional Unit 5 (UF-5-1), covering the following lengths:

- UF-4: Pedregal - Tangua, with a length of 15.76 km.
- UF-5.1: Tangua - Catambuco, with a length of 16.94 km.

Road project organization includes between Catambuco and Pasto, Functional Unit 5.2 or the last 5.3 kilometers of UF-5, which are not part of the environmental management processed with this EIA.

Figure 3.1 shows project location differentiating the functional units and municipalities crossed by the route.

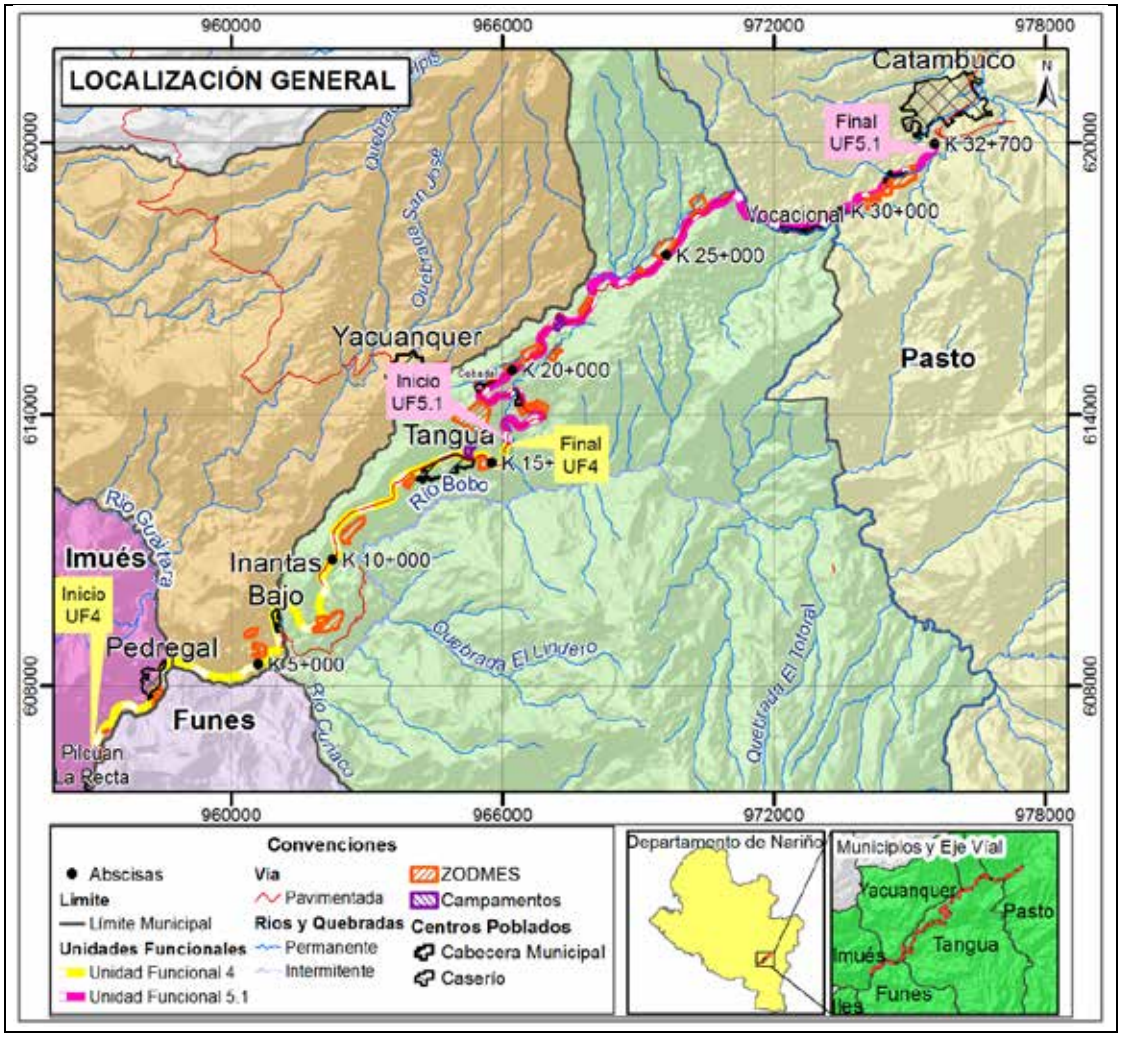

Figure 3.1 General map location of the Rumichaca-Pasto road project

Source: Gemini Environmental Consultants SAS, 2016

(See detail in Annexes: GDB / mapping / PDF / code / EIADCRP_PC_001 scale 1: 25,000)

The general location map, geographical location and political and administrative division (department, municipal and county), which including further contour lines, hydrography, landforms, human settlements and existing community facilities, are available on the Geo Data Base:

- GDB / mapping / PDF / code / EIADCRP_PC_001
- GDB / mapping / PDF / code / EIADCRP_PC_002
- GDB / mapping / PDF / code / EIADCRP_PC_002

Table 3.1 also describes Functional Unit UF-4 and the two UF-5 sectors. Note that in the last row or UF-5.2, only the initial 60 meters will be a management part of this EIA.

Table 3.1 Division of Functional Units UF4 and UF5

UF	Start			End			Total length	Sector
	abscissa	Coordinate		abscissa	Coordinate			
		N	AND		N	AND		
UF4	K 00 + 000	606679.90	957013.40	K 15 + 760	613384.73	966117.87	15.76 km.	Pedregal-Tangua
UF5	K 15 + 760	613384.73	966117.87	K 32 + 700	619975.18	975562.48	16.94 km.	Tangua-Catambuco
	K 32 + 700	619975.18	975562.48	K 37 + 959	623684.62	977560.70	5.26 km.	Pasto Catambuco
Total construction length of the dual carriageway							32.76 km.	
Total length of rehabilitation works							5.26 km	
Total length							37.96 km.	

Source Consortium SH 2017

Figure 3.2 shows greater physiographic details of the area and corridor subject matter of this study. It is recommended to refer to the cartographical annexes to clearly appreciate these details.

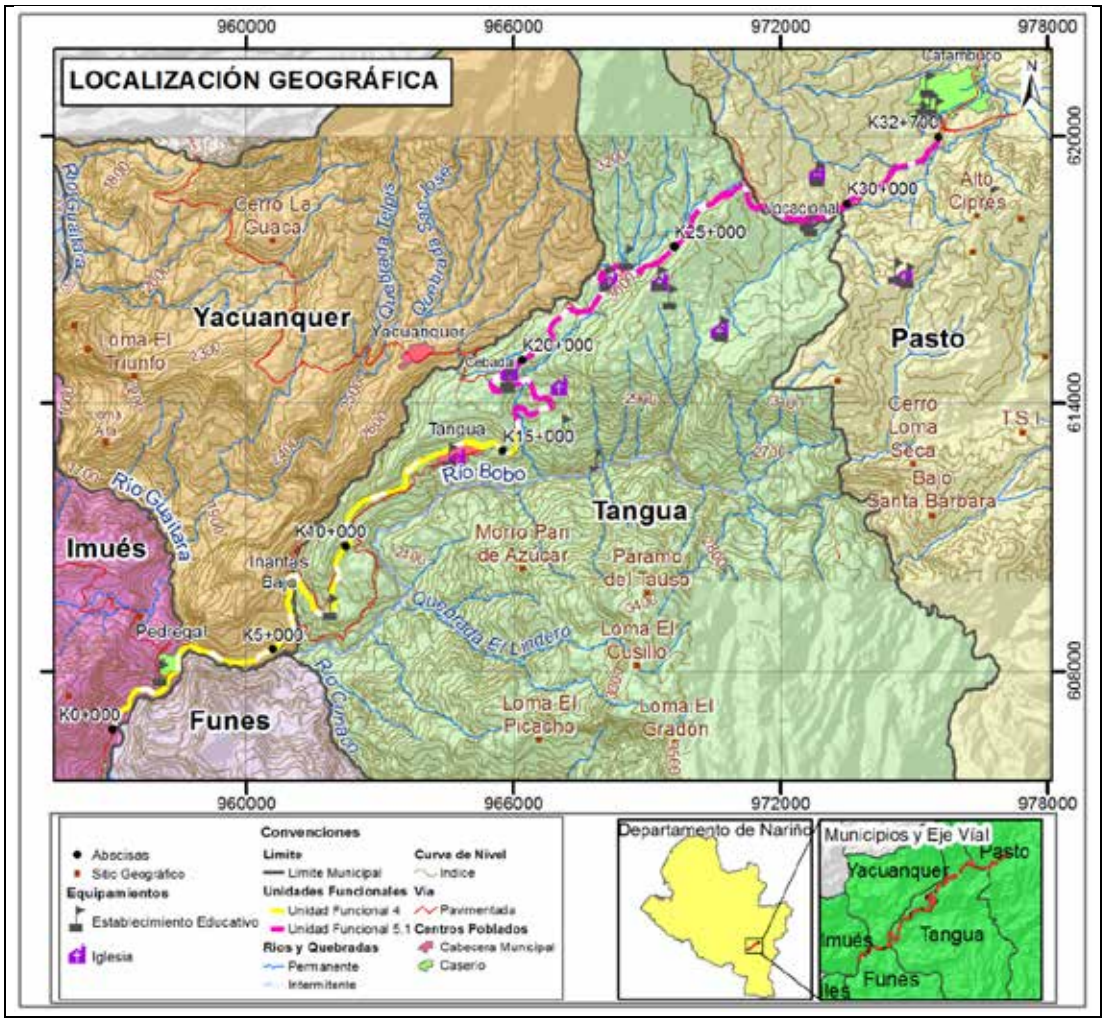

Figure 3.2 Geographical map location of the road project Rumichaca-Pasto

Source: Gemini Environmental Consultants SAS, 2016

(See detail in GDB / mapping / PDF / code / EIADCRP_PC_002 scale 1: 25,000)

3.1.1. Functional Unit UF-4: Pedregal -Tangua

UF-4 corridor, Pedregal-Tangua, is between PR43+217 to PR60+020 of National highway 2501, which is a total of 15.76 km of road (k0 + 000 760 + k15) for the project, which run along a topography with longitudinal and transverse slopes given the natural landforms.

K0 + 000 of this functional unit is located approximately 1.6 km. before crossing the Pedregal town center, Municipality of Imués, and ends at K15 + 760, in the municipality of Tangua. The layout also foresees in addition to the conventional paved roadway, the following remarkable works:

- Pedregal exchanger in the Pedregal town between Abscissa (k1+750 to k2 +300) and an underpass intersection roundabout type (k2 + 150) for access to the Pedregal town and a bypass to Imués, Túquerres and the southwestern region.
- A bridge over the Guáitara River between abscissa and k2 + 780 and k3 + 080.
- El Placer toll on abscissa K6 + 200.
- Crossing structure in the La Magdalena Stream in K7 + 000.
- Connection overpass on abscissa k8 + 600.
- Returns between abscissa k12 + 600 - k13 + 000 and k14 + 050 - k14 + 500 in the ingress and exit of the Tangua town.

Municipal entities

The municipal entities of Functional Unit UF-4 are the municipalities of Imués, Yacuanquer and Tangua where the counties of Pilcuán and Pedregal are located in the municipality of Imués; the Inantas Alto Alto and Inantas Bajo counties in the municipality of Yacuanquer and, the Cocha Verde, El Tablon Obraje, San Pedro Obraje, El Vergel, Buena Esperanza in the municipality of Tangua; the Tangua, Corazón de Jesus, Fatima and Bolivar neighborhoods.

Table 3.2 and Figure 3.3 list the major and minor territorial units that are part functional unit 4. Chapter 5 of this EIA has a detailed description of municipalities and related counties.

Table 3.2 Major and minor territorial units Functional unit 4

FUNCTIONAL UNIT 4		
Item	**MAJOR TERRITORIAL UNITS**	**MINOR TERRITORIAL UNITS**
1	Imués	V / Pilcuan
2		V / Pedregal
3	Yacuanquer	V / Inantas Alto
4		V / Inantas Bajo

FUNCTIONAL UNIT 4		
Item	**MAJOR TERRITORIAL UNITS**	**MINOR TERRITORIAL UNITS**
5	Tangua	V / Cocha Verde
6		V / El Tablón Obraje
7		V / San Pedro Obraje
8		Corazón de Jesús de neighborhood Tangua
9		Fatima neighborhood Tangua
10		Bolivar neighborhood Tangua
11		V / El Vergel
12		V / Buena Esperanza

Source: Gemini Environmental Consultants SAS, 2016

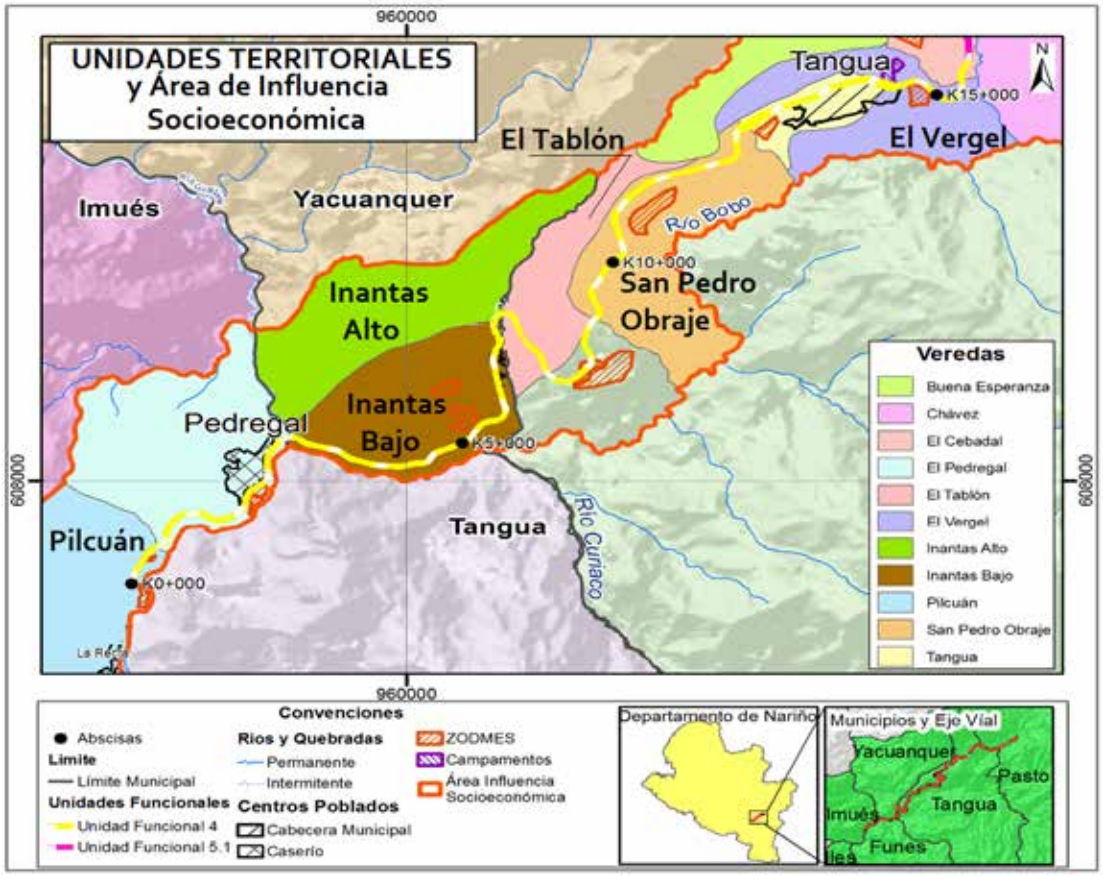

Figure 33 Major and minor territorial units functional unit 4

Source: Gemini Environmental Consultants SAS, 2016

3.1.2. Functional Unit UF-5: Tangua - Pasto

The UF-5 corridor, Tangua - Pasto, is between K15 + 760 and K37 + 959, for a total of approximately 22.20 kilometers of road and is subdivided in subsectors UF-5.1 and UF-5.2 with only the first one of interest for this EIA.

3.1.2.1. UF-5 Sub-Sector 1 Tangua-Catambuco

The UF-5 corridor Sub-sector 1, Tangua-Catambuco is between PR60 + 020 and PR77 + 750 National highway 2501 and project abscissa between K15 + 760 to K32 + 700 for a total of 16.94 km. road, running along a topography with high longitudinal slopes, but soft transverse developments allowing various relatively flat sectors. The end point is the county of Catambuco in the municipality of Pasto.

In the layout of 5 subsector 1, in addition to the second conventional road, the following works are foreseen:

- Alberto Quijano relief road between K22 + 600 - K23 + 800
- Operational return Oval type between K19 + 000 - K20 + 000 Yacuanquer and Cebadal access
- Operational return Necktie type between K26 + 500 - K26 + 900
- Operational return Necktie type between K28 + 800 - K29 + 400
- Bavaria Footbridge K31 + 300

3.1.2.2. UF-5 Sub-sector 2 Catambuco - Pasto

UF 5-2 is between the south exchanger and the eastern Pasto (Catambuco) relief road and the access to the Pasto urban area, section where the existing road will be mainly rehabilitated and where works of interest to this EIA will only be made in the initial part.

Understanding that rehabilitation is the "Reconstruction of a transport infrastructure to return it to the initial state for which it was built" and that this regulation does not establish environmental licensing, most of the UF-5-2 is not part of the management of this Environmental Impact Study, except for the first 60 meters in the village of

Catambuco to be intervened with major adaptation works to habilitate the access to the population center.

Municipal entities

Municipal entities of Functional Unit UF 5.1 and the 60 meters from the UF 5.2, are Tangua and Pasto, while minor territorial units are: El Cebadal Chavez, El Tambor, El Paramo, La Palizada, Marqueza Bajo, Los Ajos, Marqueza Alto, belonging to the municipality of Tangua and the counties of Gualmatán Alto, Vocational, Cubiján Alto, Cubiján Bajo, La Merced, San José de Catambuco, Catambuco and Huertecillas that belong to the municipality of Pasto.

Table 3.3 and Figure 3.4 list major and minor territorial units that are part of functional unit 5. Chapter 5 details municipalities and counties of this EIA.

Table 3.3 Major and minor territorial units of functional unit 5

FUNCTIONAL UNIT 5		
Item	**MUNICIPALITY (major territorial units)**	**COUNTY (minor territorial units)**
1	Tangua	El Cebadal
2		Chávez
3		El Tambor
4		El Paramo
5		La Palizada
6		Marqueza Alto
7		Los Ajos
8		Marqueza Alto
9	Past	Gualmatán Alto
10		Vocacional
eleven		Cubijan Alto
12		Cubijan Bajo
13		La Merced
14		San José de Catambuco
fifteen		Catambuco
16		Huertecillas

Source: Gemini Environmental Consultants SAS, 2016

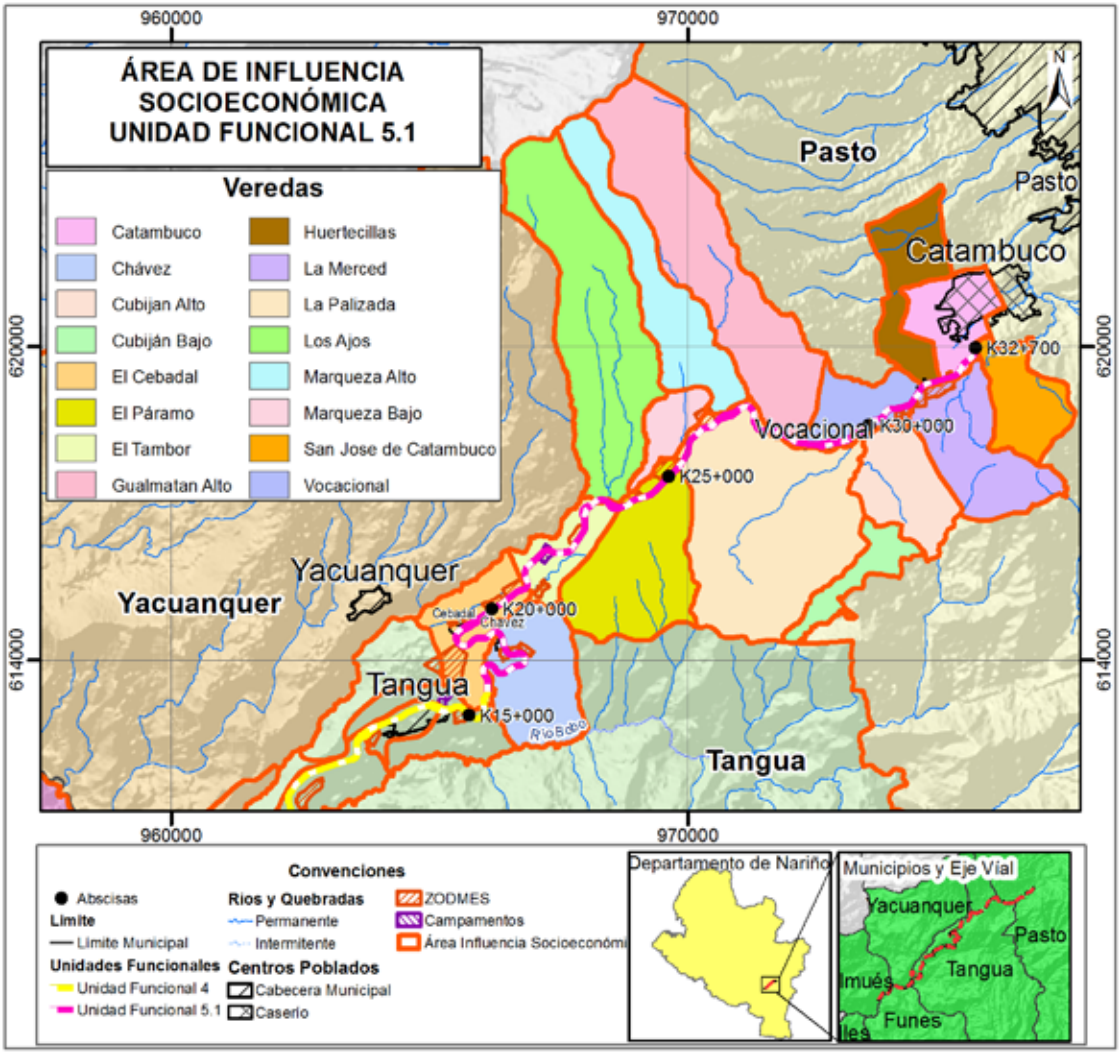

Figure 3.4 Major and minor territorial units of functional unit 5

Source: Gemini Environmental Consultants SAS, 2016

3.2. Project characteristics

The technical characteristics the Rumichaca - Pasto Dual Carriageway Road, Pedregal - Catambuco Section, Concession Contract under scheme APP No. 15 of 2015, develop according to the aspects referred to in Article 7 of Law 1682 of November 22 2013

whereby measures and provisions for transport infrastructure projects are adopted and extraordinary powers are granted.

Follows existing road infrastructure details and the relation with networks; the analysis of ethnic communities, urban heritage, architectural, cultural and / or archaeological is outlined; mining rights, reserve areas, exclusion or protected areas; phases and project activities and characteristics are specified and the geometric design of the road to be built, with its elements and transport infrastructure, drainage and geotechnics is described; project associated infrastructure such as camps, material stockpiling sites, sources of material and processing plants; the utilities infrastructure mainly interrupted utility; major supplies such as building materials, fuels, surplus explosives and materials to be used with the approximate amounts thereof; disposal and management of surplus materials from excavation, construction and demolition; waste volumes and classification; project schedule; the organization chart of the consortium responsible for project implementation and finally the projected costs of the project.

3.2.1. Existing infrastructure

3.2.1.1. Road infrastructure

As part of the project's infrastructure an existing main road is considered, described in the technical appendix 1 of the Concession Contract under Scheme APP No.15 of September 11, 2015. (See Table 3.2.)

The project has no railways and its reference abscissa is between PR.43 + 217 to PR.77 + 750 of route 2501, national highway.

Table 3.4. Existing roads used for the Project

Road to be used	Main Work or Support	Length
Current National Route 2501	Bridge River Guáitara	300
Current National Route 2501	ZODME Z4-1, Z4-2, Z4-3, ZR4-1, Z5-2, ZR5-1, ZR5-2, Cebadal Camps, ZR5-3, Z5-7, Z5-8, Z5-9, Z5- 12 ZR5-5.	34609

Inantas Bajo county road	ZODME Z 4-4 and Z4-5	1289
El Tablón county road	ZODME Z4-6	167
San Pedro Obraje county road	Z4-7 and Z4-8 ZODME	4517
County road connection to Yacuanquer	Tangua camp	311
Cubiján county road	ZODME Z5-1A and Z5-1B and The Chaquita intake	786
The Cebadal county road	ZODME Z5-3	251
Cubijan Alto county road	Cebadal camp and ZODME Z5-6	805
Marqueza county road	ZODME Z5-10	57
La Merced county road	ZODME Z5-11	286
La Merced county road	ZODMES ZR5-4 And Z5-13	390
Inantas Tangua Bajo county road	Bobo River water catchment	1270
Road to Yacuanquer	Water catchment, ZODMES Z5-4, Z5-5	2073

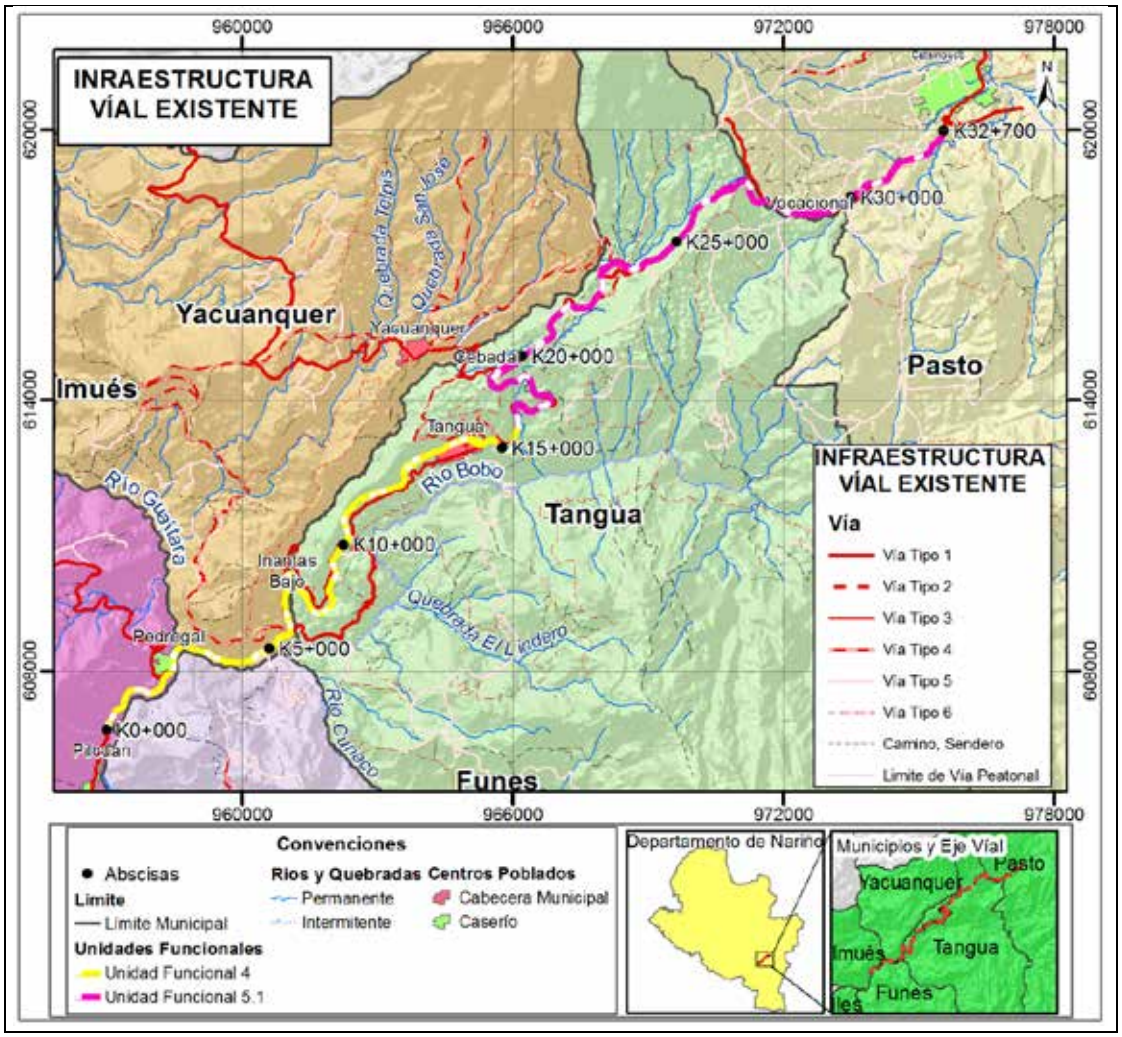

Figure 3.5 Existing road infrastructure

Source: Gemini Environmental Consultants SAS, 2016

(See detail in GDB / mapping / PDF / code / EIADCRP_PC_002 scale 1: 25,000)

Photograph 3.1 PR48 + 0100 existing road

Source: Gemini Environmental Consultants SAS, 2016

Table 3.5. Description of National highway 25 INVIAS

Road Code and Longitude	Source (Name-PR)	Destination (Name-PR)	Actual condition
Section 2501 and Section 25NRC 83 km	Eastern abutment Rumichaca International Bridge PR 0 + 0040	Pasto: PR 83 + 000 Catambuco and PR 0 + 440 Exchanger Eastern Pasto relief road	75% 3 to 4 VIZIR deterioration index, equivalent to a regular condition. 20% 1 to 2 VIZIR deterioration index equivalent to acceptable condition.

Source: Technical Appendix 1. Page 04.

National Highway 25 and the Rumichaca - Pasto road is the Pan-American highway with bidirectional operation that starts at the eastern abutment of the Rumichaca bridge PR 0 + 040 (not including the international bridge) and ends at Calle 12 with Carrera 4 of Pasto or PR 83 + 000. A part of this road is the section up to the Ipiales south exchanger PR 0 + 940, dual highway with three lanes in each direction and feeder links to CEBAF

to be built by INVIAS and includes the Ipiales relief road, the Ipiales urban crossing and crosses through population centers.

The current condition of national highway 25, the main mobility hub for the project, has indexes of remarkable deterioration in accordance with measurements results using the Surface Deterioration index (Is) of the VIZIR methodology along the study section. From the measurements, 76% is highlighted with deterioration indexes between 3 and 4, meaning that the pavement structure has a regular surface condition with structural origin cracks. Approximately 20% show impairment levels between 1 and 2 indicating pavements with limited cracks and deformations representing pavements in good overall appearance.

According to the parameters established by the Ministry of Transportation, the classification of the existing Rumichaca - Pasto road, with respect to its functionality, average daily traffic, geometric design and population is categorized into an arterial or first order route. Due to its topography it corresponds to a road with topographical features of land between Mountainous and Rugged. Regarding the classification of rural access roads in the existing road, they are categorized mostly as tertiary roads joining the municipalities with villages, farms and / or housings and because they have paved surfaces being the only main roads; Pedregal - Tuquerres Route 1002, which in turn connects with Tumaco and Yacuanquer - Sandona, which is part of Bypass 2501B road to Galeras, Annex 3.2.1.1. lists existing vehicular accesses. (See Photograph 3.2.)

Photograph 3.2 PR48 + 0100 existing road
Source: Gemini Environmental Consultants SAS, 2016

- *El Placer Toll (PR + 570- PR6 + 5 330)*

Currently the El Placer Toll is located on PR 49 + 058 with two (3) collection bays, however the estimated year of commissioning of the dual carriageway, requires placing seven (7) collection bays (including electronic toll collection areas), which requires expanding current conditions; given the aforesaid and since the topography where the current toll is located is an area of high cuts on one side and important fills on the other, the current toll needs to be relocated to an existing broad platform allowing expansion to required widths.

Photograph 3.3 PR49 + 0580 Current El Placer Toll
Source: Gemini Environmental Consultants SAS, 2016

3.2.1.2. Utility networks and assets

There are utility networks and assets and IT and telecommunications infrastructures in the area of direct and indirect influence of the project, which are listed in Table 3.6.

Table 3.6. Existing networks UF-4 and UF-5

Servicio Publico	Empresa
Alcantarillado	ASOASPIM
	EMPOTANGUA
	EMPAAAYAC SAS ESP
	ASOPEDREGAL
	EMPOPASTO
	ALCANTARILLADO PILCUÁN
Acueducto	ASOASPIM
	EMPOTANGUA
	EMPAAAYAC SAS ESP
	ASOPEDREGAL
	EMPOPASTO
	ACUEDUCTO VEREDAL CATAMBUCO
	ACUEDUCTO PILCUÁN
	ACUEDUCTO VEREDAL BARRIO PARAISO
	ACUEDUCTO VEREDAL CEBADAL - LOS AJOS
	ACUEDUCTO VEREDAL CUBIJAN
	ACUEDUCTO VEREDAL LA MERCED
	ACUEDUCTO VEREDAL MARQUEZA ALTO
	ACUEDUCTO VEREDAL MARQUEZA BAJO
	ACUEDUCTO EL PARAMO
	ACUEDUCTO VEREDAL INANTAS - EL PLACER
	ACUEDUCTO VEREDAL EL TAMBOR
Energía eléctrica	CEDENAR
Telecomunicaciones	TELECOM
	CLARO
	MOVISTAR
	DIGITEL
	TV AZTECA
	C&W NETWORK
	TV CABLE PEDREGAL Y PILCUAN

Source SH Consortium

There is no oil industry infrastructure.

The information on power grids is described in detail in section 3.2.3.3 – Infrastructure and services intercepted by the project.

3.2.1.3. Urban, architectural, cultural or archaeological heritage

The Andean Highway System, Inca Trail or Qhapaq Ñan, declared of national cultural interest (BIC-Nal) by Resolution 3317 of October 25, 2013 issued by the Ministry of Culture of the Republic is identified in the project area. (See Annex Numeral 3.2.1.3)

The Qhapaq Ñan runs parallel to the first kilometers of the UF-4 highway project on the water side opposite the road corridor and without interacting with it. Regarding the UF-5, the Qhapac Ñan is not geographically defined or is too far away, without interacting with the project's road corridor.

In the Tangua sector and in the lower part of the Inantas county there are signs of minor roads, transversals of the Andean Highway System, passing close to the Rumichaca - Pasto highway corridor, although already intervened by recent anthropic action to the point that assumed paths have already become unpaved roads since colonial times.

Overall, the road project under the EIA does not interfere with the Qhapaq Ñan, while the Archaeological Management Program will seek to contribute to the preservation of Nariño's cultural heritage.

Table 3.7. Qhapaq Ñan municipalities in the department of Nariño lists eight (8) municipalities of Nariño and nine (9) sections interacting with the Inca Trail or Qhapaq Nan.

Table 3.7. Qhapaq Ñan municipalities in the department of Nariño

File code sent to UNESCO	Section	Location
CO-RP-01-C-2011	Rumichaca	Municipality of Ipiales
CO-RP-02-C-2011	San Pedro	Municipality of Potosí
CO-RP-03-C-2011	La Cofradía	Municipality Gualmatán
CO-RP-04-C-2011	La Paz	Municipality Contadero
CO-RP-05-C-2011	Chitarran	Municipality of Funes
CO-RP-06-C-2011	Rosal del Chapal	
CO-RP-07-C-2011	Guapuscal Bajo	
CO-RP-08-C-2011	Inantás	Municipality of Yacuanquer
CO-RP-09-C-2011	Los Ajos	Municipality of Tangua and Pasto

Source: Resolution 3317 of October 25, 2013

The Inca Trail or Qhapaq Ñan covers an extensive network of roads, whose objective was to articulate the large historical, natural and cultural diversity of the various Inca

peoples throughout the Andean territory, and which are now part of countries like Argentina, Chile, Bolivia, Peru, Ecuador and Colombia.

Regarding interventions on vestiges of this and other cultural elements, archeological survey activities were carried out for the corridor, showing that construction activities of this project do not cross the existing sections of the Inca Trail. In this regard Annex 5.3.6.b presents the document corresponding to the Archaeological Management Plan, which is the result of project surveys and sent to ICANH in charge of protecting and managing the archaeological heritage of Colombia.

From information provided by the Ministry of Culture, the Assets of National Cultural Interest (BIC Nal) were checked in regard the area of project intervention, concluding that the BIC-Nal reported for the municipalities of Yacuanquer , Tangua and Pasto are not in the area of project intervention. (Figure 3.7.)

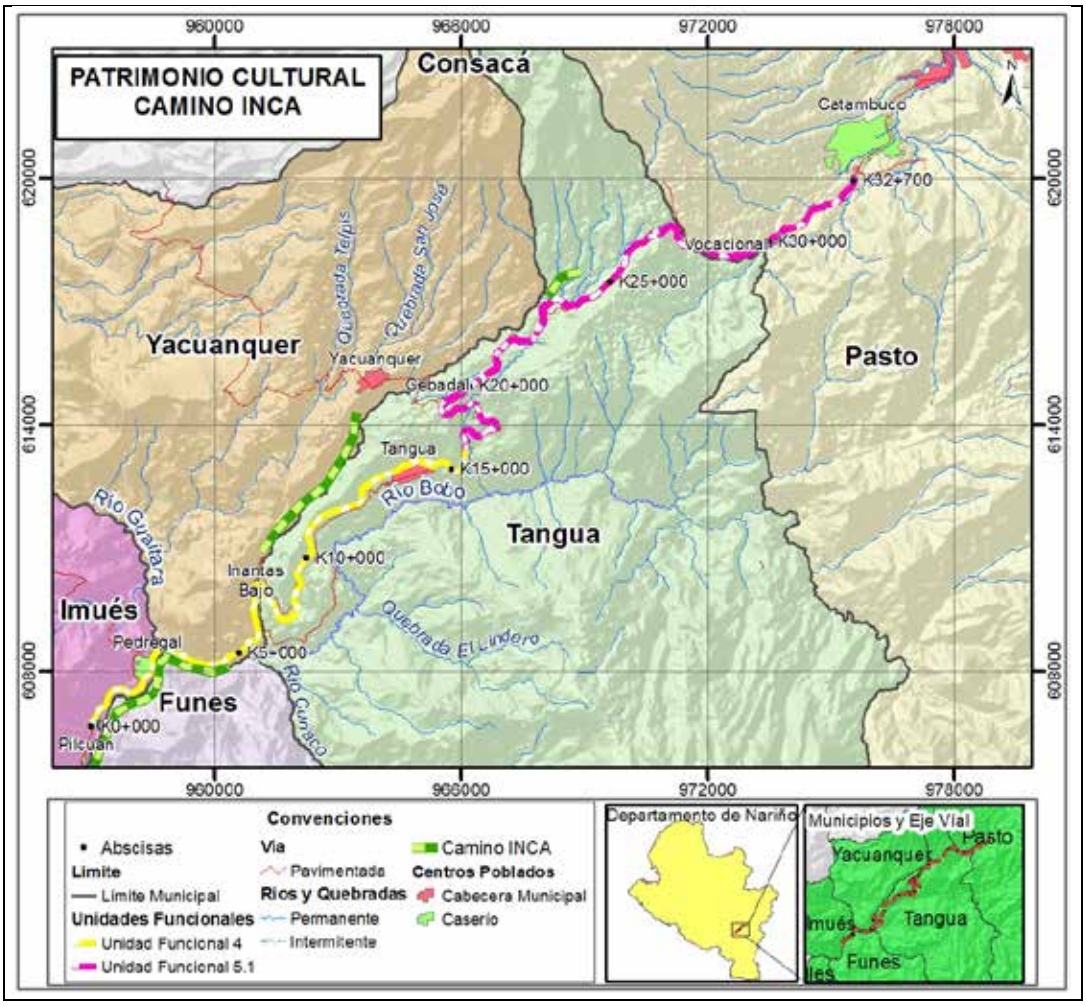

Figure 3.6 Inca trail

Source: Gemini Environmental Consultants SAS, 2016

(See detail in GDB / mapping / PDF / code / EIADCRP_PC_005 scale 1: 25,000)

3.2.1.4. Protected areas

From secondary information, the presence of strategic ecosystems areas, sensitive and protected areas in the area of influence of the project, which could see directly or indirectly affected by the construction of the dual carriageway, is discarded.

Preliminary verification is made with the Tremactos Colombia tool and overlapping road project areas of influence with information from the National Natural Parks System, local system of municipality protected areas, Reserves of the Galeras civil society, National protective forest reserves and regional protected areas (see description Ch. 5 Characterization of the influence area, numeral 5.2.1.3 Strategic, sensitive ecosystems and / or protected areas and annexes 3.2.1.4-a-b 3.2.1.4, 3.2.1.4-c and 3.2. 1.4-d).

The official response from the Regional Autonomous Corporation of Nariño CORPONARIÑO is pending. The document filed by Gemini Consulting SAS on January 18, 2016 in order to ratify the information and requesting: Certification presence or absence of areas that under some scheme are in protection within the area of influence of the proposed Ipiales-Catambuco road corridor. Areas belonging to the National System of Protected Areas (SINAP), Natural Parks System, Protective Forest Reserves, Regional Natural Parks, Integrated Management Districts, Soil Conservation Districts, Protective Forest Areas, Protective-Producing Forest Reserves. Certification of presence or absence of areas belonging to sensitive ecosystems, moors, special management areas (marshes, swamps, wetlands) or any environmental restrictions overlapping with the area defined dual carriageway project development. Flora species in the Nariño department's jurisdiction are considered endemic or threatened with extinction or those having some sort of restriction for its use (see Annex 3.2.1.4-e).

3.2.1.5. Ethnic communities

- Functional Unit 4

Certification number 110 of February 22, 2016 issued by the Ministry of the Interior on the presence or absence of ethnic communities in project areas, works or activities to be performed, legitimizes the ABSENCE OF INDIGENOUS COMMUNITIES, minorities and Roma, Black communities, Afro-Colombian, Raizales and Palenqueras in the area of project Rumichaca-Pasto Concession 4G under scheme APP No. 15 of September, 2015 - Functional Unit 4, (see *Annex 3.2.1.5 Certification 110 of Feb. 22, 2016*) located in jurisdiction of the municipalities of Imués, Tangua and Yacuanquer.

By resolution 23 of 2016, the Interior Ministry partially revokes administrative act Certification number 110 of February 22, 2016 and resolves to certify that there is presence of Cabildo Montaña de Fuego indigenous communities in the area of the "RUMICHACA-PASTO CONCESSION 4G PROJECT UNDER SCHEME APP. NO. 15 OF SEPTEMBER 11, 2015- FUNCTIONAL UNIT 4 located in the jurisdiction of the municipalities of Imués, Tangua and Yacuanquer. (*See Annex 3.2.1.5-d resolution 23 of 2016*).

- Functional Unit 5 sub-section

Certification number 111 of February 22, 2016 issued by the Ministry of the Interior on the presence or absence of ethnic communities in the project areas, works or activities to be carried out, certifies the ABSENCE OF INDIGENOUS COMMUNITIES, minorities and Roma, Black communities, Afro-Colombian, Raizales and Palenqueras in the area of project Rumichaca-Pasto Concession 4G under scheme APP No. 15 of September, 2015 - Functional Unit 5, Subsection 1, (*see Annex 3.2.1.5-b Certification 111 of Feb, 22, 2016*) located within the jurisdiction of the municipalities of Pasto and Tangua.

By resolution 22 of 2016, the Ministry of the Interior partially revoked administrative act Certification number 111 of February 22, 2016 and resolves to certify the presence of Cabildo Montaña de Fuego and Cabildo Catambuco, Quillacingas ethnic group indigenous communities in the area of the "RUMICHACA-PASTO CONCESSION 4G PROJECT UNDER SCHEME APP. NO. 15 OF SEPTEMBER 11, 2015- FUNCTIONAL UNIT 5 SUBSECTION 1 located in jurisdiction of the municipalities of Pasto and Tangua. (*See Annex C 3.2.1.5-c resolution 22 of 2016*).

3.2.1.6. Mining Titles

To identify the presence of mining in awarding proceedings, granted, existing and operating on the project area, the National Mining Agency – ANM was requested to certifying their existence and location.

In response to the request, the ANM sent graphic report of titles and mining applications in force. (See Annex 3.2.1.6 and GDB / mapping / PDF / code / EIADCRP_PC_007).

3.2.2. Project phases and activities

Development and implementation of the Rumichaca - Pasto Dual Carriageway Road Project, Pedregal - Catambuco Section, Concession Contract APP Under Scheme No. 15 of 2015, three (3) stages were identified for Functional Units UF4 and UF5:

- § Pre-construction
- § Construction
- § Abandonment and final restoration

Table 3.8. presents an overview of project activities

Table 3.8. Project phases and activities

Number	Activity	Description
PRE-CONSTRUCTION STAGE		
The initial steps to be developed in this stage are: defining project objectives and resources required for implementation. Project characteristics imply the need for a phase or prior stage for preparation thereof, a very important phase for project progress and that should be especially cared for. Much of the success or failure of this project is mainly based on these preparatory stages, since the basic designs and studies that will be the cornerstone for the project to succeed or require rethinking are resulting therefrom.		
1	Land acquisition and easement	This refers to activity prior to any intervention, involving the purchase of the areas where the project infrastructure will be established (asphalt plants, concrete, camp.), by agreements with the owners and / or title holders of the properties and clear mechanisms for trade negotiations.
2	Labor contracting	This activity is considered preliminary, but will also occur during the construction stage. The activity consists of contracting professional, technical and operational personnel required for the development of all civil and socio-environmental activities related to project implementation. It is an activity integrating corporate policies of the concessionaire responsible for implementing the project, compliance with existing labor legislation and adequate information to municipalities and communities as to magnitude and procedures. Skilled and unskilled personnel will be contracted based

Number	Activity	Description
		on the needs of each construction activity, giving preference to the labor available in the area of influence of the project.
3	Purchase and / or rental of goods and services	Purchase and / or rental of goods and services required for project implementation.
4	Initial neighborhood minutes	The initial physical state of the buildings, housing, local economic activities, sheds, fences, poles, gates, trees, living fences, crops, enclosures, driving water service and other works located on both sides of future construction activities. Neighborhood minutes are also signed in areas where the builder will use them temporarily or for the duration of the work. Minutes will be recorded in physical instrument.
CONSTRUCTION PHASE:		
5	Installation and operation of camps	Construction and / or conditioning of camps for personnel accommodation, storage of chemical supplies, operations center, gathering of materials and associated infrastructure.
		Temporary camps that will depend on the distance and number of work sites as needed for each activity.
		These camps can be conditioned or built during any stage of the project and may use the rights of way used for the existing road and to be built.
6	Installation and operation of process plants (asphalt, concrete, crushing)	There will be areas conditioned for the operation of asphalt, concrete and crushing plants in areas designated in Item 3.2.3.2 of this study.
		Core activities will be carried out in each plant in order to have permanent and necessary supplies for project implementation. There will also be material storage areas which will be charged and mobilized to the operation areas.
7	Mobilization of construction materials, supplies, machinery, equipment, waste and vehicles.	This activity refers to transportation of personnel, equipment, tools and materials to different work fronts made well in advance of commencement of construction work.
		Mobilization of waste to temporary stockpiling or final disposal areas, ZODMEs is also included

Number	Activity	Description
		Mobilization work will be conducted with the most appropriate means to prevent damage from access roads and surrounding areas where the transport takes place. To transport heavy or light equipment, low-bed or high-bed type trucks will be used and the equipment will be secured with items such as idlers, sacks and chains, to ensure that during transport no accidents will occur that could affect both transported items and the environment in its path.
		Vehicles used for transportation shall be appropriate, both in number and capacity not exceeding either the size or the load limits allowed for traveled roads and bridges. These will be in good mechanical conditions so as to not cause traffic disruptions. Transportation of building materials, supplies, machinery, equipment, waste and vehicles shall be governed by current regulations.
8	Operation and maintenance of machinery and / or equipment	Operation of equipment and machinery necessary for construction and commissioning of the structures required by the project inside intervention areas. Good maintenance of machinery and equipment will allow them to have good quality and working continuity, fewer repairs and a longer life, by implementing a program to check the status and operation by the responsible group, comprehensive management system direction / SISO deputy, residents, SST Inspector and / or environmental coordinator / inspector and workers.
9	Top soil removal and stripping	This consists of removing shrubs, stubble, weeds and, in general, all plant material in construction areas and support locations for project construction its accesses. It includes removal of roots and soil containing organic material, expansive clays or any other material deemed inappropriate by the supervisor for construction of the works. This activity includes transportation and disposal of excess material in areas designated as Debris and excavation material Management Zone (ZODME); material entrainment and loss of vegetation cover are also considered as likely to produce impacts due to generation of solid waste.

Number	Activity	Description
		The equipment used to execute the top soil removal and stripping activities must be compatible with the implementation procedures adopted and requires prior supervisor approval, considering that their ability and efficiency complies with the work implementation program as well as meeting requirements of the specification.
10	Removal of forest cover	The removal of forest cover consists of removing all plant material to the natural ground level, so that the surface is clear. This activity includes logging and eventual felling of trees and shrubs, cutting weeds and tree stumps and removal, transportation and disposal of all waste in the respective areas designated as Debris and Excavation Material Management Zone (ZODME). Forest cover removal will only apply for strictly required areas.
11	Demolition	This is closely related to tasks in connection with the improvement of existing corridors, or construction in urban and semi-urban environments involving demolition of buildings, structural elements, and in general road and urban fittings to make way for the new corridor or project. In other words, it has an indirect associated connotation affecting human settlements inhabiting the property to be removed or demolished to make way for earthworks and in general typical road infrastructure.
		It comprises demolition as such, debris loading, transportation and final disposal thereof in the ZODMEs.
12	Excavations and / or earthworks	This involves removing any material with machinery below the final stripping level to the lines and heights specified in the drawings. Backhoes and bulldozers are used, provided that such equipment and materials do not damage existing infrastructure in the work environment.
		Extracted excavation material will be assessed for reuse; if not suitable for filling, to be then disposed of in the ZODMEs.

Number	Activity	Description
13	Debris and Excavation Material Operation Management Zone (ZODME).	Is the activity of loading, transporting and disposing of surplus excavation materials and debris not used in the construction activities of the project, which are placed in a controlled and planned manner in the areas assigned for such purpose. These ZODMEs are distributed throughout the area of influence of the project on land with pastures vegetation cover and sparse trees subject to exploitation, with close access to the main road.
14	Base, sub-base and pavement installation	Consists in the eventual disintegration of the material of the existing subgrade or subgrade formed in excavations, removal or addition of material, the mixture, wetting or aeration, compaction and final profiling of the shoulder, according to the dimensions, alignments and slopes indicated in project drawings.
15	Hydraulic works and artwork construction.	Hydraulic works consist of constructing culverts and concrete structures Culvert Box type that will collect the waters, in order to ensure its natural flow. These works will have inlet and outlet structures to channel water as well as delivery structures required as speed dissipaters, avoiding erosion or scouring processes downstream. Artworks were designed to manage and control runoff to avoid instabilities due to erosion and pollution and alteration of the drainage pattern of nearby water bodies.
		Filters are also included as part of the drainage works, their function is to capture and drive sub-surface water, protecting the shoulder laterally, especially in cut and mixed sections. On the other hand, in the field of road engineering, the term "artwork" refers to materialization of structures accompanying road shoulders, which essentially consists of drainage works, which are usually constructed using hydraulic reinforced and / or simple concrete.
16	Foundations and piloting	This includes building piles, piloting, shoes and / or dice and columns used to support the superstructure of containment walls, bridges and viaducts.
17	Building superstructure for bridges and viaducts	Viaducts and bridges are made up by two (2) main parts: superstructure or and infrastructure substructure. The superstructure applies to all components that are part of the board, such as: slabs, beams, struts, frame, arch,

Number	Activity	Description
		cables, straps, king poles, kerbs, sidewalks, platforms, railings, expansion joints, supports, pavement, drains, separators, etc. Infrastructure or substructure includes stirrups, towers, stacks, piles on deep foundations and lugs with corresponding foundation. Also slabs approach or access, access embankment, cones and slopes. The constructive process for aforementioned structures considers activities such as infrastructure construction in reinforced concrete, stakeout, excavation and structure filling, reinforced steel figurative, pouring concrete, superstructure construction, works in structural steel, assembling with cranes, installing dilation joints, etc.
18	Installing and rolling asphalt layer	It consists in the realization of the pavement structure, which consists usually of layers of stone material that serve as structural support for the wearing course, composed usually of a base and a surface layer in asphalt . The granular material comes from crushing plants granular materials and the asphalt mixture also usually comes from industrial plants where the asphalt concrete manufactured with technologies especially designed for this purpose.
		This activity consists of materializing the paving structure, normally made up layers stone material serving as structural support to the final road surface, normally made up by a base and an asphalt mix layer. The granular material comes from crushing plants and the asphalt mix normally comes from industrial plants manufacturing asphalt concrete with punctual technologies for this purpose. This activity is characterized by transporting or mobilizing granular materials from the respective plants to the point of collection, where they are laid and compacted in layers on the on the shoulder or technically prepared after forming the so-called road crown. These compaction processes use water as a contributing element to densify the granular layers, to achieve the structural strength required regarding transmitted loads from vehicular traffic.

Number	Activity	Description
		The asphalt mix must be transported at appropriately high temperatures, so that upon reaching the work fronts it can be easily handled for laying and technical compaction, thus forming the driveway or vehicular traffic area. It should be noted that the pavement structure is accompanied by side works to protect its structural stability, especially from rainwater; these are ditches, side channels, curbs and / or kerbs, which can be considered as artworks and are usually made of hydraulic concrete.
19	Installation of pedestrian bridges	A pedestrian bridge is a means of connecting pathways that allow movement of persons without interfering with vehicle traffic along the corridor.
20	Slope Treatment	This refers to the coatings and protections provided to cut slopes and embankment given weathering (wind, rain, sunlight) to which they are exposed, and that could compromise their geotechnical stability, affecting security in vehicular operation.
		Comprises works as crowning trenches to minimize the runoff action, vegetal induction by forestry techniques such as grassing, sowing seeds, fascines, the biomantles, shrub planting, etc. Given the previously discussed possible behavior, this may also comprise preventive and structural reinforcement works such as stake fences, anchoring bolts or "tie" and confinement walls. Regarding stabilization works, this refers primarily to cut slope or embankment retaining walls, which can be implemented in various forms and materials (reinforced concrete, plain concrete, gabion, etc.)
		In general terms, slope treatment refers a taking action where significant impacts are mainly focused in the physical component, essentially in soils and surface water runoffs.
21	Revegetation	This consists of planting grass, seeds and / or biomantles in embankment slopes, cuts, disposal sites and other areas of the project. These activities are likely to produce impacts due to generation, transport and disposal of debris and demand of natural resources.

Number	Activity	Description
22	Toll facility	Takes into account the dual-use toll collection modules; this toll area will feature additional toll buildings located on both sides of the road where administrative and community public services activities will take place.
ABANDONMENT AND FINAL RESTORATION STAGE		
This stage includes: removing infrastructure and sanitation facilities; regarding road maintenance, the access and delivery to the community was reshaped; environmental recovery, including landscape management, cleaning; information to communities.		
23	Dismantling of temporary facilities and camps	This is defined as the set of procedures and actions to be performed in the final stage or cessation of activities to, insofar as possible to return the areas to their original conditions.
		The plan includes measures aimed at preventing environmental impacts and risks during the closure of the construction phase, consider actions such as restoring areas, pointing out decontamination actions, restoration, removal of temporary facilities and other necessary to leave the area, ensuring that recovered site does not pose risks to human health and safety, or environmental impacts or environmental liabilities.
24	Final cleaning of worksites	All infrastructures are removed, overall area cleaning, ensuring that it is free of debris or abandoned infrastructure.
25	Landscape management	As part of the visual improvement of the area where the works are constructed, conditioning and integration of landscape works is foreseen, achieving compatibility with the environment.
		As adopted criteria for landscape management use native regional vegetation. Recommended species are arranged in places not hindering pedestrian traffic, generating impairment to buildings and interference with technical networks. Intervention of existing species as strictly necessary and generating the least environmental effect.

Number	Activity	Description
26	Final survey (close-out) Neighborhood Minutes	Final record of the physical conditions of the buildings, housing, stores, houses, fences, poles, gates, trees, living fences, crops, enclosures, water service channels and other works that are to either side of the future construction activities. Neighborhood minutes are signed in areas where the builder will use them temporarily or for the duration of the works. The minutes will be registered in physical instrument.

Source: Gemini Environmental Consultants SAS, 2016
Adapted by Consorcio SH 2016

3.2.3. Project design

The design is made in compliance with the concession contract under scheme APP No. 15 of September 11, 2015 and taking into account the current bidirectional road.

The project's technical features and design parameters and information of each comprising infrastructure works are detailed under this numeral.

3.2.3.1 Layout and geometric characteristics of the roads to be built

The layout design globally contemplates the relationship between horizontal, vertical alignment and cross section, leaving the decision of the design speed not only as the result of a plant study plan, but as a global view of these design concepts.

According to the design contract APP No. 15 of September 11, 2015, the technical appendix 1 details the design speed for the road is 60km / h.

Annex 3.2.3.0-a and 3.2.3.0-b present layout drawings and geometric characteristics plant / profile of Functional Units UF-4 and UF-5, respectively.

- *Road classification*

o For its functionality:

According to the criteria defined by the National Roads Institute - INVIAS, given its functionality the Pedregal - Catambuco road project is classified as a first order road, which will be part of corridor 3 Santander de Quilichao-Chachagui-Pasto-Rumichaca, which it is conceived as an international hub linking Colombia with Ecuador.

- Its topography:

According to criteria defined by the National Roads Institute - INVIAS, the Pedregal - Catambuco road project corresponds to a road with topographical land features between steep mountains and rugged terrain with an average gradient of seven percent (7%).

- *Elements*

- Area width or right of way

According to provisions of Law 1228 of 2008, Article 2, issued by the Congress of Colombia, whereby the minimum mandatory exclusion strips for National Highway System roads are determined, the exclusion zone for the project corresponds to twenty (20m) on either side of the road, which are measured from the outer axis of each road; considering a minimal 60m strip for first order roads. (See annex 3.2.3.1-a, 3.2.3.1-b)

- Crown

The crown is the assembly formed by the road and the berms and its width, is the horizontal distance measured normally to the axis between the inner edges of the ditches.

In most of the Pedregal - Catambuco section, crowns of 21.2 m will be used, with a 2m spacing (See Figure 3.7), however, planned road returns have separate roadways with 9.6m crown length crown each.

- Road

The road is part of the crown intended for vehicular circulation, construction dimensions are set out in the technical appendix to the contract, "to have two 3.65m

wide lanes each"; understanding lane as the strip with sufficient width for a line of vehicles to circulate, therefore, a width of 7.3 m per lane is considered for Functional Units UF-4 and UF-5 subsector 1.

The type section is mainly formed by two 7.3 m wide roadways, i.e. two 3.65 m lanes, 0.50 internal berm and 1.80 m external berm; 2.0 m central spacer, with a total width of 23.20 m; on the outer side of each roadway an additional width of 2.0 m is included in the fill zone and 1 meter in the cuts in order to place necessary signs and service networks on the road. For these additional widths, and only if necessary, the existing platform will be extended. In cases where improvement remains within the limits of the existing road, these additional berms will not be included. (See Figure 3.7.)

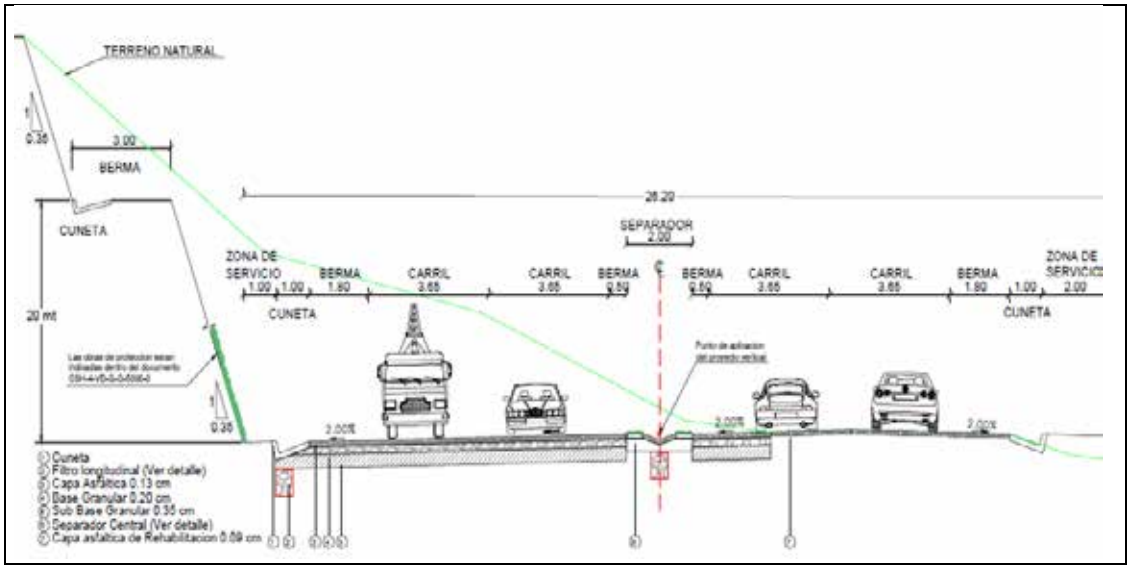

Figure 3.7. Typical cross section UF-4 and UF-5 subsector 1

Source: Consorcio SH 2016

o Berms

The berm is the strip between the edge of the road and the ditch, which plays the role of protecting the pavement and its lower layers, occasional allowing vehicle to pull over; ensure a lateral clear span acting psychologically on drivers, increased road capacity and offering additional space for emergency maneuvers, thus increasing road safety.

For UF-4 Functional Unit and Functional Unit UF-5 subsector 1 according to provisions of the technical appendix of concession contract No. 015 a 1.80m wide external berm, and a 0.5m wide internal berm are established in the dual carriageway sectors. (See Figure 3.7.)

- Ditches

Ditches are trenches opened in the ground, coated or uncoated, which collect and longitudinally channeled surface and infiltration waters. Their dimensions are derived from hydraulic calculations, taking into account the predicted rain intensity, terrain, slope of the ditch, drained area, among others.

Functional Units UF-4 and UF-5 subsector 1 have foreseen implementing two types of ditches, the first type 1 is 1m wide and 0.2m high for expansion sectors and new road and ditch type 2 is 0.8m wide 0.23m high for areas where only replacing the existing ditch is planned.

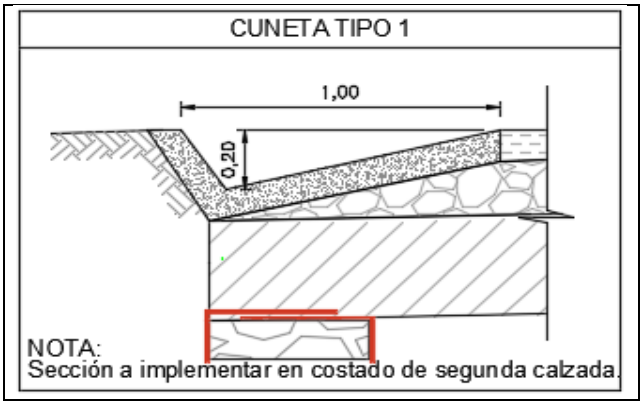

Figure 3.8. Ditch type 1 drawing UF4 and UF5 Subsector 1
Source Gemini Environmental Consultants SAS

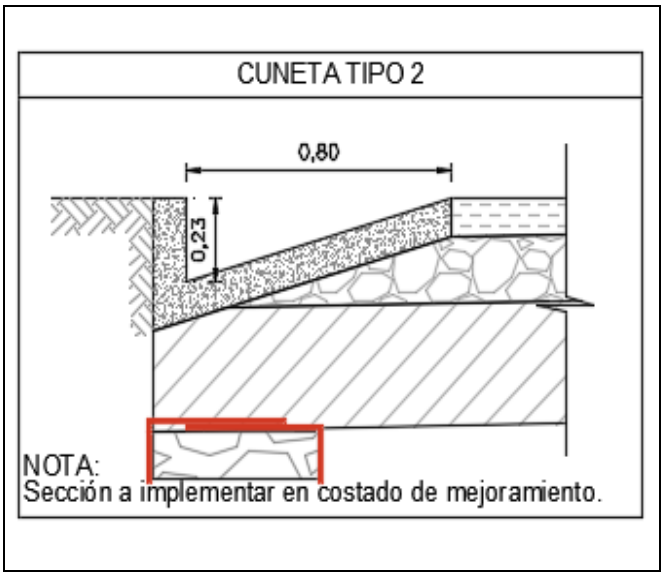

Figure 3.9. Ditch type 2 drawing UF4 and UF5 Subsector 1
Source Gemini Consulting SAS 2016

- Slopes foreseen in cuts and embankments

Slopes are flat sides limiting the earthworks. Their inclination is measured by the tangent of the angle between such planes with the vertical in each road section. The inclination of the cut slopes varies along the road, depending on the quality and stratification of soils found. The slopes and embankments must be designed according to geotechnical parameters as cohesion, friction angle, and shear strength and with minimum basic safety requirements established by the Seismic Resistant Standard NSR-10.

According to analysis of slopes based on the information obtained during the geotechnical survey, in situ field tests, laboratory tests, area geology and geometry of the existing field slopes, the inclinations cuts and fills for corridor embankments were defined. These recommendations are presented below. (See Table 3.9. Cut slopes and embankments UF-49)

Table 3.9. Cut slopes and embankments UF-4

Abscissa	Cut specification	Embankment specification
K0 + 000 - K0 + 500	0.45H: 1V 20m high max. 3m intermediate berm	Slope 1.5H: 1V
K0 + 500 - K0 + 890	0.75H: 1V 20m high max. 3m intermediate berm	Slope 1.5H: 1V
K0 + 890 - 200 + K2	0.45H: 1V 20m high max. 3m intermediate berm	Slope 1.5H: 1V
K2 + 200 - 780 + K2	0.50H: 1V 2m intermediate berm after rhe	Slope 1.5H: 1V
K3 + 090 - K3 + 860	0.7H: 1V 20m high max. 3m intermediate berm	Slope 1.5H: 1V
K3 + 860 - + 086 K4	First 20m 0.35H: 1V 3m intermediate berm thereafter 0.6H: 1V 20m high max 3m intermediate berm	Slope 1.5H: 1V
K4 + 086 - 150 + K4	0.45H: 1V 20m high max. 3m intermediate berm	Slope 1.5H: 1V
K4-K6 + 150 + 900	0.50H: 1V 2m intermediate berm after	Slope 1.5H: 1V
K6 + K7 + 900-050		1.7h: 1V 10m high max. 4m berm
K7 + 050 - 185 + K7	First 40m 0.35H: 1V 20m max. 3m berm thereafter 0.5H: 1V 20m high max. 3m berm	Slope 1.5H: 1V
K7 + 185 - K7 + 200	First 20m 0.35H: 1V 20m max. 3m berm thereafter 0.5H: 1V 20m high max. 3m berm	Slope 1.5H: 1V
K7 + 200-K7 + 550	0.5H: 1V 20m high max. 3m intermediate berm	Slope 1.5H: 1V
K7-K10 + 550 + 130		1.6H: 1V 10m high max. 3m berm
K10 + K12 + 130-205		Slope 1.5H: 1V
K12 + 205 - 275 + K12	First 20m 0.35H: 1V 20m high max. 3m berm thereafter 0.5H: 1V 20m high max. 3m berm	Slope 1.5H: 1V
K12 + K12 + 275-400	0.5H: 1V 20m high max. 3m intermediate berm	Slope 1.5H: 1V
K12 + K12 + 400-610		1.6H: 1V 10m high max. 3m berm
K12 + 610 - K12 + 830	0.75H: 1V 20m high max. 3m intermediate berm	1.6H: 1V 10m high max. 3m berm
K12 + K13 + 830-060	0.6H: 1V 20m high max. 3m intermediate berm	1.6H: 1V 10m high max. 3m berm
K13 + K13 + 060-590		Slope 1.5H: 1V

Abscissa	Cut specification	Embankment specification
K13 + K13 + 590-605	Left side 0.25H: 1V contemplating the use of a Soil Nailing type stabilization system, right side 0.6H: 1V 20m high max. 3m intermediate berm	Slope 1.5H: 1V
K13 + 605-15 + 560	0.6H: 1V 20m high max. 3m intermediate berm	Slope 1.5H: 1V
K15 + 660 - K15 + 900	0.7H: 1V 20m high max. 3m intermediate berm	Slope 1.5H: 1V

Source Note: Above information corresponds to the design feasibility phase, therefore it is subject to changes.
Source Consortium SH 2016

Table 3.10 Cut slopes and embankment UF-5 subsector 1

Homogeneous Area	Subsector	Beginning Abscissa	End Abscissa	Cut Slope	Fill Slope
1	1.1	K15 + 753.56	K15 + 900	0.70H: 1V With 3m wide berms every 20 m	1.5H: 1V
	1.2	K15 + 900	K16 + 100	0.75H: 1V With m wide berms every 20 m	1.5H: 1V
	1.3	K16 + 100	K18 + 976	0.70H: 1V With 3m wide berms every 20 m	1.5H: 1V
2	2.1	K18 + 876	K24 + 018	0.70H: 1V With berms 3m width every 20 m	1.5H: 1V
3	3.1	K24 + 018	K26 + 130	0.70H: 1V With 3m wide berms every 20 m	1.5H: 1V
	3.2	K26 + 130	K29 + 500	0.75H: 1V With 3m wide berms every 10 m	1.5H: 1V
	3.3	K29 + 500	K30 + 030	0.70H: 1V With 3m wide berms every 20 m	1.5H: 1V
4	4.1	K30 + 030	K32 + 700	0.70H: 1V With 3m wide berms every 20 m	1.5H: 1V

Note: Above information corresponds to the design feasibility phase, therefore it is subject to changes.
Source Consortium SH 2016

ü Cut slopes cross section

Figure 3.10 and Figure 3. show the typical cross section of cut slopes of functional unit UF4and functional unit UF5 subsector 1. Annexes from 3.2.3.1-d to 3.2.3.1-h present cross sections of the Pedregal- Catambuco section.

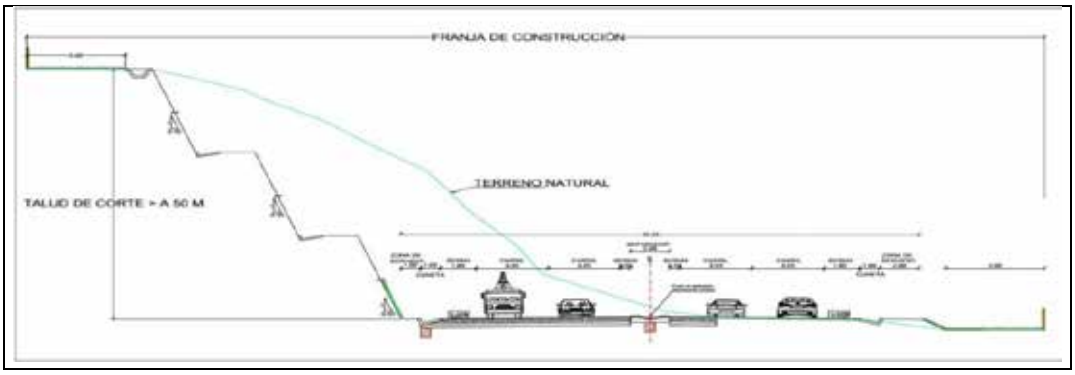

Figure 3.10 Proposed cross section for cut slopes greater than 50m

Source: Consorcio SH 2016

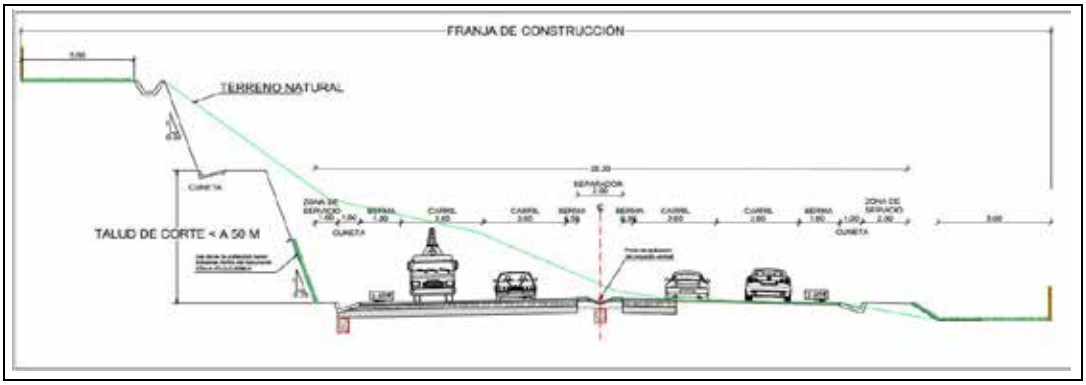

Figure 3.11. Proposed cross section for cut slopes lower than 50m

Source: Consorcio SH 2016

- Sidewalks and pedestrian paths

Based on the technical appendix, sidewalks will be built in the following area (see Table 3.11 Locati).

Table 3.11 Location of sidewalks

Begins (Name - Abscissa)	Destination (Name - Abscissa)	Type of work	Conditions and mandatory execution of the work	Approximate length (Km.) or minimum number (bridges, works, etc.)	Location coordinates
Begins PR31.7 urban area	Ends PR31.7 urban area	Sidewalks	Sidewalks urban area PR31-7	0.08km. (left side) 0,27Km. (right side)	E: 974620 N: 619298 E: 974895 N: 619354
Begins Catambuco urban area	Ends Catambuco urban area	Sidewalks	Sidewalks Catambuco urban area	0.14km. (left side) 1.70Km. (right side)	E: 976176 N: 620755 E: 976780 N: 622098
Begins Pasto urban area	Ends Pasto urban area	Sidewalks	Sidewalks Pasto urban	0.699Km. (right side)	E: 977815 N: 622923 E: 977560 N: 623521

Source 1 Appendix Technical Consortium and SH

Sidewalks and footpaths should have a minimum width of 1.0m and between 0.10 to 0.25m of elevation relative to the crown.

- Central divider

The central divider consists of a triangular ditch, one meter (1m) wide, accompanied by green areas on each side for a total width of 2mm. (See Figure 3.11.)

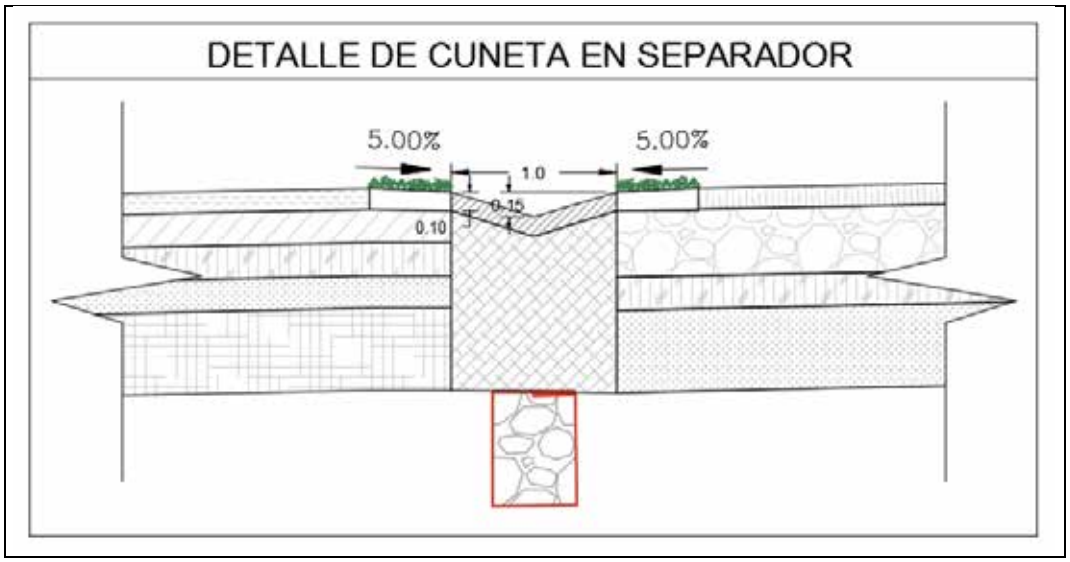

Figure 3.11. Cross section of the central divider
Source Consortium SH 2016

o Chamfers line

This corresponds to the top view of the edges of the earthworks or lines connecting the consecutive chamfer stakes. These lines indicate how far the earthworks extend laterally due to cuts or embankments determining the need for any additional land purchase and preliminary identification of containment structures requirements. (See Annexes 3.2.3.1-a and 3.2.3.1-b)

- *Transport infrastructure of the project*

Transport infrastructure corresponds to the components of the work whose purpose is to allow movement of vehicles in terms of continuity in space and adequate levels of efficiency, safety and comfort.

The Pedregal - Catambuco dual carriageway road between functional unit UF-4 K00+000 and functional unit UF-5 subsector 1 PK 32 + 700, involves the construction of two (2) exchangers, three (3) viaducts five (5) returns, (1) pedestrian bridge and tolls installed on K06 + 200.

- Roads

Based on the geometric design parameters framed in the contract's Technical Appendix, the set of design parameters discussed below is adopted. (See Table 3.12. Design Overview UF-4 and UF-5.).

Table 3.12. Design Overview UF-4 and UF-5

Parameter	Functional Unit 4	Functional Unit 5
	Pedregal-Tangua	Subsector 1 Tangua-Exchanger Variant South East Pasto Relief Road
Design speed	60 Km. / H	60 Km. / H
Design vehicle	C3S2	C3S2
Minimum bend radius	113 m	113 m
Maximum camber	8%	8%
Relative slope of the camber ramp	0.60%	0.60%
Minimum spiral length	49 m	49 m
Maximum slope	7% (exceptionally> 7%)	7% (exceptionally> 7%)
Minimum longitudinal slope	0.30%	0.30%
Percentage of length of the exemption section to maximum slope	19.67%	9.76%
Minimum length of vertical curvature	36 m	36 m
Number of lanes per carriageway	2	2
Track width	3.65 m	3.65 m
Internal berm width	0.50 m	0.50 m
Outer berm width	1.80 m	1.80 m

Source Consortium SH 2016

ü Geometric design plan and cross section profiles

Ø Design speeds

The design speed is the most important parameter for development of the geometric design studies of the road; characteristics of the road at the design stage and should ensures safety and comfort to the user. Therefore, for the Pedregal- Catambuco corridor in functional unit 4 Pedregal - Tangua and functional unit 5 subsector 1 Tangua- South Exchanger Eastern Pasto Relief Road, which corresponds to a national first order two carriageways highway with a steep mountainous to rugged terrain topographical features, and in accordance with provisions of the Technical Appendix to the Contract a design speed of 60 km / h. will be used.

Ø Maximum camber

According to Standard provisions, maximum camber value for Primary roads is eight percent (8%), which allows maintaining acceptable specific curve speeds (VCH) without inconveniencing vehicles in curves with minimum radii.

Ø Camber ramps

Based on the relative difference between the inclination of the longitudinal axis of the road and the inclination of its edge, the minimum slope of the camber ramp is 0.37% considering that the distance from the axis to the edge of the rail is 3.65m, while the maximum is 0.60% for the design speed of 60 Km. / h.

Ø Minimum turning radius

In accordance with the Speed parameter design and maximum camber design, a minimum turning radius of 113m for a speed of 60Km. / H has been established.

Ø Transition curves

Given the speed of the section and maximum camber for a minimum bend radius of 113m with an 8.0% camber, the minimum spiral length is 49mm, with criteria envelope established in the Geometric Design of Roads Manual recommendations.

This criterion becomes valid when the curve presents a critical condition from having the minimum radius and the maximum camber, otherwise the length of the spiral is

calculated as appropriate for each case considering that the larger the radius of curvature the lower the length of the transition curve.

Ø Minimum intertangency

For curves of different directions: When using spiral curves, the intertangency section can be eliminated; being circular curves, the distance travelled in 5 seconds (5 s) is considered to the lessr of the Specific Speeds (VCH) of adjacent curves to the intertangency under study.

For curves in the same direction: in designs with spiral curves the intertangency is not less than the distance in a time of 5 seconds at A Specific Rate of the Horizontal intertangency (VETH) under study; if they are not incorporated in the design of transition curves a minimum intertangency of 15 seconds to the lesser of the Specific Speed of the Horizontal intertangency (VETH) is considered.

Ø Maximum intertangency

Sufficiently long intertangency are condition that would meet the Overtaking Visibility Distance (Da), but in cases that these distances are exceeded for specific design reasons to ensures that the maximum length of line is not greater than fifteen times the lesser of the Specific Speeds (VCH) of adjacent horizontal curves. This criterion applies equally to curves in the same direction as curves in different directions.

Compliance with this parameter is restricted by development of the current corridor where situations arise outside the recommendations of the Manual where, if full compliance is followed, the existing corridor could not be used as part of the dual carriageway.

Ø Longitudinal slope

The minimum slope set by the manual design is 0.5% as recommended minimum slope and zero point three per cent (0.3%) for design on flat ground or places where it is not possible to design the desired minimum slope, considering that lower slopes could be projected provided they are justified.

Based on provisions of the Contract's Technical Appendix, a maximum longitudinal slope of 7.0% is established, which exceptionally may be exceeded provided the application length of higher slopes does not exceed the percentages stipulated in the Scope of the contract which, for Functional Unit 4 Pedregal-Tangua is stipulated in 19.67% of the total length of the section and for Functional Unit 5 Subsector 1 Tangua-south exchanger eastern Pasto relief road, application of slopes exceeding the recommended in the Manual Highway is equal to 9.76% of the total length of this subsector.

Ø Minimum length of the vertical curve

Based on safety criteria of stop visibility (K) and the speed described in the Geometric Design Manual, the minimum length of vertical curve for a design speed of 60 km. / H is 36mm.

ü Pavement structure

After performing the analysis with the AASHTO / 93 design method, it was verified by the rational method for designing pavement structures and in order to ensure proper performance for 10 years for flexible pavements, horizontal unit deformation were analyzed for two alternatives (conventional granular base and stabilized granular base emulsion) in the lower fiber asphalt and vertical effort on the subgrade for traffic loads mentioned.

For rigid pavements a period of 20 years design was considered, following the recommendations of the PCA and its effectiveness was analyzed using the PCA proposed methodology (see Annex 3.2.3.1-z)

Ø Flexible pavement

After the analysis performed with the AASHTO / 93 design method, it was verified by the rational method determining the most likely alternative for the project. This alternative is described below:

Alternative - Flexible Pavement Conventional structure: asphalt layer + Granular base + Granular Subbase.

As a result of the design six types of pavement structures were obtained due to the variation of the CBR along the UF4.

Figure 3.13 to Figure 3.16 presents pavement designs structures.

e(cm.)		METODO AASHTO								e(cm.)			MET. RACIONAL			
		PARAMETROS DE RESISTENCIA											P. RESISTENCIA		Deformación unitaria	Deformación unitaria
		a	PRUEBA			E	H	m	SN				CBR (%)	E (Kg/cm^2)		
			Descip	Un.	Valor	(Kg/cm^2)	(in.)									
13	CA	0,40		%		38.000	5,12	1	2,05	13	CA	K= 10		38.000	2,26E-04	
16	BASE	0,14	CBR	kg/cm^2	100	2.130	6,30	0,9	0,79	16	BASE			2.130		
20	SUB-BASE	0,12	CBR	%	40	1.124	7,87	0,8	0,76	20	SUB-BASE			1.124		
	SR		CBR	%	22,20	1.301					SR		22,20	1.301		2,32E-04
		SN					3,60									
# EJES EQUIVALENTES						13.866.405									14.502.194	67.131.328
# EJES EQUIVALENTES ESTIMADOS						**13.305.197**									**13.305.197**	

Figure 3.12. Proposed structure diagram for K0 + 980 Sector - K3 + 750

Source Consortium SH 2017

e(cm.)		METODO AASHTO								e(cm.)			MET. RACIONAL			
		PARAMETROS DE RESISTENCIA											P. RESISTENCIA		Deformación unitaria	Deformación unitaria
		a	PRUEBA			E	H	m	SN				CBR (%)	E (Kg/cm^2)		
			Descip	Un.	Valor	(Kg/cm^2)	(in.)									
13	CA	0,40		%		38.000	5,12	1	2,05	13	CA	K= 10		38.000	2,21E-04	
15	BASE	0,14	CBR	kg/cm^2	100	2.130	5,91	0,9	0,74	15	BASE			2.130		
20	SUB-BASE	0,12	CBR	%	40	1.124	7,87	0,8	0,76	20	SUB-BASE			1.124		
	SR		CBR	%	38,50	1.850					SR		38,50	1.850		1,80E-04
		SN					3,55									
# EJES EQUIVALENTES						28.576.916									16.254.558	186.918.312
# EJES EQUIVALENTES ESTIMADOS						**13.305.197**									**13.305.197**	

Figure 3.13. Proposed structure diagram for K4 + 250 Sector - K5 + 420

Source Consortium SH 2017

e(cm.)		METODO AASHTO								e(cm.)			MET. RACIONAL			
		PARAMETROS DE RESISTENCIA					H	m	SN				P. RESISTENCIA		Deformación unitaria	Deformación unitaria
		a	PRUEBA			E							CBR	E		
			Descip	Un.	Valor	(Kg/cm^2)	(in.)						(%)	(Kg/cm^2)		
13	CA	0,40		%		38.000	5,12	1	2,05	13	CA	K= 10		38.000	2,28E-04	
20	BASE	0,14	CBR	kg/cm^2	100	2.130	7,87	0,9	0,99	20	BASE			2.130		
28	SUB-BASE	0,12	CBR	%	40	1.124	11,02	0,8	1,06	28	SUB-BASE			1.124		
	SR		CBR	%	11,90	873					SR		11,90	873		2,53E-04
		SN					4,10									

# EJES EQUIVALENTES	13.523.512	13.816.784	47.467.362
# EJES EQUIVALENTES ESTIMADOS	**13.305.197**	**13.305.197**	

Figure 3.15. Proposed structure diagram for K6 + 600 Sector - K7 + 230

Source Consortium SH 2017

e(cm.)		METODO AASHTO								e(cm.)			MET. RACIONAL			
		PARAMETROS DE RESISTENCIA					H	m	SN				P. RESISTENCIA		Deformación unitaria	Deformación unitaria
		a	PRUEBA			E							CBR	E		
			Descip	Un.	Valor	(Kg/cm^2)	(in.)						(%)	(Kg/cm^2)		
13	CA	0,40		%		38.000	5,12	1	2,05	13	CA	K= 10		38.000	2,28E-04	
20	BASE	0,14	CBR	kg/cm^2	100	2.130	7,87	0,9	0,99	20	BASE			2.130		
27	SUB-BASE	0,12	CBR	%	40	1.124	10,63	0,8	1,02	27	SUB-BASE			1.124		
	SR		CBR	%	12,80	914					SR		12,80	914		2,50E-04
		SN					4,06									

# EJES EQUIVALENTES	14.120.806	13.969.084	50.187.433
# EJES EQUIVALENTES ESTIMADOS	**13.305.197**	**13.305.197**	

Figure 3.14. Proposed structure diagram for sector K9 + 300 - K10 + 640

Source Consortium SH 2017

e(cm.)		METODO AASHTO								e(cm.)			MET. RACIONAL			
		PARAMETROS DE RESISTENCIA					H	m	SN				P. RESISTENCIA		Deformación unitaria	Deformación unitaria
		a	PRUEBA			E							CBR	E		
			Descip	Un.	Valor	(Kg/cm^2)	(in.)						(%)	(Kg/cm^2)		
13	CA	0,40		%		38.000	5,12	1	2,05	13	CA	K= 10		38.000	2,26E-04	
16	BASE	0,14	CBR	kg/cm^2	100	2.130	6,30	0,9	0,79	16	BASE			2.130		
20	SUB-BASE	0,12	CBR	%	40	1.124	7,87	0,8	0,76	20	SUB-BASE			1.124		
	SR		CBR	%	22,00	1.293					SR		22,00	1.293		2,32E-04
		SN					3,60									
# EJES EQUIVALENTES							13.681.326								14.502.194	67.131.328
# EJES EQUIVALENTES ESTIMADOS							13.305.197								13.305.197	

Figure 3.15. Proposed structure diagram for sector K14 + - 200 - K19 +220

Source Consortium SH 2017

For sectors where subgrade improvement was required, the pavement structure shown in Figure 3.16 was established.

e(cm.)		METODO AASHTO					H	m	SN	e(cm.)			MET. RACIONAL			
		PARAMETROS DE RESISTENCIA											P. RESISTENCIA		Deformación unitaria	Deformación unitaria
		a	PRUEBA			E							CBR	E		
			Descip	Un.	Valor	(Kg/cm^2)	(in.)						(%)	(Kg/cm^2)		
13	CA	0,40		%		38.000	5,12	1	2.05	13	CA	K= 10		38.000	2,29E-04	
20	BASE	0,14	CBR	kg/cm^2	100	2.130	7,87	0,9	0,99	20	BASE			2.130		
32	SUB-BASE	0,12	CBR	%	40	1.124	12,60	0,8	1,21	32	SUB-BASE			1.124		
Variable	MEJORAMIENTO SUBRASNTE		CBR	%	10,00	781				Variable	MEJORAMIENTO SUBRASNTE		10,00	781		2,54E-04
		SN					4,25									
# EJES EQUIVALENTES							13.490.918								13.547.634	46.504.153
# EJES EQUIVALENTES ESTIMADOS							13.305.197								13.305.197	

Figure 3.16. Proposed structure diagram on improving subgrade

Source Consortium SH 2017

Similarly, as a design result for UF5, two types of pavement structures were obtained due to the CBR variation.

Figure 3.13 and Figure 3.16 present pavement structure designs.

e(cm.)		METODO AASHTO							e(cm.)			MET. RACIONAL			
		PARAMETROS DE RESISTENCIA				H	m	SN				P. RESISTENCIA		Deformación unitaria	Deformación unitaria
		a	PRUEBA		E							CBR	E		
			Descip	Un.	Valor	(Kg/cm^2)	(in.)					(%)	(Kg/cm^2)		
13	CA	0,41		%		5,12	1	2,10	13	CA	K= 10		40.000	2,170E-04	
23	BASE	0,14	CBR	kg/cm^2	100	9,06	0,9	1,14	23	BASE			2.121		
28	SUB-BASE	0,12	CBR	%	40	11,02	0,8	1,06	28	SUB-BASE			1.122		
	SR		CBR	%	12,78	913				SR		12,78	913		2,30E-04
			SN				4,30								
# EJES EQUIVALENTES						21.061.803								13.775.703	70.104.584
# EJES EQUIVALENTES ESTIMADOS						13.305.197								13.305.197	

Figure 3.17. Proposed structure diagram for sector K15 + 722 - K19 + 200

Source Consortium SH 2017

e(cm.)		METODO AASHTO							e(cm.)			MET. RACIONAL			
		PARAMETROS DE RESISTENCIA				H	m	SN				P. RESISTENCIA		Deformación unitaria	Deformación unitaria
		a	PRUEBA		E							CBR	E		
			Descip	Un.	Valor	(Kg/cm^2)	(in.)					(%)	(Kg/cm^2)		
13	CA	0,41		%		5,12	1	2,10	13	CA	K= 10		40.000	2,180E-04	
23	BASE	0,14	CBR	kg/cm^2	100	9,06	0,9	1,14	23	BASE			2.121		
35	SUB-BASE	0,12	CBR	%	40	13,78	0,8	1,32	35	SUB-BASE			1.122		
	SR		CBR	%	10,00	781				SR		10,00	781		2,26E-04
			SN				4,56								
# EJES EQUIVALENTES						22.475.279								13.462.631	74.549.275
# EJES EQUIVALENTES ESTIMADOS						13.305.197								13.305.197	

Figure 3.20. Proposed structure diagram on improving subgrade

Source Consortium SH 2017

Pavement structures considered for the new pathway of Functional Unit 4 and 5 are summarized in

Table 3.13 Pavement structure thicknesses UF-4 and Table 3.14. Pavement structure thicknesses UF-5 that show the thicknesses of the granular layers and the paving.

Table 3.13 Pavement structure thicknesses UF-4

Section				Subgrade improvement				New pavement structure				Extension					Rehabilitation			
Abscissa		PR		CBR Representational	AFIRMADOART.311A-38		TOTAL Improvement (cm)	SBG (cm)	BG (cm)	CA (cm) 450 ART		Improvement (cm)	SBG (cm)	BG (cm)	CA (cm) 450 ART		Granular Remnants (cm)	BG (cm) ART. 330-13 Class BG-27	CA (cm) 450 ART	
Start	End	Start	End		CBR	Eng. (Cm)		ART. 320Clase A SBG-38	ART. 330Clase A BG-27	MDC - 25	MDC-19		ART. 320Clase A SBG-38	ART. 330Clase A BG-27	MDC - 25	MDC-19			MDC - 25	MDC-19
K0 + 025	K0 + 980	PR43 + 250	PR44 + 130	8.9	8.9	18	18	32	20	8	5	18	32	20	8	5	52.2	15	8	5
K0 + 980	K3 + 750	PR44 + 130	PR47 + 080	22,2				20	16	8	5		20	16	8	5	52.2	15	8	5
K3 + 750	K4 + 250	PR47 + 080	PR47 + 580	8.6	8.6	22	22	32	20	8	5	22	32	20	8	5	52.2	15	8	5
K4 + 250	K5 + 420	PR47 + 580	PR48 + 780	38.5				20	15	8	5		20	15	8	5	52.2	15	8	5
K5 + 420	K6 + 600	PR48 + 780	PR50 + 040	4.9	4.90	41	41	32	20	8	5	41	32	20	8	5	52.2	15	8	5
K6 + 600	K7 + 230	PR50 + 040	-	11.9				28	20	8	5		28	20	8	5	52.2	15	8	5
K7 + 230	K7 + 860	-	PR52 + 570	6.5	6.5	33	33	32	20	8	5	33	32	20	8	5	52.2	15	8	5
K7 + 860	K9 + 300	PR52 + 570	PR53 + 560	8.0	8.0	25	25	32	20	8	5	25	32	20	8	5	52.2	15	8	5
K9 + 300	K10 + 640	PR53 + 560	PR54 + 960	12.8				27	20	8	5		27	20	8	5	52.2	15	8	5
K10 + 640	K13 + 400	PR54 + 960	PR57 + 720	8.5	8.5	22	22	32	20	8	5	22	32	20	8	5	52.2	15	8	5
																	53.6	15	8	5
K13 + 400	K14 + 220	PR57 + 720	PR58 + 470	6.2	6.2	36	36	32	20	8	5	36	32	20	8	5	53.6	15	8	5
K14 + 220	K15 + 753	PR58 + 475	PR63 + 825	22.0				20	16	8	5		20	16	8	5	53.6	15	8	5

Source Consortium SH 2017

Table 3.14. Pavement structure thicknesses UF-5

Section				Subgrade improvement						New pavement structure				Extension				Rehabilitation				
Abscissa		PR		CBR Representational	LAVISH ART. 221-13Tabla 221-1 Dmax = 20cm		AFIRMADOART. 311-13A-38		TOTAL IMPROVING (cm)	SBG (cm)	BG (cm)	CA (cm) 450-13 ART		SBG (cm)	BG (cm)	CA (cm) 450-13 ART		Granular Remnants (cm)	Existing Asphalt Binder (cm)	BG (cm)	CA (cm) 450-13 ART	
Start	End	Start	End		CBR	Eng. (Cm)	CBR	Eng. (Cm)		ART. 320-13Clase A SBG-38	ART. 330Clase A BG-27	MDC - 25	MDC-19	ART. 320Clase A SBG-38	ART. 330Clase A BG-27	MDC - 25	MDC-19			ART. 330Clase A BG-27	MDC - 25	MDC-19
K15 + 722	K19 + 200	PR58 + 475	PR63 + 825	12.8	-	-	-	-	-	28	2. 3	5	8	35	2. 3	8	5	53.6	-	15	8	5
																		59.5	-	21	8	5
K19 + 200	K20 + 800	PR63 + 825	PR65 + 440	8.6	-	-	8,60	22	22	35	2. 3	5	8	35	2. 3	8	5	59.5	-	21	8	5
K20 + 800	K21 + 900	PR65 + 440	PR66 + 570	7.0	-	-	7.00	30	30	35	2. 3	5	8	35	2. 3	8	5	59.5	-	21	8	5
																		83.9	-	15	8	5
K21 + 900	K23 + 400	PR66 + 570	-	4.8	-	-	4.80	42	42	35	2. 3	5	8	35	2. 3	8	5	83.9	-	15	8	5
K23 +	K24 +	-	PR68 +	4.5	-	-	4.54	44	44	35	2. 3	5	8	35	2. 3	8	5	83.9	-	15	8	5

400	000		800																			
K24 + 000	K24 + 700	PR68 + 800	PR69 + 480	6.7	-	-	6.71	32	32	35	2. 3	5	8	35	2. 3	8	5	83.9	-	15	8	5
K24 + 700	K25 + 400	PR69 + 480	PR70 + 170	2.2	2.20	17	3.0	53	70	35	2. 3	5	8	35	2. 3	8	5	83.9	-	15	8	5
																		100.8	-	15	7	5
K25 + 400	K25 + 700	PR70 + 170	PR70 + 470	4.5	-	-	4,55	43	43	35	2. 3	5	8	35	2. 3	8	5	100.8	-	15	7	5
K25 + 700	K25 + 900	PR70 + 470	PR70 + 670	8.2	-	-	8.2	24	24	35	2. 3	5	8	35	2. 3	8	5	100.8	-	15	7	5
K25 + 900	K26 + 200	PR70 + 670	PR70 + 990	5.3	-	-	5.28	40	40	35	2. 3	5	8	35	2. 3	8	5	100.8	-	15	7	5
K26 + 200	K27 + 400	PR70 + 990	PR72 + 200	0.9	0.9	30	3	53	83	35	2. 3	5	8	35	2. 3	8	5	100.8	-	15	7	5
K27 + 400	K29 + 600	PR72 + 200	PR74 + 500	1.8	1,82	20	3	53	73	35	2. 3	5	8	35	2. 3	8	5	83.8	-	18	8	5
																		118.0	-	20	7	5
K29 + 600	K30 + 500	PR74 + 500	PR74 + 420	5.0	-	-	5.0	41	41	35	2. 3	5	8	35	2. 3	8	5	118.0	-	20	7	5
K30 + 500	K30 + 900	PR74 + 420	PR74 + 820	2.3	2,32	16	3	53	69	35	2. 3	5	8	35	2. 3	8	5	118.0	-	20	7	5
K30 + 900	K32 + 000	PR74 + 820	PR76 + 940	5.1	-	-	5.1	41	41	35	2. 3	5	8	35	2. 3	8	5	118.0	-	20	7	5
K32 + 000	K32 + 700	PR76 + 940	Pr77 + 650	4.3	-	-	4.3	45	45	35	2. 3	5	8	35	2. 3	8	5	118.0	-	20	7	5
K32 + 700	K35 + 080	Pr77 + 700	PR80 + 000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	104.0	16	-	7	5
K35 + 080	K37 + 950	PR80 + 000	PR83 + 040	-	-	-	-	-	-	-	-	-	-	-	-	-	-	94.0	17	-	6	-

Source Consortium SH 2017

Ø Rigid pavement (El Placer Toll)

With parameters and design conditions by PCA method, and for a given thickness of slab, the fatigue and erosion analysis was conducted; according to the analyzes it is concluded that, with a thickness of 28 cm, traffic loads are supported for a design period of 20 years.

Ø High module mixtures

In the area close to the entrance roundabout to the Pedregal town, due to reduced operational speed and high temperature, to prevent rutting and asphalt concrete deformation, high module asphalt mixtures will be laid (> 10000 MPa) in an approach sector 300 m before and after the roundabout. Given the short length required, the thickness of asphaltic concrete established in the designs will remain.

3.2.3.2 Road project structures

o Tunnels

There are no tunnels built in the designs for project implementation in Functional Units 4 and 5.

o Bridges and viaducts

Functional unit UF-4 foresees the construction of 3 structures between bridges and viaducts and Functional unit UF5 does not foresee building bridges or viaducts due to the topography. (See Table 3.15. UF- 4 and UF-5.).

Table 3.15. UF- 4 and UF-5 bridges

UF	Name	Abscissa	Length (m)	Description
UF-4	Roundabout Bridge-Easter Pedregal	K 02 + 150	31.3	Elevated roundabout
	Roundabout Bridge-Western Pedregal	K 02 + 150	31.3	Elevated roundabout
UF-4	Guáitara Bridge Right Margin	K 03 + 000	309.85	Right roadway
	Guáitara Bridge Left Margin	K 03 + 000	280.57	Left roadway
UF-4	Bridge connection	K 08 + 600	36.54	It is the Pedregal-Pasto direction over the main corridor to connect with the existing road

Source SH Consortium

ü Roundabout bridges Pedregal relief road

This corresponds with two curved bridges that are part of the elevated roundabout in the Pedregal town center K2 + 130 - K2+ 180, with a 31.3 m clearance approximately.

The roundabout will allow connecting with the town center, accesses are foreseen from the dual carriageway in the Rumichaca - Pedregal direction and inversely in the Pedregal - Pasto direction whereby, in a minor development existing movements are solved to and from the center village, and will be built as a return option in this point (see Figure 3.18 and appendixes 3.2.3.1-p, 3.2.3.1-q, 3.2.3.1-r and 3.2.3.1-s).

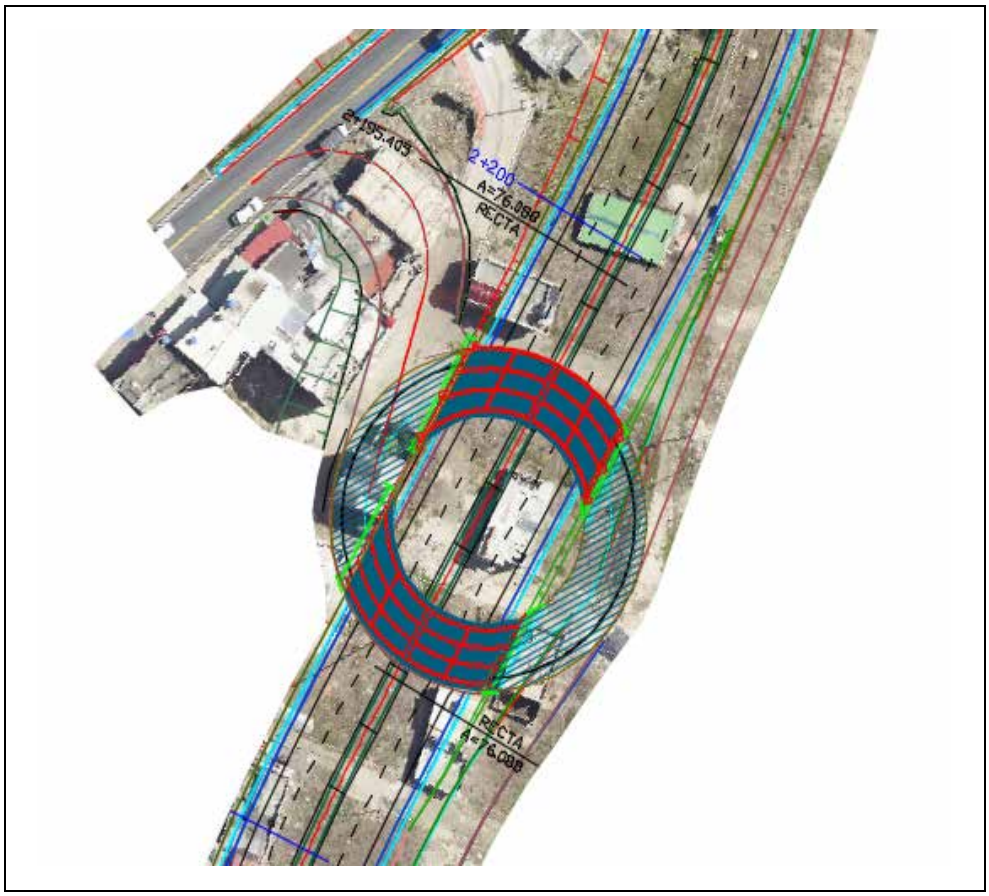

Figure 3.18 Bridge roundabout Pedregal relief road

Source Consortium SH 2017

ü Viaduct over the Guáitara River

The viaduct over the Guáitara River is located between abscissa K2 + 780 - K3 + 080 on the right carriageway and K2 + 780 - K3 + 059 left carriageway of the main corridor, whereby the river crossing will be saved as well as the intermountain valley of the Guaitara River.

The relationship between water body width and length of the structure is about 1/10, so the crossing acquires the status of viaduct markedly decreasing the actual and

potential impacts on water, water body and the riparian round of the Guáitara River and less intervention on the slopes of the intermountain valley.

Its planimetric configuration, shown in Figure 3.19, corresponds to a 175.15 m curve along the axis of the separator, steepness of 7.2%; while vertically handling a longitudinal slope of -2.3%, relatively low with four pillars to support the superstructure, as shown in Figure 3.20.

Annexes 3.2.3.1-t, 3.2.3.1-u, 3.2.3.1.v and 3.2.3.1-w show designs and plant-profile of this viaduct.

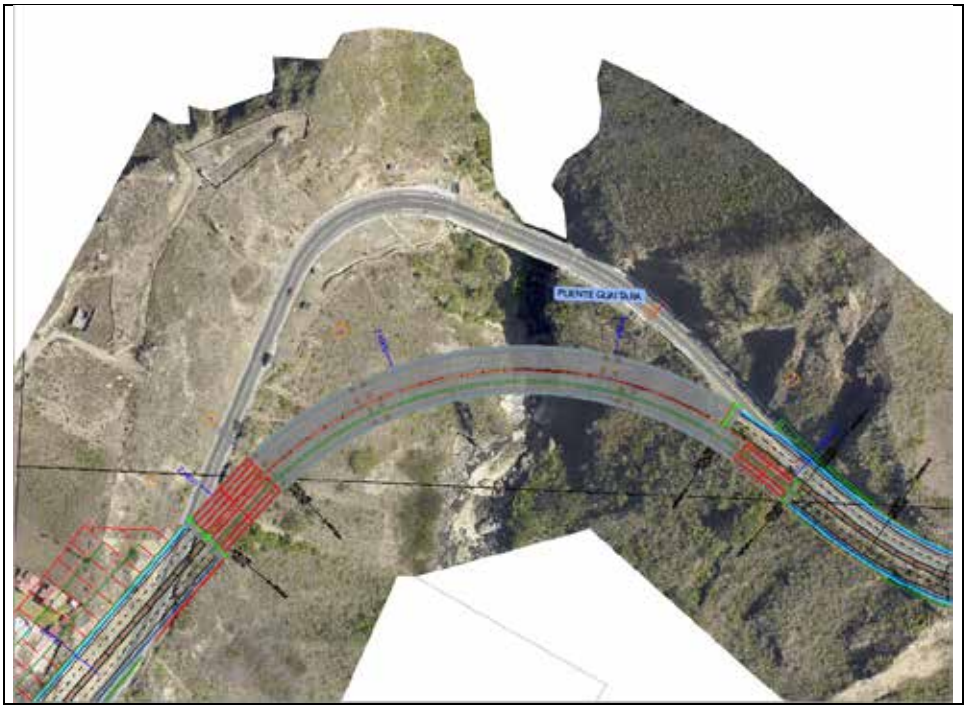

Figure 3.19 Viaduct on the Guáitara River

Source Consortium SH 2017

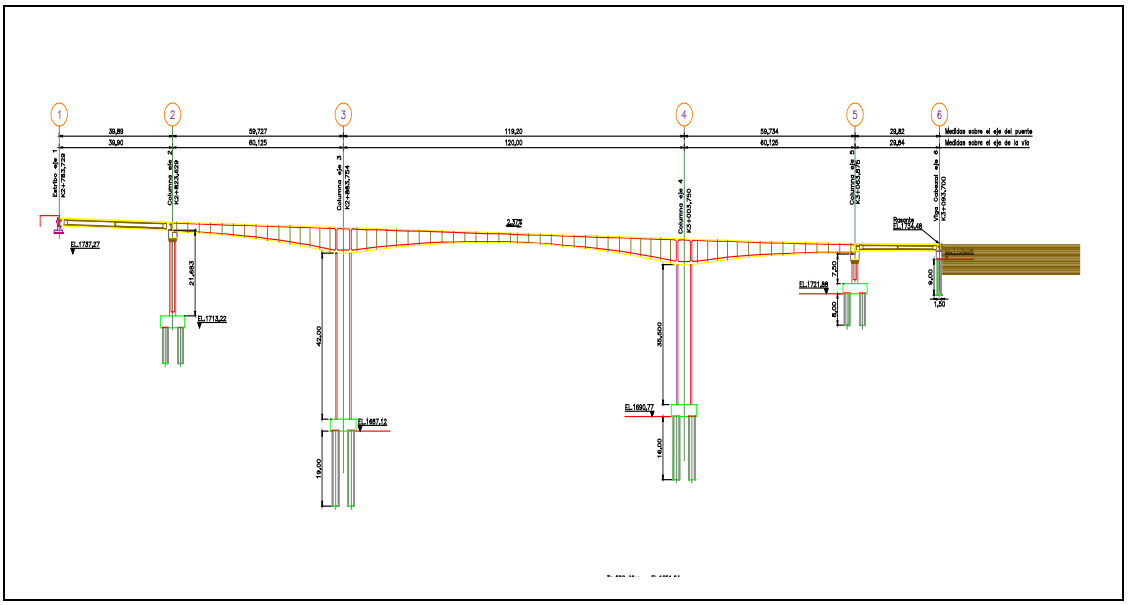

Figure 3.20 Profile Viaduct on the Guáitara river

Source Consortium SH 2017

ü Structure on the La Magdalena stream

This refers to the structure built to cross the La Magdalena stream water body and the intermountain valley, located in the k + 7 of abscissa 000 of the new road corridor.

The stream will cross a box culvert type structure of circular section, on which an embankment will be developed to allow reusing road excavation materials as shown in Figure 3.21 showing plan view construction and in Figure 3.22 showing the section along the axis of projected path.

Follows the design drawings for the Magdalena structure.

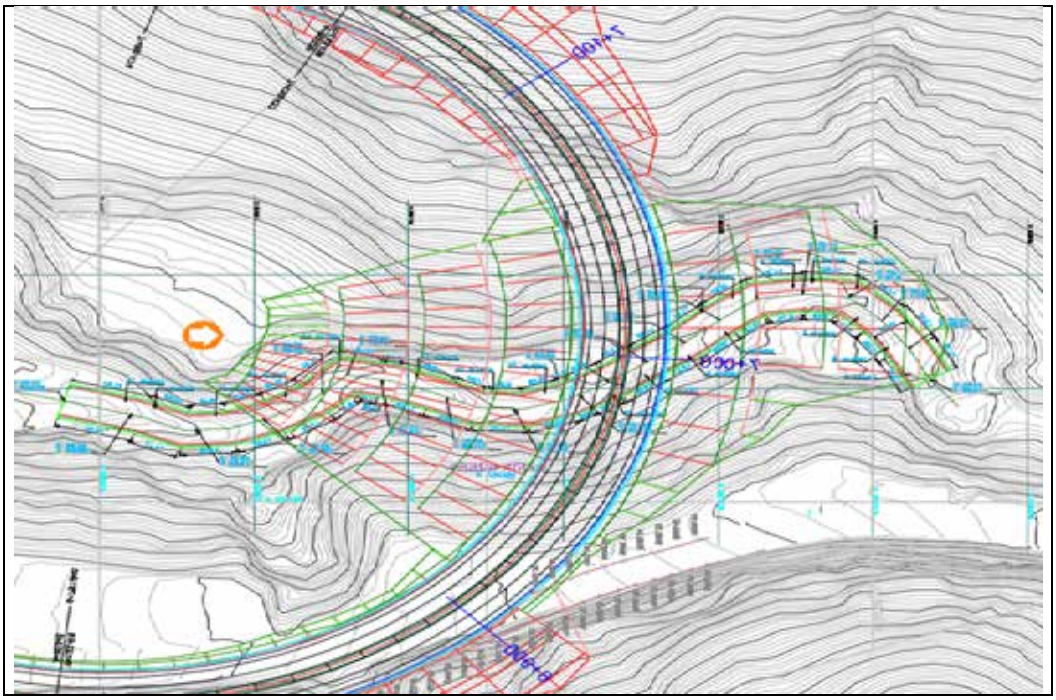

Figure 3.23 Structure plant on the La Magdalena Stream

Source Consortium SH 2017

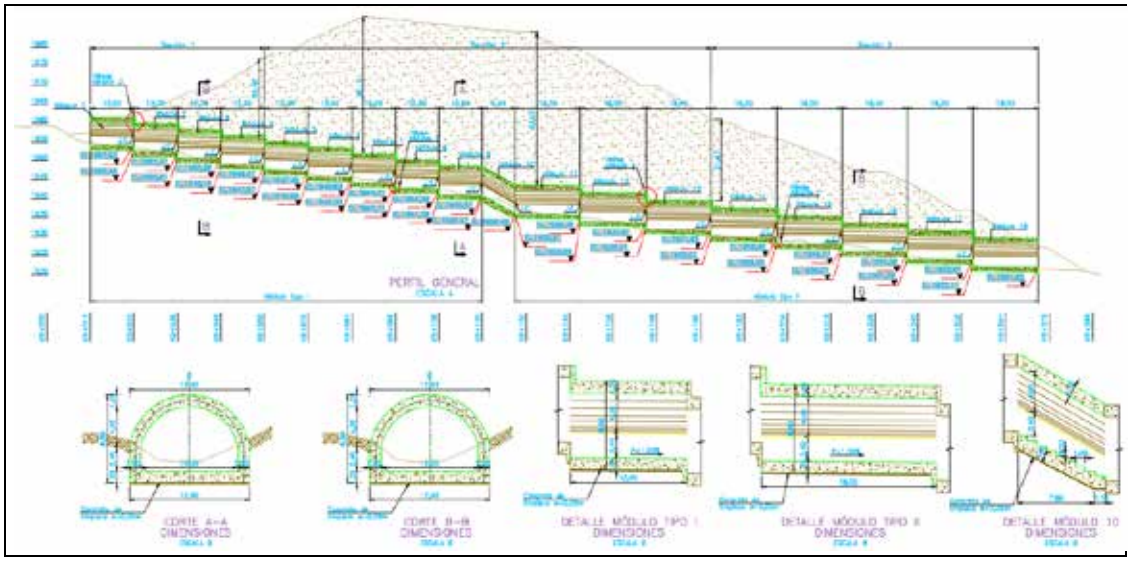

Figure 3.24 Profile structure Magdalena Stream (road axis)

Source Consortium SH 2017

ü Connecting bridge K8 + 600

This bridge corresponds to the connection on abscissa K8 + 600 where the Pedregal - Pasto direction branch rises above the main corridor to connect with the existing road, with a length of 36.54 m in a straight alignment in plan view and in profile with a longitudinal slope of 1.9%.

A trumpet-shaped overpass is projected in order to ensure the connection of those traveling on the current corridor between PR50 + 320 and PR54 + 690, with a Pedregal - PR52 +900 (current road) branch taking-off from the dual carriageway which rises above the main corridor to connect to the existing road, this branch will also allow connection in the PR52 + 900 (current road) – Pasto direction.

The existing road to Pedregal and Pasto is accessed in the connection with the dual carriageway through speed change lanes.

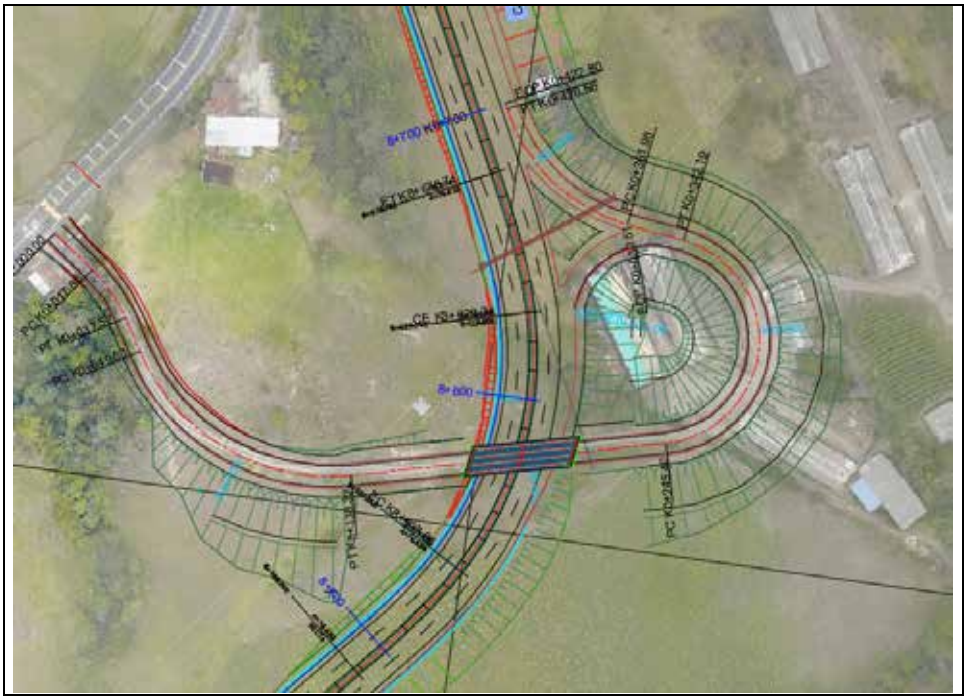

Figure 3.256 Bridge K8 + 60 connection

Source Consortium SH 2017

o Bavaria Footbridge

Based on technical appendix 1, 1 footbridge will be installed in the functional unit 5 sub-sector 1; the footbridge is forecasted in abscissa K31 + 300 between the La Merced and Vocacional counties of the Catambuco province, municipality of Pasto. The location of the bridge is close to the La Merced School. (See Annex 3.2.3.1-c).

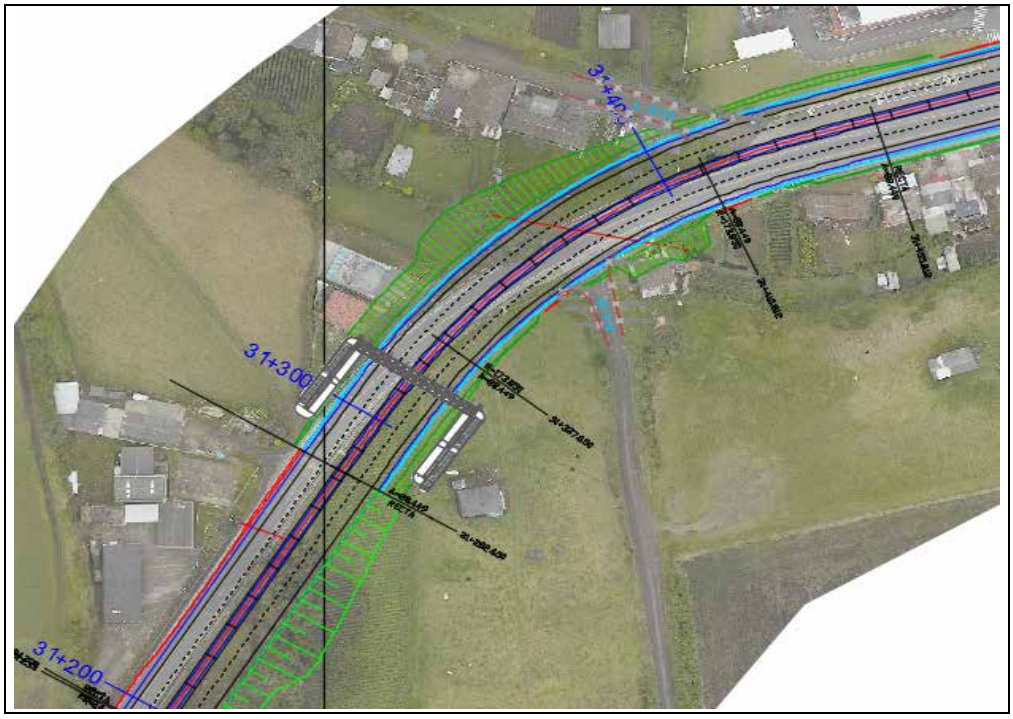

Figure 3.27. Bavaria Footbridge K31 + 300
Source Consortium SH 2017

- Level or sloping intersections

In the project's functional units UF4 and UF5 it a road interchange is planned in the town center of Pedregal with a roundabout type elevated intersection and a sloped trumpet type intersection in connection of the dual carriageway to the existing road in PR 52 + 900 (current road).

ü Pedregal road exchanger

The exchanger is located between abscissa K1 + 750 - K2 + 300 of the main road, located on the right side of the current urban development of the population center of Pedregal (PR45 + 0300); the design also foresees an elevated roundabout maintaining free flow on the main corridor. Giving access to the roundabout that allows the connection to the town center, accesses from the dual carriageway are foreseen in the Ipiales - Pedregal direction and towards it in the Pedregal - Pasto direction, whereby, in a minor developed, existing movements are solved from and to the town center; it will also be built as a return option in this point. (See Figure 3.28. Pedregal road exchanger 28.)

Figure 3.28. Pedregal road exchanger

Source Consortium SH. 2017

ü Connection K8+600

Close to the design abscissa of the main corridor K8+600, a trumpet type overpass is foreseen to guarantee the connection of those travelling on the current corridor between PR50+0320 y PR54+0690, where from the dual carriageway a branch with Pedregal – PR52+0900 (current road) branch taking-off from the dual carriageway which rises above the main corridor to connect to the existing road, this branch will also allow connection in the PR52 + 900 (current road) – Pasto direction.

The existing road to Pedregal and Pasto is accessed in the connection with the dual carriageway through speed change lanes. (See Figure 3.29.)

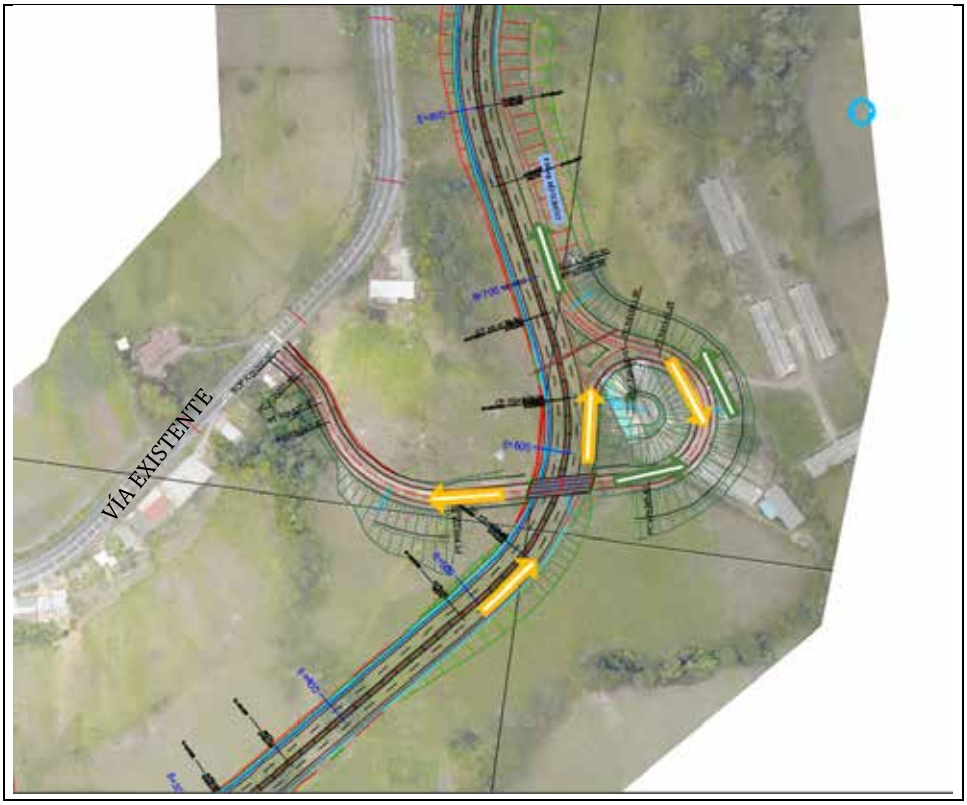

Figura 3.29. Exchanger K8+600
Source Consorcio SH 2017

ü Alberto Quijano relief road K22+600 – 23+800

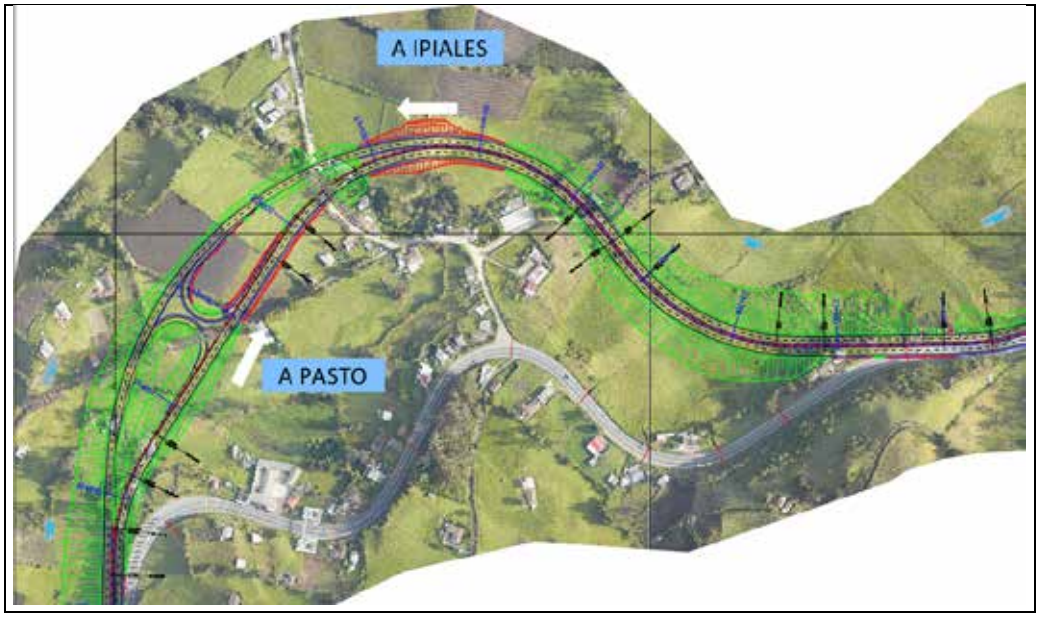

Figure 3.30. Alberto Quijano relief road K22-600 – K23+800
Source Consorcio SH 2017

o Road returns

The project's geometric design for Functional Units UF4 and UF5 considers building 5 road returns (See Table 3., Figure 3., Figure 3.26, Figure 3.27, Figure 3.34 and Figure 3.35).

Table 3.16. Location of the Pedregal – Catambuco section returns

Functional Units	N°	Type	Location
UF4	1	One-way	K12+600 - K13+000 Pasto direction
	2	One-way	K14+050 - K14+500 Rumichaca direction
UF5	1	Oval	K19+000 a K20+000 Entry Yacuanquer and Cebadal
	3	Bowtie	K26+500 – K26+900 Coba Negra
	4	Bowtie	K28+800 – K29+400 La Merced town.

Source Consorcio SH 2017

ü Return K12+800

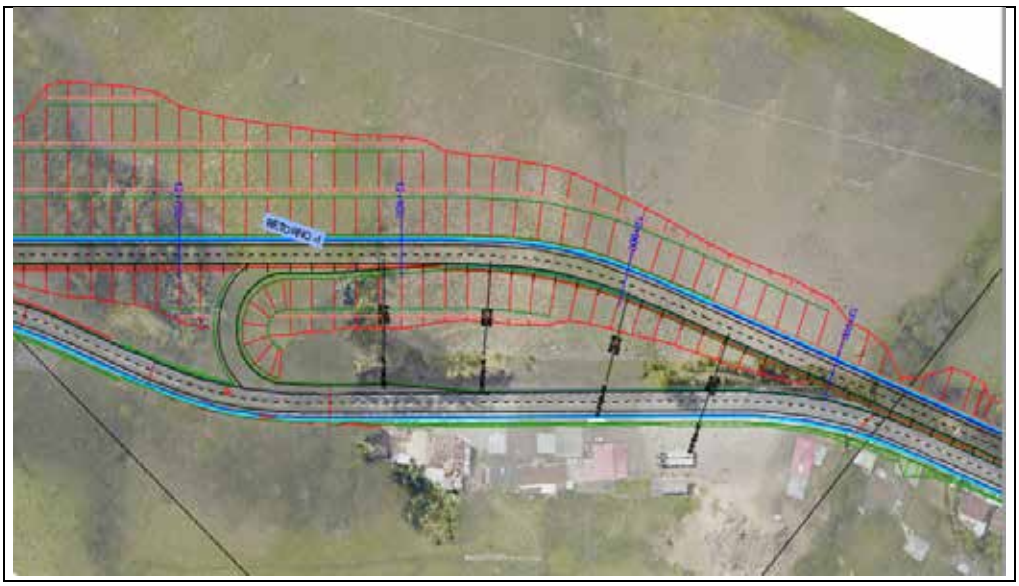

Figure 3.31. Return K12+800

Source Consorcio SH. 2017

ü Return K14+300

Figure 3.26. Return K14+300

Source Consorcio SH 2017

ü Return K19+000 – K20+000 Yacuanquer

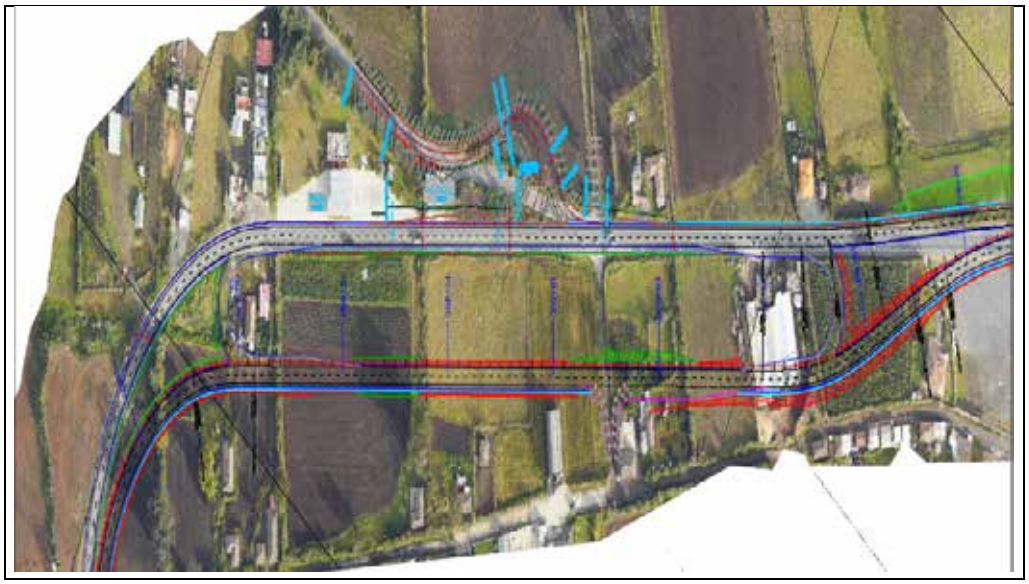

Figure 3.27. Return K19+300 – K19+800 Yacuanquer
Source Consorcio SH 2017

ü Return K26+500 - K26+900

Figure 3.34. Return K26+500 – K26+900

Source Consorcio SH 2017

ü Return K28+800 – K29+400

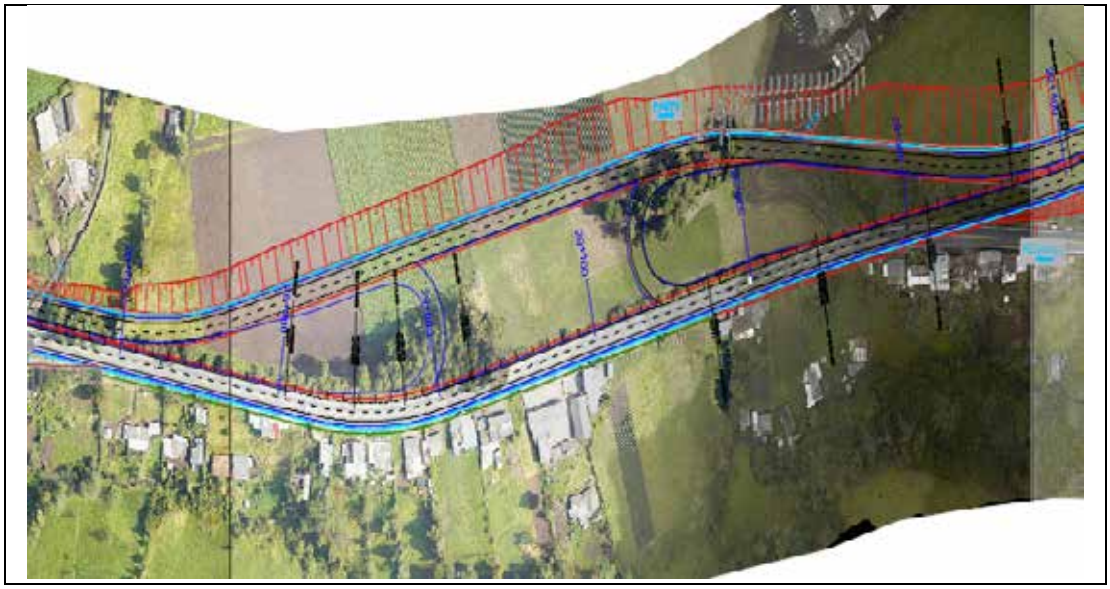

Figure 3.35. Return K28+800 – K29+300

Source Consorcio SH 2017

o Tolls and operation control centers

Currently the El Placer Toll is located on PR56 with three (3) collection bays, however, estimated forecast for the commissioning year of the dual carriageway requires placing seven (7) collection bays (including electronic toll collections) reason why current conditions must be expanded.

Considering the aforesaid and given the topography of the current toll is of high cuts on one side and important fills on the other, the need to relocate the toll arises between abscissas K06+120 and K06+300 (PR49+0700) where there is a broad platform allowing construction in required widths.

The area also includes the Operations Control Center (CCO) and user help. (See Figure 3.36.)

Figure 3.36. El Placer Toll
Source Consorcio SH 2017

- Urban areas works

According to provisions of Appendix Technical 1 (page 15), the Concessionary must perform some special works in urban crossings among which is the construction of sidewalks in the urban area of PR31 + 0700 (K31 + 540 - K32 +160) with an approximate length of 0.080km on the left side and 0.27 km. the right side.

- Crossing with other linear works

According to established guidelines, all existing accesses that were interrupted by project execution, whether access roads to neighborhoods, industries or private land must be conditioned, ensuring population connectivity with the corridor.

Numeral 3.2.3.3 it lists all roads and footpaths that are intercepted by the dual carriageway project in Functional Units 4 and 5.

- Drainage infrastructure

ü Drainage infrastructure

The drainage infrastructure for the Pedregal-Catambuco section provides for building drains such as: sewers pipe or box (box culvert), bridges, culverts and filters necessary to ensure road traffic during maximum intensity hydrologic events and return period. Follows the description of each of these structures.

Ø Transversal drainage

It is appropriate to note that drainage works meet environmental water function, drainage of road pavements and comprehensive environmental stability, reason why they lie along the road complying with provisions of the Ministry of Transport, specifications for road construction and the needs arising from hydrological studies.

As related below in a pathway of the characteristics of the UF-4 and UF-5.1 (Pedregal - Catambuco) it is necessary to construct a large number of sewers and water channels to ensure drainage, which does NOT imply that all are riverbed occupations. In fact, the vast majority are own road design culverts and do not involve water bodies.

The location of the drainage works was made taking into account the natural condition of the various drains, creeks and rivers the road will intercept, preferably seeking that crossing maintain their alignment, however, for topographical reasons minor derivations are presented to their alignments, which are corrected with short routings, and for the shorter length to maintain the natural conditions of the drains. (See Figure 3.37 Alternatives for sewer plant location37.)

Separation between drainage works obeys natural topographical conditions of the sector, generating low points in the project's road geometry, the longitudinal drainage capacity and the continuity of existing drainage works. In particular the development of many of the urban and industrial areas of the project area whose central hub has been the road, generating the need all kinds of services like restaurants, gas stations, parking, etc. that have changed the natural drainage pattern considering new structures and separation of the drainage works.

Two types of inlet structures to the drainage works were considered, depending on the location of the slope with respect to the natural drainage: when the road is in cut the projected inlet structure is box-like in reinforced concrete and when the road it is in fill the projected inlet structure is head type with fins. In some cases in the cut condition structures allowing energy dissipation by conducting the water down the slopes were projected.

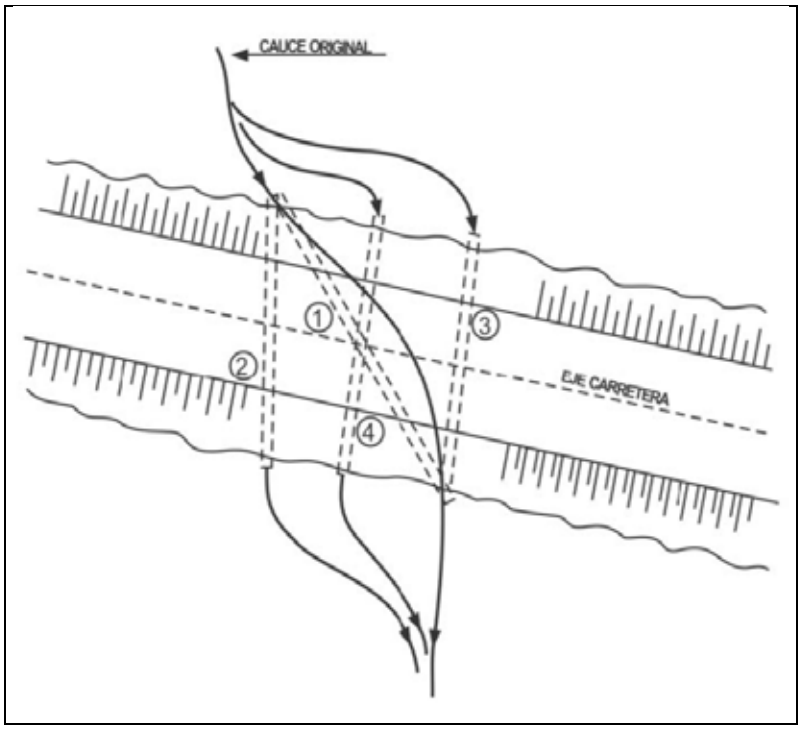

Figure 3.37 Alternatives for sewer plant location

Source DRAINAGE OF ROADS MANUAL

The minimum diameter of all new sewers will be 0.90 m, the existing 0.6 diameter sewers located under the existing roadway will be kept if the following conditions are met:

- Showing no structural damage that could potentially affect the stability of the works.

- Having the required hydraulic capacity in accordance with design established criteria.

- The work is located on the existing road and this road will be kept in the final layout of the new project (referencing the geometric layout manual that states that the existing road will be used as much as possible).

Design flows are presented in hydrological studies in Chapter 5 of this study. Table 3.17. Transversal drainage UF4 and Table 3.3 shows the location of the cross drainage works in functional units 4 and 5.1; as explained at the beginning of this section, most of them do not involve waterways, water bodies or occupations of riverbeds. Annexes 3.2.3.1-1 and 3.2.3.1-2 show drainage works in plan view.

Table 3.17. Transversal drainage UF4

ABSCISSA	TYPE OF WORK	DIMENSION (M)	LENGTH
0 + 035	SEWER	0.9	25.70
0 + 137	BOX CULVERT	2.5 X 2.5	42,00
0 + 232	SEWER	1.2	23.70
0 + 417	SEWER	1.5	24,20
0 + 518	SEWER	0.9	25,90
0 + 603	BOX CULVERT	2.5 X 2.5	30.30
0 + 702	SEWER	0.9	26.20
0 + 808	SEWER	0.9	25,50
0 + 933	SEWER	1.8	24,20
1 + 113	SEWER	1.5	26,10
1 + 193	SEWER	0.9	25,80
1 + 335	SEWER	0.9	24,90
1 + 410	SEWER	0.9	26,00
1 + 496	SEWER	0.9	29,20
1 + 594	SEWER	0.9	28.30
2 + 018	SEWER	1.2	30,50
2 + 283	SEWER	1.8	38.40
2 + 480	SEWER	1.8	24,70
2 + 680	SEWER	1.5	28,00
3 + 095	SEWER	0.9	27,60
3 + 244	SEWER	1.5	24,50
3 + 416	SEWER	1.5	23.20
3 + 632	SEWER	1.2	27.40
3 + 837	SEWER	0.9	22,80
4 + 054	SEWER	1.5	23,10
4 + 233	SEWER	1.2	31,00

4 + 360	SEWER	0.9	34,00
4 + 560	SEWER	1.8	28.70
4 + 673	SEWER	1.5	26.30
4 + 770	SEWER	1.5	22,50
5 + 099	SEWER	0.9	25,80
5 + 300	SEWER	1.8	25.10
5 + 487	SEWER	0.9	22,80
5 + 732	SEWER	0.9	31.60
5 + 915	SEWER	0.9	26,50
5 + 987	SEWER	1.8	28.30
6 + 567	SEWER	1.5	27.20
6 + 659	SEWER	1.5	28.40
7 + 418	SEWER	0.9	30.40
7 + 594	SEWER	1.2	26.15
7 + 795	SEWER	0.9	23,90
7 + 952	SEWER	0.9	22,80
8 + 212	SEWER	1.2	27,00
8 + 420	SEWER	1.2	38.56
8 + 652	SEWER	0.9	52,00
8 + 843	SEWER	0.9	26,10
9 + 079	SEWER	1.2	26,60
9 + 437	SEWER	0.9	26.30
9 + 523	SEWER	0.9	26,00
9 + 647	SEWER	0.9	26,90
9 + 767	SEWER	0.9	33,90
9 + 917	SEWER	1.2	26.20
9 + 967	SEWER	0.9	26.40
10 + 198	SEWER	0.9	27.38
10 + 459	SEWER	0.9	25.04
10 + 684	SEWER	0.9	26.20
10 + 844	SEWER	0.9	27,10
11 + 038	SEWER	0.9	25,50
11 + 275	SEWER	0.9	22,80
11 + 437	SEWER	0.9	23.20

11+ 595	SEWER	1.5	25,90
12 + 127	SEWER	0.9	23.15
12 + 325	SEWER	0.9	24,20
12 + 508	SEWER	1.2	37.44
13 + 038	SEWER	1.8	29,60
13 + 284	SEWER	1.2	23,80
13 + 421	SEWER	1.8	26.70
13 + 862	SEWER	1.8	24,70
14 + 026	SEWER	1.8	24.30
14 + 234	SEWER	1.8	42.42
14 + 546	SEWER	1.5	27.21
14 + 628	SEWER	1.8	25,30
14 + 971	SEWER	0.9	32,70
15 + 132	SEWER	0.9	27.55
15 + 465	SEWER	0.9	24,70
15 + 643	SEWER	0.9	26,10
15 + 736	SEWER	0.9	27,65

Source Consortium SH 2017

Table 3.3. Cross drainage works UF5 subsector 1

ABSCISSA	TYPE OF WORK	DIMENSION (m)	LENGTH
K15 + 862	SEWER	0.9	23,10
K15 + 913	SEWER	0.9	23,10
K16 + 139	SEWER	1.5	25,80
K16 + 238	BOX CULVERT	3.5 x 3.5	40.60
K16 + 527	SEWER	0.9	39,40
K16 + 601	SEWER	0.9	31,00
K16 + 725	SEWER	0.9	28.70
K16 + 863	SEWER	0.9	25.10
K16 + 948	SEWER	0.9	26.30
K17 + 013	SEWER	0.9	11,50
K17 + 759	BOX CULVERT	2 X 2	33,40

K17 + 830	SEWER	0.9	23.30
K17 + 935	SEWER	0.9	23,50
K 18 + 114	BOX CULVERT	2 X 2	46,00
K18 + 318	SEWER	0.9	32,30
K18 + 547	SEWER	0.9	23,50
K18 + 636	SEWER	0.9	22,80
K18 + 704	SEWER	0.9	24,70
K18 + 873	SEWER	0.9	26,10
K19 + 037	SEWER	0.9	26.40
K19 + 939	SEWER	0.9	33,00
K20 + 364	SEWER	0.9	23,80
K20 + 410	SEWER	1.2	23,90
K21 + 035	SEWER	0.9	24,50
K21 + 127	SEWER	0.9	37,00
K21 + 200	SEWER	0.9	23,80
K21 + 279	SEWER	0.9	23,00
K21 + 398	SEWER	0.9	22,60
K21 + 488	SEWER	0.9	23.20
K21 + 574	SEWER	0.9	26,00
K21 + 942	SEWER	0.9	23,80
K22 + 109	SEWER	1.5	26.30
K22 + 232	SEWER	0.9	15,70
K22 + 331	SEWER	1.8	14.44
K22 + 698	SEWER	1.5	27,00
K22 + 912	SEWER	0.9	19.77
K22 + 916	SEWER	0.9	40.75
K23 + 031	SEWER	1.5	54.36
K23 + 309	BOX CULVERT	3 x 3	74,70
K 23 + 492	BOX CULVERT	3 x 3	49.60
K23 + 962	SEWER	1.2	44.68
K24 + 171	SEWER	0.9	23.16
K24 + 335	SEWER	0.9	23,10
K24 + 490	SEWER	0.9	22,80

K24 + 569	SEWER	0.9	24,50
K24 + 678	SEWER	0.9	23,90
K24 + 787	SEWER	0.9	23,00
K24 + 943	SEWER	0.9	23,90
K25 + 018	SEWER	0.9	24.10
K25 + 170	SEWER	0.9	26,90
K25 + 279	SEWER	0.9	32.20
K25 + 375	SEWER	0.9	23,80
K25 + 477	SEWER	0.9	27,60
K25 + 595	SEWER	0.9	23.40
K25 + 739	SEWER	0.9	24,50
K25 + 819	SEWER	0.9	26,00
K25 + 974	SEWER	0.9	25,30
K26 + 078	SEWER	0.9	25.60
K26 + 161	SEWER	0.9	26.30
K26 + 294	SEWER	0.9	24,00
K26 + 374	SEWER	0.9	24,00
K26 + 456	SEWER	0.9	24,20
K26 + 551	SEWER	0.9	42.70
K26 + 915	SEWER	0.9	28.60
K27 + 016	SEWER	0.9	29,00
K27 + 256	SEWER	0.9	26.75
K27 + 407	SEWER	0.9	27,11
K27 + 459	SEWER	1.2	30.20
K27 + 670	SEWER	1.2	27,00
K27 + 729	SEWER	0.9	31.50
K27 + 859	BOX CULVERT	3 x 3	56.10
K27 + 990	SEWER	0.9	25,00
K28 + 070	SEWER	0.9	24,00
K28 + 162	SEWER	1.2	24,00
K28 + 262	SEWER	0.9	25.10
K28 + 424	SEWER	0.9	26,50
K28 + 559	SEWER	0.9	23.53

K28 + 677	SEWER	0.9	24.60
K28 + 805	SEWER	0.9	23,90
K29 + 743	SEWER	1.8	22,60
K29 + 898	SEWER	0.9	22,90
K30 + 060	SEWER	0.9	23.70
K30 + 137	SEWER	0.9	23,80
K30 + 304	SEWER	0.9	30.70
K30 + 476	SEWER	0.9	26,00
K30 + 618	SEWER	0.9	25.40
K30 + 686	SEWER	0.9	25,00
K30 + 771	SEWER	0.9	27,30
K30 + 869	SEWER	0.9	27,90
K30 + 939	SEWER	0.9	27.22
K31 + 274	SEWER	1.2	29,20
K31 + 391	BOX CULVERT	3.5 X 3.5	45,00
K31 + 507	SEWER	0.9	26.20
K31 + 608	SEWER	0.9	26,55
K31 + 713	SEWER	0.9	26.97
K31 + 790	SEWER	0.9	29.16
K31 + 993	SEWER	0.9	26,80
K32 + 093	SEWER	0.9	29,30
K32 + 161	SEWER	0.9	24,20
K32 + 251	SEWER	0.9	23,50
K32 + 354	SEWER	0.9	23,60
K32 + 433	SEWER	0.9	24,20
K32 + 526	SEWER	0.9	27,90
K22 + 994	SEWER	1.5	41.70
K28 + 856	SEWER	0.9	27.22

Source Consortium SH 2017

Ø Dissipation structures

The purpose of such work is to protect cut slopes and embankments against erosion, for such end, two types of dissipation structures in cuts were designed, the first in cases

delivery is made to the sewer inlet box (Figure 3.38. Dissipation structure with sewer38) and the second when delivery is made directly to the side of the road (Figure 3.39. Dissipation structure at the 39).

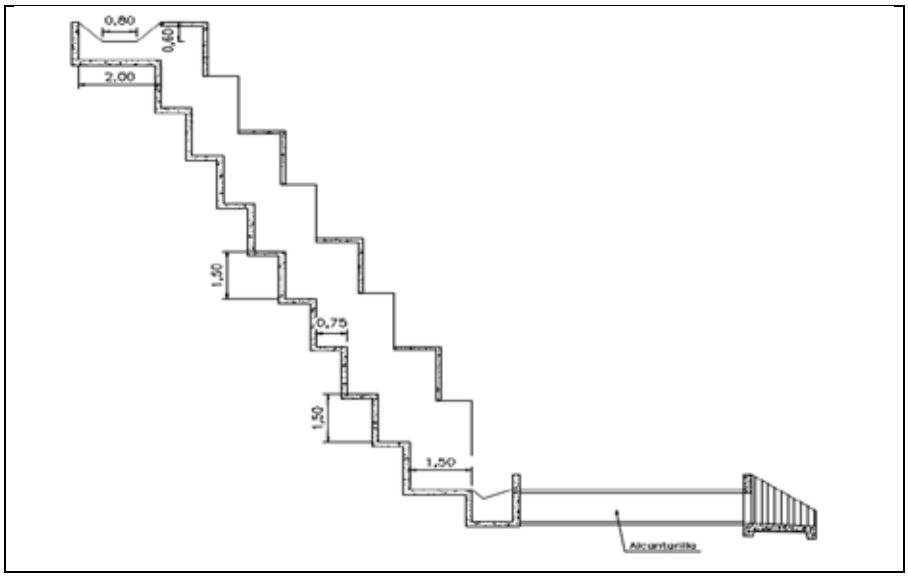

Figure 3.38. Dissipation structure with sewer inlet box

Source Consortium SH 2016

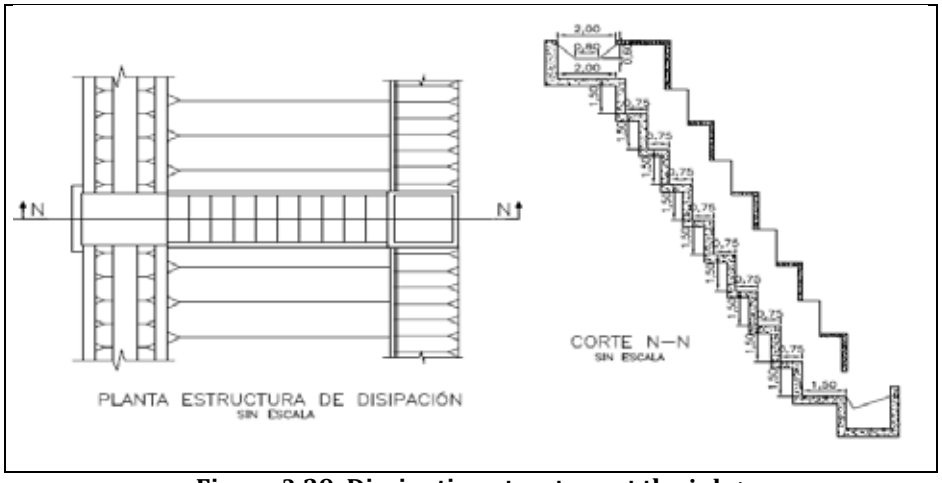

Figure 3.39. Dissipation structure at the inlet

Source Consortium SH 2016

A dissipation structure similar to that of the cuts was projected, but with a different geometry due to the difference of slope to protect embankments a. (See Figure 3.40. Dissipation structure to 40)

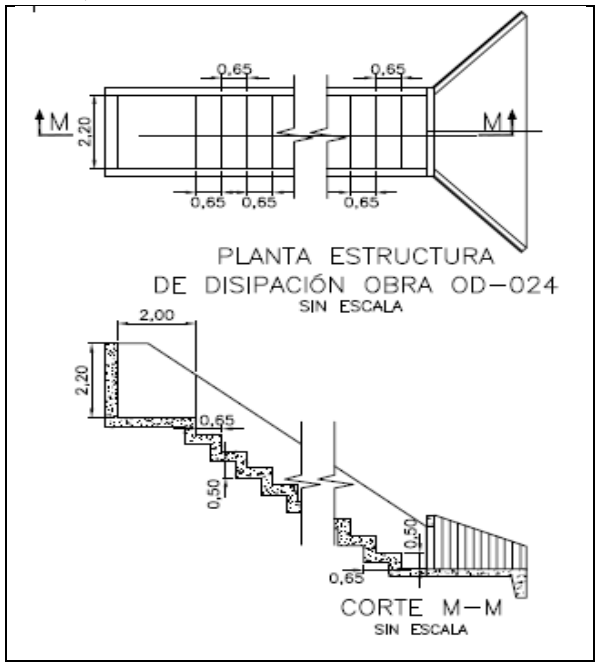

Figure 3.40. Dissipation structure to outlet

Source Consortium SH 2016

Ø Longitudinal drainage

Crown ditches were presented to manage the longitudinal drainage ditches of the road, located on the lateral cut berms and the central divider, as presented in the typical section presented in Figure 3.41.

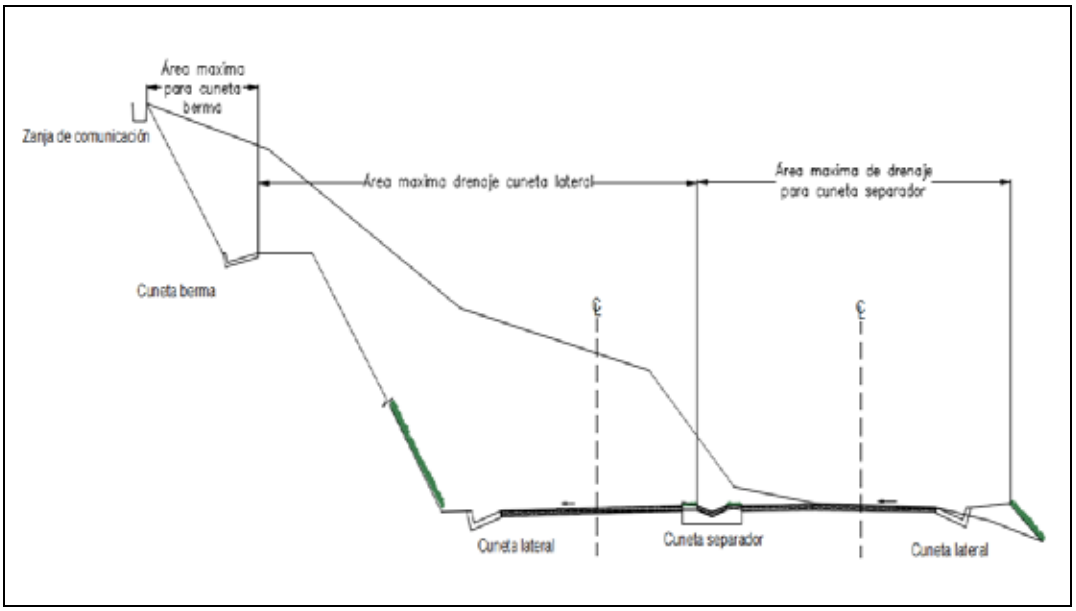

Figure 3.41. Longitudinal drainage elements

Source Consorcio SH 2016

Ø Ditches

Ditches are drainage structures that capture runoff water from the road platform and cut slopes, leading them longitudinally to ensure their proper disposal. Ditches built in embankment areas also protect the edges of the berm and embankment slopes from erosion caused by rain water.

For ditches in cut areas, disposal pints are sewer gathering culverts and natural side outlets to the natural terrain in a change from cut to embankment. In ditches in embankment, water is disposed to the ground through downcomers or relieves and in the ditches of the central divider; water is also conducted to the sewer's gathering box.

Ditches should be located in essentially all cuts, in those embankments susceptible to erosion and in all internal margin of a separator that receives rainwater from the roads.

Ø Lateral ditch

Two types of ditches will be built, the first 1m wide and 0.2m high for expansion sectors and the new road and type 2 0.8m wide and 0.23m high for zones where it is planned to only replace the existing ditch. (See Figure 3.8 and Figure 3.9.)

Ø Crown ditch

Crown ditches are runoff interceptors in the upper part of the cut slope or near the base of the embankment, respectively. Crown ditches are used to intercept rainwater, keeping them for passing through the slope, and must be located at a minimum length of 3m from the edge of the cut slope.

Crown ditches can be trapezoidal or rectangular and as with the ditches, the flow and size are estimated with the rational method and Manning's expression and a selected coating and a given topography.

Concrete crown ditches will have a 0.40 m base, a height of 0.50 m and a surface width of 1.00 m; and slopes on the side walls of 0.6H:1.0V.

Ø Central separator ditch and berm ditch

To size the ditches, the central separator and the cut berms, an analysis was made for the side ditch; the size of these ditches were standardized with a height of 0.15 m, a surface width of 1.00 m and slope sides of 1.0H: 3,33V. (See Figure 3.28 and Figure 3.29.)

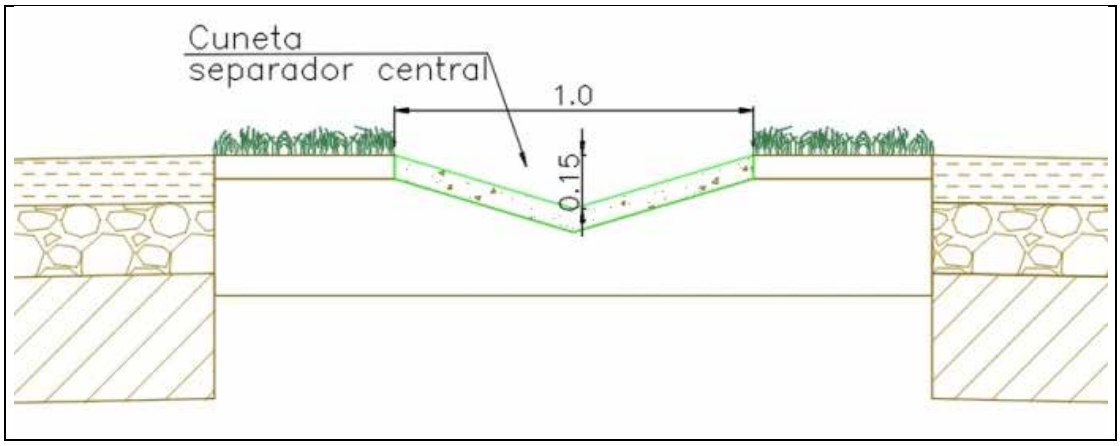

Figure 3.28. Central separator ditch

Source Consortium SH 2016

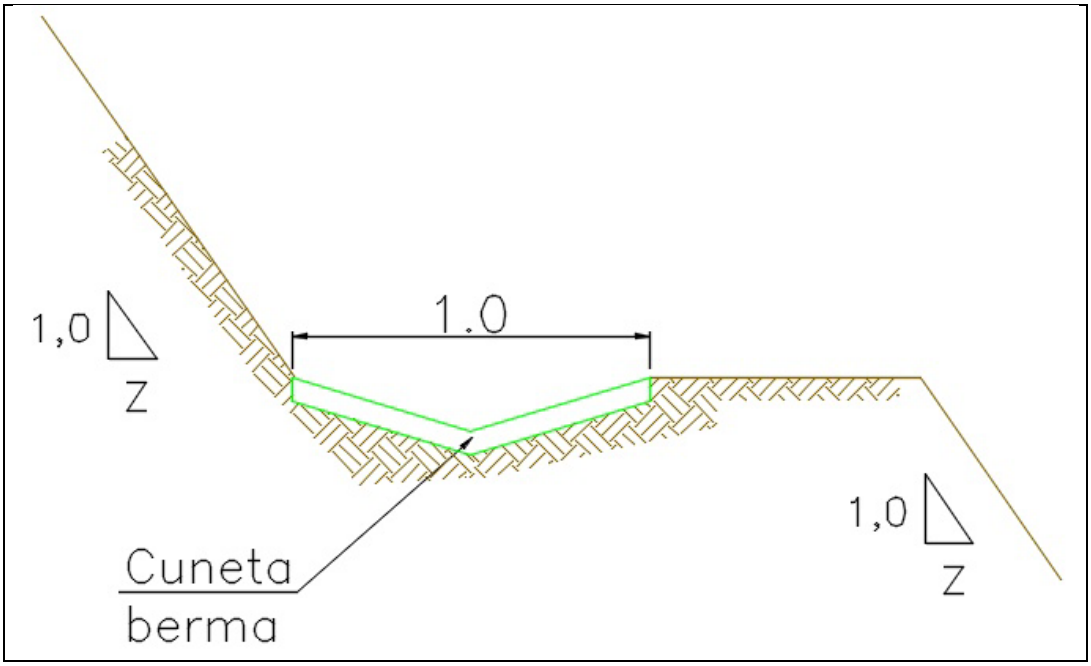

Figure 3.29. Cut berm ditch

Source Consortium SH 2016

ü Sub-drainage infrastructure

The goal of the sub-drain is to eliminate seepage water that may affect the way, in order to ensure stability of the platform, the pavement structure and the slope of the road. The functions of the sub-drain are: abate the water table in the road area, on the cut slopes, fills, the foundations of embankments and road structures, intercept underground leaks to prevent water outcrops in the pavement, drain the surface water infiltrating the pavement and containment structures, collect discharges from different sub-drain systems.

Ø Longitudinal sub-drains

This is placed in a direction substantially parallel to the axis of the road both horizontal and vertical; consisting of a ditch of a given depth, protective filter and eventually a collecting pipe. For the Pedregal-Catambuco section, longitudinal drains formed by filtering material coated with a nonwoven geotextile 50 cm wide 70 cm high are foreseen.

Ø Transversal sub-drains

These underdrains are those that cross the road from one side to the other. Usually the crossing is perpendicular but it can be in diagonal, or even as a herringbone. Constitution of these types of drains is similar to the longitudinal drains: ditch, collection pipe and protective filter. Transversal drains are used in pavement joints to drain groundwater infiltration and bases and sub-bases

Ø Horizontal sub-drains

Horizontal drains consist of small diameter pipes with small holes, which are installed with a slight upward tilt in cut slopes or embankments to drain water and relieve internal pressure from pores, looking for increased stability. One of the advantages of horizontal drains is its ability to drain water and / or abate pore pressures at depths inaccessible to other more conventional sub-drain elements.

Other structures used are Asolo filters, planar Geodren or Geodren filters, weep holes, drainage ditches, drainage mattresses, among others; these are specified in the geometrical design of each section of the road and related infrastructure.

ü Surface water crossings- channel occupations

According to the discussion in Section 3.2.3.1, (drainage infrastructure) there are over 250 sewers and minor drainage works; however, not all of them involve crossing water bodies or waterways; so in this section highlights the works and locations that do require applying for riverbed occupation permits requested under this EIA.

Crossings of surface water bodies foresee hydraulic works such as bridges, viaducts, culverts, sewers, box culverts, among others, which manage permanent and intermittent water sources that intersect with the layout. The issue is discussed in greater detail in section 7.4 (Occupation of channels) of this EIA; meanwhile Table 3.4 lists and locates occupation channels located along the corridor and Table 3.20 Channel occupation in project associated sites 20 lists relate and locates occupation channels that are on infrastructure sites associated with the project.

Table 3.4 Road corridor occupations channel

UF	TYPE OF WORK	X	Y
4	Box	957,048.315	606,818.506
4	Sewer	957,087.604	606,898.259
4	Sewer	957,244.556	607,135.06
4	Sewer	957,447.306	607,459.311
4	Sewer	957,656.898	607,587.231
4	Viaduct	958,736.481	608,557.672
4	Sewer	960,309.205	608,351.836
4	Sewer	960,802.124	608,702.696
4	Sewer	961,022.953	609,139.77
4	-	960,945.114	609,578.113
4	Sewer	960,962.533	609,864.852
4	-	960,942.034	610,060.103
UF	**TYPE OF WORK**	**X**	**Y**

4	-	961,055.985	610,060.103
4	-	961,219.787	609,953.134
4	Sewer	961,266.958	609,818.618
4	Sewer	961,384.18	609,687.675
4	Sewer	961,539.971	609,370.069
4	Sewer	961,762.853	609,272.395
4	Sewer	961,925.483	609,395.969
4	Sewer	961,933.682	609,772.628
4	Sewer	962,041.067	610,310.039
4	Sewer	962,012.106	610,390.137
4	Sewer	962,055.156	610,503.213
4	Sewer	963,995.747	612,730.249
4	Sewer	964,354.294	612,873.853
4	Sewer	964,746.331	613,063.848
4	-	964,812.341	613,086.109
4	Sewer	964,901.359	613,116.877
4	Sewer	965,070.946	613,083.418
4	Sewer	965,097.953	613,119.399
5	Box	966,054.288	613,847.893
5	Sewer	966,628.232	613,872.949
5	-	966,804.19	614,104.067
5	Box	966,463.97	614,224.216
5	Box	966,316.918	614,532.455
5	Sewer	965,650.279	614,271.265
5	Sewer	965,523.921	614,365.542
5	-	965,545.78	614,480.871
5	-	965,512.57	614,491.461
5	-	966,391.902	615,078.53
5	Sewer	967,757.427	616,132.462
5	-	967,956.17	616,411.061
5	Box	968211.9	617,051.107
5	Box	968,401.555	617,052.444
5	-	968,447.188	617,016.493
UF	**TYPE OF**	**X**	**Y**

	WORK		
5	-	970,742.945	618,707.213
5	Sewer	971,265.666	618,605.513
5	Box	971,538.78	618,399.851
5	Box	974,562.53	619,262.351
5	Sewer	974,942.985	619,381.414

Source: Consorcio SH

Table 3.20 Channel occupation in project associated sites

UF	TYPE OF WORK	X	Y
4	Sewer system	962,000.128	609,364.139
5	Sewer system	966,922.095	614,183.361
5	Sewer system	965,452.173	614,710.126
5	Sewer system	965,641.521	614,799.297
5	Sewer system	966,192.508	615,125.672
5	Sewer system	966,457.206	615,301.222
5	Sewer system	967,153.256	615,406.352
5	Sewer system	967,738.808	616,222.181
5	Sewer system	967,940.122	616,697.946
5	Sewer system	967,963.74	616,866.44
5	Sewer system	968,021.641	616,858.826
5	Sewer system	968,460.033	617,023.777
5	Sewer system	970,308.908	618,527.763
5	Sewer system	970,904.009	618,856.601
5	Sewer system	974,878.476	619,293.95

Source: Consorcio SH

- Geotechnical infrastructure

The slope stabilization infrastructure for the Pedregal-Catambuco section foresees:

- Geotechnical type works and / or Slope Stability

- Foreseen cuts

Ø Rock cut slopes

In order to establish road segments where rock IIB cuts are projected with potential kinematic, the stratigraphy of critical sections was reviewed (kinematic potential). Thus the sections where the cuts affected soils were discarded (ash, levels IC and IIA). Likewise, based on stereograms slopes where failure mechanisms can be handled with a change of cut inclination were determined.

In terms of the extent of the recommendation, the sites where potential failure was detected by kinematics are capped by soils (TQvf, TQvlp) or soil from the weathering of rock (IIA, IC) are mentioned. For this reason the recommendation covers the first terraces or even the first 10 m. Due to the nature of the rock mass (extrusive volcanic rock), it is important to check possible variations in the geometry of the discontinuities analyzed in the designs. The aforesaid with the purpose of adjusting the reinforcement measures considered in each case.

The inclination used at points where rock outcrops was assigned according to the dip of the plane and thickness of overlying soil, in order to minimize the dimensions of fractions of unstable rock. Table 30.21 Rock reinforcement areas UF4 shows the results of these analyzes for UF4.

Table 30.21 Rock reinforcement areas UF4

ZH	Abscissa		Failure mechanism	Dip plane (°)	Cut tilt	Reinforcement		Comments
	Initial	Final				L (m)	S (m)	
1	K1 + 120	K1 + 660	Planar Overturned	61 83	0.45H: 1V	5.5	2.8	In the first two terraces
3	K6 + 720	K6 + 900	Planar	51	0.5H: 1V	8.0-12.0 16.0	2.3 3.0	Bolts in the first 30m Anchor tendons from 30m
3	K12 + 285	K12 + 340	Planar	51	0.5H: 1V	6.0	1.5	In the first 10m
4	K15 + 650	K15 + 770	Overturning	83	0.7H: 1V	6.0	1.5	In the first 10m

Source Consortium SH 2017

Ø Cut slopes in soil

In order to determine the tilt and height of the cuts, the highest cuts on each of the homogeneous zones were selected. Based on the recommendations established by Rico and De Castillo (2013), the height and inclination of the slopes was changed taking into account the initial slope of the hillside and the potential erosion of materials.

Recommended slopes from stability analyzes have a minimum safety factor of 1.5 under static conditions and 1.05 under pseudo-static conditions. An acceleration of 0125 g (50% of the acceleration according to Hynes-Griffin and Franklin (1984)) was used. To clarify clear that according to Article A.1.2.4.1 NSR-10, the recommended reduction factors for Seismic Acceleration Coefficients (Aa) are not applicable for various constructions other than buildings.

One Ru 0.1 (equivalent to 25% saturation in the slope) was considered, the water table for UF4 found in the perforations is between 3 m 26 m and for UF5 it is between 3m and 10m; however, field visit did not identify water outcroppings in any of the functional units. In some areas the need to implement drains in order to reduce these water levels were identified.

Thus, using the Slide de Rocscience program under the Spencer methodology, certain recommendations are presented for UF4 and UF5 in the following Table 3.22. and Table 3.2. 3.

Table 3.22.Cutting recommendations and slope protection UF4

SECTION		TILT (°)	HEIGHT BETWEEN SHOULDERS (m)	BERM WIDTH (m)
START	FINAL			
K0 + 000	K0 + 500	0.45H: 1V	20	3
K0 + 500	K0 + 890	0.75H: 1V	20	3
K0 + 890	K2 + 200	0.45H: 1V	20	3
K2 + 200	K3 + 090	0.50H: 1V	20	3
K3 + 090	K3 + 860	0.7H: 1V	20	3
K3 + 860	K4 + 150	0.6H: 1V	20	3
K4 + 150	K12 + 610	0.50H: 1V	20	3
K12 + 610	K12 + 830	0.75H: 1V	20	3
K12 + 830	K15 + 660	0.6H: 1V	20	3
K15 + 660	K15 + 750	0.7H: 1V	20	3

Source Consortium SH 2017

ABSCISSA		PROTECTIVE SLOPE MEASURES
PK 00 + 210	PK 00 + 500	Biomantle
PK 00 + 880	PK 01 + 000	Biomantle
PK 01 + 000	PK 01 + 150	Geotextile mesh +
PK 01 + 150	PK 01 + 440	Biomantle
PK 01 + 120	PK 01 + 660	Anchor bolts (5.5m) every 2.8m with shotcrete. In the first two terraces
PK 01 + 120	PK 01 + 750	Sub-horizontal drains
PK 01 + 440	PK 01 + 750	Geotextile mesh +
PK 01 + 750	PK 01 + 900	Biomantle
PK 02 + 350	PK 02 + 750	Geotextile mesh +
PK 03 + 140	PK 03 + 165	Geotextile mesh +
PK 03 + 165	PK 03 + 190	Biomantle
PK 03 + 450	PK 03 + 560	Geotextile mesh +
PK 03 + 560	PK 03 + 775	Biomantle
PK 03 + 880	PK 03 + 900	Biomantle
PK 03 + 900	PK 03 + 950	Geotextile mesh +
PK 03 + 950	PK 04 + 040	Biomantle
PK 04 + 085	PK 04 + 210	Biomantle
PK 04 + 410	PK 04 + 550	Biomantle
PK 05 + 080	PK 05 + 370	Biomantle
PK 05 + 370	PK 05 + 450	Geotextile mesh +
PK 05 + 450	PK 05 + 500	Biomantle
PK 05 + 500	PK 05 + 740	Geotextile mesh +
PK 05 + 500	PK 05 + 740	Sub-horizontal drains
PK 05 + 740	980 PK 05+	Biomantle
PK 06 + 720	PK 06 + 900	Anchor bolts (8m - 12m) every 2.3m (in the first 30m) and anchor tendons 16m every 3m (from 30m) with shotcrete.
PK 07 + 060	PK 07 + 120	Biomantle
PK 07 + 080	PK 07 + 240	Sub-horizontal drains

PK 07 + 120	PK 07 + 200	Geotextile mesh +
PK 07 + 200	PK 07 + 240	Biomantle
PK 07 + 345	PK 07 + 410	Biomantle
PK 07 + 810	PK 07 + 870	Geotextile mesh +
PK 07 + 870	PK 07 + 905	Biomantle
PK 07 + 985	PK 08 + 110	Biomantle
PK 09 + 235	335 PK 09+	Biomantle
PK 09+ 225	PK 09 + 280	Biomantle - Der
PK 10 + 390	PK 10 + 450	Biomanto
PK 10 + 580	PK 10 + 610	Biomantle
PK 10 + 625	PK 10 + 650	Biomantle
PK 12 + 170	PK 12 + 285	Geotextile mesh +
PK 12 + 285	PK 12 + 340	Anchor bolts (6m) every 1.5m with shotcrete. In the first 10m
PK 12 + 285	PK 12 + 340	Sub-horizontal drains
PK 12 + 610	PK 12 + 830	Sub-horizontal drains
PK 12 + 610	PK 12 + 830	Geotextile mesh +
PK 12 + 620	PK 12 + 890	Biomantle - Der
PK 12 + 830	PK 12 + 950	Biomantle
PK 12 + 970	PK 13 + 005	Biomantle
PK 13 + 505	PK 13 + 675	Biomantle
PK 13 + 575	PK 13 + 605	Anchor bolts (12m-15m) every 1.4m with shotcrete.
PK 13 + 670	PK 13 + 780	Sub-horizontal drains
PK 13 + 670	PK 13 + 780	Geotextile mesh +
PK 13 + 790	PK 13 + 830	Biomantle
PK 13 + 890	PK 13 + 950	Biomantle
PK 14 + 070	PK 14 + 210	Biomantle
PK 14 + 740	PK 15 + 410	Biomantle
PK 15 + 560	PK 15 + 750	Biomantle
PK 15 + 650	PK 15 + 770	Anchor bolts (6m) every 1.5m with shotcrete. In the first 10m
PK 15 + 650	PK 15 + 750	Sub-horizontal drains

Table 3.2. 3Cutting recommendations and slope protection

Sub-Sector		Cut		Filling		Cut slope protection measures		
Abscissa		Inclination	Berm width	Inclination	Berm width	Horizontal drain	Geotextile + mesh	Biomanle
Initial	Final	(-)	(M)	(-)	(M)	(M)	(M)	(M)
K15 + 722	K15 + 900	0.70H: 1V	3	1.5 H: 1V	-			203.0
K15 + 900	K15 + 925	0.75 H: 1V	5			200.0		
K15 + 925	K16 + 100						175.0	
K16 + 100	K16 + 300	0.70 H: 1V	3					200.0
K16 + 300	K16 + 680						380.0	
K16 + 680	K17 + 185							505.0
K17 + 185	K17 + 550						365.0	
K17 + 550	K18 + 976							11410.0
K18 + 976	K22 + 380	0.70 H: 1V	3					
K22 + 380	K22 + 600			1.5 H: 1V	3.00			
K22 + 600	K22 + 660			1.5 H: 1V	-	60.0		
K22 + 660	K22 + 800							
K22 + 800	K22 + 900			1.5 H: 1V	3.00			
K22 + 900	K23 + 800			1.5 H: 1V	-			
K23 + 800	K24 + 018			1.5 H: 1V	3.00			
K24 + 018	K24 + 250	0.70 H: 1V	3					
K24 + 250	K24 + 330			1.5 H: 1V	-	80.0		
K24 + 330	K24 + 800							
K24 + 800	K24 + 900					100.0		
K24 + 900	K25 + 050							
K25 + 050	K25 + 600					550.0		
K25 + 600	K26 + 130							
K26 + 130	K27 + 800	0.75 H: 1V	3					
K27 + 800	K27 + 900			1.5 H: 1V	3.00			
K27 + 900	K28 + 960			1.5 H: 1V	-			
K28 + 960	K29 + 500						1090.0	
K29 + 500	K29 + 600	0.70 H: 1V	3					
K29 + 600	K30 + 030					500.0		
K30 + 030	K30 + 050	0.70 H: 1V	3					
K30 + 050	K30 + 100							2650.0
K30 + 100	K32 + 700							

Source Consortium SH 2016

Materials found are susceptible to erosion processes, reason why it is necessary to protect the slopes with biomantles. In areas with slope of greater height where materials show heterogeneous granulometry and evidence of falling material due to erosion, placement of a geotextile is projected reinforced with a steel mesh to ensure

permanence of the mantle and the substrate in the slope. The details and location in plan view of the protection are shown in the drawings of Annexes 3.2.3.1-I and 3.2.3.1-j.

ü Design of embankments

Road implantation generates embankments with variables height, up to 25m. For the construction of these embankments INVIAS recommendations will be followed for the designs, which indicate that the slope of the slopes should be 1.5H:1.0V. In order to ensure stability of the slopes of the embankments, maximum heights of 10 m and intermediate berms 3 m high must be implemented.

Additionally as a protection to prevent development of erosional processes on the surface of the slopes by runoff action it is recommended to implement protection grassing with lawn mantles. To implement biodegradable mantles in order to facilitate the development of vegetation in the event no lawn mantles are available.

Settling estimated on the embankments with higher altitude is presented, which are cemented on compressible soils, generating significant long-term settling. The following table lists the embankments where larger settlings over 30 cm for UF5 are estimated, which are considered excessive and measures to accelerate the development of consolidation processes must be implemented to avoid damages on the pavement structure. Estimated settling in embankment with greater heights is presented, which are cemented on poorly compressible soils, generating low magnitudes of long-term settling, in all cases below 20 cm for UF4, which are considered excessive and measures to accelerate the development of consolidation processes must be implemented to avoid damages on the pavement structure. (See Table 3.24 Settling of embankments UF4 and Table 3.25 Settlement embankments UF5).

Table 3.24 Settling of embankments UF4

ZH	Start	End	H max. (M)	S (mm)	Tc, S = 90% (years)	S in 1 year (mm)	Overload H (m)	L MD (m)
1	K16 + 180	K16 + 250	12.0	675.0	12.3	607.5	-	14.0
	K18 + 100	K18 + 190	10.0	638.0	20.4	574.2	-	18.0
2	K19 + 900	K20 + 270	5.5	156.0	12.3	67.0	2.0	-
	K20 + 720	K20 + 950	4.0	70.0	5.1			-

ZH	Start	End	H max. (M)	S (mm)	Tc, S = 90% (years)	S in 1 year (mm)	Overload H (m)	L MD (m)
	K22 + 180	K22 + 230	7.5	200.0	9.1	91.3	2.0	-
	K22 + 350	K22 + 570	9.5	149.0	3.1			-
	K22 + 800	K22 + 870	12.5	254.0	3.1	183.0	2.0	-
	K22 + 870	K23 + 070	12.0	514.0	3.1	357.0	3.0	-
	K23 + 450	K23 + 800	14.8	1058.0	20.4	952.2	-	18.0
	K23 + 800	K24 + 000	11.5	317.0	5.1	184.0	2.0	-
3	K24 + 000	K24 + 280	9.4	228.0	6.3	122.0	2.0	-
	K27 + 760	K27 + 960	10.9	280.0	1.0			-
4	K30 + 440	K30 + 560	6.8	227.0	20.4	80.0	3.0	-
	K31 + 050	K31 + 150	4.5	125.0	12.3			-
	K31 + 230	K31 + 320	4.2	135.0	20.4			-
	K31 + 390	K31 + 730	6.0	203.0	20.4	75.0	3.0	-

Source Consortium SH 2016

Table 3.25 Settlement embankments UF5

ZH	Start	End	H max. (M)	S (mm)	Tc, S = 90% (years)	S in 1 year (mm)	Overload H (m)	L MD (m)
1	K16 + 180	K16 + 250	12.0	675.0	12.3	607.5	-	14.0
	K18 + 100	K18 + 190	10.0	638.0	20.4	574.2	-	18.0
2	K19 + 900	K20 + 270	5.5	156.0	12.3	67.0	2.0	-
	K20 + 720	K20 + 950	4.0	70.0	5.1			-
	K22 + 180	K22 + 230	7.5	200.0	9.1	91.3	2.0	-
	K22 + 350	K22 + 570	9.5	149.0	3.1			-
	K22 + 800	K22 + 870	12.5	254.0	3.1	183.0	2.0	-
	K22 + 870	K23 + 070	12.0	514.0	3.1	357.0	3.0	-

ZH	Start	End	H max. (M)	S (mm)	Tc, S = 90% (years)	S in 1 year (mm)	Overload H (m)	L MD (m)
	K23 + 450	K23 + 800	14.8	1058.0	20.4	952.2	-	18.0
	K23 + 800	K24 + 000	11.5	317.0	5.1	184.0	2.0	-
3	K24 + 000	K24 + 280	9.4	228.0	6.3	122.0	2.0	-
	K27 + 760	K27 + 960	10.9	280.0	1.0			-
4	K30 + 440	K30 + 560	6.8	227.0	20.4	80.0	3.0	-
	K31 + 050	K31 + 150	4.5	125.0	12.3			-
	K31 + 230	K31 + 320	4.2	135.0	20.4			-
	K31 + 390	K31 + 730	6.0	203.0	20.4	75.0	3.0	-

Source Consortium SH 2016

H max .: Maximum height
S: Settling
Tc: Consolidation Time
H overload: overload Height
L MD: Length vertical strip drains

Among the possible measures to be implemented in these areas are overloads, building stone columns or vertical strip drains. One of the first alternatives considered was shaping an additional fill on embankments in order to increase stresses applied and accelerate the consolidation process.

Embankments where the vertical strip drains and overloading will be installed will experience significant changes during the main consolidation period (approximately one year). Once this period is completed the final pavement structure can be installed. Strip drains must be accompanied by a surface drainage layer. Details of the recommended works are shown in Annexes 3.2.3.1-I and 3.2.3.1-j.

It is recommended to install instrumentation in order to monitor the consolidation process. Recommended instrumentation consists of piezometers, with the objective of measuring pore pressure dissipation and topographic control points to evaluate settling rate.

ü Retaining walls

Table 3.26 Retaining walls UF4 and Table 3.27 Retaining walls UF5 lists retaining walls designed for the Pedregal-Catambuco section of the dual carriageway project.

Table 3.26 Retaining walls UF4

REINFORCED SOIL WALLS			
ROAD SIDE	**START**	**END**	**LENGTH**
RIGHT	PK 01 + 825	PK 02 + 004.65	179.65
RIGHT	PK 02 + 584	PK 02 + 617	32.85
LEFT	PK 03 + 068	PK 03 + 103	34,95
RIGHT	PK 03 + 102	PK 03 + 187	84.65
RIGHT	PK 04 + 768	PK 05 + 031	263.05
RIGHT	PK 05 + 934	PK 06 + 331	397.45
RIGHT	PK 07 + 224	359 PK 07+	135.25
RIGHT	PK 07 + 885	PK 08 + 017	132.3
RIGHT	PK 10 + 204	PK 10 + 369	165.45
RIGHT	PK 11 + 679	PK 11 + 859	179.65
RIGHT	PK 11 + 935	PK 11 + 980	Four. Five
RIGHT	PK 12 + 042	PK 12 + 145	103.5
8 + 580 - MI INTERCONNECTION APPROACH WALL	PK 08 + 580	PK 08 + 639	44.4
8 + 580 - MD INTERCONNECTION APPROACH WALL	PK 08 + 580	PK 08 + 639	14.5
PEDREGAL - BRANCH 1ROUNDABOUT APPROACH WALL	PK 01 + 990	PK 02 + 084	94.1
PEDREGAL - BRANCH 2 WALL APPROACH	PK 01 + 990	PK 02 + 000	10,95
PEDREGAL - BRANCH 3 WALL APPROACH	PK 01 + 990	PK 02 + 140	95.3
ROUNDABOUT WALL APPROACH	PK 01 + 990	PK 02 + 037	54.75

MURO APPROACH			

REINFORCED CONCRETE WALLS			
ROAD SIDE	**START**	**END**	**LENGTH**
RIGHT	PK 01 + 634	PK 01 + 664	30.04
RIGHT	PK 01 + 797	PK 01 + 806	9.00
RIGHT	PK 02 + 526	PK 02 + 553	27.06
RIGHT	PK 03 + 212	PK 03 + 230	18.04
RIGHT	PK 03 + 399	PK 03 + 446	47.48
RIGHT	PK 03 + 830	PK 03 + 850	20.1
RIGHT	PK 03 + 960	PK 03 + 999	39.12
RIGHT	PK 04 + 018	PK 04 + 057	39.12
RIGHT	PK 04 + 654	PK 04 + 729	75.26
RIGHT	PK 05 + 455	PK 05 + 491	36.1
RIGHT	PK 06 + 493	PK 06 + 556	62.71
RIGHT	PK 06 + 561	PK 06 + 570	9.04
RIGHT	PK 07 + 710	PK 07 + 830	120.24
RIGHT	PK 09 + 346	PK 09 + 376	30.04
RIGHT	PK 10 + 040	PK 10 + 130	90.2
RIGHT	PK 10 + 465	PK 10 + 561	96.16
RIGHT	PK 10 + 688	PK 10 + 760	72.14
RIGHT	PK 10 + 860	PK 10 + 905	45.08
RIGHT	PK 11 + 068	PK 11 + 107	39.08
RIGHT	PK 11 + 166	PK 11 + 283	117.34
RIGHT	PK 11 + 336	PK 11 + 560	224.52
RIGHT	PK 12 + 284	PK 12 + 330	46.16
RIGHT	PK 12 +	PK 12 +	45.1

	410	455	
RIGHT	PK 12 + 465	PK 12 + 570	105.32
RIGHT	PK 15 + 688	PK 15 + 730	42.06

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Table 3.27 Retaining walls UF5

No.	Abscissa		Length (m)	Max H (m)	Min H (m)	Typology	Road side
	Start	End					
1	K15 + 844	K15 + 913	59.72	8.8	4	Cantilever	Right
2	K17 + 008	K17 + 053	46,66	8	4	Cantilever	Right

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- *Energy supply infrastructure*

To develop activities in described process plants, generators or power supply will be made by generators or a group of generating generator which will be located isolated from the processing area.

These generators will have thermal and sound insulation which protect equipment from weather, dust or other elements that may endanger the operation of the equipment.

All electrical generators or group of generators will be equipped with higher safety and control systems to ensure the quality of the power supply with low fuel consumption.

Permanent camps will have electric generators for power supply or by connecting to the grid of the power company of the region CEDENAR.

3.2.3.3 Project associated infrastructure

- *Permanent camps*

The construction project, for Functional Units UF4 and UF5 subsector 1 will have two (2) camps; one for each functional unit; follows their location and approximate occupied area. (See Table 3.28. Permanent camps UF4 and UF5)

Table 3.28. Permanent camps UF4 and UF5

OBSERVATION	Tangua CAMP	Cebadal CAMP
Municipality	Tangua	Tangua
County	El Vergel	El Tambor
County	Porvenir	Nuevo Horizonte
Initial abscissa	K 14 + 200	K 21 + 500
Final abscissa	K 14 + 600	K 21 + 800
East reference coordinates	965316	967283
North reference coordinates	613251	616084
Approximate area	2.5 Ha	2.0 Ha
Functional Unit	UF4	UF5
Soil excavation	21,936 m3	49,605 m3
Embankment	19,742 m3	6,532 m3

Source Consortium SH 2017

Annex 3.2.3.2-a shows camp designs and their general location. Presented camp designs are subject to change because they are preliminary. (See Figure 3.44 Location 44)

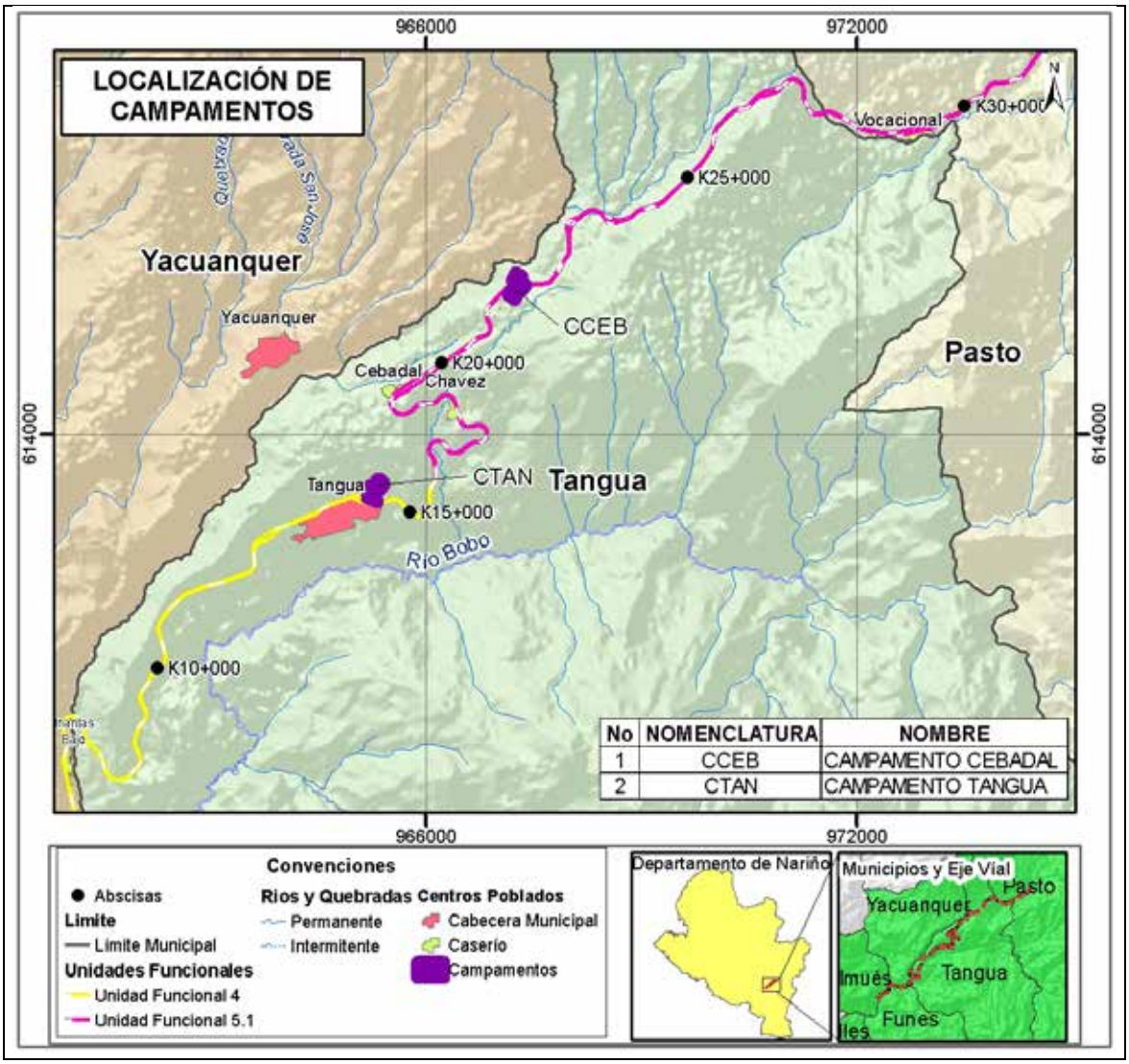

Figure 3.44 Location of Camps

Source Gemini Environmental Consultants SAS 2016

(See detail in GDB / mapping / PDF / code / EIADCRP_PC_002)

- Waste disposal:

Solid waste from the camp will be disposed of according to the provisions of the environmental management plan for management of solid and hazardous wastes.

Solid waste separation systems will be located in different parts of the camps; collection routes will also be established within the premises, temporarily storing collected waste in the area setup for this purpose. Aforesaid activities will depend on camp dynamics.

The solid waste storage area will have sufficient natural ventilation to help dissipate odors and gases generated by the temporary storage; it must be a suitable place as set out in the management plan. Solid domestic waste will be collected by the cleaning company that has a signed agreement; recyclable waste will be delivered to recycling associations in the area. Other waste generated in camp facilities will be handled in accordance with the management plan.

GDB / mapping / PDF / code / EIADCRP_PC_009 has the general plan and its respective camps location map and shows the location of collection site collected solid waste. The location of these collection sites can change, since presented drawings correspond to to the feasibility phase.

- Storage areas for supplies, materials and fuels:

Storage areas of supplies and materials will have established safety standards for their storage, also taking into account the compatibility matrix of chemicals in order to avoid incidents in storage areas.

The project will not fuel storage areas.

Liquid substances will be stored in separate containers, with a safety dike of 110% of the volume of the storage container, and must also have a natural ventilation system, a system for handling spills which must have channel system and a box for collecting substances in the event of spills within the storage site. The floor must be waterproofed and marked, with a fire control, spills or release of toxic gases system and stored substances, their safety data sheets and supplier will be controlled for correct management in the event of an emergency. Storage sites will meet all standards and security protocols required for this activity. The project will not have fuel storage sites (see numeral 3.2.4.2.).

Annex 3.2.3.2-a shows camp plans and the storage areas of chemical substances.

- Stockpiling sites and storage of materials:

As shown in camp designs process plants are included in their areas, therefore stockpiling and storage of materials sites are also located there. (See Annex 3.2.3.2-a).

- Other infrastructures - Access roads to specific sites

Table 3.5 lists the roads that will be used to transport materials and machinery, as well as access roads to the ZODMEs, water intake sites and other facilities. Annex 3.2.3.2-c, also details these access roads.

Table 3.5. Access roads to specific project sites

Name	Description	Length (M)
PEPA 01 road	Access1 Puente Guaitara construction	286
PEPA 02 road	Access 2 Guaitara Bridge construction	89
PEPA 03 road	Access 3 Guaitara Bridge construction	198
PEPA 04 road	Access ZODME Z 4-4 and Z4-5	1289
PEPA 05 road	Access ZODME Z4-6	167
PEPA 06 road	Access ZODME Z4-7 and Z4-8	4517
PEPA 07 road	Access Tangua Camp	311
PEPA 08 road	Access ZODME Z5-1A and Z5-1B and La Chaquita water intake point	786
PEPA 09 road	Access ZODME Z5-3	251
PEPA 10 road	Access Camp Cebadal and ZODME Z5-6	805

Name	Description	Length (M)
PEPA 11 road	Access ZODME Z5-10	57
PEPA 12 road	Access ZODME Z5-11	286
PEPA 13 road	Access ZODMESZR5-4 And Z5-13	390
PEPA 14 road	Access to Bobo River water intake points	1270
PEPA 15 road	Access to water intake points, ZODMESZ5-4, Z5-5	2073
PEPA 16 road	Access to ZODME Z4-1, Z4-2, Z4-3, ZR4-1, Z5-2, ZR5-1, ZR5-2, Cebadal Camps, ZR5-3, Z5-7, Z5-8, Z5-9, Z5-12, ZR5-5.	34609

Source Consortium SH 2016

- *Transients camps*

Transient camps will be used in work sites, where temporary material for project implementation will be stored. This stockpiling point will be located in the right of way of the proposed layout fulfilling the function of temporary storage of machinery and tools that are being used in the works and that, for logistical reasons, cannot be transferred to the permanent camps.

- *Sources of materials*

Table 3.30. Extraction sites and authorized marketing of materials 30 shows some extraction sites and marketing of building materials near the area of project development, where materials required for project implementation can be purchased.

Table 3.30. Extraction sites and authorized marketing of materials

Plane Coordinate		FIRST NAME	ANM CODE	CORPONARIÑO File No.	APPROVAL RESOLUTION-LICENSE
EAST	NORTH				

Plane Coordinate		FIRST NAME	ANM CODE	CORPONARIÑO	APPROVAL
975244	621115	EL HUECO	GLC - 111 of January 4, 2007	2442	Res. No. 934 of December 4, 2008
974261	628415	LA VICTORIA	GTRC - 0105-9 of July 3, 2009	163	Res. No. 226 of July 2, 1996
972886	629680	SAN JAVIER QUARRY	IFK - 08251 of July 6, 2009	LSC-004-12	Res. No. 584 of September 18, 2012
943149	624620	LA CONCEPCIÓN	JB7-14351 October 16, 2009	LSC-009-10	Res. No. 662 of August 9, 2010
976172	621466	LAS TERRAZAS	GTRC - 0081-08 of April 11, 2008,		Res. No.180 of July 1, 2003
973085	632598	LA VEGA	HJN - 11331X; July 10, 2008	735	No. 075 Res. - March 17, 1998
974715	6298881	LA ROCA	HHA - 15551: January - 04 2007	LSC-005-09	No. 551 Res. - July 31, 2009
977846.7	623101.5	CHAPALITO QUARRY	ICR - 08291 - June 5, 2009	LSC-001-10	No. 341 Res. - November 23, 2009
977840	623090	ARMENIA	Res. 003 354 December 4, 2015	170	Res No. 154 -. April 29, 1997
974039	629322	OCCIDENTE	GTRC - 0079-08 April 11, 2008	2329	No. 353 Res. - September 30, 2002
973600	620925	BRICEÑO BAJO	Res. 002616 July 3, 2014	224	Res No. 181 - May 22, 1997
973922	629280	BRICEÑO ALTO	Res. 002992 November 11, 2015	956	Res No. 200 - June 10, 1998

Plane Coordinate		FIRST NAME	ANM CODE	CORPONARIÑO	APPROVAL
974337	622150	LOS PALMOS	GBN-101 - June 1, 2006	2410	Res No. 0021 - January 8, 2008
981970	624059	CALIDAD	IFM-16061 November 2, 2007	2429	No. 649 Res. - September 19, 2008
977293	623791	LA LORIANA	WGLR-0194-08 November 7, 2008	821	Res No. 179 - June 1, 1998

Source Gemini Environmental Consultants SAS 2016

The company Concesionaria Vial Unión del Sur may work with extraction and marketing of materials companies other than aforementioned, provided they submit the relevant environmental and operational documentation required by the environmental authority. This information shall be attached to environmental compliance reports - ICA.

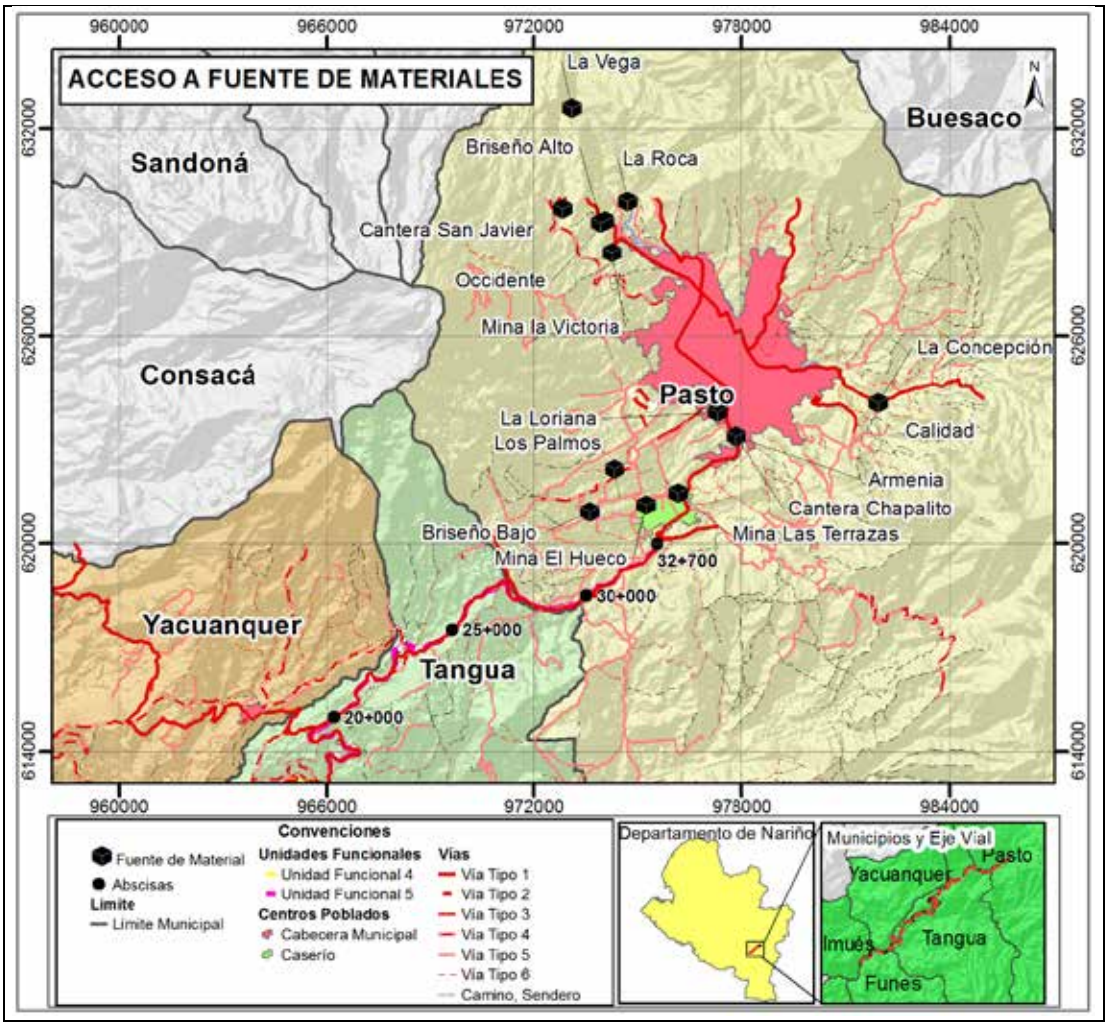

Figure 3.45 Sources of materials and their accesses

Source Gemini Environmental Consultants SAS 2016

(See detail in GDB / mapping / PDF / code / EIADCRP_PC_002 scale 1: 25,000)

- *Process plants*

To execute the dual carriageway construction project, Pedregal-Catambuco section, two (2) concrete plants and two (2) asphalt plants are designed in order to provide the necessary material to implement the project. These plants are planned in the areas of

the Tangua and Cebadal camps. (See Figure 3.46 Process Plant Location UF446, Figure 3.47 Process Plant Location UF547 and Annex 3.2.3.2-a)

Table 3.31 Location of Process Plants

Process Plant							
Name	**Abscissa**	**Processing Plant**	**Coordinates**	**Processing Plant**	**Coordinates**	**Processing Plant**	**Coordinates**
Tangua CAMP	14 + 200	Asphalt plant	E: 965,263.64	Concrete plant	E: 965219.348	Crushing plant	AND: 965227.6
			N: 613169.322		N: 613254.729		N: 613244.2
Cebadal CAMP	21 + 700	Asphalt plant	E: 967284.589	Concrete plant	E: 967335.125	Crushing plant	AND: 967202.2
			N: 616036.012		N: 616017.756		N: 615913.9

Source Consortium SH 2017

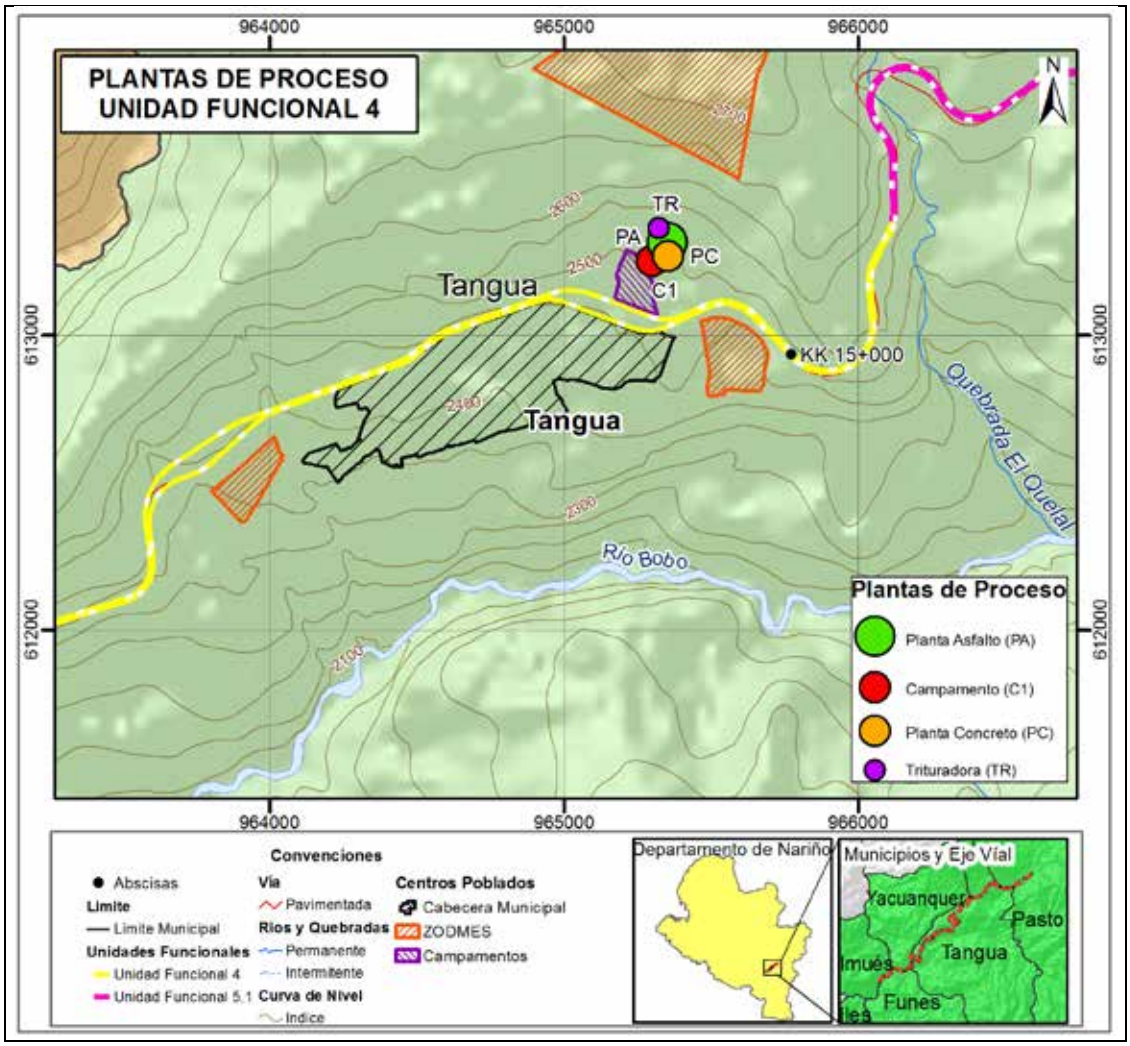

Figure 3.46 Process Plant Location UF4

Source Gemini Environmental Consultants SAS 2016

(See detail in GDB / mapping / PDF / code / EIADCRP_PC_002)

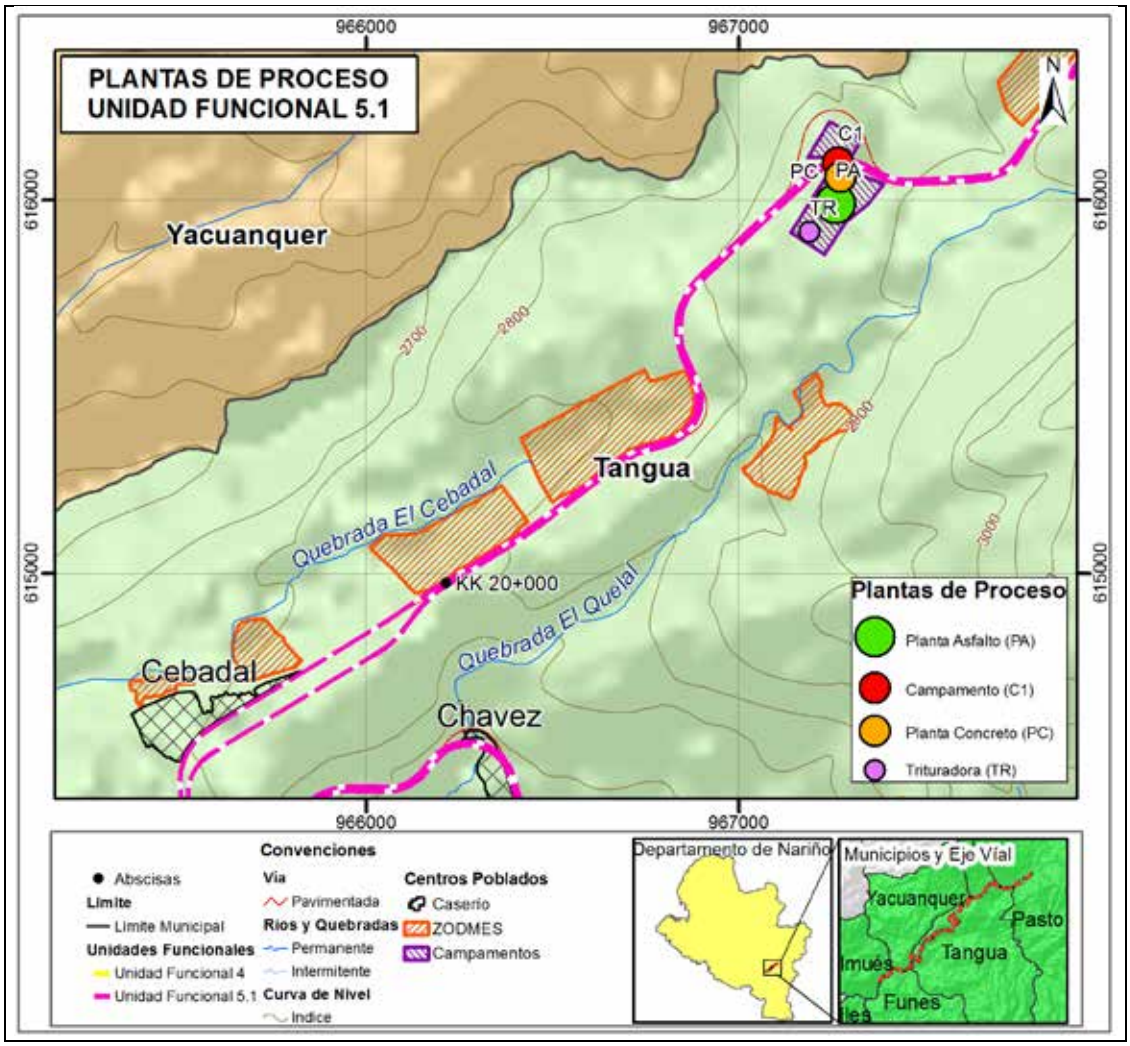

Figure 3.47 Process Plant Location UF5

Source Gemini Environmental Consultants SAS 2016

(See detail in GDB / mapping / PDF / code / EIADCRP_PC_002)

3.2.3.4 Infrastructure and services intercepted by the project

Considering the services in the area of project development, follows a description of interrupted networks.

- Utilities

ü Water and Sewerage

Table 3.6 and Table 3.7 present a summary of the different intersections of the dual carriageway project with water and sewerage networks for Functional Units 4 and 5 subsector 1. Annex 3.2.3.3-a presents the list of intersections.

Table 3.6. Intersection with sewerage network Pedregal-Catambuco Section

Location	Diameter	Interference
K2 + 150	0.25m	Existing sewerage system, built by the Chirimoyal neighborhood community, Pedregal province.
K2 + 200 - 200 + K2	0.30m - 0.36m	Existing sewerage system, built by the Chirimoyal neighborhood community, Pedregal province..
K6 + 200	0.7m	Existing network El Placer Toll, 3 3"ducts.

Note: Presented information corresponds to designs during the feasibility phase, therefore, the information is subject to change.
Source Consortium SH 2016

Table 3.7. Intersection aqueduct networks Pedregal-Catambuco Section

ABSCISSA	MATERIAL	DIAMETER	LENGTH	AFFECTED	DESCRIPTION INTERFERENCE
K 1 + 900	PVC	2"	72	ASOPEDREGAL	Right hand side (RHS) network
K 2 + 725	PVC	4"	100	ASOPEDREGAL	Network crossing road from RHS and continues along RHS of existing road crossing new design
K 3 + 200	PVC	4"	250	ASOPEDREGAL	Continuous network left hand side (LHS) of the existing road and enters the new design from K3+170 to LHS K3+420 where it crosses diagonally to LHS to K3+715 for a total network development of 410ml in 4" PVC
K 4 + 370	PVC	3"	60	PLACER INANTAS	Network crosses from LHS to RHS and continues along the new design
K 4 + 600	PVC	1"	70	PLACER INANTAS	Network cross road
K 4 + 605	PVC	3"	100	PLACER INANTAS	Network crosses road diagonally to left hand side at K4 + 665
K 4 + 700	PVC	3"	45	PLACER INANTAS	Network crosses road in Pacha at K4 + 665 2 x 3" ducts one of these networks is parallel to the LHS to the junction
K 4 + 755	PVC	1/2 "	fifty	PLACER INANTAS	
K 4 + 750	PVC	2 "and 1"	40	PLACER INANTAS	Network crosses road at Pacha K4 + 770 2 2"and 1" ducts
K 4 + 786	PVC	1/2 "	50	PLACER INANTAS	
K 4 + 880	PVC	3"	55	PLACER INANTAS	Network crosses road
K5 +000	PVC	3 "1/2"	60	PLACER INANTAS	Network crosses road 2 3"and 1/2" ducts
K 5 + 100	PVC	1/2 "	100	PLACER INANTAS	Network crosses road
K 5 + 300	PVC	3 x 1 "	75	PLACER INANTAS	Network crosses road
K 5 + 792	PVC	2 "and 1"	100	PLACER INANTAS	Network crosses road Pacha in two ducts at K5 + 900
K 6 + 140	PVC	2"	70	PLACER INANTAS	Network crosses road
K 6 + 300	PVC	1"	75	PLACER INANTAS	Network crosses road

K 6 + 250	PVC	3 x 2 "	80	PLACER INANTAS	Network crosses road at L6 + 220
K 6 + 450	PVC	1/2 "	100	PLACER INANTAS	Network crosses road
K 6 + 690	PVC	3"	200	PLACER INANTAS	Network crosses road diagonally from K7+690LD to K7+775LI
K 6 + 740	PVC	1/2 "	55	PLACER INANTAS	Network crosses road
K 6 + 860	PVC	1/2 "1" 3 "	55	PLACER INANTAS	Network crosses road in 3 ½" and 3" ducts
K 7 + 250	PVC	2 x 1/2 "	55	PLACER INANTAS	Network crosses road at Pacha in 2 1/2" ducts at K7 + 275
K 7 + 450	PVC	1/2 "	60	PLACER INANTAS	Network crosses road
K 7 + 600	PVC	2x1 / 2 "	40	PLACER INANTAS	Network crosses road
K 7 + 710	PVC	2"	90	PLACER INANTAS	Network crosses road
K 7 + 930	PVC	3 x 1/2 "	45	PLACER INANTAS	Network crosses road
K 8 + 765	PVC	1"	70	PLACER INANTAS	Network crosses road
K 8 + 905	PVC	2"	65	PLACER INANTAS	Network crosses road
K 9 + 165	PVC	1"	75	PLACER INANTAS	Section with relief road, the network corresponds to new aqueduct design section connecting with the existing network
K 9 + 435	PVC	3"	80	PLACER INANTAS	Network crosses road on new relief road section should go with new network design
K 9 + 965	PVC	1"	105	PLACER INANTAS	Network crosses road
K 10 + 121	PVC	2"	475	PLACER INANTAS	Network crosses diagonally from K10* 121LI to K10+480 LHS
K 10 + 945	PVC	1"	50	PLACER INANTAS	Network crosses road RHS of the current right of way matching new axis to K12+200 I = 1275 ml of network to move in 1" PVC
K 12 + 245	PVC	1"	170	PLACER INANTAS	Network crosses road RHS and penetrates through the new axis to K12+415 where it completely crosses to the LHS
K 12 + 500	PVC	1"	55	PLACER INANTAS	Network crosses road

K 13 + 015	PVC	2 x 1 "	40	PLACER INANTAS	Network connecting with the Yacuaquer aqueduct there is a crossing of networks
K 13 + 290	PVC	3 x 1 "3/4"	130	PLACER INANTAS	Crossing of networks and distribution in the El Paraiso neighborhood Tangua
K 14 + 025	PVC	4"	20	EMPOTANGUA	Crossing of networks the network is parallel to the existing axis on both sides
K 14 + 200	PVC	4 "x 3 1/2"	35	EMPOTANGUA	Crossing of networks and Pacha two ducts inside sewer
K 14 + 550	PVC	2 x 3 "1/2"	50	EMPOTANGUA	Crossing networks
K 14 + 628	PVC	2 x 3 "	40	EMPOTANGUA	Network crosses road
K 14 + 730	PVC	2 x 1 "	45	EMPOTANGUA	Network crosses road
K 14 + 892	PVC	2 x 1 "	35	EMPOTANGUA	Network crosses road
K 17 + 940	PVC	1/2 "	40	EMPOTANGUA	Network crosses road
K 18 + 125	PVC	2 "x 2 3/4"	70	EL TAMBOR	Network crosses road
K 18 + 546	PVC	1 "3/4"	40	EL TAMBOR	Network crosses road
K 18 + 637	PVC	3/4 "	50	EL TAMBOR	Network crosses road
K 18 + 852	PVC	1"	45	EL TAMBOR	Network crosses road
K 19 + 046	PVC	2 x 2"	45	EL TAMBOR	Network crosses road
K 19 + 157	PVC	2 x 1/2 "	120	EL TAMBOR	Network crosses road
K 19 + 430	PVC	1/2 "3/4"	35	EL TAMBOR	Network crosses road
K 19 + 788	PVC	1/2 "	30	EL TAMBOR	Network crosses road
K 19 + 900	PVC	2"	35	EL TAMBOR	Network crosses road
K 20 + 947	PVC	1 1/4 "	33	EL TAMBOR	Network crosses road
K 31 + 275	PVC	1/2 "	116	LA MERCED	Network crosses road and LHS is connected with new design
K 30 + 870	PVC	1/2 "	40	LA MERCED	Network crosses road

K 30 + 870	PVC	1 1/2 "	80	LA MERCED	Network crosses road parallel to the axis on RHS crossing to LHS
K 30 + 680	PVC	1"	150	LA MERCED	Network crosses road and connects with new design LHS
K 30 + 615	PVC	2"	100	LA MERCED	Network crosses road and connects with new design LHS
K 30 + 131	PVC	1"	40	LA MERCED	Network crosses road and connects with new design LHS
K 28 + 777	PVC	3"	60	CUBIJAN	Network crosses road
K 28 + 675	PVC	1"	40	CUBIJAN	Network crosses road
K 28 + 556	PVC	X 2 3/4 "	50	CUBIJAN	Network crosses road through sewer duct
K 28 + 165	PVC	3/4 "	45	CUBIJAN	Network crosses road
K 27 + 990	PVC	3/4 "	120	CUBIJAN	Network crosses road diagonally from K27+990 to K27+900
K 27 + 990	PVC	3 x 3/4 "	50	CUBIJAN	Network crosses road in Pacha 3 ducts
K 26 + 150	HG	2 x 1 "	65	CEBADAL - AJO	Network crosses road LHS to RHS
K 26 + 450	PVC	1"	15	CEBADAL - AJO	Network crosses road
K 26 + 700	PVC	1 "x 3/4" 1/2 "	30	MARQUESA ALTO	Network crosses road changing from 1" to 3/4" and 1/2"
K 26 + 900	PVC	1"	60	MARQUESA ALTO	Network crosses road on the return 6 north side
K 26 + 550	PVC	3/4 "	30	MARQUESA ALTO	Network crosses road on exiting road and penetrates in return 5
K 25 + 820	PVC	3/4 "	100	CEBADAL - AJO	Network crosses road from K25+820LD to K25+ 892LI
K 25 + 780	PVC	3 x 3/4 "	75	CEBADAL - AJO	Network crosses road in Pacha 3 ducts
K 25 + 710	PVC	3/4 "1"	26	CEBADAL - AJO	Network crosses road
K 25 + 617	PVC	1"	30	CEBADAL - AJO	Network crosses road

K 24 + 200	PVC	3/4 "	90	CEBADAL - AJO	Network crosses road from K24+200 to K24+280. The new aqueduct network layout is located in this junction.
K 22 + 100	PVC	1 1/2 "	70	CEBADAL - AJO	Network crosses road from K22+110LHS to K22+160RHS
K 22 + 722	PVC	1"	135	CEBADAL - AJO	Network crosses road from K22+722LHS and moves north changing sides at K22 + 885 where it exits the project changing diameter to 1 1/2"
K 23 + 000	PVC	1 1/2 "	60	CEBADAL - AJO	Network continuous along the new axis North direction
K 22 + 230	PVC	1 1/2 "	30	CEBADAL - AJO	Network crosses road from LHS to the new axis and continuing along it
K 22 + 000	PVC	3/4 "	30	CEBADAL - AJO	Network crosses road, coming from K21 + 830 LHS to K22 + 015 where it crosses to the RHS
K 21 + 750	AG	3"	65	EL TAMBOR	Galvanized network crosses road at K21+758RHS to K21+790LHS
K 21 + 600	PVC	1/2 "	80	EL TAMBOR	Network crosses road from K21+520 to K21+580
K 21 + 450	PVC	1/2 "	50	EL TAMBOR	Network crosses road
K 21 + 400	PVC	1"	35	EL TAMBOR	Network crosses road and extends RHS
K 21 + 378	PVC or PF	1/2 "	55	EL TAMBOR	Network crosses road and extends LHS
K 21 + 275	PVC	3/4 "	50	EL TAMBOR	Network crosses road
K 21 + 125	PVC	3"	85	EL TAMBOR	Network crosses road and extends LHS

Note: Presented information corresponds to feasibility phase designs, therefore, the information is subject to change.
Source Consortium SH 2017

ü Transport of petroleum products

Letter GCN 012-16 sent to ECOPETROL requested information of structures that would be affected in project area. ECOPETROL sends a letter with file number 00264744 for request follow-up. These letters are presented in Annex 3.2.3.3-b

ü Gas transportation

Letter GCN 010-16 requests ALCANOS company for information on gas networks that could be affected by project area. ALCANOS responds with letter DE0129 reporting that in the Pedregal - Tangua and Tangua - Pasto subsections there are no gas distribution networks currently.

ü Electric power

Table 3.8 presents a summary of the different impairments from the dual carriageway project with low and medium voltage power grids along Functional Units 4 and 5. Annexes 3.2.3.3-c, 3.2.3.3-d, 3.2.3.3-n present the intersections drawings listed below.

Table 3.8. Interference with medium and low voltage power grids

ABSCISSA	NETWORK TYPE	MATERIAL / CONDUCTOR	DIAMETER	LENGTH	AFFECTED PROVIDER	DESCRIPTION INTERFERENCE
K +565	Power	Low			Cedenar	
K +802	Power	Low			Cedenar	
K 1 + 430	Power	Low			Cedenar	
K 2 + 363	Power	Low	2H	32	Cedenar	Power grid is on LHS ending in pole
K 2 + 314	Power	Low	2H	25	Cedenar	Power grid is on LHS ending in pole
K 3 + 742	Power	Low	2H	385	Cedenar	Grid crosses road from K3+725LHS to K4+110RHS
K 4 + 275	Power	Low	2H	215	Cedenar	Grid crosses road from K4 + 110RHS to K4 + 275 crosses to LHS in 3 wire L = 40m
K 4 + 743	Power	Low	3H (35) - 2H (40)	75	Cedenar	Grid reaches RHS pole in 3 wires and 2H- crosses road in 2 wires- RHS connection pole
K 5 + 028	Power	Low	2H	178	Cedenar	Grid runs parallel on RHS and crosses at K5 + 028
K 5 + 256	Power	Low	2H	82	Cedenar	Grid crosses road - new parallel layout

K 6 +000	Power	Low	3H	280	Cedenar	Grid crosses road way at toll area from K6 + 100 to K6 + 370
K 6 + 950	Power	Low	2H	240	Cedenar	Grid crosses road in a sinble span at K6+950 K7+135 with pole and 2 connections
K 7 + 132	Power	Low	2H		Cedenar	Grid crosses road in a single span in K6 K7 + 950 and 135 with pole and 2 rush
K 7 + 465	Power	Low	3H	105	Cedenar	Grid crosses road diagonally in a single span
K 7 + 615	Power	Low	2H	210	Cedenar	Grid crosses road in a single span connects with new network pole LHS
K 8 + 660	Power	Low	2H	120	Cedenar	Grid crosses road in a single span to pole 778 to be moved for being inside the cut
K 9 + 253	Power	Low	3H	107	Cedenar	Grid crosses road with intermediate pole - Redrawing parallel to existing network
K 9 + 370	Power	Low Medium	B3H M2H	110	Cedenar	Grid crosses road in parallel medium and low voltage
K 9 + 735	Power	Low	3H	85	Cedenar	Grid crosses road from Pole 752 3 LHS connections
K 10 + 850	Power	Low	3H	110	Cedenar	Grid crosses road
K 11 + 340	Power	Low	3H	40	Cedenar	12m pole on RHS at 9m from roadside - move pole
K 11 + 770	Power	Low	2H	446	Cedenar	Grid comes through a new axis from K11+ 700 to K11 + 900 grids cross at K11 + 770 and MV line exists
K 12 + 500	Power	Low	3H	122	Cedenar	Grid crosses return lane land
K 13 + 049	Power	Low	3H	10	Cedenar	Concrete light pole on RHS – move pole 10m RHS and run LV line to LHS
K 13 + 120	Power	Low	3h	10	Cedenar	Concrete pole leaning on RHS – move pole 10m RHS
K 13 + 180	Power	Low	3H	10	Cedenar	Concrete pole leaning on RHS – move pole 10m RHS
K 13 + 220	Power	Low	3H	60	Cedenar	Concrete pole leaning on RHS – move pole 10m, RHS connects with LHS POLE move 10m LHS
K 13 + 277	Power	Low	3H	10	Cedenar	Leaning wooden pole RHS move pole 10m
K 13 + 300	Power	Low	3H	10	Cedenar	Leaning wooden pole RHS move pole 10m

K 13 + 330	Power	Low	3H	20	Cedenar	Leaning concrete pole RHS move pole 10m, connect with MV
K 13 + 365	Power	Low	3H	45	Cedenar	Leaning concrete pole RHS move pole 10m, RHS connects with LHS pole move 10m LHS
K 13 + 415	Power	Low	3H	60	Cedenar	Leaning concrete pole RHS move pole 10m, RHS connect with LHS move 30m LHS
K 13 + 483	Power	Low	3H	85	Cedenar	Leaning concrete pole RHS move pole 20m RHS, RHS connect with LHS move 30m LHS
K 13 + 520	Power	Low	3H	85	Cedenar	Leaning concrete pole RHS move pole 20m RHS, RHS connect with LHS move 30m LHS,
K 13 + 573	Power	Low	3H	60	Cedenar	Leaning wooden pole RHS move pole 15m
K 14 + 160	Power	Low	2H	45	Cedenar	Grid crosses road and passes divider
K 14 + 476	Power	Low	3H	125	Cedenar	Grid crosses both lanes and passes divider and intermediate poles – grid projected parallel to the existing grid
K 14 + 517	Power	Low	3H	15	Cedenar	Grid parallel to road on right hand lane axis
K 14 + 585	Power	Low	3H	15	Cedenar	Grid parallel to road on right hand lane axis
K 14 + 612	Power	Low	3H	15	Cedenar	Grid parallel to road on right hand lane axis
K 14 + 625	Power	Low	2H	170	Cedenar	Grid parallel to road on right hand lane axis move pole C12 to BD from here grid crosses road LHS
K 14 + 666	Power	Low	3H	15	Cedenar	Grid parallel to road on right hand lane axis move pole to BD
K 14 + 705	Power	Low	3H	15	Cedenar	Grid parallel to road on right hand lane axis move pole to BD
K 14 + 760	Power	Low	3H	15	Cedenar	Grid parallel to road on right hand lane axis move pole to BD
K 14 + 785	power	Low	3H	fifteen	Cedenar	Grid parallel to road on right hand lane axis move pole to BD
K 14 + 820	Power	Low	3H	fifteen	Cedenar	Grid parallel to road on right hand lane axis move pole to BD

K 14 + 860	Power	Low	3H	fifteen	Cedenar	Grid parallel to road on right hand lane axis move pole to BD
K 14 + 900	Power	Low	3H	fifteen	Cedenar	Grid parallel to road on right hand lane axis move pole to BD
K 14 + 945	Power	Low	3H	fifteen	Cedenar	Grid parallel to road on right hand lane axis move pole to BD
K 14 + 975	Power	Low	3H	fifteen	Cedenar	Grid parallel to road on right hand lane axis move pole to BD
K 17 + 845	Power	Low	2H	65	Cedenar	Grid crosses road
K 17 + 910	Power	Low	3H	80	Cedenar	Grid crosses road
K 18 + 130	Power	Low	3H	90	Cedenar	Grid crosses road
K 18 + 352	Power	Low	2H	80	Cedenar	Grid crosses road
K 18 + 850	Power	Low	2H	65	Cedenar	Grid crosses road
K 19 + 030	Power	Low	3H	fifty	Cedenar	Grid crosses road
K 19 + 259	Power	Low	3H	150	Cedenar	Grid parallel to the road LHS and crosses road to divider
K 19 + 600	Power	Low	3H (220) - 2H (120)	360	Cedenar	Grid parallel to the road LHS and crosses road to BD RHS lane
K 19 + 800	Power	Low	3H	150	Cedenar	Grid crosses road
K 19 + 900	Power	Low	3H	fifty	Cedenar	Grid crosses road
K 20 + 090	Power	Low	2H	fifty	Cedenar	Grid crosses road
K 20 + 410	Power	Low	2H	115	Cedenar	Grid crosses road
K 20 + 975	Power	Low	3H	680	Cedenar	Grid crosses road from K20 + 620 in two lines from BT LHS and RHS in a single span to K20 + 940 where it crosses to the LHS
K 21 + 050	Power	Low	3H	150	Cedenar	Grid runs parallel on RHS from K21+ 030 to K21 + 120 where it crosses road to the LHS according to the new design
K 21 + 233	Power	Low	2H	35	Cedenar	Grid crosses road
K 21 + 350	Power	Low	2H	90	Cedenar	Grid crosses road
K 21 + 475	Power	Low	2H	95	Cedenar	Grid crosses road
K 21 + 800	Power	Low	3H	300	Cedenar	Grid crosses road from K21+ 730 to K21 + 880

K 22 + 100	Power	Low	2H	fifty	Cedenar	Grid crosses road from K22 + 100 LHS to K22 + 130RHS
K 22 + 233	Power	Low	3H	130	Cedenar	Grid enters LHS lane
K 22 + 675	Power	Low	3H	250	Cedenar	Grid crosses road
K 22 + 800	Power	Half	2H	210	Cedenar	MV grid crosses road no exactness as to height and affectation
K 22 + 930	Power	Low	3H	160	Cedenar	Grid crosses road on the return lane in both lanes
K 23 + 125	Power	Low	3H	200	Cedenar	Grid crosses road on the return lane in both lanes
K 23 + 400	Power	Low	3H	196	Cedenar	Grid crosses road
K 23 + 619	Power	Low	3H	100	Cedenar	Grid crosses road
K 24 + 213	Power	Low	3H	1000	Cedenar	Grid crosses road from K34+ 168 RHS to K24 + 213 LHS and continuous LHS to K25 + 170 – crosses with MV grid
K 25 + 025	Power	Low	3H	55	Cedenar	Grid crosses road
K 25 + 200	Power	Low	3H	90	Cedenar	Grid crosses road
K 25 + 520	Power	Low	3H	450	Cedenar	Grid crosses road from K25 + 000 RHS to K25 + 570 LHS and continuous LHS to K25 + 890
K 25 + 900	Power	Low	3H	90	Cedenar	Grid crosses road
K 26 + 100	Power	Low	2H	80	Cedenar	Grid crosses road to terminal pole
K 26 + 150	Power	Low	2H	fifty	Cedenar	Grid crosses road
K 26 + 800	Power	Low	2H	210	Cedenar	Grid crosses road from return north side to BD RHS lane
K 27 + 015	Power	Half	2H	140	Cedenar	Grid crosses road
K 27 + 450	Power	Low	3H	245	Cedenar	Grid crosses road from pole LLHSI in two BT branches to RHS
K 28 + 135	Power	Low	3H	430	Cedenar	Grid parallel to the axis RHS to crossing to LHS at K28 + 130 LHS
K 28 + 750	Power				Cedenar	Grid crosses road

K 28 + 788	Power	Low	3H	343	Cedenar	Grid crosses road on RHS with AP pole crossing to LHS at I27 + 740
K 29 + 200	Power	Low	3H	870	Cedenar	Grid crosses road RHS with poles crossing to LHS at K29 + 200 crossing to RHS at k29 + 320
K 30 + 115	Power	Low	3H	65	Cedenar	Grid crosses road
K 30 + 580	Power	Low	3H	1250	Cedenar	Grid runs parallel to road RHS with MV and LV with lamppoles from K30 + 580 to K30 + 770
K 30 + 770	Power	Low			Cedenar	Grid runs parallel to road RHS with MV and LV with lamppoles
K 30 + 810	Power	Low			Cedenar	Grid runs parallel to road RHS with MV and LV with lamppoles
K 30 + 940	Power	Low			Cedenar	Grid runs parallel to road RHS with MV and LV with lamppoles

Source Consortium SH 2017

ü IT and communications networks

Table 3.9 summarizes the different interferences from the dual carriageway project with IT and communications networks along Functional Units 4 and 5. Annexes 3.2.3.3-e through 3.2.3.3-i show drawings of the following interferences.

Table 3.9. Interference with IT networks

ABSCISSA	NETWORK TYPE	MATERIAL/ CONDUCTOR	LENGTH	AFFECTED PROVIDED	DESCRIPTION INTERFERENCE
K 2 + 391	Telecommunications	Optical fiber	15	Telefónica	Pole 877 must be moved move 15m LHS - The network crosses from this pole to 866 in a span
K 2 + 785	Telecommunications	Optical fiber	15	Telefónica	Pole 866 pole must be moved 15m RHS
K 3 + 300	Telecommunications	Optical fiber	15	Telefónica	Pole 860 must be moved 15m LHS – the network crosses from this pole to 866 in a span

K +6	Telecommunications	Optical fiber	15	Claro	Pole 995 straddles RHS must be moved
K +410	Telecommunications	Optical fiber	15	Claro	Pole 981 straddles RHS must be moved
K +640	Telecommunications	Optical fiber	15	Claro	Pole 978 straddles RHS must be moved
K +740	Telecommunications	Optical fiber	15	Claro	Pole 969 straddles RHS must be moved
K +877	Telecommunications	Optical fiber	15	Claro	Pole 965 straddles RHS must be moved
K +940	Telecommunications	Optical fiber	15	Claro	Pole 963 straddles RHS must be moved
K 1 + 160	Telecommunications	Optical fiber	15	Claro	Pole 957 straddles RHS must be moved
K 1 + 565	Telecommunications	Optical fiber	20	Claro	Pole 948 straddles RHS must be moved
K 1 + 770	Telecommunications	Optical fiber	20	Claro	Pole 943 straddles RHS must be moved
K 1 + 855	Telecommunications	Optical fiber	30	Claro	Poles 902 and 901 RHS must be moved and move network crossing the road
K 2 + 336	Telecommunications	Optical fiber	30	Claro	Pole 876 straddles LHS must be move
K 2 + 490	Telecommunications	Optical fiber	160	Claro	Network crosses road Pole 868 straddles RHS must be moved
K 2 + 750	Telecommunications	Optical fiber	20	Claro	Network crosses road Pole 878 straddles RHS must be moved
K 3 + 100	Telecommunications	Optical fiber	20	Claro	Network crosses road Pole 862 straddles RHS must be moved
K 3 + 250	Telecommunications	Optical fiber	20	Claro	Network crosses road Pole 861 straddles RHS must be moved
K 3 + 481	Telecommunications	Optical fiber	15	Claro	Network crosses road Pole 859 straddles RHS must be moved
K 3 + 900	Telecommunications	Optical fiber	10	Telefónica	Pole 853 must be moved 10 RHS - network crosses out of the way from P857

K 3 + 906	Telecommunications	Optical fiber	15	Claro	Pole 852 must be move RHS
K 4 + 110	Telecommunications	Optical fiber	15	Claro	Pole 850 must be move RHS
K 4 + 186	Telecommunications	Optical fiber		Claro	
K 4 + 267	Telecommunications	Optical fiber	355	Telefónica	Network must be moved - interferes on road from P857 to P848
K 4 + 340	Telecommunications	Optical fiber	170	Claro	Network must be moved - interferes on road from P849 to P846 must be moved RHS
K 5 + 127	Telecommunications	Optical fiber	15	Telefónica	Network must be moved - P837 must be move
K 4 + 635	Telecommunications	Optical fiber	25	Claro	P843 interferes with RHS lane - must be moved to the RHS
K 4 + 800	Telecommunications	Optical fiber	25	Claro	P841 interferes with RHS lane - must be moved to the RHS
K 5 + 030	Telecommunications	Optical fiber	25	Claro	P838 interferes with RHS lane - must be moved to the RHS
K 5 + 105	Telecommunications	Optical fiber	25	Claro	P836 interferes with RHS lane - must be moved to the RHS
K 5 + 350	Telecommunications	Optical fiber	20	Claro	P834 interferes with rail pole LD - must move to the LD
K 6 +000	Telecommunications	Optical fiber	20	Claro	827 interferes with RHS lane - must be moved to the RHS
K 6 + 200	Telecommunications	Optical fiber	20	Claro	P821 interferes with toll zone - must be moved at RHS
K 6 + 440	Telecommunications	Optical fiber	15	Claro	P817 interferes with RHS lane - must be moved to the RHS
K 6 + 530	Telecommunications	optical fiber	30	Claro	P816 interferes with RHS lane - must be moved to the RHS
K 6 + 700	Telecommunications	Optical fiber	15	Claro	P815 interferes with RHS lane - must be moved to the RHS
K 6 + 900	Telecommunications	optical fiber	40	Claro	P813 interferes with RHS lane - must be moved to the RHS
K 7 + 132	Telecommunications	Optical fiber	20	Claro	Network crosses road and ends in Pole 805 LHS - Pole must be moved to LHS

K 7 + 900	Telecommunications	Optical fiber		Claro	
K 10 + 120	Telecommunications	Optical fiber	10	Claro	Network comes from LHS slope pole interferes with the slope - must be moved to LHS
K 10 + 370	Telecommunications	Optical fiber	25	Claro	Pole 747 interferes with newly designed axis - must be moved to LHS
K 10 + 530	Telecommunications	Optical fiber	25	Claro	Pole 746 interferes with newly designed axis - must be moved to LHS
K 10 + 770	Telecommunications	Optical fiber	20	Claro	Pole 742 interferes with RHS - must be moved to the RHS
K 10 + 995	Telecommunications	Optical fiber	30	Claro	Pole 738 interferes with newly designed axis - must be move at RHS
K 11 + 220	Telecommunications	Optical fiber	30	Claro	Pole 735 interferes with RHS lane - must be move to the LHS
K 12 + 166	Telecommunications	Optical fiber	30	Claro	Pole 714 interferes with RHS lane - must be move to the RHS
K 12 + 235	Telecommunications	Optical fiber	30	Claro	Pole 711 must be moved RHS to change network alignment and avoid interference
K 12 + 469	Telecommunications	Optical fiber	30	Claro	Pole 710 interferes with RHS lane - must be move to the RHS
K 12 + 650	Telecommunications	Optical fiber	10	Claro	Pole 707 with slope - must be moved RHS
K 13 + 000	Telecommunications	Optical fiber	20	Claro	Pole 704 with slope - must be moved RHS to improve network alignment RHS
K 12 + 650	Telecommunications	Optical fiber	10	Claro	Pole 707 with slope - must be moved RHS
K 16 + 700	Telecommunications	Optical fiber	250	Claro	Network crosses road from K16700 to K16 + 950 between P623 and P621
K 18 + 085	Telecommunications	Optical fiber	30	Claro	Pole 611 interferes with RHS lane - must move to the RHS
K 18 + 237	Telecommunications	Optical fiber	30	Claro	Pole 608 interferes with RHS lane - must move to the RHS
K 18 + 393	Telecommunications	Optical fiber	30	Claro	Pole 603 interferes with RHS lane - must move to the RHS
K 18 + 619	Telecommunications	Optical fiber	10	Claro	Network crosses road - P602 must be moved to LHS

K 19 + 645	Telecommunications	Optical fiber	10	Claro	Network crosses road - P573 must be moved to LHS and improve network alignment on LHS
K 19 + 645	Telecommunications	Optical fiber	10	Claro	Network crosses road - P573 must be moved to LHS and improve network alignment on LHS
K 19 + 980	Telecommunications	Optical fiber	20	Claro	Pole 565 interferes with rail pole LD- must move to the LD and improve the alignment of the LD network
K 20 + 580	Telecommunications	Optical fiber	20	Claro	Pole 553 interferes with lane RHS- must be moved to the RHS and improve network alignment of road crossing
K 20 + 700	Telecommunications	Optical fiber	10	Claro	Pole 550 interferes with LHS lane must be moved to LHS and improve network alignment
K 20 + 940	Telecommunications	Optical fiber	30	Claro	Pole 549 interferes with RHS lane must be moved to RHS
K 20 + 945	Telecommunications	Optical fiber	20	Claro	Pole 546 interferes with RHS lane must be moved to RHS
K 21 + 050	Telecommunications	Optical fiber	10	Claro	Pole 542 interferes with RHS lane must be moved to RHS
K 21 + 105	Telecommunications	Optical fiber	30	Claro	Pole 540 interferes with RHS lane must be moved to RHS
K 21 + 315	Telecommunications	Optical fiber	30	Claro	Pole 533 interferes with the axis of the new road - must be moved to RHS
K 21 + 550	Telecommunications	Optical fiber	30	Claro	Pole 529 interferes with the axis of the new road - must be moved to RHS and remove the network the axis
K 21 + 765	Telecommunications	Optical fiber	15	Claro	Pole 516 interferes with LHS lane must be moved to LHS
K 22 + 150	Telecommunications	Optical fiber	30	Claro	Pole 508 interferes with LHS lane must be moved to LHS
K 22 + 370	Telecommunications	Optical fiber	40	Claro	Pole 503 interferes with LHS lane must be moved to LHS
K 22 + 790	Telecommunications	Optical fiber	40	Claro	Pole 495 interferes with LHS lane must be moved to LHS
K 25 + 570	Telecommunications	Optical fiber	30	Claro	Pole 424 interferes with the axis of the new road - must be moved to LHS and lay network LHS
K 5 + 600	Telecommunications	Optical fiber	350	Telefónica	Network leaning in RHS - must be moved between P832 and P828

K 7 + 915	Telecommunications	Optical fiber		Telefónica	Network crossing on the road
K 9 + 400	Telecommunications	Optical fiber		Telefónica	Network crossing on the road
K 9 + 700	Telecommunications	Optical fiber		Telefónica	Network crossing on the road
K 9 + 735	Telecommunications	Optical fiber	410	Telefónica	Network leaning in LHS - must be moved between P753 and P749 to K10 + 160
K 10 + 160	Telecommunications	Optical fiber	410	Telefónica	Network leaning in LHS - must be moved between P749 and P745 to K10 + 578
K 10 + 950	Telecommunications	Optical fiber	25	Telefónica	Pole straddling RHS - P740 must be moved
K 11 + 276	Telecommunications	Optical fiber	20	Telefónica	Pole straddling RHS - P736 must be moved
K 11 + 700	Telecommunications	Optical fiber	20	Telefónica	Pole straddling RHS - P723 must be moved
K 12 + 000	Telecommunications	Optical fiber	15	Telefónica	Pole straddling RHS - must move P715
K 12 + 225	Telecommunications	Optical fiber	240	Telefónica	Optical fiber network straddles RHS lane - must move P712
K 12 + 702	Telecommunications	Optical fiber	15	Telefónica	Straddling pole RHS - must move P706
K 12 + 720	Telecommunications	Optical fiber	20	Telefónica	Straddling pole RHS - must move P706
K 13 + 120	Telecommunications	Optical fiber	400	Telefónica	Network crosses road and straddles LHS - network must be moved and move pole P702
K 13 + 483	Telecommunications	Optical fiber	400	Telefónica	Network crosses road and straddles RHS - network must be moved and move pole P686
K 13 + 920	Telecommunications	Optical fiber	440	Telefónica	Network crosses road and straddles RHS - network must be moved and move pole P674
K 14 + 385	Telecommunications	Optical fiber	460	Telefónica	Network crosses road in two sections and straddles separator at Tangue RHS - network must be moved and move pole P661

K 14 + 600	Telecommunications	Optical fiber	220	Telefónica	Network crosses road and straddle on LHS from P661 to P651 P651 must move
K 14 + 613	Telecommunications	Optical fiber	60	Telefónica	Network crosses road from LHS to RHS
K 15 + 059	Telecommunications	Optical fiber	180	Telefónica	Network crosses road on RHS - must move network and P636 and P633
K 15 + 420	Telecommunications	Optical fiber	230	Telefónica	Network crosses road on RHS and LHS - must move network and P633 and P630
K 15 + 780	Telecommunications	Optical fiber	10	Telefónica	Straddled pole RHS - must move P627
K 16 + 875	Telecommunications	Optical fiber	240	Telefónica	Network crosses road on RHS and LHS between poles P624 and P622
K 17 + 615	Telecommunications	Optical fiber	210	Telefónica	Network straddles RHS- must move P618 and P616
K 18 + 320	Telecommunications	Optical fiber	20	Telefónica	Network straddles RHS- must move P606
K 18 + 770	Telecommunications	Optical fiber	260	Telefónica	Network crosses road RHS and LHS between poles P599 and P593 - must move P593RHS
K 19 + 400	Telecommunications	Optical fiber	425	Telefónica	Network crosses road between poles RHS P593 and P575 in a single span and continuous on separator on the head return
K 24 + 000	Telecommunications	Optical fiber	495	Telefónica	Network crosses road on RHS relief road - network must be move between P470 and P463 RHS
K 24 + 670	Telecommunications	Optical fiber	15	Telefónica	Pole straddles LHS - P445 should be moved to lhs
K 25 + 400	Telecommunications	Optical fiber	315	Telefónica	Network crosses road LHS to RHS between P430 to P426
K 25 + 700	Telecommunications	Optical fiber	250	Telefónica	Network straddles on RHS between P426 to P422 - P422 should move to the RHS
K 26 + 190	Telecommunications	Optical fiber	30	Telefónica	Pole straddles RHS - must move P402
K 26 +	Telecommunications	Optical fiber	40	Telefónica	Pole interferes with separator - P398

535					should be moved to LHS
K 26 + 918	Telecommunications	Optical fiber	30	Telefónica	Pole interferes with separator - P390 should be moved to LHS
K 27 + 260	Telecommunications	Optical fiber	30	Telefónica	Network straddles LD P384 - must move to the RHS
K 27 + 900	Telecommunications	Optical fiber	30	Telefónica	Network straddles LD P371 - must move to the RHS
K 27 + 325	Telecommunications	Optical fiber	40	Telefónica	Pole P339 straddles on RHS lane in the return - should move pole to RHS
K 27 + 970	Telecommunications	Optical fiber	440	Telefónica	Network crosses road from P339 to P331 - P331 should be moved to LHS
K 30 + 334	Telecommunications	Optical fiber	fifty	Telefónica	Network crosses road from P328 to P323 - P323 must be moved to LHS and thus saves interference
K 30 + 646	Telecommunications	Optical fiber	25	Telefónica	Network crosses road from P323 to P322 - P322 must be moved to LHS and thus saves interference
K 30 + 947	Telecommunications	Optical fiber	10	Telefónica	Network crosses road LHS from P322 to P310 - P310 should be moved to RHS
K 31 + 300	Telecommunications	Optical fiber	40	Telefónica	Network crosses road from P310 to P304 - must move P304 to RHS and thus saves interference
K 31 + 675	Telecommunications	Optical fiber	40	Telefónica	Network crosses road from P274 P270 - P270 must be moved to RHS and thus saves interference
K 32 + 200	Telecommunications	Optical fiber	20	Telefónica	Network crosses road from P270 to P267 - must move P267 RHS and thus saves interference
K 32 + 680	Telecommunications	Optical fiber	40	Telefónica	Network crosses road from P266 to P265 - must move P265 RHS and thus saves interference
K 25 + 774	Telecommunications	Optical fiber	30	Claro	Pole 418 interferes with the axis of the new road - should move to LHS and lay network on LHS
K 26 + 300	Telecommunications	Optical fiber	30	Claro	Pole 400 interferes with the axis of the new road - should move to LHS and lay network on LHS
K 26 + 400	Telecommunications	Optical fiber	30	Claro	Pole 399 interferes with the axis of the new road - should move to pull network LI and LI
K 26 + 650	Telecommunications	Optical fiber	30	Claro	Pole 397 interferes with the axis of the new road - should move to LHS and lay network on LHS

K 26 + 850	Telecommunications	Optical fiber	30	Claro	Pole 391 interferes with the return separator - must move to LHS of the LHS lane
K 27 + 050	Telecommunications	Optical fiber	30	Claro	Pole 389 interferes on LHS lane - must move to LHS
K 27 + 300	Telecommunications	Optical fiber	30	Claro	Pole 383 interferes on RHS lane - must move to the RHS
K 27 + 450	Telecommunications	Optical fiber	30	Claro	Pole 381 interferes on RHS lane - must move to the RHS
K 27 + 722	Telecommunications	Optical fiber	15	Claro	Pole 376 interferes on RHS lane should move to the RHS for better alignment
K 27 + 951	Telecommunications	Optical fiber	15	Claro	Pole 370 interferes on RHS lane should move to the RHS for better alignment
K 27 + 973	Telecommunications	Optical fiber	10	Claro	Pole 369 interferes on RHS lane should move to the RHS for better alignment
K 28 + 014	Telecommunications	Optical fiber	10	Claro	Pole 368 interferes on RHS lane should move to the RHS for better alignment
K 28 + 300	Telecommunications	Optical fiber	15	Claro	Pole 364 interferes on RHS lane should move to the RHS for better alignment
K 28 + 960	Telecommunications	Optical fiber	30	Claro	Pole 350 interferes on RHS lane should move to the RHS for better alignment
K 29 + 015	Telecommunications	Optical fiber	40	Claro	Pole 338 interferes on RHS lane on the return - should move to the RHS
K 29 + 015	Telecommunications	Optical fiber	40	Claro	Pole 338 interferes on RHS lane on the return - should move to the RHS
K 29 + 865	Telecommunications	Optical fiber	20	Claro	Pole 330 interferes on RHS lane - should move to the RHS
K 30 + 632	Telecommunications	Optical fiber	20	Claro	Pole 319 interferes on RHS lane - should move to the RHS
K 30 + 917	Telecommunications	Optical fiber	10	Claro	Pole 312 interferes on RHS lane on the return - should move to the RHS – network crosses road
K 31 + 231	Telecommunications	Optical fiber	30	Claro	Pole 306 interferes on RHS lane on the return - should move to the RHS to save interference
K 31 + 341	Telecommunications	Optical fiber	30	Claro	Pole 300 interferes with separator - move to the RHS to save interference
K 31 + 445	Telecommunications	Optical fiber	15	Claro	Pole 282 interferes with RHS lane - must move to the RHS
K 31 +	Telecommunications	Optical fiber	10	Claro	Pole 281 interferes with RHS lane -

495					must move to the RHS
K 31 + 826	Telecommunications	Optical fiber	10	Claro	Pole 272 interferes with RHS lane - must move to the RHS
K 31 + 053	Telecommunications	Optical fiber	10	Claro	Pole 269 must move to the RHS to improve network alignment
K 32 + 137	Telecommunications	Optical fiber	10	Claro	Pole 268 must move to the LD network to improve alignment
K 32 + 280	Telecommunications	Optical fiber	40	Claro	Pole 289 interferes with LHS lane must move to the LHS to improve network alignment
K 32 + 459	Telecommunications	Optical fiber	25	Claro	Pole 291 interferes with LHS lane must move to the LHS to improve network alignment
K 32 + 600	Telecommunications	Optical fiber	15	Claro	Pole 292 interferes with LHS lane must move to the LHS to improve network alignment
K 32 + 600	Telecommunications	Optical fiber	15	Claro	Pole 292 interferes with LHS lane must move to the LHS to improve network alignment
K 21 + 602	Telecommunications	Optical fiber	535	Telefónica	Road crosses on RHS and LHS between P536 P522and P518
K 21 + 233	Telecommunications	Optical fiber	25	Telefónica	Pole straddles RHS - must move P537
K 20 + 955	Telecommunications	Optical fiber	twenty	Telefónica	Pole straddles RHS - must move P545 to RHS
K 20 + 630	Telecommunications	Optical fiber	300	Telefónica	Road crosses road on RHS and LHS poles P551 and P545 in single span - must move pole P545 to RHS
K 21 + 883	Telecommunications	Optical fiber		Claro	
K 22 + 500	Telecommunications	Optical fiber		Claro	
K 24 + 225	Telecommunications	Optical fiber	30	Claro	Pole 456 interferes with LHS lane must move to LHS
K 22 + 300	Telecommunications	Optical fiber	25	Telefónica	Pole straddles lhs – must move P505 to LHS
K 22 + 641	Telecommunications	Optical fiber	290	Telefónica	Network crosses from LHS to RHS between P499 and P487
K 24 + 250	Telecommunications	Optical fiber	255	Telefónica	Network crosses from LHS to RHS - P455 must move to LHS

K 33 + 738	TV		10	Digitel	Crossing of network and continuous network on RHS roadway – move pole 203 and improve alignment
K 34 + 000	TV		10	Digitel	Pole 187 interferes with RHS lane must move to the RHS
K 34 + 040	TV		10	Digitel	Pole 185 interferes with RHS lane must move to the RHS
K 34 + 070	TV		15	Digitel	Pole 183 interferes with RHS lane must move to the RHS
K 34 + 112	TV		15	Digitel	Pole 182 interferes with RHS lane must move to the RHS
K 34 + 148	TV		15	Digitel	Pole 177 interferes with RHS lane must move to the RHS thus aligning the network on the RHS
K 34 + 500	TV		15	Digitel	Pole 159 interferes with RHS lane must move to the RHS thus aligning the network on the RHS
K 34 + 540	TV		15	Digitel	Pole 157 interferes with RHS lane must move to the RHS thus aligning the network on the RHS
K 34 + 560	TV		15	Digitel	Pole 156 interferes with RHS lane must move to the RHS thus aligning the network on the RHS
K 34 + 590	TV		15	Digitel	Pole interferes with RHS lane must move to the RHS thus aligning the network on the RHS
K 34 + 620	TV		15	Digitel	Pole 153 interferes with RHS lane must move to the RHS thus aligning the network on the RHS
K 34 + 785	TV		15	Digitel	Pole 146 interferes with RHS lane must move to the RHS thus aligning the network on the RHS
K 34 + 980	TV		15	Digitel	Pole 142 interferes with RHS lane must move to the RHS thus aligning the network on the RHS
K 35 + 026	TV		15	Digitel	Pole 141 interferes with RHS lane must move to the RHS thus aligning the network on the RHS
K 35 + 082	TV		15	Digitel	Pole 138 interferes with RHS lane must move to the RHS thus aligning the network on the RHS

K 35 + 150	TV		15	Digitel	Pole 134 interferes with RHS lane must move to the RHS thus aligning the network on the RHS
K 35 + 219	TV		15	Digitel	Pole 132 interferes with RHS lane must move to the RHS thus aligning the network on the RHS
K 35 + 207	TV		15	Digitel	Pole 129 interferes with RHS lane must move to the RHS thus aligning the network on the RHS
K 35 + 335	TV		15	Digitel	The network crosses the in the right lane between P128 and 127A - should be moved to RHS
K 35 + 974	TV		15	Digitel	Pole 106 interferes with RHS lane must move to the RHS and improve network alignment
K 36 + 030	TV		15	Digitel	Pole 102 interferes with RHS lane must move to the RHS and improve network alignment
K 36 + 500	TV		15	Digitel	Pole 78 interferes with RHS lane crossing the road to the LHS to pole 88 and on returns the LHS to exit the area of influence
K +50	TV		15	TVPYP	Pole 994 interferes with RHS lane must move to the RHS and improve network alignment
K +150	TV		15	TVPYP	Pole 990 interferes with RHS lane must move to the RHS thus aligning the network on the RHS
K +424	TV		15	TVPYP	Pole 980 interferes with RHS lane must move to the RHS and improve network alignment
K +539	TV		15	TVPYP	Pole 979 interferes with RHS lane must move to the RHS and improve network alignment
K +815	TV		15	TVPYP	Network crosses road between 974 and 966 – Pole 966 interferes with RHS should move LHS
K +875	TV		15	TVPYP	Pole 964 interferes with RHS lane must move to the RHS and improve network alignment

K +927	TV		15	TVPYP	Pole 963 interferes with RHS lane must move to the RHS and improve network alignment
K 1 + 205	TV		15	TVPYP	Pole 956 interferes with RHS lane must move to the RHS and improve network alignment
K 1 + 263	TV		15	TVPYP	Pole 954 interferes with RHS lane must move to the RHS and improve network alignment
K 1 + 360	TV		15	TVPYP	Pole 953 interferes with RHS lane must move to the RHS and improve network alignment
K 1 + 450	TV		15	TVPYP	Pole 949 interferes with RHS lane must move to the RHS and improve network alignment
K 1 + 550	TV		15	TVPYP	Pole 946 interferes with RHS lane must move to the RHS and improve network alignment
K 1 + 687	TV		15	TVPYP	Pole 944 interferes with RHS lane must move to the RHS and improve network alignment
K 1 + 763	TV		15	TVPYP	Pole 942 interferes with RHS lane must move to the RHS and improve network alignment
K 1 + 851	TV		50	TVPYP	Pole 902 interferes with the axis – the network crosses the road must move LHS and improve network alignment
K +50	TV		15	TVAZTECA	Pole 994 interferes with RHS lane must move to the RHS and improve network alignment
K +150	TV		15	TVAZTECA	Pole interferes with lane LD 990 - LD should move network and improve alignment
K +424	TV		15	TVAZTECA	Pole 980 interferes with RHS lane must move to the RHS and improve network alignment
K +539	TV		15	TVAZTECA	Pole 979 interferes with RHS lane - network crosses road must move to RHS and improve network alignment
K +815	TV		15	TVAZTECA	Network crosses road between 974 and 966 – Pole 966 interferes with RHS lane must move RHS
K +875	TV		15	TVAZTECA	Pole 964 interferes RHS lane – the network crosses the road must be moved RHS and improve network alignment

K +975	TV		15	TVAZTECA	Pole 961 LD interferes RHS lane – the network crosses the road must be moved RHS and improve network alignment
K 1 + 123	TV		15	TVAZTECA	Pole 958 interferes RHS lane – the network crosses the road must be moved RHS and improve network alignment
K 1 + 159	TV		10	TVAZTECA	Pole 957 interferes RHS lane – the network crosses the road must be moved RHS and improve network alignment
K 1 + 430	TV		10	TVAZTECA	Pole 952 interferes RHS lane – the network crosses the road must be moved RHS and improve network alignment
K 1 + 500	TV		15	TVAZTECA	Pole 949 interferes RHS lane – the network crosses the road must be moved RHS and improve network alignment
K 1 + 550	TV		15	TVAZTECA	Pole 946 interferes RHS lane – must be moved RHS and improve network alignment
K 1 + 687	TV		15	TVAZTECA	Pole 944 interferes RHS lane – must be moved RHS and improve network alignment
K 1 + 763	TV		15	TVAZTECA	Pole 942 interferes RHS lane – must be moved RHS and improve network alignment
K 1 + 851	TV		50	TVAZTECA	Pole 902 interferes with axis - network crosses the road must move LHS and improve network alignment

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- Others

ü Roads

Annex 3.2.1.1 presents the list of roads and paths intercepted by the project. Presented information was obtained from a field survey.

ü Properties

Annex 3.2.3.1-a and 3.2.3.1-b presents the right of way for the project.

3.2.4 Project supplies

Annexes 3.2.4-a to 3.2.4-w presents safety data sheets of supplies to be used in the project for information and appropriate handling thereof.

Table 3.10. shows the total amount of each project supply.

Table 3.10 Number of supplies of functional units UF4 and UF5

SUPPLIES FUNCTIONAL UNIT 4 AND 5		
Id	SUPPY NAME	TOTAL QUANTITY
30	Concrete pump	50,968.66 m3
83	Excavation material	44,650,055.11 m3
84	Embankment material	9,805,764.47 m3
85	Terraplain material	5,796 m3
86	Geotextile NT 1600	31,569.57 m2
87	Geotextile NT 2500	24,582.35 m2
89	Concrete Class E (17.5 MPa)	13,995.34 m3
90	Concrete 21 Mpa	4305.62 m3
91	Concrete 28 Mpa	27,133.26 m3
92	Steel reinforcement fy = 420 Mpa	7,914,866.65 kg
93	Concrete Pipe D = 1.8 m	354.07 ml
94	Concrete Pipe D = 1.5m	152.04 ml
95	Concrete Pipe D = 1.2m	478.17 ml
96	Concrete Pipe D = 0.9m	3135.72 ml
97	PVC Perforated pipe 2-1 / 2 "	17.076 ml
98	Selected fill material	229,276.77 m3
99	Structural Steel ASTM A500	116,211.7 kg
100	Decking sheet 3 "	782.86 m2
101	Welding (electrodes E-7018)	368.64 kg
102	Neoprene (40x20x5.2cm)	4 units
103	Elastomeric joint 50mm	1188.26 ml
104	Metal formwork	100,923.08 m2

105	PVC pipe 4 "	2774.12 ml
106	PVC pipe 2 "	3253.1 ml
107	Filteromg material	7729.53 m3
108	Biomantle	349.944 m2
110	D = 25mm bolt	16.512 ml
111	Nut and plate for bar D = 25mm	ud 2311.68
112	Slurry a / c 0.40: 0.60	165.12 m3
113	Concrete 35 Mpa	15,325.92 m3
116	Bentonite	20.469 kg
122	Transflex joint TR2400	76.8 ml
123	Neoprene D60 60x45x6	32 ud
124	Neoprene D60 25x25x2	64 ud
125	Neoprene D60 25x20x2	24 ud
126	Neoprene D60 50x50x6	20 ud
127	Self-leveling mortar	23 Lt
128	Concrete 24.5 Mpa	210 m3
129	Hot dense mixture type MDC-2	328.49 m3
130	Hot dense mixture type MDC-3	33,139.11 m3
133	Pre-stressed steel	289,333.97 kg
134	Topsoil – top soil removal	652.986 m2
136	Climbing formwork	7881.93 m2
137	Pole-stressed beams	12 units
150	Tack CRR-1	662,783.41 m2
151	Asphalt emulsion CRR-1	298252.54 Lt
152	Dense hot mixture type MSC-1	53,726.68 m3
153	Acrylic paint	Gal 3875.54
154	Microspheres	3,841 kg
155	Demarcation lines	184448.6 ml
156	Reflective speed bumps	30.482 ud
157	Epoxy	6096.4 kg
158	Signals Type I (90x90)	564 ud
160	Signal Type V	42 ud
161	Prefabricated mileage pole	64 ud
168	Trash cans	1 pc

179	Improvement material	229,022.58 m3
180	Subbase	200,394.62 m3
181	Base	139941.7 m3
182	Asphalt emulsion	1511063 Lt
183	Priming irrigation	671,583.59 m2
184	Vertical Type II signal	21 ud
185	Vertical Type III signal	610 ud
186	Metal defense	28697.34 ml
187	Final section	1,004 ud
188	Light reflector	8,063 ud
190	TOLL	1 pc
199	Tritube UF4	1 Global
200	SOS poles UF4	1 Global
201	Earthworks and urbanization UF4	1 Global
202	Lighting UF4	1 Global
203	Triple torsion mesh	247.887 m2
214	POLES CCTV UF 4	1 Global
215	Variable message panels UF 4	1 Global
216	Gage metering panels and points UF 4	1 Global
217	UF4 connections	1 Global
218	UF4 buildings	1 Global
222	Tritube 5.1	1 Global
223	5.1 SOS poles	1 Global
224	Cctv poles UF 5.1	1 Global
225	Variable message signs 5.1	1 Global
226	Lighting 5.1	1 Global
238	Booster	6,158 ud
239	Non-electric detonator 18 m	6,158 ud
240	Iinsensible electric detonator	6,158 ud
241	Connector 3; 6 m 42 ms	6,158 ud
242	Explosive Emulin-b	123.154 Kg
247	Transportation and handling of explosives	6,158 ud
248	Enclosure with barbed wire	68.000 ml
249	Geotextile TR 6000	259,416.45 m2

250	Geotextile TR 5000	219,090.35 m2
251	Geotextile TR 3000	20554.4 m2
253	Excess material	275.44 m3
254	Welded Mesh D84	61.438 m2
255	Concrete 14 Mpa	19,537.22 m3
257	Vertical strip drains	40.406 ml
258	Geotextile NT 6000	70,936.74 m2
259	Pin D = 1-1 / 8" includes slurry and accessories	24954.52 ml
266	Rockfill riprap for protection	116.34 m3
291	14MPa shotcrete	5571.7 m3
314	Gunite machine	5571.7 m3
354	Advancer carriage width 11.40m - Guaitara	2 PAIRS

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3.2.4.1 Construction materials

Annex 3.2.4.1-a presents data sheets of stone materials which describe their management and specifications because it is important to have the best materials for construction of the dual carriageway.

As the project develops, consumption of material used for the project will be listed in the environmental compliance reports -ICA.

3.2.4.2 Materials and products such as fuels, oils, greases, solvents, among others.

The fuel used for the project will be fuel oil for engines (diesel fuel) which is a mixture of hydrocarbons obtained by fractional distillation of petroleum, and is used for internal combustion engines Diesel or heat engines type.

For operation of machinery, plant, equipment, power generation and vehicles transporting machinery, materials, equipment and personnel, a total of 30 million l / day is forecasted, which will be distributed in the different work fronts using a tank truck with pump.

Because diesel fuel is a flammable liquid, there will be no temporary storage at the work sites or process plants; they will be supplied by tanker trucks with pump capacity not greater than 10000 liters considering the measures set out in the fuel security sheets Annex 3.2.4-b.

Machinery in the work sites and process plants will be supplied by tanker trucks with pumps owned by the service provider that will receive safety follow-up, review of the license to transport dangerous substances issued by the ministry of transport and carry of the security elements defined for transportation of chemicals.

When supplying, the tanker truck should remain with the safety brake and properly blocked in order to avoid unwanted movement, the engine off but the driver should be near the truck in order to evacuate the car in case of an emergency.

To ensure that the connections are in good condition without visual leaking fuel, and the meter should give the value of supplied fuel in liters or gallons; a record must be kept in the field per unit (machine, vehicle, generator, plant) in order to calculate fuel consumption per month.

3.2.4.3 Processed supplies as hydraulic concrete, asphalt concrete, prefabricated and crushed, among others.

Processed supplies as hydraulic concrete, asphalt concrete and prefabricated will be produced in processing plants depending on project requirements. Annexes 3.2.4.a to 3.2.4-u present the approximate amounts of these supplies for project implementation.

3.2.4.4 Explosives

To implement project activities and proposed works, Functional Units UF4 and UF5 considered the need for blasting and / or explosives or other similar construction material as the project develops.

The environmental compliance reports –ICA will list the amount of explosives as well as the places where they will be used for project development. Annex 3.2.4-w includes the instructions for handling explosives.

3.2.4.5 Surplus material

Annex 3.2.4.5-c presents the mass diagrams for Functional Units UF4 and UF5 Subsection 1.

3.2.5 Handling and disposal of surplus excavation and construction materials and demolition at the feasibility level

For project execution in the Functional Units UF-4 and UF-5.1, waste construction excavation material will be disposed of in 33 Debris and Excavation Material Management areas (ZODME), of which 11 are in UF4 and 22 in UF5 respectively. Table 3.11 and Table 3.12 lists and summarizes the general characteristics of each ZODME also indicating the annex containing the design.

Table 3.11. General description of ZODMES UF4

ID	Location		Side of the road	Area (Ha)	Capacity (M3)	Design		
	Abscissa	Sector				Annexed	Filters	Works
Z4-1	K 0 + 000	Pilcuan	Right	2.68	311.253	3-2-5-a	X	X
Z4-2	K 0 + 400	Pilcuan	Right	0.47	5,954	3-2-5-a	X	X
Z4-3	K 2 + 000	Pedregal	Right	0.79	29.415	3-2-5-a	X	X
ZR4-1	K 2 + 100	Pedregal	Right	1.10	47.716	3-2-5-a	X	X
Z4-4	K 5 + 200	Inantas Bajo	Left	6.75	763810	3-2-5-a	X	X
Z4-5	K 5 + 200	Inantas Bajo	Left	5.05	694.854	3-2-5-a	X	X
Z4-6	K 8 + 600	Cocha Verde	Right	6.43	737.886	3-2-5-a	X	X
ZR4-2	K 8 + 600	Cocha Verde	Right	2.67	93.159	3-2-5-a	X	X
Z4-7	K 10 + 400	San Pedro Obraje	Right	10.65	1221882	3-2-5-a	X	X
Z4-8	K 12 + 680	Tangua	Right	3.13	216.794	3-2-5-a	X	X
Z4-9	K 14 + 560	El Vergel	Right	3.74	465.186	3-2-5-a	X	X

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Table 3.12. General description of the ZODMES UF5

ID	Location		Side of the road	Area (Ha)	Capacity (M3)	Design		
	Abscissa	Sector				Annexed	Filters	Works
Z5-1A	K 17 + 200	Chávez	Right	3.60	200.621	3-2-5-b	X	X
Z5-1B	K 17 + 350	Chávez	Right	1.44	76.935	3-2-5-b	X	X
Z5-2	K 17 + 600	Chávez	Left	1.98	140.646	3-2-5-b	X	X
Z5-3	K 18 + 900	Cebadal	Left	15.76	3246017	3-2-5-b	X	X
Z5-4	K 19 + 300	Cebadal	Left	0.54	9,400	3-2-5-b	X	X
Z5-5	K 19 + 600	Cebadal	Left	1.71	127.177	3-2-5-b	X	X
ZR5-1	20 + 100	Cebadal	Left	5.28	537.224	3-2-5-b	X	X
ZR5-2	20 + 520	Cebadal	Left	7.82	794.203	3-2-5-b	X	X
Z5-6	K 20 + 900	Chávez	Right	3.26	181.432	3-2-5-b	X	X
ZR5-3	22 + 450	El Tambor	Left	3.95	425.701	3-2-5-b	X	X
Z5-6B	K 22 + 800	El Tambor	Left	2.21	164934	3-2-5-b	X	X
Z5-7	K 24 + 500	El Paramo	Left	0.78	32.345	3-2-5-b	X	X
Z5-8	K 25 + 000	El Paramo	Left	6.59	815.711	3-2-5-b	X	X
Z5-9	K 26 + 280	Marqueza Alto	Left	3.85	229.772	3-2-5-b	X	X
Z5-10	K 26 + 900	Marqueza Alto	Left	0.51	14,368	3-2-5-b	X	X
Z5-10B	K 28 + 400	Gualmatán Alto	Right	3.24	75.945	3-2-5-b	X	X
Z5-10C	29 + 000	Vocational	Left	1.95	69.190	3-2-5-b	X	X
Z5-11	K 30 + 730	Vocacional	Right	1.19	19,575	3-2-5-b	X	X
Z5-12	K 30 + 780	Vocacional	Right	2.16	133.001	3-2-5-b	X	X
ZR5-4	30 + 950	La Merced	Right	4.5	509.423	3-2-5-b	X	X
Z5-13	K 31 + 600	La Merced	Right	7.27	813.426	3-2-5-b	X	X
ZR5-5	31 + 840	La Merced	Left	0.68	27827	3-2-5-b	X	X

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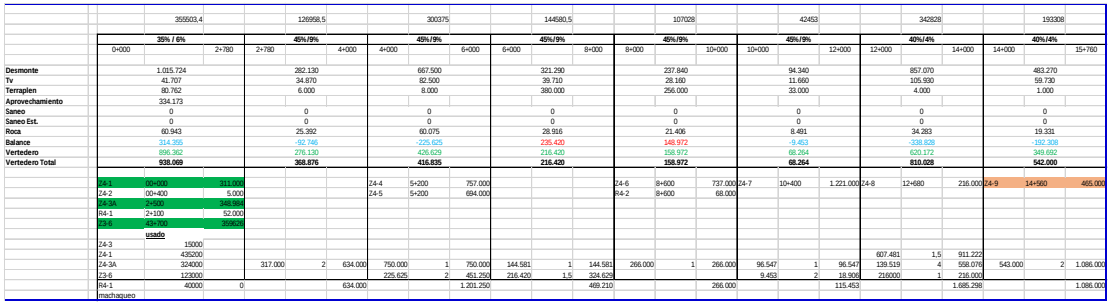
As previously noted in UF4, nine (9) waste disposal areas and two (2) non-structural landfills were identified. In UF5, seventeen (17) waste disposal areas and five (5) non-

structural landfill areas were identified. The total capacity reached in UF4 is 4,587,909 m^3.

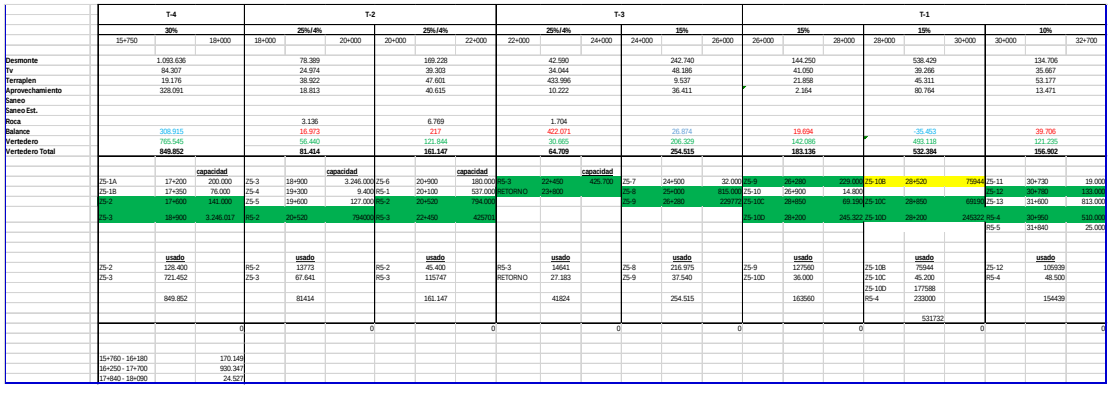
This capacity is sufficient to meet the requirements of landfill areas for the project, which is about 4,150,000 m^3 for studied Functional Unit. Should additional volume be needed, there is excess capacity in the UF5 deposit, which has a total reached capacity of 8,725,272 m^3. This capacity is sufficient to meet the landfill area requirements of the project, which is 3,400,000 m^3 for studied Functional Unit.

Table 3.13. Land plot UF.4



		355503,4			126958,5			300375			144580,5			107028			42453			342828			193308		
		35% / 6%			45%/9%			45%/9%			45%/9%			45%/9%			45%/9%			40%/4%			40%/4%		
		0+000		2+780	2+780		4+000	4+000		6+000	6+000		8+000	8+000		10+000	10+000		12+000	12+000		14+000	14+000		15+760
Desmonte		1.015.724			282.130			667.500			321.290			237.840			94.340			857.070			483.270		
Tv		41.707			34.870			82.500			39.710			28.160			11.660			105.930			59.730		
Terraplen		80.762			6.000			8.000			380.000			256.000			33.000			4.000			1.000		
Aprovechamiento		334.173																							
Saneo		0			0			0			0			0			0			0			0		
Saneo Est.		0			0			0			0			0			0			0			0		
Roca		60.943			25.392			60.075			28.916			21.406			8.491			34.283			19.331		
Balance		314.355			-92.746			-225.625			235.420			148.972			-9.453			-338.828			-192.308		
Vertedero		696.362			278.126			436.629			216.420			158.972			68.264			620.172			349.692		
Vertedero Total		**938.089**			**368.876**			**416.835**			**216.420**			**158.972**			**68.264**			**810.028**			**542.000**		
	I-1	00+000		311.000									Z4-6	8+600	737.000	Z4-7	10+400	1.221.000	Z4-8	12+680	216.000	Z4-9	14+560		465.000
	Z4-2	00+400		5.000									R4-2	8+600	68.000										
	Z4-2A	2+000		246.564																					
	R4-1	2+100		52.000																					
	I-2	4+800		20800																					
		usado																							
	Z4-3	15000																							
	Z4-1	435200																		607.481	1,5	911.222			
	Z4-3A	324000			317.000	2	634.000	750.000	1	750.000	144.581	1	144.581	266.000	1	266.000	96.547	1	96.547	139.519	4	558.076	543.000	2	1.086.000
	Z3-6	123000						225.625	2	451.250	216.420	1,5	324.629				9.453	2	18.906	216000	1	216.000			
	R4-1 machaqueo	40000		0			634.000			1.201.250			469.210			266.000			115.453			1.685.298			1.086.000

Table 3.14. Land plot UF.5



		T-4			T-2						T-3						T-1								
		30%			25%/4%			25%/4%			25%/4%			15%			15%			15%			10%		
		15+750		18+000	18+000		20+000	20+000		22+000	22+000		24+000	24+000		26+000	26+000		28+000	28+000		30+000	30+000		32+700
Desmonte		1.093.636			78.389			169.228			42.590			242.740			144.250			538.429			134.706		
Tv		84.307			24.974			39.303			34.044			48.186			41.050			39.266			35.667		
Terraplen		19.176			38.922			47.601			433.996			9.537			21.858			45.311			53.177		
Aprovechamiento		328.091			18.813			40.615			10.222			36.411			2.164			80.764			13.471		
Saneo																									
Saneo Est.																									
Roca					3.136			6.769			1.704														
Balance		308.915			16.973			217			422.071			26.874			19.694			-35.453			39.706		
Vertedero		765.545			58.460			121.844			30.665			206.329			142.086			493.118			121.235		
Vertedero Total		**849.852**			**81.414**			**161.147**			**64.709**			**254.515**			**183.136**			**532.394**			**156.902**		
			capacidad			**capacidad**			**capacidad**			**capacidad**														
	Z5-1A	17+200	200.000	Z5-3	18+900	3.246.000	Z5-6	20+900	180.000	R5-3	22+450	425.710	Z5-7	24+500	32.000	Z5-9	26+280	229.000	Z5-10B	28+520	75944	Z5-11	30+730	19.000
	Z5-1B	17+350	76.000	Z5-4	19+300	9.400	R5-1	20+100	537.000	RETORNO	23+800		Z5-8	25+000	615.000	Z5-10	26+900	14.800				Z5-12	30+780	133.000
	Z5-2	17+600	141.000	Z5-5	19+600	127.000	R5-2	20+520	794.000				Z5-9	26+280	225772	Z5-10C	28+850	69.196	Z5-10C	28+850	69196	Z5-13	31+600	813.000
	Z5-3	18+900	3.246.017	R5-2	20+520	794000	R5-3	22+450	425702							Z5-10D	28+200	245.322	Z5-10D	28+200	245322	R5-4	30+850	510.000
																						R5-5	31+840	25.000
		usado			**usado**			**usado**			**usado**			**usado**			**usado**			**usado**			**usado**		
	Z5-2	128.400		R5-2	13773		R5-2	45.400		R5-3	14641		Z5-8	216.975		Z5-9	127560		Z5-10B	75944		Z5-12	105939		
	Z5-3	721.452		Z5-3	67.641		R5-3	115747		RETORNO	27.183		Z5-9	37.540		Z5-10D	36.000		Z5-10C	45.200		R5-4	48.500		
																			Z5-10D	177588					
		849.852			81414			161.147			41824			254.515			163560		R5-4	233000			154439		
																				531732					
			0			0			0			0			0			0			0					0
	15+760 - 16+180		170.149																						
	16+250 - 17+700		930.347																						
	17+840 - 18+080		24.527																						

ZODMEs will be shaped following management set out in Chapter 11 of the EIA and provisions of Resolution 541 of 1994 which are presented in Annex 3.2.5-i.

Table 3.15 and Table 3.16 show the presence or not of homes and water sources in proposed ZODME areas for the Catambuco-Pedregal, Annex 3.2.5.j.

Table 3.15 Housing and Water sources in ZODME UF4

ID	Location	Identified Water Sources	Housings Identified
Z4-1	K 0 + 000	No presence of water sources in the ZODME	No presence of housings in the ZODME.
Z4-2	K 0 + 400	No presence of water sources in the ZODME	The presence of 1 housing in coordinates: N 607036.219 - W 957182.99
Z4-3	K 2 + 000	No presence of water sources in the ZODME	No presence of housings in the ZODME
Z4-4	K 5 + 200	No presence of water sources in the ZODME	No presence of housings in the ZODME
Z4-5	K 5 + 200	No presence of water sources in the ZODME	No presence of housings in the ZODME
Z4-6	K 8 + 600	No presence of water sources in the ZODME	The presence of one housing in coordinates: N 609457.604 - W 962180.109
Z4-7	K 10 + 400	No presence of water sources in the ZODME	No presence of housings in the ZODME
Z4-8	K 12 + 680	No presence of water sources in the ZODME	No presence of housings in the ZODME
Z4-9	K 14 + 560	No presence of water sources in the ZODME	No presence of housings in the ZODME
ZR4-1	K 02 + 100	No presence of water sources in the ZODME	No presence of housings in the ZODME
ZR4-2	K 08 + 600	No presence of water sources in the ZODME	No presence of housings in the ZODME

Source Gemini Environmental Consultants SAS

Table 3.16 Homes and water sources in ZODMES UF5

ID	Location	Identified Water Sources	Housings Identified
Z5-1A	K 17 + 200	No presence of water sources in the ZODME	No presence of housings in the ZODME
Z5-1B	K 17 + 350	No presence of water sources in the ZODME	The presence of 1 housing in coordinates: N 614391.818 - W 966716.829

ID	Location	Identified Water Sources	Housings Identified
Z5-2	K 17 + 600	No presence of water sources in the ZODME	No presence of housings in the ZODME
Z5-3	K 18 + 900	No presence of water sources in the ZODME	No presence of housings in the ZODME
Z5-4	K 19 + 300	No presence of water sources in the ZODME	No presence of housings in the ZODME
Z5-5	K 19 + 600	No presence of water sources in the ZODME	No presence of housings in the ZODME
Z5-6	K 20 + 900	No presence of water sources in the ZODME	No presence of housings in the ZODME
Z5-7	K 24 + 500	No presence of water sources in the ZODME	No presence of housings in the ZODME
Z5-8	K 25 + 000	No presence of water sources in the ZODME	No presence of housings in the ZODME
Z5-9	K 26 + 280	No presence of water sources in the ZODME	No presence of housings in the ZODME
Z5-10	K 26 + 900	No presence of water sources in the ZODME	No presence of housings in the ZODME
Z5-11	K 30 + 730	No presence of water sources in the ZODME	No presence of housings in the ZODME
Z5-12	K 30 + 780	No presence of water sources in the ZODME	No presence of housings in the ZODME
Z5-13	K 31 + 600	No presence of water sources in the ZODME	No presence of housings in the ZODME
ZR5-1	K 20 + 100	No presence of water sources in the ZODME	No presence of housings in the ZODME
ZR5-2	K 20 + 520	No presence of water sources in the ZODME	No presence of housings in the ZODME
ZR5-3	K 22 + 450	No presence of water sources in the ZODME	No presence of housings in the ZODME
ZR5-4	K 30 + 950	No presence of water sources in the ZODME	No presence of housings in the ZODME
ZR5-5	K 31 + 840	No presence of water sources in the ZODME	No presence of housings in the ZODME
Z5-6B	K 22 + 800	No presence of water sources in the ZODME	No presence of housings in the ZODME
Z5-10B	K 28 + 400	No presence of water sources in the ZODME	No presence of housings in the ZODME
Z5-10C	K 29 + 000	No presence of water sources in the ZODME	No presence of housings in the of ZODME

Source Gemini Environmental Consultants SAS

Table 3.17 Social infrastructure identified in ZODME - UF 4

ID	Location	Infrastructure
Z4-1	K 0 + 000	There is a storage tank with irrigation hoses. Crops of beans and coffee
Z4-2	K 0 + 400	The premises have vehicular access Land used for farming In front of the property there is a farm that is used for social events. One house is located in coordinates: 1. N 607036.219 - W 957182.99
Z4-3	K 2 + 000	The land has access, a short span in treadplate and the other unpaved. Power pole evidenced in the access Approximately 50 mts away there are homes in a nucleated settlement.
Z4- 4	K 5 + 200	Vehicular access leading to the Inantas Bajo and Alto counties Four utility power poles are identified inside the premise Property used for livestock There are houses nearby the property.
Z4-5	K 5 + 200	Vehicular access leading to the Inantas Bajo and Alto counties Land used for livestock and agriculture Some houses are identified on both sides of the road A county aqueduct tank is located inside the premises A community use soccer field is located inside the area
Z4-6	K 8 + 600	The premises have vehicular access. Some homes are evident on both sides of the road. An inhabited house is observed in the area of the premises It also has a smaller species breeding shed The property has a water storage tank for livestock use. Property mainly used for livestock Handmade 3 mt approx. bridge connecting the shed with the house.
Z4-7	K 10 + 400	Evident scattered dwellings along the path The land is used for agriculture and livestock Hoses arranged for irrigation Power tower is observed at 11 meters of the property boundary
Z4-8	K 12 + 680	There are nearby houses and two cemeteries the area surrounding the property The land is used for agriculture Along the way public lighting poles observed.
Z4-9	K 14 + 560	Access to the property is pedestrian type Presence of housing observed along the access to the property No housings observed inside the property The land is used for agriculture
ZR4-1	02 + 100	The land has access, a short span in treadplate and the other unpaved. Power poles and inspection box evidenced in the access Approximately 50 mts away there are homes in a nucleated settlement. An approx. 25 meters gabion wall is observed
ZR4-2	08 + 600	Agricultural land use The premises have vehicular access There is no social infrastructure and / or utilities in the premises.

Source: Geminis Environmental Consultants SAS

Table 3.18 Social infrastructure identified in ZODME - UF 5

ID	Location	Housing Identification
Z5-1A	K 17 + 200	The property has access from the Pan American Highway to the road leading to the Chávez county. There is evidence of dwellings along the entrance road and close to the property. The land is used for livestock There is evidence that the property is used for pedestrian access to nearby farms.
Z5-1B	K 17 + 350	The property has access from the Pan American Highway to the road leading to the Chávez county There is evidence of dwellings along the entrance road and close to the property. The land is used for agriculture 1 concrete power pole is identified and an irrigation network system. Nearby houses were observed at 5 and 10 mt approx. away from the boundary of the property.
Z5-2	K 17 + 600	The premises have vehicular access A power pole is observed within the premises There are houses along the access road 80 meters from the area of the property. The land is used for agriculture
Z5-3	K 18 + 900	The property has access from the Pan American Highway to the road leading to the Buena Esperanza county There is evidence of dwellings along the entrance road and close to the property. The property is used for livestock Inside the premises a wooden warehouse to store agricultural products is observed. A water service hose is evidenced on the grounds of the premises A sewer system is seen on the access road
Z5-4	K 19 + 300	The property has access from the Pan American Highway to the road leading to the municipality of Yacuanquer, which is being rehabilitated. Some homes are observed along the access road The property is used for livestock
Z5-5	K 19 + 600	There is a power pole inside the property The land is used for agriculture There are housing neighboring the property
Z5-6	K 20 + 900	The land is for agricultural use A small water storage tank for livestock use is seen. Inside the property a PVC water pipe is observed
Z5-7	K 24 + 500	It has vehicular access Agricultural land use A land irrigation hose is seen in the premises There is a nearby housing power pole is evident in the path
Z5-8	K 25 + 000	The premises have vehicular access The aqueduct network of the Marqueza Baja county crosses the premises Storage tanks for cattle use observed Land for agricultural use Four homes are evident on the access to the property
Z5-9	K 26 + 280	The premises have vehicular access Storage tank for livestock use out of operation

ID	Location	Housing Identification
		Houses are observed neighboring the property A power pole close to the property The land is used for agriculture
Z5-10	K 26 + 900	The land is used for agriculture Nearby houses are observed Power poles evidenced.
Z5-11	K 30 + 730	The premises have vehicular access Nearby houses are observed Agricultural land use Irrigation hoses observed
Z5-12	K 30 + 780	The premises have vehicular access Power poles evidenced. Nearby houses are observed Agricultural land use
Z5-13	K 31 + 600	It has two vehicular accesses One access has nearby houses and power poles Land for livestock use The land has irrigation hose It has two intake tanks for the La Merced county aqueduct. The other access leads to a factory of concentrates.
ZR5-1	20 + 100	The property does not have vehicular access The property is used for cattle grazing A power tower is identified 30 mts Nearby houses are observed.
ZR5-2	20 + 520	The premises have vehicular access Land for agricultural use A shed for minor species breeding is observed Power poles evidenced whose cables crosses the premises at low level.
ZR5-3	22 + 450	With vehicular access passing in front of housing. Land for livestock use Sewer drain evidence inside the premises A power pole is evident
ZR5-4	30 + 950	With vehicular access Access leads to a concentrates plant. An energy power pole is evidenced Nearby houses are observed Agricultural land use. Pipe is observed specifically for handling water discharge from the sewer A road leading to neighboring housing is observed
ZR5-5	31 + 840	A power pole is observed inside the property The land is used for agriculture The premises have vehicular type access There are neighboring houses to the property No evidence of housings inside the premises
Z5-6B	K 22 + 800	A dwelling adjacent to the property is identified. There are power poles with cables crossing the area of the premises. There is an aqueduct system
Z5-10B	K 28 + 400	There is a power pole. A sewer discharge is identified. Houses nearby to the property.

ID	Location	Housing Identification
Z5-10C	K 29 + 000	There is a water well. A power pole is identified.

Source: Geminis Environmental Consultants SAS

Deposits overall stability evaluation was performed by analyzing limit equilibrium using the methodology of Spencer for a mechanism of rotational fault. For such end, critical sections of each deposit were selected; these calculation reports are in the Annex 3.2.5 3.2.5-f-h.

Among the analysis, static conditions and pseudo-statistics were involved for the drainage behavior of materials whose general stratigraphy was defined as homogenous areas of roads, seismic lines, and perforations for available ZODMES.

Geo-mechanical parameters of the fill of the deposits were selected conservatively considering the heterogeneous nature thereof. Since its composition is given by different remolded soil layers and with low volcanic ash compaction level, volcanic flows and some rocks with weathering levels IIA and IIB according to Deere and Patton (1971). Table3.19 shows a 0.05 Ru given the presence of sandy soil and blocks facilitating drainage of the materials.

Table3.19 Geo-mechanical parameters of deposit fills

c'[KPa]	φ' [°]	γ [KN / m^3]	Ru [-]
15	28	20	005

Source Consortium SH 2016

The following tables summarize the results obtained in the stability analysis performed considering 10 m high terraces with 2.0H:1V slopes and berms 3 m wide.

Table 3.20 **Deposit stability analysis**

ZONA	SAFETY FACTOR	
	Static	Seism

ZONA	SAFETY FACTOR	
	Static	Seism
Z4-1	1	1
Z4-2	2	1
Z4-3	1	1
R4-1	1	1
Z4-4	1	1
Z4-5	1	1
R4-2	1	1
Z4-6	1	1
Z4-7	1	1
Z4-8	1	1
Z4-9	1	1

Source Consortium SH 2016

Table 3.21 **Storage stability analysis**

ZONE	SAFETY FACTOR	
	Static	Seism
Z5-1A	1.7	1.3
Z5-1B	2.0	1.5
Z5-2	1.8	1.3
Z5-3	1.6	1.1
Z5-4	2.6	1.8
Z5-5	1.8	1.3
R5-1	1.9	1.4
R5-2	1.8	1.4
Z5-6	1.6	1.2
R5-3	1.7	1.3
Z5-7	1.8	1.3
Z5-8	1.6	1.2
Z5-9	1.8	1.3
Z5-10	2.1	1.5
Z5-11	2.7	2.0
Z5-12	2.0	1.5
R5-4	1.8	1.3
Z5-13	2.1	1.6
R5-5	2.3	1.7

Source Consortium SH 2016

ZODME stability review and settlement and consolidation calculations are contained in Annexes 3.2.5-d, 3.2.5-f, 3.2.5-g and 3.2.5-h.

Based on the methodology defined in Annex 3.2.5-c that further details the bearing capacity analysis for the ZODME waste disposal; the calculation results are presented in Annex 3.2.5-e, as a result of this analysis high bearing capacities allowable are obtained, greater than 2 MPa which are above the maximum stresses induced by the embankments, which are of the order of 700 kPa.

Compressibility parameters for the foundation soils of the waste disposal facility (ZODMES) were estimated from the correlations defined in the methodology and design criteria presented in 3.2.5-c.

Based on this characterization, the ZODMES Z4-1and Z4-2 were defined as located on poorly compressible granular strata, not presenting consolidation settlement but elasticized settlement. For the other dump sites the existence of foundation soils comprise be clay and low / moderate plasticity silt was determined.

Selected sites with the highest storage capacity found in large areas such as ZODMES Z4-7 Z4-4, Z4-6, Z5-3, Z5-8 and Z5-13, require installing a permanent drainage. For this reason, these deposits (ZODMES) must include sizing from the standpoint of hydraulic works management for these water bodies.

The surface of the deposits must be protected with controlled hydro-seeding similarly as in the case of the embankments.

As a solution to handle the flows converging towards dump sites, construction of perimeter interceptor channels is proposed, and to manage runoff from the area construction of culverts was adopted on the inside of each terrace to route collected water to the perimeter channels.

These structures finally discharge at low points of the natural terrain or drainage works, and as far as possible away from structures that may be susceptible to erosion problems; the purpose of these drainage works is to maintain the stability of the

deposits. To estimate the design flows a 10 years return period was adopted, considering a minimum concentration time of 15 minutes.

The design flow was calculated with the most used two methods, the Rational Method for drainage areas less than 2.5 km^2 and for areas greater than 2.5 km^2 and the method of hydrograph unit of the Soil Conservation Service. (See Figure 3.48)

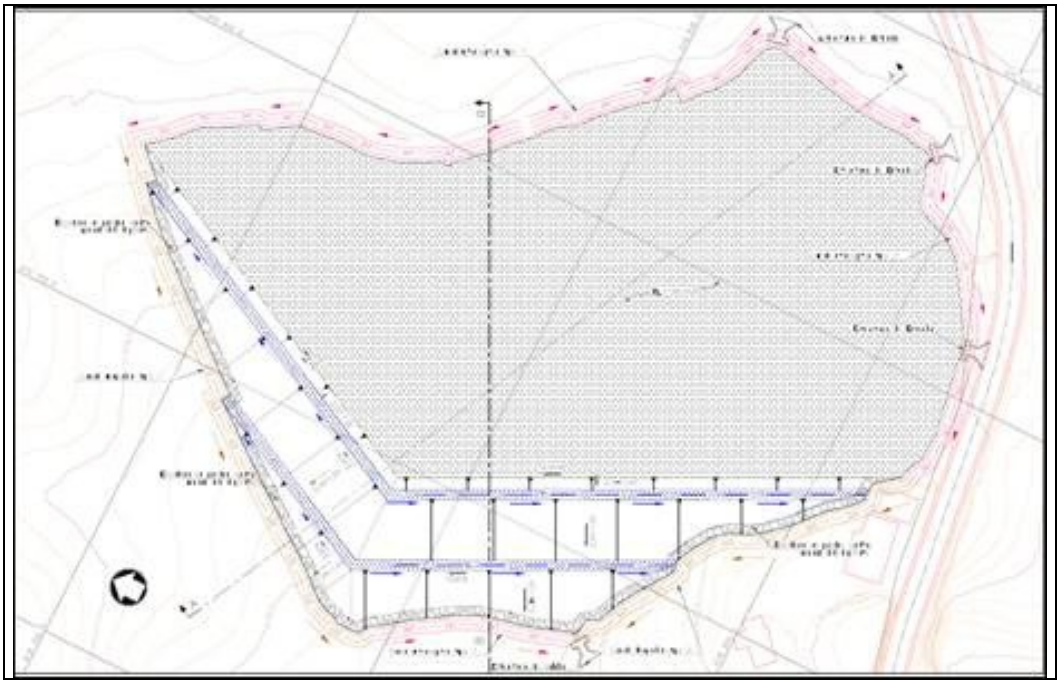


Figure 3.48 Landfill perimeter drainage
Source Consortium SH 2016

The results and the criteria adopted to size the drainage works in the material deposit areas are as follows:

- The dimensions of the hydraulic drainage were calculated from the design flow, the slope and the roughness coefficient corresponding to the coating material of the work surface, using the Maning expression for uniform flow.
- According to the flow, drainage works consisting of perimeter channels adapting their geometry to the topographical conditions are projected, in addition intake structures for permanent channels, structures for channel delivery to permanent

existing channels, and other hydraulic works required for water management were considered.
- In areas with steep slopes dissipation structures are projected.
- In output structures, fins built in reinforced concrete at the beginning and end of the structure is foreseen, in order to give stability to the structure.
- Longitudinal filters along natural drainage troughs and to collect infiltrations that may occur in deposits are foreseen.

Annexes 3.2.5 a and 2.5-b show the drawings for each ZODMES as well as the analysis of safety and risk of movement factors vis-à-vis external loads, which were taken into account for the ZODMES design.

Filters for the ZODMES

Filters implemented in the ZODMES are traditional drainage systems consisting of combining stone aggregates in gravel size, pebbles and boulders with a nonwoven geotextile which allows the passage of water and retains fine particle size, while the granular material and the pipe iares responsible for water drainage (see Annex 3.2.10 a and 3.2.10 b).

The main filtering systems will be built before starting filling of the ZODME, and its shaping will be finished simultaneously with the first layers of materials.

Some type designs for filters and ZODME structures have been developed; however, all facilities may have a design adjusted or a new structure included always considering special conditions encountered when starting the tasks, as often happens in this type of works. Follows the filter type design for the ZODMEs.

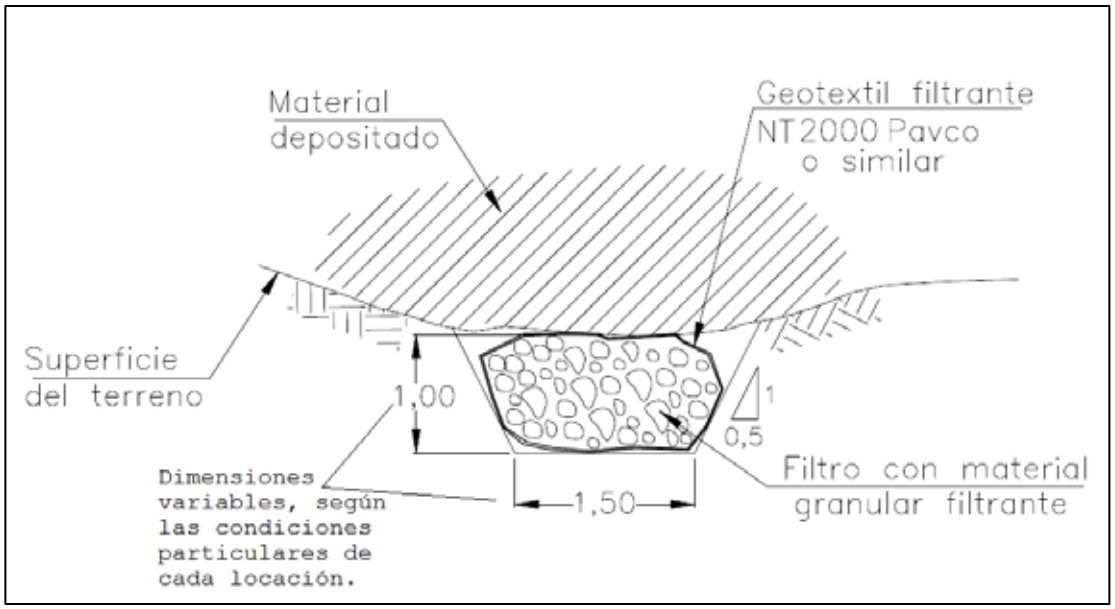


Figure 3.49 Design Filter Type for ZODMEs
Source Consortium SH 2016

Likewise, filtering material consisting of edges between 20 and 30 centimeters edge feature have been established; however, the particle size could be designed otherwise according to tank loads and evacuated flows. Contingent pipe laying and more concrete area for the charge, route and discharge of filter is not discarded.

The filter network established for each ZODME as prepared until October 2016 can be relocate or increased to strengthen the drain either due to punctual conditions found at each location or new recommendations of specialists serving the project. In any case, to will always seek to ensure drainage and stability of deposits, as well as naturalness and harmony conditions in the environment of each ZODME. Changes or adjustments to the filter designs, containments and other elements of the ZODMEs will be recorded by Contractors and Supervisor in the Environmental Compliance Reports addressed to environmental authorities.

Some ZODME project designs have filters on the ZODME base and others do not. The criterion for designing the filters on the ZODME base has been the existence of a groove or mark on the ground to guess the surface runoff flow. In this case, a filter following the geometry and layout of said grooves has been included as the water is likely to run

along such trajectories due to the existence of the grooves, proving that this has been done along the years.

The main reason for ZODMEs without designed filters is that the system designed to collect surface runoff does not allows water infiltrating through the ZODME body and therefore the filter does not receive water reason why it make no sense designing one. Where there is no evidence of grooves or streams it means that water is not running through the area.

The filter has a twofold function. For one thing is to have the hydraulic capacity to drain water received either by increased water table or infiltration (which is not the case for the ZODME, since disposed of material is surplus, that is, with excessive fines and consequently waterproof). Furthermore, the filter prevents the fines entrained by water infiltration leaving the ZODME (the purpose of the geotextiles).

The surface drainage system prevents water from infiltrating the ZODME body and therefore reaching the filter. During the construction phase, for environmental purposes, water treatment shall be such that the fines carryover is not much higher than what is currently produced, i.e., before intervening the area.

Additionally, many of the ZODME are in areas flatter or erodible and drag support. Some ZODME planned building a perimeter ring or rockfill gabions, which also performs the function of the filter along the entire perimeter of the ZODME avoiding entrainment of fines outside the limits of this.

Abandonment plan and final closing of the ZODMEs

For abandonment and final closing of different ZODMEs, stabilization and grassing are planned; the final use will depend on the agreement made with the property owner, which will be recorded in minutes of opening of each ZODME and enclosed to the Environmental Compliance Reports (ICA). When the activities begin in each ZODME, the intent is for the ZODMES be returned to their original use.

Table 3.22 Proposed end use of ZODMES UF4

No.	ID	Location	Initial coverage	Initial use	Final coverage	Final use
1	Z4-1	K 0 + 000	- Mosaic of crops and natural arboreal areas - Dense brushes	-Agroforestry -Conservation	-Mosaic crops and natural arboreal areas - Dense brushes	-Agroforestry -Conservation

No.	ID	Location	Initial coverage	Initial use	Final coverage	Final use
			- Open rocky grasslands		- Open rocky grasslands	
2	Z4-2	K 0 + 400	Mosaic of crops, pastures and natural shrub areas	Agroforestry	Mosaic of crops, pastures and natural shrub areas	Agroforestry
3	Z4-3	K 2 + 000	-Mosaic shrubby grassland with natural spaces -Weedy grasslands -Continuous urban fabric	-Agroforestry -Livestock -Infrastructure	-Mosaic shrubby grassland with natural spaces -Weedy grasslands - Continuous urban Fabric	-Agroforestry -Livestock -Infrastructure
4	Z4-4	K 5 + 200	Woodlands - Pastures -Mosaic pastures with herbaceous natural areas	-Livestock -Agroforestry	Woodlands - Pastures -Mosaic pastures with herbaceous natural areas	-Livestock -Agroforestry
5	Z4-5	K 5 + 200	Mosaic of pasture and crops	-Agricultural	Mosaic of pasture and crops	-Agricultural
6	Z4-6	K 8 + 600	Mosaic of pasture and crops	-Agricultural	Mosaic of pasture and crops	-Agricultural
7	Z4-7	K 10 + 400	-Mosaic pasture and crops -Weedy grasslands	-Agricultural -Livestock	-Mosaic pasture and crops -Weedy grasslands	-Agricultural -Livestock
8	Z4-8	K 12 + 680	Mosaic of pasture and crops	-Agricultural	Mosaic of pasture and crops	-Agricultural
9	Z4-9	K 14 + 560	-Weedy grasslands -Mosaic pasture and crops	-Livestock -Agricultural	-Weedy grasslands -Mosaic pasture and crops	-Livestock -Agricultural
10	ZR4-1	K 2 + 100	-Weedy grasslands -Continuous urban fabric	-Livestock -Infrastructure	-Weedy grasslands -Continuous urban fabric	-Livestock -Infrastructure
11	ZR4-2	K 8 + 600	-Mosaic shrubby grassland with natural spaces -Mosaic crops, grasses and shrubs natural areas	Agroforestry	-Mosaic shrubby grassland with natural spaces -Mosaic crops, grasses and shrubs natural areas	Agroforestry

Source Gemini Environmental Consultants SAS 2016

Table 3.49 Proposed end use ZODMES UF5

No.	ID	Location	Initial coverage	Initial use	Final coverage	Final use
1	Z5-1A	K 17 + 200	-Other transient crops -Mosaic pasture and crops	-Agricultural -Agricultural	-Other transient cultures -Mosaic pasture and crops	-Agricultural -Agricultural
2	Z5-1B	K 17 + 350	Mosaic of pasture and crops	-Agricultural	Mosaic of pasture and crops	-Agricultural
3	Z5-2	K 17 + 600	Mosaic crops -Mosaic crops, grasses and natural shrubs areas	-Agricultural -Agroforestry	Mosaic crops -Mosaic crops, grasses and natural shrubs areas	-Agricultural -Agroforestry
4	Z5-3	K 18 + 900	Mosaic crops -Mosaic arboreal crops and natural areas -Mosaic pasture and crops	-Agricultural -Agroforestry -Agricultural	Mosaic crops -Mosaic arboreal crops and natural areas -Mosaic pasture and crops	-Agricultural -Agroforestry -Agricultural
5	Z5-4	K 19 + 300	Mosaic of crops, pastures and natural shrub areas	Agroforestry	Mosaic of crops, pastures and natural shrub areas	Agroforestry
6	Z5-5	K 19 + 600	Mosaic of crops, pastures and natural shrub areas	Agroforestry	Mosaic of crops, pastures and natural shrub areas	Agroforestry
7	Z5-6	K 20 + 900	- Clean pastures Mosaic of crops	-Livestock -Agricultural	-Clean pastures Mosaic of crops	-Livestock -Agricultural
8	Z5-7	K 24 + 500	Mosaic of pasture and crops	-Agricultural	Mosaic of pasture and crops	-Agricultural
9	Z5-8	K 25 + 000	-Weedy grasslands -Other transient cultures -Clean pastures -Mosaic pasture and crops -Mosaic crops, grasses and natural shrubs areas	-Livestock -Agricultural -Livestock -Agricultural -Agroforestry	-Weedy grasslands -Other transient cultures -Clean pastures -Mosaic pasture and crops -Mosaic crops, grasses and natural shrubs areas	-Livestock -Agricultural -Livestock -Agricultural -Agroforestry
10	Z5-9	K 26 + 280	- Clean pastures -Mosaic pasture and crops	-Livestock -Agricultural	- Clean pastures -Mosaic pasture and crops	-Livestock -Agricultural
11	Z5-10	K 26 + 900	Mosaic of pasture with natural arboreal areas	Agroforestry	Mosaic of pasture with natural arboreal areas	Agroforestry

No.	ID	Location	Initial coverage	Initial use	Final coverage	Final use
12	Z5-11	K 30 + 730	Mosaic of crops -Weedy grasslands	-Agricultural -Livestock	Mosaic of crops -Weedy grasslands	-Agricultural -Rancher
13	Z5-12	K 30 + 780	-Mosaic of crops, pastures and natural arboreal spaces Mosaic of crops	-Agroforestry -Agricultural	- Mosaic of crops, pastures natural arboreal spaces Mosaic of crops	-Agroforestry -Agricultural
14	Z5-13	K 31 + 600	-Clean pastures -Mosaic pasture and crops -Mosaic grass with natural arboreal areas	-Livestock -Agricultural -Agroforestry	-Clean pastures -Mosaic pasture and crops -Mosaic grass with natural arboreal areas	-Livestock -Agricultural -Agroforestry
15	ZR5-1	20 + 100	Mosaic of crops -Mosaic pasture and crops	-Agricultural -Agricultural	Mosaic of crops -Mosaic pasture and crops	-Agricultural -Agricultural
16	ZR5-2	20 + 520	-Mosaic grass with arboreal natural areas -Mosaic pasture and crops	-Agroforestry -Agricultural	-Mosaic grass with arboreal natural areas -Mosaic pasture and crops	-Agroforestry -Agricultural
17	ZR5-3	22 + 450	-Clean pastures -Mosaic grass with natural arboreal areas -Mosaic crops, pastures and natural arboreal spaces	-Livestock -Agroforestry	-Clean pastures -Mosaic grass with natural arboreal areas -Mosaic crops, pastures and natural arboreal spaces	-Livestock -Agroforestry
18	ZR5-4	30 + 950	Mosaic of crops -Mosaic crops, pastures and natural arboreal spaces	-Agricultural -Agroforestry	Mosaic of crops -Mosaic crops, pastures and natural arboreal spaces	-Agricultural -Agroforestry
19	ZR5-5	31 + 840	Mosaic of crops, pastures and natural arboreal spaces	Agroforestry	Mosaic of crops, pastures and natural arboreal spaces	Agroforestry

Source Gemini Environmental Consultants SAS 2016

3.2.6 Hazardous and non-hazardous waste

Follows the waste types and amounts that could be generated from the dual carriageway construction project activities for Functional Units UF-4 and UF-5 subsector 1 solving management, collection and final disposal issues.

3.2.6. Hazardous and non-hazardous waste

- *Non-Hazardous Waste*

o Organic Solid Waste

Residues characterized by high output and high environmental impact mainly due to their high content of unstable or immature organic matter, minerals, phytotoxins, plant pathogens, among others, finding food debris, decaying peels from foods, fruits and vegetables and animal fats.

o Recyclable Solid Waste

They are residues whose characteristics can be reassigned to different production processes or can be reused as raw material (without transform) for other activities.

They are mainly represented by plastics, paper, cardboard, uncontaminated wood, glass bottles, aluminum cans and other metals.

o Non-recyclable

These wastes are characterized by having no value in production processes or whose processing has higher economic or environmental costs than their disposal.

These include tissue papers, polystyrene, some plastics, paper and cardboard impregnated with other waste, food bags, napkins, paper towels, ceramics, swept material, cigarette butts, among others.

- *Hazardous and special wastes*

Are those that by their corrosive, explosive, toxic, flammable, infectious, radioactive or reactive characteristics may cause risk or harm to human health or impair environmental quality to levels that cause risk to human health. Hazardous waste is also the one that without being in their original form are transformed by natural processes into hazardous waste.

Likewise, containers, packing and packaging having been in contact with them is considered hazardous waste (Decree 4741, 2005).

Table 3.50 presents generation sources and characteristics of industrial solid waste.

Table 3.50 Special and Hazardous Waste

Type of waste	Characteristic
SPECIAL	Packing materials, equipment packaging, tools, mechanical parts, etc. other than cardboard, wood or plastic and which are free of chemicals or fuels can be treated as recyclable and have the same treatment as domestic recyclable waste.
DANGEROUS	Supply drums, batteries, metal air filters, oil filters, metal cans, containers and paper bags of chemicals, fuel and oil cans are among these waste.

Source Gemini Consulting SAS

3.2.6.2. Estimated waste generated.

During the Construction Phase waste is mainly generated from camp housing areas, industrial plants and work fronts.

Follows the solid waste estimate for the project in Functional Units UF4 and UF5.

Domestic and industrial solid waste generated from project works will be correctly managed as described below:

- *Domestic waste (non-hazardous)*

To estimate the amount of household waste generated in maximum work peaks, where a population of 250 workers per camp is foreseen, provisions of RAS in title F (Table F.1.1) which establishes an average production (per capita) of household waste for a low level of complexity (<2500 inhab) of 0.45 kg / person-day were considered. According to the aforesaid, in Table 3.51. day production of household waste in camps housing is calculated.

Table 3.51. Estimation of household waste to be generated in the residential camps

Characteristics	Quantity
Camp housing (inhab)	250
Average production value of household waste per capita (kg / inhab-day)	0.45
Total household waste generated (kg / day)	112.5
Total household waste generated per month (kg / month)	3375

Source Gemini Environmental Consultants SAS 2016

The activities described in the environmental management plan will be carried out for management and control of generated household waste.

- *Industrial Waste (Hazardous and Special)*

In order to quantify production of industrial solid waste generated in development of the project, waste delivered in the integrated management plan for solid waste in containment works, mitigation and maintenance study of the Bogota - Villavicencio road were used as the basis.

Table 3.52 shows projected production of solid waste:

Table 3.52 Estimated solid waste to be generated by the project

Type of waste	Unity	Amount (month) *
Excavation	m3	713
Concrete	m3	125.6
Reinforcing steel	kg	11792
Wood	m2	140
Demolition	m3	4
Others	kg	100

* These values are approximate; they are used as reference values given in integrated management plan for solid waste in containment works, mitigation and maintenance study of the Bogota - Villavicencio road.
Source: (Moncada Rojas, Ramirez Naranjo, Chavez & Porras, 2009)

3.2.6.3. Waste Management

Waste management and disposal, inside and outside the work will be handled as set out in the environmental management plan of the project, Chapter 11. Environmental Management Plan, 11.1.1 Environmental Management Plans (MRS 4) which takes into account the PGIRS of municipalities in the area of influence of the project. Solid waste generated will be separated and classified, considering its characteristics.

Ecological points will be distributed throughout Functional Units UF4 and UF5, depending on the different work fronts, industrial camps or activities, with plastic containers and plastic bags to sort the waste and temporary storage.

Follows a description of management measures for waste generated by the activity.

- *Non-hazardous waste*

  · Organic Solid Waste

Organic waste will be taken to a nearby landfill such as licensed Antanas landfill of the municipality of Pasto, which is licensed by CORPONARIÑO or other authorized third party with an environmental license for management and disposal of such waste.

  · Recyclable Solid Waste

In order to reduce the volumes of waste generated throughout the project, there will be plans for separation of solid waste within camp facilities, plants and work sites using colored cans properly identified Figure 3.48, which will have a gray bag (materials such as paper, cardboard, paper and the like), blue (plastic materials such as polypropylene, polyethylene, bags, bottles, etc.)

	**Material no reciclable (Verde)**: sustancias orgánicas biodegradables como restos de comida, residuos vegetales, bolsas de alimentos, servilletas, toallas de papel, icopor entre otros
	**Material Reciclable (Gris)**: como por ejemplo papel, Cartón, plegables entre otros.
	**Material plástico (Azul)**: como por ejemplo polipropileno, polietileno, bolsas, garrafas, y vidrio

Figure 3.48 Separation of Solid Waste

Source Adapted from the GTC-24

This waste will be taken to temporary collection centers within each facility and from there delivered to authorized third parties (recycling cooperatives and / or recycling companies) which will be responsible for recycling and reusing waste.

In order to keep control over generated and delivered waste, these will be weighed prior to delivery to authorized third parties who must ensure through minutes of disposal their final management.

- Non-recyclable waste

Non-recyclable waste will be stored in green colored bags and cans correctly covered and marked for later disposal through the garbage utility services and are taken to a site licensed for their management, treatment and disposal.

- *Special and hazardous waste*

Wastes considered hazardous or special will be stored in 55-gallon metal drums or red bags depending on the condition of generated waste and its source. Waste will be properly sealed during storage and far from waterways and water deposits and the presence of people or work fronts in order to reduce exposure factors and risks of spills contact or odors produced by such waste.

According to the type of waste, containment barriers may be used and in any case adequate and sufficient signs will be used specifying the type of danger to health and the environment according to national and international standards in this regard.

Waste will be labeled with basic information for delivery to the authorities or the transport and final disposal company with full waste identification and generated amount.

Waste will be delivered to companies with the necessary environmental permits to operate and must issue the certificate of disposal of waste collected.

· Special waste

Currently there is no site for special waste disposal. Reason why the project ensures its proper disposal through authorized third parties, who must have environmental permits required by the corporations and must also provide a certificate of disposal evidencing correct disposal of the waste.

· *Hazardous residues*

There are currently companies responsible for management and disposal of hazardous waste such as batteries, tires, used oils, among others, that must be collected in suitable containers for that purpose.

The plan for solid waste management will comply with existing national standards and goals set in the management of solid waste and hazards program included in Chapter 11 of this Environmental Impact Study.

The transportation activity from the work fronts to the industrial camps where the temporary storage is located is carried out in compliance with transport regulations and the transit code for transportation of cargo and special waste if this waste is generated in the work fronts and taken to their final disposal site.

3.2.6.4. Solid waste disposal

Final disposal must consider the classification of solid waste and their selection for disposal.

Third parties must have the necessary environmental permits for the final disposal operation.

• Organic Waste:

Must be delivered to a company with an environmental license for management, treatment and disposal of such waste.

• Unusable Waste:
Must be arranged in an area that is licensed for handling, treatment and disposal.

• Usable waste:
Must be delivered to a recycling company duly incorporated in the area.

• Hazardous and special waste:
Will be delivered to a company with an environmental license for handling and disposal of such waste.

3.2.7. Project Costs

The estimated cost of the Rumichaca - Pasto Dual Carriageway Road Project Pedregal - Catambuco Section, Concession Contract Under Scheme APP No. 15 of 2015, Functional

Units UF1 and UF5 is four hundred and seventy four billion five hundred and twenty-nine million seven thousand and twenty-seven COP $474.529.727.000,00.

3.2.6. Project chronogram

The Rumichaca - Pasto Dual Carriageway Road Project, Pedregal - Catambuco Section, Concession Agreement under Scheme APP No.15 of 2015 will have a construction duration for Functional Unit UF4 48 of months and for Functional Unit UF5 of 36 months according to the concession contract under scheme APP No 15 of September 11, 2015 - special part page 37.

The execution schedule of the works for each Functional Unit is indicated in the project schedule, Annexes 3.2.8-a.

3.2.6. Project Organization

The Rumichaca - Pasto Dual Carriageway Road Project, Pedregal - Catambuco Section, Concession Agreement under Scheme APP No.15 of 2015 has the flowchart described in Annex 3.2.9.