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TABLES

10.0 ENVIRONMENTAL

10.1 Introduction

This section describes the background for the physical, biological, and constructed environment for the Guanaco mine, as well as the major environmental assessment criteria for the Chilean authorities in an Environmental Impact Statement. This section also describes the environmental legislation and environmental and/or sectorial permits applicable to the project.

The Guanaco Mine Re-opening Project was submitted to the Environmental Impact Evaluation System (SEIA) as an Environmental Impact Statement. This implies that the project will not generate any of the effects, characteristics, or circumstances stated in Article 11 of the Environmental Law.

10.2 Characterization of the Project Area

10.2.1 Physical Environment

a) Weather y Meteorology

The area where the project will be developed is in a location where the weather is defined as desert, according to the Köeppen climate classification which is characterized by a clear atmosphere, low relative humidity, and moderate fluctuation between average temperatures for the warmest and coldest months, but with large temperature differences between day and night.

Measurements taken at GCM's meteorological station from January to November 2009 indicate that the average wind speed reached 2.8 m/s. The maximum average speeds were in the months of July to September. The maximum speed was 4 m/s in September 2009. Maximum speeds in the period were registered between May and October. The maximum wind speed during the period was 10.8 m/s recorded in July.

The percentage of calm varied in this period between 0.6% in September and 3.9% in March. During the summer months the average calm was 3.3%, however, the winter months and early spring the periods of calm decreased to 1.8%.

During the same period the predominant direction was N. During the morning the winds were predominantly from the NNE and in some cases from NNW. During the afternoon a predominant of the SSW component was present, followed in most of the cases by a SW component. In June and July the predominant component was N. At night NNE winds always predominated.

The maximum temperature during this period was registered in October and was 26.1°C. The minimum temperature was registered in July, and was -5.4°C. The maximum temperature difference was 20.4°C average for the period.

Relative humidity was higher in the summer (around 60% average) and was lower in the winter (around 38% average). The atmospheric pressure was very stable around 553 mm Hg.

b) Geology and Hydrogeology

The Guanaco zone is characterized by outcrops and sub-surface altered and mineralized volcanic rocks mainly with gold-silver and copper mineralization.

In the area mainly volcanic and volcano-clastic rocks of continental origin outcrop, belong to the Lower Tertiary, Eocene-Miocene where the gold-copper bearing mineralization occurs. The rock units are discordantly overlain by the Recent continental sedimentary unit that shows different clastic facies. These clastic facies are associated on one side with the plains area to the west of the Domeyko Cordillera which presents deposits associated with fluvio-alluvial environments with clay and gravel. There are also deposits associated with the source of the Guanaco ravine which can be seen in the sections in the Cachinal area that are alluvial in character with angular clasts, poorly classified, with sizes from 6 to 8 cm in an abundant, light brown argillaceous matrix.

The main structures recognized in the mine show east-west oriented faults which correspond to the orientation of the mineralized veins.

Hydrogeologically the area is located between La Negra and Pan de Azúcar ravines. The drainage systems in the area are characterized by relatively mature reliefs associated with sedimentary processes of mainly fine material. The softness of the relief and the lack of surface run-off produce poorly defined drainage systems, especially towards the watersheds.

The Guanaco ravine starts very close to the Guanaco deposit and empties close to the Catalina station, a river only 20 km long.

The estimated average rainfall and evapo-transpiration are the same which indicates, at a regional level, that the flow available for surface or underground run-off is zero for years with probability of exceedance of 50% (years in which the rainfall is average or less than average).

The average elevation of the water table in the mine area is 2,540 to 2,530 masl according to the drilling performed in the area. The average elevation of the working area is approximately 2,720 masl, hence the water table is at a depth of around 180 to 190 m.

c) Geomorphology and Landscape

The Guanaco District is located in the Intermediate Depression, a geo-morphological feature consisting of the lower areas between the Coastal Range and the main Cordillera, which is represented here by the Domeyko Cordillera. In general the area of the Guanaco deposit is located in the zone that presents a topographic gradient to the west, reaching elevations of about 5,000 m in the east (the Domeyko Cordillera) and about 2,500 m in the west. Although some areas reach considerable elevations the topography is gentle and no mass movement is observed.

The local landscape is characterized by the roads and mines that define the presence of man in the area for centuries. The natural landscape is dominated by the Atacama Desert systems, dry with a complete absence of flora and fauna. There are no zones declared as places of touristic or scenic interest in the area.

d) Noise

Measurements were carried out in 2006 when there was no operation to determine the background noise level in the area of the Guanaco mine.

Measurements covered three periods of the day: morning, afternoon, and night, and were taken in the area of the administration offices and the camp.

It was concluded that the background noise level in the zone is low, fluctuating between a minimum of 29 dB(A) during the night, in practically a total absence of activities and with calm winds, and a maximum value of 38 dB(A) in the afternoon, mainly due to the wind.

e) Quality of the air

A baseline level for particulate material under 10 microns (PM10) was measured in August/September 2006 at the monitoring station called “Administration”. Measurements were carried out for 24 hours for three days, with no mining operation.

The levels of PM10 fluctuated between 2 and 23 µg/Nm^3 for 24 hour concentrations, and were on average 9 µg/Nm^3. A conservative maximum baseline value was obtained by applying statistical analysis assuming a normal distribution (Gaussian) of the PM10 concentrations gave a PM10 in 24 hours of 29 µg/Nm^3, based on the measurements performed in August and September 2006. The maximum average concentration of the baseline level of PM10 from the statistic analysis was 14 µg/Nm^3 based on the measurements performed in August and September 2006.

Information from December 2009 is provided in Table 10.2-1.

Table 10.2-1: Air Quality

	Concentration of Particulate Material ($\mu g/Nm^3$)
N° of samples	11
N° of valid samples	11
% of valid samples	100%
Average concentration	13
Maximum concentration	23
Minimum concentration	9
Historical average concentration	14
Historical maximum concentration	108
Percentile 98 Dec 08 – Nov 09	30
Percentile 98 Jan 09 – Dec 09	30
Average 2006	14
Average 2007	14
Average 2008	15
Average 2009	15
Standard	**150**

10.2.2 Biotic Environment

a) Flora and Fauna

According to the literature for mining projects in the Guanaco District, the area is an ecotone, a transition between the Taltal interior desert and Domeyko Cordillera mountain desert. This area is predominantly arid and is a highly restricted physical system for biological development, so that only highly specialized species can survive. The area could be defined as a biological depopulated zone with an absence of flora and extremely poor fauna. The baseline study for the EIA for the Concentrate Roasting Project for Soledad presented in 2000 indicated that the area around the Guanaco and Soledad mineral deposits has no vegetation. The only charted vegetation was found approximately 5 km south of this area.

In March 2006 and February 2007 two field campaigns were carried out. The goal was to characterize the area of influence of the project – the mine area and the Pastos Largos, Las Mulas, Punta del Viento, and Varitas ravine areas, where GMC has water rights.

In these campaigns it was confirmed that the mine area which belongs to the Taltal Interior Desert has a low botanical diversity and scarce coverage (less than 5%) which is characterized by presenting patchy almost exclusively annual herbaceous formations and scattered sub-bushes. The grasses were almost exclusively Portulacaceae (cistanthe celosioides) accompanied by some disperse individual Chenopodiaceae. There were scarce specimens of Portucalaceae (calandrinia) and Papilionaceae (vulnerable adesmia).

In the Pastos Largos and Las Mulas ravines there was more diverse vegetation. In Pastos Largos there were the Asteraceae, Papilionaceae and Poaceae families, such as Senecio sp., Adesmia sp., and Stipa sp. In Las Mulas, Adesmia spp., Ephedra breana and Gymnophyton spinosissimum were found. In the moist soils on the sides of the ravine grasses such as Deyeuxia sp. were found. Of all the species found only one has conservation issues. This is the Opuntia conoidia cactus which is classified as rare because of its restricted distribution between Ollague and Talabre.

The most fauna were found in Pastos Largos and Punta del Viento ravines followed by Varitas and Las Mulas.

The mine area showed less fauna with the presence of reptiles, granivorous bird flocks (chirihues) that fly over the entire area, and sparrows (Passer domesticus), a species introduced specifically in the mine area.

In the ravines species are those typical of the high Andean plateau fauna in the Domeyko Cordillera (Río Frío and Salar de Punta Negra) with an almost total absence of fauna associated with water bodies in flat areas. Species found directly associated with the presence of water were the cojón partridge, tuco tuco, Andean mouse, and vizcacha (a rodent of the genera Lagostomus). All of them are herbivores, they eat fresh shoots and roots which are not available in dry areas. The presence of the reddish nape dormilona (dormilona de nuca rojiza) and the white wing churrete were noted, both insect eating birds that normally find their principal source of food around water bodies; the Andean partridge, associated with wetlands, salt lakes, and high Andean marshlands, and the vicuna that depends directly on these water sources because it is a daily drinker.

The results obtained in the campaigns confirmed that this area of the Domeyko Cordillera is an area of active reproduction of Camelidaes, in particular guanacos.

Of the species found, 12 are in the Conservation category for the Northern Zone, according to Supreme Decree N° 05, 1998, Hunting Law. These are listed in Table 10.2-2.

Table 10.2-2: Species Identified in the Conservation Category for the Northern Zone

Species	Scientific name	Conservation Category
Birds	Vultur gryphus	Vulnerable
	Buteo poecilochrous	Inadequately known
	Falco peregrinus	Vulnerable
	Attagis gayi	Rare
Mammals	Lama guanicoe	In danger of extinction
	Vicugna vicugna	In danger of extinction
	Lagidium viscacia	In danger of extinction
Reptiles	Liolaemus platei	Rare
	Liolaemus sp.	¿?
	Liolaemus (Eulaemus) nigriceps	Vulnerable
	Liolaemus constanzae	Rare
	Phrynosaura audituvelatus	Rare

10.2.3 Human Environment

The Guanaco Mining District, in the north-east area of the community of Taltal, is part of the community of Taltal (Antofagasta Province). The inhabitants of the Guanaco area have historically had much more connection with the city of Taltal than with other population centers such as Antofagasta.

The project is connected to Taltal by Route 5, the main north south road in Chile. To access the project from Taltal the road is via Route 1 which is a paved road approximately 22 km in good condition. Then Route 5 continues to the north-east before turning off onto a dirt road at Km 1,198 of Route 5 which connects with road B-865. Road B-865 is also a dirt road and in fair condition, it starts at the former Flor de Chile mine and ends at the former Chile mine. Access to the project from Antofagasta is by Route 28 then south on Route 5 to Km 1,198 and then by the dirt roads described above.

Taltal is one of the most isolated inland communes of the Antofagasta Region, it is 306 km south of Antofagasta and 25 km from Route 5, with no local public transportation to Antofagasta and with scarce public transport between other local communities.

The population growth in Taltal has been associated with mining. When nitrates were being mined there was much activity in Taltal and 21 mines in the area that attracted a large population. However, with the closure of the mines unemployment and poverty rose and many moved away from the mines into urban centers including Taltal, which increased the poverty levels at that time.

Mining is still the main economy of the town (26.13%) followed by wholesale and retail business (11.89%), construction (9.14%), and real estate and rental (9.02%).

Taltal's mining activity is now centered on metal mining in small and medium size mines mainly small copper mines. These mines work intermittently and the work force is not stable. This means that Taltal's economy is vulnerable to the oscillations of the international metal prices and goes into depression every time the metal prices fall below the economic value for the small mines.

Taltal is the only urban entity in the community and has 86.16% of the total population of the community. Paposo is the next biggest urban zone with 10.29% of the population of the community. The remaining 3.55% is divided between other small villages. The city of Taltal acts as a center for goods and services supplying for the rural areas. Services provided are education, health services, and products that are not found in the local villages.

The economically active population in the Taltal community is broken down as follows;

- 19.64% are supervisors, workmen, and craftsmen in mechanical and other trades
- 16.69% are unqualified workers
- 15.25% are machine operators in assembly plants
- 14.99% are professionals and/or technical personnel.

In the Taltal community 42.39% of the population has elementary school education and the regional average is 32.55%. The Taltal community population has 9.58% with secondary education and the regional average is 21.09%. This is reflected in the poor working opportunities in the community and also the low teenage and young adult population (between 15 and 29 years). Young people leave for higher education and better work opportunities.

Taltal has good services, the sewage system serves 95.57% of the population, 96.14% have electricity, and 98.65% have potable water. There are valuable natural assets on the coast and the coast range of the cordillera, but very little development in terms of services and infrastructure which limits the tourist activities. The local and regional authorities see this as a potential source of development.

Geographical isolation, poor job opportunities, low levels of education and vocational training, and the absence of senior school education are serious disadvantages for the community compared to the rest of the Antofagasta region and the rest of the country. This is reflected in the high proportion of the population in poverty. The government has listed the community amongst the 71 poorest communities in the country.

10.2.4 Cultural Heritage

Archaeological surveys in the project area and its area of influence (mine and water sources) detected two types of archaeological evidence which are differentiated by their chronology, pre-Hispanic or historical sites.

Table 10.2-3: Summary of the Archaeological Sites detected in the Project Area

Site	Type	Sector	UTM (North)	UTM (East)	Height (masl)	Dimensions (m)	Chronology	State of Conservation
Ca-01	Camp	Cachinales	7.219.393	444.521	2.567	20 x 10	Pre-Hispanic	Good
Ca-02	Town	Cachinales	7.219.391	444.350	2.568	600 x 180	Historical	Bad
Ca-03	Cemetery	Cachinales	7.219.239	444.676	2.576	25 x 35	Historical	Bad
CH-01	Cemetery	Mine	7.224.127	445.830	2.650	25 x 35	Historical	Bad
PL-01	Camp	Pastos Largos	7.215.861	463.574	3.267	15 x 40	Historical-sub-current	Good
PL-02	Settlement	Pastos Largos	7.215.275	469.838	3.722	15 x 50	Historical-sub-current	Regular
PV-01	Small mining camp	Punta del Viento	7.226.182	475.790	3.656	40 x 130	Historical-sub-current	Good
QLS-01	Camp	Quebrada Los Sapos	7.210.717	468.883	3.543	20 x 20	Pre-Hispanic	Good
QLS-02	Settlement	Quebrada Los Sapos	7.210.700	468.586	3.529	200 x 80	Historical	Good
QS-01	Camp	Quebrada Sandón	7.203.039	463.810	3.170	10 x 10	Historical-sub-current	Good

Only two pre-Hispanic sites were found: Ca-01 registered by De Souza (2007) and re-visited in 2007 by Cabello; and QLS-01 registered by Cabello (2008). Both show the same pattern and from the type of evidence, as well as the moderate density, were interpreted as sporadic camps associated with the circulation of groups during the Formative period (1500 BC to 600 AD). The chronology is the result of the identification of diagnostic elements. On QLS.01 site the head of a pedunculated projectile, a type of arrowhead that began to appear during the Formative period. However, because of the small size it was diagnosed as belonging to a later phase (José F. Blanco com. Pers) known as “Séquitor” for the Salar de Atacama (100 BC to 400 AD). This site is located at about 80 m south-west of the WE-09 well, but just below the slope where an old pipe from this well runs. The conservation conditions of the site are relatively good, abundant cultural material can be observed. However, the surface of the site has been slightly

altered by the presence of animals that inhabit the place (rodents and saurians) and others that pass through (from the camelidae family):

On site Ca-01 the chronology proposed is based on the presence of a ceramic fragment identified by De Souza (2007b:4) as "*brown polished on both faces, possibly of the "Séquitor type from the Atacamanan Formative period*". This site is about 60 m southwest of well WE-26. However, materials are also spread over the terraces to the west and to the north of the Cachinales fertile plains as far as the Guanaco ravine, covering a surface greater than 100 m^2. Although the conservation conditions of this site are good and abundant cultural material is observed, the human activity for agriculture has resulted in movement of the soils and the construction of well WE-26 and adjacent wells has also altered the area. Because these sites are not easy to see it is recommended that the areas be marked off and signs posted prior to further work in the area. Any construction work should be done in the presence of a professional archaeologist. Also any drilling and/or well excavation should only be carried out after consultation with the National Monuments Council.

The second group of archaeological sites are historical sites, these are divided into two types. One type includes the major settlements associated with industrial mining in the Guanaco area that date back to the XIX century. There are two sites, the town (Ca-2) and the cemetery (Ca-3), registered by De Souza (2007b) in the vicinity of the Cachinales area; and the cemetery (CH-01) registered by Cárdenas (2006) between the Dumbo open pit and the Soledad camp.

The other type includes the minor structures (markings and small mining camps) where the absence/mixture of cultural material does not allow a precise chronological definition, however, they are associated with the artisan mining of the Guanaco district at the end of the XIX century to more recent time. These were registered by De Souza (2007b) in Pastos Largos (PL-01 and PL-02) and Punta del Viento (PV-01) where the pipeline runs, and by Cabello (2008) in the Sandón (QS-01) and Los Sapos (QLS-02) ravines. These sites are archaeological sites that are classified as relevant for the understanding of the historical dynamics of the local mining activity, both artisan and industrial mining (at the end of the XIX century). They are indirectly associated with areas that will be intervened, and it is recommended that the locations be taken into consideration when working in the area.

These sites are very visible and it will only be necessary to train personnel to take care not to damage these sites when working in the area.

10.3 Project Environmental Impact Assessment

10.3.1 Atmospheric Emissions

In the construction stage of the project it is expected that emissions of breathable particulate material PM10 during earthmoving in the plant and mine area and in the dry

tailings deposit area. There will also be emission of particulate material as a result of vehicle traffic movement.

During the operating stage principal emissions of breathable particulate material PM10 in the plant will be from crushing and materials handling and vehicle traffic. In the mine, particulate material generation sources will be vehicles, waste deposition, and the emissions produced during blasting.

In order to demonstrate that these emissions will not produce a deterioration of the air quality and that the primary air quality standards will be met, the quality of air expected in the camp was modeled using expected emissions from the project. The modelling and analysis of meteorological variables indicated that:

- The Guanaco camp is well placed from the point of view of air quality it is not exposed to particulate material emissions from the mining operations, since there is a very low to zero frequency of winds from W and NW (there are practically no winds from the mine area towards the camp area).
- The results of the model represent a conservative condition, i.e. they predict higher levels than those that would actually occur. This is because of the conservative assumptions adopted, principally considering the closest possible proximity between the emission sources and the camp, and not including any mitigation of the emissions (e.g. road watering and dust suppression in the crushing area).
- The results show that the total levels of PM10 including the baseline level outside the camp, will be less than 150 µg/Nm^3 as the maximum concentration in 24 hours, and less than 50 µg/Nm^3 as an annual average concentration. The forecast values are below the current, primary standard for air quality in populated centers (see Appendix D).

The particulate material emission is the most relevant measurement and the modelling shows that there will be no impact on the camp which is where the environmental measurements will be taken. Although there will be gaseous emissions from vehicles and fixed sources, it will not be required to control these unless the authorities specifically request this as part of the environmental approval.

10.3.2 Waste

Liquid Waste

The only liquid wastes that will be generated during construction and operations will be liquid sewage. The plant will be designed so that there will be no outflow of water, except for water lost through evaporation. All waste process waters will be recirculated within the plant.

The project will not emit or generate in any of its stages, outflows, emissions, or pollutants in liquid form that, combined or interacting between them could adversely or significantly affect the quantity and quality of the renewable natural resources in the project area.

Solid Waste

The amount of solid waste generated will depend on the mining and processing rates. These wastes can be classified as:

- Solid Industrial Waste (RIS)
- Solid Industrial Waste similar to domestic waste (RIS a D)
- Domestic Waste (RD)

Table 10.3-1 shows the classification, generation rate, temporary storage, and final disposition of solid wastes expected at the site.

Table 10.3-1: Estimated Solid Waste during Operations

Waste	Type	Quantity	Temporary Storage	Final Disposition
Explosives waste [1]	RIS	1 t/month	_	Incineration
Process reagents containers	RIS Hazardous	1,500 kg/month	Hazardous Waste Temporary storage Area	Company authorized for the final disposal of hazardous wastes, or returned to the supplier
Heavy and light vehicle batteries	RIS Hazardous	3 units/ month	Hazardous Waste Temporary storage Area	Company authorized for the final disposal of hazardous wastes, or returned to the supplier
Glass and other laboratory materials	RIS Hazardous	2,500 kg/ month	Hazardous Waste Temporary storage Area	Company authorized for the final disposal of hazardous wastes, or returned to the supplier
Cyanide boxes	RIS Hazardous	50 boxes/ month	Hazardous Waste Temporary storage Area	Company authorized for the final disposal of hazardous wastes, or returned to the supplier
Oil filters, cloths, and minor materials contaminated with grease/oil	RIS Hazardous	200 kg/ month	Hazardous Waste Temporary storage Area	Company authorized for the final disposal of hazardous wastes, or returned to the supplier
Residual oils	RIS Hazardous	5 m^3/ month	Hazardous Waste Temporary storage Area	Company authorized for the consumption of waste oils as fuel, or company authorized for the final disposal of waste oil
Other residues such as oil filters, hoses, cans contaminated with grease, oil, paint,	RIS Hazardous	500 kg/ month	Hazardous Waste Temporary storage Area	Company authorized for the final disposal of hazardous wastes, or returned to the supplier

[1] These residues typically correspondent to: a) containers, cardboard boxes, sacks, bags, and other packing materials from the normal use of explosives, or b) explosives that, due to freezing, exudation, decomposition, or other circumstances, lose their original properties and are not suitable for use.

Waste	Type	Quantity	Temporary Storage	Final Disposition
various containers, contaminated PPE				
Filter cloths	RIS Non Hazardous	500 kg/ month	Salvage Yard	Domestic waste dump
Carbon	RIS Non Hazardous	500 kg/month	Salvage Yard	Domestic waste dump
Bags, plastic material and non-contaminated containers	RIS a D	500 kg/ month	-	Domestic waste dump
Scrap metal	RIS	1,500 t/ month	Salvage Yard	Company authorized for the final disposal of ferrous material
Wood	RIS	1 t/ month	Salvage Yard	Authorized burning on site
Tires, rubber, used equipment parts	RIS	1 t/ month	Salvage Yard	Company authorized for the recycling and/or final disposal of these wastes
Remains of organic and non-organic material from the dining room, offices, and administration activities.	RD	1,500 kg/ month	-	Domestic waste dump

10.3.3 Noise

During the construction stage noise emissions will result from the use of machinery for earthmoving, tools and equipment used in refurbishing the process plant and blasting for the development of the underground mine.

During operations the main noise emissions will be from blasting in the open pits and the underground mines which will have the characteristics of specific noise emissions. In the process plant the main noise emissions will be from the crushing and agglomeration processes.

According to the modelling performed for these emissions and considering the background noise, in both the construction and operations stages the sound pressure levels in the camp area will not change and there will be no effect on the health of the people working and living in the camp. The background emission calculations showing the sound pressure levels expected in the camp area are provided in Appendix D,

There are no native fauna nesting, reproducing, or feeding in the project area that could be affected by the noise emitted by the project.

10.3.4 Water Consumption

Some of the project water supply comes from wetlands approximately 30 km east of the site. These wetlands are the sources of surface waters for which GMC has exploitation rights for a total of 4.84 L/s. These waters have been historically captured and used by

the different mining operations that exploited the Guanaco properties. This exploitation has included mineral processing and accommodation for more than 300 people at the peak.

The historical use of renewable natural resources in the area is in agreement with the information obtained by GCM. It can be inferred that the flora and fauna present have not been impacted by the historical use of this water therefore, it is expected that maintaining the same water extraction rate will not affect the baseline condition.

10.3.5 Biodiversity

The area where the project will be developed have been strongly intervened by humans. Vegetal coverage in the mine area is practically zero with only some isolated individual plants. The water resources have been used for a long time and no effect on the existing vegetation has been noted. GCM will continue to use these water resources in the same way and no significant adverse impacts on the existing vegetation are expected.

The project will not intervene or exploit native vegetation. Although during exploration of the biotic environment specimens of herpeto-fauna were found in the area where the dry tailings deposit will be built; the project area of influence is not in an area where there is a concentration of this species. Low diversity and low abundance were confirmed, only isolated individuals were observed and in a very small numbers.

Water resources have traditionally been extracted and no effect has been noted on fauna in the conservation category in the area. GCM will continue to extract water in the same way and no significant adverse impacts are expected on the fauna.

10.4 Applicable Environmental Standards

This section identifies the authorizations that GMC already has and the permits that GCM must obtain. Sectorial environmental authorizations granted during the environmental qualification process for the project are also identified and the background documentation that was used to support the applications.

The Guanaco Mine Re-opening Project was submitted to the Environmental Impact Evaluation System (SEIA) by means of an Environmental Impact Statement, this indicates that the project will not generate any of the effects, characteristics, or circumstances observed in Article 11 of the Environmental Law.

Details of the applicable law including the specific articles, the relationship with the project, and guidelines for meeting the requirements are included in Appendix D (Matrix of Environmental Commitments).

10.4.1 Authorizations in Effect - Guanaco Compañía Minera

a) Environmental Qualification for the Project

A favourable environmental qualification for the Guanaco Mine Re-opening Project was granted by the Region II Corema as Resolution of Environmental Qualification 0251 dated July 15 2009 (see Appendix D).

b) Potable Water Supply System

Exempt Resolution 973, dated March 12 1996, Antofagasta Health Service, authorizes the water supply system for human consumption, consisting of a storage reservoir and distribution networks for the camp.

c) Sewage Water Treatment System

Exempt Resolution 972 dated March 12 1996, Antofagasta Health Service, authorizes the aerobic system of sewage water treatment by sedimentation pond, sludge accumulator and stabilization ponds, with a treatment flow of 36,288 L/day located in the camp.

d) Waste Management

Resolution 002 dated 21 December 2000, Antofagasta Health Service, authorizes the installation and operation of a salvage yard at Guanaco Mine, consisting of delimited locations for each product with appropriate signs, fenced and with gates for control.

This resolution was modified by Resolution 022 dated July 25, 2001, Antofagasta Health Service to assign Area N°1 for empty cylinders with residual lubricant oil and Area N°10 for empty plastic cylinders.

Resolution 676 dated February 14, 1997, Antofagasta Health Service, authorizes the installation of a domestic waste landfill site at Guanaco Mine.

Resolution 3147 dated October 25, 2006, Regional Ministerial Department of Health, Antofagasta Region authorizes the temporary storage of hazardous waste in the GCM facilities. The authorized site is 42 m^2 assigned for the temporary storage of residual oils, empty drums and cloths contaminated with grease and oils, and 6 m^2 assigned to the storage of batteries.

e) Fuel Storage for Own Consumption

GCM has a registration with SEC for two diesel petroleum tanks (50 m^3 each) under folio number 28, dated May 2, 2007.

GCM has a registration with SEC for a buried gasoline tank (20 m^3) under folio number 29, dated May 02, 2007.

10.4.2 Environmental Authorizations for the Project

The project will request the sectorial environmental authorizations listed below and in Table 10.4-1 as required by Supreme Decree 95/2001:

- Sectorial Environmental Authorization for Construction of Dry Tailings Deposit (Article 84 SEIA Regulation). Authorization to construct a tailings deposit, referred in Article 47 of Supreme Decree 86/70, Ministry of Mining, Construction and Operation of Tailings Deposit Regulation.
- Sectorial Environmental Authorization for Wastes Dumps and Heap Leach (Article 88 SEIA Regulation). Authorization to establish a mining waste dump referred in Clause 2 of Article 233 and waste dumping to which Article 318 is referred, both from Supreme Decree 72/85, Ministry of Mining, Mining Safety Regulation.

Both the above sectorial environmental authorizations (Articles 84 and 88) and Supreme Decree 95/2001 require the presentation of the same background. The most relevant aspects are:

1) **Land use.** Land use description, capacity of use, classification according to ability and use characteristics. If there is any instrument of territorial planning or if it is part of an area under official protection, this must be noted.

   The land in the project area in general terms was formed between and in the surroundings of Cerro La Estrella and the Domeyko Cordillera. Explicitly in the project area, the surface soil can be identified as of alluvial origin, directly related to ancient and recent alluvial phenomena, after heavy rainfalls such as those that occur in what is known as the Andean high plateau winter. As with all typical sedimentation alluvial cones the size distribution of the surface soils is associated with the alluvial deposition, where fine material of stony origin predominates. This is supported by the tests performed on the soil samples taken in the project areas.

   At the present time the land use is industrial, and has poor drainage capacity which results in a null agricultural capacity, confirmed by the poor presence or absence of vegetation.

Table 10.4-1: Environmental Permits Required by Law

Description	Regulation Type Of	Standard format Organization	Source	Status	Preparation Time	Authorization Approval Time Estimate
Positive environmental qualification Transportation and Storage of Sodium Cyanide	Environmental Permit	Corema Region II	Law 19300; Supreme Decree 95/2001	In process; requested.	NA	90 days
Permission to initiate the construction of tailings dams, Article 47 D.S N. 86/70 of Ministerio de Minería, Tailings Dams Operation and Construction Regulations. The requirements for the award as well as the technical and formal contents to certify compliance will correspond to those outlined in said article.	Sector Environmental Permit Dry Tailings Deposit	Sernageomin Region II	Article 84 SEIA Regulation pertaining to the Sanitary Code, Art. 71 Letter b.	Environmental Permition Awarded in RCA. Sector submission to the Sernageomin is required.	1 month	60 days
Permission to establish a mining waste dump, referred in the 2nd paragraph of Article 233 and waste dumps, referred to in Article 318, Supreme Decree N. 72/85 Ministerio de Minería, Mining Safety Regulation.	Sector Environmental Permit Waste Dumps	Sernageomin Region II	Art. 88 of the SEIA Regulations. Art. 233 and 318 of the Mining Safety Regulations 1985.	Environmental Permit Awarded in the RCA. The permition for the Cachinalito dump was submitted and approved. Sector submission to Sernageomin is required for the additional waste dumps included in the project.	1 month	60 days
Permission for the set-up of any place for to the accumulation, selection, trading or final of disposal waste and garbage of any kind, referred in Articles 79 and 80, D.F.L Nª 725/67, Código Santiario	Sector Environmental Permit Hazardous Waste Temporary Storage Yard	Seremi Salud Region II	Art 93 SEIA Regulations. Art. 79 and 80, Código Sanitario	After the Environmental Permit Award, Sectorial submission to the Sanitary Authority of the Seremi de Salud of Antofagasta Region	2 weeks	60 days for the construction and later operation.
Permission for the qualification of the industrial facilities or storage referred in Article 4.14.2 , Supreme Decree N.47/92, Ministerio de Vivienda y Urbanizmo, "Ordenanza General de Urbanismo y Construcciones".	Sectorial Environmental Permit Industrial Qualification	Seremi Salud Region II	Article 93 SEIA Regulation. Article 79 and 80, Código Sanitario	Environmental Permit Awarded in the RCA. Sectorial submission to the Sanitary Authority of the Seremi de Salud of Antofagasta Region is required	1 month	
Permit for industrial constructions outside urban limits, Paragraphs 3rd and 4th Article 55, D.F.L. N.458/75 of Ministerio de Vivienda y Urbanismo.	Sectorial Environmental Permit Land Use Modification	Seremi Agricultura Region II	Article 96, SEIA Regulation. Paragraphs 3rd and 4th ,Article 55, D.F.L. N. 458/75 of Ministerio de Vivienda y Urbanismo	Land use modification permit has been awarded for some areas of the Guanaco mine. Permits for other areas must be requested. Mining rights of way must first must be set.	2 weeks	30 days
LPG facilities for the camp, process plant, chemical and metallurgical laboratory buildings.	Statement	SEC	Supreme Decree 66/2007 Regulations for interior gas installations and gas meters.	To be requested. GCM must hire installation certification entities authorized by the Superintendencia, to certify said installations, and all modifications every time they are modified by periodical reviews, according to the interior "Gas Set-Up and Inspection Certification Process" established by the Superintendencia. Once the statement is submitted to the Superintendencia, GCM must maintain GLP cylinders in good condition including meters and service regulators.	1 month	30 days
Authorization for the final disposal of non-hazardous industrial wastes, outside GCM lands.	Sectorial Permit	Seremi Salud Region II	Supreme Decree 594/2000, Art 19	To be requested	1 month	45 days

2) **Subsoil.** According to the Unified System of Classification of Soils (USCS) soils in the project area are classified as SM, sand with high proportions of fine materials (clays or silts) but with non-plastic characteristics and poor draining capacity. The soils in many project areas are composed of sediment of alluvial and wind-blown origin. Three horizons are differentiated:

   Unit U-1: 0.5 to 0.7 m thick, silty type sands, loose compaction, low moisture, and fines with medium to low plasticity. Gravel is maximum size 2". Abundant quantities of salts are present.

   Unit U-2: 1.9 and 2.5 m thick, this unit is a sandy-silty fine gravel, with medium to high compaction, low moisture, and fines with medium to low plasticity. Gravel is maximum size 5", generally less than 1". The unit shows moderate cementation by salts which are high in local form.

   Unit U-3: Caliche of undetermined thickness.

   No phreatic level was detected in the excavations performed.

3) **Geology and geomorphology**. Includes risk of mass movement, volcanic action, geomorphology, and seismic risks related to geological structures and surface conditions.

   The area of study is located entirely within the hydrographic basin of the Taltal Quebrada (ravine) where rocky formations are mainly Mesozoic and practically impermeable, so that where these outcrop (outcrops or isolated hills) they constitute effective barriers to run-off of waters, both surface and underground.

   Geologically the area is controlled by parallel, small faults systems with a north–south longitudinal axis; one is the Catalina fault which is close to the project facilities.

   In addition to the structural control by the fault systems the project area is geologically characterized by being implanted over rock of andesitic origin directly related to the Domeyko and Central Cordilleras which appear in this area of the Antofagasta Region (the Catalina and Julia mountain ranges).

   The material of the surface decomposed rock (soil) below the alluvial beds is of Miocene origin and was generated by early metamorphic phenomena that ground the tops of the rock masses that are now underground. The Cenozoic layers are of tertiary to quaternary origin, and always show a strong predominance of volcanic materials from the origin in the Andes Cordillera and the plateau. In general, compaction is present with some consolidation, so that permeabilities are commonly low, this is especially true for tertiary deposits that have a high degree of lithification and often appear as very compact and with characteristics of solid rock.

The risk of mass movement is controlled by the fact that the area is a deposit of ancient mega-alluvium that forms the upper layer of the surface. Alluvium in this area of the Antofagasta Region is directly related with the rainfall (typically in the months of December to February) due to the phenomenon known as of the high plateau winter. This can generate significant water flows with capacity to undercut when the rainfall intensity exceeds 8 mm/hour and extend for more than 2 uninterrupted hours. With this scenario, the greatest alluvium flows could be greater than 1 $m^3/sec/km^2$/drainage.

Therefore, the mass movement risk in the area of study is medium to low, and can be mitigated with civil works such as diversion channels, canalization, and drainage ditches for rain water. Thus will prevent the occurrence of washouts and will facilitate the flow of rain water in surface run-offs.

There is no volcanic risk at the local regional scale.

The geo-morphological risk includes settlements, uplifting, sinking, and similar movements. The soil composition and surface rocks do not indicate any specific geo-morphological characteristics that would be susceptible to these problems.

The area is in Seismic Zone 3, according to the Chilean Regulation (NCh) 433/1993. The structure consists of longitudinal, north-south geological faults which approximately follow the line of the Domeyko Cordillera. In these areas the seismic acceleration estimated is associated with 30% importance, which is a medium-high seismic risk.

4) **Hydrogeology and hydrology (Underground and surface water flows)**

The main underground aquifer that drains to the Guanaco mine has a minimum area of about 90 km^2, with a principal discharge or geo-channel with an average upper width of 4 km and a saturated level to 60 m deduced from interpretation of the stratigraphic profiles of the pits to the north of Quebrada Varitas. Pumping tests performed in Pampa Yerbas Buenas indicated transmissibility between 50 m^3/day/m and 100 m^3/day/m.

The Guanaco mine aquifer is delimited by four corners, the UTM coordinates (from IGM mapping) and elevations are indicated in Table 10.4-2.

Table 10.4-2: Guanaco Mine Aquifer Location

Corner Location	UTM Coordinates (m)		Elevation (masl)
	North	East	
1	7.230.500	480.000	3,120
2	7.229.500	550.000	2,945
3	7.160.000	620.000	3,280
4	7.180.000	490.000	2,912

Soils in the project area have medium to zero surface permeability (soils with silty sands) which implies that the risk of contamination of the aquifer related to the permeability is medium-low and almost zero if measures such as the placement of geo-membranes are implemented to reduce infiltration.

The area is entirely within the Quebrada Taltal hydrographic basin. This extends over an area of 4,992 km^2 and has potential recharge above the 3,000 masl elevation from rain and snow, especially during the high plateau winter.

In the areas where the waste dumps and heap leach pad will be located there are no permanent surface runoffs that could be affected these installations. The main hydrological risk is the alluvium phenomena that could occur during periods of intense rain. These rainfalls can cause medium to large alluvial flows that can undercut the surface and cut interior roads. However, this risk can be minimized by the installation of protection in critical areas for roads, platforms, and buildings.

There are no centres of population near the project area.

- Sectorial Environmental Authorization for Temporary Storage of Hazardous Wastes (Article 93 SEIA Regulation).

Articles 79 and 80 of D.F.L. 725/7, Sanitary Code cover the authorization for construction, modifications, or enlargement of any waste and garbage treatment plant of any kind, or for the installation of any place for the accumulation, selection, industrialization, commerce, or final disposition of waste and garbage of any kind.

The information presented for this sectorial environmental authorization for the temporary storage yard for hazardous waste is presented below.

a) Temporary Waste Storage

Table 10.4-3 shows the types and quantities of hazardous waste that the project will produce.

Table 10.4-3: Hazardous Waste Classification

Waste	Quantity	Classification (DS 148/03)
Process reagent packaging	1,500 kg/month	A3020: Chronically Toxic
Vehicle batteries	3 per month	A1170: Corrosive
Glass and other laboratory material	2,500 kg/month	A3020: Chronically Toxic
Cyanide packaging	50 boxes/month	A3020: Chronically Toxic
Oil filter, rags, and other materials with minor amounts of oils and greases	200 kg/month	A3020: Chronically Toxic
Waste oil	5 m^3/month	A3020: Chronically Toxic
Other waste such as oil filters, hoses, containers with oil and grease, paint containers, contaminated PPE	500 kg/month	A3020: Chronically Toxic

b) Work

The temporary storage yard for hazardous wastes must comply with Title IV of the Sanitary Regulation for Hazardous Waste Management. The yard must have a continuous, waterproof, structural base that is chemically resistant to the wastes; there must be a perimeter fence at least 1.80 m high so that people and animals cannot freely access the yard; and the area must be roofed and protected from moisture, temperature variations, and solar radiation. Volatilization, entrainment, leaching, and in general any other environmental contamination mechanism must be minimized so that there are no effects on the population. There must be run-off and leakage retention with capacity not less than the volume of largest container stored. There must be signs that comply with Chilean Standard NCh 2.190 Of. 3.

c) Control and management of particulate material, gaseous, smells, noises, and liquid emissions.

The temporary storage must not permit the generation of particulate material, gaseous emissions, emission of particles different from those modeled for the access and internal roads, or smells, noises, or other effects.

d) Risk Prevention and Accident Control

The risk prevention and accident control plan for the storage yard must be concordant with those prepared by the project operations. These plans must accompany the request for the sectorial permit.

e) Storage alternatives

Waste will preferably be stored in 200 L capacity drums or 1 m^3 isotainers, properly sealed, labelled, and stored. The drums and isotainers must be in good condition, leak proof, resistant to the material stored, and allow appropriate management of the waste. Large volumes of waste that cannot be handled in drums will be stored in bulk in separate bermed areas.

- Sectorial Environmental Authorization - Change of Land Use (Article 94 SEIA Regulation). Qualification of the industrial facilities or warehouse referred to in Article 4.14.2, Supreme Decree 47/92, Ministry of Housing and Urbanisation, General Ordinance of Urbanisation and Constructions.

The following information was presented for this sectorial environmental authorization.

a) Technical Report of Construction and Enlargement Characteristics

During the construction stage the main activities will be the reconditioning of the existing equipment and infrastructure. This will leave all equipment operating mechanically and electrically, and the infrastructure will be ready for the operation, with safety standards that meet the regulations.

The agitation leach plant will also be built. This installation will be on land adjacent to the existing facilities and will include foundations and the erection of structures and equipment. The leach plant will have a conventional grinding circuit; an agitation leach circuit; a CCD washing circuit; a tailings thickener; a tailings filtering system, and an emergency pond.

Construction materials will be transported mainly from Antofagasta. Structural steel will be fabricated in a workshop and field assembled. New and existing installations will have impermeable secondary containment so that any spillage can be collected and returned to the process by sump pumps.

b) Production Process and Flow Diagrams

The production processes to be used at the Guanaco Mine Reopening Project include:

- Ore from open pit and underground mining
- Crushing
- Heap leaching of material from the existing heaps (after crushing) and from low grade fresh ore
- Agitation leaching of high grade fresh ore
- Gold recovery from pregnant solutions.

- Electro-winning and doré smelting
- Disposition of dry tailings.

The processes are described in Section 6.

c) Preliminary Plan for Control of Biological, Physical, and Chemical Contamination

The project will have a sewage treatment system consisting of an aerobic process sedimentation pond, sludge accumulator and stabilization pond which has operated previously without difficulties. Residual water and sludge will be removed from the site by authorized companies.

It is not expected that any liquid industrial wastes will be generated. All spillage will be contained in the existing or new secondary containment and returned to the process by sump pumps. Hazardous reagents will be stored close to the point of consumption. Reagents will be stored separately in enclosed, ventilated areas with suitable floors that will allow the recovery of any spillage of solid reagents. Liquid reagents will be stored in areas with secondary containment that will permit their recovery without contamination so that the reagent can be returned to the process.

Domestic and industrial wastes, hazardous and non-hazardous, will be handled in the existing authorized infrastructure. A temporary hazardous solid waste storage yard will be built for operations designed to comply with the current regulation. Authorizations will be requested as established in the DIA.

Although it has been shown by means of modelling that the levels of particulate material will be below the regulated levels in the camp area, it is expected that roads will be watered to reduce dust emission.

It is expected that sound pressure levels in the camp area will be below the regulated values.

The new heap leach and the dry tailings deposit have been designed to operate without producing physical and chemical contamination.

d) Qualitative and Quantitative Characterization of Hazardous Substances

Table 10.4-4 lists the estimated reagent consumptions, their classification according Chilean Regulation 382, estimated consumption, physical state, and container/packing. The packing/containers are based on current data, the actual packaging will depend on the selected supplier.

Table 10.4-4: Estimated Reagent Consumptions

Reagent	Class	Expected Consumption (per month)	Physical State	Container/Packing
Explosives	1.1D	15 units	Solid and liquid of high density	Units inside boxes
Blasting agents	1.5D	80 units	Solid	Polypropylene sacks
Liquefied Petroleum Gas (LPG)	2.1	40 m^3	Gas	Bulk in tanks authorized by SEC
Diesel	3	350 a 400 m^3	Liquid	Bulk in tanks authorized by SEC
Gasoline	3	100 m^3	Liquid	Bulk in tanks authorized by SEC
Zinc Powder	4.3	5 to 8 t	Solid (powder)	Metallic drums 50 to 100 kg
Lead Nitrate	5.1	4 to 5 t	Solid (crystals)	Propylene sacks (25 kg)
Sodium Cyanide	6.1	45 to 50 t	Solid (briquettes)	1 t polypropylene maxi-sacks
Litharge	6.1	0.3	Solid (powder)	50 kg metallic drums
Hydrochloric Acid	8	1 t	Liquid	Polyethylene isotainer 1 m^3 or leak-tight plastic drums
Caustic Soda	8	2 t	Solid (flakes)	25 kg polypropylene sacks
Sodium Hypochlorite	8	0.5 to 1.0 t	Liquid	Polyethylene isotainer 1 m^3 or leak-tight plastic drums
Lime	8	90 a 100 t	Solid (fine granulated)	Granulated bulk, lime silo.

e) Control of Risks to the Community

The project area is 220 km south-east of Antofagasta and 42 km north-east of Taltal, therefore, there is no risk for the community.

- Sectorial Environmental Authorization - Change of Land Use (Article 96 SEIA Regulation). Authorization to subdivide and urbanize rural lands to complement any industrial activity with housing, provide equipment to a rural area, or set up a bathing place or tourist camp; installing industrial construction, equipment, tourism, or housing outside urban limits, referred to in Clause 3rd and 4th, Article 55 of D.F.L.458/75, Ministry of Housing and Urbanisation.

Information presented for this sectorial environmental authorization is described below.

a) Loss and Degradation of the Natural Land Resource

The project is in an area characterized by aridity and definitely impacted by human action particularly related to mining activities from small mining activities to significant size mineral processing plants. The soils in the area presents high drainage capacities on the surface which results in zero agricultural capacity, there is also scarce to zero presence of vegetation.

The project is designed to minimize interior roads using only those necessary for the movement of material and personnel, to reusing to the maximum extent possible the existing infrastructure and only intervene in those areas strictly necessary for the project development. In this way it is estimated there will no significant further alteration of the features in the area.

b) No New Urban Center will be Created

The project will not generate any new urban centers. The project will use the existing Guanaco camp only for GCM and contractor personnel working on site. Once these facilities are no longer required they will be dismantled and closed.

c) Land Use Changes Granted

Exempt Resolution 02, dated February 04, 2000, Seremi of Agriculture for the Antofagasta Region authorized the change of use of 300 hectares of land with the coordinates of the corners as shown in Table 10.4-5.

Table 10.4-5: Land Use Change Area Coordinates

UTM Coordinates (m)		
Corner	**East**	**North**
B1	445150	7224500
B2	446750	7224500
B3	446750	7222500
B4	445150	7225000

Exempt Resolution 003, dated March 20, 2001, Seremi of Agriculture for the Antofagasta Region authorized the change of land use of 32.87 hectares for the construction of the camp. The coordinates of the corners of this area are shown in Table 10.4-6.

Table 10.4-6: Land Use Change Area Coordinates for the Camp

UTM Coordinates (m)		
Corner	**East**	**North**
A-1	447350	7223350
A-2	447472.5	7223384
A-3	446675	7223380
A-4	447830	7223130
A-5	447830	7222740
A-6	447750	7222650
A-7	447320	7222690

d) Areas for which a Change of land Use is Required, Declared in the Environmental Assessment

The areas for which land use change is required that have been declared in the environmental assessment are listed in Table 10.4-7 along with the surface area required. The coordinates for the corners of these areas are listed in Table 10.4-8 to 10.4-20.

Table 10.4-7: Areas Requiring Land Use

Name of Area	Use	Area of Land Use Change (m^2)
Cachinalito West	Portal	0.25
Cachinalito	Portal	0.25
Salvadora	Waste dump	7.85
Cachinalito	Waste dump	6.9
Tailings	Dry tailings deposit	34.94
Plant	Plant location	33.43
Dumbo	Mine development	13.85
Dumbo	Waste dump	11.17
Perseverancia	Mine development	4.6
Perseverancia	Waste dump	16.48
Administration	Administration area and camp	24.84
Heap	Phase I and II heap	35.38
Heap	Phase III heap	14.85
	Total	**204.79**

The land use changes granted in 2000 and 2001 were for a total of 332.87 hectares. Land use change for a further 204.79 hectares has been requested in the DIA, the areas for these land use change areas must be defined.

Table 10.4-8: Land Use Change Coordinates - Portal Cachinalito West

V	East	North
1	443595	7223750
2	443595	7223800
3	443645	7223800

Table 10.4-9: Land Use Change Coordinates - Portal Cachinalito

V	East	North
1	444505	7223720
2	444505	7223770
3	444505	7223770

Table 10.4-10: Land Use Change Coordinates - Salvadora Dump

V	East	North
1	443417.48	7224157.20
2	443698.69	7224208.56
3	443729.87	7224037.88
4	443718.57	7224005.68
5	443695.09	7224004.98
6	443695,09	7333912.31

Table 10.4-11: Land Use Change Coordinates - Cachinalito Dump

V	East	North
1	444485.05	7223683.88
2	444759.10	7223765.31
3	444827.85	7223533.92
4	444553.80	7223452.49

Table 10.4-12: Land Use Change Coordinates - Tailings Deposit

V	East	North
1	446029.00	7225069.00
2	446652.67	7225111.29
3	446701.66	7225697.76

Table 10.4-13: Land Use Change Coordinates - Process Plant

V	East	North
1	445753.27	7223591.91
2	446046.81	7223658.44
3	446046.81	7223753.85
4	445726.68	7223753.85
5	445726.68	7224070.11
6	446500.00	7224307.57
7	446500.00	7224100.31
8	446381.65	7224063.97
9	446381.65	7223906.6
10	446211.76	7223856.53
11	446211.76	7223593.28
12	445775.38	7223494.38

Table 10.4-14: Land Use Change Coordinates - Dumbo Mine Development

V	East	North
1	445328.18	7223210.85
2	445814.65	7223321.10
3	445753.27	7223591.91
4	445266.81	7223481.66

Table 10.4-15: Land Use Change Coordinates - Dumbo Dump

V	East	North
1	445547.43	7223074.27
2	445916.95	7223074.27
3	445916.95	7222771,82
4	445547.43	7222771,82

Table 10.4-16: Land Use Change Coordinates - Perseverancia Dump

V	East	North
1	446518.95	7223615.46
2	446934.76	7223615.46
3	446934.76	7223219,03
4	446518.95	7223219,03

Table 10.4-17: Land Use Change Coordinates - Development Perseverancia Mine

V	East	North
1	446339.73	7223141.75
2	446526.75	7223141.75
3	446526.75	7223113,60
4	446656.82	7223113,60
5	446656.82	7222985.09
6	446339.73	7222985.09

Table 10.4-18: Land Use Change Coordinates - Administration

V	East	North
1	447296.73	7223425.98
2	447741.02	7223425.98
3	447741.02	7223000,00
4	447500.00	7223000,00
5	447500.00	7222709.02
6	447296.73	7222709.02

Table 10.4-19: Land Use Change Coordinates – Heap Phases I and II

V	East	North
1	445159.06	7224707.97
2	446587.79	7224875.22
3	446748.94	7224312,76
4	446500.00	7224224,91
5	446500.00	7224307.57
6	445956.36	7224140.63
7	445868.69	7224432.35
8	446190.24	7224531.11
9	446222.06	7224542.77
10	445159.06	7224707.97

Table 10.4-20: Land Use Change Coordinates – Heap Phase III

V	East	North
1	445904.43	7224124.69
2	445726.74	7224722.05
3	446107.18	7224843.99
4	446222.06	7224542.77
5	446190.24	7224531.11
6	445868.69	7224432.35
7	445956.36	7224140.63

10.5 Environmental Management of the Project

10.5.1 Seepage, Run-off, and Leakage Control

The new and existing facilities will have impermeable secondary containment so that any type of spillage will be collected by sump pumps and returned to the process.

The ADR circuit will be installed in an area with concrete secondary containment that includes sump pumps to recover any cyanide solutions in case of spillage. Sump pumps in these areas have alternative connections that allow the material to be pumped to the head of the adsorption columns or to the waste solution sump. The acid wash circuit is in a separate secondary containment area for safety reasons.

The base of the new heap, the solution collection system, and the solution recovery system will be double lined. The upper liner will be a 1.5 mm thick HDPE geo-membrane and the lower liner will be a 1 mm thick HDPE geo-membrane. There will be a geonet between the geo-membranes to allow any solution to be collected if there is a leak in the upper liner. The underpad drainage and collection system will be designed to conduct any leakages into the recovery system.

Collection of heap solutions – There will be solution collection channels on both sides of the heap with 2 mm (80 mil) double HDPE liners above and below the main liner. There will be a leak detection system between the liners. The solution collection system will consist of a drain at the foot of the west slope of the new heap that will capture all the solutions from the underpad drainage system and conduct them to the solution recovery system. The collector drain is a ditch filled with clean gravel within has three 18” diameter Drenaflex type pipes.

Emergency pond – downstream of the plant an emergency pond will be installed that will have capacity for 110% of the total volume of the slurry and solution in the CCD circuit, (8000 m^3). This pond will be built with a soil base and will be lined with 1.5 mm thick HDPE.

Any process spillage will be confined in the secondary containment in the plant from which they will be pumped back to the process by sump pumps.

10.5.2 Management of Rain Water

A diversion ditch will be built east of the new heap which will start at the containment wall downstream of the future tailings deposit and will extend to the existing diversion ditches for the Phase I and II heaps.

A diversion ditch will be built to divert rain water around the waste dump area.

A berm will be built downstream of the tailings deposit to control any spillage due to erosion by rain.

10.5.3 Management of Hazardous Substances

Materials required for the plant operation will be stored in warehouses which will comply with hazardous substance storage standards. GCM will base the design on the design submitted that meets the regulations for Storage of Hazardous Chemical Substances. The material will in general be provided through agreements with the suppliers. The quantities stored in the warehouses will be sufficient to allow 3 months operation in the case of cyanide, lead nitrate, and zinc powder.

Materials considered hazardous substances will be transported to site using existing public roads Region II, especially through the cities of Mejillones and Antofagasta (port, industrial area, and La Negra) from the points of supply of the materials to Guanaco. In the urban areas transport during peak periods will be avoided i.e.: 1) Morning from 07:00 to 09:00 hours; 2) Midday from 12:00 to 14:00 hours; 3) Afternoon from 18:00 to 21:00 hours.

Urban roads used for the transport of hazardous substances must meet the following criteria: 1) Not have legal restrictions for transit. 2) Must be main service roads in condition for the permanent transit of freight trucks and with no restrictions. 3) Must be roads with priority at intersection, except where there are traffic lights. 4) Must be paved, two lane roads with lanes 3.5 m wide minimum, with a central division and pedestrian sidewalks away from the road. If possible, transit of trucks will be avoided through the following places: roads and intersections that have low levels of service; roads through densely populated areas, central areas, recreational areas; roads and intersections where any type of congestion exists; intersections with or without regulation that present deficiencies in the highway or pedestrian movement; intersections and railroad crossings with bad visibility.

Inter-urban roads for the transport of hazardous substances must meet the following criteria: 1) Roads with two or more lanes for one-way traffic such as highways and some primary roads. 2) Roads with more than two lanes that have two adjacent lanes for each transit direction. 3) Roads with two lanes and two-way transit. 4) Lanes must be in good condition with a minimum width of 3.5 m. 5) Berms must be in good condition and wider than 1.80 m. 6) Horizontal curves must have a minimum radius between 80 and 400 m, for operating velocities between 45 and 100 km/hour. 7) Visible road signs in good condition.

Cyanide management – Cyanide will be stored in labelled Maxisacs in a dry, well ventilated warehouse that will comply with the regulations for the storage of hazardous substances. The Maxisacs will be kept sealed and dry prior to use. The warehouse will be isolated and no other substances such as acids or acid salts, water containers, weak

alkali or oxidizing agents will be stored in the same building. Cyanide solutions will be prepared in a dedicated, isolated area, well ventilated and safe. Equipment used will guarantee a safe working environment and will not expose the plant operators to gaseous emissions during the cyanide solution preparation. The preparation area will have signs to identify it and to indicate that personal protection equipment (PPE) must be used in the area.

10.5.4 Waste

Liquid Waste

Waste water from bathrooms, showers, washbasins, and the mess hall/kitchen will be collected and treated in an aerobic sewage treatment system consisting of sedimentation ponds and stabilization ponds to treat a 36 m^3/day flow authorized by Exempt Resolution 972, March 12, 1996, Antofagasta Health Service. Based on a daily average sewage generation of 100 L/inhabitant/day and a staff during construction of 340 and during operation of 200, the volume of sewage will be approximately 34 m^3/day and 20 $m^{3/}$/day, respectively.

Sewage generated by the use of chemical toilets in the work areas will be removed by a contractor specializing in the supply, cleaning, and maintenance of chemical toilets.

Solid Waste

As far as possible, GCM will have contracts with the suppliers of the main raw materials that have clauses for the suppliers to remove the wastes produced by these materials on time and according to the regulations.

Domestic waste and industrial waste classified as domestic waste will be disposed of in the Guanaco sanitary landfill site which is authorized. This landfill site is operated by means of trenches which are covered on a daily basis.

Non-hazardous industrial wastes will be stored temporarily in the salvage yard. These wastes such as scrap metals, tires, rubber, and old spare parts will be recycled as far as possible by authorized third parties. Authorization will be requested from the authorities for removal of these materials from the site by certified transport companies.

Explosives waste will be handled as required by the Complementary Regulation of Law 17.798 for control of guns and explosive materials.

Hazardous industrial waste will be stored in Guanaco's temporary hazardous waste storage yard that will be built to comply with the provisions of Supreme Decree 18/2003, Sanitary Regulation for Hazardous Waste Management. As far as possible GCM will establish clauses in the supply contracts for the suppliers to remove wastes derived from these materials on time and according to the regulations.

10.5.5 Fire Water System

A fire water distribution system will cover all the production areas, the power house, laboratories, camp, workshops, warehouses, and offices. This network will include fire pumps with automatic start, a 400 m^3 tank, and elements to fight fires.

10.5.6 Control of Atmospheric Emissions

Particulate emission control will include the following:

- Covers for conveyors in crushing plant.
- In the crushing circuit a system of water sprinklers will reduce dust generation. Sprinklers will be installed at all ore transfer points including the main feed hopper, primary crusher, conveyor transfer chutes, screen feed chutes, screen discharge, and crusher discharge.
- The additive used in the water for dust control in the primary crushing plant will be DUSTFOA™ from NALCO (or similar) that does not have any ingredients that will damage the environment.
- Roads will be watered as required to reduce dust and a record will be kept.
- Speed limits will be used to limit dust emissions as a mitigation measure.
- GCM will comply with Chilean Standard 1.333, Requirements for Water Quality for Different Uses as applicable to water used on roads.

10.5.7 Road Maintenance

GCM will sign an agreement with the Ministry of Public Works (MOP) for the regular maintenance (construction and operation) of the access road to the project area from Route 5.

10.5.8 Protection of Water Fowl

Tanks and thickeners in the plant will be provided with electronic devices that emit sounds to repel birds so that they will not gather in these areas.

10.5.9 Mitigation Measures for the Catchment of Water in the Watersheds.

Watering places will be installed so that fauna can easily access existing water. This will depend on the information collected in the baseline monitoring campaigns and, if necessary, the nature and position of these watering places will be agreed with the Regional Direction of Agricultural and Cattle Service for the Antofagasta Region, and the definitive locations will be notified to the Antofagasta Region Corema.

Modify the existing catchment system downstream of the present positions (without modifying the final catchment).

Inform to the Regional Direction of the Agricultural and Cattle Service for the Antofagasta Region of the monitoring campaigns, so that they can participate in these visits if they wish.

10.5.10 Monitoring

Phase III Heap Monitoring

To evaluate the quality of underground water at least two monitoring wells will be installed downstream of the new heap. The proposed monitoring well locations are shown in Table 10.5-1.

Table 10.5-1: Proposed Monitoring Well Locations

Wells	UTM Coordinates	
	North (m)	East (m)
PMLX1	7.224.950	446.030
PMLX2	7.224.880	446.290

Each well will be at least 30 m deep which corresponds to the sediment thickness. If the sediments are thicker the wells will be drilled as far as the fresh rock (not weathered rock).

During detail engineering GCM will perform a hydro-geologic characterization of the area which will include the heap leach and the area downstream of it. This study will include a geological-geotechnical assessment to determine the geological features of the surface; the excavation of test pits to establish the average depth of the sedimentary contact with the base rock; drilling and permeability tests (to support the number and location of the monitoring wells).

If the hydro-geologic study shows that it is necessary to relocate the wells in order to meet the monitoring requirements for potential seepage, this will be reported to the authorities with the justification for the new locations.

A report with the results of the hydro-geological characterization and confirmation of the monitoring well locations will be delivered to the authorities when the study is finished prior to construction.

Dry Tailings Deposit Monitoring

Daily sampling of the deposited tailings (operational control). The parcels of deposited material will be sampled daily to check cyanide degradation. When concentrations of less than 2 ppm are confirmed a new layer of fresh tailings deposition will be started. The deposit will therefore be subdivided into 25 to 30 parcels of material that will always allow fresh tailings to be deposited on top of material with cyanide below 2 ppm. Each time a thickness of approximately 0.5 m is achieved the area will be compacted to stabilize the deposit. When the deposit reaches 10 m new deposition will start 5 m in from the edge of the last layer producing a stepped pyramid that will provide more stability.

Monthly monitoring of tailings deposit. Monitoring of the tailings deposit will be performed once per month by third parties, to confirm the cyanide and heavy metals content, the grain size of the material, permeability, moisture, density, and compaction. This monitoring will be carried out at six different points of the dry tailings deposit in parcels where cyanide degradation is in process. This will confirm that the deposit is being managed correctly, that the parameters are within the range of design values, and that the conditions established for physical-chemical stability and approved by the authority are being achieved. A detailed procedure for this monitoring will be presented to the authorities before start up of the project.

Monitoring wells for the tailings deposit. GCM has committed to install monitoring wells WE-36, WE-35 and WE-37 with a quarterly sampling frequency for quality control. Parameters to be measure are: Total Cyanide; metals (As, Cd, Cu, Pb, Zn, Fe, and Mn); pH, physical characteristics and conductivity; salts (Cl^-, SO_4^{2-}, NO_3^-, and HCO_3^-) and cations (Ca, Mg, Na, and K).

Monitoring of Biotic Environment

GCM will monitor the biotic system associated with the watersheds once per year (in March) from 2010 through project construction and during operations.

The plan for monitoring the flora and vegetation will include:

- Coverage (surface covered by vegetal formations)
- Specific richness
- Origin, endemism, biological type, state of conservation
- Height of vegetation
- Phenology.

The plan for monitoring the fauna will include:

- Richness
- Abundance
- Origin, endemism, state of conservation
- State of development (youth or adult)
- Indicators of reproduction events (offspring, nests).

Monitoring of flora, vegetation, and fauna will be performed in the following places:

- Upstream of the catchment point
- In the vicinity of the catchment point
- Downstream of the catchment point (50 m, 100 m, 150 m, 200 m, and 500 m).

In the first monitoring campaign a geo-referenced survey of vegetation present in each of the ravine established floristic richness, vegetational coverage by species, total coverage and surface of each vegetation type.

If activities are carried out on the water sources close to the pre-Hispanic and historical sites the recommendations included in Appendix D will be followed.

If ruins, deposits, pieces or objects of historic, anthropologic, archaeological or paleontological interest are found during project activities the requirements of Law 17.288, National Monuments will be complied with and the authorities will be informed.

10.6 General Considerations of the Project Closure

Closure activities will take place take place where possible during the life of the project and mainly at the end of the project life. The goal is to control and/or mitigate any situations that could lead to unexpected impacts after operations and to assure the long term physical and chemical stability of all project works, providing safe environmental conditions in the long term.

a) Process Equipment and Ancillary Installations

All process equipment will be removed (crusher, conveyors, process piping, electrical cables, process tanks, etc.) provided that these are not required for subsequent activities or projects. Architectural structures and elements will be removed from the buildings and ancillary facilities if these could create danger for people. The project area will be cleared

of scrap metal and debris. Areas where buildings, process ponds, and similar facilities used to stand will be returned to conditions similar to those prior to the intervention.

Warning signs will be installed round the project area.

b) Waste Dumps, Open Pits, and Underground Mine.

Surface waters originating at higher elevations will not be allowed to enter the waste dumps. The closure conditions for the tailings deposit, open pits, and underground mine will be the following:

- Final configuration will be that at the last year of exploitation.
- GCM will analyze the final safety of the waste dumps, open pits, and underground mine and will adopt the technical measures to provide long term stability for the safety berms in the pits, sealing all entrance to the underground works (pits, tunnels, shafts).
- GCM will install warning signs to prevent accidental entry to the waste dumps, open pits, and underground mine.

c) Heap Leach

In general terms the closure of the heap leach considers:

- Stopping the application of solution
- Washing of the heap with re-circulated residual leach solution to which fresh water is added. The goal is to destroy any residual cyanide by aeration and exposure to ultraviolet radiation.
- Removal of pumps and piping external to the heap and cleaning of the area.

d) Dry Tailings Deposit

The dry tailings deposit is in a flat area and will be designed with methods to control surface waters from higher elevations and prevent them from entering the deposit. The slopes and surface will be protected by placing a layer of coarse material or other material that will stop the emission of particulate material. Prior to this the slopes will be reshaped and flattened to a single, gentle slope that will prevent minor sloughing or slippage and facilitate the placement of the protective layer. Warning signs will be placed to identify the tailings deposit area.