ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT

Fruta del Norte Project

March 2018

Cardno
Shaping the Future

Executive Summary

Environmental and Social Impact Assessment for the Fruta del Norte Mining Project

1. Background Information

Fruta del Norte (FDN) is an underground gold mining project located in the southeastern region of Ecuador, alongside the Cóndor Cordillera. The FDN Project (the Project) is located approximately 139 km east-northeast of Loja, the fourth largest city in Ecuador and capital of the Loja province (Figure 1).

Arrival at the Project area from the city of Loja involves passing through smaller cities and towns that include Zamora (Zamora Chinchipe Province capital city), Yantzaza and Los Encuentros, the latter being the largest community closest to the Project.

Figure 1 General Project Location

Prepared by: Klohn Crippen Berger, June 2016 and Cardno, March 2018.

Since its formal inception in 2001, development of the deposit has been advanced by three different companies, Aurelian Resources Corporation Limited (2001 through September of 2008), Kinross Gold Corporation (September 2008 through December 2014) and Lundin Gold Inc., aka Aurelian Ecuador S.A. (December 2014 - present).

The main aspects related to the Project's history are detailed below and shown in Figure 2. Following discovery of the FDN deposit In September of 2008, Aurelian Resources Corporation Limited decided to sell 100% of its financial interests to Kinross Gold Corporation, a Canadian firm. Kinross was to complete the advanced exploration activities required to develop the deposit.

Beginning in 2008, Kinross began public consultation and participation activities. However, in April of 2008, the Ecuadorian government issued a moratorium on mining activities (commonly known as the "mining mandate") as part of its efforts to regulate mining activities in Ecuador.

After a new mining law was issued in Ecuador in 2009, Kinross resumed exploration activities; it also updated the Environmental Management Plan, performed environmental audits, public participation processes, environmental permitting and the environmental impact assessments required by Ecuador for permitting exploration activities (2009, 2010, and 2011). Kinross even made efforts to permit exploitation activities (2013), although it ended up never performing any exploitation.

In July 2013, Kinross communicated its decision not to continue developing the FDN Project, thereby initiating the process to stop operations and make an orderly exit from the country. In December 2014, Kinross sold its shares in Aurelian Ecuador S.A. to Lundin Gold.

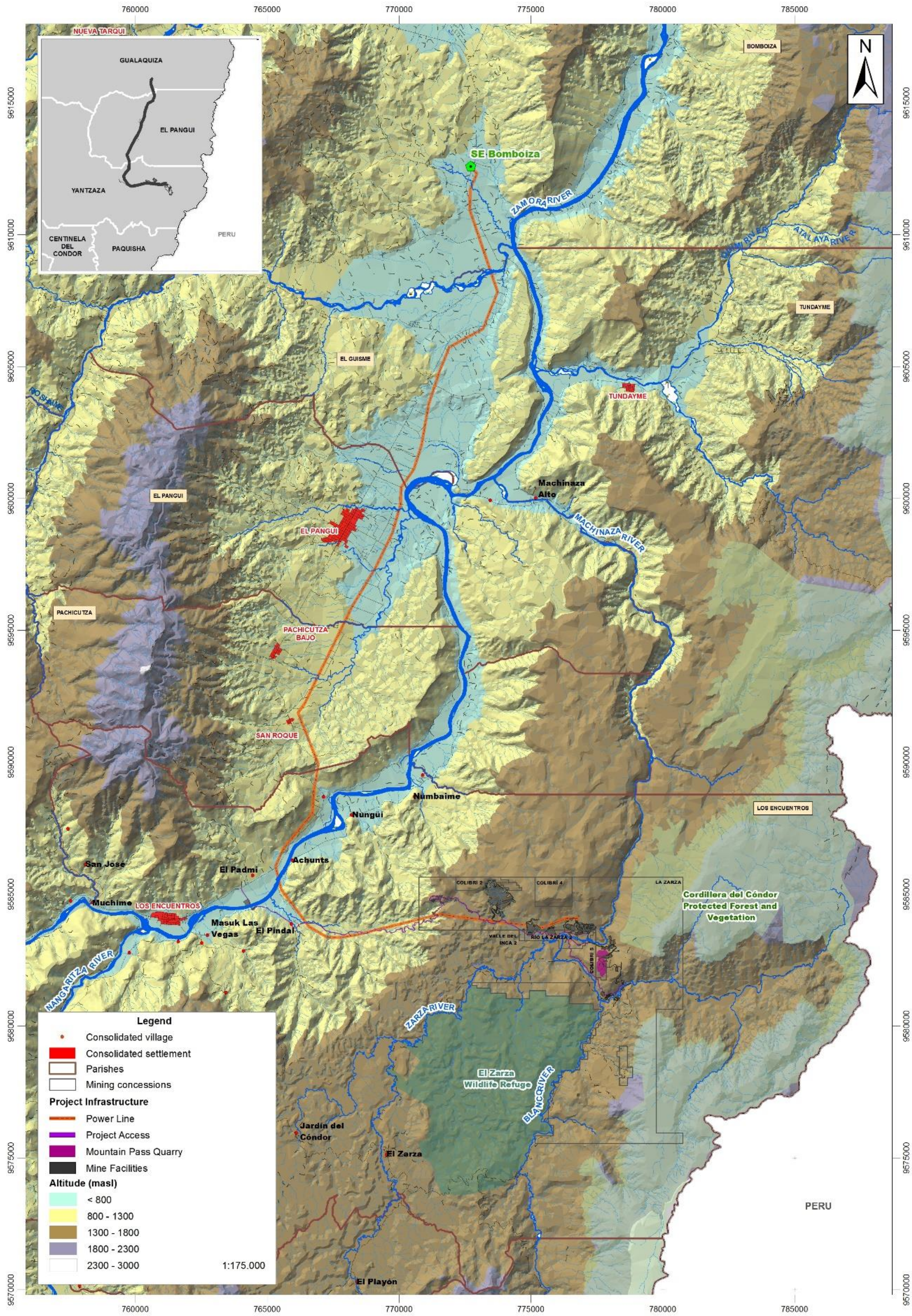


Figure 2 FDN Project Geographic Location

Source: Aurelian Ecuador S.A., January 2018
Prepared by: Cardno, January 2018

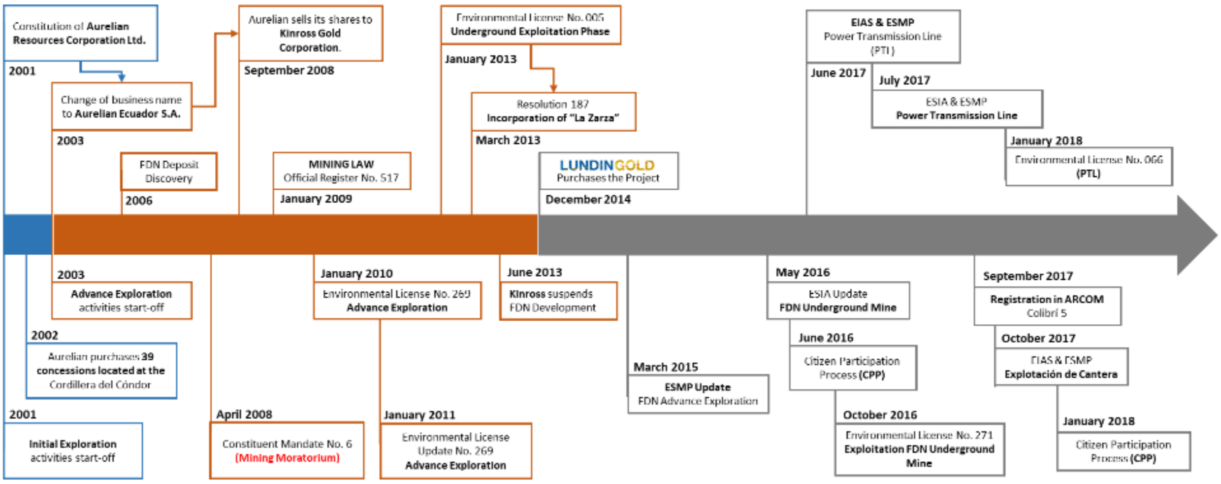


Figure 3 Fruta del Norte Mining Project Timeline

Source: Aurelian Ecuador S.A. 2012-2018
Prepared by: Cardno, January 2018

The Project includes the following major infrastructure component areas:

- Underground mine and associated support and processing facilities
- Tailings storage facility (TSF)
- Construction material quarry
- Power transmission line (PTL)
- Access roads

Figure 2 shows a general Project layout. The mine operations area is outlined in red, the quarry area is outlined with a yellow line and shaded purple; the power line in is shown in orange, while the access roads are in purple.

2. Objectives of the Environmental and Social Impact Assessment

The main objectives of this Environmental and Social Impact Assessment (ESIA) are to establish a social and environmental management system for the Project that mitigates potential social and environmental impacts resulting from Project implementation during construction, operation, and closure (including temporary closure) of the Project and associated infrastructure. The ESIA is compliant with national regulations and international environmental and social best practices, specifically the Performance Standards on Environmental and Social Sustainability promulgated by the International Finance Corporation (the IFC Performance Standards) and the World Bank Group and IFC Environmental, Health, and Safety (EHS) guidelines. Specific objectives include:

- Defining prevention and mitigation measures to reduce adverse socio-environmental impacts and to enhance positive impacts resulting from Project implementation.
- Creating a socio-environmental supervision and monitoring plan to verify compliance and effectiveness of impact mitigation and management measures.
- Establishing public participation mechanisms for relevant stakeholders such that they are provided ongoing information throughout the Project.
- Developing a biodiversity action plan (BAP) to protect the biological systems in the Project area and to offset impacts to biodiversity resulting from Project implementation.
- Creating a robust Environmental and Social Management Plan (ESMP) in accordance with the laws in force and international best practice, that contains specific plans and programs for monitoring and managing key potential impacts and contingencies generated by the Project throughout construction, operations, and closure.
- Developing procedures for an effective and timely response to potential emergencies that arise during all phases of Project implementation, including the mechanisms, roles, and responsibilities for the corresponding reporting and follow-up.
- Promoting Project investment from lenders.

The current ESIA incorporates integrally the FDN Project, including the underground mine, quarry, PTL, and access roads. Furthermore, this ESIA is based on the national approved ESIAs for each of the Project´s components, and it includes the specific title and date of approval for each national ESIA and permit.

3. Legal and Institutional Framework

Several key aspects, including environmental protection, community and occupational health and safety, social dynamics, biodiversity conservation, and other factors related to the Project activities are subject to an array of national, regional, and international regulations and standards. In preparing this ESIA, Lundin Gold has followed all relevant Ecuadorian regulations and complied with the IFC Performance Standards and EHS Guidelines. Likewise, and in addition to the current mandatory compliance regulations (*hard law*), during all the Project phases, Lundin Gold has voluntarily followed a referential framework of guidelines (*soft law*).

Hard Law

This includes the main regulatory controls currently in force that are relevant to the Project during all its stages, including international conventions, the Constitution, organic and ordinary laws, executive orders, regulations, treaties, rules and regulations that are relevant to the execution, management, and performance of the Company's activities.

Soft Law

During all Project stages and activities and in relation to social and environmental components, Lundin Gold voluntarily adheres to Soft Law guidelines, which are described in this document, in addition to the abovementioned Hard Law.

Institutional Framework

Institutional analysis is the first step in the process for review and approval of an ESIA, and consists of a clear definition of stakeholders and responsible parties involved in an assessment's preparation and review. The process includes inter-institutional coordination mechanisms that make it feasible to evaluate and understand the institutional procedures required.

Based on this identification, it is possible to also establish other authorities and entities related to Project execution, legalization and follow-up. The most important national authorities directly related to the Project shall be:

- Ecuadorian National Government
- Ministry of the Environment of Ecuador
- Ministry of Mining
- Water Secretariat
- Water Regulation and Control Agency
- Ministry of Electricity and Renewable Energy
- Mining Regulation and Control Agency

4. International Standards

Lundin Gold responsibly applies internationally recognized environmental, safety, and social standards to successfully and efficiently meet objectives on all Project activities. This includes the IFC Performance Standards, General EHS Guidelines and EHS Guidelines, and other documentation as described below providing guidance and setting forth international best practice. These standards and guidelines work together to define the general and technical requirements to be fulfilled in environmental assessments, and specific mitigation and management actions to avoid, decrease, mitigate, and manage adverse impacts and to enhance Project benefits. A summary of the international standards applied to this ESIA follows.

IFC Performance Standards, 2012[1]

The following eight (8) IFC performance standards were analyzed in preparing this ESIA:

- PS1: Assessment and Management of Environmental and Social Risks and Impacts.
- PS2: Labor and Working Conditions.
- PS3: Resource Efficiency and Pollution Prevention.
- PS4: Community Health and Safety.
- PS5: Land Acquisition and Involuntary Resettlement.
- PS6: Biodiversity Conservation and Sustainable Management of Living Natural Resources.
- PS7: Indigenous Peoples.
- PS8: Cultural Heritage.

[1] IFC (https://www.ifc.org/wps/wcm/connect/115482804a0255db96fbffd1a5d13d27/PS_English_2012_Full-Document.pdf?MOD=AJPERES)

IFC General EHS Guidelines, 2012

The project considers IFC EHS guidelines as described below:

- **IFC General EHS Guidelines** (https://www.ifc.org/wps/wcm/connect/554e8d80488658e4b76af76a6515bb18/Final%2B-%2BGeneral%2BEHS%2BGuidelines.pdf?MOD=AJPERES).
- **IFC EHS Guidelines for Mining** (https://www.ifc.org/wps/wcm/connect/1f4dc28048855af4879cd76a6515bb18/Final%2B-%2BMining.pdf?MOD=AJPERES&id=1323153264157).
- **IFC EHS Guidelines for Construction Materials Extraction** (https://www.ifc.org/wps/wcm/connect/d6bb0e80488551afa93cfb6a6515bb18/Final%2B-%2BConstruction%2BMaterials%2BExtraction.pdf?MOD=AJPERES&id=1323162191491).
- **IFC EHS Guidelines for Electrical Power Transmission and Distribution** (https://www.ifc.org/wps/wcm/connect/66b56e00488657eeb36af36a6515bb18/Final%2B-%2BElectric%2BTransmission%2Band%2BDistribution.pdf?MOD=AJPERES&id=1323162154847).

These standards provide guidance and detail the processes involved in monitoring and managing the following aspects associated with Project implementation:

- Air Emissions and Ambient Air Quality
- Discharge of Wastewater and Water Quality
- Land Use and Biodiversity
- Energy Use
- Visual Impacts
- Hazardous Materials Management
- Waste Management
- Noise
- Electric and Magnetic Fields
- Occupational Health and Safety
- Community Health and Safety

Lundin Gold responsibly applies internationally recognized environmental, safety, and social standards to successfully and efficiently meet objectives on all Project activities, such as follows:

- **NFPA Standards**
  - National Fire Protection Association NFPA 30:2000
  - National Fire Protection Association NFPA 600:1996
  - National Fire Protection Association NFPA 704

- **WHO Air Quality Guidelines**
  - For Particulate Matter, Ozone, Nitrogen Dioxide and Sulfur Dioxide (updated October 2005)

- **ICMM Sustainable Development Framework Principles**
  - ICMM Mining and Biodiversity Good Practice Guidance
  - ICMM Good Practice Guidance on Health Impact Assessment
  - ICMM Good Practice in Emergency Preparedness and Response

- **Voluntary Principles on Security and Human Rights Principles**
  - Project safety risk assessment, respect for human rights, potentials for conflicts and violence, and rule of law.
  - Company interaction with private security forces.
  - Company interaction with public security forces.

- **International Cyanide Management Code**
  - The company shall hire a cyanide supplier that will be consistent in following the International Cyanide Management Code (ICMC) requirements.
  - The company shall be consistent in following ICMC requirements for cyanide transportation and use in the FDN Project.

5. Project Description

This chapter is a snapshot of the Project design at a specific time (Dec 2017). Consequently, for the purposes of this ESIA, the chosen date to develop this document is March 2018. The FDN Project includes exploitation, beneficiation, smelting, and refining of gold and silver ore from the Fruta del Norte deposit. The deposit will be exploited using underground mining development. Project implementation requires a series of activities, generally including:

Construction

- Earthmoving and clearing across various Project footprints
- Development of the underground mine
- Construction of surface infrastructure and facilities
- Constructions of a TSF
- Construction and operation of a construction material quarry
- Construction of a PTL
- Construction of internal and external access roads

Operations

- Advancement and exploitation of the underground mine
- Mineral processing
- Operations of the TSF and waste rock disposal areas
- Facility maintenance

Closure

- Closure and dismantling of the various underground and surface facilities
- Rehabilitation of closed and disturbed areas

The figure below shows the location of each facility:

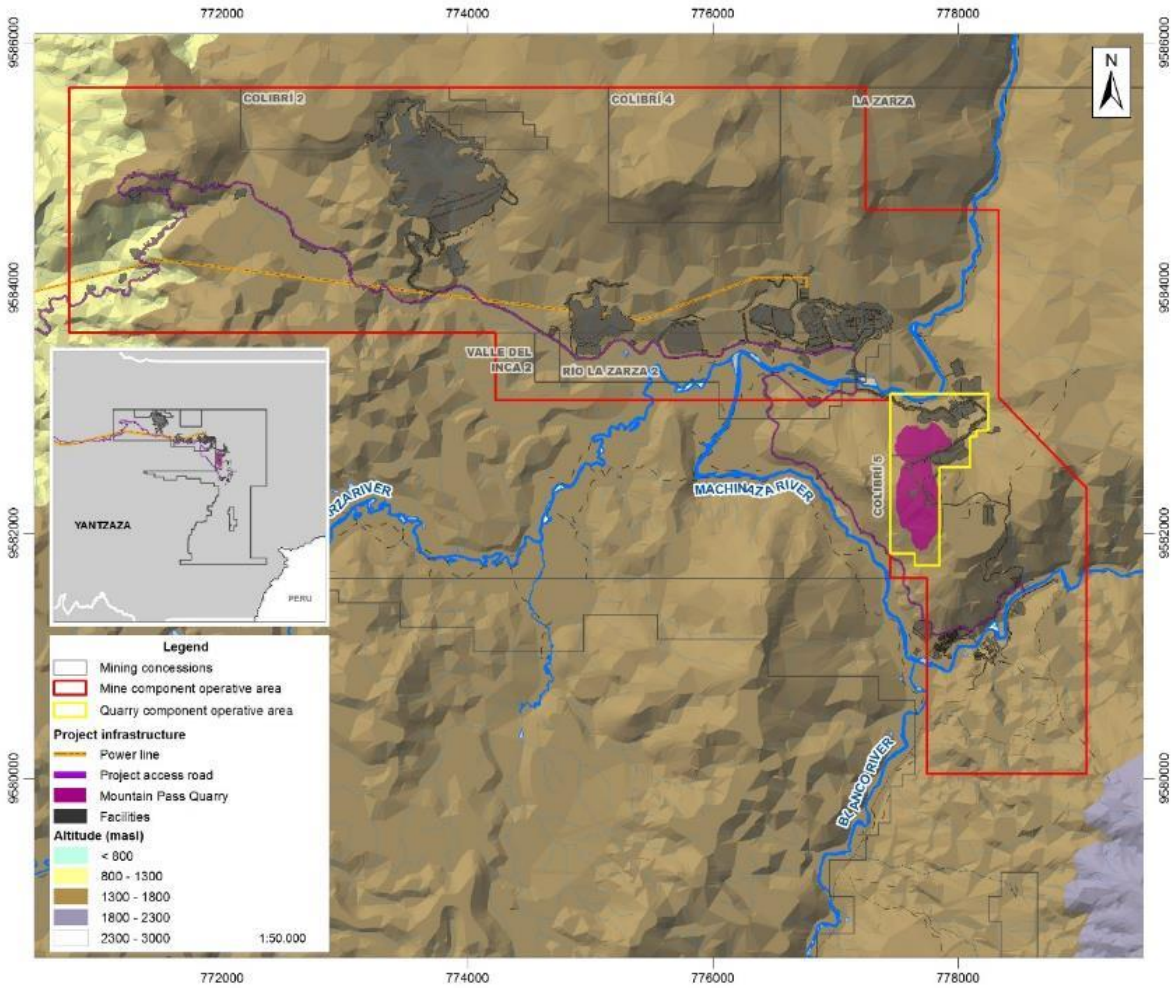


Figure 4 Fruta del Norte Project Diagram Detail (Mine and Quarry Area)

Source: Aurelian Ecuador S.A. January 2018
Prepared by: Cardno, January 2018

General Project Schedule

The FDN Project construction phase started in 2017 and is planned to be complete in the last quarter of 2019, with commissioning following construction completion. The commercial production phase is expected to start in the second half of 2020, with an estimated duration of 15 years of production based on current ore reserves.

During this stage, the operation will process an estimated 16,774,071 tons of material extracted from the underground mine in the production plant, with an average approximate grade of 9.2 g/t for gold ore and 12.6 g/t for silver ore.

The final closure stage is currently projected to last for 5 years; nonetheless, this timeframe is subject to assessment depending on the development of the FDN Project as described in the Closure and Rehabilitation Plan. This stage includes dismantling and post-closure monitoring in accordance with current Ecuadorian environmental legislation.

Infrastructure Footprint Areas

The table below refers to the approximate layout area for Project infrastructure:

Table 1 Project Infrastructure Area

Infrastructure	Approximate Surface Area (ha)	Approximate Total Area (ha)
Underground Mine, Aggregates Quarry and Complementary Infrastructure		
Excavation Surplus Stockpile Area	10.2	149.5
Topsoil Stockpile Area	7.10	
Communications Antenna Area	0.01	
Ventilation Shaft Area	0.1	
Mine Waste Rock Storage	5.8	
Waste Dump Area	3.9	
Laydown Area offsite	4.3	
Parking and Turning Area along the main FDN access road	0.3	
Stormwater Management Pond for Processing Plant A RS004	0.9	
Stormwater Management Pond for Processing Plant B RS005	1.1	
Pond Area for Tailings Pipeline Drainage	0.3	
Aggregates Plant Area	1.6	
Processing Plant Area	2.9	
Paste Plant Area	2.3	
Pad A Area (Portal)	2.8	
Pad B Area (Portal)	2.9	
POND RS-003B1 Area	2.2	
Tailings Area	55.1	
Main Substation Area	0.6	
Explosives Magazine Area	1	
Crusher Area	0.1	
Quarry	18.4	
Quarry Waste Rock Dump	9.9	
Riverside road's Dumps	1.9	
Las Peñas Camp Facilities and Expansion	3.6	
Ore Stockpile Facilities	0.7	
Dump Facilities at the South Portal	0.8	
Heliport Facilities	0.2	
Tailings Area Polishing Pond	2.8	
Mine Pond 003B2	0.4	

Infrastructure	Approximate Surface Area (ha)	Approximate Total Area (ha)
Mine Pond RS-002	1.1	
Power Line		
Temporary Access Roads	6.9	135.2
Transmission Line Easement Areas	128.5	
Towers pad	1.4	
Project Accessibility		
Las Peñas Camp - Fruta del Norte Project Alternate Access Road	3.2	26.2
Main FDN Access Road (west boundary of the project operative area - Machinaza)	13.7	
Access Roads	9.2	
Slopes and additional constructive area for the entire Project		
Additional Constructive Area	57.2	118.3
Slopes	61.1	
Total Approximate Footprint of the Project Layout		**422.7**

Source and Prepared by: Cardno, March 2018.

Underground Mine and Ancillary Facilities

Underground Mine

The mine is an underground facility where the mineral resource is exploited. The mine is accessed through two portals, from which two mainly parallel drifts will be excavated.

These parallel underground declines will pass beneath the Río Machinaza and connect the portals on the west side of the river with the ore body to the east.

Portals and Declines

The initial section of the underground developments will be performed using soft-tunneling technique.

In order to begin building the tunnel corresponding to the production decline or the main decline, a portal entrance opening must be established.

A ventilation system will also be built in the southern part of the mine, along with a separate emergency escape.

The declines will run under the Machinaza River. At the river crossing, the cover thickness will be approximately 150m.

A protective structure will be installed at each portal as precaution against any material falling from the wall.

This structure will be a metal culvert with 7m diameter.

Although the structure will protrude from the outer wall, it will also extend underground between 10 m and 20 m, depending on the soil's structural quality.

Underground Mine Development

The underground mine drifts will be made using standard drilling and blasting methods. The dimensions of the underground drifts will be approximately 5 m wide by 5.5 m high.

To maintain the structural stability of the opening, geo-technical or ground supports will be installed. Utility services will be installed throughout the underground drift and will be hung on the ceiling or walls.

Ore Exploitation Method

Exploitation of the ore body will be performed using two exploitation systems:

- **Stope Exploitation:** this consists mainly of drilling and extracting mined ore. As the mined ore is extracted from the initial levels, they will be subsequently filled in.
- **Drift and Fill Exploitation:** exploitation done using drifts, followed by filling.

Mine Stabilization System

To ensure the long-term stability of the mine and safe extraction of the ore, underground voids will be filled once the mining is complete.

Fill material in the mine rooms will be made up of a mixture of paste backfill, rock, and aggregates with various amounts of cement added. In some areas, aggregates may be added to the fill paste, while in other areas of the mine, waste rock will be used as fill.

Ventilation System

The ventilation system will be composed of a fresh air return (FAR). The south vent will be used for fresh air intake, while the two main access declines will be used for the exit or escape of air. The system will be reversible.

Lighting Systems

A lighting system will be installed to shall comply with Ecuadorian regulations in force, which include the Worker Health and Safety Regulation and Mining Safety Regulations, in addition to meeting specialized international underground mining standards.

Dewatering Wells

Part of the underground water management will consist of establishing a series of surface wells to extract water. The purpose of these wells is to drain the groundwater ahead of underground production.

Compressed Air Provision System

Three compressors will be installed (two in operation and one on stand-by). Air will be distributed in the mine interior from the air accumulators to the equipment and service stations.

Anti-Fire System

The anti-fire system will be installed to safeguard the lives of all occupants and protect Project infrastructure, regarding both surface and underground fires.

Mine Waste Dumps

Most of the waste rock will be produced during the mine development phase, including that generated during the access ramp construction.

Waste rock from the access declines will be stored in the waste rock dump or used in construction activities.

The waste rock dump area will be built in an area with natural slopes of between 5 and 10%, where excavation surplus shall be removed to build on a compacted saprolite base, if possible; otherwise, the surface will be waterproofed (Ex., with geomembrane), to create a naturally waterproof barrier.

The waste material will be separated according to its acid generating capacity. The results will be incorporated into the mine's geological model.

Non-Acid Generating (NAG) waste material that can be used as aggregates shall be stored inside of the waste dump, but separated and differentiated from the Potential Acid Generating (PAG) waste rock and waste rock that is not appropriate for use as aggregates for surface construction.

Ore Stockpiles

During the life of the mine, it will be necessary to stockpile different grade ore in order to maintain stability of the grade and other parameters of the material to be processed.

Several stockpiles have been planned to store different types or grades of ore. The location of these stockpiles will be near the primary ore crusher.

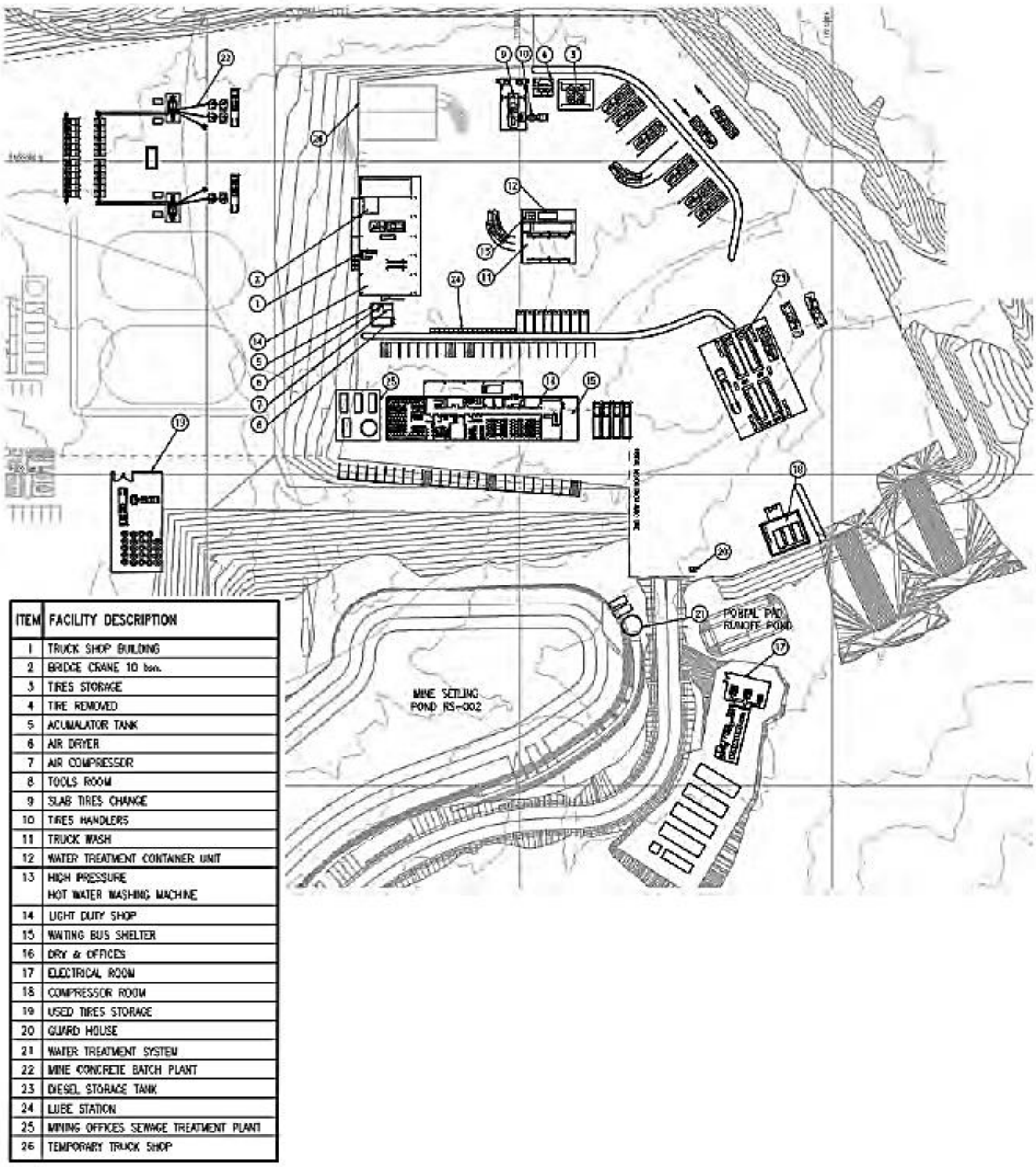
Ore stockpiles will be exposed to wind and weather. Rainwater contact with ore has the potential of generating ML/ARD. Therefore, a pond has been included to capture runoff water from the ore stockpile.

Likewise, rainwater that infiltrates into the rock mound will be intercepted by a leveled layer of compacted saprolite.

Surface Mine Infrastructure

Surface mine infrastructure is understood to be all surface facilities needed to operate the underground mine.

A diagram of the surface infrastructure for the underground mine is shown below.



ITEM	FACILITY DESCRIPTION
1	TRUCK SHOP BUILDING
2	BRIDGE CRANE 10 ton.
3	TIRES STORAGE
4	TIRE REMOVED
5	ACUMALATOR TANK
6	AIR DRYER
7	AIR COMPRESSOR
8	TOOLS ROOM
9	SLAB TIRES CHANGE
10	TIRES HANDLERS
11	TRUCK WASH
12	WATER TREATMENT CONTAINER UNIT
13	HIGH PRESSURE HOT WATER WASHING MACHINE
14	LIGHT DUTY SHOP
15	WAITING BUS SHELTER
16	DRY & OFFICES
17	ELECTRICAL ROOM
18	COMPRESSOR ROOM
19	USED TIRES STORAGE
20	GUARD HOUSE
21	WATER TREATMENT SYSTEM
22	MINE CONCRETE BATCH PLANT
23	DIESEL STORAGE TANK
24	LUBE STATION
25	MINING OFFICES SEWAGE TREATMENT PLANT
26	TEMPORARY TRUCK SHOP

Figure 5 Mine Surface Infrastructure Diagram

Source and Prepared by: G Mining Service INC., April 2017

Paste Backfill Plant

The Paste Backfill plant will provide the necessary fill for the mine stabilization operations during the underground mining activities. This plant will be the mine's main supplier of paste and cemented rockfill.

The fill paste is made up of tailings and cement, and the cemented rockfill consists of tailings, rock and cement.

Concrete Plant

The concrete plant will be located on the northern boundary of Portal Platforms A and B. This is a plant that will function outdoors and requires no protective building.

The operation platform (floor) will be made of compacted structural fill. All the solids spills from the operation will be managed using a front-end loader.

Mineral Processing Plant

The main plant processing areas include:

- Crushing
- Grinding
- Gravity Concentration
- Flotation
- Thickening
- Carbon-in-Leach (CIL)
- Cyanide Destruction (DETOX Circuit)
- Refining
- Tailings and Reclaim Water
- Reagents, Services, and Utilities
  - Cyanide storage
  - Fluid handling system

Tailings Storage Facility

The TSF will store approximately between 10 to 16 million tons (Mt) of tailings produced in the processing plant over the mine's planned 15-year life. Tailings generate because of mineral processing are routed to the DETOX circuit to remove residual cyanide prior to deposition in the TSF.

Following detox, a portion of the tailings will be pumped to the Paste Plant for use in backfill for the underground mine. The remaining tailings not required for backfill will be pumped via an above-ground pipeline to the TSF for final storage.

The TSF will also store the sludge generated by the water treatment plant, as well as sediments removed from the stormwater/settling ponds located in the mine's surface infrastructure area. The design and general arrangement of the TSF includes the following main components:

- Tailings storage basin with compacted clay/saprolite liner and seepage control system
- Rockfill embankment
- Decant pond.
- Settling ponds
- Perimeter diversion channel
- Downstream monitoring/pumpback well network

In geological terms, the TSF area is part of the Zamora batholith formation. The predominant foundation materials are residual soils and saprolites created by weathering of the batholith bedrock (granodiorite). Saprolites are the main soils making up the foundation material that is predominant in the TSF zone.

The content of fines and plasticity of the saprolites diminishes with depth; consequently, these materials are described as silty clays with low to medium plasticity and sandy silts. The thickness of this horizon varies between 10 m (in the low areas of the valley) and 45 m (on the valley slopes).

Geotechnical testing of TSF basin materials show that the materials are firm to dense, with \density and resistance increasing with depth. Permeability tests show that the saprolites and clays in the basin area have low permeabilities, with hydraulic conductivity of between $4x10^{-7}$ m/s and $7x10^{-8}$m/s.

TSF Embankment Design Criteria

The TSF embankment design incorporated the following international standards and industry best practice:

- Canadian Dam Association Standards (CDA, 2014), with the embankment classified under “extreme” for potential failure consequences
- International Committee of Large Dams (ICOLD)
- Standards of the Mining Association of Canada (MAC)
- Standards of the American Society for Testing and Materials (ASTM) for the laboratory testing program

Description of the Structure

The TSF has been designed to store the tailings generated in the processing plant that are not used in the paste backfill plant. The tailings will be stored inside of a basin created by an embankment and the natural valley topography. A starter dam will be built initially, designed to store tailings (toward the TSF), and then the dam will be progressively heightened throughout its useful life until achieving the end configuration.

The embankment will be mainly made up of rock fill from the FDN construction quarry. The slope upstream of the embankment will have three zones with a layer of low-permeability compacted clay (saprolite) that will provide a bed for support and control for a geomembrane liner, followed by two layers of filter (sand) and transition material (gravel) designed to avoid internal erosion processes in the embankment body.

Polishing Pond

The polishing pond is a structure designed to control sediment from diversion channel flows of non-contact water, to later be returned to the natural surface water system. This pond will control sediments generated during TSF construction and operation.

The pond design characteristics are:

- The minimum design volume corresponds to a 10-year, 24-hour precipitation event, with a minimum 10-hour retention time.
- The design flow for sizing the discharge site corresponding to the peak flow produced by a precipitation event with a 200-year recurrence and 24-hour duration.
- This discharge site is made up of an entry channel with a 0.5% slope and rapids with a slope of up to 12%.

- The lining material for the rapids is masonry or riprap, to resist erosion during high speed flows.

TSF Seepage Control System

Embankment seepage will be minimized using a 200-mil geomembrane placed on the upstream embankment slope, which will be complemented by compacted clay zones, filters, and transition zones.

Seepage analyses show that the infiltration flows will be very low, under 1.5 L/s. Any potential bottom filtrations through the embankment will be minimized by the low permeability of the natural saprolites found in the TSF area and the deposited tailings. However, the following have been proposed as additional control measures:

- Geomembrane.
- Impermeabilization ditches upstream of the embankment and downstream of the geomembrane.
- Additionally, a network of groundwater quality monitoring/pumpback wells will be located downstream of the TSF embankment. Any filtration encountered by the monitoring network will be pumped back to the TSF basin.

Other natural effects that will help to control the water quality of potential TSF filtrations are:

- Natural degradation of any residual cyanide in the tailings from ultraviolet (solar) radiation and attenuation due to the slow filtration speed resulting in the low permeability saprolites.
- Dilution and natural degradation of cyanide or other components in the decant pond from direct precipitation into the dam. Attenuation of metals due to geochemical interactions with the clay-rich saprolites.

Tailings Delivery System

The Tailings Delivery System into the FDN TSF begins in the FDN concentrate processing plant, and ends with discharge into the tailings distribution box in the TSF.

Embankment Physical Stability Control System

The first activity to control the embankment's physical stability involves preparing the foundation. This preparation will consist of removing topsoil and soft, permeable soil near the surface, until reaching firmer soils.

The high strength of rock fill to be used in building the embankment and the recommended construction method will make it possible to control the embankment stability, due to the following effects:

- Fill laid during embankment construction will allow for consolidation and dissipation of excess pressure through pores in the foundation floor. This will make it possible to increase in the soil cut strength and maintain the required safety factors.
- Fill will be laid downstream of the operative embankment. This fill will function as the safety crest walls, which increase short and medium-term embankment stability.
- The embankment will have maximum overall slopes of 2.4 H:1V to comply with minimum safety factors. However, during construction, the overall slopes will be flatter than 2.4 H: 1V, to ensure short term stability of the structure.

The TSF embankment stability will be governed by the undrained strength and dissipation capacity for pore pressure excess from the foundation soils.

Additionally, during embankment construction, the "observational method" will be applied; this consists of installing and applying an instrumentation program that will make it possible to monitor the embankment and the foundation behavior.

The polishing pond embankment will also be built with quarry rock or saprolite, and will have a maximum height of 13 m with slopes of 2.5 H:1V, upstream, and 2 H:1V, downstream, with a brow width of 10 m. Analyses show that this dam layout complies with the specified stability factors.

Topsoil Stockpiles and Excavation Surplus Waste Dumps

A total area of 12 ha has been estimated for topsoil stockpiling, with a maximum height of 2.5 m to minimize compacting of the material.

Topsoil will be stockpiled in areas that have a low slope to minimize soil weathering due to erosion.

Waste Management Center and Landfill

To decrease pressure on nearby municipal facilities and to assure adequate and environmentally protective disposition of non-hazardous waste, the Project will construct, operate, and close a dedicated on-site landfill and a Waste Management Center (WMC).

The WMC is sized to receive waste during the exploitation and beneficiation phases during all their various stages, and will, at minimum, consist of a compost plant, landfill, and a temporary waste storage area. In this structure, hazardous, non-hazardous and special waste will be temporarily stored separately by type of waste prior to final disposition in duly permitted facilities off-site.

Personnel Camps

The Company has two personnel camps in the Project area. The base camp is Las Peñas, which provides on-site housing and dining accommodations for Company personnel and its various service Contractors. Following its expansion, the Las Peñas Camp now has a capacity of approximately 740 people. The Project is in the process of constructing the Fruta del Norte Camp, which provides accommodation for approximately 1,000 people

Explosives Storage Areas

Explosives used during construction and mining activities will be stored in both specifically designed and dedicated explosives storage structures on the surface and in the underground facilities. These storage areas are described below:

Surface Explosives Magazine for Mine and Quarry Explosives

Three types of explosives will be stored:

- Bulk explosives emulsions
- Powder bars and blasting accessories for auxiliary detonators and detonator cable
- Detonators, which will be stored separately from explosives magazines according to the statutory minimum distances under Ecuadorian law

Underground Explosives Magazines

The underground explosives magazines will be located on different levels of the mine. The detonator warehouses are located underground in magazines that are separate from yet located near the explosives magazines.

Water Requirements and Management

The Project area is characterized by its abundant water resources, including year-round high precipitation.

Accordingly, Project design had to consider specific measures to manage surface runoff water, precipitation falling on the effluent catchment and containment infrastructure, and separation of contact and non-contact waters, as well as groundwater inflows that interact with the various Project areas. The proposed water management model for was designed with six main objectives:

- Prevent and/or minimize potential impacts to water resources
- Minimize freshwater intake requirements by using contact water, along with groundwater pumped from the mine, to the extent possible
- Maximize the recirculation of contact water within the Project.
- Minimize the footprint of the area that will involve operation of hydraulic structures.
- Treat contact water prior to its discharge into the environment.
- Minimize the discharge volume of effluents into the environment.

Contact Water

Contact water is that which has had contact with facilities, infrastructure, equipment and materials related to mining activities or that was used for operations or processes. There is the possibility that the natural physical, chemical, or biological properties of such water has been modified. Such water may require secondary and/or advanced treatment before being discharged.

Contact water is also considered as that which falls on Project areas where no specific mining activities are taking place, but in which, because of contact with such areas, the water's physical and chemical composition changes.

This water transports mainly sediments or other elements that require only preliminary or primary treatment before being discharged into the environment. Finally, underground water that enters underground drifts may require preliminary or primary treatment before being discharged into the environment, which is why it is considered contact water.

Non-Contact Water

Non-contact water includes precipitation that falls outside of Project facilities or construction areas, as is water recovered from coverings and areas unaffected by the mining process. Non-contact water is collected and transported using independent systems (drains, gutters, pipes, etc.), to maintain the water's original characteristics without allowing for cross-contamination with affected (contact) water. To achieve this, the water will be drained toward nearby surface waterways.

Water Requirement for Domestic Use

Average demand during the construction and operations phase has been calculated at between 6-10 L/s. To collect water for domestic processes and for utility or washing purposes (industrial use make-up water), water usage permits will be requested from SENAGUA for the water sources deemed to be most appropriate.

Supply sources could be gullies, underground water wells specifically designed to that effect, or stormwater collected in the Project surface water management pond (SWMP). Water treatment plants will be installed to meet domestic water needs (showers, toilets, kitchen, etc.).

Water Requirement for Industrial Uses

Freshwater will be obtained from water catchments approved by SENAGUA or through stormwater collection ponds for the Project's construction, operation and closure activities.

The makeup water needs of various processing plant activities, including the Paste Backfill Plant, will be served by recirculated contact water.

Water Balance Inputs

Main inputs to the Project water balance include: (i) Groundwater infiltration and dewatering system flows from the mine area, and (ii) Rainwater and surface runoff; both of which are described below; and freshwater intake.

Groundwater from the Mine Area

There are two main groundwater sources from the underground workings:

- Groundwater unaffected by Project activities and pumped from dewatering wells before it enters the underground mine. This non-contact water can therefore be discharged in compliance with current environmental standards. The groundwater flow from the dewatering wells is estimated to be approximately 1,670 m^3/h.
- Water collected in the mine (contact water), having a flow of collected and evacuated water estimated at 335 m^3/h; this is the most significant inflow volume in the FDN Project.

Stormwater and Surface Runoff

Stormwater is defined as precipitation falling onto the Project area surface; once it moves across the surface of the Project footprint it becomes surface runoff or contact water, depending on the interaction it has with Project infrastructure.

Likewise, interception of water upstream of Project areas and its diversion toward nearby natural waterways is non-contact water, in addition to all water pumped from underground water dewatering wells as previously described.

Differentiated Water Management on the Project

The mechanisms to be applied in managing each of the Project water inflows are summarized below.

Water Management for Industrial Uses

The project was designed so that the water demand for industrial processes is mostly covered by recirculation of contact water and through recovery of process and tailings supernatant water, instead of requiring fresh water from the environment. For this, contact water will be initially delivered to settling ponds located throughout the Project.

From the settling ponds, the contact water will be delivered to the water demand points for industrial activities. Water surplus, which is water not used in industrial activities, as well as contact and affected water (change in physicochemical conditions), will be diverted to water treatment plants to meet compliance with the environmental legislation in force at the time of discharge.

Stormwater and Surface Runoff Management

Stormwater management for the Project will be based on eliminating or reducing as much as possible the impact of water downstream of the Project.

Stormwater runoff management shall be done fundamentally using a system of diversion ditches; embankments or berms will surround the different areas of the Project site, isolating the operations areas from the surrounding areas. Below, we have showed the location of water management-related infrastructure, as well as the Project's general water management flowsheet.

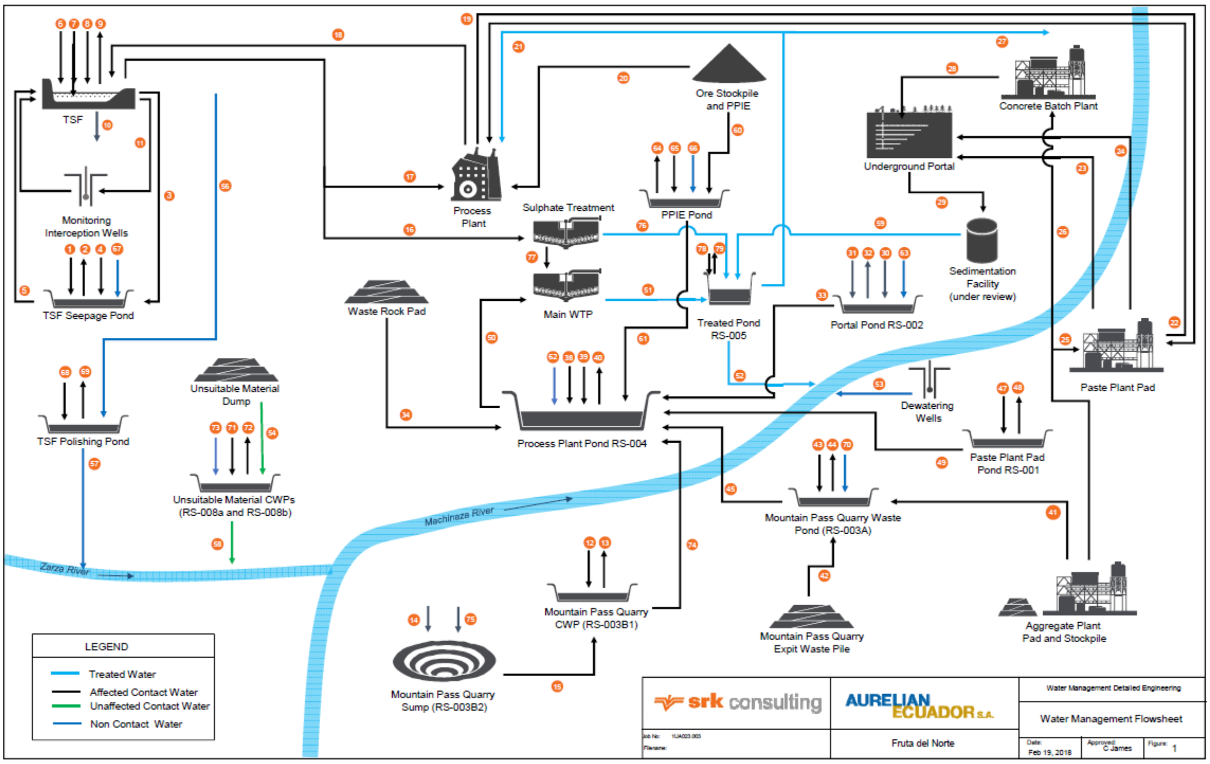


Figure 6 **General Project Water Management Flowsheet**

Source and Prepared by: SRK Consulting, February 2018

Power Transmission Line (PTL)

A 230-kV power line will be built to provide the FDN Project with the electricity from the national grid. The proposed PTL (power transmission line) will start at the existing Bomboiza Substation, owned by the Ecuadorian Electrical Corporation (CELEC EP), and will run to the new FDN Substation, which will be owned by the Company. This PTL will be approximately 43 km long. The main characteristics of the PTL are detailed below:

Table 2 Characteristics of the PTL

Technical characteristic	Value/Specification
Rated voltage	230 kV
Power system	three-phase
Frequency	60 Hz
Number of circuits	1
Number of conductors per phase	1
Number of guard cables	1
Conductor arrangement	Triangular
Maximum transport power	33 MW
Type of conductor	Acar 500 MCM conf 18/19
Line length	42.83 km
Initial elasticity module	6,370
Supports	Approximately 107 metal towers will be installed (this is an approximate number; the location, distance and the exact number of towers to be installed will be determined when the geotechnical studies are carried out) that will occupy an approximate area of 6 x 6 m each, with a height varying between 40 and 50 m. There is approximately 400 to 450 m distance between towers.

Source: Help Energy, 2017
Prepared by: Cardno, 2017

The following table details the activities corresponding to each PTL phase:

Table 3 Activities and Phases of the PTL

Phase	Activities
Construction	Geotechnical study (drilling), soil sampling, manual test pits, and topographical surveys
	Upgrades to existing roads and/or access roads to the areas where the PTL towers will be installed.
	Rights-of-way and easements
	Plant cover removal to install the towers along the PTL easement strip.
	Construction of civil works.
Operation	Electrical transmission
	Electromechanical maintenance
	Easement area maintenance
Closure	Equipment Dismantling and Structural Demolition

Prepared by: Cardno, 2018

Construction Material Quarry

Construction aggregate and rock fill materials will be mined in the Colibri 5 Mining Concession (50001075), of which the Company is the titleholder.

The quarry will have complementary infrastructure to support aggregates exploitation on land belonging to the Company or its related companies (Aggregates Plant, Offices and Health Facilities, and Infrastructure associated with the internal quarry roads).

Quarry

The quarry operation facilities will be mobile, including a crushing and screening plant, office, breakroom and sedimentation ponds. The quarry project design occupies an approximate 21 ha area.

The rock found within the designed quarry represents approximately 13,544 kt (kilotons) of aggregates and 5,804 kt of material that is not useful, which will be deposited in a waste dump.

The quarry's extraction capacity will be that required by the construction works to be performed on the site, as well as the fill requirements of the FDN Project underground mine.

Aggregates Plant

Quarry material will be transferred to the aggregates processing plant using dump trucks or similar vehicles.

Crushing processes are performed at the aggregates processing plant to produce construction materials that come from the quarry.

the aggregates obtained from the quarry will be crushed at the aggregates plant. Then, the crushed aggregates will be loaded onto a front-end loader to be dumped into the feeding hopper for each work front.

Offices and Health Facilities

To facilitate the temporary nature of Project activities, prefabricated modular infrastructure has been considered, consisting of an office, dressing room, guard post and portable toilets.

Internal Road Infrastructure for the Quarry

Finally, the construction material quarry will have internal roads connecting the quarry area with the various facilities that surround it, including the waste dump and aggregates plant.

Project Access

Internal and external access roads are needed for the Project, to replace existing access roads to the Project and to facilitate access within the Project site. These roads are detailed below:

- Access Roads in the Project Area
  - Los Encuentros-Las Peñas Camp Access Road
  - FDN Main Access Road
  - El Pindal Machinaza Access Road and Zamora River Bridge
  - Las Peñas Camp - Machinaza River Road
- Secondary access roads will connect to the main access road.
  - Access Road from the Ore Stockpile to the Mine Waste Rock Dump
  - Access Road to the Mine Surface Infrastructure Area
  - Access Road to Ventilation Shafts
  - Access Road to the Paste Backfill Plant
  - Access Roads to Mine Dewatering Wells
  - Processing Plant Access Road
  - TSF Access Road
  - Filtered Water Structure Access Road
  - Access Road to the Tailings Area Polishing Pond
  - Excavation Surplus Waste Dump Access Road
  - Topsoil Stockpile Access Road
  - Landfill Access Road
  - Access Road to the Aggregates Quarry and Explosives Magazine
  - Service Roads to the Contacted Water Pond
  - Access Road from the Aggregates Quarry and Machinaza River Bridge.
  - Access to Supporting Infrastructure

Alternatives Analysis

To optimize Project design and reduce potential environmental impacts, the Company conducted an analysis of alternatives for the primary infrastructure components, including:

- TSF location
- Mineral processing technology
- Power transmission line route
- Location of the construction material quarry
- Access route alignments

6. Physical Baseline

The physical baseline study describes the existing conditions in the general Project area from May 2015 to December 2017. The baseline of the current ESIA is a compilation of baselines from each national EIAs of each component of the Project, as enlisted as follows:

- Mine ESIA, October 2016.
- Power Transmission Line ESIA, August 2017.
- Quarry ESIA, October 2017.
- Mine ESIA Update to include the road, March 2017

The environmental factors analyzed as part of the physical baseline studies for the FDN Project area were:

- Weather
- Air Quality
- Geology
- Geomorphology
- Geotechnical Characteristics
- Soils and Land Use
- Hydrology and Sediments
- Hydrogeology
- Noise
- Vibrations
- Electromagnetic Radiation
- Natural Landscape

Climate

To characterize the climate in the Project area, public and private meteorological stations located closest to the Project area were identified, characterizing the following variables:

- Precipitation
- Temperature
- Relative humidity
- Wind speed and direction
- Potential evaporation
- Cloud cover

The climate baseline results showed that the Project area has a humid mega-thermal tropical climate, with a high humidity index, denoting an excess of water in both summer and winter (Evapotranspiration Potential – ETP - less than average precipitation).

This means that there is a surplus of available water in the Project area, and the main characteristic of vegetation is that it is always green and abundant, with a rapid growth cycle. The estimated Probable Maximum Precipitation (PMP) over 24 hours is 400 mm in the FDN area. This estimate is based on only seven years of data and should be updated once a minimum of 10 years has been logged.

Regarding climate change, the baseline investigation determined that the climatic response to the El Niño Southern Oscillation (ENSO) phenomenon greatly impacts the FDN Project region, resulting in reduced local precipitation rates from April to July during El Niño events.

ENSO-related decreases in precipitation during extreme events can range from –8% to –29% during these months. It is expected that the frequency of El Niño events will double in the future, as return periods drop from 20 to 10 years (Muñoz, 2010). Therefore, the impact of El Niño events on the regional climate over the course of the Project's life is expected to be reduced precipitation in a high rainfall area, and the Project has been designed to handle extreme rainfall events.

Air Quality

To assess air quality, selected monitoring points were used according to the location of the FDN Project's Critical Impact Points (sensitive receptors). Note that although air quality follows regional dynamics, the points analyzed were representative of the local dynamics for this baseline component.

The results of the assessed parameters were compared with the Maximum Permissible Limits (MPLs) for Air Quality, in accordance with the environmental legislation in force in Ecuador.

These findings show that during the study period (2015-2017), all parameters measured (carbon monoxide [CO], nitrogen oxide [NO_2], sulfur oxides [SO_2], ozone [O_3] and particulate matter [PM_{10} and $PM_{2.5}$]) were below the MPLs. This means that there are no sources that alter air quality in the baseline study area.

Geology

The following geological aspects were described for the geology baseline in the study area:

- Stratigraphy
- Geochemistry of potential Project waste and construction materials
- Tectonics
- Seismicity
- Volcanology

The Project area is part of the eastern Ecuadorian sub-Andean zone, consisting of marine-continental sedimentary rock units.

Following a major sedimentary hiatus in the Upper Mesozoic, the continental sediments of the Misahuallí Formation were covered by a Cretaceous marine transgression. During this transgression, the Hollín, Napo and Tena Formation sediments were deposited in a large pericratonic basin over what is now the general Project region.

Geochemical characterization of the waste rock and ores in the mine area determined the materials' potential for metal leaching and generation of acid rock drainage (ML/ARD), projected for materials from the underground development areas, ore zones (potential waste rock) and construction materials quarry.

Several geologic faults cross the Project area, including two parallel northeast-trending faults that serve to hydrogeologically isolate the groundwater system in the mine area from the Rio Machinaza.

An historical seismic analysis confirmed that the study area is in one of the most seismically active areas of the country. This includes the Cordillera Real and part of the sub-Andean region, whose seismic density ranges from high to intermediate.

In addition, volcanic activity in the study area is related to the mobile belts of the Ecuadorian Andes. The active volcano closest to the Project is Sangay, about 225 km north of the Project area; Sangay's last major eruption occurred in 1628.

Little is known about this volcano's activity because it historically has not affected inhabited areas, unlike other volcanoes in the country. However, explorations by researchers, mountain climbers and monitoring flyovers by the Geophysical Institute suggest that this volcano commonly causes pyroclastic flows, lava flows and lahars.

Geomorphology

The geoforms in the study area are part of the major landscape known as the sub-Andean region. Geographically, it comprises most of the Cordillera del Cóndor that runs north-south, parallel to the overall upheaval of the Andes mountain range.

The geomorphological units identified in the Project area include the following:

- Alluvial terraces
- Moderately dissected hills
- Moderately dissected mountains
- Highly dissected mountains
- Plateau surfaces
- Structural mountains

Soils and Land Use

The following samples were taken for soil characterization: 25 environmental samples, 75 edaphological samples, and 25 geotechnical samples throughout the study area.

At each sampling point, the procedure was standardized, georeferenced and analyzed by a laboratory accredited under both ISO 17025 and the Ecuadorian accreditation service. Physical characterization of soils included the following parameters:

- Humidity
- Liquid and plastic limit
- Plasticity index (PI)
- Natural density
- Permeability ranges
- Classification according to the Unified Soil Classification System (USCS)

From a physical-mechanical viewpoint, prospected soils in the study area are of residual and sedimentary residual origin, with fine to medium grains more than 2 m thick, most highly plastic MH silty-clays.

In addition, granular soils of alluvial origin were found in the same proportion, such as silty SM sands with fine to medium grains and medium to high density, making them highly permeable.

To a lesser degree, inorganic and organic clays and silts of medium to high compressibility, CH and OH, were found with medium to high plasticity and permeability.

Meanwhile, chemical characterization of the soils included the following parameters:

- **General Parameters:** pH, Conductivity.
- **Inorganic parameters:** Arsenic, Sulfur, Barium, Boron, Cyanide, Total Chromium, Chromium VI, Cobalt, Cadmium, Copper, Tin, Mercury, Molybdenum, Nickel, Lead, Selenium, Vanadium and Zinc.
- **Organic Parameters:** TPH.

In general, there was no evidence of significant soil pollution at the sampling points within the Project area.

However, high concentrations of certain metals, such as barium, copper, cadmium, cobalt, hexavalent chromium, mercury, lead, vanadium and zinc, were identified, which are related to the geochemical characteristics specific to the study area from which the samples were analyzed. This is due primarily to the fact that polymetallic mineralized zones have been found in the study area.

This issue has also led to most of the soil sampling points (84%) having pH figures of slightly acidic to acidic (lower than pH 7), which are in accordance with those found in the agronomic studies of those soils.

Turning to edaphological characteristics of soils, the predominant type in the area is *Typic Dystrundepts* which is found to have texture profiles from loam to silty loam, with high water retention capacity, usually poor in available nutrients

In addition, as mentioned above, the soils are generally acid. Therefore, they have a low level of natural fertility, which limits their use in farming. Additionally, most of the prospected soils have low permeability, except for Alluvial Terrace soils.

To evaluate the capacity of land use in the Project area, data was used with the following variables:

- Effective soil depth
- Slope of the terrain

- Stoniness
- Erosion risks
- Chemical characteristics
- Climate variables

Results showed that the study area is mostly made up of *marginal farm lands, generally suited to forestry for protection purposes* and *land generally suited to permanent crops, pastures and forestry*. To a lesser extent, the study area also contains *land not suited to agricultural or forestry purposes*. In the case of the specific area to be intervened by the infrastructure construction, the land corresponds mostly to *forestry for protection purposes.*

Assessments of land-use conflicts found that, based on the National Ecuadorian Authority of Geographic Information (IGM), most of areas were dedicated to correct use (C1) which means that the current land use agrees with the suitability of such land. This means that soil degradation processes were not observed.

This category is associated with feasible use (F); normally on the terraces of the Zamora River and areas difficult to access, steep slope areas, such as the high hills that contain natural vegetation with minimal disturbance. We also observed a minimal presence of areas with incorrect land use (I).

Hydrology and Sediments

To characterize surface water quality, 58 samples were collected in all the water bodies located throughout the study area.

At each sampling point, the sampling procedure was standardized, georeferenced, and analyzed by a laboratory accredited under both ISO 17025 and the Ecuadorian accreditation service.

In terms of water resource use in the Project's area of influence, given the low numbers of inhabitants in the sector, most water resources are not utilized. There is a reduced number of water users in the area, which sporadically visit the area for fishing or for their cattle. The following parameters were analyzed to characterize the physicochemical conditions.

- **General Parameters:** pH, Dissolved Oxygen, Turbidity
- **Inorganic parameters:** Aluminum, Arsenic, Barium, Boron, Cadmium, Cyanide, Zinc, Cobalt, Copper, Chrome, Iron, Manganese, Mercury, Nickel, Silver, Lead, Selenium, residual Chlorine
- **Organic Parameters:** Oils and grease, Total Petroleum Hydrocarbons, Phenols, Surfactants, Fecal Coliforms, Nitrites, Nitrates

The characterization was complemented with onsite measurements of the following variables: pH, electrical conductivity, total dissolved solids, and temperature. Concentrations of aluminum, arsenic, iron, manganese, mercury lead, selenium, silver, nickel, cadmium, cyanide, zinc, and chromium were elevated above the established quality criterion for the preservation of freshwater aquatic and wild life in several locations (Appendix 1, Table 2 Ministerial Order 097-A). These metals having values above the quality criteria are associated with geological conditions particular to the area and mineralization from the FDN orebody.

Several sampling points have lower pH values outside of the quality criteria set under Ecuador's environmental regulations (Appendix 1, Table 2, Ministerial Order 097-A). The pH range is 3 from minor drainages to 9.41 in some creeks near the Project. For instance, The pH of Machinaza River ranges from 4.4 and 8.9 at several locations. Possible causes include local geology, with many sulfates in the Project area, which in contact with oxygen or water cause the sulfur to oxidize, thereby increasing water acidity and leading to an acidic pH. Another possible cause is the decay of organic matter, which generates humic acid, therefore leading to a low pH.

As for the organic components analyzed, very few cases show fecal coliform figures above the MPL, due primarily to anthropic activities such as farming, which increases fecal matter from cattle. The samples analyzed show no figures above the quality criteria set in the Ecuadorian environmental regulations for oil and grease parameters and total petroleum hydrocarbons.

To gain a better understanding of the hydrological dynamics, surface water sampling was complemented with physicochemical characterization of the sediments present in the same surface water sampling points.

The results of such sampling find levels below the referential Quality Criteria (QC). However, there are parameters whose values are above such QC, such as for example: pH, arsenic, cobalt, sulfur, barium, cadmium, boron, copper, molybdenum, nickel, lead, selenium, vanadium, and mercury. Several parameters above the QC have values above surface water QCs. No free cyanide concentrations were detected in the sediment samples.

Considering that the predominant lack of industrial, agricultural or livestock activities near the specific area where samples were collected, it was concluded that the metal concentrations reported in sediment are due to natural physical-chemical composition, reflecting the edaphological and geological features of the study areas.

Hydrogeology

For hydrogeological characterization, piezometers were installed in the area where the underground mine, TSF, and tailings area polishing pond will be located. Onsite hydrogeological characterization was performed using data provided by the Company as part of its engineering studies for Project design.

Across the Project site, depth to groundwater in the headwaters of hydrological basins was found to be greater than 30 m and hydrogeological conditions in the area are mainly influenced by the degree of fracturing of the substrate and the lithology; regardless, it can be said that there is a fractured aquifer system that naturally discharges through several streams in high fracturing areas.

Likewise, aquifer recharge is regional and comes from highland precipitation where saprolite has little potential and granulometry increases, which coincides with highly fractured areas.

This analysis shows that the results of the general parameters and main ions do not exceed the MPL. However, in some groundwater samples, dissolved metals such as chromium, arsenic, barium, iron, lead, molybdenum and zinc are above the MPL, attributed to the nature of mineralization near the base of the deposit.

Noise

Ambient noise monitoring points selected were located mostly in the area where Project infrastructure will be built, primarily where potential critical impact points (CIPs) were identified.

Twenty-seven daytime and nighttime measurements were made to characterize ambient noise; this was done in areas where the Project infrastructure will be installed. For each measurement, a log was prepared describing the methodology used, characterization of the emission source, the noise emission schedule, measurement conditions, applicable legal framework, measurement parameters, and charts.

According to the results obtained in both day and night monitoring, we found that the values were below 49 dB (daytime) and 54 dB (nighttime), which means that they did not exceed the MPL in Ecuador's current environmental regulations in Ecuador. This information was used, then, to establish the background values for each point.

Vibrations

To characterize vibrations, measurements were taken at 6 points and 4 transects, which were mainly located at sites where the Project infrastructure will be installed. Vibrations in the Project area were characterized using the peak particle velocity (ppv), characterizing the following variables:

- Perception: 0.3 mm/s (ppv)
- Inconveniences: 1.0 mm/s (ppv)
- Structural damage: 10.0 mm/s (ppv)

Upon analyzing results, it was found that no vibrations exceeded a particle velocity of 0.3 mm/s, and only two measurements were above the equipment detection limit: point P1 at the KFV04 transect (close to the existing access road to Las Peñas camp) and point KFV06 (close to the abscise 12 of the northern access road), with figures of 0.02 mm/s. These results are consistent with the fact that no potentially vibration-generating activities were being carried out (such as earthworks or clearing) at the time when the measurements were taken.

Electromagnetic radiation

To characterize the electromagnetic fields (EMF) in the Project area, 24 measurements were taken along the PTL route, the FDN Substation area, and projected crossings with existing powerlines.

The methodology used met the ANSI/IEEE 644-1994 standard and the Hi3604 (Power Frequency Field Strength Measurement System), designed to assess EMF associated with 50/60 Hz power transmission. The characterized variables included:

- Intensity of electric fields (E)
- Magnetic flux density φ (mg)
- Temperature
- Relative humidity
- Barometric pressure
- Wind speed

The results obtained from EMF measurements along the 230-kV power line were lower than the maximum permissible limits for the public, as detailed in the Technical Regulations on Referential Levels for Exposure to Electric and Magnetic Fields in Ecuador, which are 60 HZ.

Natural Landscape

Natural landscape features were assessed based on visual fragility, which is defined as a landscape's capacity to respond to an intended use, and manifested as the degree of degradation it could suffer due to changes in its properties.

To evaluate the visual fragility of landscapes, we adapted the Muñoz-Pedreros (2004) methodology, assessing eight biophysical factors for each geomorphological landscape unit in the study area. The analyzed biophysical factors were:

- Density of vegetation layers
- Diversity of vegetation layers
- Vegetation height
- Seasonality of vegetation
- Vegetation/vegetation chromatic contrast
- Vegetation/soil chromatic contrast
- Slope
- Historical and cultural value

Results found that visual fragility in the inter-montane valleys of alluvial terraces (T), in the Project area, is lower than in other geomorphological units of the area. This figure is consistent with the hypothesis that, should the forest remnants in Moderately dissected mountains (MD1), Highly dissected mountains (MD2) and Structural mountains (ME) be disturbed, the impact would be much more visible than if activities were carried out in an already disturbed area such as T. In other words, units MD1, MD2 and ME are more susceptible to impacts if such disturbance happens.

7. Biologic Baseline

Study Area

The low hillsides of the Andean rainforests constitute some of the habitats with the highest level of species richness in the world, although they continue to be among the least explored (Schulenberg & Awbrey, 1997).

One of these areas located on the low Andean hillsides is called the Cordillera del Cóndor, found in the southeastern Ecuador, in the provinces of Zamora Chinchipe and Morona Santiago; the cordillera extends into Peru.

The Cordillera del Cóndor is separated from the Andes range by the lower Zamora River basin to the west, while the Santiago River basin to the north separates it from the Kutukú Cordillera. Its altitudes reach up to 2,900 m, but on average, the highest areas are around 2,300 m (Birdlife International, 2018).

From a physiographic point of view, the Cordillera del Cóndor represents the largest and most diverse area of sandstone mountains in the entire Andes region; this could be part of the reason why the Cordillera del Cóndor, including the lower parts of its mountain slopes and foothills, probably contains the greatest richness of vascular plants in all South America.

It is also part of what is known as the Tropical Andes Hotspot, which covers 1,258,000 km^2 and encompasses the Andean-Amazonian regions of Bolivia, Peru, Ecuador and Colombia, the Chocó Department of Colombia, and northwestern Ecuador.

The Cordillera del Cóndor occupies first place among world hotspots in terms of its diversity of vascular plants, endemic vascular plants, bird diversity and endemism, and amphibians and vertebrates in general.

Types of Ecosystems

There are 91 ecosystems in continental Ecuador. The biogeographic region of the Amazon has a total of 22 ecosystems, 6 of which are found in the study area:

- Piedmont evergreen forest of the El Condor and Kutukú mountain ranges (BsPa02)
- Low montane evergreen forest of the El Condor and Kutukú mountain ranges (BsBa02)
- Piedmont evergreen forest on limestone outcrops of the Amazonian mountain ranges (BsPa03)
- Low montane evergreen forest on sandstone plateaus of the El Cóndor and Kutukú mountain ranges (BsBa03)
- Montane evergreen forest on sandstone plateaus of the Cóndor Cordillera (BsMa01)
- Montane evergreen forest of the El Cóndor and Kutukú mountain ranges (BsMa02)

Types of Vegetation

The study area is characterized by an excellent conservation status, based on variables including structure, physiognomy, presence of indicator species, etc.

The following types of vegetation were found in the Project area:

- Minimally disturbed natural forest (Mdnf)
- Secondary forest (Sf)
- Pastures and crops

Vegetation Units

In addition to the ecosystems and types of vegetation in the study area, further detail has been able to be determined for the Project area by adding biogeographical variables to subclassify the area into vegetation units, whose varied characteristics in terms of substrate, altitude, climate, slope, physiography, plant composition, make it possible to distinguish between each unit. The main vegetation units in the study area include the following:

- Dwarf Shrubs on Sandstone Plateau (Dssp)
- Mature Forest in Sandstone Plateau (Mfsp)
- Mature Forest out of Sandstone (Mfos)
- Mature forest on slopes below sandstone plateaus (Fssp)
- Mature Forests on Slopes below Sandstone Plateaus over 1800 meters (Fssp > 1800 m))
- Valley Forests on Poorly Drained Soils (Vfpds)

Protected Areas and IBA, KBA, AZE

To protect the cloud forests and highlands of this mountain range, the Ecuadorian government, through the Ministry of the Environment, has created four nature reserves along the mountain range at different altitudes, which jointly protect some 41,000 hectares of forest (MAE, 2016). These reserves are:

- El Quimi Biological Reserve
- Cerro Plateado Biological Reserve
- El Zarza Wildlife Refuge
- Cordillera del Cóndor Protected Forest

Of these four, the Cordillera del Cóndor Protected Forest and the El Zarza Wildlife Refuge are located closest to the Project. These areas are located within a particularly important area for animal and plant species, being one of the few remnants of biodiversity.

Accordingly, the Cóndor Cordillera is one of the Important Bird Areas (IBAs) for conservation in Ecuador.

The Cóndor Cordillera has also been categorized as a Key Biodiversity Area (KBA) and an Alliance for Zero Extinction (AZE) site, due primarily to:

- A significant number of globally threatened species
- A significant number of endemic species only found in a limited area
- A significant number of species that occur only in a particular biome

Sampling Sites

The field survey of biological components afforded an opportunity to observe the forest's structure and composition, and the species of terrestrial fauna associated with the vegetation units, whose functions within the ecosystem are ecologically interrelated.

Additionally, it included the evaluation of aquatic ecosystems present within the Project's area of influence, with the goal of characterizing the aquatic fauna components present therein, to determine their conservation status.

To evaluate this data, we included information obtained for the following studies:

- Mine ESIA, October 2016.
- PL ESIA, August 2017.
- Quarry ESIA, October 2017.
- Mine ESIA Update to include the road, March 2017
- Additional FDN biotic inventories, March 2017
- Biotic inventories before installing ancillary facilities in Los Encuentros Parish, January 2018.

Table 4 Number of quantitative and qualitative sampling points for the Project

Biological component	Quantitative	Qualitative	Total
Flora	19	33	**52**
Mammals	44	42	**86**
Birds	38	65	**103**
Herpetofauna	55	31	**86**
Entomofauna	34	42	**76**
Ichthyofauna	65	-	**65**
Aquatic macroinvertebrates	41	-	**41**

Prepared by: Cardno, March 2018.

Table 5 Summary of the richness, abundance and diversity of the various biotic components

Biological component	Number of Species	Number of Individuals	Shannon-Wiener Index
Flora	926	3,289	25.02
Mammals	90	250	13.68
Birds	443	1,494	22.29
Herpetofauna	126	732	14.59
Entomofauna	264	2,868	17.74
Ichthyofauna	59	625	10.45
Aquatic macroinvertebrates	299	2,807	16.17
Total	**2,207**	**12,065**	**119.94**

Prepared by: Cardno, April 2018.

Assessment of Ecosystem Services

It was found that there are 26 ecosystem services (ES) in the Project area: 11 for supply, 8 for regulation, 3 social, and 4 for support.

However, of these 26 ES, only one would be relevant (Collection of mineral raw materials), since the Project could affect its beneficiaries' access thereto, which, in turn, could decrease economic revenues stemming from its exploitation by local miners.

An analysis was also presented on the conclusions and recommendations arising from the ecosystem services assessment:

- Mitigation of impacts and management of Project dependencies on priority ecosystem services
- Mitigation of impacts and management of project dependencies on ecosystem services important to communities

Identification of Critical Habitats

According to IFC's Performance Standard 6 (Biodiversity Conservation and Sustainable Management of Living Natural Resources – PS6), "habitat" is defined as a terrestrial, freshwater, or marine geographical unit or airway that supports assemblages of living organisms and their interactions with the non-living environment (IFC, 2012). Additionally, according to PS6, habitats are divided into modified, natural, and critical.

Modified habitats are areas that may contain a large proportion of plant and/or animal species of non-native origin, and/or where human activity has substantially modified an area's primary ecological functions and species composition.

Modified habitats may include areas managed for agriculture, forest plantations, reclaimed coastal zones, and reclaimed wetlands (Ibid.).

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

Critical habitats are areas with high biodiversity value, including: (i) habitat of significant importance to Critically Endangered and/or Endangered species; (ii) habitat of significant importance to endemic and/or restricted-range species; (iii) habitat supporting globally significant concentrations of migratory species and/or congregatory species; (iv) highly threatened and/or unique ecosystems; and/or (v) areas associated with key evolutionary processes (Ibid.).

Based on IFC's PS6, the process of defining study area boundaries made it possible to establish an area of 26,818 hectares that includes not only the Project area but also eight Discrete Management Units (DMUs) - areas with a definable boundary in which biological communities and/or management problems have more in common among each other than with those in adjacent areas. Of these, DMU 6, DMU 1 and DMU 8 are the largest, representing 10.7%, 11.9% and 13.8% of the study area, respectively.

These DMUs are home to functional ecosystems and reaffirm (based on the ecological dynamics of these areas) the ecosystem approach adopted for the analysis of Critical Habitats. Habitat assessment processes found that the largest portion of the study area (73.8%) contains habitats with optimal conditions, which is related to the high richness, biodiversity and endemism that is characteristic of the area.

Additionally, according to the application of criteria C1 and C2, 36 species were identified (14 flora and 22 fauna) that have quantitative thresholds (Tiers 1 and 2) according to IFC PS6. Meanwhile, based on IFC PS6 C4 and C5 criteria, we determined the existence of three specific areas that would be classified as unique ecosystems having key evolutionary processes, which are the following:

- Mature forest on Sandstone Plateau,
- Cordillera del Cóndor Protected Forest, and
- El Zarza Wildlife Refuge.

Finally, based on the C1, C2, C4 and C5 criteria, the flowing table presents the habitats encountered in the study area:

Table 6 Types of habitats in FDN

Type of Habitat	Fraction
Critical Habitat	48%
Natural Habitat	33.3%
Modified Habitat	18.7%

Source and Prepared by: Cardno, March 2018.

These results correlate to the habitat condition evaluation for the study area, as well as to the biodiversity values observed in the area.

Upon comparing the project footprint with types of habitat in the study area, it was possible to estimate that a reduced fraction (in comparison with the total study area) of the Project footprint in the construction stage will affect critical habitats (0.3%), natural habitats (0.8%), and modified habitats (0.4%), with the aggregates quarry being the infrastructure that will most affect critical habitats.

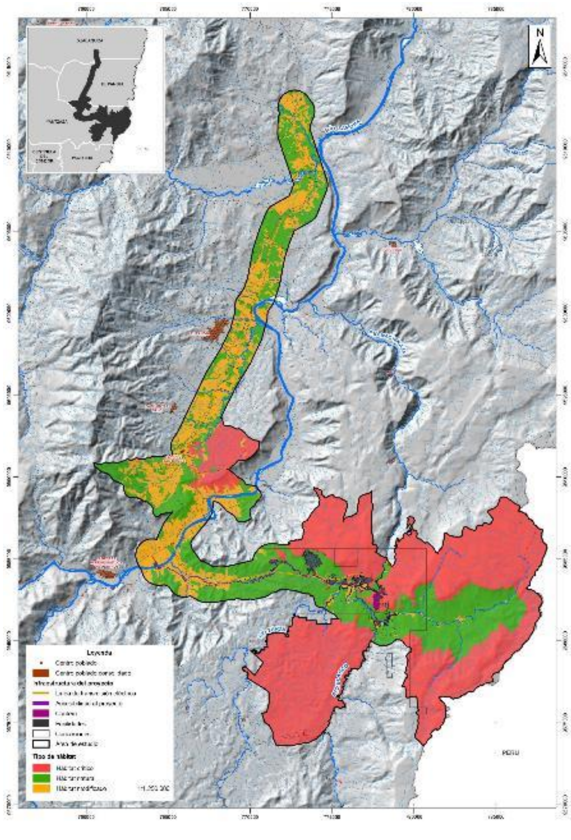


Figure 7 Critical, natural and modified habitats in the Project's study area

Prepared by: Cardno, March 2018.

8. Socio-Economic Baseline

Below is a description of the political-administrative boundaries for each Project component.

Table 7 Political administrative boundaries of the Project components

Component	Province	Canton	Parish District
Mine	Zamora-Chinchipe	Yantzaza	Los Encuentros
Quarry			
Access Roads			
Power Line	Morona Santiago	Gualaquiza	Bomboiza
	Zamora-Chinchipe	El Pangui	El Güismi
			El Pangui
			Pachicutza
		Yantzaza	Los Encuentros

Source and Prepared by: Cardno, March 2018.

Data Collection Tools

Qualitative and quantitative methodologies were used to collect data, thus ensuring data comparability when updates are made to the information in the future.

First, and for all project components, information surveys were planned before doing any fieldwork. Such surveys were planned based on information from the development and land-use plans (PDOT) for each territory, as well as on census maps and plans used by the National Institute of Statistics and Census (INEC) in 2010.

- **Quantitative Tools:** Census, socio-economic questionnaires, sample-level information
- **Qualitative Tools:** Interviews with qualified stakeholders, review of bibliographic sources, geo-referenced survey of information related to infrastructure and services.

Demographic aspects

Morona Santiago Province has 147,940 inhabitants, of which 74,849 are men (50.59%) and 73,091 are women (49.41%). This represents 1.02 % of the total national population.

Meanwhile, Zamora Chinchipe Province has 91,376 inhabitants, of which 47,452 are men (51.93%) and 43,924 are women (48.07%). This represents 0.63 % of the total national population. The following figure represents the demographics characteristics in terms of gender in the study area.

Yantzaza Canton, with 18,675 inhabitants, has the second largest population of the nine cantons in Zamora-Chinchipe, representing 20.44% of the province's population.

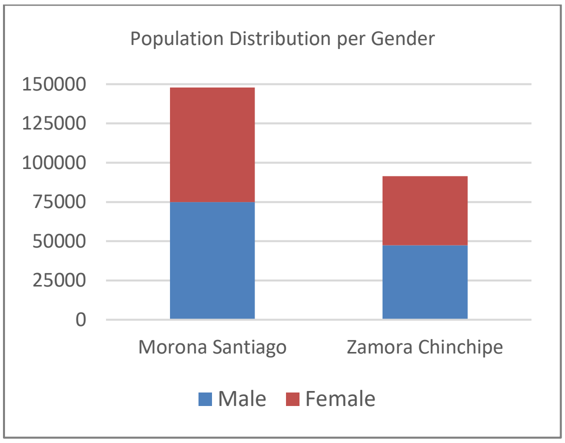
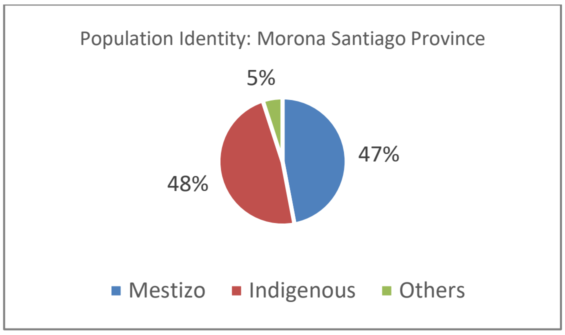


Figure 8 Population per Gender in the Study Area

Source: Cardno, March 2018.

At the parish district level, the population is 3,560 inhabitants, most of whom are concentrated at the Los Encuentros Parish District seat, while at the study area's community level, the population is highly concentrated in Muchime, El Padmi, and El Pincho, followed by Nankais, El Zarza, and El Pindal.

In Morona Santiago Province, the indigenous population (48%) is similar to the mestizo population (47%). Zamora Chinchipe, on the other hand, reflects the national figures, where 80% of the population is mestizo, followed by an indigenous population making up 16%.



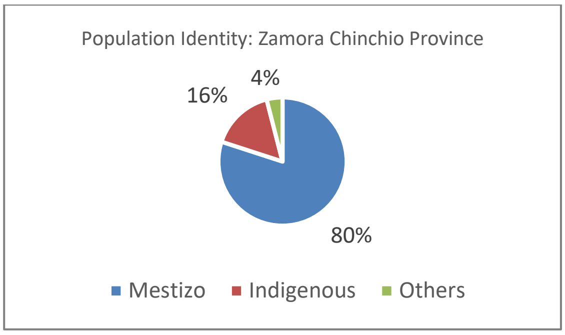


Figure 9 Demographics per Ethnicity in the Study Area

Source: Cardno, March 2018.

At the cantonal level, Gualaquiza, El Pangui, and Yantzaza have similar figures (the mestizo population is between 65% and 85%, followed by the indigenous population, which ranges between 10% and 30%).

In the parish districts of Zamora Chinchipe Province, the trend reflects the national data. The mestizo population constitutes between 65% and 80%, followed by the indigenous population, which ranges between 15% and 30%. The Bomboiza Parish District, on the contrary, has the largest percentage of indigenous population (81%), followed by the mestizo population (18%).

The clear majority of the population is mestizo, except in Masuk Las Vegas, Achunts, Numbaime, San Luis del Vergel, Nankais and Los Almendros. The most representative nationalities or indigenous peoples identified in the study areas are Shuar and Saraguro; however, only the Shuar ethnic group is native to this area of the Ecuadorian Amazon region and has an ancestral relationship with the territory.

Economic Aspects

The economically active population (EAP) is mostly male (77%), with the main job source being farming and unskilled labor.

A fairly large percentage also work in services and trade; this is due to the fact that it is a parish district seat, where there is more trade and services.

Looking at communities in the study area, 46.48% reported that their household income is in the range of $251 and $500 [per month], which is at the minimum wage level.

However, 30.11% reported household income of between $101 and $250 [per month], which is below minimum wage; 15.93% of households reported income of between $500 and $1000 [per month].

In 96.10% of cases, respondents said that their largest household expense is food. Of the surveyed households, the vast majority (88.59%) reported saving less than $100 per month.

Education

There are 29 schools in the area, 14 of which are currently functioning; nine institutions are located at the Yantzaza cantonal seat, and two high schools, six elementary schools, and one state-funded religious school are located at the Los Encuentros Parish District seat – which is where the Unidad Educativa del Milenio 10 de Noviembre (10th of November Millennium School) is located.

Among the communities in the study, there were four educational institutions, a state-funded religious elementary school, two other elementary schools, and a Bilingual Intercultural Community School (CECIB).

Regarding illiteracy, at the parish district level, the illiteracy rate is consistently higher in the female population, with the highest rate in Tundayme Parish District, with 12.7%, and the lowest in Paquisha Parish District, at 5.2%.

In the case of the male population, the Pachicutza Parish District has the highest illiteracy rate, at 7.9%, and the lowest rate is in the Paquisha Parish District, at 2.5%.

At the level of the communities in the study area, some, such as El Playón, El Zarza, Jardín del Cóndor, La Delicia, and San Luis del Vergel have no cases of illiterate men.

The highest number of illiteracy cases is concentrated in Los Encuentros Parish District, with 10; turning to women, San Luis de Vergel is the only community where there are no illiterate women; in each of the others, there is at least one illiterate woman.

Regarding the level of education at the provincial level, the highest level reached by the population is elementary school, at 26.58%.

On the other hand, in the communities of the study area, the highest level of education corresponds to middle school education, both for men and women; on average it is 34.31%, followed by a 31.04% population with elementary education, that is, 6 years of study.

Health

There are nine health centers in the study area: a basic services hospital, a nested clinic unit, three Type A healthcare facilities, and four health clinics to which the people report going when they require medical attention.

According to the survey, most of the inhabitants say they go to the nearest health facility; in some cases, they mean the public Yantzaza Basic Services Hospital, although in this case they may also be referring to the nested clinic unit, which operates in the same facility; on average, less than 1% of the population in the study area go to a private hospital, and 1.62% receive healthcare from a private doctor.

According to the data of the Yantzaza 19D04 health district, the main illnesses recorded in 2014 in the medical facilities attached to that district are as follows (Health District 19D04, 2015):

- Respiratory tract ailments
  - Acute bronchitis
  - Pneumonia
  - Bronchopneumonia
- Intestinal diseases
  - Intestinal helminthiasis
  - Diarrhea
  - Stomach flu
- Skin diseases:
  - Pityriasis versicolor
- Psychological disorders:
  - Vomiting associated with other psychological disorders
  - Depression
  - Lack or loss of sexual desire
  - Sleep disorders or nightmares

Respecting cases of illness occurring in the last month in the study communities, it is apparent that around 70.34% of the population have not had any symptoms of illness, and it is considered a healthy population.

Dwellings and Households

In terms of dwellings, more than 80% of homes at the provincial and parish district levels are of the house or villa type. The main roofing material in homes is zinc. At the provincial level, the most commonly used wall material is brick (48.84%). At the parish district level, the main material is wood. The most common flooring material is untreated wood.

Regarding utilities, most water comes from public networks and to a lesser extent, water catchments or wells in the most remote areas. Electricity is widely available in the area, with coverage that in some areas serves more than 85% of the population. In terms of waste disposal, garbage collection services are minimal (under 35%), and several people reported burning their garbage as a disposal alternative.

Finally, in reference to excreta disposal, except for in the parish district seat, most communities have no sewer system; this waste is generally disposed of in septic tanks.

In terms of household characteristics, more than 70% of the homes are owned by their inhabitants; even so, most families live in overcrowded conditions. More than 60% of the population of the study area has access to safe water and generally use natural gas as their main fuel.

Land-related Aspects

At the rural level, most of the households have land devoted to agricultural uses. The primary land use recorded in the study area is agriculture for family consumption and farm produce for sale.

The opposite occurs in the parish seats, where the land is devoted to urban development and the land tracts are smaller. Most households (averaging 63.14%) said they had deeds to their land, although there is a representational percentage of land inherited with no probate issues, 16.69%. In most communities, on average 50.08%, the size of the farms is less than 10 ha.

In the study area, Lundin Gold owns most of the land near its operating sites. There is a small area of independent farmers located towards the outskirts of the operational areas.

Within the area of the different parish jurisdictions that make up the study area, nearly all landholdings are private, except in certain sectors where there are community tracts belonging to indigenous peoples, in addition to protected areas, military lands, and state-owned lands near the border.

Another very important use of land in the areas close to the Company's operations (but outside of the FDN operative area) is nature conservation, since two protected areas are located in the area: El Zarza Wildlife Refuge and the Cordillera del Cóndor Protected Forest. These areas are part of the protected areas system under the Ministry of the Environment and have separate management plans. It is also important to mention that, due to the high mining potential of this area of the Cordillera del Cóndor, at several sites in the study area there are informal, or artisanal, miners, whose activity also plays an important role regarding land use and use of natural resources.

Cultural Issues and Indigenous Peoples

Zamora Chinchipe Province has historically been inhabited by the Shuar and Saraguro peoples. At the time of Colonization, the area of the Cordillera del Cóndor was inhabited by an indigenous population of Bracamoro ancestry whose ethnic descendants would come to be the Shuar and Achuar peoples. In the fifteenth century, the Bracamoros put up fierce resistance against the Incan attempt to conquer them.

The Shuar and the Saraguro represent the largest nationalities or indigenous groups identified in the study areas; however, only the Shuar ethnic group is native to this area of the Ecuadorian Amazon region and only they have an ancestral relationship with the land.

Shuar people maintain strong links with their physical environment, and the human settlements of the Shuar are dispersed. The Shuar world view sees nature as a living being in which man is immersed; plants and animals have spiritual entities and genders, and their cultivation or use establishes a division of labor between men and women.

Moreover, Shuar is a warrior ethnic group, also identified as being from the "interior," whose most important food source is from hunting, complemented by the cultivation of cassava, plantains, and fruits, in addition to fishing and gathering. The ancient past of the Saraguro people, on the other hand, dates to two periods in the history of Loja Province. The first period is that of the Paltas in the Integration Period (800 AD), and the second is the Inca occupation at the end of the 15th century.

The predominance of the Quichua language in Saraguro Canton is a consequence of the Inca presence through the *mitimaes* (displaced peoples or tribes) who settled in the area, either for economic or military reasons. The ancestral territory of the Saraguros in in the Andean landscape of Loja Province, particularly in the Saraguro and San Lucas settlements.

Use of Natural Resources

Natural resources are material goods and services provided by nature without human alteration. They make important, direct contributions to the population's wellbeing and development through the provision of raw materials, minerals, foodstuffs, and ecological services.

A vital part of this concept is the conservation of biodiversity, which serves an important role in regulating climate stability, in addition to protecting of watersheds and areas susceptible to erosion, and providing sedimentation control. The Zamora-Chinchipe Province, as a province within the Amazon region with high rainfall and uniform temperature, has widely diverse water resources, mountains, and forests.

All the households in the Morona-Santiago Province and 85.80% of those in towns in Zamora-Chinchipe have private properties used for agriculture and livestock. In Morona-Santiago, 55.58% of households allocate their properties for family use. In Zamora-Chinchipe, an average of 40.97% dedicate their properties to agricultural production. 71.88% of the properties in Morona-Santiago and 31.58% of the properties in Zamora-Chinchipe are used between 50% and 75% for animal grazing.

Water is used by the local population in many ways. Upon listing such uses, in Zamora-Chinchipe, 99.70% of survey respondents reported using water for domestic purposes, with 56.06% reporting water use for animals.

1.06% mentioned that they also use water for irrigation, and 42.83% reported other uses. In Morona-Santiago, an average of 41.45% of water is consumed by animals, making it the second biggest use of water behind domestic use.

With the gradual depletion of natural resources, cultural changes, and improvements to quality of life, hunting is no longer a relevant activity within the study area. However, all of the Shuar communities report that they engage in hunting to a certain extent, with 50.00% and 23.10% reporting that they do some hunting.

Of these groups, in Morona-Santiago, on average, 50.00% hunt on *fincas* (rural properties) and 50.00% hunt in forests, while in Zamora-Chinchipe 56.37% report that they hunt in forests and 46.30% hunt on their own property. As for fishing, 38.93% of households in the Morona-Santiago study area engage in this activity, while 29.33% do so in Zamora-Chinchipe.

Finally, in Morona-Santiago, only 14.33% of communities engage in timber harvesting. In Zamora-Chinchipe, the majority do not engage in timber harvesting.

Artisanal Mining

The artisanal mining report dated December 2017 establishes the existence of 2 legalized artisanal mining operations under active operation contracts on the FDN Project, specifically on the La Zarza concession.

Below is a table detailing these two mining operations:

Table 8 Legalized Miners on the La Zarza Concession

No.	Name	Status	Ending	Env. Registry	Ha	No. workers	Type of activity
1	Pablo Montoya Merino	Active	10/27/18	Yes	6	5	Alluvial Mining
2	Maximo Montoya Guamán	Active	10/27/18	Yes	5.83	5	Alluvial Mining

Source: Lundin Gold 2018.

The company also has 2 legalization requests under evaluation corresponding to the FDN Project on the La Zarza Concession. The table below provides further details.

Table 9 Mining Legalization Requests

No.	Name	Concession	Location	Estate
1	William Conde Jiménez	La Zarza	Machinaza	Yantzaza
2	Maximo León	La Zarza	Machinaza	Yantzaza

Source: Lundin Gold 2018.

An important observation here is that these legalization processes are still valid, as is the company's willingness to continue such formalization. Additionally, on the La Zarza Concession, there are mining operations whose contracts have expired. The table below provides further details.

Table 10 Expired Mining Legalization Contracts

No.	Name	Concession	Residence	Signed	Ended	Status
1	Second Armijos Pesantes	La Zarza	Yantzaza	01-mar-11	10-mar-16	Mr. Armijos did request renewal of this contract. The contract term expired.
2	Plinio Tapia Guevara	La Zarza	Yantzaza	01-mar-11	10-mar-16	Mr. Tapia requested renewal of this contract. It was not renewed because it interferes with FDN operations. An assignment of rights is being processed on the Dominic concession for the legalization process.
3	Froilán Zhagñay	La Zarza	Yantzaza	15-feb-12	22-mar-17	Mr. Zhagñay did request renewal of this contract. The contract term expired.

Source: Lundin Gold 2018.

Table 10 shows Expired Mining Legalization Contracts shows that in two cases, the contracts were not continued because the artisanal miners did not make any effort to renew them. The understanding is that such persons changed their economic activity or are now working in another area with more production.

Mr. Plinio Tapia Guevara's contract was not renewed due to reasons specific to the Project. Since this operation has been going on legally for 5 years, an economic resettlement is applicable. This includes economic compensation, livelihood restitution, and/or job retraining. The table shows that legalization is being processed on the Dominic Concession so that the miner can continue his activities. It is important to ensure that during the period between the contract expiration and when activities can be restarted, compensation is provided to cover any losses and not negatively affect permanent workers.

Public and Community Infrastructure

Some of the communities no longer have their own schools, since, beginning in 2008, when the program known as “Millennium Schools” (UEM) was launched, many community schools were shuttered. This means that now, children have to travel to the Millennium Schools to receive education. (Ministry of Education, 2017).

As for health care, most communities do not have their own health centers, as these are located mainly in parish district seats, meaning that people must travel to such towns if they require medical care. Many of the communities have community centers: these are spaces where members of the community can gather to discuss topics of shared interest. Many of these centers have athletic fields and facilities that can be used for recreation and leisure. Finally, many of the communities have their own houses of worship or religious temples. Meanwhile, in terms of roads, the main ones are listed below:

Table 11 Main roads of accessibility

Road Name	Description
Troncal Amazónica E45	Primary paved road that crosses through the Sucumbíos, Napo, Pastaza, Morona-Santiago, and Zamora Provinces. The Troncal Amazónica is the main road for accessing the Zamora Province, and, consequently, many communities are located along it, including, from north to south: Yantzaza (canton capital), Muchime, Los Encuentros (parish district seat), El Padmi, and El Pincho.
Los Encuentros-Cordillera del Cóndor	Tertiary gravel road that begins on the eastern bank of the Zamora River, crosses through a hilly area, and ends at Cordillera del Cóndor. It crosses through the following communities: La Centza, Santa Lucía, La Libertad, Jardín del Cóndor, and El Zarza, where a new section splits off in the direction of El Playón, in the Bellavista Parish District. The main road continues through El Zarza Protective Forest, eventually reaching what is known as the “Y de San Antonio,” where the road forks: one branch goes north to the Company's Las Peñas camp, crossing through San Antonio del Cóndor, and the other goes south to Río Blanco in the Paquisha Parish District, and ends at the Paquisha military post on the border with Peru.
La Centza - San Luis del Vergel	Tertiary gravel road that runs parallel to the Zamora River, along its eastern bank, crossing through La Centza, El Pindal, Nungüi, Masuk Las Vegas, Achunts, Numbaime, and San Luis del Vergel, then continuing 2 km further to the end of the road.
Los Encuentros-Paquisha Road Corridor	A southbound tertiary gravel road that begins at the Zamora River Bridge in the parish district seat of Los Encuentros. It crosses the communities of El Carmen, Nankais, La Merced, and Los Almendros, continuing south, crossing several communities in the Bellavista and Paquisha Parish Districts, as well as both parish district seats.
Zumbi-El Dorado-Paquisha Road Network	In the canton seat of Paquisha, the Zumbi-El Dorado-Paquisha road network comes together in a secondary paved road. Although this road system does not cross through any of the communities in the study area, it does connect with other parish district seats.

Source and Prepared by: Cardno, March 2018.

Organizations and Stakeholders

The following types of Project stakeholders were defined within the study area; these organizations include community directives, women's groups, water committees, and clubs, among other organization, as briefly described below:

Table 12 Social organizations and Stakeholders

Organization	Description
Community Groups	These sorts of basic social institutions within the study area are associated mainly with social and community interactions. That is, they are first-level organizations with specific objectives within a limited context. These organizations consist mainly of different community boards and, in several instances, parents' organizations at schools. The communities within the study area (mestizo and indigenous alike) are organized into community directives, which select a leader to represent them by popular vote. However, decisions are made by consensus at meetings, and so the board is considered a representative authority in dealings with government entities.
Women's Associations	Many of these organizations join together to form coordinating groups, federations, or other second-level groups based on territory or functionality. In turn, they coordinate with non-governmental organizations (NGOs) to address specific issues (domestic violence, community education, environmental issues, and communication), resulting in the development of a women's social movement. There are several women's organizations in the study area.
Water Committees	On the community level, and in rural areas and the outskirts of urban areas, there is a form of association known as a water committee ("junta de agua"). These are community organizations that fall within the category of Administrative Boards for Drinking Water and Sanitation (JAAPyS). These community organizations emerge out of the community's need to regulate and organize water management when there are no formal systems in place to deliver water to the population. This organizational logic corresponds in large part to the capacity for self-management developed by the community organizations themselves, which usually end up "providing the service, under a self-management regime, to rural areas and on the outskirts of urban areas." (Foro de los Recursos Hídricos, 2013)
Indigenous Peoples	In the specific case of the indigenous communities, in addition to their local leadership, they are affiliated to a second-level organization that groups such communities together. The Shuar people are organized in Centers that, in turn, belong to the Federation of Shuar Centers of Zamora Chinchipe.
Artisanal Miners	Since the artisanal mining activity cannot be carried out on an entirely individual basis, persons working in this activity usually collaborate with others, who are generally members of their family groups. In this activity, family relationships and the workplace become intermixed; making it possible to carry out the day-to-day activities related to mining and ensuring family survival.
Farmers	At community level, people form "farmers' associations," which brings together small- and medium-scale farmers in the study area. Note that these associations, which may be formal or informal, have shared goals based on cooperation agreements that promote members' mutual interests.
Clubs	At the community level, there are associations known as "clubs" based on shared interests, especially sporting activities. By organizing into clubs, the population can form relationships with other communities.

Source: Cardno, March 2018.

The graph below represents the number of social organizations, community directives, indigenous peoples, and artisanal miners identified for each component.

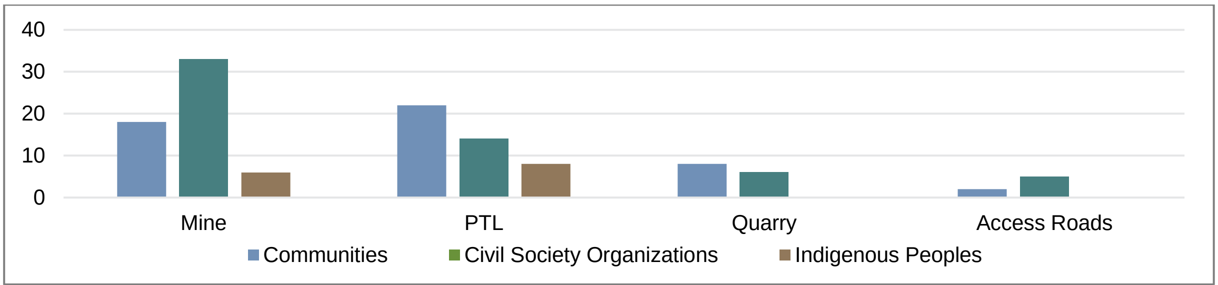


Figure 10 Number of Stakeholders in the Study Area

Source: Cardno, March 2018.

Political-Administrative Structure and Levels of Government

In 2010, the National Secretariat of Planning and Development (SENPLADES) created administrative levels for national planning purposes, dividing the country into zones, districts, and circuits to improve the administrative organization of Executive Branch agencies.

These divisions serve to identify needs and solutions in the provision of public services. The zones are made up of provinces, based on their geographic, cultural, and economic proximity.

Nine zones were identified, each of which is made up of districts, which are in turn made up of circuits. Every zone has an administrative headquarters for SENPLADES, except for Zone 9 of the Quito Metropolitan District, which is centrally administrated.

On the zone level, they strategically coordinate with public-sector entities to design politics for the area in their jurisdiction.

According to the established planning zones, Zamora-Chinchipe Province corresponds to Planning Zone 7 (SENPLADES, 2017). Meanwhile, the following categories exist in relation to levels of government:

Table 13 Categories of level of government.

Type	Description
Decentralized Autonomous Governments	Provincial. Their most important duties include: Planning provincial development and formulating corresponding land-use plans, together with national, regional, canton, and parish district planning. Planning, building, and maintaining a provincial road system, not including urban areas. Municipal. Planning canton development and putting together the corresponding land-use plans, together with national, regional, canton, and parish district planning, in order to regulate the use and occupation of urban and rural land. Controlling the use and occupation land at a canton level. Parish District Planning parish district development and its corresponding land-use plans, in coordination with the canton and provincial government. Planning, building, and maintaining physical infrastructure, the parish district's facilities and public spaces within its development plans and including the same in its annual participatory budgets; planning and maintaining the parish district's rural roadways, in coordination with provincial governments.
Governor's Office and National Government Delegates	In addition to locally elected officials, the executive branch designates a local representative for every parish district through the provincial governor's office; these local agencies are part of the Ministry of the Interior.
Executive Branch	The state's Executive Branch (headed by the president of the republic), includes four national secretariats: The National Secretariat for Public Administration, the National Secretariat for Planning and Development (SENPLADES), the National Secretariat for Political Management, and the National Secretariat for Communication. Besides the secretariats, the Executive Branch is divided up into ministries that are centrally managed and focus on duties related to specific issues or industries.
Local organizations	Social organizations are mechanisms that enable the population to establish their own institutions to manage and regulate everyday life, within the framework of local needs. Organizations differ depending on their level of social representation.
Community Organizations	These sorts of basic social institutions within the study area are associated mainly with social and community interactions. That is, they are first-level organizations with specific objectives within a limited context. These organizations consist mainly of different community boards and, in several instances, parents' organizations at schools.
Indigenous Peoples	Indigenous people are represented by community directives, but they are also registered with a secondary organization.

Prepared by: Cardno, March 2018.

The below figure offers a visual summary of the number of stakeholders by type, identified by each of the Project's components. The central government stakeholders are shared among all the Project components.

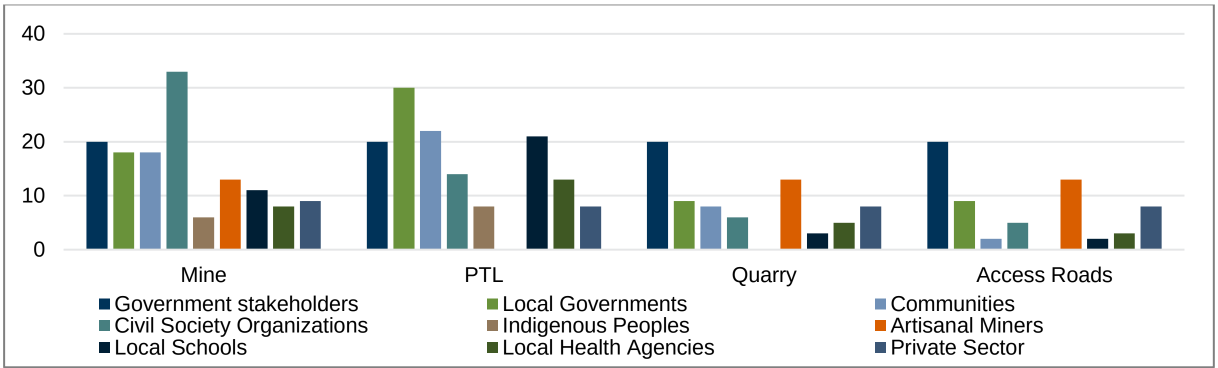


Figure 11 Stakeholders by Project Component

Source: Cardno, March 2018.

Perception of the Project and Mining Activity

The population's perception was assessed specific to four areas of interest:

- Current quality of their natural environment
- Quality of their social environment
- Knowledge about mining
- Perception of the Company

In reference to current environmental quality, 41.74% of the population reported that there was some form of pollution in the sector, while 56.42% reported that there was not.

With respect to the population's perception of the social environment, half of those surveyed (50.07%) considered the job market to have worsened in the previous year, while 47.56% believed that the degree of poverty had not undergone any considerable changes.

The overwhelming majority of those surveyed (67.28%) reported that the quality of education had improved in the past year, and a little over half (57.25%) said that the various aspects of healthcare had improved during that same period of time.

With respect to the population's perception of mining, 57.26% reported familiarity with one or more mining companies that operate in Ecuador, which proves that this industry has already had a presence in the study area.

Finally, related to perception of the Company, 81.84% of the population reported that they were familiar with the Company.

Note that, at the time of the survey, many of the respondents linked the Kinross Corporation with Lundin Gold.

Identification of Sensitive Issues and Vulnerable Groups

There are several groups and stakeholders within the project's study area who are considered vulnerable: indigenous peoples, women, seniors and children, and artisanal miners.

Indigenous Peoples were assessed in the section on Cultural Matters and Indigenous Peoples. In relation to women, elderly, and youth, one particular feature of the Project is that it is located in an extremely remote, uninhabited region, and so there is no vulnerable population there that could be directly affected by the operation.

Note that the only dwelling in which people lived, and whose degree of vulnerability and possible impact by the construction and operations of the Project was determined, was the Cabrera family home.

However, in this case, as part of the land purchase agreement, Lundin Gold put together a Resettlement Plan for the Cabrera family.

The Cabrera family was relocated to their new house in late August 2016. Lundin Gold is working with the family to ensure that they are well integrated in their new neighborhood and monitoring to detect any problems that may arise, as stipulated in the Resettlement Plan.

In order to follow up on the needs of the members of the Cabrera family, Lundin Gold, through the Corporate Responsibility and Communities Department, is issuing monthly reports on follow-up visits with the family. The plan reports that evaluative monitoring is to be carried out for a period of five years following resettlement.

Generally speaking, the makeup of the population in the study area in virtually every jurisdiction has a broad-based structure, with a young, growing population. That is, the population consists predominantly of people between 1 and 25 years old.

In reference to artisanal miners, the Company is seeking to identify, authorize, and train legalized miners who are located within its concessions; Lundin Gold has been engaging in this task since it began operations.

Such activities have been undertaken in consultation and coordination with government bodies and local authorities, law enforcement agencies, surrounding communities, and the informal miners themselves.

Thus, Lundin Gold has been able to develop a clear policy and process regarding small-scale mining activities.

The legalized miners within Lundin Gold's concessions hold operating contracts, which are followed-up on by the Company, while informal miners are constantly monitored, given the furtive nature of their activity.

There is an established procedure for regularizing artisanal miners, and that process will last for approximately four to six months.

The Company does not charge a percentage of the material extracted in the granted area, which must be no larger than 4 ha for primary or 6 ha for alluvial mining. Furthermore, Lundin Gold supports artisanal miners through a payment of USD$950 for the contract legalization processes.

9. Archaeological Baseline

The province of Zamora Chinchipe has been studied by archeological experts since 1959. One of the most well-known experts is Dr. María Aguilera, who is the current Company's archeological contractor.

Circular housing structures and flat-topped natural or artificial mounds have been found here, in addition to terraces and petroglyphs.

The pre-Hispanic cultures that interacted in the area include the Palta, Sangay, Mayo-Chinchipe, and Inca, as shown by the "Corrugated Horizon" defined basically by the type of ceramics in the area.

The pre-Hispanic cultural material recorded in the study area suggests a cultural sequence from the pre-ceramic period (10,000 –1500 BCE), when livelihoods depended primarily on hunting and gathering.

This prioritized the use of stone tools up to the Regional Development Period (500 BCE – 500 CE), defined by the independent, stratified social organization of pre-Hispanic groups.

Among other things, they sought political-social control by modifying the landscape, and this knowledge enabled them to expand their territories and dominate trade routes.

In this context, the simple fact of their existence makes these important sites, as they cover a transition period from hunters to potters. An example of this type of cultural sequence is the Machinaza Archaeological Site in Sector 1.

In addition, fourteen areas of archaeological interest have been identified in the Colibrí Concession, where monumental changes to the landscape have been recorded, meaning that the inhabitants of the area modified the natural mounds or ridges of the Condor Cordillera by creating flat areas for use in socioeconomic development.

Field records and laboratory analyses, show the presence of stone artifacts, ceramics, charcoal and charred phytoliths.

Note that the cultural material recorded in the archaeological sites discovered and studied during project execution was thanks to the coordinated work of community members or guides who provide daily accompaniment to archaeologists and the National Institute of Cultural Heritage (INPC), a government agency that authorizes and controls all types of archaeological research.

Specific results obtained from the field characterization made it possible to conclude that the cultural material recorded is not critical cultural heritage according to the criteria of IFC Art. 13.

Archaeological analyses of the territory lead us to infer that areas with highly irregular topographies are not of archaeological interest.

Slopes and "bamba" type vegetation prevent people from crossing the area easily, which prevents domestic or residential human settlements from forming.

This position is based on the absence of pre-Hispanic cultural material in hard-to-access areas characterized by rocky outcrops on the surface, steep slopes skirted by swamps and water tables 12 cm below the surface.

However, since southwestern Zamora Chinchipe is little known in archaeological terms, through the archeology team, the Company has managed to propose a hypothesis aimed to define the settlement patterns of Amazonian populations in the southern part of present-day Ecuador.

Consequently, human domestication of the landscape, use of alluvial terraces for production, and construction of embankments or flat areas along geographical ridges constitute a settlement pattern in the study area, which explains the high degree of social and political organization among pre-Hispanic peoples in the area.

Ceramic cultural material suggests two types of clay, one soft and porous, with soot from cooking food, and the other a hard, impermeable clay that was possibly used to carry water.

Stone cultural materials exhibit more detailed construction, better definition and stricter criteria for selecting raw materials.

This shows that pre-Hispanic peoples were more interested in making axes than in producing ceramics, although the latter is important for carrying water in an area where access to this vital fluid is limited by a topography that limits mobility.

The petroglyphs recorded in the area have been interpreted as a recognition of symbolic interaction between the people and their deities.

Finally, to mitigate any impacts, the Company plans to conduct archaeological monitoring in areas evaluated using archaeological prospecting.

Whether or not pre-Hispanic cultural material is recorded, the National Cultural Heritage Institute establishes the process to be followed.

Cultural Heritage Sites within the Study Area

There are reported to be over 120 heritage sites in Zamora Province, the majority of which are open-air.

The most common of these encountered are residential sites, evidence of petroglyphs, roads, and caves.

According to the Ecuadorian Cultural Heritage Information System (SIPCE), there are six archeological settlements in Yantzaza Canton and Los Encuentros Parish, which are the study area and described below.

Table 14 Registered Archaeological Sites in the Yantzaza Canton and in the Los Encuentros Parish District

Type of Archaeological Site	Location:	Site Name	Description (Cultural Affiliation/Description)
Surface site (open air)	Los Encuentros Parish District	La Centza	Cultural Affiliation: Southeastern Cañari/Paltas Description: Deforestation of the site for agricultural use, deterioration of soil and pasture grown for livestock.
	Yantzaza (Canton seat)	City of Yantzaza	Cultural Affiliation: Regional development period (500 b.C to 500 a.C) Description: Deforestation of the site for agricultural activities, deterioration of soil and pasture grown for livestock.
		La Pita	Cultural Affiliation: Regional development period (500 b.C to 500 a.C) Description: N/A.
		City of Yantzaza	Cultural Affiliation: Early and Late Cretaceous Description: Works related to widening the access route to the town of Yantzaza
		Yantzaza 1	Cultural Affiliation: Eastern Cañaris/Paltas Description: Urban growth has forced residents to build dwellings on archaeological sites.
		Yantzaza 2	Cultural Affiliation: Southeastern Cañaris/Paltas Description: Works related to widening the access route to the town of Yantzaza

Source: (National Cultural Heritage Institute, 2018)
Prepared by: Cardno, March 2018.

Table 15 Registered Cultural Sites observed in the Project's Area around each Component

Component	Description
Mine	Waterfalls are sites where ritual baths are performed, and according to Shuar beliefs, such sites are places where spiritual powers are received and where one's fortunes may change. In the context of the ritual practice, the falls are sources of purification and a place where believers may acquire a supernatural power known as Arútam. According to a 2015 field survey, there are several falls that are important to the Shuar population in the communities within the study area. The waterfalls are the following: Shiram Nua (Bohim), Bellavista, Numbayme, Bonita, Poderosa de Numbayme, Namakunts, unnamed 1 and 2. Note that no watershed belonging to these falls has been affected by the Project.
Power Transmission Line	The communities within the study area in the Morona-Santiago Province are Centro Shuar Chumpias and San Pedro de Chumpias. According to reports from within the community, there are no sites that are considered sacred or of ritual importance. The communities within the study area in the Zamora Province are: Certero, Santiago Paati, Pakintza, San Andrés, La Alfonsina, Reina del Cisne, and Anchuts. According to reports from within the community, there are no sites that are considered sacred or of ritual importance. The only relevant site reported within the Numbaime community is the Shira Nua Waterfall (Bohim). Note that the Numbaime community is not affected by the power line route.
Quarry	No heritage site or site of cultural interest has been identified within the study area.
Access Roads	No heritage site or site of cultural interest has been identified within the study area.

Source and Prepared by: Cardno, March 2018.

10. Areas of Influence

An area of influence (AI) is the spatial environment where the potential environmental, social, and cultural impacts resulting from project activities are expected to manifest.

In that sense, the cartographic scale and the level of detail of the AI information for a given project will depend on the environmental impact being evaluated, the environmental characteristics of whatever or whomever is receiving the impact, and the spatial scope of said impacts.

Based on the above, some impacts influence the environment in a way that is clearly visible and demonstrated using quantitative methods.

In this case, their effects are manifested in the short term (Direct Area of Influence).

Meanwhile, there are also impacts whose influence on the environment is not as simple to demonstrate and usually requires qualitative methodologies.

These effects are generally manifested over the medium and long term (Indirect Area of Influence). There are also cumulative impacts which are the result of past, present and future actions that can appear in the geographical area where the Project is located. Results of the Project's area of influence analysis are detailed below:

Area of Direct Influence

For this Project, the Total Direct Area of Influence (DAI) has been defined as 24,280 ha, based on the criteria used for each component. The results are provided below.

Table 16 Direct Area of Influence Project FDN.

Component DAI			Surface (ha)		
Surface	Physical	Geology and Geomorphology	423	7,551	24,280
		Soil Quality	423		
		Fugitive emissions of particulate material (dust)	835		
		Noise	3,546		
		Hydrology and Surface Water Quality	2,046		
		Hydrology (Catchments)	10		
		Hydrology (Discharge)	140		
		Electromagnetic Fields	128		
	Biological	Terrestrial Flora and Fauna	423	497	
		Aquatic Fauna (Facilities Layout)	61		
		Aquatic Fauna (Catchments)	-		
		Aquatic Fauna (Discharge)	13		
	Social	Socioeconomic	15,494	15,917	
		Archaeological	423		
Underground	Physical	Subsoil	123	315	
		Hydrogeological	192		

Source and Prepared by: Cardno, February 2018.

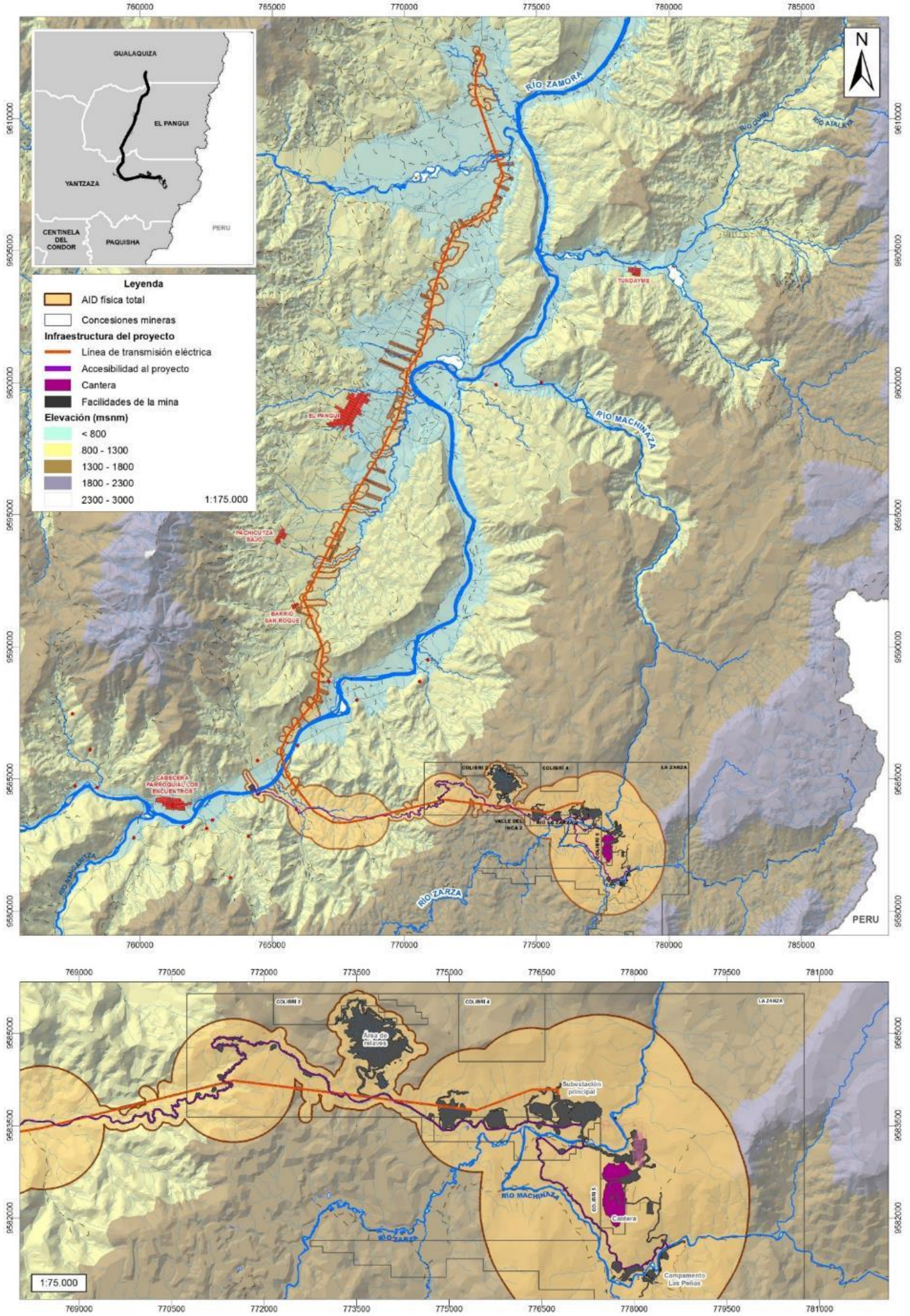


Figure 12 **Direct Area of Influence for the Physical Component (Surface)**

Source and Prepared by: Cardno, February 2018

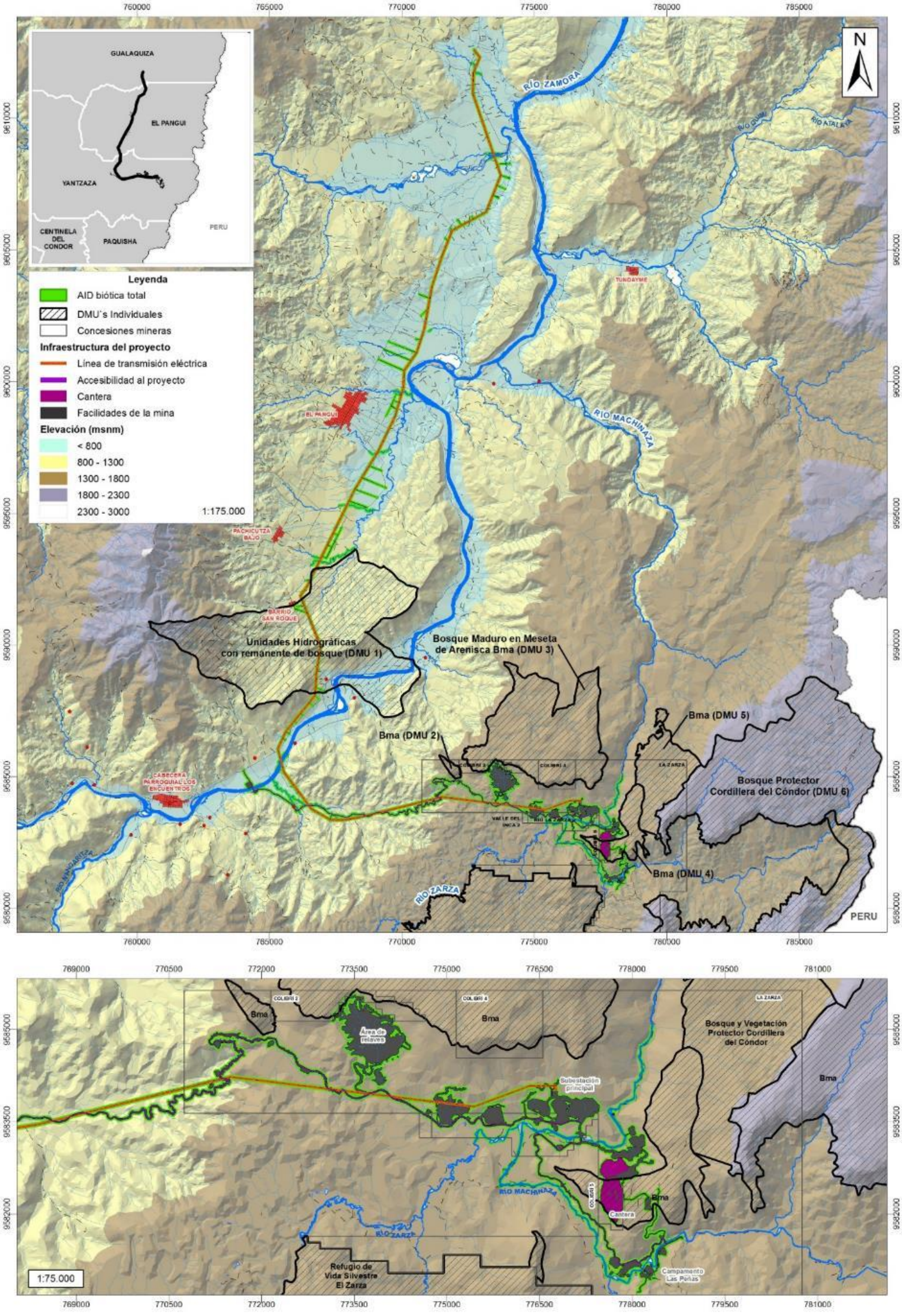


Figure 13 Direct Area of Influence for the Biological Component

Source and Prepared by: Cardno, February 2018

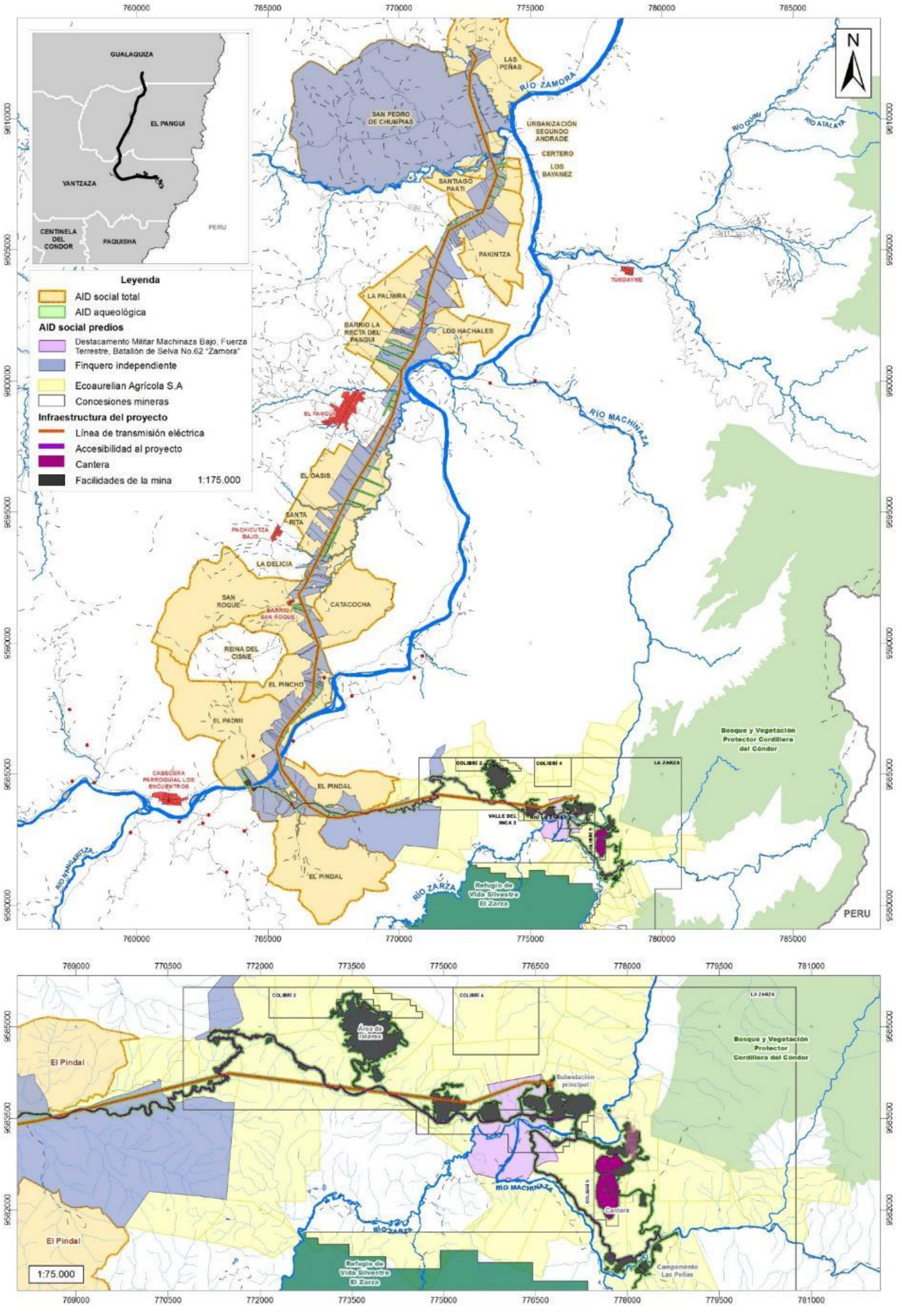


Figure 14 Direct Area of Influence for the Socioeconomic and Cultural Components

Source and Prepared by: Cardno, February 2018

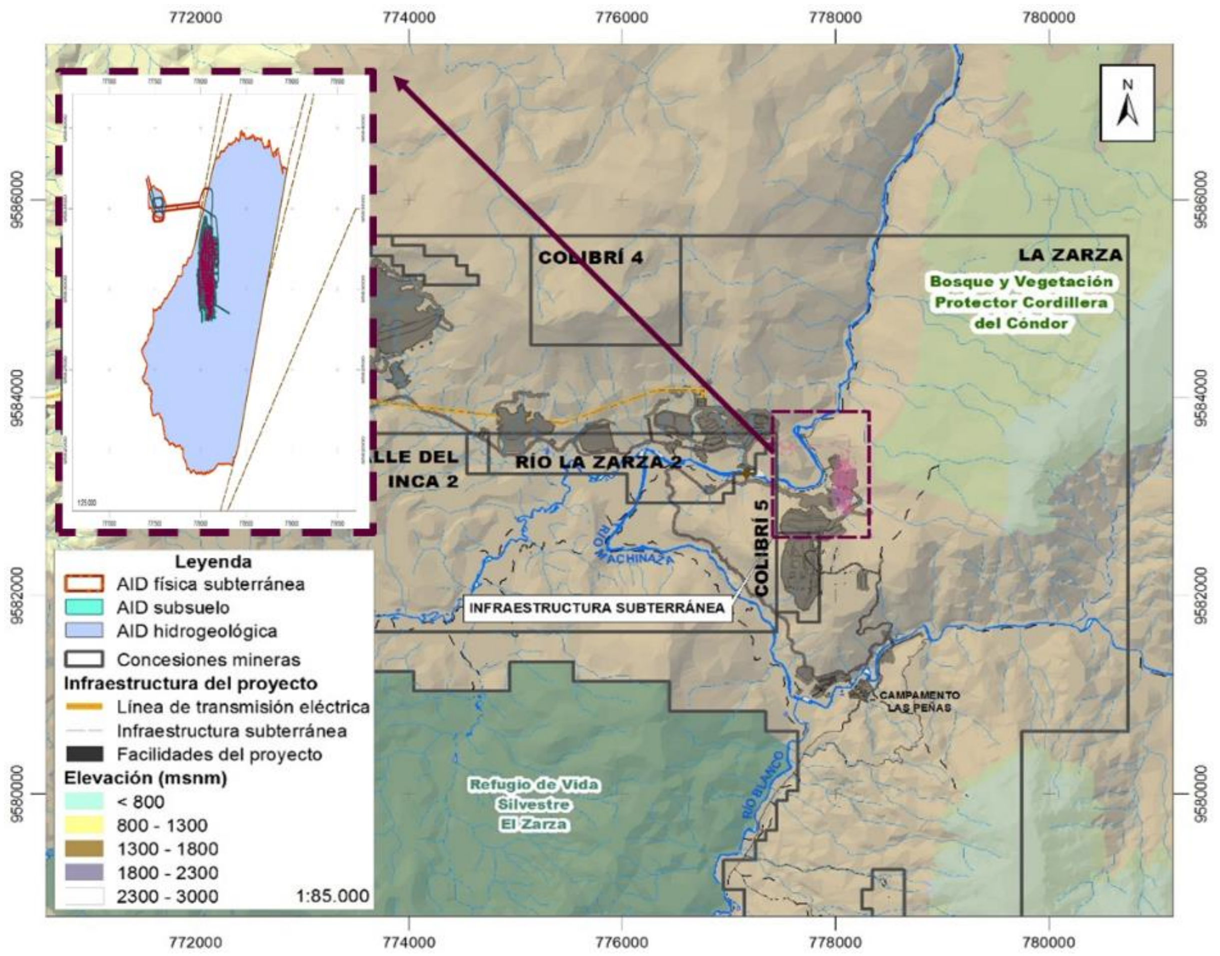


Figure 15 Direct Area of Direct Influence for the Physical Component (Underground)

Source and Prepared by: Cardno, February 2018

Indirect Area of Influence

For this Project, the Total Indirect Area of Influence (IAI) has been defined as 164,971.79 ha, based on the criteria used for each component. The results are provided below.

Table 17 Total Indirect Area of Influence

<table>
<tr><th colspan="3">Component IAI</th><th colspan="3">Surface (ha)</th></tr>
<tr><td rowspan="7">Surface</td><td rowspan="2">Physical</td><td>Logistics and Transportation Activities</td><td>3,082</td><td rowspan="2">15,134</td><td rowspan="7">164,971.79</td></tr>
<tr><td>Hydrographic Unit</td><td>12,052</td></tr>
<tr><td rowspan="2">Biological</td><td>Terrestrial Flora and Fauna</td><td>5,068</td><td rowspan="2">5,662</td></tr>
<tr><td>Aquatic Fauna</td><td>54</td></tr>
<tr><td rowspan="3">Social</td><td>Parish Districts</td><td colspan="2" rowspan="3">144,175.79</td></tr>
<tr><td>Communities</td></tr>
<tr><td>Protected Areas</td></tr>
</table>

Source and Prepared by: Cardno, February 2018.

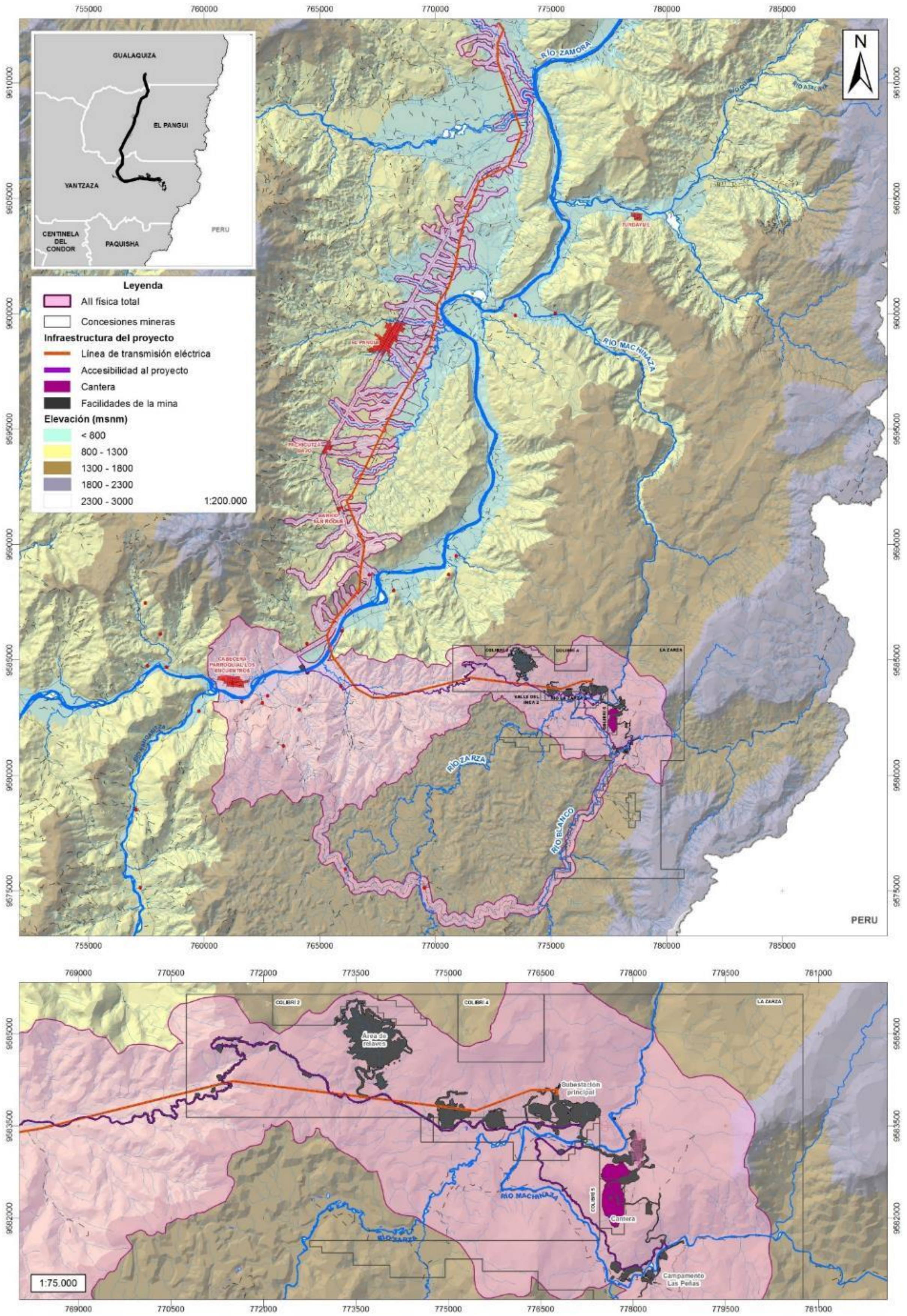


Figure 16 Indirect Area of Influence for the Physical Component

Source and Prepared by: Cardno, February 2018

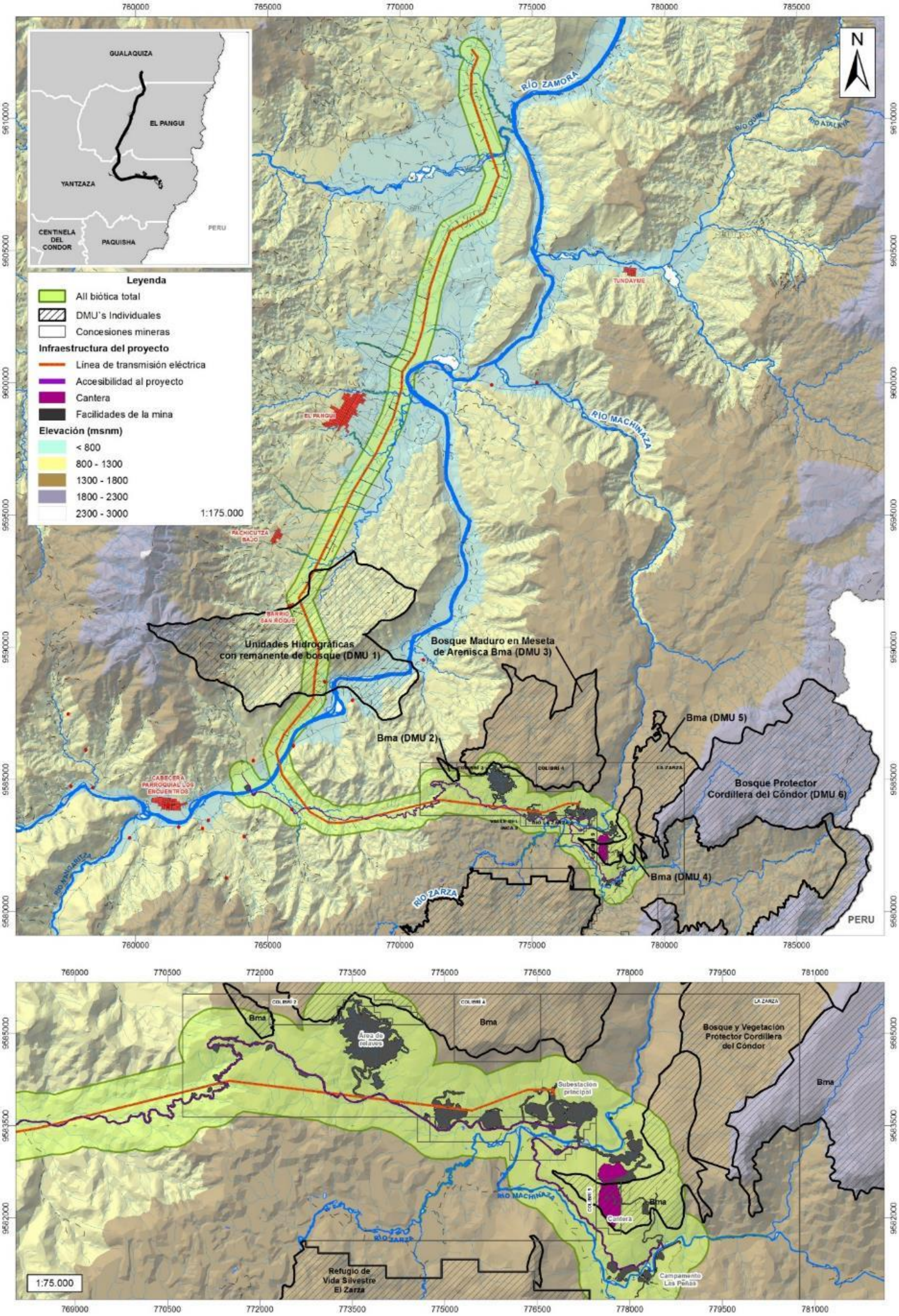


Figure 17 Indirect Area of Influence for the Biological Component

Source and Prepared by: Cardno, February 2018

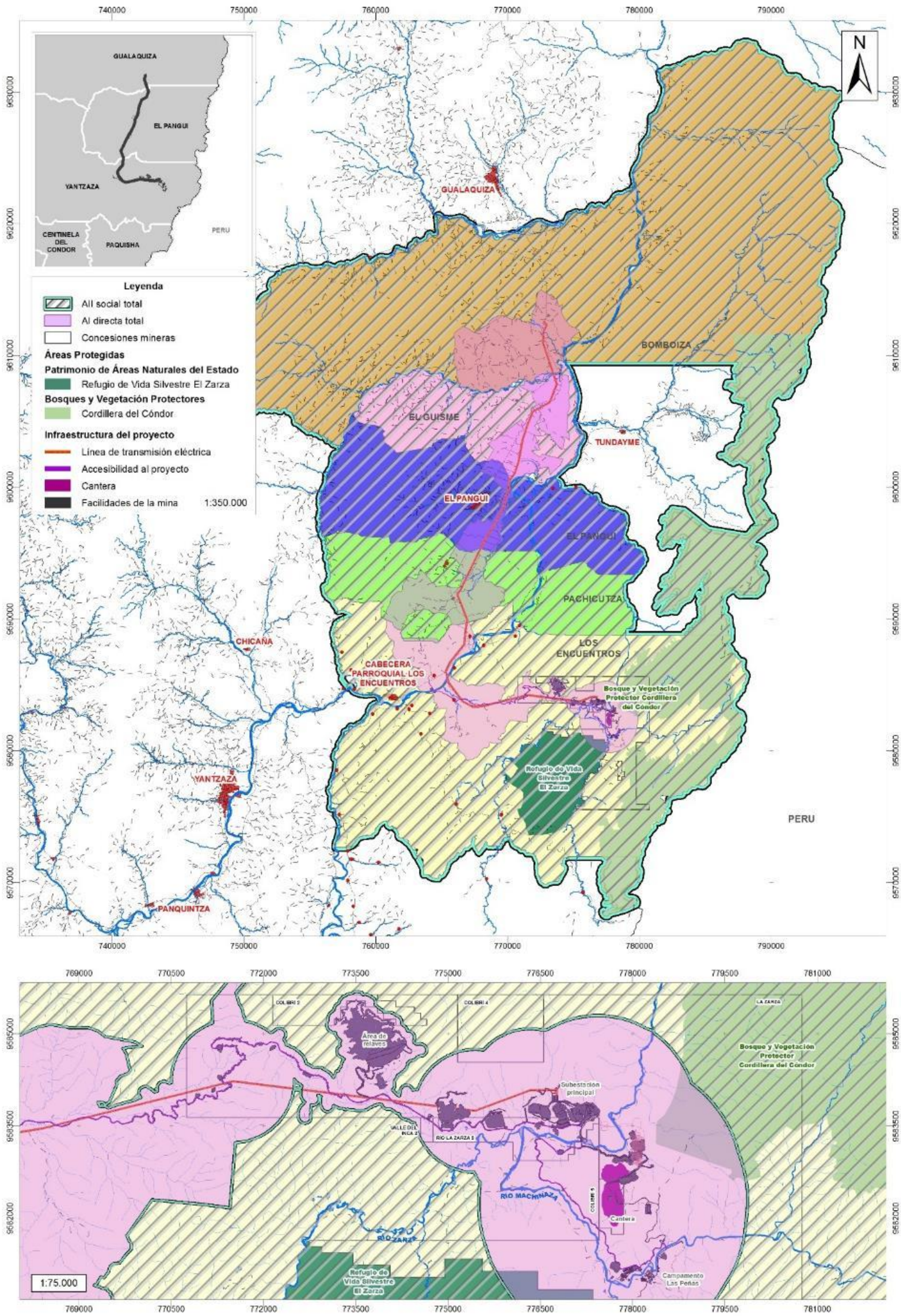


Figure 18 Indirect Area of Influence for the Socioeconomic Component

Source and Prepared by: Cardno, February 2018

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11. Impacts and Mitigation Measures

Identification, evaluation and ranking of the potential socio-environmental aspects and impacts (physical, biological, social, archaeological) that are expected to result from Project implementation are shown below, along with during which phases of the Project the impact is predicted to occur:

Table 11-1 Significance of Social and Environmental Impacts from the Project

Section of the ESIA	Affected Component	Infrastructure	Impact	Primary Receptor	Significance Ranking: NO MITIGATION – Short-term[2] (Negative / Neutral / Positive)	Significance Ranking: AFTER APPLYING MITIGATION MEASURES – Short-term (Negative / Neutral / Positive)	Significance Ranking: AFTER APPLYING MITIGATION MEASURES – Long-term[3] (Negative / Neutral / Positive)
Physical Baseline	Air Quality	Mine and Quarry	Deterioration of air quality due to fuel combustion emissions generated from mobile sources	Nearby residents, Project personnel			
			Increased concentration of dust (particulate matter) during earthworks	Flora and fauna			
				Nearby residents, Project personnel			
			Increased concentration of dust (particulate matter) during operations activities	Nearby residents, Project personnel			
				Flora and fauna			
			Generation of fugitive dust emissions from the crushing area	Project personnel			
		PTL	Deterioration of air quality due to fuel combustion emissions generated from mobile sources	Nearby residents			
			Increased concentration of dust (particulate matter) during earthworks	Flora and fauna			
				Project personnel			

[2] Covers the period of time that spans the Project life cycle.

[3] This comes after the Project's life has ended (post-closure stage) and is related to residual impacts.

Section of the ESIA	Affected Component	Infrastructure	Impact	Primary Receptor	Significance Ranking: NO MITIGATION – Short-term[2]	Significance Ranking: AFTER APPLYING MITIGATION MEASURES – Short-term	Significance Ranking: AFTER APPLYING MITIGATION MEASURES – Long-term[3]
					Negative / Neutral / Positive	Negative / Neutral / Positive	Negative / Neutral / Positive
Physical Baseline	Air Quality	PTL	Generation of fugitive dust emissions during construction and maintenance activities	Nearby residents			
				Flora and fauna			
		Access Roads	Deterioration of air quality due to fuel combustion emissions generated from mobile sources	Nearby residents and Project personnel			
			Generation of fugitive dust emissions resulting from vehicle traffic on access roads	Nearby residents and Project personnel			
				Flora and fauna			
	Noise	Mine and Quarry	Increased noise levels from construction activities	Project personnel			
				Flora and fauna			
			Increased noise levels due to operations activities (mining, processing, excavation)	Project personnel and fauna			
			Increased noise levels due to the use of explosives (blasting) in the mine and quarry area	Project personnel and fauna			
			Increased noise levels from mobile sources	Nearby residents and Project personnel			
		PTL	Increased noise levels due to construction activities, use of mobile sources and vehicle traffic	Nearby residents			
				Project personnel			
		Access Roads	Increased noise levels from traffic on public roads from transportation of materials and concentrate	Nearby residents			
				Project personnel and fauna			

Section of the ESIA	Affected Component	Infrastructure	Impact	Primary Receptor	Significance Ranking: NO MITIGATION – Short-term[2] (Negative / Neutral / Positive)	Significance Ranking: AFTER APPLYING MITIGATION MEASURES – Short-term (Negative / Neutral / Positive)	Significance Ranking: AFTER APPLYING MITIGATION MEASURES – Long-term[3] (Negative / Neutral / Positive)
Physical Baseline	Electromagnetic radiation	PTL	Increased electromagnetic radiation levels	Nearby residents			
	Vibrations	Mine and Quarry	Increased vibrations from construction and operations activities	Nearby residents and Project personnel			
			Increased vibrations due to the use of explosives (blasting)	Nearby residents and Project personnel			
			Increased vibrations from crushing and the use of heavy machinery	Nearby residents and Project personnel			
		PTL	Increased vibrations from construction and operations activities	Nearby residents			
		Access Roads	Increased vibration from traffic on public roads from transportation of materials and concentrate	Nearby residents			
	Relief and landscape	Mine, PTL and Access Roads	Alteration of topography due to clearing, construction, and operations activities	Nearby residents			
				Nearby residents			
		Quarry	Alteration to the topography due to clearing and aggregates quarrying	Nearby residents			
		TSF	Alteration of topography from building the tailings storage facility (TSF)	Nearby residents			

Section of the ESIA	Affected Component	Infrastructure	Impact	Primary Receptor	Significance Ranking																				
					NO MITIGATION							AFTER APPLYING MITIGATION MEASURES													
					Short-term[2]							Short-term							Long-term[3]						
					Negative			Neutral	Positive			Negative			Neutral	Positive			Negative			Neutral	Positive		
Physical Baseline	Soils	Mine, Quarry, PTL, and Access Roads	Deterioration of soil quality due to accidental spills during construction, operations, and closure	Soil and surface water		■								■								■			
Physical Baseline	Soils	Mine, Quarry, PTL, and Access Roads	Soil compacting in facility areas	Soils		■								■								■			
Physical Baseline	Soils	Mine, Quarry, PTL, and Access Roads	Increased erosion	Soil and surface water		■								■								■			
Physical Baseline	Soils	Access Roads	Deterioration of soil quality due to accidental spills during operations	Soil and surface water		■								■								■			
Physical Baseline	Soils	Access Roads	Deterioration of soil quality due to cyanide spills	Soil and surface water	■								■									■			
Physical Baseline	Surface water	Mine, Quarry, PTL, and Access Roads	Increased turbidity and sedimentation due to construction activities, vehicle traffic	Recipient waterbodies		■								■								■			
Physical Baseline	Surface water	Mine, Quarry, and Access Roads	Modification of surface water systems	Surface drainage within the Project components footprint			■								■							■			
Physical Baseline	Surface water	Mine, Quarry, and Access Roads	Deterioration of water quality due to spills and accidental discharge of chemicals and fuels	Recipient surface waterbodies		■								■								■			
Physical Baseline	Surface water	Mine	Deterioration of water quality due to spills and accidental discharge of cyanide from the processing plant	Recipient surface waterbodies	■								■									■			
Physical Baseline	Surface water	Mine	Deterioration of water quality resulting from ML/ARD.	Machinaza River	■								■									■			

Section of the ESIA	Affected Component	Infrastructure	Impact	Primary Receptor	Significance Ranking: NO MITIGATION – Short-term[2] (Negative / Neutral / Positive)	Significance Ranking: AFTER APPLYING MITIGATION MEASURES – Short-term (Negative / Neutral / Positive)	Significance Ranking: AFTER APPLYING MITIGATION MEASURES – Long-term[3] (Negative / Neutral / Positive)
Physical Baseline	Surface water	Mine	Deterioration of water quality resulting from TSF overflows or seepage	Machinaza River			
			Deterioration of water quality due to discharge (or accidental effluents)	Surface water			
			Reduced flow rate in the Machinaza River due to lower water table levels resulting from underground mine development	Machinaza River			
			Reduced flow rates in surface waterbodies due to water use in industrial processes	Machinaza River			
	Groundwater	Mine, Quarry, PTL, and Access Roads	Variations in groundwater flow resulting from soil compaction and reduced infiltrations	Groundwater			
		Mine	Alteration to groundwater systems due to pumping water out of dewatering wells	Water table within the cone of depression			
			Leaching from stockpiles used to store PAG material	Groundwater			
			Leaching from the tailings storage facility	Groundwater			
			Deterioration of groundwater quality due to leach from accidental spills	Groundwater close to the surface			

Section of the ESIA	Affected Component	Infrastructure	Impact	Primary Receptor	Significance Ranking – NO MITIGATION – Short-term[2] (Negative / Neutral / Positive)	Significance Ranking – AFTER APPLYING MITIGATION MEASURES – Short-term (Negative / Neutral / Positive)	Significance Ranking – AFTER APPLYING MITIGATION MEASURES – Long-term[3] (Negative / Neutral / Positive)
Biological Baseline	Vegetation	Mine, Quarry, PTL, and Access Roads	Loss of vegetation species biodiversity through clearing and edge effect arising from construction activities	Endemic and non-endemic flora			
			Loss of natural habitat (fragmentation) due to infrastructure construction	Natural habitats			
			Loss of critical habitats (fragmentation) due to infrastructure construction	Critical habitats			
		PTL	Loss of farmland and grazing areas due to clearing and edge effect arising from construction activities	Local population			
	Terrestrial Fauna	Mine, Quarry, PTL, and Access Roads	Behavior impacted by noise and vibrations resulting from construction, mining, blasting, and processing activities.	Terrestrial Fauna			
			Behavior impacted by human presence	Terrestrial Fauna			
			Habitat fragmentation due to infrastructure construction	Terrestrial Fauna			
			Loss of critical habitat as defined by PS6	Species listed in the critical habitat identification report			
		Mine, Quarry, and Access Roads	Loss of terrestrial fauna species biodiversity due to animals being run-over by vehicles	Terrestrial Fauna			

Section of the ESIA	Affected Component	Infrastructure	Impact	Primary Receptor	Significance Ranking																				
					NO MITIGATION							AFTER APPLYING MITIGATION MEASURES													
					Short-term[2]							Short-term							Long-term[3]						
					Negative			Neutral	Positive			Negative			Neutral	Positive			Negative			Neutral	Positive		
Biological Baseline	Aquatic Fauna	Mine, Quarry, and PTL	Loss of aquatic fauna species biodiversity due to spills and accidents affecting waterbodies	Invertebrates, fish and aquatic vegetation																					
			Loss of aquatic fauna species biodiversity due to increased turbidity during construction activities	Invertebrates, fish and aquatic vegetation																					
			Loss of aquatic fauna species biodiversity due to generation of ML/ARD and sediments from excavations	Invertebrates, fish and aquatic vegetation																					
			Loss of aquatic fauna species biodiversity due to cyanide spills affecting waterbodies	Aquatic Fauna																					
			Loss of biodiversity among aquatic fauna species resulting from increased sediments caused by traffic on roads near waterbodies	Aquatic fauna and vegetation																					
		Access Roads	Loss of aquatic fauna species biodiversity due to spills and accidents affecting waterbodies	Invertebrates, fish and aquatic vegetation																					
			Loss of aquatic fauna species biodiversity due to Project effluents and sediment release	Invertebrates, fish and aquatic vegetation																					
Socioeconomic Baseline	Economic development	Mine and PTL	Economic downturns due to a reduction in working capital	Local population																					
		Mine	Creation of dependency on the mining industry due to changes in productive activities	Local population																					

Section of the ESIA	Affected Component	Infrastructure	Impact	Primary Receptor	Significance Ranking – NO MITIGATION – Short-term[2] (Negative / Neutral / Positive)	Significance Ranking – AFTER APPLYING MITIGATION MEASURES – Short-term (Negative / Neutral / Positive)	Significance Ranking – AFTER APPLYING MITIGATION MEASURES – Long-term[3] (Negative / Neutral / Positive)
Socioeconomic Baseline	Jobs	Mine, Quarry, PTL, and Access Roads	Job creation	Local population			
			Worker strikes	Company			
			Economic revitalization due to increased floating capital	Indirect project jobs, local suppliers			
	Migratory influx	Mine, Quarry, PTL, and Access Roads	Increase in social problems (drug and alcohol consumption, prostitution, domestic violence, crime)	Local population			
			Increased land values due to real estate demand	Local population			
			Changes to land-use	Local population			
			Increase of non-endemic diseases	Local population			
			Creation of a floating population	Local population			
			Increased urban and rural population	Local population			
			Increase in the cost of living due to increased floating capital (local inflation)	Local population			
			Pressure on local services (access to water, electricity, garbage and human waste disposal, etc.)	Local population			
			Introduction of foreign (external) values into indigenous communities	Local population			

Section of the ESIA	Affected Component	Infrastructure	Impact	Primary Receptor	Significance Ranking					
					NO MITIGATION			AFTER APPLYING MITIGATION MEASURES		
					Short-term[2]			Short-term	Long-term[3]	
					Negative	Neutral	Positive	Negative / Neutral / Positive	Negative / Neutral / Positive	
Socioeconomic Baseline	Livelihoods and resettlement	Mine and Quarry	Increases in informal mining activities due to an expectation of finding minerals in the vicinity of the operating area	Nearby residents						
			Negative interactions or conflicts with communities interested in gaining access to processed ore.	Formal and informal owners of properties along the route						
			Loss of artisanal mining livelihoods	Artisanal miners						
	Perceptions	Mine, Quarry, PTL, and Access Roads	Generation of unrealistic expectations by the population	Local population						
			Project activity shutdowns due to community complaints or discontent	Company						
	Indigenous Peoples	Mine, Quarry, PTL, and Access Roads	Deterioration of the relationship with indigenous communities due to difficulty in accessing the grievances and claims mechanism	Indigenous Peoples						
			Interruption of the intergenerational transmission of indigenous knowledge due to changes in productive activities	Indigenous Peoples						
		PTL	Deterioration of the relationship with indigenous communities due to poor communication (difficulty in understanding the language)	Indigenous Peoples						
	Com munit :	Mine, Quarry, PTL, and Access Roads	Vehicle accidents or vehicle-pedestrian collisions due to increased vehicle traffic	Nearby residents						

Section of the ESIA	Affected Component	Infrastructure	Impact	Primary Receptor	Significance Ranking – NO MITIGATION – Short-term[2] (Negative / Neutral / Positive)	Significance Ranking – AFTER APPLYING MITIGATION MEASURES – Short-term (Negative / Neutral / Positive)	Significance Ranking – AFTER APPLYING MITIGATION MEASURES – Long-term[3] (Negative / Neutral / Positive)
			Impact on community health due to chemical, cyanide or hydrocarbon spills into local water supply sources	Nearby residents			
			Work accidents involving community personnel	Project Personnel			
			Unplanned growth of economic activities and industrial services	Nearby residents, Project personnel			
Socioeconomic Baseline	Community Health and Safety	Mine, Quarry, and PTL	Impact on community health and safety due to incorrect use of force by physical security personnel	Nearby residents, Project personnel			
		PTL	Emergence of diseases related to exposure to electromagnetism or accidents due to electrocution	Nearby residents, Project personnel			
Archaeological Baseline	Cultural resources	Mine, Quarry, PTL, and Access Roads	Impact or loss of cultural heritage during construction activities	Cultural Heritage			
Project Description	Infrastructure and Services	Mine, Quarry, PTL, and Access Roads	Limited access to local services or infrastructure because of the Project's demand for materials and services	Nearby residents			

Source and Prepared by: Cardno, 2018

12. Environmental and Social Management Plan

The Environmental and Social Management Plan (ESMP) was prepared to avoid, reduce, mitigate, and manage potential impacts and contingency situations resulting from development of the FDN Project.

The ESMP is intended to be an operational that applies to Project staff and contractors, and which includes actions (mitigation, operation and monitoring) for all the Project's stages. The ESMP complies with applicable national law and international standards as defined in the Legal and Institutional Framework of this ESIA.

The current applicable law in Ecuador is Article 32 of Ministerial Order No 061 (Official Gazette No. 270, dated February 13, 2015), with its technical appendices, and Article 23 of the Environmental Regulation of Mining Activities (RAAM).

At the international level, this ESMP complies with IFC Performance Standards and EHS guidelines and other relevant international standards that are described within this ESIA.

Additionally, the ESMP complies with the Company's environmental and social responsibility policies. This ESMP details the commitments that the Company has undertaken with the State and the international community to guarantee the mitigation of possible Project-generated impacts, enhancement of Project benefits, and management of environmental, health and safety, and community relations.

The structure of the Project ESMP is briefly described below:

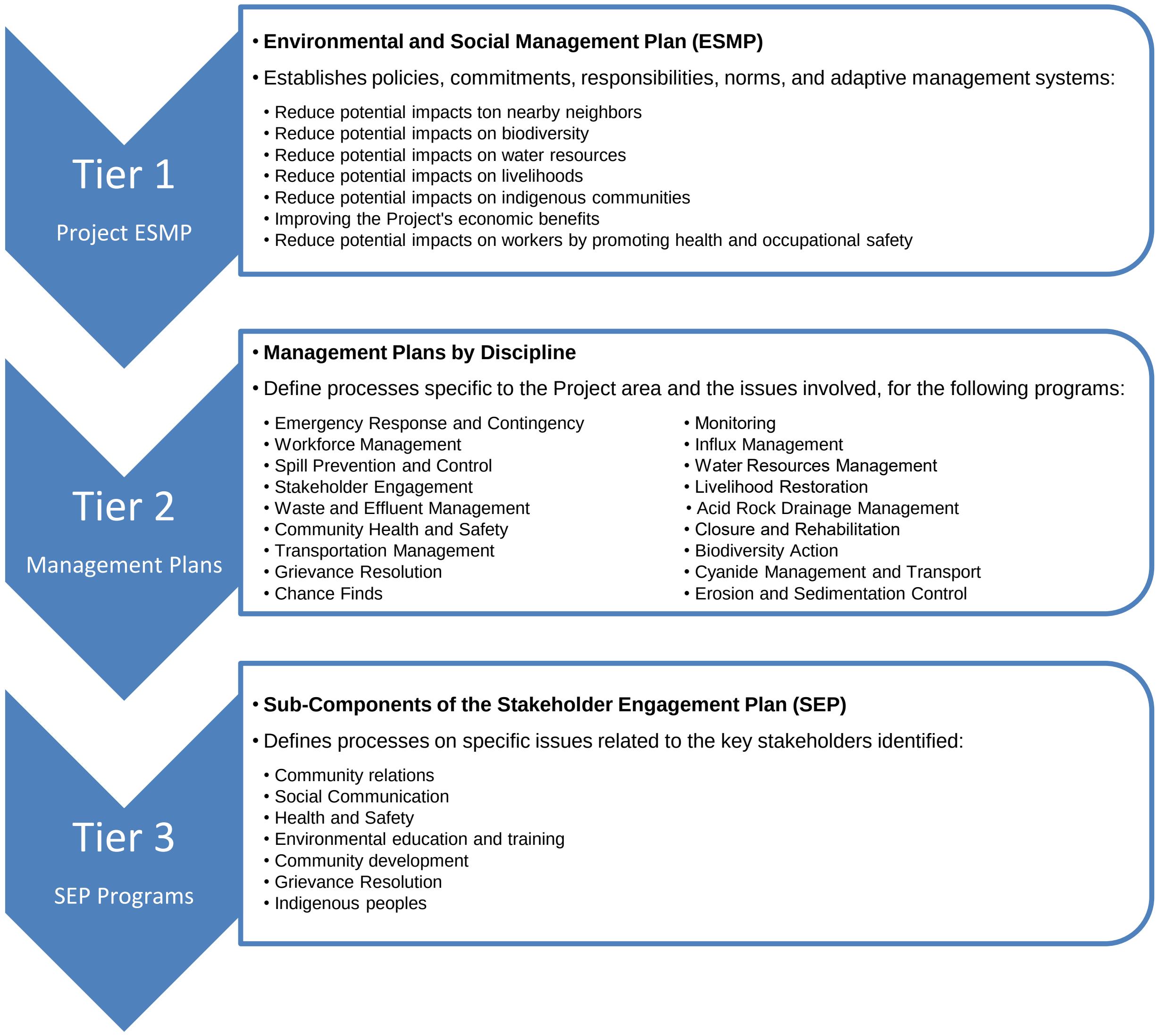

Figure 19 Project ESMP Structure

Source and Prepared by: Cardno, March 2018.

Management Plans

The ESMP is made up of eighteen (18) plans and corresponding programs or sub-plans, which are interrelated and focused on mitigating different types of impacts. These plans are summarized in the following figure:

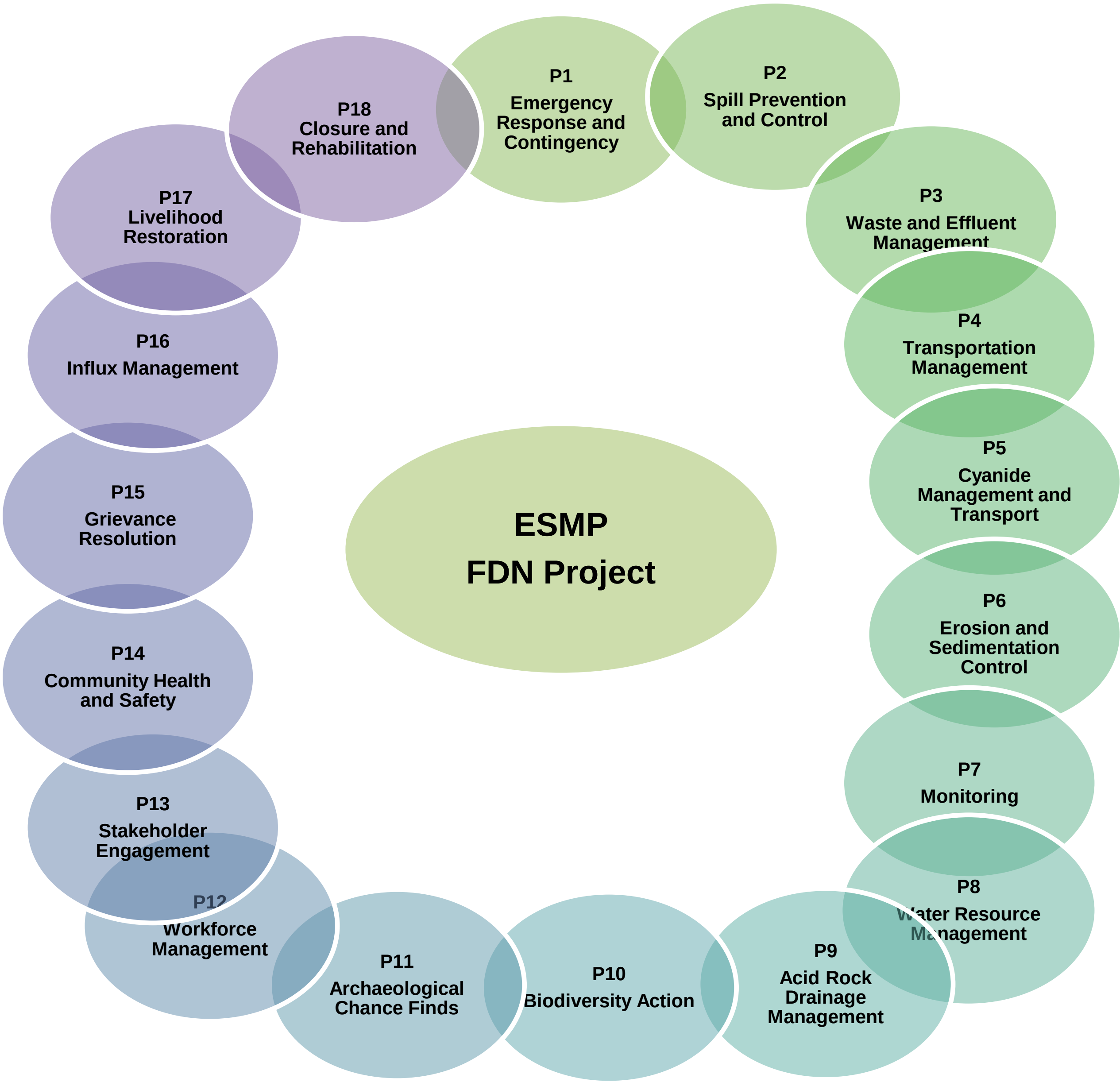

Figure 20 ESMP Management Plans for the FDN Project

Source: Cardno, March 2018.

In this ESMP, each plan is structured by Project phase. The following sections provide brief summaries of the key points of each plan; the complete plans are presented in the Appendices of this ESIA. The performance indicators and the frequency of social and environmental, occupational health and safety monitoring are included in the Monitoring Plan.

Table 2 Summary of the Specific ESMP Management Plans

Plan	Description
P1 Emergency Response and Contingency	Describes the steps to follow in the event of an emergency to obtain a rapid, timely and organized response. This Plan provides planning and work to ensure quick and effective responses when emergencies occur, support decision-making, and organize and coordinate actions to control emergencies.
P2 Spill Prevention and Control	This plan is focused on reducing the potential impact of spills by establishing response procedures to attend to the various types of spills. It provides action measures before, during, and after a chemical and/or fuel spill.
P3 Waste and Effluent Management	This plan focuses on the management of hazardous and non-hazardous solid and liquid waste generated through activities in the Project’s construction, operation, and closure phases.
P4 Transportation Management	This plan is aimed at avoiding risks, accidents, incidents, or injuries to workers, contractors, and communities near the established routes to carry out the various Project activities. It includes measures to avoid environmental impacts and control the occupational health and safety of workers, passengers and drivers involved in Project activities.
P5 Cyanide Management and Transport	This plan is focused on compliance with the International Cyanide Management Code to avoid risks, accidents, incidents, or injuries to workers and/or members of the public and to avoid environmental impacts in any specific place where gold is extracted from ore through the cyanidation process. It includes measures to ensure safe handling of cyanide in its transportation and use in the gold recovery process.
P6 Erosion and Sedimentation Control	This plan focuses on implementing mechanisms to minimize the unnecessary exposure of unprotected soils, as well as to identify the materials and techniques required to reduce the loss of soil during the Project stages.
P7 Monitoring	This plan constitutes a tool for determining whether the Project activities are implemented as planned by assessing their level of compliance. It defines the monitoring, follow-up, and compliance assessment systems established to mitigate potential Project-generated impacts at a global level. It describes the parameters to be monitored, including limits and/or action thresholds and frequency of monitoring, all of which make it possible to measure the Project's social and environmental performance.
P8 Water Resource Management	This plan focuses on preventing, minimizing and mitigating the incidence of negative effects on surface and underground water resources, particularly in relation to the rivers located near the Project (Machinaza and Zarza) and their tributaries during all Project phases.
P9 Acid Rock Drainage Management	This plan defines measures for mining operations management through the prevention, control and/or treatment of acid rock drainage to reduce potential impacts on the environment.
P10 Biodiversity Action	This plan focuses on the following issues: (i) Identifying discrete management units (DMUs), at-risk biodiversity values, and determining the natural, modified and critical habitats within the Project and the surrounding conservation areas; (ii) Ensuring the effective management of possible direct, indirect and cumulative impacts of the Project on critical habitats during the Project phases; (iii) Establishing prevention and compensation measures by applying a mitigation hierarchy for potential biodiversity impacts in the Project's direct and indirect areas of influence; and (iv) Measuring the performance of this plan (using the indicators described in Appendix I.7 Monitoring Plan, which outlines the performance, implementation, and follow-up for effective monitoring of indicators to understand changes and trends in biodiversity).
P11 Chance Finds	This plan focuses on providing the guarantees needed to maintain and preserve any archaeological artifacts in the territory encountered during earthworks in the construction and operations stages.
P12 Workforce Management	This plan is based on the principle of non-discrimination and reflects dialogue with workers, their organizations and, where appropriate, with the government, in addition to strictly complying with local labor legislation, international standards and existing collective agreements. It focuses on managing the impacts produced by the partial or total increase, reduction, or demobilization of the Company's workforce for any reason, whether due to a change of phase, temporary closure or permanent closure. It provides measures for managing human resources, guaranteeing respect for the individual and collective rights of workers, considering the conventions of the International Labor Organization and including mechanisms for grievance resolution (Appendix I.15 Grievance Resolution).

Plan	Description
P13 Stakeholder Engagement	The purpose of this plan is to identify and integrate key stakeholders as a fundamental part of Project development to ensure effective information disclosure, prior consultation, negotiation of complex situations, formation of strategic associations, management of claims or grievances, and to promote participation. The plan provides guidelines to ensure that key stakeholders and affected communities are informed and engaged on the Project's progress and activities. This plan establishes responsibilities to ensure that management has sufficient ability to leverage relationships with key stakeholders. It covers identification and analysis of the interests and/or concerns of key stakeholders, with systems to address and resolve these situations and achieve progress in the sustainable development of affected communities, including indigenous communities.
P14 Community Health and Safety	This plan establishes guidelines for preventing impacts related to Project activities that could put the safety or health of the local population at risk, particularly in the areas where the Project will be developed and transportation routes. The main objective of this plan is to anticipate and avoid adverse impacts on the health and safety of the communities in the area of influence during the project lifecycle from both routine and non-routine circumstances. It also seeks to guarantee that safeguarding of personnel and property is carried out in accordance with relevant human rights principles and in a manner, that avoids or minimizes risks to the communities.
P15 Grievance Resolution	This plan describes the mechanism for resolving grievances by applying the Company's "Grievance Mechanism" procedure. The objectives of the Grievance Mechanism include implementing a grievance resolution mechanism for the Project that complies with the Guiding Principles mentioned above, and that is flexible, accessible, confidential, understandable, culturally appropriate, effective, non-judgmental and transparent. It also seeks to establish a clear procedure that facilitates timely and equitable response to grievances and claims by workers, contractors, and stakeholders, guaranteeing that the Company truly applies its best efforts and assigns all resources necessary to resolve grievances. Accordingly, this plan ensures that the Company responds in a consistent and correct way to all grievances even when a final solution is not possible (e.g., when dealing with issues that are outside of the Company's control). The Plan also creates an environment of trust with stakeholders, making it possible to comply with internationally recognized human rights standards and facilitating transparent communication with all of the Project's stakeholder groups, including vulnerable populations and individuals.
P16 Influx Management	This plan is structured to handle the dynamics and potential impacts generated by the migratory influxes a result of the Project. The strategies included in this plan are geared towards managing Project-induced in-migration in the Project area; this includes minimizing in-migration, managing migratory influx, and managing the social and environmental footprint of in-migrants. It also fosters improving participation and monitoring stakeholders, as well as mitigating the adverse impacts associated with the migratory influx.
P17 Livelihood Restoration Plan	This plan focuses on ensuring that the impacts generated from land purchase and/or access roads do not cause economic impacts or physical displacement. If such physical displacement does occur, the affected persons should have the ability to recover their livelihoods to a level equal or better than the one from which they were displaced. This plan also considers the rights of artisanal miners in the Project area.
P18 Closure and Rehabilitation	This plan focuses on implementing specific measures to identify the facilities and activities that will have to be shut down during the progressive closure, temporary closure and upon definitive closure at the end of the Project life. The main objectives of this plan include: (i) Protecting the health and safety of communities, (ii) Preventing, minimizing and mitigating adverse social and environmental impacts, (iii) Rehabilitating disturbed areas to a self-sustaining land use in accordance with the closure plan, and (iv) Ensuring long term chemical, physical and hydrological stability of the waste rock storage piles, TSF, and other Project infrastructure.

Prepared by: Cardno, March 2018.

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