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1.0
INTRODUCTION

1.1 GENERAL CONSIDERATIONS

Perú LNG S.R.L. (PLNG) is a company established in Peru, having as shareholders Hunt Oil Company from the U.S. and SK Corporation from South Korea. The company aims at building and operating a Natural Gas Liquefaction Plant and a port in the province of Cañete shore. The liquefied natural gas shall be exported from this port to the international markets in ships specifically designed to that effect.

To safely operate the port facility, building a wave breaker to protect the ships from the constant and strong waves in the area is needed. This wave breaker shall be built with rocky material extracted from a nearby quarry, located East the Plant, hereinafter called GNL-2 Quarry.

In order to extract said material, PERU LNG has prepared this Environmental and Social Impact Assessment (ESIA) for the GNL-2 Quarry Development Project, located in the Province of Cañete, Department of Lima. This assessment incorporates and complies with the national environmental laws, the international standards and PERU LNG's environmental policy.

This ESIA has been prepared by Walsh Perú S.A. Ingenieros y Científicos Consultores (Walsh), a company with the professional and technical capabilities to carry out the Environmental Management Programs and Assessments. Walsh is entered in the Authorized Consulting Companies Register, with the Ministry of Energy and Mines, to prepare EIAs, by virtue of Directorate Resolution Nr 051-2005-EM/DGAAM.

1.2 BACKGROUND

By Directorate Resolution 061-2004-MEM/AAE dated June 21, 2994, PERU LNG obtained the approval for the Environmental Impact Assessment to build and operate the Liquefied Natural Gas Export Project in Pampa Melchorita, Peru.

According to its environmental policy, PERU LNG commissioned Walsh to carry out the studies for setting out the environmental feasibility for the development of several alternatives of rock quarries.

The alternatives assessment aimed at determining the best option from the environmental and social perspectives.

As part of this study, four quarry areas or groups were assessed, called GNL Quarry and neighboring areas, Los Molinos Quarry, El Sol Quarry (Punta Olleros) and Quarries in the area of Jatun (Jatun, Huaya, Huaya II, Huarangal and Rinconada). The first one, with an area of 300 ha is relatively close to the plant, some 15 km straight, East-oriented, in the department of Lima. The second one, with 200 ha, is located around 150 km south-east the department of Ica. The third, also with 200 ha, is located over 200 km south the Liquefaction Plant, in the department of Ica; and the fourth with 1200 ha, located in the desert-like valley of Quebrada Río Seco and Pampa Guadalupe, department of Ica.

The result of this alternatives assessment was that the most environmentally and socially feasible quarry areas were those located in the GNL and Jatun areas.

1.3 ESIA OBJECTIVES

- To identify and assess the physical, biological and socioeconomic components in the Project area of influence.
- To identify and assess the impacts resulting from rocky material extraction and transportation activities in the GNL-2 quarry.
- To create the most suitable preventive, corrective and/or mitigation measures for the Project works predicted.
- To comply with the Peruvian Government environmental requirements, mainly with the standards set out in the Environmental Protection Rules for the Mining and Metallurgic Activity (Supreme Decree 016-93-EM), the Environmental Protection Rules for Hydrocarbon related Activities (Supreme Decree 046-93-EM), the Environmental Management Guidelines for Non-Metallic Mining, the Environmental Guidelines from the Ministry of Energy and Mines for the Preparation of Environmental Impact Assessments and the Community Relations Guidelines.
- To comply with the international financing entities requirements, such as the World Bank.
- To get the competent authorities approval for the quarry environmental, social and cultural plans, obtaining the required permits from the Ministry of Energy and Mines (MEM) and their approval.

1.4 ESIA LEVEL AND SCOPE

The Environmental and Social Impact Assessment was prepared according to the Ministry of Energy and Mines (MEM) requirements, to which effect the rules and guidelines as made official by said entity were considered. This Ministry is the competent environmental authority for the activity under analysis, in the application of Article 50 of the Legal Framework for the Private Investment Development (Legislative Decree Nr. 757).

The ESIA scope covers the assessment of the following components:

- Quarry development, operation and closure.
- Access road construction and/or development from the Panamerican Highway to the quarry.
- Rock material land transportation from the quarry to the Southern Panamerican Highway.

This study excludes the construction and operation activities in the Panamerican Highway by-pass (super spam), the access road there from to the shore and the rock sea transportation to the wave breaker. These components are included in the Liquefaction Natural Gas Export Project EIA in Pampa Melchorita, Peru.

According to the legal rules in force, the different stakeholders (including local people and NGOs), the Regional Governments and the pertinent Municipalities shall be considered in the Public Hearing processes.

1.5 ASSESSMENT METHODOLOGY

1.5.1 TERMS OF REFERENCE

The Ministry of Energy and Mines (MEM) is the competent authority in the mining-metallurgic activities and is legally empowered to grant mining lease title deeds (through the National Institute of Mining Leases and Properties –INACC-), to approve EIAs (through the General Directorate of Mining Environmental Affairs –DGAAM), to inspect the compliance of the sector rules and other related matters.

The ESIA was prepared according to provisions of the Environmental and Natural Resources Code (Legislative Decree Nr 613, dated 09-08-90), stating that "the environmental impact assessments shall contain a description of the proposed activity and the predictable direct or indirect effects resulting from this activity in the physical and social environments, in the short and long term; as well as a technical assessment of them (Art. 9). Also, the assessments shall contain the necessary measures to avoid or reduce damages to tolerable levels and shall include an executive summary of the assessment for publication purposes".

In order to establish the ESIA contents, the items specified in the technical criteria set forth in the "Environmental Impact Assessment Guidelines for the Mining Metallurgic Activities" from the Ministry of Energy and Mines have been considered, as well as the provisions of the "Rules for Environmental Protection in the Mining Metallurgic Activities", the "Rules for Environmental Protection for the Hydrocarbons related Activities" and the Guidelines to Prepare the Environmental Impact Assessments in the Mining Sub-sector.

To develop the social topics, Ministerial Resolution Nr 596-2002-EM/DM (12-20-2002) provisions were applied, whereby the Rules for Community Involvement and Public

Consultation were approved in the Approval Procedure of the Environmental Assessments submitted to the DGAA.

To prepare the ESIA, international guidelines such as those established by the World Bank Group in the Pollution Prevention and Abatement Handbook, as well as their Safekeeping Operational Policies have been used as framework. Among the referenced guidelines and standards used, the air quality environmental standards and the environmental noise standards are considered as established in the Pollution Prevention and Abatement Handbook, July 1998, which are more demanding that the Peruvian standards.

Also, the "Environmental Program" created by the United States Export-Import Bank (US EXIM BANK) was considered, which aims at maintaining competitiveness in the global market, guaranteeing simultaneously that the projects it supports are environmentally liable. To this effect, said entity established procedures and guidelines setting forth the qualitative and quantitative limits for elements such as air and water quality.

1.5.2 ASSESSMENT STAGES

The ESIA planning process was arranged in three stages: desk work draft study stage, field stage and desk work final study stage. In the first stage, the ESIA terms of reference and contents were defined, the basic engineering studies supplied by PERU LNG were reviewed and the elements and components to be assessed on site were also defined. Also, mapping documents and satellite imagery of the area were analyzed. With this preliminary information, the site work plan was prepared, considering the physical, biological and socio-economical characteristics of the Project area of influence.

The field stage included noise and air quality measurements, as well as soils, biologic, geologic sampling, among others. Information from primary and secondary source was recovered and preliminary mapping was reviewed.

In the final desk work study stage, samples were analyzed in the laboratory, thematic maps were prepared and sections corresponding to the ESIA contents were developed. The main sections characteristics are described as follows.

1.5.2.1 Determination of the Area of Influence

The mining lease, called GNL-2 Quarry, comprises a total surface of 500 ha, having as access point kilometer 168 boundary of the Southern Panamerican Highway. To develop the quarry, an access road construction to the East of around 21 km. long shall be needed.

Considering the assessment components and their geographic location characteristics, the assessment defined direct and indirect areas of influence. Also, two particular assessment areas within the direct area of influence were considered. These refer to the quarry development area and the access road from the Southern Panamerican Highway.

The quarry direct area of influence exhibits environmental effects related to its extension. Its direct area of study was defined in a radius of 2 km as maximum distance to natural limits (water divides and creek beds). The thematic mapping shall be shown at a scale of 1:25 000; its approximate surface is 8 996 ha. The access road exhibits characteristics of a linear project. Therefore, its analysis shall be carried out over a corridor made of 1,5 km to both sides the road axis. Thematic mapping shall be shown at a scale of 1:25 000.

The study indirect area of influence includes a geographic extension between the Concón and Topará valleys; its approximate surface is 39 551 ha.

As for the social component, the Project direct and indirect area of influence is detailed in the Social Base Line section.

1.5.2.2 Activities Performed

The activities to develop this ESIA comprised the following stages:

Stage 1: Documents Review and Field Work

PERU LNG submitted Walsh the necessary information to determine the Project characteristics, which, in turn, made easier identifying the environmental considerations likely to create impacts during its development. Based on the analysis of the information supplied, a field work was carried out allowing the development of the environmental assessment with a previous land survey. Also, the physical, biological, social and archaeological environmental elements of the area of influence were assessed.

Stage 2: Environmental Analysis

Once the Project activities and the environmental elements likely to be affected were defined, the Project environmental issues were identified. This preliminary identification allowed, in turn, defining the Project potential impacts, according to their compliance level with the environmental standards provided for in the environmental legislation.

For assessment purposes, the Project elements (components or processes) potentially creating favorable or adverse environmental impacts have been considered as an environmental concern[1]. Thus, it could be stated that environmental impact refers to the environment alteration as a result of the environmental concern. The environmental effect[2] is any modification in the environment resulting from human works, while the impact is the meaningful environmental alteration, determined based on the environmental quality standards compliance.

For the environmental analysis, check lists and interaction networks were used. The environmental impacts qualification required the use of matrixes for cause-effect, favorable importance indexes (positive effects) and adverse importance indexes (negative effects). Also, it required an estimation of the effects likely to occur. The corresponding chapter extends the criteria used for the impacts qualification.

[1] *INDECOPI (PERÚ). 1998. Sistemas de Gestión Ambiental. Directrices Generales sobre Principios, Sistemas y Técnicas de Apoyo. NTP-ISO 14004. Lima, INDECOPI; p.12.*
[2] *ESCA. OACA. s.f. Guía para la Elaboración de Estudios de Impacto Ambiental. Lima, Esc. Sup. Cienc Amb. p.10.*

Stage 3: Final Report

The ESIA Final Report was carried out based on the review of all existing documentation and the on-site visit. This document is the Final Report containing 11 chapters. The contents of each chapter are detailed as follows.

1.6 ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT CONTENTS

This ESIA is supported by environmental and social base line studies performed between September 2004 and February 2005, and a detailed public consultation process carried out between November 2004 and April 2005. Also, a timely consultation process with the different and competent State organizations related to environmental and cultural affairs, including the Ministry of Energy and Mines (MEM), the Ministry of Transportation and Communications (MTC), the National Institute of Culture (INC) among others, allowed this study to include the above institutions' concerns and points of view.

The ESIA contents have been arranged in eleven (11) chapters. Following is a summary of their contents.

Chapter 1.0 Introduction

This chapter contains a description of the ESIA general considerations, the environmental assessment terms of reference and methodologies, the study objectives, and the ESIA scope and contents.

Chapter 2.0 Legal Framework

This chapter contains the legal framework description applicable to the Project. It analyzes and describes the general legal framework, the environmental protection rules, the allowable limits and standards, and the verification and control regulations. It also contains a legal regulations summary.

Chapter 3.0 Alternatives Assessment

This chapter contains the environmental, social and cultural assessment and comparison of the different quarries options selected for the rocky material development to construct the wave breaker in the Liquefaction Plant. The analysis has an exploratory level and impacts quantitative matrixes were used for its preparation.

Chapter 4.0 Project Description

A detailed Project description is an essential part of the ESIA. Predicted activities during the development and transportation processes of rocks in the quarry have been duly described and explained including the following:

- Mining plan for the rock development process

- Access road construction and/or preparation
- Rock material load and transportation

Chapter 5.0 Environmental and Social Base Line

This chapter contains the physical, biological, socioeconomic and archaeological environmental assessments carried out in the Project area of influence. This assessment was prepared taking into consideration the MEM's Environmental Impact Assessment Guidelines for the Mining Sub-sector. Also, the environmental and social base line descriptions contain a set of thematic maps.

On the other hand, considering the area of influence characteristics, two seasons of the year were analyzed: Summer or dry season and winter or wet season. This due to the fact that during the wet season plant formations ("hills") appear, which are typical in the Peruvian southern and central coast.

For the environmental components description, a field work in the quarry and surrounding areas, and the access road was performed. The social analysis comprised consultation and information workshops, mainly in the districts of San Vicente de Cañete and Grocio Prado, in the provinces of Cañete and Chincha, in the departments of Lima and Ica, respectively. These workshops allowed obtaining data of the people perception regarding the Project.

The information obtained during the field work was completed with the information obtained from State entities centralized in Lima, such as: the National Institute of Natural Resources – INRENA-, the National Institute of Statistics and Data Processing – INEI-, the Institute for Mining, Geology and Metallurgy – INGEMMET- and the National Service of Meteorology and Hydrology – SENAMHI-, among others.

Chapter 6.0 Environmental and Social Impacts Assessment

This chapter identifies, assesses and analyzes the environmental and social impacts likely to result from the Project execution during its construction, operation and closure stages.

The method for identifying the environmental impacts comprised the concern-impact check lists, the interaction matrixes and use of thematic maps techniques, taking into consideration the Environmental Impact Assessments Guidelines from the General Directorate of Environmental Affairs (DGAA) dependent on the Ministry of Energy and Mines (MEM).

Chapter 7.0 Environmental Management Plan

The Environmental Management Plan (EMP) contains the environmental policies and guidelines under which the Project shall be executed. The EMP complies with the requirements contained in the Ministry of Energy and Mines (MEM) and the international entities' regulations.

To structure the EMP guidelines were used to prepare environmental planning plans and environmental quality assurance systems. For each meaningful item creating an environmental impact, measures to prevent, correct or mitigate were determined. These measures are grouped by activity or program lines. The activity lines are the elements to materialize the management plan objectives. This plan contains an environmental mitigation and control program, a waste management program, a monitoring program and a health and safety program.

Chapter 8.0 Social Affairs Management Plan

This Plan contains the measures to be implemented in the different construction or operation Project stages with the aim to maximize the positive effects and impacts and reduce and control aspects likely to be adverse.

Chapter 9.0 Contingency Plan

This Plan contains the response strategy for each type of accidents and/or emergencies likely to occur during the quarry and its access road construction and operation stages. It contains the response team responsibilities and arrangement, as well as the contact list.

Chapter 10.0 Abandonment and Closure Plan

This chapter describes the procedures and actions to take once the Project execution is concluded. The operation stage will comprise the infrastructure final abandonment once its useful life is over.

Chapter 11 Community Relations Plan

This Plan outlines and implements PERU LNG corporation responsibility policy framework and it defines the responsibilities to execute preventive measures and Project-related social aspects handling.

2.0
LEGAL FRAMEWORK

2.1 INTRODUCTION

This Environmental and Social Impact Assessment (ESIA), drawn up for the GNL-2 development activities to be carried out by PERU LNG, has been developed in accordance with the legal framework for environmental conservation and protection in force in Peru. The GNL-2 Quarry exploitation requires the carrying out of activities which fall under the jurisdiction of the Ministry of Energy and Mines.

The exploitation project of the aforementioned quarry also seeks to comply with international guidelines, such as the World Bank Guidelines and the United States Export-Import Bank (EX-IM Bank) Guidelines on environmental and social issues. These organizations' environmental standards, guidelines, and policies applicable to the project are, therefore, included in this chapter.

Environmental regulation in Peru is abundant and widespread because it is based on a criteria by which the use of natural resources is regulated by means of sectoral rulings; that is, laws relating to every economic activity. In this sense, the rules issued by the various Ministries, such as the Ministry of Energy and Mines, the Ministry of Production, the Ministry of Transport and Communications, the Ministry of International Trade and Tourism and the Ministry of Agriculture (in charge of the management of renewable natural resources through INRENA), among others, regulate environment as a separate item, not from a holistic approach.

Under this conceptual premise, the existence of three kinds of legal order can be noted:

- **Environmental Legislation in itself**: Where the legal statutes are issued for the protection of the environment with a modern approach of understanding the environment as an interdependent system of relations between society and nature.

  In this case the Code for the Environment and Natural Resources, the rule for consultation processes, civil participation, and the development of specific terms for the formulation of environmental and social impact studies.

- **Sectoral Legislation of Environmental Relevance**: The legal statute issued for the protection of certain environmental elements or the protection of the environment from the effects of certain productive or non-productive activities. These laws are issued by the diverse productive sectors, such as the mining, hydrocarbons, wild fauna and flora and fishing sectors.

- **Legislation of Causal Environmental Relevance**: These legal rules have been issued with no environmental purposes, but can regulate behaviors that may have an effect on the protection of the environment. This is the case for the rules governing civil, judicial, criminal and administrative laws.

The aforementioned explains the abundance of State laws whose relevance for quarry exploitation and transport of aggregates is explained in this chapter.

2.2 GENERAL PERUVIAN ENVIRONMENTAL LEGISLATION FRAMEWORK

2.2.1 GENERAL PERUVIAN ENVIRONMENTAL POLICY

The general principles aimed at protecting the environment in Peru are incorporated into the Political Constitution of Peru, the legal regulation highest in rank. Title I, Chapter 1, Article 22, Clause 22 states: "*everyone has the right to peace, tranquility, the enjoyment of free time and rest, as well as a balanced and appropriate environment all through their lives.* Article 67 declares: "*The State determines the environmental national policy. It promotes the sustainable use of natural resources"*

On the other hand, Legislative Decree Nº 613 of 08 September, 1990, Code for the Environment and Natural Resources, states in its Preliminary Title: *"Every person has the right to enjoy a healthy, ecologically balanced and appropriate environment for the development of his/her life, as well as the preservation of the landscape and nature. Everyone has the duty to conserve the environment."* It also establishes three applicable principles to any industrial or exploitation activity: 1.) the obligation to submit an environmental impact assessment for the development of new activities (Art. 8). 2.) civil participation (Chapter VII, Art. 34). 3.) The Polluter Pays Principle (Chapter 1, Article 1, paragraph 6)

It also indicates that the State promotes a dynamic balance between socio-economic development, conservation, and sustainable use of the environment and natural resources (Article 1, Clause 1).

The Environmental Management Act, Law N° 28245, has the role of ensuring the most effective fulfillment of environmental objectives by public organizations. They do this by strengthening cross-sectoral mechanisms for environmental management, with the help of the National Council for the Environment (CONAM) as well as sectoral, regional and local organizations in the exercise of their environmental functions.

The general policy framework for private activities and environmental conservation is expressed in Article 49 of the Framework for the Growth of Private Investment Act, approved by Legislative Decree Nº 757, dated 13 November, 1991. The Framework states that: *The State promotes a sound balance between socio-economic development, the conservation of the environment and the sustainable use of natural resources by guaranteeing due legal security for investors through the establishment of clear regulations to protect the environment.*

The Modernization of State Management Act, Law Nº 27658 and its Regulations D.S N° 030 -2002 – PCM, make up the initial framework from which the modernization process in the management of the State will be developed. With the goal of obtaining higher efficiency at the State level to get better assistance to the people by prioritizing and optimizing the use of public resources.

The Political Constitution of Peru was modified in its Decentralization Chapter on 6 March, 2002. Then, the Organic Law for Decentralization Bases (Law N° 27783 of 17 July, 2003) was approved. Followed by the Organic Law for Regional Governments (Law N° 27867) and Organic Law for Municipalities (Law N° 27972) .

It is with the purpose of guaranteeing harmonious development and the integration of its various governmental levels with the general public that the Peruvian State also enacted Law N° 27806, Transparency and Access to Public Information Act. The main objective of this Act is to foster civil participation and the development of democratic awareness.

2.2.2 LAND USE ZONING

The main management tool in effect to protect agricultural and forest soils is the Regulations on the Classification of Lands, D.S Nº 062-75-AG of 22 January, 1975, which has an interpretation system to classify lands according to its major or permissible optimal use in relation to its ecological and intrinsic characteristics. It is not a law in itself, for it only establishes the criteria for determining the major land use capacity without making reference to sanctions for those who do not use their lands in accordance with such classification or providing incentives for those who do. It establishes five types of major appropriate land use: clean lands apt for crops, lands apt for permanent crops, lands apt for grazing, lands apt for forestry production and protection lands.

On the basis of those criteria, this rule is a guiding instrument to develop planning and arrangement plans. The Territorial Arrangement Plan is the tool that allows for the sustainable use of natural resources, the equitable distribution of residents, and the development of public and private investment in the urban and rural scopes of action within a provincial territory. It establishes, among other things, the general policy related to land uses. In this process, the Urban Development Plan is used as a governing technical instrument to promote and guide urban development for each human settlement at the provincial level, in accordance with the Territorial Arrangement Plan.

Zoning is the set of urban technical rules, contained in the Urban Development Plan, that regulates the use of land in relation to the physical, economic and social demands of the city. This enables officials to locate activities with housing, recreation, protection, and furnishing purposes as well as industrial production, trade, transport and communications. It rules land property right. In accordance with the characteristics determined in pertinent studies, the following zones will be taken into account:

- Residential
- Housing-Workshop
- Industrial
- Commercial
- Pre-Urban
- Recreation
- Special Uses

- Supplementary Public Services
- Special Rule Zone
- Monument

It shall be noted that there is a procedure to formalize, with a corresponding registrar inscription, informal property. This can be defined as informally-occupied lands, informal urban centers, urbanizations and any other form of land possession, occupation or informal ownership on State-owned property for housing purposes, as long as they existed on or before December 31, 2001. Also applies to fiscal or municipal property, designated as such or by any other name given to a State-owned property. The following lands are exempted from this procedure:

- Those being used or reserved for public services and those for national reserve, national defense and mining zones.
- Those located in archeological zones or those part of the Nation's cultural heritage.
- Those destined to State housing programs, as long as works on the land have been initiated or are being executed.
- Those located within protected natural areas or reserved zones, according to law.
- Those located in a risk zone, after confirmation on the part of the National Institute for Civil Defense (Instituto National de Defensa Civil) or any other competent agency.
- Those of social interest acquired with resources from the liquidation del Fondo Nacional de Vivienda (FONAVI) before November 16, 2004.

2.3 INSTITUTIONAL FRAMEWORK

2.3.1 COMPETENT AUTHORITY

The Framework for the Growth of Public Investment Act, Legislative Decree N° 757, establishes the sectoral functions of the Ministries to address environmental issues as stated in the Code for the Environment and Natural Resources. Second paragraph of Article 50 of the Framework for the Growth of Private Investment Act (Legislative Decree Nº 757) states that *for companies developing two or more activities falling under the competence of different sectors, the competent authority will be the one that relates to the activity that renders the biggest annual turnover.* Taking this into consideration, the MEM shall be the competent authority to address the environmental issues related to the quarry development to be undertaken by PERU LNG S.R.L.

2.3.2 MINISTRY OF ENERGY AND MINES

The Ministry of Energy and Mines (MEM) is the governmental entity in charge of regulating the granting and exploitation of mining and energy resources nationwide, in accordance with the national environmental policy.

According to the Rules and Regulations for the Organization and Functions of the Ministry of Energy and Mines approved by Supreme Decree No. 025-2003-EM, the bureaus related to quarrying are the General Bureau for Mining Environmental Affairs (DGAAM) and the

General Bureau for Mining (DGM). However, in view of the connection to the Natural Gas Export Project, a much larger project to be undertaken by PERU LNG for which the GNL-2 quarry will provide the material needed for the construction of facilities, this mining activity becomes a complementary activity to that energy project. This is the reason why the Environmental and Social Impact Assessment (ESIA) shall be submitted to the General Bureau for Energy Environmental Affairs (DGAAE), which will approve the ESIA, observing the requirements and guidelines contained in the mining legislation.

The Sole Arranged Text for the Mining General Act, Supreme Decree N° 014-92-EM of 4 June 1992 , states in its Article 14 that *non-metallic concessions or concession extensions cannot be established on neither intangible agriculture areas nor on rustic lands of agricultural use for which natural pastures are not considered.* It adds: *if urban or urban expansion areas are involved, the concession title will be granted after an authoritative agreement has been reached with the respective Provincial Council.*

On the issue of Servitude for Non-Metallic Mining Concessions, Article 3 of Supreme Decree N° 017-96-AG applies. It states, in accordance with Article 14 of the Sole Arranged Text for the Mining General Act and the Seventh Complementary Provision of Legislative Decree N° 653, Promotion for the Investment in the Agriculture Sector, that servitude on agriculture or farming lands is not to be granted for the development of non-metallic mining activities.

Supreme Decree N° 037-96-EM of 25 October 1996 indicated that the Ministry of Energy and Mines shall issue the provisions to govern the development conditions for construction material quarries, depending on depth limits, height, extension, volume and schedule, so that damages to the ecosystem can be avoided and the welfare of people is assured.

Ministerial Resolution N° 188-97-EM/ VMM issued on 12 May 1997 states, in its Article 1 that mining claimants must submit by the initiation or re-initiation of quarry development activities for the excavation of construction material, the following:

- A general plant plan using UTM coordinates indicating the pit development limits, its horizontal projection, vertical sections and non-mining areas of influence – the latter being a minimum of a one-hundred-meter-wide (100) strip around the open pit, as measured from the final limit. Exploitation activities shall be devised in such a manner so that the strip will not affect existing road infrastructure or human settlements.
- A pit design, including ramps, berms and work benches.
- A bench slope design or development levels.
- A description of the equipment to be used.
- An exploitation schedule (years, deepest contour line proposed for exploitation).
- An Environmental Impact Assessment, including a Closure Plan drawn up by any of the companies listed with the General Bureau for Environmental Affairs Registry.
- A report on the security and hygiene measures to be adopted at the main, auxiliary, and complementary facilities.
- A Closure Plan including guarantees to reclaim the exploitation affected areas.
- A document to demonstrate that the applicant is authorized to use the land on which the exploitation will take place.

- Authorization by the Ministry of Transport and Communications for the exploitation of quarries that are situated near human settlements, roads or highways.

Article 2 of this law makes reference to considerations that need to be taken into account when designing a pit for the excavation of construction material. They include: the bench height, berm and ramps width, inclination of slopes, and final limits of open pit and development limits, as determined by the place where the quarry is situated. In this case, and since the quarry is located far away from towns, human settlements or urban expansion areas, the limit in the concession area is set within the economic limits of the quarry.

With regard to construction materials which are transported by streams and deposited on their floors, controlling and monitoring will be performed by the Water Authority, in accordance with Article 7 of the Ministerial Resolution mentioned above.

Finally, it must be noted that compliance of environmental regulations is the same for either metallic mining or non-metallic mining concessions.

2.3.3 NATIONAL INSTITUTE FOR MINING CONCESSIONS AND CADASTRE (INACC)

The National Institute for Mining Concessions and Cadastre (Instituto Nacional de Concesiones y Catastro Minero - INACC) is a decentralized public agency of the Energy and Mines Sector. It is a legal entity for domestic public law with technical, economic and administrative autonomy. Its objectives are to grant mining concession titles to incorporate into the national Cadastre and to administer and distribute the In-Effect and Penalty Right.

The INACC's functions are to:

- Process mining applications, grant concession titles and resolve applications related to mining rights.
- Expedite resolutions of extinction, non-payment, exclusion and free denounce ability of mining rights.
- Manage the National Mining Cadastre, Pre-Register, and Mining-Restricted Areas Register.
- Elaborate on the Mining Cadastre and administer and distribute the In-effect and Penalty Right.

2.3.4 THE NATIONAL COUNCIL FOR THE ENVIRONMENT- CONAM

The National Council for the Environment (Consejo Nacional del Ambiente (CONAM)) created by Act Nº 26410 of 2 December 1994 is the guiding agency for the national environmental policy. Among its functions are: the establishment of the criteria and general standards for environmental quality, the coordination of the establishment of permissible limits for environmental protection, and the establishment of general Environmental Impact Assessment (EIA) guidelines. Furthermore, CONAM is the decision making authority in the event a conflict arises between two authorities claiming the right to impose sanctions after an infraction has been committed.

The National Environmental Impact Assessment System Act (SEIA) – Law N° 27446 was enacted on 23 May 2001. This law states that the SEIA is coordinated for the identification, prevention, supervision, control and early correction of the negative environmental impacts arising from human activities in investment projects.

The SEIA Act incorporates the absolute obligation for every public and/or investment project involving construction activities or works that can cause negative environmental impacts to have an environmental certification before execution starts. The environmental certification is the resolution issued by the competent authority upon approval of the environmental impact assessment.

The SEIA Act will be in effect on the date its Regulations are approved. Until this happens, the applicable environmental laws on EIA are the ones approved by each sector, bearing in mind that when the Regulations are approved, each sector shall ensure that their environmental impact assessment procedures are consistent with the law. No activity could, then, be initiated without it being certified.

The Environmental Impact Assessment for Works and Activities Act enacted on 13 May 1997, Law Nº 26786, establishes that each Ministry shall advise CONAM about the EIA regulations they have developed for their sectors. The Law does not specify sectoral functions with regard to competent environmental authorities.

Non-metallic quarry project owners do not require direct coordination with CONAM. The MEM, in its capacity as responsible authority at the sectoral level on environmental issues, can advise CONAM with regard to the quarry development and the related environmental aspects, if or when required.

2.3.5 NATIONAL INSTITUTE OF NATURAL RESOURCES (INRENA)

The National Institute of Natural Resources (Instituto Nacional de Recursos Naturales) (INRENA), created by Organic Law from the Ministry of Agriculture –Decree Law Nº 25902 of 29 November 1992, modified by Law Nº 26822– is a decentralized agency of the Ministry of Agriculture.

The Regulations for the Organization and Functions of INRENA, Supreme Decree N° 02 – 2003 – AG published on 15 January 2003, modified by Supreme Decree N° 018 - 2003 – AG and published on 15 May, 2003, establishes that the technical line organs to be involved in the project activity are: the Head Office for Forestry and Wild Fauna (Intendencia Forestal y de Fauna Silvestre), which is in charge of the protection of wild biodiversity; the Head Office for Hydrological Resources (Intendencia de Recursos Hídricos), the ultimate legal and technical authority for the sustainable use of hydrological resources; the Office for Cross-Sectoral Environmental Management, Assessment and Information on Natural Resources (Oficina de Gestión Ambiental Transectorial, Evaluación e Información de Recursos Naturales), whose function it is to issue an early technical opinion for those investment projects in all productive sectors involving activities or actions that modify the native state of natural resources, such as water, soils, wild flora and fauna that can affect protected natural areas. They can be:

- Alteration in the flow and/or quality of fresh and underground waters.

- Damming and channeling of water courses.
- Soil and vegetation removal.
- Alteration of wild fauna habitats.
- Use of land to deposit non-usable materials (slurry, industrial wastes, hazardous or toxic waste).
- Slope destabilization.
- Alteration of marginal strips (riversides).

The sectoral competent authority shall forward INRENA a copy of the document to obtain its Technical Opinion within a 20-day period. This rule states that if INRENA does not pronounce itself within this timeframe, the competent authority can approve the EIA. This last paragraph shall be understood as implicitly abolished by Article 34 of the General Administrative Procedures Act, Law No. 27444, which clearly states the existence of an administrative silence for cases of public interest such as the environment and natural resources.

2.3.6 NATIONAL INSTITUTE FOR CULTURE - INC

The National Institute for Culture (Instituto Nacional de Cultura) is a Decentralized Public Agency, under the authority of the Ministry of Education, and is a legal entity for domestic public law with technical, administrative, economic and financial autonomy. The INC is responsible for executing the State's policy on culture. Among its functions are the formulation and execution of State policies and strategies on the cultural development, defense, conservation, dissemination and research of National Cultural Heritage.

The National Cultural Heritage General Act, Law Nº 28296, recognizes archeological sites as cultural goods, and stipulates administrative sanctions for major offences or dishonesty acts in the conservation of the Nation's cultural heritage goods.

The Sole Text for Administrative Procedures of the National Institute for Culture approved by Supreme Decree N° 022-2002-ED contains Procedure N° 10 “Authorization to Make Archeological Assessment Projects for Environmental Impact Assessments and/or Use of Resources”. A National Technical Commission for Archeology is responsible for authorizing the required studies which will allow to define the existence or non-existence of archeological sites (Certificate of Non Existence of Archeological Sites (CIRA)), both for the quarry development area, as well as for the area where access roads will be opened. This Commission is also in charge of proposing sanctions to those who do not abide by the protection of archeological heritage laws.

2.3.7 MINISTRY OF HEALTH – GENERAL BUREAU FOR ENVIRONMENTAL HEALTH (DIGESA)

Article 57 of Supreme Decree Nº 261-69-AP which approved Regulations for Titles I, II and III of the Water General Act states that no dumping of solid wastes, liquids or gaseous elements shall occur at sea or land countrywide without having previously obtained authorization by the sanitation authority.

The General Bureau for Environmental Health is the line organ of the Ministry of Health responsible for regulating, supervising, controlling, evaluating and concerting with regional and local governments, other components of the National System for Health as well as other sectors' aspects related to environmental protection, basic sanitation, food hygiene, zoonosis control and occupational health.

The Regulations for Titles I, II and III of the Water General Act indicate that it is the duty of the Bureau for Environmental Sanitation of the Ministry of Health, to fulfill the following functions:

- Monitor the strict compliance of the general provisions regarding any dumping of wastes, liquids or gaseous elements that can pollute waters in the country.
- Record all dumping of waste at sea or fresh waters countrywide.
- Undertake inspection visits and prepare the corresponding reports on the dumping of wastes at sea or in fresh waters, and undertake periodic inspections to ensure compliance with the corresponding regulatory provisions.
- Verify the quality of wastes to be dumped at sea or in fresh waters. Samples need to be taken for the required analysis of waste.

The specific functions of the General Bureau for Environmental Health are to:

- Propose the content of the national environmental health policy and oversee its implementation, with the aim of controlling polluting agents and improving environmental conditions for the protection of human health.
- Formulate and reach consensus on national environmental health plans, programs and projects.
- Establish regulations on environmental health and evaluate their impacts.
- Lead the monitoring of environmental risks and the planning of prevention and control measures.
- Oversee compliance with the technical rules on environmental health.
- Promote environmental health awareness among the public at large by fostering people's participation in the establishment of healthy physical environments, which protect health, control environmental risks, and develop a better quality of life.
- Promote a permanent advancement in the development of capacities, skills, and knowledge of human resources on environmental health.
- Develop applied research that is based on identified environmental risks.

Taking the above into account, PERU LNG shall ensure that all the water and health legislation and policies will be complied with during the development of activities in the selected quarry, especially in relation to the installation of camps/facilities and the disposal of sewage. It shall also comply with any new laws that the Ministry of Health may have issued by the time of exploitation and it will ensure that it obtains the required authorizations.

2.3.8 MINISTRY OF INTERIOR - DICSCAMEC

The use of explosives for civil use is regulated by Supreme Decree Nº 019-71-IN of 04 October 1971. Granting of authorizations and permissions required for the transport and handling of explosives is detailed in the Sole Arranged Text for Administrative Procedures (Texto Único de Procedimientos Administrativos) from the Ministry of Interior – Supreme Decree Nº 006-93-IN of 30 October 1993 and its two modifying decrees (D.S Nº 008-93-IN and D.S No. 004-94-IN).

Decree Law Nº 25707 of 31 August 1992 and its Regulations, Supreme Decree Nº 086-92-PCM of 2 November 1992, restrain the use of explosives for civil use as part of the struggle against terrorism. Coordination with DISCCAMEC for the use of explosives for civil use is imperative, as well as coordination with the National Police and/or Armed Forces in the area. Operators in charge of explosives must obtain a permit from DISCCAMEC to be able to detonate loads.

2.3.9 MINISTRY OF TRANSPORT AND COMMUNICATIONS (MTC)

General Bureau for Land Transport

The General Bureau for Land Transport is in charge of governing, authorizing, supervising, inspecting and regulating land transport and transit of people and cargo. The National Regulation of Vehicles describes the requirements and technical characteristics that vehicles must have to be entered, registered, authorized for transit, operated and withdrawn from the National System of Land Transport. This Regulation defines a cargo vehicle as a motorized vehicle destined for the transport of merchandise that can be equipped additionally to offer specialized services. The exhaust system buffer must cushion the noise produced by engine combustion in order to comply with the Maximum Permissible Limits in force for Noise.

In Addition to that, the National Regulations for Transit regulates the use of public roads that are used for the movement of people, vehicles and animals, activities linked to transport and the natural environment in relation to transit. With respect to heavy cargo transport, it establishes that implements, such as ropes, cords, chains, canvas covers and nets that can condition and protect cargo must be installed in such a way as to not go beyond the height of the vehicle's chassis. They must be properly secured in place to avoid the risk of load falling off the vehicle.

It also establishes the prohibition of:

- Transit of vehicles that discharge or emit gases, fumes or any other polluting substance, which can provoke an alteration in the quality of the environment, at a level that is beyond the established maximum allowable limits.
- Noise generation that goes beyond the established maximum permissible levels.
- Installation of horns in compressed-air discharge equipments, as well as the use of sirens, bells, alarms or any other equipment that can produce a similar sound.

With regard to the competence of the Ministry of Transport and Communications as sectoral authority for this assessment, a letter attached as Annex 11 expresses that PERU LNG is a company linked to activities for the export of natural liquefied gas, and therefore, the DGAA is the competent authority for the evaluation of this EIA.

Environmental infractions are the following:

- To drive a vehicle that has the exhaust pipe exit on the right side, so as to let emissions be discharged towards the side of the road where pedestrians walk. (Minor).
- To drive a vehicle that produces noise levels higher than the maximum permissible levels (Major).
- To drive a vehicle that does not have a noise reduction device in the exhaust system (Major).
- To transport hazardous cargo or goods, contravening regulations (Major plus).
- To drive a vehicle that produces pollution at a level that is beyond the maximum permissible limits (Major plus).

Supreme Decree N° 047 - 2001 - MTC establishes in its Annex I the Maximum Permissible Limits (LMP) for Polluting Emissions for motor vehicles in transit, new vehicles to be imported or assembled in the country and used vehicles that are to be imported, as referred to by the National Regulations for Vehicles approved by Supreme Decree Nº 058-2003-MTC.

Table 2-1 Maximum Permissible Limits (LMPs) for Polluting Emissions from Vehicles

Gasoline, Oil Liquefied Gas and Natural Gas Driven Large Vehicles (light, medium and heavy)			
Manufacturing year	**Volume of CO %**	**Hc (ppm) (1)**	**$CO + CO_2$ % (minimum)**
Until 1995	3,0	400	10
1996 henceforward	2,5	300	10
2003 henceforward	0,5	100	12

(1) **For gasoline vehicles**: Approved hydrocarbons (HC) values for control points in roads or public thoroughfare at over 1800 meters above sea level only. Models manufactured in or before 1995 = HC 450 ppm and 8% $CO + CO_2$; models in or after 1996 = HC 350 ppm and 8% CO + CO2.

Diesel Driven Large Vehicles (light, medium and heavy)		
Manufacturing year	**Opacity: k (m^{-1})(2)**	**Opacity percentage**
Before 1995	3,0	72
1996 henceforward	2,5	65
2003 henceforward	2,1	60

(2) **For gasoline vehicles**: For control points in roads or public thoroughfare at over 1000 meters above sea level, a height correction of 0.25 k (m^{-1}) for every extra 1000 m up to a maximum of 0,75 k (m^{-1}). 0.25 k (m^{-1}) can be applied.

2.3.10 REGIONAL GOVERNMENTS

Regional governments – the Regional Government of Lima in this case – share functions on the evaluation and regulation of economic and productive activities. This involves the following sectors: Industry, Trade, Tourism, Energy, Hydrocarbons, Mining, Transport, Communications, and Environment. They perform specific functions to control and supervise the compliance of environmental laws, agreements, projects, studies, and the sound use of natural resources under their respective jurisdiction.

2.3.11 LOCAL GOVERNMENTS

The Organic Law for Municipalities prescribes the specific functions of provincial Municipalities. They are:

- Promote a strategic coordination for the formulation and implementation of district development plans. Such plans shall be in accordance with the provincial Municipalities' general plans and regulations, specifically where it relates to the organization of the physical space and the use of land.
- Issue the general technical regulations on the organization of physical spaces and the use of land, as well as on the protection and conservation of the environment.
- Exert functions on territorial organization.

On the issue of sanitation and health, provincial Municipalities are responsible for regulating the process of solid waste and liquids disposal and industrial dumping at the provincial level. They are also responsible for regulating and controlling the emission of fumes and gases, the production of noise, as well as other polluting elements that are emitted into the atmosphere and environment. This leaves the district Municipalities in charge of the monitoring and control, in particular, with respect to fumes and gases emissions, noise-production and other forms of environmental pollution.

2.4 ENVIRONMENTAL LEGISLATION ON NON-METALLIC MINING

2.4.1 ABANDONMENT PLAN AND MINE CLOSURE

An Abandonment Plan is required for the abandonment of quarries. The claimant shall submit such document to the General Bureau of Mining for approval. The Plan shall contain the reclamation procedure along with a schedule and budget, which shall be consistent with the Closure Plan approved with the Environmental Impact Assessment.

The Environmental Guides for Mine Closure and Abandonment Projects establish criteria which shall be specially developed for each mineral deposit. The criteria for mine closure include:

- Physical and chemical characteristics of the mine and waste material.
- Climatic and hydro geological conditions of the mineral deposit.
- Local superficial and ground water conditions including quality, quantity, future uses and proximity to the mineral deposit.
- Vulnerability to extreme events, such as earthquakes, landslides and flooding.

- Water balance for the mineral deposit including precipitation, superficial and ground water balance along the mine and waste material dump sites.
- Engineering design for the mine facilities.
- Operative history of the mine including environmental control results.
- Required Land Use after mining operations.

The physical characteristics of the mining waste, the mine structures, and open pit or underground mines are important to determine resistance to wind and water erosion. The physical characteristics include:

- Resistance to wind and water erosion: grain size, cohesion, slope, vegetation growth capacity.
- Drainage: humidity contents, hydraulic conductivity, vegetation growth capacity.
- Stable slopes: Resistance to cuttings, durability, hydraulic conductivity, vegetation growth capacity.

In order to address specific issues and conditions for a mineral deposit, environmental impact studies will assess the following:

- Vegetation: Assessment of the potential success of the measures to have vegetation grow, including species succession and climax vegetation, metal absorption by plants, potential for fodder (where appropriate) and potential for erosion control.
- Public Use and Wild Fauna: Impact of the closure measures as to the use given to the site by wild animals and the potential impact on the health and safety of the people entering the site.
- Pollution of Superficial Waters: When superficial waters are prone to pollution, it is necessary to determine or predict the concentration and magnitude of such pollution and to make a quantitative assessment of the potential impact.
- Aquatic environment downstream: If superficial waters and sediments in those waters are polluted, it will be necessary to assess the impact on the aquatic environment downstream.

With regard to the land use, the closure plan shall consider the following:

- Foreseen use of land after closure.
- Level of environmental impact, nearby land productivity and natural physical risks in the area.
- Population density in nearby areas and easy access to the site.

Law Nº 28090 of 14 October 2003 sets forth all obligations and procedures that claimants must take into consideration for the formulation, presentation, and implementation of Mining Closure Plans and their corresponding environmental guarantees. In its Article 7, it also establishes that the timeframe for submitting a Mining Closure Plan is one year, to count down from the date right after the approval of the Environmental Impact Assessment.

The World Bank states that mining project owners are obliged to prepare and implement a Mining Closure Plan. The plan must include the reclamation of the slurry deposits, any open pit, sedimentation pools and camps, milling yards or other associated facilities.

The main objectives of a closure plan are to:

a. Return the land to conditions capable of supporting prior land use or uses that are equal to or better than prior land use, to the extent practical and feasible.
b. Eliminate significant adverse effects on adjacent water resources.

Mine reclamation plans shall incorporate the following components:

a. Conserve, stockpile and use topsoil for reclamation purposes.
b. Slopes of more than 30% should be contoured to minimize erosion and runoff.
c. Native vegetation should be planted to prevent erosion and encourage self-sustaining development of a productive ecosystem on the reclaimed land.
d. Budget and schedule for pre-and post-abandonment reclamation activities.
e. Plan views that show areas cleared, mined, refilled and revegetated during each of the next 5 years and estimated activities at subsequent 5 year intervals.

2.4.2 MAXIMUM PERMISSIBLE LIMITS AND ENVIRONMENTAL QUALITY STANDARDS

The Regulations for National Standards for Air Quality – D.S Nº 074-2001-PCM of 24 June 2001 – establishes the corresponding values for the National Ambient Air Quality Standards, shown in Table 2-2.

Table 2-2 National ambient air quality standards

Contaminants	Period	Standard form		Analysis Method 1
		Value	Format	
Sulphur Dioxide	Annual	80	Annual arithmetic mean	UV Fluorescence (automated method)
	24 hours	365	NH 1 a year	
PM-10	Annual	50	Annual arithmetic mean	Inertial separation/filter Gravimetric
	24 hours	150	NH 3 times a year	
Carbon Monoxide	8 hours	10 000	Mobile Average	Non-dispersive Infrared (NDIR) (automated method)
	1 hour	30 000	NH 1 a year	
Nitrogen Dioxide	Annual	100	Annual arithmetic mean	Chemical Luminescence (automated method)
	1 hour	200	NH 24 times a year	
Ozone	8 hours	120	NH 24 times a year	UV Photometry (automated method)
Lead	Annual [2]			Method for PM 10 (atomic absorption spectrometry)
	Month	1,5	NH 4 times a year	
Hydrogen Sulphur	24 hours [2]			UV Fluorescence (automated method)

All values are concentrations in micrograms per cubic meter.
NE Not higher than.
1 Or equivalent proven method.
2 To be determined.

Set forth in its Pollution Prevention and Abatement Handbook (PPAH) of July 1998 are the World Bank's air quality limits that will serve as legal framework for this study, as shown in Table 2-3

Table 2-3 World Bank Standards for Air Quality– within property borders

Pollutant	Period	Concentrationμ g/m^3
PM_{10}	Maximum 24-hour average	70
Sulfur Dioxide (SO_2)	Maximum 24-hour average	125
Nitrogen Dioxide (NO_2)	Maximum 25-hour average	150
Carbon Monoxide (CO)	---	NE

NE: Not established

Supreme Decree No. 085-2003-PCM approved the Regulations on the National Standards for Air Quality for Noise. But since this standard does not consider a rural category, it will not be applicable for this study. Table 2-4 shows the aforementioned national standard.

Table 2-4 Environmental quality standards for ambient noise

	Limits in LAeqT	
	Daytime Schedule *(1)*	**Night time Schedule *(2)***
Zone of special protection	50	40
Residential Zone	60	50
Commercial Zone	70	60
Industrial Zone	80	70

(1): From 07:01 to 22:00
(2): From 22:01 to 07:00
DS-085-2003-PCM. Annex 1

The World Bank's Pollution Prevention and Abatement Handbook (July, 1998) establishes the maximum noise levels for sensitive receivers located beyond the project property borders. Table 2-5 shows the aforementioned international standard.

Table 2-5 World Bank Standards for Ambient Noise

	Limits in LaeqT	
	Day time (1)	**Night time (2)**
Residential, institutional or educational	55	45
Industrial or commercial	70	70

(1): from 07:01 to 22:00
(2): From 22:01 to 07:00
Pollution Prevention and Abatement Handbook

It is essential to consider the noise level produced within the property limits. To that end, the NIOSH (National Institute for Occupational Safety and Health) guidelines for noise exposure, which has established a limit of 85 dB for an 8-hour working period, are presented. Also, Supreme Decree Nº 046-2001-EM Regulations on Mining Safety and Hygiene considers 85dB for an 8-hour working period exposure as occupationally safe and healthy. Table 2-5 presents the limits for occupational health considered for this study.

Table 2-6 Guidelines for noise in occupational health – within property limits

Environment Type	Period	dBA (Decibels)
Laboral (*)	8 hours	85
Exterior diurnal	Day	55
Exterior nocturnal	Night	45

National Institute for Occupational Safety and Health
(*) D.S. Nº 046-2001-EM. Regulations on Safety and Mining Hygiene

Rock exploitation does not generate mining or metallurgic effluents; consequently, Ministerial Resolution Nº 011-96-EM/VMM of 10 January 1996, which disposes the maximum permissible levels for such effluents is not applicable.

The General Water Act, Law Nº 17752 of 24 July 1969 establishes the regulating framework for water quality for different uses. Regulations of Titles I, II and III, approved by Supreme Decree Nº 261-69-AP of 12 December 1969 and Supreme Decree Nº 007-83-A of 11 March 1983 which modified Article 81 in the Regulations for Titles I, II and III classifies waters with a use criteria. Supreme Decree Nº 003 - 2003 - SA published on 29 January 2003 modified the limits for the protection of waters.

The World Bank established standards for the discharge of effluents into superficial waters in its Pollution Prevention and Abatement Handbook. Since this project will neither generate residual waters nor discharge effluents into superficial waters, these standards are not applicable.

2.4.3 SPECIES PROTECTION

Article 5 of the Organic Law for the Conservation and Sustainable Use of Biological Diversity, Law 26839 published on 26 July 1997, is a response to Article 68 of the Political Constitution of Peru as it establishes a series of parameters relating to the conservation of biological diversity, such as pollution prevention and land and aquatic ecosystem degradation, through environmental conservation and management practices.

This law also stipulates in its Article 31 that the State manages biodiversity through competent authorities in accordance with the functions identified in their respective creation laws.

In this sense, INRENA, through the Forest and Wild Fauna Head Office (Intendencia Forestal y de Fauna Silvestre), is in charge of protecting wild biological diversity including all vertebrates, with the exception of fish, cetaceae, sirenia and marine snakes; as well as invertebrates whose life cycle is not completely aquatic. Within the framework of the National Strategy for Biological Diversity, which recognizes the need to adopt special measures to protect threatened species and their natural habitats, the State of Peru approved by Decree Supreme N° 034 - 2004 – AG conservation categories for threatened wild fauna species. These categories are as follows.

Critically endangered (CR), Endangered (EN), Vulnerable (VU) and Near Threatened (NT).

2.4.4 WASTE DUMP MANAGEMENT

The "Environmental Guide for Slope Stability of Solid Waste from Mining Activities" published after Directorial Resolution Nº 034-98-EM/DGAA authorization of 12 September 1998, provides guidance for the selection of management measures for waste dump sites.

2.4.5 FRAMEWORK FOR THE ENVIRONMENTAL IMPACT ASSESSMENT APPLICABLE TO NON-METALLIC MINING ACTIVITIES

2.4.5.1 The National System for Environmental Impact Assessment

The National System for Environmental Impact Assessment Act, Law Nº 27446 published on 23 May 2001, establishes an independent and coordinated system for the identification, prevention, supervision, control, and anticipated correction of negative environmental impacts arising from human actions. This law proposes the following categories, depending on the environmental risk: Category I – Environmental Impact Statement (Declaración de Impacto Ambiental), Category II – Semi-detailed Environmental Impact Assessment (Estudio de Impacto Ambiental Semidetallado), Category III – Detailed Environmental Impact Assessment (Estudio de Impacto Ambiental Detallado). The submittal of this EIA for the quarry development to the competent authority complies with the requirements of this law.

2.4.5.2 Contents of Environmental Impact Studies (EIA's) and Environmental Adjustment and Management Programs (PAMA's)

The Code for the Environment and Natural Resources – Legislative Decree Nº 613 – states in its Article 9 that an Environmental Impact Assessment shall contain a description of the proposed activity, the predictable short-term and long-term direct and indirect effects on the physical and social environment, as well as a technical assessment. It shall also indicate the measures that will be taken to avoid or reduce damage and to ensure that any changes that will occur will stay within the permissible levels.

The Environmental Management Guide for Non-Metallic Mining describes a list of identified environmental impacts in quarries, as well as guidelines for mitigating them.

2.4.5.3 Early Opinions

Supreme Decree No. 056-97-PCM published on 19 November 1997, establishes that EIA's and PAMA's from diverse productive sectors whose activities and/or actions modifying the natural state of renewable natural resources require the technical opinion of INRENA (see 2.3.5), within a 20-day period.

2.4.5.4 Civil Participation

The Regulations for Civil Consultation and Participation for the Approval Process of Environmental Studies in the Energy and Mining Sector – R.M N° 596-2002-EM-DM, published on 21 December 2002 – regulates the participation of people and social organizations, owners of mining and energy projects, and authorities involved in the evaluation process of Environmental Impact Studies, Environmental Adjustment and Management Programs, Semi-detailed Environmental Impact Studies, Preliminary Environmental Impact Studies and Environmental Assessments. The instruments for civil participation envisaged by this law are: early consultation and public hearing.

Early consultation consists of early workshops that will be convened by the General Bureau of Environmental Affairs (DGAA) of the Ministry of Energy and Mines, in coordination with the regional authority (that is, the corresponding Regional Bureau for Mining – DREM). The number of workshops will be determined by the DGAA and depends on the project size. A consultation is required in the following cases:

- Before the initiation of environmental studies and in the project area of influence: The workshop shall give people information about their rights, environmental law and new technologies brought in by the project.
- During the elaboration of the EIA or semi-detailed EIA: Information about the project and progress on the elaboration of the EIA will be provided during the workshop. Participants will be in a position to comment and provide input to the elaboration process.
- After an EIA or semi-detailed EIA has been submitted: At this stage, the project owner will present the scope of the study; the possible environmental, social and cultural impacts and the environmental management plan.

The public hearing is the public act for which the DGAA is responsible. At this meeting the EIA or semi-detailed EIA will be presented to the public. If necessary, the organization of the hearing can be delegated to the corresponding DREM.

The hearing will be made public through advertisements published in the official gazette 'El Peruano' and through an advertisement posted in a major newspaper in the locality or localities, at least 40 days before the scheduled date for the hearing. The language of the hearing will be Spanish or the dominant language in the area, with the assistance of interpreters.

2.4.6 QUARRY MANAGEMENT

Within the framework of the sectoral statute, a mining claim grants its claimant the right to explore and exploit the mineral resources granted within a solid of indefinite depth limited by vertical planes corresponding to the sides of a square, rectangle or closed polygon whose vertexes are referenced to Universal Transversal Mercator (UTM) coordinates.

A mining claim is defined as an administrative and legal act by which the State, the owner of mines, authorizes individuals, and/or the State itself (governmental agencies) can carry out exploration, development, beneficiation, general labor or transport activities on a mining area in compliance with conditions set forth by legislation. Furthermore, the legal nature (not contractual) of this maneuver implies irrevocable granting and extinction causes to be explicitly enumerated by law.

Mining activities in Peru are governed by the General Mining Act, approved by Legislative Decree N° 109 and supplementary rulings, such as Legislative Decree N° 708 – Promotion of Investment in the Mining Sector Act – integrated in a Sole Arranged Text approved by Supreme Decree Nº 014-92-EM.

As contained in Ministerial Resolution Nº 188-97-EM/VMM of 12 May 1997, the Ministry of Energy and Mines (MEM) must issue the provisions to establish exploitation conditions for the development of construction materials quarries, including depth levels, height, extension, volume and schedule, so that damages to the ecosystem can be avoided and the welfare of people can be assured. The guidelines and requirements for non-metallic mining development are contained in the Guide for Environmental Management for Non-Metallic Mining, issued by the General Bureau for Environmental Affairs.

On an Affidavit, the mining claimant must commit to the following:

- Develop productive activities within a policy framework for environmental excellence.
- Act respectfully around institutions, authorities, local culture and customs, keeping a professional relationship with the people involved in the mining operations.
- Keep a continuous and timely dialogue with regional and local authorities, the influential people within the mining operations, and their representative organizations, by providing information about the mining activities.
- Foster building local development among the people of influence in the mining operations by drawing up studies and collaborating on the creation of development opportunities that will go beyond the life cycle of the mining activity.
- Foster local employment preferably, among others, by offering the required training opportunities.
- Preferably acquire local goods and services for the development of mining operations and personnel assistance, applying reasonably good conditions, opportunities, and competitive pricing, by creating appropriate negotiation mechanisms.

2.4.7 ARID LANDS

Arid lands can or cannot be appropriate for farming activities. Arid lands with farming capacity are those which are not being exploited because of lack or excess of water while arid lands without farming capacity are forest and reforest soils, lomas formations with natural grass for grazing, coastal lands, stream floors, riversides and river marginal strips, urban lands, those lands used for domestic or industrial purposes, protected lands and lands which are part of the national archeological heritage. Article 23° of the Foreign Investment Promotion Act of the agricultural sector indicates that the State is the owner of arid lands with farming capacity and that INRENA is the body in charge of their identification and delimitation.

Supplementary Provision 2 of the Lands Acts, modified by Law N° 26681 of 10 November 1996 pointed out that the State could sell its arid lands at public bids as soon as the Lands Act would enter into effect (11 November 1996). This time limit was postponed to 28 July 2001 by means of a modification law enacted by Law N° 27887 of 18 December 2002. The only way for keeping the right over superficial uses on State-owned arid lands outside the perimeter of the mining claim was through the submittal of a scale plan of the land and an executive summary to the Ministry of Energy and Mines, indicating the land occupied by development activities, infrastructure, facilities and services. Only in this way, the MEM could organize a registry for the exclusion of such land from these bidding procedures.

Later on, Supreme Decree N° 027 - 99 – AG of 30 July 1999, authorized the Commission for the Promotion of Private Investment (COPRI), known today as the Private Investment Promotion Agency (PROINVERSION) (Agencia de Promoción de la Inversión Privada), to sell or grant under concession State-owned arid lands to be destined for agricultural production preferably. The buy-sell process is carried out by the Superintendencia de Bienes Nacionales.

If the land is the property of an individual, a servitude proceeding must be filed, as set forth in Article 7 of the Lands Act, Law N° 26505, regulated by D. S N° 017 - 96 - AG. This provision has been modified by D. S N° 014 - 2003 – AG published on 7 May 2003. A servitude proceeding has two stages:

- Direct dealings between the mining claimant and the land owner is initiated and requested via notarized letter. If the parties do not agree, the General Bureau of Mining will call the parties to conciliate in a conciliation center. The presence of two experts is needed; one for the mining side (who will express the need and magnitude of the servitude) and one for the agronomical side (who establishes the compensation amount and announces whether or not the property right is enervated). If conciliation is not possible, legal servitude can be filed.
- The Administrative Proceeding for Servitude is regulated by the dispositions in Chapter IV, Title XII of the Mining General Act, approved by Supreme Decree N° 014 - 92 - EM. In this process, the possibility of servitude being imposed without enervating the property right shall be expressed. If servitude does not enervate the property right, a draft Supreme Resolution stating the compensation amount will be issued. Shall the opposite be the case, the mining claimant's request will be denied and made known in a Ministerial Resolution issued by the Ministry of Energy and Mines.

When the right to land property is not proven, the petitioner will deposit the compensation amount in an account opened for that purpose at Banco de la Nación (National Bank) to be given to whoever can prove without a doubt his/her property right to the land.

By means of Legislative Decree Nº 885 of 10 November 1996, the Promotion of the Agricultural Sector Act was approved. Law Nº 26865 of 15 October 1997 modifies it in relation to tax benefits for the agricultural sector. The Regulation for Legislative Decree Nº 885 was approved by Supreme Decree Nº 02-98-AG of 17 January 1998. This Regulation has one title which explicitly addresses the issue of special tax benefits for investment in arid lands with farming capacity.

2.4.8 SAFETY AND MINING HYGIENE

The General Health Act, Law Nº 26842 of 20 July 1997 establishes that health protection is an issue of public interest. It is an inherent right much like the freedom to work, do business, trade and industry and as such is subject to the limitations set forth by law in defense of public health. The Regulations of Safety and Mining Hygiene, Supreme Decree Nº 046-2001-EM, states that the economic administrative units, namely, mining claims, beneficiation concessions, general labor concessions, and mining transports hiring 50 or more workers, will be required to formulate their own Annual Security and Mining Hygiene Program. The claimant who hires 50 or more workers will be required to formulate a Safety and Mining Hygiene Annual Program with the following objectives:

- Develop preventive safety and health guidelines, combining human behavior with theoretical-practical systems and work methods.
- Practice the sound development of mineral resources, with a view to caring about life, workers' health, and the environment.
- Foster leadership, commitment, participation, and teamwork in safety issues throughout the organization.
- Boost morale among workers, so that they can identify themselves with peers, the job and the company.
- Promote, through training, knowledge and understanding of all standards, procedures, and practices with the objective to operate well.
- Promote the fulfillment of Safety and Mining Hygiene standards, by applying the provisions established in the laws and policies and the professional technical knowledge of prevention.
- A proper overall safety inspection of mining operations.

Ministerial Resolution Nº 426-90-SA-DM contains provisions with the objective to safeguard blue-and-white collar workers working at mining camps. It states that mining companies are obliged to conduct physical, chemical, and bacteriological tests on the potable water they provide to mining camps. It outlines the number of samples to take per month from the distribution system at camps for lab purposes.

2.4.9 INSPECTIONS AND SANCTIONS

Title XIII of the Penal Code, Legislative Decree Nº 635, establishes the penalties against environmental offences. These offences are the following:

- Environment pollution, through dumping of solid wastes, liquids, gaseous elements or any other beyond the established limits, and which causes or can cause damage or alterations in flora, fauna and hydro biological resources.
- The deposit, trade, or dumping of industrial or domestic waste at non-authorized sites or without fulfilling sanitary or environmental protection rules.
- The illegal entry into Peruvian territory, whether permanently or in transit, of wastes or scrap of a production process, extraction, transformation, use or consumption not brought into the country to serve as input for productive processes, and /or qualified as hazardous

or toxic by special legislation on the matter, posing a risk to the environmental equilibrium.

- Hunting, capture, collection, extraction or trade of flora or fauna species legally protected. Sanctions are stronger if the crimes are committed during seed production, reproductive or growth periods for rare or endangered species or with the use of explosives or toxic substances.
- Extraction of aquatic flora or fauna species in quantities and prohibited periods or closed seasons, or the use of prohibited hunting practices.
- Destruction, burning-off, damage, or logging of forests or any other natural or cultivated vegetation formation legally protected.
- The use of lands said by the competent authority to be for agricultural use, but instead are used with urban expansion, extraction or construction material production purposes or other specific uses.

To report crimes against environmental legislation in a criminal court, a written grounded opinion on the matter from competent sectoral authorities is needed. This report must be processed in a no-longer-than-30-day period. If two or more sectoral authorities are competent in a case for which their opinions on the reports differ, a settling opinion on the part of CONAM will be requested. If the project owner has an EIA, a penal action for crimes against the environment and ecology can be filed only when environmental legislation is contravened because the guidelines on the EIA have not been executed.

The Mining Activities Investigation Act, Law N° 27474, establishes that investigation into the fulfillment of law in the sector will be in the hands of natural or legal entities called “external investigators”, duly qualified by the General Bureau of Mining. At random, external investigators as well as MEM officials assigned as investigators, could perform the job in any mining site or wherever the mining activities are being carried out in order to inspect, recommend safety, hygiene and environmental measures, as well as to determine the compliance degree of environmental protection law.

Title IV of the Regulations on Environmental Protection for Mining-Metallurgic Activities, Supreme Decree Nº 016-93-EM (modified by Supreme Decree 59-93-EM) establishes the infractions and sanctions for non-compliance of said Regulations.

Ministerial Resolution N° 353-2000-EM/VMM establishes the fines and sanctions to be applied upon non-compliance of the provisions of the Sole Arranged Text for the Mining General Act and its Regulations, published on 2 September 2000. Among its provisions are:

- Fines imposition will be drawn up in the form of a Directorial Resolution by the General Bureau for Mining, after irregularities detected have been proven.
- In the environmental field, the Resolution foresees fines for the following:
  - For infractions that are committed on provisions related to the environment, detected after inspection or special tests.
  - When operations are initiated by project owners before the approval of the corresponding environmental impact assessment or if project owners are not honoring the commitments made and stated in the approved EIA.

– For non-compliance of recommendations formulated as a result of inspections and investigations of cases to prevent environmental damage.

2.5 WORLD BANK ENVIRONMENTAL GUIDELINES

2.5.1 OPERATIONAL POLICY (OP) 4.01 – ENVIRONMENTAL ASSESSMENT

Operational Policy (OP) 401 establishes the obligation for projects requesting World Bank financing be subject to environmental assessments with the aim of guaranteeing environmental soundness and sustainability, as well as an improvement in decision making processes. Operational Policy 401 defines environmental assessment as a process for assessing the potential risks and environmental impacts of a project in its area of influence.

Operational Policy 4.01 states that during the environmental assessment process, the groups affected by the project and local non-governmental organizations must be consulted with respect to the environmental aspects of the project. It also establishes that adequate material regarding the project and potential impacts must be provided in a timely manner and in a language comprehensible and accessible to all consulted groups.

During project execution, there will be reports on the fulfillment of the measures set up on the basis of the environmental assessment, the effectiveness of the mitigation measures and the conclusions of the follow-up programs.

2.5.2 OPERATIONAL POLICY (OP) 4.04 – NATURAL HABITATS

Operational Policy (OP) 4.04 establishes that the conservation of natural habitats and the performance of environmental protection and improvement measures must seek the protection, maintenance and reclamation of natural habitats and their functions.

Projects involving considerable change(s) in natural habitats are not recommended unless there are viable alternatives for the project and the place where it is being executed, and unless the cost-analysis shows that the general benefits overcome the environmental costs by far.

Preparation activities, initial assessment and supervision must include the participation of environmental specialists to ensure the proper formulation and execution of the mitigation measures.

OP 4.04 states that the development and environmental strategies must incorporate an analysis for every important issue related to natural habitats; including but not limited to the identification of important natural habitats, their ecological functions, their degree of threat, conservation priorities and related needs for finance and capacity-building. Those who develop projects must consider the points of view, functions, and rights of the involved groups, including local non-governmental organizations and communities related to the natural habitats. To this effect, participation of the involved groups in the planning, design, follow-up and evaluation of projects shall be promoted.

2.5.3 CULTURAL HERITAGE (OPN 11.03)

Operational Policy 4.11 which protects cultural heritage is being drafted, therefore, the Operational Policy Note (OPN) 11.03 is, at this time, applicable. Article 3 of OPN 11.03 establishes that research must be made by specialists to determine the presence of cultural property in the project area.

Lastly, the International Finance Corporation and World Bank guidelines presented in the document *Doing Better Business Through Effective Public Consultation and Disclosure. A Good Practice Manual* (1998), applicable to projects looking to obtain financing from international agencies, will serve as framework for the development of public consultation processes.

2.6 US EX IM BANK ENVIRONMENTAL POLICIES

The United States Export-Import Bank (US EX-IM BANK) is the official export credit agency of the United States. It supports the acquisition of U.S. goods and services by solvent international buyers who cannot be given credit from traditional trade or structured financing sources.

The Bank assumes country and credit risk that the private sector is unable to accept and helps to level the playing field for U.S. exporters by matching financing that other governments provide to their exporters.

The Bank has established an Environmental Program with the objective of maintaining competitiveness in the global marketplace while ensuring that the projects it supports are environmentally responsible. To this end, it has adopted procedures and guidelines including 10 sector tables, which list the qualitative and quantitative limits for elements, such as air and water quality, which its Engineering and Environment Division will use to assess the environmental effects of investment projects.

The US EX-IM Bank uses the international guidelines established by the World Bank in the Pollution Prevention and Abatement Handbook (PPAH), as well as its Operational Safeguard Policies. In case there is ambiguity between the information contained in any of the US EX-IM Bank Tables and the relevant section of the PPAH and World Bank Operational Policies, the information and guidelines stated in the PPAH and World Bank Operational Policies shall prevail.

The following seven principles establish the scope of the US EX-IM Bank Environmental Policies for investment projects:

1. *Air Quality.* Through available technologies and good practices, protection of air quality is sought to be controlled or reduced to quantitative limits, as set forth in the applicable international guidelines proposed by the World Bank.

2. *Water Use and Quality.* Protection of fresh, marine, and ground water resources from pollution is provided through methods for controlling or treating project effluent

discharges to quantitative limits, as set forth in the applicable international guidelines.

3. *Waste Management.* Waste management through recycling, storage, treatment and disposal of materials, garbage and toxic and hazardous wastes, in accordance with the provisions set out in the applicable international guidelines.

4. *Natural Hazards.* Design and location of projects so as to reduce environmental risks from natural hazards following engineering practices such as designing to seismic criteria and in accordance with the provisions of the applicable international guidelines.

5. *Ecology.* Protection and conservation of ecological resources and biodiversity is managed with the help needed for the restoration of critical natural habitats containing endangered and rare species, in accordance with the provisions of the applicable international guidelines.

6. *Resettlement.* Project development must aim at reducing or mitigating the effects of resettlement, adverse impacts to indigenous peoples and their cultural property, in accordance with the provisions of the applicable international guidelines.

7. *Noise.* Control and reduction of project-related noise levels shall comply with the quantitative limits set forth in the applicable international guidelines.

2.6.1 ENVIRONMENTAL POLICIES FOR MINING

The guidelines in Table 4 are relating to metallic minerals processing. It contains condensed texts from PPAH and applicable World Bank Operational Policies. Since the GNL-2 Quarry Environmental and Social Impact Assessment is being carried out for a non-metallic mineral development project, all guidelines in Table 4 on Environmental Guidelines for Mining are not applicable. It is, therefore, relevant to note some of the prevention and control forms applicable to non-metallic mining, such as air quality, water quality, mining wastes disposal, resettlement and natural habitats, as stated in the said document.

Air quality

Mining equipment like conveyors, perforation systems and all transfer points must be covered by adequate dust collector machinery or any other equipment to eliminate dust. Mining equipment and other related equipment including those for perforation, land movement and excavation purposes must be maintained in a manner that minimizes emissions of particulates and CO, reducing in this way the adverse effects on the ambient air quality of the area.

Water quality

The guidelines for liquids discharged into superficial waters from waste pools, mine drainage, sedimentation watersheds, sewage systems and rain drainage systems are not applicable to direct discharge of waste into the marine environment. If the project has the potential to cause erosion sedimentation impacts upon the discharge of liquids, a plan must be formulated and implemented to assure that the concentration of suspended solids from project areas are controlled in such discharges, thus, minimizing impacts on water quality and aquatic life.

Water Management Plan

A water management plan needs to be formulated and implemented to ensure the effective use of water at the mining area. The plan should also contain implementation measures that will ensure that the generation of acid rock drainage (ARD) are reduced to the minimum, by limiting disturbed areas and isolating sewer systems. The plan shall contain measures for the recycling of process waters and for diminishing polluted discharges onto land and into superficial waters.

Mining Waste Disposal

Waste shall be disposed of in such a way as to optimize protection of human security and the environment. Waste collection systems on land must be designed and made in accordance with engineering practices that are internationally recognized, local seismic conditions and precipitation conditions.

If mining operations include an open pit, investors must look at the possibility of using abandoned open pits to deposit their waste.

Resettlement

The site selection for the project must take into account the adverse impact on local communities situated within or near the project area. Negative impacts on these human groups can be the result of a change in land use, the influence due to easier access generated by the project or the effects on goods and places of cultural significance. A Resettlement Action Plan must be developed and implemented in those places where major resettlement is not possible, in accordance with country statutes and international guidelines such as the World Bank's Operational Policy OD 4.30.

Natural Habitats

Project site selection must take into account and be aimed at minimizing the possible environmental impact within the area of influence. Strong noise must be minimized or avoided in areas inhabited by highly endangered or protected species, so that animal life is not negatively effected. Care for impact mitigation must be particularly demonstrated in those critical and important natural areas, as set forth in Operational Policy 4.04.

3.0

ANALYSIS OF ALTERNATIVES

3.1 GENERAL POINTS

This chapter gives an environmental, social and cultural comparison of the different quarry options for the extraction of rock to be used to build the breakwater for the proposed Liquefaction Plant.

The evaluation of the quarries is presented from an environmental and social viewpoint based on physical, biological and socioeconomic indicators determined specifically for the areas of influence for each quarry. The analysis was carried out at an exploratory level using matrices of quantitative impacts (see Annex 6).

Four quarry areas were evaluated: the GNL area, Los Molinos, El Sol-Punta Olleros and those referred to as "Jatun" (Jatun, Huaya, Huaya II, Huarangal and Rinconada).

The GNL quarry locations, covering an area of 300 Ha and 500 ha, are relatively close to the Liquefaction Plant site (Pampa Melchorita), approximately 20 km from the coast in the Department of Lima. The Los Molinos site (200 ha) is about 150 km southeast, in the Department of Ica. The El Sol-Punta Olleros, also 200 ha in size, is more than 200 km south of Pampa Melchorita, in the Department of Ica; and the Jatun site, covering 1200 ha, is in the desert valley of the Rio Seco and Pampa Guadalupe, in the Department of Ica.

In addition, the option of not opening a quarry to supply materials for the breakwater was also evaluated in order to evaluate the favorable or adverse aspects that the quarry would bring to the natural gas export project and the affected areas.

3.2 METHODOLOGY FOR THE ANALYSIS OF ALTERNATIVES

In developing potential quarry location alternatives, all project components were analyzed including quarry operations and rock transport. The intention was to evaluate each quarry alternative with respect to the possible environmental and social effect, both on the terrestrial and marine environments. However, the scope of this ESIA covers only the quarry operations and truck transport to the Pan American Highway for the preferred alternative. The other components (land rock transport, pier construction and marine rock transport) are included in the Liquefaction Plant EIA – Pampa Melchorita.

The methodology employed to identify and evaluate the environmental impacts of the project alternatives under consideration was as follows:

- Analysis of the project

- Analysis of the environmental and social situation in the area of influence of the project
- Identification and evaluation of potential environmental and social impacts

3.2.1 ANALYSIS OF THE ENVIRONMENTAL AND SOCIAL SITUATION

A baseline of the study area for each alternative quarry was carried out and the physical, biological, cultural and socioeconomic conditions applying to it were described. The environmental baseline was conducted based on field evaluations of air quality and noise, as well as physical and biological sampling. The social baseline was prepared using quantitative studies of the populated areas within the areas of influence of each quarry. Details of the environmental and social baselines are given in the Annex 6.

3.2.2 METHOD OF ANALYSIS

The analysis of the potential environmental impacts of the exploitation of each quarry used matrices, which are a two-dimensional method enabling comparison of the environmental and social components with project activities. It consists of a listing of project activities that could alter the environment on the vertical axis and a listing of the environmental and social components with attributes that could be affected by the project activities on the horizontal axis.

Using this method to predict and assess environmental impacts can involve one or more matrices depending on the criteria used by the scientific professionals responsible for the task. In order to facilitate understanding of the analysis, a summary matrix was prepared for each alternative site that was utilized to analyze the potential environmental and social impacts through the interaction between the project activities and environmental components. The impacts were evaluated based upon the criterion of magnitude.

3.2.2.1 Criteria for evaluation of potential environmental and social impacts

In the assessment phase of potential environmental impacts, each impact was evaluated as adverse or favorable, as well as the impact magnitude.

- **Classification as favorable or adverse**

Each impact was rated as favorable or adverse whether it improved or reduced environmental or social quality. An impact was considered favorable if it improved the quality of an environmental component. Impacts are adverse if they reduce the quality of the environmental component. The objectives and activities chart uses a plus or minus sign to indicate this classification.

- **Magnitude (m)**

This refers to the severity of the activity on a given environmental component in the specific area affected. It refers to the size of the impact; that is, the quantitative or qualitative change in an environmental parameter caused by a given action. The following classifications were used: (1) very small magnitude, (2) small magnitude (3) medium magnitude (4) high magnitude (5) very high magnitude, can be seen in Table 3-1. It should be understood that the classification “very small” means an impact that is barely perceptible and of little importance, or which is easy to mitigate or correct if it is negative. In contrast, “very high” means an impact of great importance that is seriously prejudicial to the environment or social setting if negative and, if it cannot be avoided or mitigated, may make the project infeasible.

Table 3-1 Summary of criteria and classifications

Ranges	Evaluation criteria
	Magnitude (*m*)
1	Very small
2	Small
3	Medium
4	High
5	Very high

3.3 CHARACTERISTICS OF THE ALTERNATIVES EVALUATED

The scope and characteristics of the alternative quarries evaluated are given below. The exact location of each quarry is shown on the map attached to the chapter (M 3-1).

The areas of influence of the four quarry zones involve different sectors and situations within the central coastal region. The zones evaluated are in mountainous desert areas; it is envisioned that the rock will be transported across the coastal regions using existing main roads or access roads to be built for the purpose or by sea.

3.3.1 ALTERNATIVE 1: GNL QUARRY AND SURROUNDINGS

The GNL and GNL-2 quarries are located in a desert area to the south of the Department of Lima, where arid mountains dominate the extensive coastal plain. The area around the quarries is even more desert and unpopulated, almost devoid of vegetation and wildlife and far from natural sources of water.

For transport of the rock from this location, it is proposed to build an access road approximately 20 km long across the desert plain, following dry river beds. At km 168 on the Panamerican Highway, a crossing will be built and the road will extend to the Liquefaction Plant on the coast.

3.3.2 ALTERNATIVE 2: LOS MOLINOS QUARRY

The Los Molinos quarry is located in the inland desert of Ica (close to the Andean highlands). It is a very short distance from the village of Los Molinos and a cultivated valley containing the Ica River. The exploitation of this quarry, therefore, has important environmental and social connotations.

Transport of the rock from this quarry is envisioned to use of a stretch of the Pan American Highway from the village of Los Molinos to the entry to the Bay of Paracas (Port of San Martín) where the rock will be carried by sea to the site of the breakwater.

3.3.3 ALTERNATIVE 3: EL SOL – PUNTA OLLEROS QUARRY

The Punta Olleros quarry is on the coast, in contrast to the other alternatives that would involve the extraction of rock from quarries located in desert mountainous areas far from the coast.

In the case of Punta Olleros, the rock outcrop and the access roads and installations envisaged for the transport of material are all very close to the shore, in a small desert area near the southern limit of the Department of Ica. It is an unpopulated area devoid of vegetation and animals, with no rivers or available ground water, where groups of artisanal fishermen operate occasionally. Despite these environmental and social conditions being favorable for the exploitation of this quarry, the coast at Punta Olleros is particularly complex and includes islands inhabited by different animal species that are protected by Peruvian and international legislation. One of these islands was once the habitat of species now declared extinct, so this is an extremely sensitive ecosystem from the biological point of view.

It is envisioned hat transport of the rock will be by sea from a jetty to be constructed at the beach below the quarry zone to the site of the breakwater.

3.3.4 ALTERNATIVE 4: JATUN AREA QUARRIES

The Jatun quarries consist of five locations: Jatun, Huaya, Huaya II, Huarangal and Rinconada. These are located in an area called Pampa de Guadalupe, in the districts of Humay and Salas in the provinces of Pisco and Ica respectively, in the department of Ica.

The area is mountainous, arid desert; but in contrast to Los Molinos, this quarry is located in a completely unpopulated area with no vegetation or wild fauna and with no nearby sources of water.

As with the Los Molinos quarry, the rock would be transported on a section of the Pan American Highway to the Port of San Martín on Paracas Bay, where it would be transported by sea to the site of the breakwater.

3.3.5 THE NO QUARRY ALTERNATIVE

This is the alternative of not establishing a quarry and evaluating the favorable and adverse environmental effects for the project areas under these circumstances.

3.4 IDENTIFICATION OF POTENTIAL ENVIRONMENTAL IMPACTS FOR THE ALTERNATIVES

This section is a summary of the evaluation of environmental and social impacts created by the proposed alternatives. The matrices and detailed descriptions are contained in Annex 6.

3.4.1 DESCRIPTION OF POTENTIAL ENVIRONMENTAL IMPACTS – GNL QUARRY AND SURROUNDING AREAS

Considering the different project components, exploitation the GNL and GNL-2 quarries would have a very low environmental and social impact. The unpopulated desert character of the quarry zone and the possibilities of safe access through equally unpopulated areas that are not sensitive, from the quarry to the shipping area and breakwater, are very favorable conditions for this project, making it highly viable from an environmental and social point of view.

In detail, the quarry area holds almost no geodynamic risks except for seismic activity, its soils are unproductive and the quality of the natural landscape is very low. Therefore, the magnitude of most of the impacts of the activities on these components will be nil or very small, the absence of sensitive natural elements such as ground and surface water should be emphasized, and there is very little wild flora and fauna. One exception will be an increase in particulate materials in the air, an impact that is normally high in all quarrying, but it is an impact that can be mitigated and will occur in an area where it will do little harm.

With slight variations, it is thought that the access road to the quarry is also not sensitive, and this project activity is not expected to have significant impacts. The comparative analysis included a rock load out jetty perpendicular to the shoreline that was later replaced in the design with a modification to a planned piled trestle pier that will avoid beach morphology changes typically associated with jetties constructed perpendicular to the shoreline.

The project zone does not conflict with populated areas or on economic activities such as cultivated areas, industrial areas, and recreational activities. The baseline also shows that this zone is either free from important archaeological remains, or that such remains as do exist are not monumental and can be rescued. All of these factors represent negative socioeconomic impacts that are very small or small. In addition, there would be important positive socioeconomic impacts primarily because the quarry would provide a considerable stimulus for the local, regional and even national economy.

A great advantage for the use of this quarry is that none of the operational area is within a natural protected area, or buffer zone for a protected area. Such areas can be considered an obstacle to quarrying activities and any activities in them tend to generate significant opposition from public interest groups. This generally very negative effect can represent a high or very high impact is not present with this quarry option.

In summary, the possibility of extracting material from this quarry is a highly viable option from the environmental and social perspective.

3.4.2 DESCRIPTION OF POTENTIAL ENVIRONMENTAL IMPACTS – LOS MOLINOS QUARRY

Exploitation of the Los Molinos quarry is not considered a viable option from the environmental and social point of view, since it is estimated that the operations would cause high and very high negative impacts on particularly sensitive environmental and social aspects and components.

It should be pointed out that despite the fact that the quarry zone is desert and unpopulated and despite the low geodynamic risk in this area (except for seismic activity) there are a number of restrictive aspects that prevent this option being recommended.

First, the quarry area contains valuable archaeological remains that are very complex and probably large, which would be at great risk if the quarry were to be exploited. This is an impact of a very high magnitude that is difficult to mitigate.

In addition, although operation of the quarry would generate positive impacts on the very poor local economy and contribute to solving the severe problem of unemployment suffered by the local population, exploitation of the quarry would likely affect the embryonic tourism business in Los Molinos. Other potential impacts include damage to the local population caused by noise, particulate materials, traffic, deterioration of the landscape, as well as damage to sensitive natural components such as the Ica River valley and the ground water supply.

Quarried materials would be transported on the Pan American Highway, which would cause negative impacts on the already congested Pisco – Ica section of the highway. Furthermore, it is envisaged that this material would be trucked through the Paracas Protected Area to the Port of San Martin from where it would be shipped to the breakwater site. The use of the sensitive Paracas Protected Area would be difficult as the regulatory authorities, public interest groups and environmental organizations interested in preserving the protected area would likely be in opposition to this plan.

It is estimated that, depending on the efficiency of the mitigation measures, trucks carrying rock through the Paracas Protected Area could cause small to medium negative impacts to the environment as well as medium impacts on tourism and economic activity in the Paracas Bay. Nevertheless, the perception of social organizations in an area covered by special legislation constitutes a negative situation that has a serious impact on the environmental viability of the project.

In summary, exploitation of Los Molinos quarry is considered nearly infeasible from the environmental or social point of view.

3.4.3 DESCRIPTION OF POTENTIAL ENVIRONMENTAL IMPACTS – EL SOL – PUNTA OLLEROS QUARRY

Exploitation of the Punta Olleros quarry is not considered highly viable from the environmental point of view because, although most of the environmental and social components of the zone would not be seriously affected by the quarrying operations, some of them would be very seriously affected, which is a determining factor for this overall recommendation.

In the first place, the area is home to several protected species and, significantly was the habitat of a species that has been declared endangered in Peru (the South American fur seal) that has been the focus of government and institutions dedicated to the preservation of the species and its habitat.

The impact of quarry operations on this species at this location would be very high as it is thought that the small islands that constitute its habitat would be affected by the operations. The noise, constant light and the presence of people and machinery would cause this species to migrate and probably disappear, as there are no similar islets or habitats nearby.

In addition to this clear environmental restriction, the landscape would be damaged by the quarrying operations and a particularly sensitive section of the shoreline would be affected by the shipping, discharging and transport operations, which are also high magnitude impacts that are difficult to mitigate. At present the zone is unpopulated, but it is visually attractive and could become a source of tourism activity for the department of Ica in the future.

The fact that the majority of the impacts on environmental elements would be very small or small (due to the total absence of human settlement or farming, no ground water, almost no flora or fauna, no geodynamic risks or archaeological remains, etc.), the negative impacts on marine life and the coastal ecosystem and its landscape are significant and recommend against this alternative. These impacts are difficult to mitigate using any operational techniques, being expensive, difficult to put into practice and would not guarantee effective results.

Finally, the project area for this alternative is not currently a protected area so its legal status does not merit very rigorous management plans. However, the authorities and public opinion are generating a consensus of considering coastal areas consisting of rocky outcrops and islets protected areas in the near term. The uncertainty of potential legislation also constitutes a negative situation for the operation of this quarry.

In summary, the exploitation of Punta Olleros quarry is considered marginally viable from the environmental point of view, despite the fact that the majority of the environmental and social elements would not receive significant impacts if the quarry were to be exploited.

3.4.4 DESCRIPTION OF POTENTIAL ENVIRONMENTAL IMPACTS – "JATUN" AREA QUARRIES

Considering the different variables, we can conclude that quarrying operations in the "Jatun" area represent a low level of environmental and social impact for most of the components and operational aspects of the project. The unpopulated desert character of the quarry zone and the possibility of safe access zones that are also unpopulated and not sensitive, from the quarry to the Pan American Highway (to be used by the trucks carrying rock to the port of San Martín for shipment to the breakwater site), are very favorable conditions for this project.

In detail, the quarry area holds almost no geodynamic risks except for seismic activity, its soils are unproductive and the quality of the natural landscape is very low. Therefore, the magnitude of most of the impacts of the activities on these components will be negligible or very small. The absence of sensitive natural elements such as ground and surface water should be emphasized and there is very little wild flora and fauna. One exception would be the increase in particulate materials in the air, an impact that is normally high in all quarrying operations, but is also susceptible to mitigation, which will affect areas where there are no inhabitants or farming activity. With slight variations, it is thought that the areas of possible access to the quarry are not sensitive also and, consequently, this project activity will not have significant impacts either.

Nevertheless, transport of materials from the quarry will use the Pan American Highway, which will have a negative impact on the already fairly congested Pisco – Ica section, but above all is the fact that trucks carrying rock will enter the Paracas Protected Area on their way to the port of San Martín, and an identical situation will be faced as described for the Los Molinos quarry in relation to the Paracas Reserve and tourist areas. The associated attention anticipated from the regulatory authorities, public interest groups, and environmental organizations interested in the preservation of this highly sensitive area was also viewed as a negative factor.

In summary, exploitation of the "Jatun" area quarries is considered viable from the environmental and social point of view, but there is an important consideration in that the rock must be transported through the protected area. As a result, the project will require extremely rigorous mitigation measures to minimize impacts to the Paracas Protected Area, considered prominent in the considerations of Peruvian and international bodies interested in preservation of the environment.

3.4.5 NO QUARRY ALTERNATIVE

The "no quarry" alternative is intended evaluate the environmental and social impacts that would occur if the project did not take place. Such an analysis necessarily focuses on the positive impacts, primarily socioeconomic, that would be eliminated if no quarry were constructed.

The quarry is part of the overall development being implemented by PERU LNG and is integral to the entire LNG project. The purpose of the quarry is to construct a breakwater to protect the LNG tanker ships from strong wave action while they are taking on cargo. A breakwater is essential to the safe and effective functioning of the LNG plant and implementation of the "no quarry" alternative would result in unacceptable operating conditions. Under such circumstances, the LNG plant would not be built or would be built in an area protected from wave action, such as a natural embayment, most of which inolve sensitive habitats or are in protected zones.

Directly, the quarry project is expected to create 290 jobs during peak employment periods, and a total investment of between $19 to $23 million will be required to construct the quarry and access road and create the breakwater. This represents a significant contribution to the local and national economies that would be lost as a result of the "no quarry" alternative.

There are no negative environmental impacts that would occur as a result of implementing the "no quarry" alternative, but the positive social impacts of employment and indirect community benefits associated with the quarry and with the LNG plant located at Pampa Melchorita would not occur. The quarry site and access road would remain undeveloped and the existing and environmental and social settings would remain in place.

3.5 CONCLUSIONS

The most notable conclusion from the analysis of alternatives is that quarries in “Jatun" area and GNL and surrounding areas are the most viable from an environmental and social point of view.

The Jatun quarry has minimal environmental and social impacts, and is a recommended option, despite the fact that the Jatun quarry has a very important negative, the probable effect on the Paracas Protected Area through which the trucks carrying rock will pass on their way to the Port of San Martin. Apart from this one aspect, most environmental and social elements will receive little impact from the Jatun quarry.

The GNL quarries and surrounding areas would also have minimal potential impacts, the majority being small or very small and only certain ones, such as changes to the shoreline at Melchorita beach, a potential impact that has been mitigated with a design change, or probable effects on informal settlements, increase the classification of negative impacts. In spite of this, the analysis indicates that this is also a highly viable option from the point of view of the environment.

The quarries at Punta Olleros and Los Molinos are the least viable, especially Los Molinos, which has important environmental and social restrictions, principally archaeological sites, effects on the economic activities of the local population, deterioration of the landscape, and probable effects on protected areas. The majority of these impacts do not apply to Punta Olleros; however, this quarry would produce very high negative impacts because of the presence of sea animals within the area of influence of the project that are protected by Peruvian and international legislation. It is considered that working these quarries would be counterproductive under the circumstances.

PERU LNG initially hired Walsh to produce environmental, social and archaeological studies as part of an ESIA for the GNL quarry. However, this project was not completed because PERU LNG decided to use a quarry designated GNL-2 for technical reasons. This ESIA covers the GNL-2 quarry, although the data collected for the GNL quarry is relevant due to its proximity and similar environment to GNL-2.

A description of the project for exploitation of the GNL-2 is presented in this ESIA document, and subsequent chapters of this study contain the evaluation of potential environmental and social impacts, the environmental management plans, community relations plan, contingency plan, closure plan and other documents required by the competent authority.

4.0
PROJECT DESCRIPTION

4.1 INTRODUCTION

The project description presents the activities that will take place during operations at the GNL-2 quarry, located in the Peru LNG SRL concession area. The concession has a total surface area of 500 hectares, including a proposed access road located at kilometer 168 on the Pan American Highway. The quarry concession is in the western Andes Mountains in an area where the quantity and quality of coastal batholitic rocks are adequate to construct a breakwater for the Liquefaction Plant.

The total weight of rock necessary to build the breakwater is 3.4 million metric tons, in blocks of up to 10 tons. Generation of this amount of usable rock will require the blasting of up to 7.6 million tons of rock. The majority of the rock will be obtained during the first 11 months of operation. The project is estimated to last approximately 2 years, with 4 months of construction, 18 months of quarrying, and 2 months of decommissioning. The access road necessary for transport of the rock to the LNG Plant will be approximately 21.5 km long.

The project demands application of high technical standards in design and planning of activities, use of the best available technologies, and application of policies that ensure adequate performance in the industrial safety and environmental quality areas. The government must approve certain guidelines, manuals and security regulations that will be adopted by Peru LNG.

4.2 QUARRY DESCRIPTION

4.2.1 LOCATION

The GNL-2 quarry will be located in Culebrilla creek, approximately 20 kilometers east of the 168th km milepost on the Pan-American Highway, in the District of San Vicente de Cañete, Department of Lima.

The rock planned for extraction is located at an elevation of 1,130 m within an area of about 50 ha.

The areas that will be used for quarrying operations include:

- Access roads to the quarry and the dumpsites.
- Rock staging and handling area (6 Ha).
- Rock dump site (17 Ha)
- Temporary buildings and facilities for the mining contractor (4 Ha)

The GNL - 2 quarry drilling and blasting concession coordinates are shown in Table 4-1 and the operations area coordinates are shown in Table 4-2.

Table 4-1 Mining concession UTM coordinates

QUARRY	VERTEX	UTM COORDINATES	
		NORTH	EAST
GNL – 2	V 01	8549 000	376 000
	V 02	8549 000	378 000
	V 03	8547 000	378 000
	V 04	8547 000	377 000
	V 05	8546 000	377 000
	V 06	8546 000	376 000

Source: INACC petitionary – February 2005

Table 4-2 UTM coordinates of the operational area

QUARRY	VERTEX	UTM COORDINATES	
		NORTH	EAST
GNL – 2	OP 01	8549 000	376 000
	OP 02	8549 000	376 500
	OP 03	8548 500	376 500
	OP 04	8548 500	377 500
	OP 05	8547 500	377 500
	OP 06	8547 500	377 000
	OP 07	8547 000	377 000
	OP 08	8547 000	376 000

Source: San Martín Mining report – March 2005

There are no populated areas or farmland near the area where quarrying operations will take place. Table 4-3 shows the distances from the GNL-2 quarry to the nearest populated places. Figure 4-1 shows the location of the GNL-2 quarry and Figure 4-2 shows the area of operations.

Table 4-3 Distance from the GNL-2 Quarry to populated places

LOCALITIES	APPROXIMATE DISTANCE FROM QUARRY (KM)
San Vicente de Cañete	45.5
Grocio Prado	48.5
Chincha	42.5
Nuevo Ayacucho	23.5
Nuevo Cañete (CETEC)	22
CETEC (3º Stage development)	21
Brisas ConCon	23.5
El Trebol	23.5
Santiago Apóstol	24
Cinco Cruces	22.5
Eliane Karp	26
Buentavista – Topará Ravine	20
Conoce – Topará Ravine	24
La Capilla – Topará Ravine	27.5
Santa Beatriz – Topará Ravine	28

Figure 4-1 Location of the GNL - 2 Quarry

Figure 4-2 The area of operations GNL – 2 Quarry

4.2.2 CHARACTERISTICS OF THE ROCK

Several rocks of different sizes and weights will be extracted for the construction of the breakwater. First, a stratification layer will be placed over the marine bed. On top of this layer, filter and core rocks will be placed, in the shape of a knoll. Finally, heavy blocks for armoring will be placed on top of the breakwater.

Table 4-4 shows the different rock sizes, weights and volumes of rock to be extracted, each corresponding to the different layers of the breakwater.

Table 4-4 Weight and volume of the rocks

Layer	Rock Weight	Volume, m^2	Weight, tons
Bedding Layer	0.01 kg – 1 kg	126,000	220,500
Filter	1 kg – 1 ton	126,000 381,500	242,550 693,000
Nucleus	50 kg – 1 ton	649,500	1,193,456
Armor 2-8	2 – 8 tons	383,500 53,000	696,329 94,000
Armor 6-10	6 – 10 tons	159,500	283,144
Total		**1,879,000**	**3,422,979**

4.2.3 OPERATION ACTIVITIES SCHEDULE.

The approximate duration of mining activities at the quarry will be 2 years. During the first 4 months, an access road and other site improvements will be constructed. After that, quarry operations will begin that are estimated to last for 18 months. Two months will be needed to remove the temporary installations, and for the rehabilitation of areas affected by the project. Table 3-5 shows the tentative project schedule.

Table 4-5 Project Schedule

PROJECT SCHEDULE

			PRELIMINARY TASKS				QUARRY OPERATION																		CLOSURE	
	DESCRIPTION	Months	-4	-3	-2	-1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1.0	MOBILIZATION	1																								
2.0	MAIN ROAD CONSTRUCTION	3																								
3.0	PRELIMINARY WORK AT THE QUARRY																									
3.1	INSTALATION OF WORKSHOP, WAREHOUSE AND OFFICES	2																								
3.2	CONSTRUCTION OF EXPLOSIVES BUMBER AND NITRATE WAREHOUSE	2																								
3.3	ACCESS RAMP, INTERNAL ROADS AND INITIAL PLATFORM	2																								
3.4	DUMPSITE AND SELECTION ZONE CONSTRUCTION	2																								
4.0	QUARRY EXPLOITATION	18																								
5.0	QUARRY CLOSURE	2																								
6.0	DEMOBIILIZACION	1																								

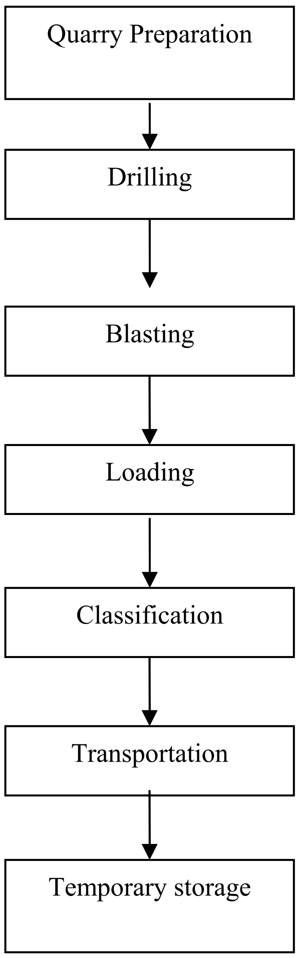
4.2.4 DESCRIPTION OF QUARRY ACTIVITIES

Quarry extraction will be undertaken using open quarry mining procedures. This is the only option possible for obtaining and handling rock with the required characteristics using conventional surface mining methodology. The primary activities during quarrying operations will be drilling, blasting, loading and transportation.

Open quarry procedures require that the surface soils and any eroded surface rock layers be removed. The total thickness of this material is between 10 and 15 meters, based on geotechnical investigations carried out on the quarry (see Geotechnical Investigations Annex). Results of the geotechnical investigation agree with tunnel and excavation drilling reports from rock with similar characteristics in the Peruvian littoral. This information will be confirmed in the initial stages of quarrying.

4.2.4.1 Productive Process Flow Chart

The production process will take place according to the following sequence of events:



4.2.4.2 Quarry Preparation

Quarry preparation includes the following activities:

1. Exploratory drilling

A total of 550 meters of exploratory drilling is planned for the GNL-2 quarry. The objective of the exploratory drilling is to confirm the geological and geotechnical characteristics of the rock selected for extraction as determined by field inspections and seismic refraction geophysical studies.

Table 4-6 shows the sites that have been planned for drilling. These locations are not final and may change depending upon actual conditions found.

Table 4-6 Location of proposed drilling sites

WELL Nº	LOCATION		DEPTH, M	INCLINE	DIRECTION
	NORTH	EAST			
DHO-QC1	8548134	376875	200	50º	N 080º
DHO-QC2	8548055	376810	150	50º	N 140º
DHO-QC3	8547886	376772	100	50º	N 180º
DHO-QC4	8547951	376956	100	HORIZONTAL	N 350º

2. Access Ramp Construction

The access ramp will be constructed to provide access to more than one extraction point. The main access ramp will be approximately 2,500 meters long, 25 meters wide, and with appropriate geometry to allow for circulation of 90-ton trucks and semi trailers. The access ramp will have a slope no greater than 8 percent.

3. Platform and Bank Construction

A platform will be built on the highest part of the quarry. The platform will be large enough to facilitate the creation of successive lower banks for rock extraction. This will allow for simultaneous operation of a minimum of two 200-meter long quarry banks. The equipment necessary for construction of the platform and banks will be the following: drillers, explosives, tractors, excavators and dump trucks. The platform will open up with a 3 meter wide access point, which will allow for movement of equipment. It will be enlarged later on, until it is large enough to support the development of the lower banks.

4. Dump sites

The quarrying of 3.4 million metric tons of rock will generate the production of waste rock not able to be used in the breakwater. Approximately 4.2 million metric tons of waste rock will be generated during quarry operations. Using an expansion factor of 1.5, the quantity of rock unable to be utilized for the breakwater represents 2.5 million cubic meters of material. This material will remain in dump sites located within the quarry.

Three locations have the required characteristics to be used as dump sites. These are shown in Figure 3-2. These locations are in creek beds near the quarry, and have been designated as the East dumpsite, Southwest dumpsite, and North dumpsite, according to their position relative to the extraction area. The total area of the dumpsites is 17 hectares. If additional dumping areas are required, they will be located within the concession area.

Once the project has begun, the feasibility of processing the waste rock in the dumpsite will be evaluated since it will be high quality, small to medium sized rock that may be able to be crushed and used as concrete aggregate for LNG plant structures.

5. Waste Rock Roads

Each waste rock dump site will have an access road leading from the quarry location and ranging in length from 400 to 1000 meters. They will be 25 meters wide, with gradients of less than 9 percent and very wide curves to ensure safe operation. Each dump site will be accessible by a ramp with a 6 percent slope.

6. Accumulation Platform and Rock Selection Area

The area required for accumulation of quarried rock and selection of rock for the breakwater will be approximately 6 hectares. This area will be located 800 meters to the west of the quarry extraction zone, a safe distance from blasting operations.

7. Drainage System Construction

Hydrological studies of the Culebrilla creek indicate flooding at flows exceeding 10 m^3/s. This necessitates proper precautions to keep quarry operations from being affected by a sudden change in the weather that may cause the creek to overflow. As a preventive measure, ditches, evacuation canals, containment structures and other structures will be constructed during quarry operation.

4.3 QUARRY EXTRACTION

Quarrying activities will take place 24 hours a day, 7 days a week, with two 12-hour shifts a day. Three groups of operators will work: one group on the day shift, a second on the night shift, and the third group will be off. Each crew will work 10 days on and 5 days off. The total estimated time for quarry operations is 24 months. Four months will be for initial mobilization and preliminary work, 18 months for active quarry extraction operations, and 2 months for site closure down. See project schedule - Table 4-5

4.3.1 EXTRACTION

Extraction activities will take place in the following order:

4.3.1.1 Drilling and Blasting

The demand for rock will require at least two active banks, each 200 m long. Each bank will have two work faces, each one 100 m long. The two work faces on each bank will alternate between drilling-blasting and loading-transportation. By using this work arrangement, positioning, maneuvering and equipment traffic in the work area should be unaffected by surrounding activities. The work faces on each bank will maintain at least nine meters of free space between them.

The approximate drilling speed will be 15 meters/hour. Two drills will be operated in order to cover the necessary daily production. An additional drill will be on stand-by in case of emergencies.

The diameter of the drill will be the smallest possible, so as to be able to best distribute the explosives. Initially, the diameter will be 2 ½ to 3 inches. The best combination of drill - steel drilling columns will be selected, so as to obtain minimal errors during drilling.

Table 4-7 presents drilling parameters that must be verified and optimized during field trials.

Table 4-7 Drilling Parameters

PARAMETER	CHARACTERISTIC
Bank Height	10 meters
Mesh – Burden	3 meters
Mesh - Spacing	3 meters
Drilling diameter	2.5" – 3.0"

The preferred blasting method for the project will be in rows and blasting will occur daily. Typically, blasting will be scheduled for midday after evacuating equipment and personnel from the area. In some cases, two daily blasting events may occur. Equipment required for this operation will be one small 5-ton mixing truck to make ANFO (ammonium nitrate and diesel number 2).

The recommended explosives charge is approximately 0.2 kg/m3, which will be corroborated with blasting tests until an optimum design has been reached and a charge factor developed for each size of rock required.

The extraction plan calls for the quarry slope to follow the natural slope of the terrain to the extent possible. The quality of the rock at the site will permit very steep slopes without risk of a landslide.

Geological inspections will be carried out, so as to verify a considerable structural discontinuity does not exist, and conditions like fracturing do not become a problem. In fairly shallow quarry extraction areas, slopes will not fail due to problems related to quality of the rock. Should a slope failure occur, it would likely be caused by a structural failure. In order to prevent structural failures, a detailed geological report will be conducted. The final slope is estimated to be 6 vertical: 1 horizontal.

4.3.1.2 Warehouses and Explosives Bunker

The warehouses and gunpowder storages will be located a safe distance from the offices, highways and other installations, in accordance with the applicable law DS 019-71/IN. The storage facilities also comply with other requirements, such as ventilation, barricades, etc. The ammonium nitrate warehouse will be located a safe distance from other installations, according to current regulations.

All the installations have a 24 hour a day guard post. Explosives will be handled by specially trained personnel authorized by the Arms Control, Civilian Use of Munitions and Explosives, Security Services Control General Management. Table 4-8 details the explosives that will be used.

Table 4-8 Explosive materials to be used

Material	Unit	Quantity
Ammonium Nitrate	Kg	800,000
Non-electric blasting caps	Units	35,000
Booster	Units	35,000
Detonation Cable	m	115,000
Safety wick	m	5,250
Blasting caps	Units	2,100

Bunkers and explosive warehouses will contain each component separately (non-electric blasting caps, detonators and safety wicks), explosives (dynamite, boosters and detonation cable) and blasting agents (ammonium nitrate). The explosives bunkers will be located east of the quarry; they will have barricades and proper protection in accordance with current regulations. Figure 4-2 shows the location of the area of operations.

According to the proposed work plan, the greatest use of ammonium nitrate occurs during the production phase - approximately 66 tons/month. The ammonium nitrate warehouse has enough capacity to store 3 months of production (200 tons). The area required for the warehouse is 1,000 m^2 and will be covered and well ventilated.

The greatest use of accessories (6,500 units of non-electric blasting caps) and explosives (1,000 kg of dynamite and 10,000 m of detonation cable) occurs during the construction of the main quarry access ramp. The area required for the safekeeping of these products is 500 m^2, which includes barricades and berms for safety.

Only a limited amount of explosives and detonation accessories will be stored in the warehouses. The explosives deposit must be surrounded by berms to protect other buildings in the event of an explosion. There must be at least 1,000 meters between the explosives bunker and the quarry, offices, warehouse or any other service area.

According to Peruvian regulations, there will be more than one explosives deposit. Only one site is necessary for the ammonium nitrate. However, electrical and non-electrical detonators, emulsion cartridges, detonation cables and boosters will be stored in different places.

A 20 m^2 concrete platform, roofed accordingly, will be made available for the ammonium nitrate, as well as two modified containers. One of the containers will store detonators, another, detonation cables, emulsion cartridges, and boosters.

The explosives bunker will be encircled by sharp wires, and it will have a central light post with sufficient brightness to light up the entire area and surroundings. The explosives bunker will have one entrance which will be patrolled by two armed guards and an overseer who will make periodic visits at day and night.

4.3.2 LOADING AND CLASSIFICATION PROCESS

4.3.2.1 Classification

Rock selection will be carried out at the quarry on the classification platform by special equipment. Armor rock does not need to be classified, as it will be previously segregated. However, the nucleus, the filter and the stratification layer will undergo a two stage classification process. The optimum locations for equipment will be established during preparation of the rock extraction plan.

4.3.2.2 Loading and Transportation

Loading and transportation will be divided into three phases, each one unique due to the size of the rocks, transportation distances and equipment used. This description only addresses loading and transportation inside the quarry concession area and transport to the Pan American Highway. Transportation to the beach and sea transportation to the breakwater construction area will be addressed with in the Liquefaction Plant EIA.

1. <u>From the Quarry to the selection zone or dump site.</u>

Blasted rock will be moved quickly so as to allow for continuous drilling and blasting. The equipment required will be:

- Wheel loader (CAT 988 or CAT 992)
- Hydraulic excavator (CAT 365 o equivalent).
- Off Highway Trucks (60 to 90 ton capacity).
- Tractor (CAT D8R or equivalent).
- 5,000 gallons cistern truck
- Motor grader (CAT 14H or equivalent).

The tractor will be necessary for occasional support for cleaning the work platform, as well as removal of large pieces of rock. Loading equipment must be highly mobile, as any number of blasting operations could take place during the day, on several operational fronts and multiple banks. A CAT 988 or 992 wheel loader, as well as a CAT 365 excavator for 60 to 90 ton dump trucks, is the best combination for this case.

Transportation distance from the quarry to the rock selection or waste rock site is about three km. Off-highway trucks will be used for this activity. The equipment will use a road of up to 25 meters wide.

2. From the Quarry

The largest rocks (armor rock and core rock) will be loaded directly from the bank to semi-trailer trucks, using cables from one end of the wheel loader or excavator. The semi-trailer trucks will directly transport the rock from the quarry to the Pan-American Highway.

3. From the Selection Zone to the Quarry

All selected or classified rock will be transported using the following equipment:

- Wheel Loader (CAT 966G, CAT988G or equivalent).
- 12 ton crane
- 15 m^3 or 22 ton dump truck
- 45TM semi-trailer trucks
- 9 000gallons cistern truck
- Motor grader (CAT 12H or equivalent)

4.3.3 PERSONNEL REQUIRED DURING CONSTRUCTION AND OPERATION

Construction of roads, provisional installations and preliminary quarry construction will require about 50 workers, including heavy equipment operators and camp workers. Food will be prepared offsite and transported to the work site. No camp facilities will be installed in the operations area. Personnel will leave the quarry site after work.

During the operating stage of the quarry, 231 workers will be required for the quarry and other installations. Approximately 70 to 90 will be from nearby towns with little or no prior experience in quarry operations.

The personnel in the operations stage of the quarry will be:

- 11 Staff
- 15 mechanics
- 155 heavy equipment operators
- 26 helpers
- 15 auxiliary (3 pick-up trucks, maintenance truck, warehouse assistant, etc.)
- 09 guards

4.3.4 MAIN RESOURCES, MATERIALS AND CONSUMABLES

4.3.4.1 Water

Water will be used during the development and operation of the quarry, for access road construction, auxiliary and secondary road and for road maintenance. Water will be supplied from Cañete and/or Chincha, using tank trucks with a capacity of up to 9,000 gallons. The quantities of water expected to be used are displayed in table 4-9. Cooling of the machinery will not employ water as these are air-cooled.

Consumption of water for an operations area with no on-site camp and portable chemical restrooms will be 2,500 gallons of water a day. Water will be used for bathrooms and showers in the workers' locker rooms. Bottled water will be used for human consumption.

The equipment and machinery will be washed every two days. The approximate consumption of water for this activity is 5,000 gallons a day.

Wetting the quarry access road to control dust will require very large amounts of water. Full time tank trucks will be used to maintain the highway and control emissions of dust. The average estimated water use for this activity is 65,000 gallons per day.

Table 4-9 Approximate consumption of water

Type	Quantity	Gallons per day	Subtotal
Human	1	2,500	2,500
Equipment maintenance	1	5,000	5,000
Highway irrigation	1	65,000	65,000
Total			72,500

4.3.4.2 Electric energy

Electricity will be supplied by 75 kilowatt electrical generators that will be used for offices, warehouses, mess hall, workshops and explosives storage. A 30 kilowatt unit will be kept in reserve in the event of an emergency.

4.3.4.3 Fuels

The primary fuel that will be used is diesel number 2, as most heavy equipment and electrical generators operate on this fuel. Supply of the fuel will be conducted so that efficiency is optimized:

- <u>Low mobility equipment</u>

  Tractors, wheel loaders, mining trucks, and cranes will use a mobile tank truck filled with fuel.

- High mobility equipment

  Mining trucks will refuel at a fuel station located in the quarry concession area.

- Equipment that moves between the Quarry and the Plant

  Dump trucks and semi-trailer trucks will refuel at a fuel station located in the quarry concession area.

4.3.5 EMISSIONS, EFFLUENTS AND RESIDUE GENERATED DURING OPERATION

4.3.5.1 Particulate matter emission

During quarry operations, only a limited a limited amount of dust is expected to be generated. The predominant northeast winds will carry dust towards the mountains and away from the Pan American Highway or population centers.

Approximately four tank trucks with water spray bars will be used to decrease the amount of fugitive dust from the access road. Other control measures are being considered, such as the use of seawater instead of fresh water.

4.3.5.2 Noise emissions

As conventional equipment will be used for the quarrying operation, the noise level will be within Peruvian and international established limits. Operators will be wearing protection for the ears, as established by legislation on extraction operations.

The operator in charge of extraction is responsible for providing personal protective equipment (PPE), and to ensure PPE is used properly at all times during work hours. Table 4-10 shows approximate noise levels that will be created by equipment and machinery at the quarry.

Table 4-10 Primary sources of noise[1]

Source of noise	Source of contribution	Level of noise (dB)
Tractor, Wheel loader, Excavator, Trucks	Engine noise (the impact of the noise could increase the levels by about 5 to 10 dB)	110 - 120
Hydraulic drilling machines	Compressed air expanding. Drilling noises	120
Pneumatic drilling machines	Compressor noise Drilling noise	130
Vibrating Screening	Flow of materials of the sieve. Engines	100 - 110

[1] Environmental guide for management of noise problems in the mining industry - MEM Mining Sub sector

4.3.5.3 Emission of combustion gases

Gases emitted by engines in operation can be classified as: emitted by the extraction equipment or emitted by the fleet of trucks and auxiliary equipment, operating primarily on roads inside of the concession area and during transportation of rocks.

During operations, the total amount of diesel fuel estimated to be used daily by equipment and vehicles is 25,000 liters.

4.3.5.4 Liquid effluents

Domestic effluents generated in portable chemical restrooms will be withdrawn by an authorized solids residue service company. According to Peru LNG policies, no domestic effluents will be discharged to the environment; they will be treated chemically or removed from the project location by an authorized contractor.

Maintenance of the machinery and equipment will generate liquids containing residual grease and other contaminating substances. To address this, all maintenance and cleaning of machinery and equipment will take place in a special location where the liquids can be properly managed.

Locker rooms with showers and washing rooms will be available for personnel.

Contaminated water coming from the machinery cleaning area and used water from the locker rooms will be collected in a retention pond and will be disposed of using percolation ponds or filtration beds. This will not affect the aquifer as ground water is very deep and is overlain by impermeable igneous rock.

Water used for dust control on the access road will evaporate.

4.3.5.5 Solid waste

Filters and other wastes from the extraction equipment will be collected and properly disposed of by mechanics and equipment operators, in accordance with the Waste Management Plan. They will be removed from the quarry by an authorized solid waste company for recycling or disposal.

As operations will be conducted 24 hours a day, with two or three shifts a day, equipment must be subjected to maintenance every two weeks (or 250 hours), primarily changes of oil and filters. Used filters will be collected and stored for removal by an authorized solid waste disposal company.

Offices will produce paper and food waste. The area where the equipment and electrical and mechanical workshops are will produce paper waste, used pieces of equipment, grease and oily rags. Waste products will be collected and disposed of properly according to the Waste Management Plan. An authorized solid waste disposal company will be used to conduct final disposal of waste materials.

4.3.6 SUPPORT INSTALLATIONS

Because the quarry is located near Cañete and Chincha, housing may be provided there for personnel. However, portable chemical restrooms will be available for personnel on site. A one-hectare area has been set aside for these facilities. Figure 4-2 presents the general layout for support installations.

4.3.6.1 Mess hall

A roofed mess hall will be available, but food will not be prepared on site. Catering companies will provide food for the workers, and will transport it to the work site.

4.3.6.2 Workshops

Workshops will be constructed on top of concrete slabs. The workshops will have removable roofed structures and containers. An area will be designated for washing vehicles that will include a trap for greases and liquids. Waste from these facilities will be transported offsite for disposal by an authorized contractor.

4.3.6.3 Offices

Twenty and forty foot trailers will be used for offices. They will be placed on top of wooden support blocks. The offices will be used for the project manager, technical department, administration, laboratory, production manager, meeting room, etc.

4.3.6.4 Generators

Two electrical generators will be used to power the aggregate selection plant and the mining contractor's installations.

4.3.6.5 Warehouses

One warehouse will be a closed off and roofed area and one will be open air. The enclosed warehouse will consist of containers and/or removable structures. The warehouses will hold replacement parts, lubricant, tires, etc. Both warehouses will be built on concrete slabs.

4.3.6.6 Service station

Portable tanks will be used, properly constructed according to current regulations. Fuel storage tanks will be protected appropriately from vehicular traffic.

4.3.6.7 Maintenance shop

A maintenance shop will be available for mechanical maintenance of equipment and for performing minor repairs. More complicated repairs will be carried out in other shops.

A concrete slab will be necessary as well as a removable metal structure that will be used for cover. The lubrication and maintenance bays will be large enough to allow the entrance of mining trucks. An area for washing will include sand traps for grease and a water circulation system.

4.3.6.8 Portable Chemical Restrooms

These restrooms will be maintained by specialized suppliers, which will guarantee a high operational standard.

4.3.6.9 Quarry Access

Construction of a main quarry access ramp

An access ramp will be built to accommodate the 90-ton capacity off-highway trucks and semi-trailer trucks. The ramp will be approximately 2,500 m long and 25 m wide with a maximum gradient of 8 percent.

Secondary access

Three 400 m to 1,000 m long roads will be constructed to provide access to the dumpsites. They will be 25 meters wide and will have a gradient of no more than 9 percent.

4.3.6.10 Lighting services

The electrical energy generation area will be located near the mechanical and electrical workshops.

4.4 ACCESS ROAD DESCRIPTION

4.4.1 LOCATION OF THE ACCESS ROAD

The access road will begin on the Pan American Highway, head northeast across the "Cinco Cruces" Pampa, then north on the dry riverbed of the "Cansa Caballo" creek. The route is approximately 21.5 km long. Access road elevation gain is 75 m, from 150 m to 900 m above sea level.

Figure 4-1 shows information on the location of the access road. Its coordinates are shown on Table 4-11.

4.4.1.1 Route description

The access road will start on kilometer 168 of the South Pan American Highway. It heads northeast, then crosses Camisea gas pipeline right of way within one km. This crossing will require a special design, because the type and intensity of traffic requires solutions different from other crossings of the Camisea gas pipeline.

At approximately 3.5 kilometers the path is in a mostly flat pampa. However, at this point, the road may veer slightly, so as to avoid small hills. Between 3.5 and 4 kilometers, a steep ascent and descent takes place, to negotiate through a rock outcropping where visibility conditions will be a concern. On vertical ascent and descent curves, visibility measurements should be taken to minimize risk to road traffic. Additionally, vertical curves should be properly signed to improve safety conditions.

Between 4 and 9 km, the road continues east. This stretch of road has no notable vertical curves. The upward slope is approximately 2.3 percent. The road will cross a power line within this section, however, no specific design or construction requirements are expected to be implemented. Nonetheless, special care must be taken for the security and safety of this crossing focusing primarily on the possibility of the impact of a truck with the pylons. Construction of anti-impact containment or trenches around the pylons may be necessary

Between 9 and 10 km, a section of 5 percent slope begins, until the road reaches the bottom of the "Culebrilla" gorge where vehicular access is currently denied. Starting at the 10 km point, the road will follow the inside of the "Culebrilla" Gorge, towards the north. The slope of the grade from km 10 to where the quarry is located at 21.5 km varies between 3.5 percent and 5 percent.

Table 4-11 Geographical description of the access road

Description	UTM Coordinates (Datum WGS84)	
	East	North
Beginning of the road	360,132	8,537,089
End of the road (quarry location)	376,449	8,547,262

4.4.2 GENERAL DESIGN ASPECTS

4.4.2.1 Length

The access road will be approximately 21.5 km long.

4.4.2.2 Width

The access road will be a minimum of 12 m wide, with 8 m shoulder on either side. Additionally, every 1,000 meters and in places with a steep slope, 2 more meters will be added on either side for emergency stops or for vehicles to stop.

4.4.2.3 Berms

The access road will have 2 meter side berms. Additionally, the road will have lateral containment berms, to keep vehicles from falling off the road, and to keep unauthorized vehicles from accessing the road. Containment berms will be built with excess materials, which will avoid having to load, transport and store them in deposits.

4.4.2.4 Right of Way

The required width for the right of way will be 20 meters, or 10 meters from the centerline on each side of the road.

4.4.2.5 Restricted property area

On each side of the strip that makes up the right-of-way, a Restricted Property Zone will be demarcated measuring 10 meters from the road centerline.

4.4.2.6 Maximum speed

According to the proposed road design, vehicles may reach a maximum speed of 60 kph.

4.4.2.7 Number of lanes

The access road is a two-lane, two-way road.

4.4.2.8 Rolling Surface

The access road will have a shoulder, 8 meters wide, which will allow vehicles to travel in both directions in complete safety.

4.4.2.9 Longitudinal profile

A longitudinal profile of the route can be established. It can easily adjust to the slopes on the terrain, except for a few occasions at the "Culebrilla" gorge. The road will have gradients no greater than 8 percent.

4.4.2.10 Geology

The geological study has identified 7 different stratigraphic units, aged from the Cretaceous through the Quaternary. The sequence of the stratigraphic column will be described, in order of the oldest to the most recent.

The largest stratigraphic unit is the Cinco Cruces Pampas, of the Cañete Formation (Qp-c). Ancient deposits of conglomerate belonging to the Pleistocene are present, approximately 100 and 200 meters thick. Certain areas have eolic sand covering the conglomerate. The Cañete Formation is originally continental, formed by ancient alluvial accumulations that came from alluvial fans. They also formed semi-consolidated polymictic conglomerates, anywhere from rounded- to sub-rounded gravel, with biconvex, collated sand, and varied granulometry.

The "Cansa Caballo" and the "Culebrilla" creek are Torrential Deposits (Qr-to) made up of ancient and modern accumulation of gravel, angular and sub angular edges and rocks, with plenty of a sandy or sandy-silty matrix , not very cohesive, and slightly to moderately dense.

Examples of these deposits are found at the Venturosa, Cansa Caballo (Culebrilla) and Huamanpuquio creek.

The beds of the creek become thinner as the scarped pampas continue to slope downwards. In some areas, the creek has been invaded by sand, obstructing the channel.

Colluvial deposits (Qr-co) are present along the Culebrilla creek and are accumulations made up of a number of different sized rocks but having a sandy or silty matrix formed by the alteration and disintegration of rocks located slightly higher. They are characterized by the presence of gravel and angular and sub angular blocks, distributed chaotically, with no apparent selection or stratification, regular to poor consolidation, and occasionally containing biconvex, silty, sandy horizons. These materials cover alluvial or more ancient torrential deposits. In other places, eolic sand covers colluvial deposits. The geological map presented only covers the most dominant outcroppings.

Accumulations of sand deposited by the wind on the prairie are part of the Eolic Deposits (Qr-e). This sand is very fine, colored gray, due to the high amount of quartz present. The sand presents itself as mantles of sand, covering wide areas and usually several meters thick. In some specific areas these deposits form dunes. These accumulations contain a high proportion of biotitic micas when found close to the rock outcroppings. These deposits correspond to the recent Quaternary period.

4.4.2.11 Phreatic level

The GNL-2 quarry geological study concludes that, based on analysis of the results, "there is no possibility of an aquifer in the GNL-2 quarry area, due to depth differences between the Cañete and Topará Rivers, and the fact that the quarry is located on top of impermeable igneous rock. There are no considerable rains during the year that could generate superficial drainage or infiltration."

4.4.2.12 Life span

Due to characteristics of the road, and an average use of 200 vehicles per day, the life span of the road is approximately 5 years.

4.4.2.13 Loads

The access road to the GNL-2 Quarry is designed according to the semi-trailer trucks' and dump trucks' needs. The road will be private, designed to carry 45-ton capacity semi-trailer trucks and 22-ton capacity dump trucks.

4.4.2.14 Pavement

The existing surface will require compacting and conformation. When executing this task, a depth of 20 cm is recommended in areas where filling is unnecessary and 30 cm where the road goes through unconsolidated eolic deposits. Pavement will be between 5 and 30 cm thick based on the specific design parameters. As the access road is private, it must meet the physical-mechanical standards outlined in the Peruvian Highway Regulation.

4.4.3 DESCRIPTION OF THE CONSTRUCTION ACTIVITIES

Main activities in construction of the access road to the GNL-2 quarry, according to information currently available, that could produce impacts on the environment are:

4.4.3.1 Provisional work

1. Construction of provisional installations

Due to the short distance between the quarry and the cities of Cañete and Chincha, no camps will be constructed. Workers will return home when their shift is completed.

The only installations that will be in place are the guardhouse, offices and the mess hall. All mobile structures will be pre-fabricated structures, permitting easy disassembly and transport. Figure 4-2 shows the proposed location for the operation support facilities.

The offices, guard houses and mess hall will be located mostly on level ground with no vegetation and far away from rivers and streams.

The installations must be sited properly so as to have basic services available to working personnel such as electrical power, a water supply system, sewage and drainage, handling of residual solids, and other equipment and facilities. The machinery yard must have washing installations set up along with grease traps. The Supervisor must approve the location of installations.

Conservation of the environment in its original state is important, and so the location of the installations must be planned carefully. When the work is finished, all constructed structures must be removed, and the entire area restored to its original form as best as possible, according to the surroundings.

2. Road Drainage

The hydrological study of the Culebrilla Creek indicates a maximum passage of water of 10.2 m^3/s. Therefore, the road must have an adequate drainage system for storm water. The construction of drainage canals, culverts, slopes and other preventive measures may be necessary to avoid storm water affecting the quarry operation.

It is possible to simply restrict activities to one side of the creek at a higher elevation than water could reach and material deposited on the creek could be used to construct an embankment. The option of using culverts on some crossings is also possible to reduce the movement of dirt and allow the construction of a platform over the area where the largest accumulation of materials exist, and thereby reducing construction costs and modifications to existing natural conditions.

PRELIMINARY WORK

1. General cleaning

This activity involves the removal of all loose material and small vegetation located within the future access road. This will be carried out using a grader, wheeled dozer/loader and dump trucks.

2. Channel cleaning

The existing channels that are currently dry will be cleaned and improved in order to provide a controlled flow of water that does not affect extraction and transportation of quarried rock in the event of a change in the flow of water.

4.4.3.2 Earth Moving

1. Cuts

Cuts (excavation, loading and elimination of extra material) will be executed mostly on Culebrillas Creek to establish the design contours. Various kinds of cuts will be executed.

2. Fills

The execution of fills (placement, conformation and compacting) will be carried out to comply with the following requirements:

- To create the desired vertical grade and smooth surface variations where they occur (undulations, ramps, ravines, etc.)
- To replace areas where inadequate earth materials are present

3. Subgrade Shaping

The road subgrade (graded natural lands upon which the road pavement will be placed) will need to be shaped along the length of the road to a width of approximately 14 meters to accommodate the pavement, shoulders and berms.

Construction will include the following processes:
- Removal of loose material at least 30 cm deep
- Construction of successive layers of fill (placement, grading, compacting) with material coming from cuts or quarries
- Material collection
- Quarry activities
- Transportation

4. Activities on other quarries

The quarry that will be used for the construction of the access road is located on the flat areas near the Cansa caballo Creek. This quarry is approximately 18,850 m^2. This quarry is easily accessible from the work area to avoid long and unnecessary trips. Figure 3-3 shows the location of the Cansa Caballo Creek.

In order to avoid adverse effects on the landscape, quarry activities will take place according to the following considerations:

- Quarry areas will be clearly signed to avoid entry of unauthorized persons
- Extra care must be taken not to affect the area surrounding the quarry
- A 300 hp tractor on treads will extract the rocks from the quarry. A wheel loader will later sift the extracted rock, using mechanical or static screening
- Rock extracted from the quarry will be loaded onto transport vehicles, using wheeled front-end loaders
- A specific area will be destined for loading of extracted rock
- Once quarry activities are completed, the used area will be reclaimed as well as possible
- Restoration will consist of grading the area to restore the natural topography

5. Transportation of materials

Transportation of rock will be carried out using 15 m^3 capacity dump trucks. The load will be covered, so as to avoid emission of dust particles. Leftover rock will be used for the construction of the containment berms, with excess materials deposited in an area where rock was extracted.

4.4.3.3 Pavement

1. Placement of Ballast Layer

The first layer will be the road subgrade material. It will be fairly thick material no larger than 4 inchs from the Culebrillas Creek site. Current thickness is proposed to be 20 cm, with one layer being sufficient.

Construction will include the following:

- Construction of the fill layer, use of rock from the quarry.
- Rock storage
- Quarry extraction
- Rock transportation

2. Placement of a second layer of cement

The difference between this stage and the previous one is the characteristics of the cement, which will be made up of smaller material (maximum size of 2 inches). The second layer will be placed on the road.

Aggregates for construction should be adjusted to the sieve sizes shown in Table 4-12.

Table 4-12 Sieve sizes for road materials

Sieve	Percent that passes through	
	A-1	A-2
50 mm (2”)	100	---
37,5 mm (1½”)	100	---
25 mm (1”)	90 – 100	100
19 mm (¾”)	65 – 100	80 – 100
9,5 mm (3/8”)	45 – 80	65 – 100
4,75 mm (Nº 4)	30 – 65	50 – 85
2,0 mm (Nº 10)	22 – 52	33 – 67
4,25 um (Nº 40)	15 – 35	20 – 45
75 um (Nº 200)	5 – 20	5 – 20

Source: AASHTO M - 147

It should also satisfy the following quality requirements:

- Wear Los Angeles Machine : 50% maximum. (MTC E 207)
- Liquid limit : 35% maximum. (MTC E 110)
- Plasticity index : 4 – 9 (MTC E 111)
- CBR : 40% minimum. (MTC E 132)
- Sand equivalent : 20% minimum. (MTC E 114)

4.4.3.4 List of required equipment

Table 4-13 lists the required equipment for the construction stage.

Table 4-13 Equipment required for the construction stage

a) Creek bed exploitation and rock processing

Quantity	Equipment
1	300 HP TRACTOR ON TREADS
2	125 HP WHEEL LOADER 2.5YD3
2	6X4 380 HP 15 M3 DUMP TRUCK
1	SCREENING STATION

b) Cleaning and cutting

Quantity	Equipment
1	300 HP TRACTOR ON TREADS
1	260 HP HYDRAULIC EXCAVATOR ON TREADS
4	6X4 380 HP 15 M3 DUMP TRUCK

c) Placement of borrowed material

Quantity	Equipment
1	300 HP TRACTOR ON TREADS
2	101-135 HP 10-12 TON ASPHALT COMPACTOR
1	125 HP MOTORGRADER
2	4X2 (WATER) 145-165 HP 2,000 GALLON CISTERN TRUCK

d) Transportation of rocks and road maintenance

Quantity	Equipment
1	125 HP 2.5YD3 WHEEL LOADER
5	6X4 330 HP 10 M3 DUMP TRUCK
1	125 HP MOTORGRADER
1	4X2 (WATER) 145-165 HP 2,000 GALLON CISTERN TRUCK

Note: the equipment can change according to the Contractor's program's needs

4.4.3.5 Approximate number of personnel during the construction phase

During the construction stage of the access road, approximately 91 workers will be needed, including technical personnel, heavy equipment operators, surveying personnel and support personnel. Table 4-14 shows the number of people necessary for each stage of the construction of the access road.

Table 4-14 Personnel required for the construction stage of the access road

Quantity	Specialty
5	Technical personnel
26	Equipment operators
26	Equipment helpers
3	Topography
4	Workshop
5	Camp operation, security, cleaning, mess hall, administrative office
4	Aggregates production
8	Watches and traffic control

4.5 LAND TRANSPORTATION OF ROCK

4.5.1 TYPE AND QUANTITY OF TRUCKS

The following trucks will be used for transportation of quarried rock:

- 15 m^3 or 22 ton dump trucks

- 45 ton semi-trailer trucks

The quantity of trucks will vary between 20 and 40 units, according to transportation needs.

Larger rocks (armor and core) will load directly from the bank onto the semi-trailer trucks, using cables tied to one end of a large wheel loader, such as a CAT 992 or CAT 365 excavator. Semi-trailer trucks will transport the rock directly from the quarry to the storage site on the beach.

Rock ranging in size from 0.5 m^3 to 1.5 m^3 will be loaded onto 15 m^3 capacity dump trucks.

4.5.1.1 Frequency

Between 20 and 40 trucks will be used daily to transport rocks, making 2 to 6 trips a day. Therefore, there will be between 40 and 240 trips a day.

4.5.1.2 Transport route

The road used for transportation will be the access road that connects the quarry to the Pan American Highway.

4.5.1.3 Traffic study

As there is no direct intersection between the access road and the Pan American Highway, no traffic study was considered necessary.

4.6 LEGAL CONDITIONS FOR LANDOWNERS

According to information obtained from public records and the Ministry of Agriculture's Rural Cadastral and Land Ownership Special Project, the access road is included in a record showing the sole owner being the Ministry of Agriculture. A Cadastral Certificate is present which states that within the concession there is no record of other registered owners. Figure 4-3 shows the cadastral units map for this project. In summary, Peru LNG will be able to use the surface lands of the concession area.

4.7 PERMITS FOR THE WORK

Peru LNG requested a mining petition for the GNL-2 Quarry from the Mining Concessions and Cadastral National Institute on January 3rd, 2005, which was approved. One copy of the approval is available in the public record.

Peru LNG has also requested permission to use the Ministry of Agriculture's land, through which the quarry access passes through. This permit is in the process of approval.

Peru LNG is also requesting permission from the Ministry of Energy and Mines - General Environmental Management Department to explore and test the quality of the rock. This permit is also in the process of approval.

Should results of the rock quality test come back favorably, Peru LNG will request permission from the Mining Promotion and Development Management of the Ministry of Energy and Mines to initiate mining activities at the quarry. This permit will require, among other things, the presentation of this ESIA, the presentation of a mining plan, and the closure plan.

Once these permits have been obtained, Peru LNG will require permission for use of explosives accomplished by obtaining a Certificate of Mining Operations from the Ministry of Energy and Mines - Mining Fiscal Management, and Security Services Control, Weapons Control, Munitions and Explosives for Civilian Use General Management (DICSCAMEC), a part of the Interior Ministry, to obtain a Global Authorization for Explosives.

The procedure to obtain the Certificate of Mining Operations begins once the ESIA is approved. The request must also contain:

- The corresponding Sworn Declaration (Category B) must be approved.
- A copy of the concession title.
- A work plan, drawn up on a horizontal and vertical plane, where programmed and executed work is designated by UTM coordinates. A mining engineer or a qualified geologist must sign the plan.
- Simple Sworn Declaration by the contracting companies.
- Work Plan.
- Availability of equipment and machinery.

After 30 calendar days, Mining Fiscal Management will notify Peru LNG if their request for use of explosives has been approved and the quantity allowed. The permit will allow the company to use explosives for one year (365 days).

Once the Certificate of Mining Operations is obtained, Peru LNG must request permission from DICSCAMEC for a Global Authorization for Explosives. The request must come with the following documents:

1. Certificate of Mining Operations, granted by the Ministry of Energy and Mining.
2. Company security services lease contract.
3. List of all handlers of explosives, indicating license number for each of them.
4. DICSCAMEC must open and sign a book of acts that controls the use of explosives for civilian use.

When the request is presented, DICSCAMEC will carry out an initial evaluation, and send the request to the Armed Forces. With their approval, the file returns to DICSCAMEC, who will then issue the Global Authorization for Explosives, indicating the quantity of explosives the company can use in 6 month periods - January to June and July to December.

Each time the company purchases explosives, it has to file an official and specific transportation document, indicating the exact amount of explosives they are purchasing.

Figure 4-3 Cadastral Units Map

5.0 BASELINE

5.1.1 CLIMATE

5.1.1.1 BACKGROUND

The central coast of Peru has an arid climate due to the vertical descending movements that impede the development of clouds that produce rain. According to Tossi's Zones of Life classification, the area is catalogued as Subtropical Super Arid Desert ds-S. The local topographic and physiographic configuration creates variable and complex circulations effects. During the summer, the wind's daytime variation is less defined due to strong heating of the uneven and desertic surface, which creates a mixed layer of air as the wind increases its speed. These conditions increase the atmospheric mixing conditions and increase the dispersion of particles and gases.

The baseline weather description was based on information gathered from the meteorological stations of Cañete, Pacarán, Huancano and Yauyos. The information was prepared by the National Service of Meteorology and Hydrology (SENAMHI), in 2005. SENHAMHI collected data for temperature, humidity, wind direction and wind speed. Table 5.1.1-1 shows the location of the mentioned meteorological stations and the attached section presents the information provided by SENAMHI.

Table 5.1.1-1 Location of the Meteorological Stations

Meteorological Station Name	Location					
	Latitude	Longitude	Altitude (m)	Department	Province	District
Cañete	13° 04'	76° 20'	150	Lima	Cañete	Imperial
Pacarán	12° 51'	76° 03'	721	Lima	Cañete	Pacarán
Huancano	13° 36'	75° 57'	1 006	Ica	Pisco	Huancano
Yauyos	12º 29'	75º 56'	2871	Lima	Yauyos	Yauyos

Source: SENAMHI

These stations were used because of their proximity to the area of influence of the GNL-2 Quarry, so that a forecast can be made of the prevailing weather conditions in the area of influence. See the Climate Map in the maps section.

To complement the information from the national meteorological station, data was also collected at the quarry site itself. Data for temperature, relative humidity, and wind speed and direction was collected from different locations at the quarry and nearby areas from March 1st to March 6th, 2005.

In addition, researchers completed a field visit to the Topará creek to identify the topographical and physiographical factors that determine local circulation patterns and to validate the wind's flow in lower levels. It would have been preferable to collect information on weather patterns in the Culebrillas creek, but it does not have an access road. Instead, the Topará creek was selected due to its proximity and similar topography, physiography, and orientation to the Culebrillas.

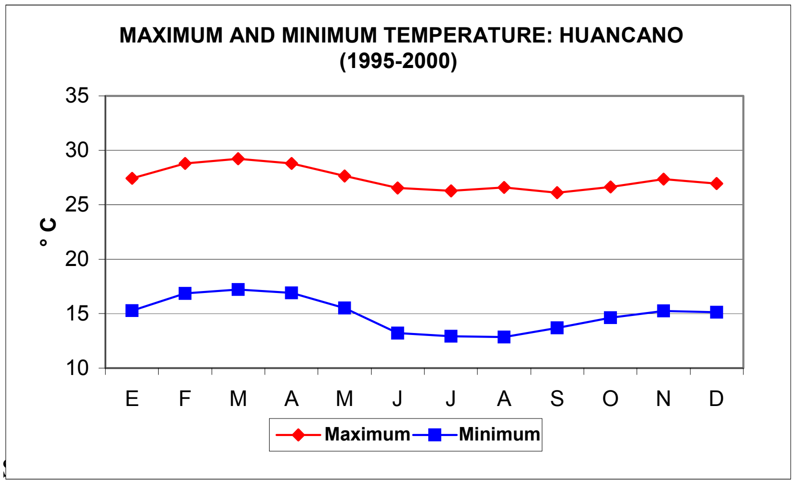
5.1.1.2 WEATHER

A. Air Temperatures

The Huancano station and the quarry are located at the same altitude and have similar physical characteristics and interactions among the oceanic, continental and atmospheric environments. Therefore, the zone of interest is well represented by the air temperature data of the Huancano Station.

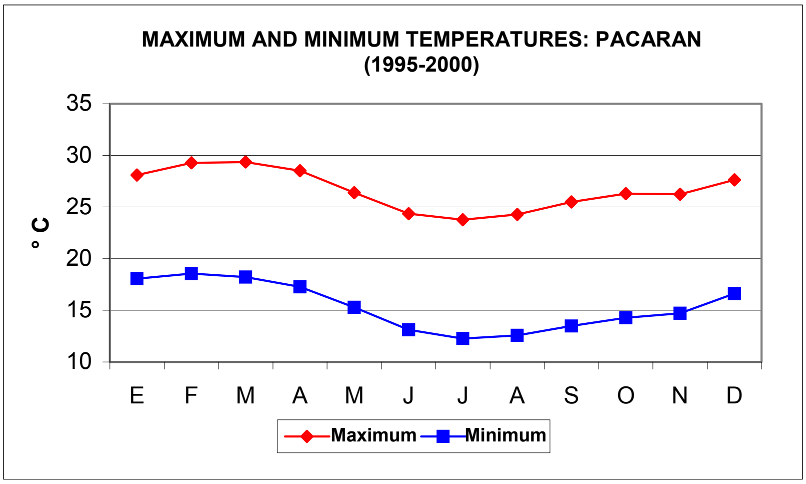
Figure 5.1.1-1 shows the average maximum monthly temperatures with values between 26.1° C and 29.2° C during September and March respectively. The average minimum monthly temperature varies from 12.9 ° C during July-August to 17.2 ° C in March. The minimum average annual temperatures are between 3° C and 4° C, which indicates a small seasonal variability.

Figure 5.1.1-1 Monthly average temperature for 1995 – 2000 period, Huancano Station



The average monthly temperature values at Pacarán vary from 18°C to 29°C during the summer. The temperature during the winter presents lower values with a maximum temperature of 24°C and a minimum temperature of 12°C (figure 5.1.1-2). Therefore, the maximum temperatures in Pacarán are slightly lower than in the quarry's zone (represented by the Huancano Station), while the minimum temperatures show similar values.

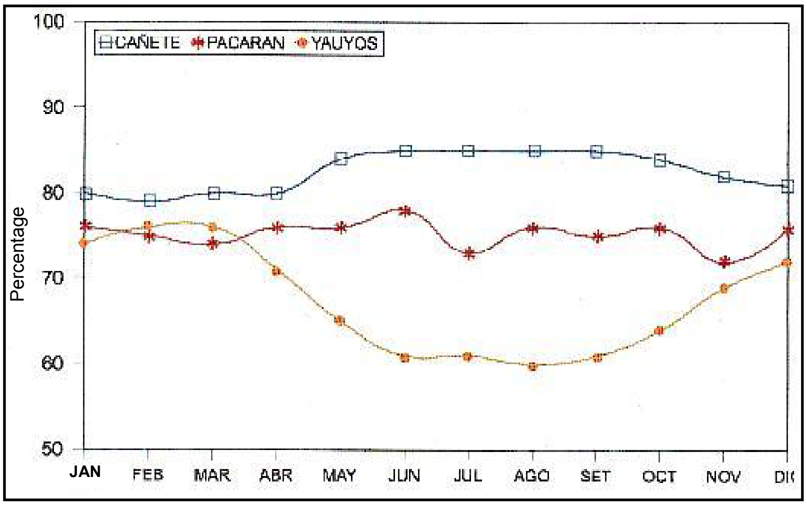
Figure 5.1.1-2 Monthly average temperature for 1995 – 2000 period, Pacarán Station



B. Relative Humidity

The review of the Cañete, Pacarán and Yauyos meteorological data for the period 1968-1997 show important variation on relative humidity values throughout the year. All stations show relative humidity values from 75% to 80% from January to April. Starting in April, the Yauyos Station, which is located at a higher altitude, decreases relative humidity to approximately 60%. By contrast, the Cañete and Pacarán stations show slight increases reaching 85%, especially in Cañete due to its proximity to the Pacific Ocean (figure 5.1.1-3).

Figure 5.1.1-3 Monthly average relative humidity for 1968–1997 period, Cañete, Pacarán and Yauyos Stations

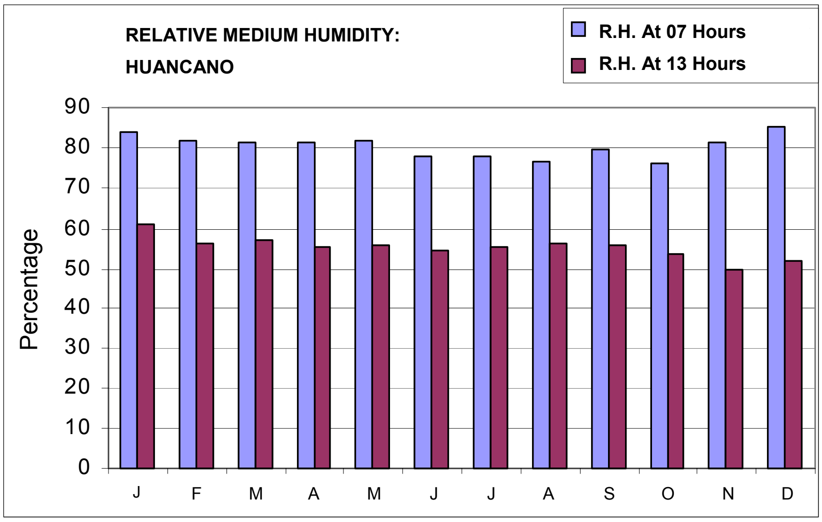


Source: Agricultural-Climatic Study of the Cañete River Basin, 2004

The Huancano Station shows the relative humidity daily behavior based on the data from 2005 shown in figure 5.1.1-4). Typically, morning hours throughout the year have a relative humidity of 80%. Early afternoon relative humidity values decreases to 50% and 60%. Both conditions show lower relative humidity values in comparison to areas located closer to the coast.

The quarry area presents daily and monthly relative humidity variation because of its exposure to humid marine air. It is estimated that early morning conditions will approach 75% to 80% while early afternoon will be 50%. During the fall, winter and part of spring, relative humidity will show lower values (up to 45%).

Figure 5.1.1-4 Monthly average relative humidity for 1995–2000 period, Huancano Station



C. Fogs

The central coast of Peru typically experiences fog during the fall and winter. Fog is generated when humid air, originated in the sea, reach 400 – 600m, and night temperatures drop. Fog occasionally reaches 800m when the marine breezes are more intense. Because the quarry's area is located between approximately at 900 to 1450m, fog will rarely be an issue at the operations area but will be very common along the access road.

D. Cloudiness

The central coast of Peru experiences cloudiness up to the 1500m and higher coverages during the winter season. Table 5.1.1-2 shows cloudiness values in "eights" for the Cañete, Pacarán and Yauyos stations. The "eights" ("oktas") are a measure of how much sky is visible and are typically represented by fine (clear) conditions (1 to 2), partly cloudy (3 to 4), mostly cloudy (5 to 6), cloudy (7), and overcast (8).

The Cañete Station is typically mostly cloudy to cloudy during winter due to its proximity to the Pacific Ocean. The Pacarán Station due to its altitude has lesser cloudiness during the winter, with partly cloudy skies. Based on the information gathered, the quarry should experience clear to partly cloudy skies. Due to its location and altitude, cloud coverage during the summer could reach up to mostly cloudy, reducing to clear skies during fall, winter and spring.

Table 5.1.1-2 Cloudiness in "Oktas" (eights) for 1968 – 1997 period

Meteorological Stations	Months											
	J	F	M	A	M	J	J	A	S	O	N	D
Cañete	5.8	5.7	5.8	5.9	6.4	7.7	7.5	7.5	7.4	6.6	6.4	6.1
Pacarán	3.2	3.4	3.3	2.3	2.0	1.8	1.7	1.6	1.6	2.2	2.3	2.5
Yauyos	5.6	5.5	5.8	3.6	1.2	1.2	1.4	1.7	1.9	2.7	3.5	4.7

E. Precipitation

The precipitation baseline used data from the Huancano, Cañete and Pacarán Meteorological Stations that was collected from 1964 to 1980. Figure 5.1.1-5 shows that precipitation starts in Huancano in September and ends in April. From April to August there is little to no precipitation. January, February and March account for 90% of the total yearly precipitation. February has the higher monthly precipitation with 43% of the total annual precipitation. As this station is representative of the location of the quarry, precipitations are expected to be slight and scarce, with the exception of summer, when they could accumulate from 20 to 25 mm of rain.

Figure 5.1.1-5 Monthly average precipitation for 1964 – 1980 period, Huancano Station

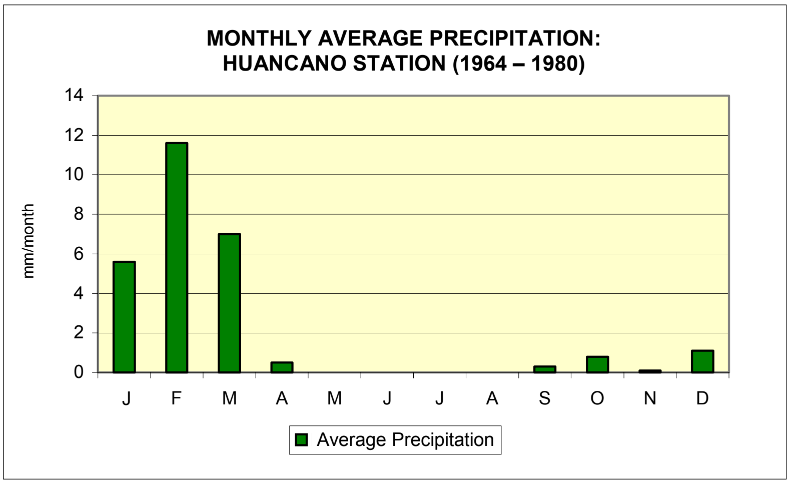
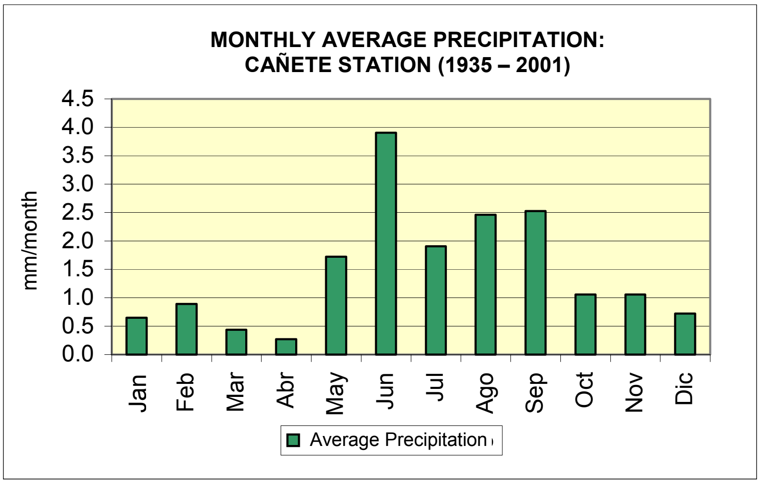


Figure 5.1.1-6 shows that winter months represent 75% of the annual total precipitation (20.2 mm/year) in Canete, with the highest average of 4.4 mm/month for June. The summer months represent 13% of the total precipitation. The predominant type of precipitation is "drizzle" and occurs from June to September.

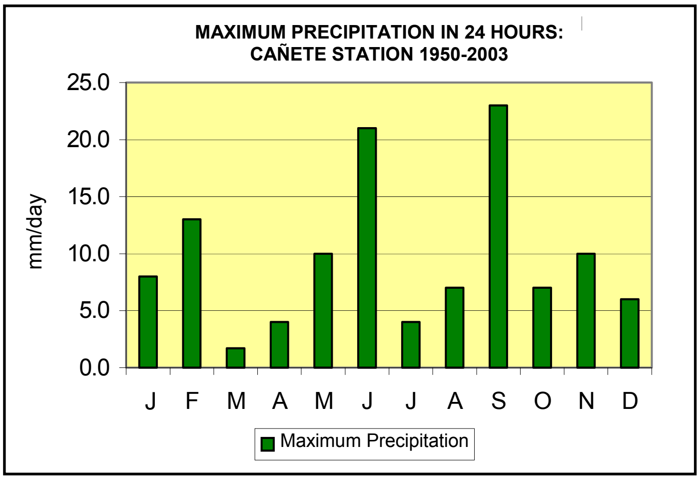
Figure 5.1.1-6 Monthly average precipitation for 1935 – 2001 period, Cañete Station



e.1 Maximum Precipitation in 24 Hours

Figure 5.1.1-7 shows Cañete Station data for the period 1950-2004. The maximum daily precipitation registered during that period is 23 mm during a year catalogued as El Niño. These data is representative of precipitation intensities that may occur at the quarry.

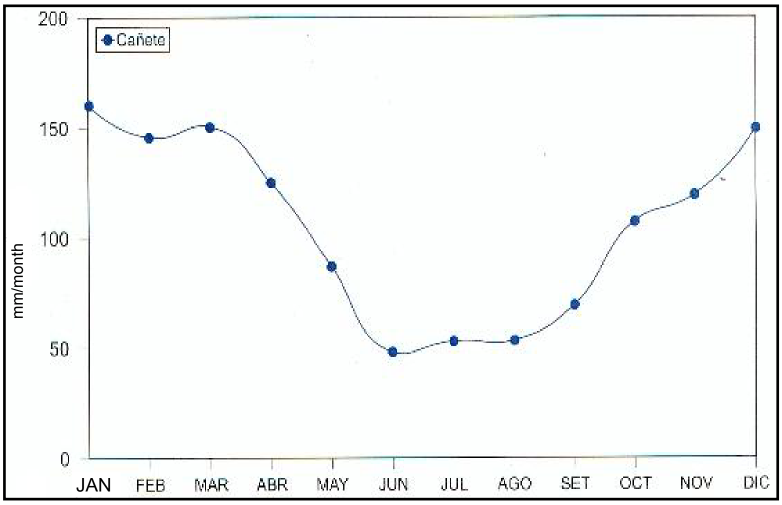
Figure 5.1.1-7 Maximum 24 hr precipitation by month for 1950–2003 period, Cañete Station



F. Evaporation

Figure 5.1.1-9 shows that the evaporation rates at the Cañete Station are three times higher during the summer (150 mm/month in January) than those of the winter (50 mm/m in June). It is estimated that evaporation rate at the quarry area are higher during the summer. The annual total evaporation is estimated around 1800 mm/year (SENAMHI, 1994). During the summer, the daily average evaporation is 6 mm/day in January. During the winter, the value reduces to 5 mm/day in July.

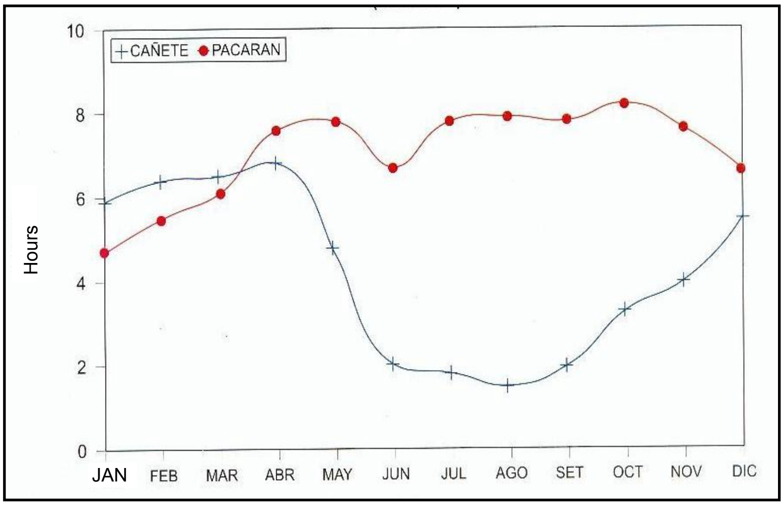
Figure 5.1.1-9 Monthly average evaporation for 1968 – 1997, Cañete Station



G. Sunshine Hours

Sunshine hours have an inverse relationship to cloudiness. During the summer, Cañete and Pacarán show between 4.7 to 6 hours per day. From fall to spring, Pacarán shows more sunshine hours of sun than Cañete (figure 5.1.1-10). The quarry area has considerably higher sunshine hours than Cañete and Pacarán throughout the year.

Figure 5.1.1-10 Monthly average sunshine hours for 1968 – 1997 period, Cañete and Pacarán Stations



H. Wind

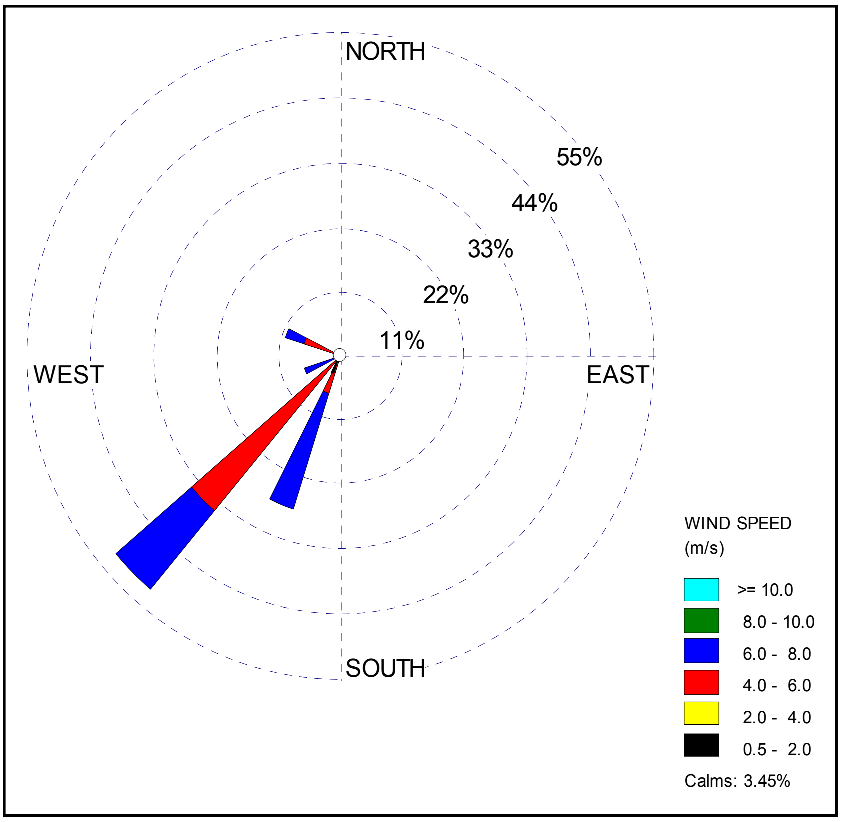
The wind significantly influences the region's weather. The wind varies due to climatic events such as the El Niño and La Niña phenomena. Data from the Cañete Station were collected for 1995-2000, which includes typical as well as El Niño data. Wind data acquired corresponds to the 13 hours when the main eolic activity occurs in the area.

h.1 Wind's behavior during a normal year

The wind behavior for normal climatic conditions was based on the data for the 1995 - 1996 period. This period shows that during the **summer**, the predominant southwesterly winds (SW) blow with frequencies between 55% and 75%. Winds blow less frequently from the west (WSW, WNW, SSW). Wind speed velocities vary between 6 m/s to 10 m/s. (Figure 5.1.1-11).

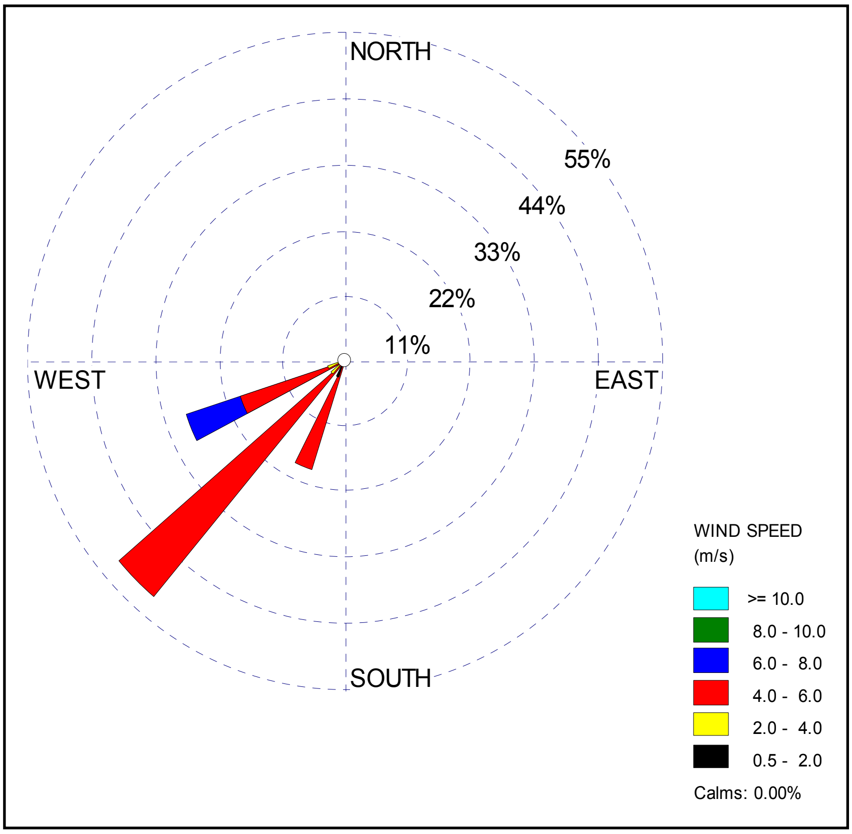
Winter conditions show predominant southwesterly winds with frequencies similar to those of the summer. Other wind directions are South (S) and West (W). Wind speeds registered during this period range from 4 to 8 m/s. The predominant southwestern direction reflects the valley's orientation in this area and indicates the marine air influence that produces minor atmospheric stability. (Figure 5.1.1-12)

Figure 5.1.1-11 Wind direction during a normal year – Summer conditions*



*February 1996, 13 hours

Figure 5.1.1-12 Wind direction during a normal year – Winter conditions*



*July 1996, 13 hours

h.2 Wind behavior during El Niño year

Summer wind behavior during El Niño phenomena was analyzed based on February 1998, while July 1997 was selected as a representative winter month. Predominant winds during the summer were northeasterly (NE) and east northeasterly (ENE) with frequencies of 57% and 36% respectively. The wind speed shows velocities in the range of 4 to 10 m/s. Winter wind direction were also northeasterly with a 70% frequency and wind speeds ranged from 4 to 8 m/s. See the wind direction in the annex "Evaluation of Meteorological and Climate Conditions in the Quarry Zone", Cañete – Lima, 2005.

h.3 Wind behavior during a La Niña year

The latest climatic anomaly, "La Niña," occurred from winter 1998 until winter 2001. The description of these conditions was based on data from February 1999 and 2000 for the summer and July 1999 and 2000 for the winter. Summer data shows predominantly northeasterly winds (NE), with a frequency of 53% in 1999 and 42% in 2000, with minor occurrences of north northeasterly and east southeasterly winds. Winds speeds ranged from 4 to 10 m/s. The winter data shows predominantly northeasterly (NE) winds with a frequency of 55%. Wind speeds varied from 2 to 10 m/s. See the wind direction in the annex "Evaluation of Meteorological and Climate Conditions in the Quarry Zone", Cañete – Lima, 2005.

5.1.1.3 FIELD DATA COLLECTION

Table 5.1.1-3 shows the location of the four sites selected for gathering meteorological data. The collection period was representative of a normal year, with a strong Pacific Ocean's anticyclone, which is the controlling weather factor for the Peruvian coast. Therefore, typical trade winds associated with the Peruvian littoral and marine breezes had more intensity.

Meteorological monitoring in the quarry's area of influence was carried out in order to characterize the meteorological conditions in a short period of time. The results fell within the typical ranges and characteristics for wind speed and direction, temperature and relative humidity as section 5.1.1.2 Weather of this chapter describes.

Table 5.1.1-3 Meteorological Data Collection Stations

Sampling Point	Location	UTM Coordinates (WGS 84, 18L)	Date and Start Time
P1	Topará's Creek High Part	378,333 8,543,759	Date: 01/03/05 Hour: 03:00 p.m.
P2	Access Road to GNL 2 Quarry's Middle Point	369,457 8,540,437	Date: 02/03/05 Hour: 06:00 p.m.
P3	GNL 2 Quarry – Point 1	376,031 8,546,794	Date: 04/03/05 Hour: 10:30 a.m.
P4	GNL 2 Quarry – Point 2	376,872 8,547,729	Date: 05/03/05 Hour: 12:30 p.m.

Data collected at all stations showed typical patterns and characteristicsas compared with bibliographic references.

Night temperatures at all stations were stable at approximately 20° C, which indicates calm winds and usually stratiform cloud coverage. As the day progresses the temperature gradually increases, reaching a maximum of 31 to 33° C at 2 p.m.

Relative humidity changes hourly, with variations among stations due to marine breeze exposure. The Topara and the Access Road stations show a maximum relative humidity of 79% at 6:00 a.m. and a minimum of 31% at 2 p.m. The maximum relative humidity at the two stations at the GNL-2 Quarry were lower (69%), because they are farther away to the Pacific Ocean, which is a source of humidity.

Due to stable temperatures, night winds show calms or low speeds of up to 1.7 m/s. Data at the two stations at the quarry showed calm winds to velocities less than 1 m/s.

The speed of daytime winds increases as horizontal temperature gradients develop between the atmosphere and desert. The gradient reaches its maximum in the afternoon, causing the highest wind speeds. Speeds start early in the morning with low velocities (1 m/s) and reached up to 4 m/s.

The wind direction in the area is influenced by orientation of the local hills. The Topara station showed predominant westernly to west southwesternly winds 52% of the time. The Access Road station, due to its proximitiy to the sea shore and its location on the coastal plain shows a higher wind direction variation. Nevertheless, this station shows the predominant south-west quadrant direction typical for the area.

The Quarry stations show similar wind direction patterns than the Topara station. Southwesternly winds had the predominant frequency at both stations, given the valley's orientation, with values from 28 to 80%.

An analysis of the meteorological data collected in the zone of influence of the GNL-2 quarry during monitoring in the month of March 2005 (summer), leads to the conclusion that the temperature, relative humidity and wind speed and direction records are representative of the climate characteristics in the study zone.

5.1.1.4 MIXING LAYER HEIGHT

The atmospheric mixing layer is where the transportation and dispersion of heat, gases, and suspended materials occurs. The layer height depends on local temperature gradients, wind strength, wind variability, and cloud coverages and is not constant throughout the year.

The estimated mixing layer heights are presented in Table 5.1.1-4. The average annual maximum height is 320 m during the daytime, with its maximum value at 449 m during February.

The nighttime thermal inversion creates atmospheric stability, decreasing the mixing layer's average annual height to 294 m and a maximum height of 479 m in February.

The mixing height also shows that seasonal variations reach the highest height during the summer and the lowest during the winter with 182 during the day and 153 during the night.

Table 5.1.1-4 Mix layer's maximum height (m) during day and night periods

Month	Day	Night
January	488	464
February	499	479
March	455	436
April	426	413
May	237	209
June	259	230
July	196	164
August	185	157
September	166	138
October	194	167
November	305	276
December	424	395

5.1.2 GEOLOGY

5.1.2.1 GENERAL GEOLOGY

This chapter describes the chronostratigraphic column of the area and its geologic past. It also describes geologic considerations related to interventions in the geologic medium such as removals, excavations.

The evaluation describes the main rock formations of the quarry area, their physical, chemical and structural characteristics, their potential uses, and the environmental implications regarding the work in the quarry. It also deals with its seismic and geodynamic characteristics, as well as the relations with the types of soils and the probability of pollution. The study is based on:

- Information published by the INGEMMET in the Chincha and Lunahuaná Quadrangles at a 1:100 000 scale
- The ONERN reports that deal with the Cañete and San Juan-Topará river basins
- The interpretation that Walsh completed from the high resolution Landsat 7 TM satellite images
- Information obtained during the field visits.

Geologically, the area of study is situated between the coastal plains and the western Andean foothills. This area includes characteristics of a distinctive rock group with a particular geohistoric development, structures, altitude and lithology. Its relief ranges from alluvial, torrential and eolian plains, to abrupt and scarped hilly or mountain slopes.

Volume III of the Maps shows the Geological Map (M 5-2). The lythological characteristics can be seen in Figure 5.1.2-1, which presents the chronostratigraphic column of the region.

Stratigraphy

In the area of study, seven (7) stratigraphic units have been identified. Their ages range from the Cretaceous to the Late Quaternary. The sequence of the stratigraphic column is described below, starting with the oldest and ending with the most recent unit.

- **Quilmaná Formation (Kis-q)**

This unit is formed by volcanic rocks of andesite type, which are greenish-gray in color and have a porphyritic texture. The sequence lies in a Northwest direction in contact with the Coastal Batholith. Through weathering, this formation has developed reddish brown to yellow tones. This unit presents pseudo stratifications, which are visible in some sectors of the area of study as they form hills with moderate to abrupt slopes, with fractured rocks and a light eolian cover.

This stratigraphic unit is dated between the Lower and the Upper Cretaceous and its thickness is calculated to be 1,000 meters. Obvious outcrops in the area occur in the western sectors of the Andean foothills.

- **Pocoto Formation (Ts-p)**

This stratigraphic unit was formed by a sequence of continental sediments and volcanic tuffs. In its lower section, it is comprised of coarse sand in medium layers, breccias and volcanic agglomerates with a sand-silty matrix. Its upper section consists of pink, brown and whitish rhyolitic and rhyodacitic tuffs. The rocks are massive and present pseudostratification locally.

The sequence rests discordantly and sub-horizontally over the cretaceous rocks and over the Coastal Batholith units. It is considered to belong to the Tertiary (Miocene) Era, with a thickness of about 120 meters. It has minor outcrops on both sides of the Topará creek and in some reduced sectors in the neighborhood of the Venturosa creek, where it forms small hills with moderate slopes.

- **Cañete Formation (Qp-c)**

This is a formation of continental origin, formed by old alluvial accumulations coming, from dejection cones, that have formed semi consolidated polymictic conglomerates, with rounded to subrounded gravels and with lenticular sand intercalations, with varied granulometry, that may present cross stratification.

The lithology changes southwards, as in cliffs in the Jahuay area and the Topará creek. The base of the sequence is formed by fine to coarse sand with some layers of small gravels, and towards the top it becomes a silt-clay mixture, with fine to coarse sand embedded in continual and lenticular layers. These layers present some horizons with cross-stratification.

These conglomerate deposits correspond to the Pleistocene Quaternary. The thickness of this formation ranges from 100 to 200 meters. This stratigraphic unit occurs quite widely in the Pampas Cinco Cruces and in Jahuay. Eolian sands conceal the deposits in some locations.

- **Alluvial Deposits (Qr-al)**

These deposits consist of fluvial accumulations of loose and consolidated materials of a heterogeneous or heterometric nature that have been transported at great distances by the fluvial currents. They are formed by rounded or sub rounded blocks, cobbles, and gravels, covered with a sandy silty matrix, that was deposited during the Holocene. They occur as long and narrow strips (terraces) along the Topará creek.

- **Torrential Deposits (Qr-to)**

These deposits occupy the beds and margins of the dry creeks, but are activated in the wet seasons. They are formed by old and recent accumulation of gravels, pebbles, and sub angular to angular blocks, with abundant sandy or silty-sandy matrix. They are not very cohesive or dense. We can find examples of these deposits in the Venturosa, Cansa Caballo (Culebrilla) and Huamanpuquio creeks.

It is important to mention that the beds of the creeks narrow gradually in the coastal plains as they move downgrade. In some sectors, eolian sands obstruct the course of the creeks.

- **Colluvial Deposits (Qr-co)**

These accumulations are made of material of different sizes, but are homogeneous in lithology. They are located in a silty or sandy matrix that is distributed unevenly in the sides and bases of the hills. They have been formed by the alteration and disintegration of the rocks located on the sides of the adjacent upper levels. They contain gravels and angular to sub angular blocks distributed haphazardly, without any selection or apparent stratification and with a regular to poor consolidation. Occasionally they contain some lenticular sandy silt horizons.

In some sectors, these materials cover older alluvial or torrential deposits. In other stretches, eolian sands cover the colluvial deposits. Because they have a small extension, only the most obvious outcrops are identified in the geologic map enclosed.

- **Eolian Deposits (Qr-e)**

The wind deposited these accumulations of sand on the plains. They comprise the coastal peneplains and sit on the low sides of the Andean hillsides. The sands have a fine to medium grain and are of light gray color because of their high quartz content.

In the area of study, the eolian deposits form sand layers that are several meters thick and cover great extensions of land. In some locations, the form sand dunes and show ripple marks. Near the rock outcrops, these accumulations contain a high proportion of biotite mica. These deposits are dated as Late Quaternary.

Figure 5.1.2-1 Chronostratigraphic column

Era	Sistema	Serie	Formación geológica	Sección	Descripción Litológica
CENOZOICO	CUATERNARIO	HOLOCENO	Depósitos Eólicos		Acumulación de arenas eólicas de grano medio a fino
			Depósitos Coluviales		Granos, cantos y bloques subangulosos con matriz areno limosa
			Depósitos Torrenciales		Granos, cantos y bloques subangulosos y angulosos con matriz arenosa o limo-arenosa
			Depósitos aluviales		Acumulación de gravas, arenas, limos y arcillas
		PLEISTOCENO	Formación Cañete		Conglomerado semi-consolidado con una matriz areno limosa
	TERCIARIO	SUPERIOR	Formación Pocoto		Areniscas de grano grueso, brechas, aglomerados volcanicos y tobas riolíticas y riodacíticas
MESOZOICO	CRETACEO	SUPERIOR	Formación Quilmaná		Volcánicos, andositicos seudo estratificados
		INFERIOR			

Intrusive Rocks

Intrusive rocks are represented by a set of intrusions of the Coastal Batholith, whose petrological classifications present a wide range of variation (granodiorites, monzonites, granites, tonalites, diorites and gabbros). These intrusive bodies are exposed towards the East of the evaluated areas, where they occur as prominent hills with a moderate to abrupt relief.

The intrusion of the Coastal Batholith is dated as Cretaceous, and has been divided in great plutons, also known as super units. The following plutons have been identified in the study area:

- **Patap Super Unit**

  This super unit constitutes the first intrusive episode of the Coastal Batholiths. It is distinguished by presenting lithology, grading from gabbros to diorites (K-gbdi-p), with mesocratic to melanocratic characteristics and with variable textures. Their alteration minerals are also variable.

- **Incahuasi Super Unit**

  This super unit mainly consists of tonalites and granodiorites (k-tgd-i), including some cream- gray color quartz-diorites, with reddish-brown tonality and porphyritic texture.

- **Tiabaya Super Unit**

  This super unit is the youngest member of the batholithic components in the area of study. Most of the outcrops are granodiorites but with variations that range from tonalite to monzogranite (k-gd.mgr-/t, k-tgd-t). It presents grayish colors with cream and reddish tonalities.

In general, these intrusive rocks from the Coastal Batholith would be useful in constructing breakwater dams. Structurally these rocks appear in banks with a moderate thickness with a high superficial fracturing (diaclase). Physical weathering can significantly alter the surface of these rocks, as it erodes them and produces colluvial accumulations of grits and coarse sands in the sides and base of hills.

That being said, when the rocks are “fresh”, they present good competence and great hardness, which make them suitable for the construction of breakwater dams..

On the other hand, as the sedimentary and plutonic lithological units that outcrop in the area of the lease do not contain sulfurated or copper oxide minerals, no acid drainage is likely to be generated.

5.1.2.2 HISTORICAL GEOLOGY

The historical geology of the region is the result of the several geotectonic events. It starts with the deposition of sedimentary and volcanic-sedimentary materials from the Cretaceous on an oscillating basin. After this sedimentary stage, the first event of the Andean geotectonic cycle (Peruvian phase) occurred during the Upper Cretaceous. This event uplifted the Andean rock blocks to moderate levels and initiated the intrusion of the extensive Coastal Batholith, whose outcrops are mainly exposed in the eastern sector of the area of study.

The third stage of the Andean geotectonic cycle (Quichuana phase) occurred during the Plio-Pleistocene times. It moderately folded and raised the rocky block of the western slope, forming the hilly and mountain relief that is characteristic of the middle Andean area and the western foothills. This epeirogenic uplift was accompanied by an intense denudation and accelerated dissection which enabled the Andean rivers and creeks to establish their courses, as in the case of the Topará, Cansa Caballo and Venturosa creeks.

Climatic oscillations during the Pleistocene caused an intense alluviation. This resulted in the Cañete formation that formed the coastal plains that extend in the lower sector of the area of study and which eolian sands partially cover. In Holocene times, and in arid to semi arid climatic conditions, a new series of alluvial, torrential colluvial and eolian sediments were deposited.

5.1.2.3 STRUCTURAL GEOLOGY

In the area of study, the sedimentary formational and the volcanic-sedimentary units present an intense deformation as a consequence of the Andean tectonic phases. The Coastal Batholith follows a NW – SE orientation, clearly parallel to the littoral. Its location is probably a consequence of an area of faults. In this geological environment, the following structures have been identified:

Faulting

- **Tectonic Faults:** The study area includes faults that affect the intrusive and volcanic-sedimentary rocks. These faults do not present any risk as they are quite old and inactive. The most important faults include:

  Fault with NE-SW direction: The upper stretch of the Topará creek courses through this 12 km-long fault. The fault affects the tonalites and granodiorite bodies transversally in the Incahuasi and Tantará super units.

  Fault with NW-SE direction: This 10 km-long fault cuts the Topará and Culebrilla creeks transversally. In the latter, the fault starts a deflection to change to a NE-SW direction in its northern stretch. Structurally, it truncates the outcrops of the Patap and Tiabaya plutonic bodies.

- **Neotectonic Faults:** According to the document prepared by IGP: “Observaciones acerca de la Neotectónica del Perú” (1982), (Observations on Neotectonics in Peru), it is clear that no active faults nor earthquakes with focal points have been registered in the study area. Therefore, the influence of neotectonic structures in the area is not an important consideration.

5.1.2.4 HYDROGEOLOGY

The hydrogeologic analysis identifies the aquifers in the study area and the way they may be affected by quarry operations. This study utilized a study area of 395 km^2 to ensure adequate understanding of the hydrogeological aspects of the region.

- **Topography**

The anticipated location of the quarry extraction works is located over 1000 m., with a difference of 600m with the level of the Rio Cañete valley.

- **Influence of the Geologic and Geomorphologic Frameworks over the Hydrogeology in the area of study**

Geologic, geomorphologic and structural factors have formed the basins of the aquifers and determined the potential volume of water in each. These factors have also formed the drainage network, the main branches of which are the Cañete River and the Topará Creek.

There are two main hydrologic groups of rocks: *the consolidated pre-Quaternary rocks and the old and recent alluvial Quaternary rocks.* These latter are from the Pleistoce sediments of the Cañete Formation. They are characterized by impermeability, fluvio-alluvial sediments which formed the alluvial cone of the rivers, and desert alluvial accumulations of the creeks. The composition of the alluvial sediments includes boulders (intrusive and volcanic) of different sizes and some layers of sand, silt and clays (sometimes inter fingered). The recent alluvial and torrential deposits are restricted to narrow bands on both margins of the Topará, Cansa Caballo (Culebrilla) and Venturosa creeks.

Another important factor are the igneous outcrops that correspond to the Western Andean foothills and are cut by creeks of variable lengths and widths. Thus, the Topará creek, which collects the rain water of higher zones, presents better conditions for the storage of groundwater because of its length and width. By contrast, the Culebrilla (Cansa Caballo) creek, where the quarry is located, has a short course and has little capacity for storing and infiltrating groundwater. The angular and sub angular materials that fill this creek are a result of the relatively limited flows - the creek remains dry for most of the year.

- **Superficial Hydrology**

The hydrography of the study area is mainly formed by the Topará, Cansa Caballo (Culebrilla) and Venturosa creeks, with narrow valleys. The most important one is the Topará creek that only presents runoff during the wet season, from December to April. Such creeks lose water by evaporation and infiltration. The infiltration is minor in the Topará. In the study area, the superficial waters do not run to the ocean. To the North, near the evaluated area, the Rio Cañete River produces significant volumes of water throughout the year.

Dry and inactive creeks are located on higher grounds. They carrproduce landslides or “huaycos” very sporadically. This part corresponds to untilled land with scarce vegetation.

- **Underground Hydrology**

Aquifers are fed by the infiltration of rainfall that occurs during annual wet seasons.

The aquifer is circumscribed to the narrow margins of the Topará and Cansa Caballo creeks. Thus, the limits of the reservoir are the impervious Pleistocene rocks previously described. The rock base is formed by the intrusive igneous and volcanic rocks of the Western Andean foothills.

Groundwater is rarely accessed from the middle of the Cansa Caballo and Topará creeks, or from near the littoral, South of the Melchorita beach. These areas are non-consolidated sedimentary formations with a lower condition for the flow and storage of underground water.

While in the area of the creek where the GNL-2 quarry is located, there are no major fractures or fissures in the igneous outcrops that would favor the infiltration of water.

It is not possible to find an aquifer in the GNL-2 quarry area for several reasons - the small dimension of the basin, the difference in elevation between the rivers Cañete and Topará, and location of the area over impervious igneous rock with a superficial fracturing that does not permit the flow of any fluids. It is also important to mention that in the area there are no significant rainfalls during the year that generate superficial runoff or infiltration.

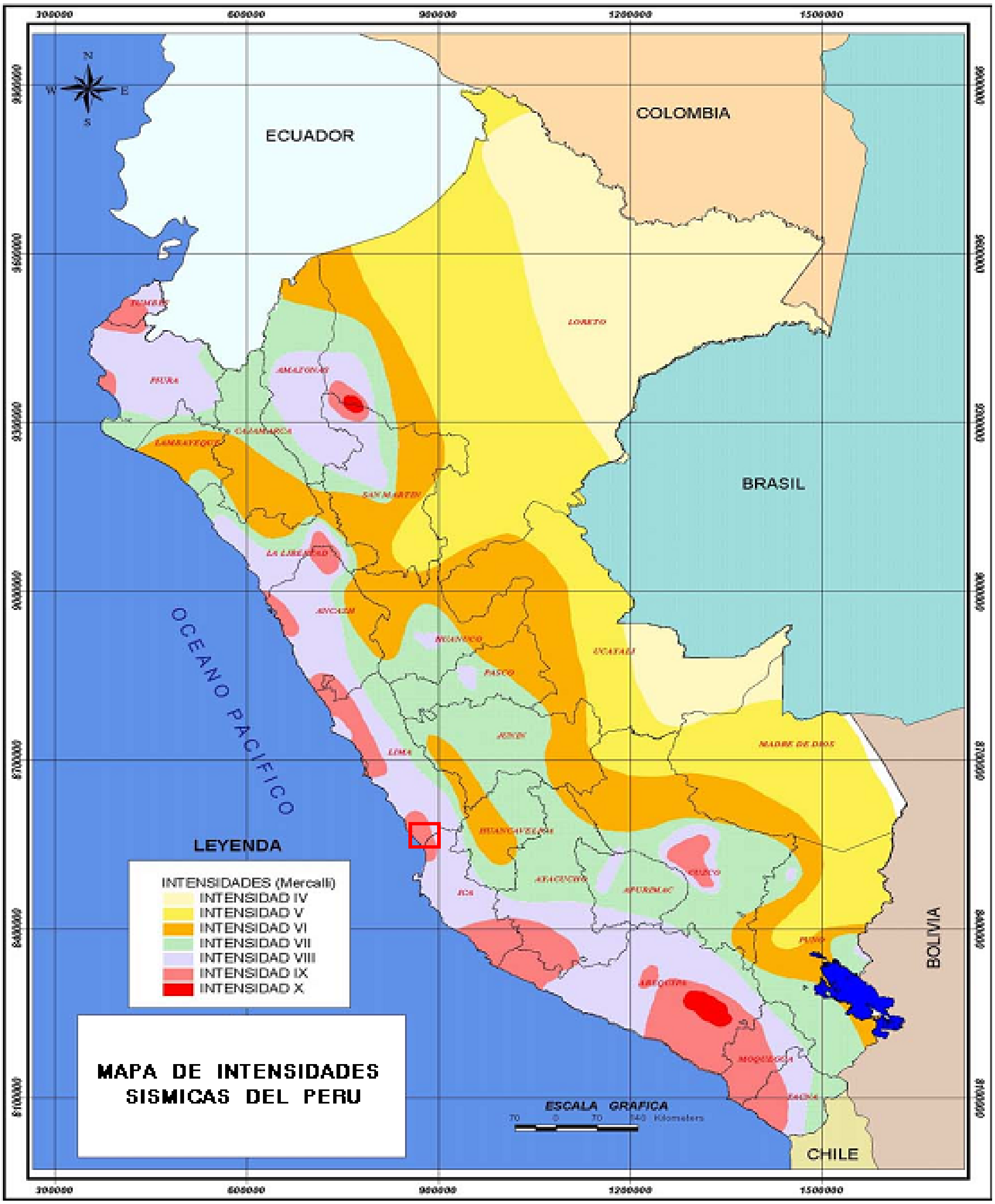
5.1.2.5 SEISMICITY

The Peruvian territory is located in an area with the highest seismic and tectonic activity on the planet. Fourteen percent of the planetary seismic energy is released on Peru's continental border. Therefore the occurrence of earthquakes with great intensity in the general region fo the quarry can be expected during its useful life. The seismic activity of the region is related to the subduction of the oceanic plate under the South American continental plate in the littoral segment comprised between parallels 2º and 15º South latitude. The subduction takes place at a rate of about ten centimeters a year, causing frictions of the earth's crust, with the resulting release of energy through earthquakes, which generally is more violent when the origin is more superficial.

Earthquakes in the region originate from the cortical frictions due to the subduction of the oceanic plate under the continental plate. Therefore, earthquakes are generally more intense in coastal regions. Their intensity decreases towards the highlands and the jungle, where the subduction and cortical friction are gradually deeper. The remote areas in the Amazon experience fewer seismic events than coastal areas because the subduction under this region occurs at greater depths.

The study area is located in an area with a high risk of seismic activity. Earthquakes are relatively frequent in this area and relatively severe as they occur quite near the surface. According to the Instituto Nacional de Defensa Civil (INDECI National Institute for Civil Defense) the study area is located between areas of intensity VIII and IX in the Seismic Intensity Map, based on the modified Mercalli scale. (See Figure 5.1.2-1).

Figure 5.1.2-2 Seismic Intensity Map - Perú



In the last 450 years, the South central area of the country has suffered more than 19 telluric movements with intensities that range between class VII and class IX in the Modified Mercalli Scale. In 1966, 1970 and 1974, very strong earthquakes affected the region. After 1974, there was a "seismic calm" of about 23 years that was broken by the earthquake of 1997. This earthquake had a magnitude of 6.5 and destroyed most of the city of Nazca. The most recent event in this region occurred in 2001, when an earthquake with a magnitude of 6.9 struck Camaná (Arequipa), and neighboring areas.

The seismicity may different consequences on the medium in reference, particularly due to the nature of the relief, the nature of the existing materials and the climate in the region. The quaternary loose formations present the highest risks as they have been recently accumulated, are scarcely consolidated, are deposited near or between rocky massifs which would inevitably give way to a refraction of the seismic waves increasing the level of vibration. Among these deposits, the colluvial accumulations are the most unstable because of their inclination and limited cohesion.

It is also important to keep in mind that an earthquake could trigger the fall of rocks and landslides in the scarped sections of the rocky slopes, especially in those areas affected by superficial diaclase or intense weathering.

Table 5.1.2-1 presents the seismic characteristics for the region. The Appendix lists the most important earthquakes that have affected the region.

Table 5.1.2-1 Seismic characteristics

Place of Analysis	Maximum acceleration (g)*	Effective acceleration (g)*	Acceleration (g) for the Pseudo-static analysis
HUMAY (-75,75 - 13,69)	0.42	0.32	0.22
LURIN (-76,82 – 12,21)	0.44	0.33	0.22
CHILCA (-76,67 - 12,44)	0.43	0.32	0.22
CAÑETE (-76,34 – 13,03)	0.44	0.33	0.22
CHINCHA (-76,09 - 13,36)	0.43	0.32	0.22
PISCO (-76,01 – 13,61)	0.44	0.33	0.22

5.1.2.6 APPLIED GEOLOGY

5.1.2.6.1 The Incidence of Geological Formations in the Project

To develop the quarry, it will be necessary to construct an access road and platforms to form banks, slopes and berms. The geological formations will directly impact these activities. The most important geological formation or lithological unit is the intrusive rock from the Coastal Batholith as it contains the building material. The quality of these intrusive rocks is related to their cohesion and dimensions of blocks not smaller than 1.20m.

The loose deposits (e.g., eolian and alluvial) will also influence the construction of the access road. It will be critical to construct a stable roadbed that can support the anticipated traffic.

Also, the physical quality of the materials will be the deciding factor in the building of the temporary pier.

Note that the different geological formations have no sulfurous or oxidized minerals. Therefore, the extraction activities will not generate acid rock drainage (ARD).

The incidence of geological formations in the project is summarized in table 5.1.2-2.

Table 5.1.2-2 Incidence of the Geological Formations in the Area of Study

Geological Formation	Symbol	Lithology	Surface (area)	Percentage (%)
Quilmaná Formation	Kis-q	Andesite		
Coastal Batholith	K gdmgr tgd gbdi	Granodiorite, monzogranite, tonalite, granodiorite, gabbrodiorite, diorite		
Pocoto Formation	Ts-p	Agglomerate sandstones, volcanic conglomerates, andesites and rhyolitic tuffs.		
Cañete Formation	Qp-c	Conglomerates		
Alluvial Deposits	Qr-a	Pebbles, gravel and sands.		
Torrential Deposits	Qr-co	Blocks, gravels, sands and silts.		
Eolian Deposits	Qr-e	Fine to medium sands		
Colluvial Deposits	Qr-co	Gravels, sands and silts		

5.1.2.7 RESULTS OF THE GEOTECHNICAL EVALUATION

The seven (7) samples collected in the field were sent to SENCICO Laboratory of Materials Testing, where the textural classification was performed in the American Soil Classification Unified System (SUCS) and the Atterberg limits were determined. These last parameters are indispensable to judging the plasticity conditions of the rocks.

In desert environments, sand accumulations are relatively abundant and are characterized by high permeability, low plasticity and low carrying capacity. Such sand accumulations are also found in plains or hilly lands, in an essentially arid medium.

The results obtained are based on an interpretation of the geomechanic properties of the 7 samples. Table 5.1.2-3 presents the results of the SUCS classification for the samples. The chain of custody and the laboratory analysis reports are enclosed in the appendices. Also the main geomechanic properties of the rocks are presented in the appendixes.

Table 5.1.2-3 SUCS Classification Results

Sample	LL (%)	PL (%)	PI (%)	SUCS Classification
GE – 01	NP	NP	NP	SW
GE – 02	NP	NP	NP	SW
GE – 03	NP	NP	NP	SP-SM
GE – 04	NP	NP	NP	SW
GE – 05	NP	NP	NP	GP-GM
GE – 06	NP	NP	NP	SP-SM
GE – 07	26.1	17.8	8.3	CL

Source: Walsh, 2004
LL = Liquid Limit LP = Plastic Limit IP = Plastic Index NP = Non Plastic

The geotechnical characteristics of the sedimentary units according to SUCS classification aredescribed below:

CL soils - These recent alluvial soils comprise the alluvial terraces and are constituted in the surface by silty-clays. These soils have low to intermediate plasticity, an intermediate compressibility and expansion, and are practically impervious when compacted. They have a soft consistency, and a low to very low carrying capacity. In general, these soils are found in relatively flat areas. The sample taken in these lands was the GE-07.

SW soils - These soils are found in hillsides with a plutonic substratum. They are formed by well-balanced sands, with scarce fine elements. Their degree of compressibility and expansion is virtually zero. Their drainage ranges from excellent to poor. The compactions vary from permeable to impermeable. They exhibit good resistance to shear, a negligible to low compressibility, and have an intermediate carrying capacity. Their texture reflects the location of these soils, where the fine elements have been carried by the wind or the sporadic rains. The SW samples were GE-01, GE-02 and GE-04.

GP-GM soils - These soils form the sides of hills with a volcanic substratum. They are comprised of a poorly graduated mixture of gravels and sands with few fine elements. Their degree of compressibility and expansion is low and they have good to moderate drainage. They are characterized by low plasticity and expansion, a negligible to low compressibility, and an intermediate carrying capacity. Their granularity reflects the lithology of the substratum and their location in the slopes. The GP-GM sample was GE-05.

SP-SM soils - These soils of the plains are formed by siliceous clear sands or average to fine grain with no plasticity. They are gritty, silty sands, and poorly sorted. Their scarce fine elements do not affect drainage or the soil resistance properties. They have excellent permeability, almost no compressibility, expansion and excellent drainage. They are loose soils with a high susceptibility to liquefaction and a low carrying capacity, with a plasticity index less than 1. The SP-SM sample was GE-06.

5.1.2.8 CONCLUSIONS

- The geology of the area contains intrusive, resistant and compact materials that can be used to build a breakwater.

- Due to the geological and topographic conditions of the area, the quarry operations should not affect groundwater.

- Seismic activity occurs in the region surrounding the project area, but the project area itself is quite stable due to its compact rocky formations. That being said, there is some instability in the colluvial accumulations in the hillsides.

- The Culebrilla creek may present brief and weak superficial water runoffs seasonally in the area of the quarry.

5.1.3 GEOMORPHOLOGY AND PHYSICAL STABILITY

The GNL-2 quarry is located in the lower level of the western mountain front of the Andean Western mountain range and has a very desertic climate. It has aggressive topography, very steep and rocky slopes, and very scarce soil cover.

The mountain front includes the Topará valley. Seasonal runoffs are common in this area. There are also dry creeks that are filled with alluvial materials by landslides or torrential mudflows that occurred periodically mainly in the times of the Pleistocene, mainly as mud flows or “huaycos”.

At the foot of the mountain front a great plain extends to the West. The plains are formed by a thick cover of desert deposit of a torrential origin, alternated with aeloian (windblown) deposits of a great volume. In some sectors, the desert plains are very flat, and in other cases the topography varies by incisions, waves, dunes, or rocky outcrops.

The erosive processes that characterize the morphology of the area are of the desert and sub desert types, with semi arid stages or short rainy periods that shaped the landform in past times. Nowadays, the erosive actions are generally quite weak.

This work is based on the photo interpretation of Landsat 7 satellite images of high resolution and the review of photogrammetric charts, complemented with direct observations in the field.

Volume III of maps present the Geomorphology map (M 5-3) and the Physical Stability map (M 5-4).

5.1.3.1 MORPHOGENESIS

The mountains of the quarry area were created by the intrusion of the Coastal Batholith over the sedimentary formations of the Andean west. This intrusion, which occurred at the beginning of the Tertiary, cut the Western Andes in two volcanic and sedimentary blocks - one to the East and another to the West, currently in a littoral position. After the intrusion of the Batholith, in the mid-Tertiary some phases of volcanism occurred that affected especially the block located to the East of the Batholith, while to the West the phases of marine regression and transgression were alternated. Some of these left modern calcareous sediments.

The general uplifting of the Andes occurred by the end of the Tertiary and formed the present rough landform of the mountain range. During this lengthy epoch, drought with periods of episodic torrential rains spurned the development of the great plains that are now found to the West of the Andean mountain fronts, which descend gradually from some 500 m. to the littoral.

The erosive processes of the study area are typical of those in desert and semi desert regions. Sheet floods and rill washes have pulled particles and rock fragments from the mountain front and deposited them in the piedmont plains. The mountain front also has some small creeks, through which voluminous mud flows descended frequently during the wettest phases of the

Quaternary. These mudflows contributed to the formation of the thick alluvial load that covers the plains.

The plains are comprised of old alluvial sections of gravel and semi rounded fragments, alternated with deposits of aeolian sands from the driest climatic phases. Nowadays, the erosive actions are very weak, reduced to sporadic runoffs and small mudflows from the mountain that advance slowly along the plain. However, during exceptional events such as El Niño, erosion from overflowing streams can be quite significant. The aeloian action is more constant, but the winds are not very strong, as they rarely surpass 50 km/h.

5.1.3.2 PHYSIOGRAPHY

The physiographic context of the project is that of the desert. Winter fogs shape the coastal deserts. By contrast, the inland deserts are characterized by sunny and warm weather, and plains, hills, and mountains. The inland deserts contain a few valleys with seasonal runoff, as in the case of the Topará creek.

At the end of this chapter, Table 5.1.3-1 presents a descriptive diagram with the characteristics of the different geomorphologic units.

<u>Plains</u>

An extended plain lies at the foot of the mountains and stretches to the Pacific, descending from approximately 500 m. Slopes range from 0 to 15%, and originated from the cumulative action of external erosive agents. Areas with little to no slope are present because of the alluvial and aeloian erosive actions. The following landforms have been identified in the geomorphologic map:

- ***Recent valley alluvial terrace (Symbol Ta)***

These landforms were created by the accumulation of the creeks that pass through the area of study and descend from the Andean foothills, as in the case of the Topará creek which contains some terraces on its margins. The lowest level is the current floodplain, while the other levels are some tens of meters high. These terraces are comprised of stratified banks of sands, silts, and round gravel, with a very small proportion of clay.

The Topará creek, when leaving the mountain range and entering the coast, extends into plains with dominant slopes of 0 to 4%. It also includes sections with slopes of up to 10%.

A large part of this unit is used for crops that utilize natural water flows, or water that is pumped from the ground. The crops modify the upper layers of the soil.

The Topará narrows in its lower sections. In some sections it is covered by layers of aeloian sand, as the seasonal runoffs rarely reach this sector.

- ***Dry torrential Riverbeds (Symbol Cts)***

These are narrow riverbeds that come from the Andean foothills and are formed by gravels and semi-rounded fragments that are wrapped in fine sand and silts. Runoff events and small mudflows course through these riverbeds on occasion, moving slowly through the plains because the flows filter quickly through the highly porous materials. During major El Niño events, these creeks may have an important but short role in presenting important erosion risks.

The dominant slope in these riverbeds is 0 to 4% with small undulations and topographic variations, due to the unevenness of the rocky substratum and the Quaternary cover.

The mid and the lower stretches of these riverbeds are covered by layers of sand that build up and eventually obstruct their way. This is due to the large periods of time that pass between important runoffs. Among these creeks we can mention: Venturosa, Cansa Caballo (Culebrilla) and Huamanpuquio.

- ***Desertic plains (Symbols Po and Pfd)***

Desertic plains comprise the largest part of the barren coastal plains in the area of study. The slope in these plains ranges between 0 and 15%. In the geomorphologic map, two units per slope have been identified: the flatter, called *plains and desert undulations* (symbol Po), has a slope of 0 to 5%. The steeper units are called *strongly dissected desert plains with slopes between 5 and 15% (symbol Pfd).*

Both forms of plains originated from flattening processes of the final foothills of the mountain range that occurred in the coast during the brief but intense rainy phases during the Quaternary and the pre-Quaternary eras. These rainy phases produced landforms with slopes more or less uniformly inclined towards the sea. These are the great west glacis or inclined flattenings that originate at the foot of the mountain.

Creek runoffs later dissected these inclined plains into somewhat parallel sections. In addition, the rocky outcrops from the substratum caused the erosion to occur in generalized undulations. The aeloian activity caused the greatest irregularity in topography of the coastal plains by forming dunes in certain areas and digging depressions in others. .

These piedmont plains constitute the physiographic group over which the access road to the quarry will be built.

- ***Colluvial Cones (Symbol Cc in the map)***

The colluvial cones were formed by colluvial accumulation. They have a Holocene origin and developed at the foot or on the sides of hills and mountain slopes.

The colluvial cones are also called debris cones and have a predominantly gravitational origin. They constitute landforms with 15 to 50% slopes. The bases of the cones consist of thick fragments, while the tops are comprised of smaller and finer materials.

<u>Hill areas</u>

Among the piedmont interior plains and the last western foothills of the Western Mountain Range, some hills appear from the rock substratum and are partially covered by aeloian sands. The substratum is mainly volcanic and the rocks are not very greatly weathered. In the geomorphologic map, the following units have been identified:

- ***Desert Hills with aeloian cover. (Symbol Cd in the map).***

These rough hills have aeloian covers and slopes generally ranging between 25 and 50%. The elevations are less than 300 m, measured between the peak and the respective base. These hills are usually found as the final spurs of the Andean foothills, forming low orographic systems that alternate with the coastal plains. In most cases, they correspond to the outcrops of the Mesozoic volcanic and sedimentary rocks. There is also an important system of hills that corresponds to landforms of Quaternary alluvial accumulations. Tectonics uplifted these hills and erosion further isolated them.

The rocky outcrops of the hills are equally as compact as the mountain slopes. Additionally, the lesser degree of slope makes them less sensitive to the seismic waves and erosive actions that may occur in the desert. By contrast, several hills have thick aeloian covers (e.g., Loma Negra hill) that are sensitive to erosive agents and seismic movements, especially when their slopes are steep.

Mountain Front

The GNL-2 quarry lease is located in this area. As its name suggests, the Mountain Front is an aggressive physiographic group, with slopes that correspond to the western foothills of the Andes. The slopes are mainly formed by intrusive rocks that rise above 500m. The height of the slopes range from 500 to more than 1,000 m above the coastal plain, and the predominant slopes range from 20 to more than 35°. The lease is located on slopes with altitudes of 900 to a little more than 1,400m., but the area of study considers slopes located more to the east of the quarries, that rise a little above 2,000m.

The hills have surfaces formed almost completely by rocks, or else, they are covered by several decimeters of particles of an aeloian origin or produced by physical weathering. In the area of study, sand covers most of the western slopes in contact with the plains. Even the hills that are located between these plains have several meters of this cover. A little farther to the east, at the same elevation of the GNL-2 quarry, the rock formations appear to be covered by centimeters or decimeters of silts, weathered sandy material, and incipient soils, especially at higher ground in less desertic areas near 2,000 m.

The coastal Batholithis, a compact and impermeable rock formation, has caused the superficial runoff of sheet floods and rill washes. As these runoff events do not easily permeate the soil, they eventually dry on the surface. This has resulted in numerous watercourses being dry, along with very sporadic and reduced flows.

In the geomorphologic map, the mountain slopes have been categorized in three morphologic groups based on their altitudinal and climatic differences:

- ***Desert Mountain Slopes (Symbol Vmd in the map)***

These are the lower slopes in the western Andean flanks, which are located on the coastal plain between 500 to 600 m and around 1,000 m. They have an aggressive topography and are generally characterized by very dry slopes with almost no vegetation. In places, they are covered by a thick layer of aeloian slimes and very fine sands that develops a numerous furrows, including some that are decimeters deep. Sporadic and brief rainfalls cause the furrows.

- ***Sub desert mountain slopes (Symbol Vmsd on the map)***

These are the slopes of the western Andean flanks that are located above the desert slopes, approximately between 1,000 and 1,400 m. They have an aggressive topography, with dry slopes with almost no vegetation except for some scattered cacti. These slope have rockier surfaces than those of the lower floors, as the cover of aeloian silt and very fine is thinner. The cover is thinner because the aeloian particles must travel a greater distance from the desert plains from which they originate, and also because the rains are somewhat more frequent and they wash away the cover of loose particles on the hillsides.

- ***Semi arid mountain slopes (Symbol Vmsa on the map)***

These are the slopes of the western Andean flank, which are located above the sub desert slopes, around 1,400m. They have a very aggressive topography, with arid slopes and almost no vegetation, except for some scattered cacti. In contrast to the sub desert mountain slopes, the semi arid mountain slopes are covered by seasonal herbage during the short slightly wet period from January to March. The surfaces of the slopes are quite uneven, with numerous rock outcrops and colluvial deposits, and with some sectors of aeloian slimes and incipient soils. These environments are highly erosive during the short wet season. The watercourses are highly torrential and discharge mud flows that are considered as “huaycos”.

These slopes are located to the East and Northeast of the quarry and are not adjacent to the proposed quarry area. Therefore, any erosion that may occur in the quarry would have no affect, except for the alluvial load that descends to the valleys and then circulates among the dry creeks to the plains where the access roads are located.

5.1.3.3 COMPLEMENTARY PHYSIOGRAPHIC FEATURES

The geomorphologic table presents physiographic features overlaid with the cartographic units that describe and characterize the landform. Among these features, it is important to mention the following:

- **Sub-basin Divides:** These are the lines that connect the highest topographic points, that separate the mountain sides from one or another hydrographic basin.

- **Glacis:** These are indicative traces that show the existence of flat inclined surfaces towards a uniform direction. The weft in its cartographic representation indicates the direction of the inclination.

Table 5.1.3-1 Description and Distribution of Geomorphologic Units

<table>
<tr><th colspan="2" rowspan="2">Geomorphologic Units</th><th rowspan="2">Origin</th><th rowspan="2">Slope</th><th rowspan="2">Lythological Composition</th><th rowspan="2">Location and/or Altitude</th><th rowspan="2">Erosive Processes</th><th colspan="2">Influence in the outline</th></tr>
<tr><th>Area (Ha)</th><th>Percentage (%)</th></tr>
<tr><td rowspan="5">Plains</td><td>Recent Valley Alluvial Terraces (Ta)</td><td rowspan="3">Aggradation</td><td>Slope 0 to 2%</td><td rowspan="3">Gravel, sand and silt banks with a mostly alluvial origin, with aeloian sand cover.</td><td>Current waterbeds and terraces</td><td>Floods and undermining</td><td></td><td></td></tr>
<tr><td>Plains and Desert undulations (Po)</td><td>Slope 0 to 5%</td><td rowspan="2">Pampas and Piedmonts</td><td>Slight aeloian erosion</td><td></td><td></td></tr>
<tr><td>Strongly dissected desert plains (Pfd)</td><td>Slope5 to 15%</td><td>Slight aeloian erosion, and sporadic low intensity runoffs.</td><td></td><td></td></tr>
<tr><td>Dry torrential riverbeds (Cts)</td><td rowspan="2">Denudation</td><td>Slope 0 to 4%</td><td>Gravel, sand and silt banks with a torrential origin</td><td>Pampas and Andean foothills</td><td>Torrential erosion</td><td></td><td></td></tr>
<tr><td>Colluvial Cones (Cc)</td><td>Slope 15 to 50%</td><td>Scouring accumulation</td><td>Hilly or mountain slopes</td><td>Sporadic landslides</td><td></td><td></td></tr>
<tr><td>Hills</td><td>Desert Hills with Aeloian coverage (Cd)</td><td>Denudation and Aggradation</td><td>Slope 25 to 50%</td><td>Intrusive and volcanic rocks substratum</td><td>Final Andean foothills</td><td>Slight aeloian erosion, and sporadic low intensity runoffs.</td><td></td><td></td></tr>
<tr><td rowspan="3">Mountains</td><td>Desert Mountain Slopes (Vmd)</td><td rowspan="3">Denudation</td><td rowspan="3">Slope 50 to more than 70%</td><td rowspan="3">Intrusive and volcanic rocks substratum</td><td rowspan="3">Andean foothills</td><td rowspan="3">Physical weathering and sporadic landslides and rock fall.</td><td></td><td></td></tr>
<tr><td>Sub desert Mountain Slopes (Vmsd)</td><td></td><td></td></tr>
<tr><td>Semi arid Mountain Slopes (Vmsa)</td><td></td><td></td></tr>
</table>

5.1.3.4 MORPHODYNAMICS AND CURRENT EROSIVE PROCESSES

- ***Weathering***

Weathering is a natural process that results in relatively small modifications of the landform that are usually hardly noticeable during any given human lifetime. However, in certain areas it results in noticeable erosion. In the case of the area of study, the physical weathering is very active in the desert and Sub-desert Mountain slopes, disintegrating and fissuring the rocks. In this environment, weathering turns igneous rocks into sands relatively quickly. The result of this process is the formation of a layer of colluvial sand detritus in the hillsides and the foot of the slopes, which contribute to the viscosity of the occasional torrential flows.

- ***Rock Landslide***

Rock landslides are a common phenomenon in the steep slopes of the rocky massifs, especially due to the weathering and the occurrence of earthquakes. The construction of access roads can decrease the stability of slopes and increase the likelihood of landslides. The magnitude of the landslides that occur in this region is relatively low, but landslides could affect the quarry facilities or the roads built on the slopes.

- ***Torrential erosion***

Torrential erosion is produced in torrents or watercourses of seasonal or sporadic occurrences. Within the study area, they occur in the lower Andean sector and the piedmont plains.

The most severe torrential erosion is caused by mudflows in the outlet of the main torrents during most of the rainy seasons. The Topará creek area is particularly susceptible to torrential erosion, but this is not relevant to the project as it is relatively far from the quarry area.

In order to produce mud flows, torrents must have specific hydro-geomorphologic properties, such as: a minimal basin surface that varies according to environmental factors, a pronounced slope, impermeable rocks in the substratum, a loose detrital cover, a particular shape and internal waterbeds. These factors sometimes tend to concentrate runoffs and sediments near the final outlets, with which the risk of further occurrence of mudflows or huaycos is propitiated.

Factors that are favorable to torrents in the project area include the huaycos, the detrital cover and the impermeability of the substratum. However, other factors reduce the likelihood of torrents such as the reduced size of the waterbeds, their elongated shapes, their unevenness (i.e., full of bends) and their relatively small slopes.

The creeks that present sporadic occurrences of huaycos are Venturosa, Cansa Caballo (Culebrilla) and Huamanpuquio.

The Venturosa creek is located to the North of the area of study and is a tributary by the left margin of the Cañete River. Its sources reach 1600m. It is a torrential creek that in exceptionally rainy years transports torrential flows and severely impacts its outlets - the neighboring croplands in the Cañete valley. Because of its relatively far location from the project area, it does not affect the development of the quarry project.

The Cansa Caballo creek, called Culebrilla creek in its upper stretch, has sources that reach 1800m. Seasonally, it transports some small water sheets of short duration, but in exceptionally rainy years, it does not transport very torrential flows. The characteristics of this creek include a relatively rectilinear character, reduced width, flat bottom and the presence of old torrential accumulations. Its waterbed is narrow and defined with some pronounced side gullies. There are at least two levels of old terraces at its banks. It is the most important creek for the project, as it crosses the whole central area of the GNL-2 quarry. In the event of a major event, it may pose safety problems to the projected facilities. Therefore, it is recommended that facilities are built on high grounds.

The Huamanpuquio creek is located to the South of the area of study and is a tributary by the left margin of the Topará creek. Its sources reach 2200m. During the rainy seasons, it transports short duration water flows, but in exceptionally rainy years, it may transport torrential flows of a medium magnitude. These flows will lose energy in the creek's lower stretches because the waterbeds widen. Because this creek is relatively far from the study area, it does not affect the development of the quarry project.

Other small creeks, such as the one located north of the Cansa Caballo creek and that goes through the GNL quarry lease, present accumulated torrential deposits during climatic stages that are wetter than the present one. They are creeks that were activated along decades and only in exceptionally rainy years in the coast.

5.1.3.5 CURRENT EROSIVE PROCESSES AND PHYSICAL STABILITY

Erosive processes are important in some areas within the GNL-2 quarry project. However, in most parts of the area these processes are not significant and in some cases they are virtually non-existent. The weak sporadic summer runoffs do not pose a risk to the physical stability of the quarry operations in the mountain front, even though some of these occurrences may affect the access roads to the quarries temporarily. This scheme should occur infrequently during the two-plus years of the project, unless any extraordinary event such as El Niño Phenomena with an exceptional magnitude occurs.

The seismic activity poses a much greater risk in the project area, as it is a risk along the entire coast of the country. That being said, it is not anticipated that the operative component of the project will cause significant seismic occurrences, provided that the quarry operations are carried out within the normal standards of slope stability for cuts and material dump pits.

Given all these considerations, this section presents a comparative zoning of the different media, including their levels of geomorphologic stability. Such stability is mainly established based on the current morphodynamic processes, their physiographic characteristics, and the potential conditions to generate erosive actions. The stability and physical risk map identifies the following categories:

- ***Stable Areas (Symbol E in the physical stability map)***

Stable areas include locales where the current occurrence of erosive actions does not present significant deterioration conditions. These areas can be subjected to substantial modifications. However, care must be taken not to alter some of the conditions of environmental conservation that help ensure the area remains stable. The areas considered as stable are the U*ndulated Desert Plains*, as well as the *Recent Valley Alluvial Terrace*s in the Topará creek.

- ***Slightly Unstable Areas (Symbols LI in the Physical Stability map)***

In contrast to the previous category, slightly unstable areas experience erosion. This erosion does not cause significant environment damage, and it is estimated that these areas do not have high geodynamic potential, due to its lithology of the predominance of coherent igneous rock. However, a certain degree of instability is present in the sectors of weathered, fissured rocks or accumulation by gravity.

Four kinds of sectors are recognized as slightly unstable:

- *Mountain slopes on the desert and sub desert areas.* Although these areas have a rough topography, they are fairly stable because limited rainfall.
- *Desert hills with an aeloian cover.* These hills are covered by very loose sands which renders them slightly unstable.
- *Strongly dissected desert plains*
- *Colluvial cones*. These areas are only slightly unstable.

- ***Moderately Unstable Areas (Symbol MI in the Physical Stability map)***

The areas considered as moderately unstable are the ones that show some visible and active morphodynamic actions on the environment. In that sense, due to their higher slope and topographic accidents, *the Semi arid mountain slopes* have significant instability conditions, as the eventual rains, more frequent than in the lower parts, produce active erosive actions, such as grooves, ditches and small occasional land slides, on the slopes.

- ***Unstable Areas (Symbol I in the Physical Stability map)***

These areas have the highest risk. Unstable areas can experience extreme erosion and present a high risk for the project during extremely rainy periods. In this category are located *the Dry Torrential Waterbeds* of the several creeks that descend from the Andean hills sides. These areas periodically erode during short rainy phases in the wettest climatic years. Through these waterbeds descend torrential muddy flows (huaycos) of blocks and water masses, saturated with solids. These flows eventually spread out over the coastal plain and penetrate it unevenly.

At least a couple of unstable areas could impact the GNL-2 quarry. One of them is a creek that occurs in the future project site. This creek's headwaters reach semi arid sectors where there is some frequent rainfall during the summer months.

The other creek called Culebrilla can influence access to the quarry GNL-2. It should not impact the quarry operations themselves as they will take place in the rocky hillsides around the creek and would not be influenced by occasional mudflows.

5.1.3.6 CONCLUSIONS

- There are three main geomorphologic areas within the project location. The first is where the quarry project is located. This sector corresponds to a mountain sector of very rough topography in a very desert environment. The second is the alluvial valley of the Topará creek, with cultivated soils with a high agricultural value, and which is located very far away from any influence or impact from the quarry activities. The third sector is the desert plain, formed by loose alluvial and aeloian materials, through which the access road to the quarry will traverse.

- The physiography of the area presents very favorable conditions for the exploitation and operations of the quarry. The location for the quarry itself is basically a barren mountain which experiences little erosion, has rather easy accessibility, and whose exploitation should not pose significant risk to the physical safety of workers. The plains through which materials will be transported are also very safe.

- The geomorphologic stability is also very apparent in all the sectors. The area is quite stable with the exception of the occasional torrential runoffs that could affect the access roads to the quarry.

5.1.4 SOILS AND LAND USE CAPACITY

Soil is one of the most sensitive environmental elements to the actions of nature and mankind. Erosion can deteriorate or destroy it in a relatively short period of time, causing serious damage to flora and the environment in general. Commercial activities can accelerate deterioration of the soil when adequate protective measures are not taken.

The soil evaluation carried out in the area of influence of the GNL-2 quarry identified soil types based on the morphological, physical, chemical and biological characteristics of the different soil horizons. The soil characterization analysis was conducted in the La Molina Agrarian National University (See annex 2.3 in the Volume II of Annex). The volume III of maps present the Soil map (M 5-5) and the Major Land Use map (M 5-6).

This study used the guidelines contained in the Soil Survey Manual 1993 and the soils were classified to sub-group level using the Soil Taxonomy (2003), both utilized by INRENA.

The soils in the study area are found mainly in marine, alluvial, fluvial, colluvial-alluvial, hilly and mountainous landscapes.

Soils in the study area were classified to sub-group level and given a common name. The cartographic classification of the soils was made by determining consociations and associations. A *consociation* is a geographic unit in which one soil type or miscellaneous area predominates and covers more than 85% of its area. An *association* is a geographic unit in which two soil units and/or miscellaneous areas predominate and cannot be separated because of the scale used. It also covers 85% of the surface area. Eleven consociations and seven associations were found in the study area.

The gradient (slope) of the surface helps determine appropriate uses of soils. Stages of gradients were identified to classify the use capacity (Table 5.1.4-1).

Table 5.1.4-1 Gradient phases

SYMBOL	GRADIENT RANGE (%)	DESCRIPTIVE TERM
A	0 – 4	Flat to slightly inclined
B	4 – 15	Moderate to steeply inclined
C	15 – 25	Moderately inclined
D	25 – 50	Steep
E	50 - 75	Very steep
F	+ 75	Extremely steep

The land use potential was established according to Land Classification by Use Capacity published by the Ministry of Agriculture (1975), with additions made by ONERN (1980), also used by INRENA.

5.1.4.1 SOIL CLASSIFICATION AND DESCRIPTION

The environmental conditions in the zones give the soil a torrid moisture regime. In other words, the soil is dry for most of the year and has thermal temperatures (i.e., the average annual temperature of the soil ranges from 15 to 22 degrees centigrade). The physiography of the quarry area consists principally of untilled rocky hillsides with gradients of 50% to more than 75%. Access to the quarries is across extensive flat or undulating plains with dominant gradients between 2% and 15%.

In accordance with the characteristics described above, almost all the area's soils show poor edaphic development. Slight edaphic development is found on the surface where there is a greater accumulation of organic material producing a rather darker color; this can be seen on small or non-representative areas of the hillsides in the quarry area, where some vegetation and winter mists favor this development. Some changes in edaphic development, principally physical, can be seen in certain parts of the flat land which give access to the quarry, where sub-surface soil horizons are sometimes found to be hardened by flakes of salt and gypsum.

Table 5.1.4-2 shows the soil sub-groups, determined by applying the Soil Taxonomy Classification (2003). Table 5.1.4-3 presents the consociations and associations (cartographic units) found in the area.

Table 5.1.4-2 Natural soil classification

ORDER	SUB-ORDER	LARGE GROUP	SUB-GROUP	NAME
ENTISOLS	Fluvents	Torrifluvents	Typic Torrifluvents	Topará
	Orthents	Torriorthents	Typic Torriorthents	Venturosa
			Lithic Torriorthents	Bolivar Caltopa Jacalla
	Psamments	Torripsamments	Typic Torripsamments	Estación Jaguar
ARIDISOLS	Salids	Haplosalids	Typic Haplosalids	Piaña Old terrace Dry river
			Petrogypsic Haplosalids	Cruz Pampa

Table 5.1.4-3 Cartographic soil units

Consociation	Symbol	Proportion (%)	Gradient
Topara	To	100	A
Jaguay	Jg	100	A B
Estación	Es	100	A B C D
Río Seco	RS	100	A B
Piaña	Pi	100	B
Terraza Antigua	TA	100	B
Cruz Pampa	CP	100	A B C D
Caltopa	Cp	100	C D
Venturosa	Ve	100	A B C
Miscellaneous Cauce	MC	100	B
Miscellaneous Pedrones	MPe	100	B
ASSOCIATIONS			
Estación – Cruz Pampa	Es - CP	60-40	C
Estación – Caltopa	Es - CP	60-40	D
Caltopa - Miscellaneous Rock	Cp - MR	60-40	E F
Bolivar - Miscellaneous Rock	Bo - MR	60-40	E
Jacalla - Miscellaneous Rock	Jc - MR	60-40	E F
Miscellaneous Rock – Caltopa	MR - Cp	60-40	F
Miscellaneous Rock - Jacalla	MR -Jc	60-40	F

The main soils found in the study zone are described below.

- **TOPARA CONSOCIATION (To)**

This consociation consists of the Topará soil belonging to the Typic Torrifluvents sub-group. It has an ochre-coloured epipedon as its sole horizon and a stratified profile originating from materials deposited by Topara creek. It is located, in part, along man-made terraces that have changed the natural gradient of the land.

It has an AC type profile with poor genetic development, a flat to slightly inclined (0 to 4%) slope, a dark yellowish brown color (10YR 4/4) when moist. The soil texture is medium to moderately coarse (sandy loam) with moderately rapid permeability and good drainage.

The pH of the soil varies from neutral to moderately alkaline (pH 6.7 to 8.4) with a base saturation of 100% and low salt content (less than 3.0 dS/m). The surface layer has a low organic material content (less than 1.3%), low to medium available phosphorus content and a variable potassium content. All these conditions determine that the natural fertility of the cultivable layer is low.

The Topará soil is found on gradients phase: flat to slightly inclined (0-4%).

- **JAGUAY CONSOCIATION (Jg)**

The Jaguay Consociation consists of Jaguay soil belonging to the Typic Torripsamments sub-group. It has an ochre-colored epipedon as its only diagnostic horizon and is coarse in texture. The Jaguay Consociation is found on the coastal plain affected by the wind, on gradients that are flat to moderately inclined (0 - 15%).

It has a C-type profile, is light yellowish brown in color (10 YR 6/4) to greyish brown when dry, it is deep and wind-blown sand is prominent in the surface horizon with medium sand in the lower horizons; it has no structure (loose).

The soil is slightly acidic to slightly alkaline (pH 6.8) and its organic material content is 0.07%. In some cases gravel is present in the profile, with 1.8% free carbonates and a heavy salt content (higher than 8 dS/m) at 25 ºC; its natural fertility is low and its natural drainage excessive.

The Jaguay soil is found on the following gradients: flat to slightly inclined (0-4%) and moderate to steeply inclined (4-15%).

- **ESTACIÓN CONSOCIATION (Es)**

The Estación Consociation consists of the Estación soil belonging to the Typic Torripsamments sub-group. It has an ochre-coloured epipedon as its sole horizon and a coarse texture (sandy). Physiographically it is found on the coastal plain where influenced by the effects of the wind, with a flat to steep gradient (0-50%).

Its has a stratified AC type profile, is light yellowish brown in color (10 YR 6/4) to yellowish brown (10YR 5/4) when dry, it is deep, has a significant presence of medium sand in the surface horizons and fine sand in the lower horizons, and is loose when dry. This soil is neutral to moderately alkaline (pH 6.7 to 8.2) with a low organic material content (0.1 to 0.7%) with a low level of free carbonates (less than 1.3%) and a salt content that varies from 4 to 8 dS/m at 25ºC; its phosphorus content is low and its available potassium content low to medium, which gives its low natural fertility.

Estación soil is found on the following gradients: flat to slightly inclined (0-4%), moderate to steeply inclined (4-15%), moderately inclined (15-25%) and steep (25-50%).

- **RIO SECO CONSOCIATION (RS)**

The Rio Seco Consociation consists of Rio Seco soil belonging to the Typic Haplosalids sub-group. It has an ochre-coloured epipedon and a saline horizon. It is found on the coastal plain with a flat to steeply inclined gradient (0 - 15%).

It has an upper horizon of more than 30 cm, with a stratified profile, moderate depth, type AC, light yellowish brown in colour (10YR 6/4) to light brown when dry; it has the texture of sandy loam to medium sandy, without structure (loose and powdery), loose when dry and very friable when moist, its natural drainage is rather excessive. It is neutral (pH 6.6) and has an organic material content of 1.14%. Free carbonates in the soil mass are not detectable with dilute HCl, its salt content is variable (higher than 15 dS/m) at 25 ºC, and its natural fertility is low.

Rio Seco soil is found on the following gradients: flat to slightly inclined (0-4%) and moderate to steeply inclined (4-15%).

- **PIAÑA CONSOCIATION (Pi)**

The Piaña Consociation consists of the Piaña soil type, belonging to the Typic Haplosalids sub-group because its epipedon is ochre in colour and has a saline horizon as its diagnostic horizon.

This soil is of marine origin, deriving from the ancient sea which emerged with the uplifting of the continental plate, it is found on the coastal plain which has a flat to slightly undulating relief. This soil generally contains wind-blown sand on its surface.

It has an AC type profile, it is deep with a surface horizon of 15 to 25 cm, greyish brown in colour (10YR 5/2) to pale yellow (10YR 6/3) when dry. Its texture is sandy loam to sandy, without structure and loose when dry. Small concentrations of salts that have hardened slightly, can be found in the top layer (first 50cm from the surface).

This soil is slightly to moderately alkaline (pH 7.6 – 8.4) and it has a low organic materials content (0.4%). It contains free carbonates which react mildly to dilute HCl (1.2 - 2.6%) and its salt content is moderate to heavy (greater than 8 dS/m). The available phosphorus content is low and the available potassium content is medium. All these conditions determine that the natural fertility of the cultivable layer is low.

The Piaña soil is found on the following gradients: moderate to steeply inclined (4-15%).

- **TERRAZA ANTIGUA CONSOCIATION (TA)**

The Terraza Antigua Consociation consists of the Terraza Antigua soil type belonging to the Typic Haplosalids because of its ochre epipedon, which is the sole diagnostic horizon, and accumulations of salt in its profile.

It is found on slightly undulating parts of the coastal plain with a moderate to steeply inclined gradient (4 - 15%).

Its has an AC type profile, is moderately deep, stratified, with a surface horizon of 35 cm, light yellowish brown in colour (10 YR 6/4) to light greyish brown when dry. Its texture is sandy loam with sand in the surface horizons and coarse sand in the underlying layers; its structure is loose when dry and its natural drainage is good to rather excessive.

This soil is slightly acidic (pH 6.2) and its organic material content is medium (2.01%). It has free carbonates that are not detectable with dilute HCl. It has a high salt content (greater than 16 dS/m). All these conditions determine that the natural fertility of the surface layer is low.

Terraza Antigua soil is found on the following gradients: moderate to steeply inclined (4-15%).

- **CRUZ PAMPA CONSOCIATION (CP)**

The Cruz Pampa Consociation consists of the Cruz Pampa soil type, belonging to the Petrogypsic Haplosalids sub-group because of its ochre coloured epipedon which is the sole diagnostic horizon, and a layer encrusted with soluble salts.

It is of marine origin and is found on undulating parts of the coastal plain near the Pan American Highway.

The soil is superficial, limited by a layer of encrusted salts, it has an ACkm profile, is light yellowish brown in colour (10 YR 6/4) to pale brown (10 YR 6/3) when dry, its is coarse in texture (sandy loam to sandy), massive, very hard when dry and its drainage is imperfect. This soil contains a layer of sand encrusted with sulphate salts at a depth of 15 to 30 cm.

The soil reaction is slightly acid to neutral (pH 6.5 - 6.8), with a low organic material content (less than 2.0%), its free carbonate content is of little significance and it has a heavy salt content (up to 148 dS/m). Although the surface layer has a high content of available phosphorus and potassium, its natural fertility is low.

The Cruz Pampa soil is found on the following gradients: flat to slightly inclined (0-4%), moderate to steeply inclined (4-15%), moderately inclined (15-25%) and steep (25-50%).

- **CALTOPA CONSOCIATION (Cp)**

The Caltopa Consociation consists of the Caltopa soil type belonging to the Lithic Torriorthents sub-group, as it has an ochre-colored epipedon as its sole diagnostic horizon and a rocky layer at a depth of less than 0.50 meters.

It is found on moderately steep to steep slopes on the western side of the uncultivated part of the study zone.

These soils are residual in origin, deriving principally from volcanic rocks, with an ACrR type profile and incipient genetic development, moderately coarse to coarse texture (sandy loam to sandy), containing between 20% and 50% angular rock fragments (gravel) and having excessive drainage.

The soil reaction is slightly acid to moderately alkaline (pH 6.1 - 8.4), with a low organic material content (less than 1.4%), low free carbonate content (less than 1.5%) and high salt content (from 8 to 15 dS/m). The low available phosphorus content and available potassium content varying from low to high causes the fertility of the surface layer to be low.

Caltopa soil is found on gradients: moderately inclined (15-25%) and steep (25-50%).

- **VENTUROSA CONSOCIATION (Ve)**

The Venturosa Consociation consists of the Venturosa soil type, belonging to the Typic Torriorthents sub-group because of its ochre-coloured epipedon as the diagnostic horizon and variable content of rocky fragments (gravels).

It is alluvial in origin since it derives from materials deposited by flowing water in creek beds and small narrow valleys with flat relief.

The soil has an AC type profile with little genetic development, it is moderately deep to deep coloured light yellow-brown (10 YR 6/4) to pale brown (10 YR 6/3), it has a coarse texture (sandy loam to sandy), although it is sometimes of medium texture (muddy loam) and moderately coarse (sandy loam) with good to somewhat excessive drainage.

The soil is neutral to moderately alkaline (pH 7.2 to 8.3), 100% base saturated, with moderate salt content (from 8 to 15 dS/m) and a high content of soluble boron (greater than 6 ppm). The surface arable layer contains a low level of organic material (less than 1%), medium available phosphorus content (9 ppm) and high available potassium content (260 ppm). All these conditions determine that the natural fertility of the cultivable layer is low.

The Venturosa soil is found on the following gradients: flat to slightly inclined (0-4%), moderate to steeply inclined (4-15%) and moderately inclined (15-25%).

- **MISCELLANEOUS CAUCE CONSOCIATION (MCa)**

The Miscellaneous Cauce Consociation consists principally of the miscellaneous unit called Cauce, found in the river beds of Topara creek and other smaller water courses, mainly with moderate to steeply inclined gradients (4-15%).

This non-edaphic unit consists of deposits of coarse material (gravel, pebbles, and stones) and sand and is found throughout the above-mentioned creeks, which are flooded annually during the rainy season (December to March). The lithological composition of the coarse material varies, principally consisting mainly of intrusive, volcanic and sedimentary rocks.

- **MISCELLANEOUS PEDRONES CONSOCIATION (MPe)**

The Miscellaneous Pedrones Consociation consists principally of the miscellaneous unit called Pedrones and is found in the upper parts of certain creeks among the hills, with moderate to steeply inclined gradients (4-15%).

This non-edaphic unit is made up of deposits of rocky material, especially gravels, pebbles, stones and larger rocks, which cover the entire creek, especially the upper parts and prevent it from being used.

The lithological composition of the material is varied principally intrusive rock and, to a lesser extent, volcanic rock.

- **ESTACION - CRUZ PAMPA ASSOCIATION (Es - CP)**

The Estación -Cruz Pampa Association consists of the Estación and Cruz Pampa soil units in percentages of 60% and 40% respectively, both on moderately inclined gradients (15 - 25%). This is found on the undulating plain in the Northeastern part of the study area.

The edaphic characteristics of both units have been described earlier.

- **ESTACION - CALTOPA ASSOCIATION (Es - Cp)**

The Estación-Caltopa Association consists of the Estación and Caltopa soil units in percentages of 60% and 40% respectively, both found on steep gradients (25 - 50%). Also found on some hills or moderately steep slopes in the eastern section of the study area.

The edaphic characteristics of both units have been described earlier.

- **CALTOPA - MISCELLANEOUS ROCK ASSOCIATION (Cp - MR)**

The Caltopa-Miscellaneous Rock Association is made up of the Caltopa soil unit and the miscellaneous area unit known as Rock in percentages of 60% and 40% respectively, both found on very steep gradients (50 - 75%) and extremely steep gradients (+ 75%). It is found on the steep slopes to the west of the untilled land in the study area.

Only the miscellaneous unit is described here, as the soils were described earlier.

Miscellaneous Rock

This non-edaphic unit consists of exposed rock (outcrops) and deposits of loose rocky detritus on the sides of hills and mountains having a gradient steeper than 50%.

The lithological composition is varied, including principally intrusive rocks (granodiorite, granites, diorites, andesites, etc.)

- **JACAYA – MISCELLANEOUS ROCK ASSOCIATION (JC - MR)**

The Jacaya-Miscellaneious Rock Association consists of the Jacaya soil unit and the miscellaneous area unit in percentages of 60% and 40% respectively, both found on very steep (50-75%) and extremely steep (+ 75%) gradients. It is found on the steep slopes to the west of the unused land in the study area.

Only the soil unit is described here, as the miscellaneous area has already been described.

Jacaya soil

Jacaya soil is a member of the Lithic Torriorthents sub-group as it has an ochre-coloured epipedon as its diagnostic horizon and superficial soils, being limited by a rocky layer at a depth of less than 50 cm.

These soils are residual and colluvial in origin, derived from intrusive rocks, mainly granite, granodiorite, diorites, etc., found on slopes steeper than 50% and having an ACrR type profile with little genetic development, its texture is moderately coarse (sandy loam), and its gravel content fluctuates between 20% and 70%, this later one, when it derives from colluvial deposits has excessive drainage.

This soil is strongly acidic (pH 5.5 - 7.,8) with a low organic material content (less than 1.9%) and a low free carbonate content (less than 1.0%) and low salt content (less than 4 dS/m). The surface layer has a low to medium available phosphorus content and medium to high available potassium content, which gives it a low natural fertility.

These soils are very sensitive to erosion because of their steep gradients.

- **BOLIVAR - MISCELLANEOUS ROCK ASSOCIATION (Bo - MR)**

The Bolivar-Miscellaneous Rock Association consists of the Bolivar soil unit and miscellaneous rock unit in percentages of 60% and 40% respectively, both found on very steep gradients (50 - 75%). They are found on the mountain slopes in the northern sector of the study area.

Only the soil unit is described here as the miscellaneous area has already been described.

Bolivar soil

Bolivar soil belongs to the Lithic Torriorthents sub-group because of its ochre-coloured epipedon which is the sole diagnostic horizon and rock close to the surface (at a depth of less than 0.50 m).

It is of residual origin, deriving mainly from intrusive rock (granite and granodiorite) and is distributed on hill and mountain sides.

It has a CR type profile, colored brown to yellowish brown and is very superficial, limited by the rock layer; it is found on steep to extremely steep slopes (more than 50%) and its texture is coarse (sand to sandy loam) with a content of 20% to 30% angular gravels and somewhat excessive to excessive drainage.

This soil is neutral to slightly alkaline (6.9 to 7.5) with a low organic material content (less than 1.0%), low phosphorus content (3 ppm) and high available potassium content (greater than 300 ppm), it is strongly saline (more than 30 dS/m). All of these characteristics ensure that its natural fertility is low.

- **MISCELLANEOUS ROCK – CALTOPA ASSOCIATION (MR - Cp)**

The Miscellaneous Rock-Caltopa Association consists of the miscellaneous rock unit and the Caltopa soil unit in percentages of 60% and 40% respectively, both found on extremely steep gradients (+ 75%). This association is found on the steep slopes in the western section of the study area.

- **MISCELLANEOUS ROCK – JACAYA ASSOCIATION (MR - Jc)**

The Miscellaneous Rock-Jacaya Association consists of the miscellaneous rock unit and the Jacaya soil unit in percentages of 60% and 40% respectively, both found on extremely steep gradients (+ 75%). This association is found on the steep slopes in the western section of the study area.

5.1.4.2 LAND USE CAPACITY

The land use capacity of the soils is determined using the guidelines of the Land Classification Rules published by the Ministry of Agriculture (Supreme Decree Nº 062-75-AG) and modifications established by the National Office for the Evaluation of Natural Resources ONERN. This regulation considers three categories: land use groups capacity; capacity classes (agrological quality) and land use capacity sub-class (limiting factors).

The study area is classified into three land use groups: land suitable for intensive agriculture, land suitable for permanent cultivation, and buffer land. Each group is described below.

- **LAND SUITABLE FOR INTENSIVE AGRICULTURE (A)**

The land of this class meets the environmental conditions for preparation of the soil for the sowing of herbaceous and small shrubs with a short growing season. The study area contains Class A3 lands (low agricultural quality), which are described below.

Low Agricultural Quality (A3)

These lands are of low agricultural quality because of severe limitations imposed by the soil, salinity and drainage. These areas require soil management and preservation work to prevent degradation. Sub-classes A3s(r) and A3sl (r) were identified within the study area.

Sub-class A3s (r)

These lands consist of deep soils having a medium to moderately coarse texture (loam to sandy loam), with good drainage. This soil is strongly alkaline (pH 7.9 - 8.7) with a low salt content (less than 4 dS/m) and the fertility of the plowable layer is low. This sub-class includes the Topará edaphic unit on flat to slightly inclined gradients (0-4%).

Agricultural operations will require irrigation on these lands because this is an arid area, and the soil has low fertility.

Sub-class A3sl (r)

These lands consist of deep soils having a coarse texture (sand), good to excessive drainage and very rapid permeability. This soil reaction fluctuates between neutral to strongly alkaline (pH 6.6 - 8.8) with a low salt content (4 to 8 dS/m). The fertility of the plowable layer is low. This sub-class includes the Estación edaphic unit on the following gradients: flat to slightly inclined (0-4%) and moderate to steeply inclined (4-15%).

Use is limited principally by the low salt content, which affects crops, especially those susceptible to salinity, and low fertility, especially the low content of nitrogen and available phosphorus, as well as its coarse texture (sand) and excessive drainage.

- **LAND SUITABLE FOR PERMANENT CULTIVATION (C)**

These lands include areas that are not suitable for continual ploughing but which are suitable for perennial herbaceous crops or shrubs and trees (fruit trees mainly). The study area contains class C3, which is described below.

Low agricultural quality (C3)

Includes soils with low agricultural quality, mainly because of severe soil quality limitations, salinity and erosion, which restricts the range of perennial crops that can be grown. The condition of this land demands intense conservation and management practices in order to obtain economically acceptable yields over time. The study area contains sub-classes C3sl(r) and C3sel(r).

Sub-class C3sl(r)

This sub-class includes land of low agricultural quality that are unsuitable for intensive cultivation because of the high salt concentration (between 8 and 16 dS/m) and, in some cases, the existence of a high proportion of gravel. These soils are coarse to moderately coarse (sand to sandy loam), moderately deep to deep and with good to excessive drainage. The reaction is neutral to strongly alkaline (pH 6.8 – 8.8), generally have a high soluble boron content (greater than 4 ppm) and their natural fertility is low.

This sub-class includes the Rio Seco, Jaguay and Venturosa soil types, all found on flat to slightly inclined (0-4%) and moderate to steeply inclined gradients (4-15%); and the Piaña soil type on moderate to steeply inclined gradients (4-15%).

The limitations on use are due to a high salt content and, in some cases (Venturosa soil type) to rocky fragments (gravels), low fertility and coarse texture.

Sub-class C3sel(r)

Includes moderately deep to deep soils of coarse texture (sandy loam to sand), having somewhat excessive to excessive drainage, a pH that is moderate to strongly alkaline (pH 8.1 – 8.5), a high salt content (8-16 dS/m) and low fertility.

The sub-class includes the Estación and Venturosa soil types, both on moderately inclined gradients (15-25%).

Limitations refer to the gradient, which can accelerate the process of water erosion, the soil's coarse texture and high salt content, lack of moisture in the soil because of the arid environment in which it is found, and low fertility, especially because of the low levels of organic materials and available phosphorus.

- **BUFFER LAND**

This land does not possess the minimum environmental conditions for agriculture, grazing or forestry. The following units have been identified in the study area:

Unit Xs

This unit includes the miscellaneous areas identified as Miscellaneous Cauce and Miscellaneous Pedrones, both on moderate to steeply inclined gradients (4-15%), formed principally by the riverbeds of Topará creek and other minor creeks. These zones are exposed to water flow during the rainy season and are made up of deposits of sand, gravel, pebbles and stones with no soil presence.

Unit Xse

This unit includes the Bolivar edaphic unit on very steep gradients (50-75%); Caltopa on moderately inclined (15-25%) and steep gradients (25-50%); Caltopa and Jacaya on very steep (50-75%) and extremely steep (+ 75%) gradients; and the unit identified as Miscellaneous Rock on very steep (50-75%) and extremely steep (+ 75%) gradients.

The Bolivar, Caltopa and Jacaya soils are superficial to very superficial, coarse in texture (sand to sandy loam), with a certain contents of gravels (20 to 70%), low fertility, slightly acid reaction to moderately alkaline (pH 6.1 – 8.4) and a variable salt contents.

Agricultural potential use of this land is limited by steep slopes and shallow soils in the case of Bolivar, Caltopa and Jacaya soils, and by the absence of soil in the miscellaneous rock unit. It should be mentioned that some parts of the Jacaya soil unit contain thin vegetation consisting mainly of cacti species where the soil is slightly developed and there is an accumulation of organic material; these have not been mapped because of limitations imposed by the scale of the maps used.

Unit Xsl

This unit includes the Terraza Antigua soil on moderate to steeply inclined (4-15%) gradients and the Cruz Pampa unit on slightly inclined (0-4%) and moderate to steeply inclined (4-15%) gradients.

It consists of shallow to deep soils having a moderately coarse to coarse texture (sandy loam to sand), and imperfect to somewhat excessive drainage. This soil fluctuates between slightly acid to strongly alkaline (pH 6.2 to 8.4) with a variable salt content that reaches more than 30 dS/m in the case of the Cruz Pampa soil , while the fertility of the plowable layer is low.

The limitations on use derive from the salt content which affects crops, especially those susceptible to salinity, and low fertility, caused especially by low nitrogen and available phosphorus contents, as well as its coarse texture (sand) and excessive drainage in some cases. In other cases the shallowness of the soil places limits on its use for agriculture.

Unit Xsel

This unit includes the Estación soils on steep slopes (25-50%) and the Cruz Pampa unit on moderately inclined (15-25%) and steep (25-50%) gradients.

These soils are moderately coarse to coarse in texture (sandy loam to sand); and have a high salt content (greater than 30 dS/m), in the case of the Cruz Pampa soil. The soils are shallow to deep, with low natural fertility, are neutral to strongly alkaline (pH 6.9 – 8.5) and have a high soluble boron content (more than 4 ppm). The excess of salts, principally together with the coarse texture and steep gradient which increases the risk of erosion in some cases, limits the use that can be made of this land.

5.1.4.3 CONCLUSIONS

The reconnaissance study of the GNL 2 zone shows a physiography dominated by a mountainous landscape with gradients steeper than 25% and, to a lesser extent, by alluvial land.

Depending on their origin, soils were found that had developed from residual, colluvial-alluvial, alluvial, fluvial and marine materials.

11 soil units and 3 units of miscellaneous areas were determined, as well as others which, as they could not be mapped at the scale used for the study, were not considered.

Taxonomically, soils belonging to the sub-groups Torriorthents and Torripsamments were dominant. Soils of the Torrifluvents and Haplosalids sub-group were found to a lesser extent.

Because of the prevailing weather conditions in the zone (arid), most of the soils are poorly developed.

The soils with the best edaphic conditions for cultivation were found in the area adjacent to Topara creek (Topara soil) and certain flat areas (Estación and Jaguay soils).

Classifying them by land use capacity, three groups were identified: Intensive cultivation (A), permanent cultivation (C) and protection (X).

5.1.5 LANDSCAPE

5.1.5.1 GENERAL

In evaluating the visual landscape, one must keep in mind that the perception of the beauty is an act of interpretation by the observer through his physiological and psychological mechanisms. The observer will determine the characteristics of his interpretation, without forgetting that landscape is the result of geomorphologic, climatic, biotic and anthropic combinations. The observer must remember that the current landscape is not the end of the process, since it will always be subject to changes in time, thus becoming a dynamic assembly.

The objective of this section is it to describe the visual environment where the project will be built and describe its value before and after the project start-up.

5.1.5.2 METHODOLOGICAL ASPECTS

This study analyzes the relevant aspects considered in the *Evaluation of Perceived Landscape* prepared for the project (see full study in the Landscape Exhibit). This chapter contains a study of the basic components of the elements involved both in the composition and formation of the landscape, which are observed in order to determine their composition, contrast, and visual dominance. Furthermore, this chapter describes the current condition of the landscape according to its Landscape Quality[1] and Visual Fragility[2].

The two study areas include:

- Area A, corresponding to the GNL 2 Quarry
- Area B, represented by the Access Road

The Maps Volume contains a map with the proposed zoning for the Landscape Visual Quality Evaluation.

5.1.5.3 PROJECT LOCATION WITH RESPECT TO THE SOIL USAGE

This section describes the area where the GNL 2 Quarry Project and access road will be constructed. This land is classified as untilled land freely available to the State (Supreme Resolutions No. 001-99 and 057-2000-AG) ratified by Supreme Resolution No. 026-2002-AG. Pursuant to these resolutions and the Zoning Map as well as the Roads of the Provincial Council of Cañete (November 1984), there is no compromise of areas destined to urban settlements and productive use. Therefore the projects will not be incompatible with the use referred to in the territorial rules.

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[1] Landscape quality: evaluation in comparable terms of the basic visual characteristics (form, line, color, texture) of the landscape components.
[2] Visual fragility: Susceptibility to the change in a landscape when it is put to use.

5.1.5.4 RELATIONSHIP AMONG PERCEIVED LANDSCAPE COMPONENTS

Zone A

Existing visual contrast: The predominant shapes and characteristic colors of Zone A do not allow the perception of a visual contract. The lighting, especially during the daytime, enhances the aridness of the environment. The background settings allow certain variety in perception but this is not determining.

Visual dominance: The shape and predominant volume of the landscape are rocky formations (mountains), which prevail over other elements of the setting. The sky as a background setting also dominates the scene. These two elements are the most relevant of the composition of the landscape.

Visual characteristics: The most outstanding visual characteristic of this landscape is the aridness, due to a low level of chromatic contrast in the location.

Zone B

Existing visual contrast: There is no predominant visual contrast, or shapes, or colors, or texture**.**

Visual dominance: The flat shape of the land and its characteristic color prevail, which, together with the background setting are the most outstanding elements of the composition.

Visual characteristics: The main characteristic of this landscape is its area, according to the observer's scale. The uniformity of the composition does not lend to the distinguishing of important visual characteristics.

5.1.5.5 IMPORTANT COMPONENTS AND AESTHETIC POTENTIAL OF THE LANDSCAPE

Using the information obtained from the foregoing analysis, a table[3] was prepared to evaluate the landscape's aesthetic qualities by identifying the most relevant or important elements both in the biophysical and architectonic composition.

The following results were obtained from this analysis: Zone A possesses a Medium Landscape potential, indicating that certain the elements in the aesthetic composition of the landscape are important to the viewer. Zone B possesses a *low* landscape potential, which indicates that the elements have little influence on the aesthetic composition of the landscape.

The three most important elements of composition include the shape of terrain, the scale, and axis. The excessive lighting in the study areas causes a dazzling effect to the viewer and reduces

[3] Based on the table of Weighted Values in the Environmental Diagnosis of Potentiality-Engineering Applied to Industrial Reconversion and to the Reclamation of Degraded Industrial Landscapes- Mariano Seoánez Calvo 1998.

his or her ability to identify details. This data is relevant in the design of measures to recover the landscape.

5.1.5.6 ANALYSIS OF THE VISUAL QUALITY OF THE LANDSCAPE

This study utilized The Bureau of Land Management's (BLM 1980) indirect method to assess visual quality of the landscape. This method is based on an evaluation of the basic visual characteristics (form, line color, texture) of the components of the landscape (morphology, vegetation, water, color, background, rarity, human activity). A value is assigned according to a criteria of sequence and the total sum of these determines the class of the visual quality, of the area under study.

When applying such an evaluation to the zones of the study, the result was that both in Zone A and in Zone B, the visual quality of the landscape is found to belong to Class *C*, described as areas of low quality, with very little variety in form, color, line and texture.

5.1.5.7 ANALYSIS OF LANDSCAPE FRAGILITY AND ABSORPTION CAPACITY

This study utilized the YEOMANS (1986) method to determine the fragility and the Visual Absorption Capacity of the landscape. "Fragility" refers to the susceptibility of the landscape to change when it is put into use. The "capacity of the landscape" refers to its ability to receive proposed actions without producing variations in its visual characteristics. The YEOMANS method involves assigning a value to the biophysical factors of the landscape. The values obtained are then placed in a formula, which classifies the landscape based on a given scale.

In Zone A, the value obtained corresponds to a Low visual capacity of absorption, which leads to the realization of a low fragility of the landscape with respect to specific human activity and the low deterioration that the landscape will suffer under the development of certain activities. Since the concept of fragility is the opposite to the concept of visual absorption capacity, it expresses the high aptitude of the landscape to visually absorb modifications or changes without harming its visual quality.

The values obtained in Zone B correspond to a moderate visual absorption capacity. In other words, this scenery is more vulnerable to change and will, experience a greater a deterioration of visual quality when construction of the project occurs.

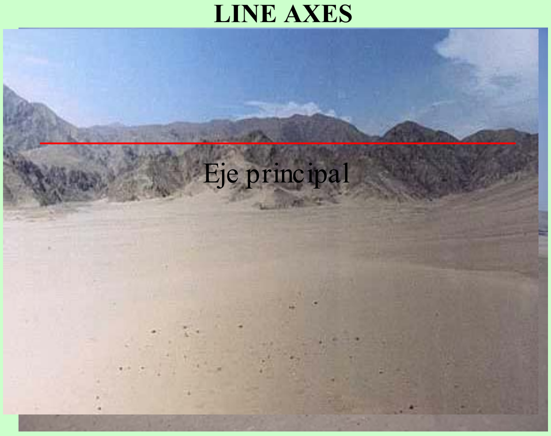
5.1.5.8 CONCLUSION

According to the analyses, the quarry area and access road area do not have much aesthetic value or manifest much complexity in its composition. These areas appear to be very common scenes which are easy to find along the country's coast. Both in Zone A and in Zone B, the feeling of monotony is accentuated by the visual characteristics such as space, scale and color, which limit these landscapes' aesthetic potential. Tables 5.1.5-1 to 5.1.5.4 show the most noticeable visual landscape components and the architectural composition of visual landscape around the influence area of the project.

Table 5.1.5-1 Most noticeable visual landscape components zone A

COMPONENT	MOST NOTICEABLE VISUAL CHARACTERISTICS	ATTRIBUTES	COMMENTS
FORM OF TERRAIN (RELIEF) 	Rugged mountain relief that stands out in most of the scene. The area of direct influence appears as flat desert terrain dominated by rocky formations.	Mountain slope gradient: from 50% to 70% Plains gradient: between 2% and 10%.	Because of the topography of the scene there is the possibility of an obstructed view.
SOIL AND ROCK 	Rocky formations, dark grayish brown in color, with little contrast. Rocks dominate over the rugged ground.	Structure: Angular gravel uncovered in mountains; thick sandy texture soil.	There is no chromatic contrast or diversity in the soil or in the rocky formations, as a whole.
VEGETATION 	Scarce vegetation with little chromatic contrast blending into the color of the landscape, dispersed along the scene.	Dispersed Tillandsias (500-700 masl) Cactus (700 – 1200masl) Seasonal herbaceous shrubs (about 1200 masl) Widely dispersed hills	The type of vegetation does not allow for chromatic contrast or diversity, giving the scenery an arid and dry look.
WILDLIFE	The majority of existing wildlife is nocturnal, blending with the texture and color of the rock and soil. It is difficult for the observer to distinguish.	Presence of reptiles, rodents and some birds.	The existent wildlife has little relevance on the composition of the scene.
CLIMATE	Hot, with little rain and overcast in the winter months.	Annual average temperature is 20° C	The sun is very bright during the day
HUMAN ACTIVITY	There is no evidence of human activity	–	–

Table 5.1.5-2 Architectural composition of visual landscape zone A

COMPONENTS	MOST NOTICEABLE CHARACTERISTICS OF THE COMPOSITION
FORM 	This appears as a three-dimensional form which volume stands out because of the visual evenness of the rocky formations due to the existing tones. Visual dominance of this volume, over the other elements in the composition.
SCALE - SPACE 	Taking into account the position of the LNG Quarry and its area of influence (Zone A), the scale is hard for the observer to follow. The space dominated by the volumetric composition.
LINE AXES 	The axes in the composition depend on the position of the observer, the further the observer the more noticeable an axis parallel to the horizon becomes. In the quarry area the axis develops perpendicular to the visual cone's axis. The straight dominates, not so continuously, but strong enough to determine only one reading.

COMPONENTS	MOST NOTICEABLE CHARACTERISTICS OF THE COMPOSITION
TEXTURE 	The texture appears in groups and randomly isolated.
COLOR 	The colors in the scenery are gray, dim brown, without any sharp color contrast.
SCENERY BACKGROUND 	The sky is this scenery's background. Because of the climate of the area, sunlight is predominant, accentuating the aridity of the terrain .

Table 5.1.5-3 Most noticeable visual landscape components zone B

COMPONENTS	MOST NOTICEABLE VISUAL CHARACTERISTICS	ATTRIBUTES	COMMENTS
FORM OF TERRAIN (RELIEF) 	Terrain is not so rugged, vast plains and desert areas.	Gradient: between 2% and 10%.	Due to the type of terrain, views are very similar during the observer's journey.
SOIL AND ROCK 	Predominance of warm yellow sandy ground.	Structure: Soil with thick sandy texture.	The continuity of the terrain and the never changing color does not make allowance for contrast.
VEGETATIÓN 	Scarce vegetation with little chromatic contrast blending into the color of the landscape, dispersed along the scene.	Cactus	The type of vegetation does not allow for chromatic contrast
WILDLIFE	The existent wildlife blends with the texture and color of the rock and soil.	Presence of reptiles and rodents.	The existent wildlife has little relevance on the composition of the scene.
CLIMATE	Typical of the Peruvian coast, with little rain and presence of clouds in the winter months.	Annual average temperature is 20° C	The sun is very bright during the day especially in the summer months.
HUMAN ACTIVITY 	There is a presence of anthropic activity in the zone.	Presence of utility structures (high tension towers)	Changes in the composition of the scenery.

Table 5.1.5-4 Architectonic composition of visual landscape zone B

COMPONENTS	MOST NOTICEABLE CHARACTERISTICS OF THE COMPOSITION
FORM 	The scenery as a whole appears as a bi-dimensional form, almost without perspective, no volumetric formations stand out to dominate the composition; strong presence of horizontal planes lead to a plain surface view.
SCALE - SPACE 	This scene is characterized by depicting unlimited space, denoting a scale which is difficult for the observer to manage.
LINE AXES 	The horizontal axis is dominant in the composition. The horizontal line dominates the composition organizing its elements

COMPONENTS	MOST NOTICEABLE CHARACTERISTICS OF THE COMPOSITION
TEXTURE 	The scene does not present many irregularities, the few contrast elements appear to be randomly dispersed.
COLOR 	There is no color variety in the scenery; the presence of cream-like colors is accentuated. Because of the existent sunlight and the vastness of the scenery there is monotony in the color.
SCENERY BACKGROUND 	From the view of the observer, both the sky as well as the terrain's surface stand out as the composition's background scenery.

5.1.6 CURRENT LAND USE

The purpose of this section is to identify the land uses in the quarry area, the area of influence, and the access route. It includes a map of the different forms of land use, using as a reference the International Geographical Union (IGU) Land Use Classification System, which is used by INRENA. This information on land use, when integrated with information from other disciplines (soils, geomorphology, hydrology and others) will provide a basis for drafting the design and construction plans and designing the mitigation measures aimed to prevent or minimize the environmental impacts of the project.

Land uses were identified by interpreting Landsat satellite images using ARC VIEW 3.2 software and information from a field survey. We also used information from the publication entitled “Inventario y Evaluación de Recursos Naturales de la Costa: Cuenca de los Ríos Cañete, y San Juan - Topará (ONERN 1970 Y 1971)”, which included an inventory of land use in the study area.

Most of the study area consists of desert areas where vegetation is sparse. The study area is primarily unused by humans. The primary use is traditional farming along Topará creek. .

5.1.6.1 CURRENT LAND USE CATEGORIES

Using the IGU Land Use Classification System as a reference, the study area was grouped into three categories: Land with natural vegetation, cultivated land, and unused land. It should be pointed out that the IGU system is very flexible and enables the particular characterizations of each area to be incorporated. The land use categories identified in the study area are described below.

5.1.6.2 CULTIVATED LAND

- **Cultivated Land (TC)**

This land is located along Topara creek. It includes a significant proportion of land having a high agricultural quality, with the main limitations being fertility and water. The lands close to the creek are frequently eroded when heavy rains in the highlands cause the water levels to rise.

Despite the seasonal fluctuations of the creek, there is enough water available in summer for this land to be intensively farmed. Harvesting occurs during the wet season. This land is planted principally with annual species such as *Zea mays* “maize,” “*Manihot utilissima* “cassava,” *Phaseolus vulgaris* “frijol beans,” Phaseolus lanatus “butter beans,” and Gossypium barbadense “cotton.” These crops will depend on the availability of water, particularly during the planting season.

In some areas of the creek, land is used for the cultivation of avocados, pecans, grapes, and citrus fruits. Most of this produce is consumed in Peru with Lima as the main market.

Wells have been dug in some areas to enable access to groundwater, which allows for two harvests a year.

This land has a high agricultural value in Peruvian terms. It is level, has no climate restrictions apart from the lack of rain which has been replaced by artificial irrigation, and has received higher levels of investment and technical management encouraged by the conditions in the area and the proximity of large markets.

- **Land lying fallow (TD)**

This land consists of agricultural land which is currently lying fallow, a method of land management aimed at preserving its fertility or because there is not enough water in that area. In the wet season it is planted mainly with cotton, pumpkin, butter beans and frijol beans.

During the year, the area of land left fallow varies, it is highest between June and September and is less during the rest of the year, mainly, as we have mentioned, because of the lack of water.

5.1.6.3 LAND WITH NATURAL VEGETATION

This category has been broken down in accordance with the dominant type of vegetation, which is described below:

- **Land growing tillandsia on plains and piedmonts (VTP)**

This is land is found in some areas of the coastal wind-blown plains, especially between the coast and the mountains. It is also found on the piedmont close to the hills and mountains where sandy materials predominate and in which tillandsias flourish between July and October due to the ocean mists.

- **Land growing tillandsia on undulating plains and seasonal hills (VTPO)**

This land contains scattered tillandsias and is found on the undulating coastal plains affected by winds. It is also found on volcanic hills sometimes covered with wind-blown sand. The vegetation flourishes from July to October, as a consequence of the mist arising from the evaporation of seawater.

- **Land growing cacti in creek beds (VCC)**

This land is located in the beds of creeks in the study zone contains scattered cacti. Dominant species include "monkey's tail" and "candelabra." These plants flourish from the mists that condense on contact with them.

- **Land growing cacti on hills and mountain slopes (VCM)**

This land is characterized by cacti scattered across hills and mountain slopes, where species known as "monkey's tail" and "candelabra" predominate. This sparse existing vegetation depends on the condensation of water vapor carried by the mist.

- **Land growing herbaceous species on hills and mountain slopes (VHM)**

This land contains scattered herbaceous plants and small shrubs. This vegetation is found on hillsides and mountain slopes in the higher reaches of the study area. It is influenced by clouds coming off the sea, which condenses on contact with the plants and soil.

5.1.6.4 LAND WITHOUT VEGETATION

The lands devoid of vegetation include the desert plains (including flat land and piedmont; undulating plains and low hills), dry creek beds, and some hillsides and mountain slopes.

Some desert areas can become productive if considerable investment is made in leveling the land and sinking wells to tap into the groundwater, in contrast other areas that will always remain unproductive due to an excess of salts, salt caking, lack of soil, etc.

- **Land without vegetation on plains and piedmont (SVP)**

This land on the desert plains and flat piedmont dominated by a sandy texture is bereft of vegetation when the exposed soil is subject to wind erosion.

- **Land without vegetation on undulating plains and low hills (SVPO)**

This land on the undulating desert plains and low hills of volcanic origin is covered by a layer of sand and is devoid of vegetation when the exposed soil is subject to wind erosion and sand deposits.

- **Land without vegetation in creek beds (SVC)**

This land, in the beds of Topará creek and other minor creeks, lacks vegetation because there is insufficient water and the upper reaches consist only of rocks, gravel and small stones. The lower reaches are covered with a layer of sand.

- **Land without vegetation in hillsides and mountain slopes (SVM)**

This land, on the sides of hills and mountains, is devoid of vegetation because it is very steep and has no soil (rocky outcrops) or because the soil is very thin and there insufficient water. This land is very steep and as it is unproductive has no agricultural use.

5.1.7 AIR QUALITY AND ENVIRONMENTAL NOISE

The air quality and noise baseline is based on data collected from five monitoring points and other available information. Sampling was performed at the GNL-2 Quarry, the Access road and the Topará creek from March 1 to 6, 2005. To complement this information, sampling was also conducted at kilometer 168 of the South Panamerican Highway on October 9 and 10, 2004.

5.1.7.1 STANDARDS AND MAXIMUM PERMISSIBLE LEVELS

Standards and maximum permissible levels are the highest values that a national regulatory or an international agency has set in order to minimize the risk to human health or the environment. The Government of Peru established the “Regulations for National Air Quality Standards” through the Supreme Decree 074-2001-PCM. Table 5.1.7-1 shows these standards.

Table 5.1.7-1 National Air Quality Standards

Parameters	Period	Form of Standard		Method of Analysis
		Value µg/m3	Format	
Particulate Matter Smaller than 10 microns (PM_{10})	24 hours	150	NE more than 3 times a year	Inertial separation / filtration (Gravimetry)
Carbon Monoxide (CO)	8 hours	10 000	Running average	Non-dispersive infrared (NDIR) (Automatic method)
	1 hour	30 000	NE more than once a year	
Sulfur dioxide (SO_2)	24 hours	365	NE more than once a year	Fluorescence UV (Automatic method)
Nitrogen dioxide (NO_2)	1 hour	200	NE more than 24 times a year	Chemiluminiscence (Automatic method)

NE: This value should not exceed

The World Bank Group (WBG) also set quality standards for ambient air through the Pollution Prevention and Abatement Handbook (July 1998). The Standards set are presented in Table 5.1.7-2.

Table 5.1.7-2 World Bank Group Ambient Air Conditions at Property Boundary, for General Application

Pollutant	**Period**	**Concentration µg/m3**
Particulate Matter Smaller than 10 microns (PM_{10})	Maximum 24 hours average	70
Sulfur dioxide (SO_2)	Maximum 24 hours average	125
Nitrogen dioxide (NO_2)	Maximum 24 hours average	150
Carbon Monoxide (CO)	---	NL

NL: No limit established

The Government of Peru has also issued Regulations for National Ambient Noise Quality Standards through Supreme Decree No. 085-2003-PCM. However, these regulations are not applicable to the project as they do not consider rural settings. Table 5.1.7-3 shows this standard.

Table 5.1.7-3 National Ambient Noise Quality Standards

Areas of Application	**Values Expressed in L_{AeqT}**	
	Day Schedule (1)	**Night Schedule (2)**
Special Protection Area	50	40
Residential Area	60	50
Commercial Area	70	60
Industrial Area	80	70

(1): From 07:01 to 22:00
(2): From 22:01 to 07:00

The World Bank Group also established standards for noise through the Pollution Prevention and Abatement Handbook (July 1998). Under certain conditions, these standards are stricter than those established by the GoP. The Standards set are presented in Table 5.1.7-4.

Table 5.1.7-4 World Bank Ambient Noise Standards at Property Boundary

Receptor	**Values Expressed in L_{AeqT}**	
	Day Schedule (1)	**Night Schedule (2)**
Residential, Institutional or Educational	55	45
Industrial or commercial	70	70

(1): From 07:01 to 22:00
(2): From 22:01 to 07:00

The National Institute for Occupational Safety and Health (NIOSH) has established guidelines for worker noise exposure without hearing protection. These guidelines establish a limit of 85 dB for an eight-hour work shift. The GoP through Supreme Decree Nº 046-2001-EM, the Mining Safety and Health Regulations, also consider 85 dB per eight-hour shift as the standard in occupational safety and health. These standards are presented in Table 5.1.7-5.

Table 5.1.7-5 Noise Occupational Health Guidelines – within property boundary

Type of Ambient	Period	dBA (Decibels)
Working (*)	8 hours	85
Outdoors diurnal	Day	55
Outdoors nocturnal	Night	45

National Institute for Occupational Safety and Health
(*) D.S. Nº 046-2001-EM. Reglamento de Seguridad e Higiene Minera (Mining Safety and Health Regulations)

5.1.7.2 MONITORING STATIONS

The following criteria were used to select the air quality and noise monitoring stations:

- The project's future operation points.
- The activities and emission sources currently existing in the area.
- The nature of the possible impacts on the air quality associated with the project development, which will be monitored in the future, and
- The weather conditions in the area.

Table 5.1.7-6 shows the main characteristics of the air quality monitoring stations through UTM coordinates and their altitude in meters above sea level.

Table 5.1.7-6 Description and location of air quality monitoring stations

Monitoring Station		Coordinates UTM	
		North	East
P0*	Start of Access road to GNL-2 Quarry	8 536 220	360 220
	Description: Desert area near the South Pan-American Highway, at Km. 168. At the sampling point, strong winds are perceived.		
P1	Top of Topara creek	8 543 759	378 333
	Description: Stony area, next to a hillside, near a agricultural area.		
P2	Km. 11 Access Road to Quarry GNL 2	8 540 437	369 457
	Description: Half way to the north side of the access road to Quarry GNL 2. Desert area.		
P3	GNL 2 Quarry – Pto. 1	8 546 794	376 031
	Description: Entrance to Quarry GNL 2 concession.		
P4	GNL 2 Quarry – Pto. 2	8 547 729	376 872
	Description: End of the Quarry GNL 2 concession.		

* Monitoring at this point was carried out on October 09 and 10, 2004.

Measurement of environmental noise was performed around the air quality monitoring stations. Table 5.1.7-7 describes the noise monitoring sites.

Table 5.1.7-7 Description and location of the environmental noise monitoring stations

Measuring point			UTM Coordinates North	UTM Coordinates East
P0*	Beginning of the access road to Quarry GNL 2		8 536 220	360 220
	Description: Desert area next to the South Pan American Highway, at the level of Km. 168.			
P1	Top of Topara creek		8 543 650	378 381
	Description: Agricultural area.			
P2	Halfway in the GNL 2 quarry access road			
	P2-1	Flat desert area	8 541547	368 880
	P2-2	Flat desert area	8 540300	369 399
	P2-3	Flat desert area	8 540999	370 201
	P3-4	Flat desert area	8 541547	371 048
P3	GNL 2 Quarry – Pto. 1			
	P3-1	Creek	8 546796	376 036
	P3-2	Creek	8 547102	376 348
	P3-3	Stony hillside	8 546977	376 461
	P3-4	Creek	8 547331	376 044
	P3-5	Creek	8 547851	375 956
	P3-6	Stony hillside	8 547352	376 374
	P3-7	Stony hillside	8 547621	376 355
	P3-8	Creek	8 547498	376 731
	P3-9	Stony hillside	8 547730	376 873
P4	GNL 2 Quarry – Pto. 2			
	P4-1	Stony hillside	8 547610	377 101
	P4-2	Stony hillside	8 547589	377 199
	P4-3	Creek	8 547991	376 689
	P4-4	Stony hillside	8 548195	376 680

* Monitoring at this point was carried out on October 09 and 10, 2004

5.1.7.3 SAMPLING EQUIPMENT AND METHODS

Table 5.1.7-8 shows the sampling equipment and methods used for monitoring **P0** (Beginning of the access road to Quarry GNL 2 , kilometer 168 of the South Pan-American Highway, on October 9 and 10, 2004). Annex 2.5 shows the technical specifications of the equipment used.

Table 5.1.7-8 Air quality sampling equipment and methods – October 2004

Parameters	Equipment	Method
Particles PM_{10}	Low volume Sampler	Reference method USEPA, RFPS-1298-127
Carbon Monoxide	CO API 300 Analyzer	Reference method USEPA RFCA-1093-093
Sulfur dioxide	SO_2 API 100 Analyzer	Reference method USEPA EQSA-0495-100
Nitrogen dioxide	NOx API 200 Analyzer	Reference method USEPA RFNA-1194-099

Table 5.1.7-9 shows the equipment, sampling methods and analysis methods used for monitoring points P1 – P4 (March 1-6, 2005). Annex 2.5 shows the technical specifications of the equipment.

Table 5.1.7-9 Air quality sampling equipment and methods – March 2005

Parameters	Sampling Method / Equipment	Meted of Analysis	Period of sampling	Standards
Total Suspended Particles PM10	Reception in Bravo Plus M Sampler	Gravimetric	24 hours	ASTM (1)
Gases (SO_2, NOx and CO)	Dynamic Sampling System (Collection Solution Absorption)	Physicochemical	24 hours 1 hour	ASTM (1)
Meteorology	Meteorological Tower Davis Instrument	----	24 hours	---
Coordinates UTM	GPS	----	----	----

Table 5.1.7-10 shows the technical characteristics and settings of the equipment used for monitoring noise at P0, on October 9-10, 2004. Table 5.1.7-11 shows the characteristics of the sound level meter used to monitor noise in points P1 – P4, carried out from March 1-6, 2005.

Table 5.1.7-10 Noise Monitoring equipment and settings – October 2004

Parameters	Equipment	dB (A) Scale	Reply	Weight
Noise	Metrosonic 3080	40 – 140	Fast	A

Table 5.1.7-11 Noise Monitoring equipment and settings – March 2005

Parameters	Equipment	dB (A) Scale	Reply	Weight
Noise	TESTO 816	30 – 140	Fast	A

5.1.7.4 CALIBRATION AND VERIFICATION PROCEDURES

Calibration procedures established for each analysis and equipment were followed. These procedures are based on the Quality Assurance Handbook for Air Pollution Measurement Systems (Q.A. Handbook) and EPA documents (40 CFR 50 and 40 CFR 58). All equipment was calibrated in the field. The calibration instruments used during October, 2004 were:

Gas Analyzers

- ✓ API Mass Calibrator, model 700
- ✓ API Zero Air Generator, model 702
- ✓ Standard Gases with EPA Certification

Particle Sampler

- ✓ Streamline Flow Calibrator

The calibration instruments for the March 2005 sampling were:

PM10 Bravo Plus M Sampler

- ✓ TCR Tecora Flow Calibrator
- ✓ Testo Standard Thermometer
- ✓ Environmental Pressure Barometer

Sound level meter

- ✓ Testo Calibrator (94 and 104 dB to 1000 hz frequency)

The calibration procedures used for air quality and noise monitoring in March 2005 are further detailed in Annex 2.5. This appendix also includes the calibration certificates for this equipment.

All sample analyses were subcontracted to a laboratory certified by INDECOPI (National Institute Consumer Defense and Intellectual Property). Annex 2.5 presents the accreditation certificates issued by INDECOPI.

5.1.7.5 RESULTS

Suspended Particles PM_{10}

The results of the PM_{10} samples are shown in table 5.1.7-12. Annex 2.5 presents the laboratory results. All PM10 concentrations meet the National Air Quality Standard and WBG Standards.

The GNL 2 Quarry – Pto. 1 station showed the lowest concentration, while the highest was measured at the beginning of the Access Road to GNL-2 quarry. The concentration measured is very close to the WBG standard.

The stations located inland show similar concentration with the highest value located at the Topara Creek station. This may be due to grazing and burning crops, which can generate such particles.

Table 5.1.7-12 PM_{10} Particles Concentration

Monitoring Station		Monitoring Period	Concentration (µg/m^3)
			PM_{10}
P0	Beginning of the Access Road to the GNL-2 quarry	From October 09 to10, 2004	97.0
P1	Top of Topara Creek	From March 01 to 02, 2005	46.1
P2	Half way the access road to GNL-2 quarry	From March 02 to 03, 2005	44.3
P3	GNL 2 Quarry – Pto. 1	From March 04 to 05, 2005	33.7
P4	GNL 2 -Quarry– Pto. 2	From March 05 to 06, 2005	41.3
Air Quality National Standard (ECA)(µg/m^3)			**150 (1)**
WBG Standard (µg/m^3)			**70**

(1) Average 24 hours - Appendix 1- DS. 074-2001-PCM

Carbon Monoxide (CO)

Table 5.1.7-13 shows the hourly averages of CO recorded in the monitoring stations and the national standard for comparison. CO concentrations measured in the five (5) monitoring stations are under the Quality Standard of 30,000 ug/m^3 for one hour.

Table 5.1.7-13 Carbon Monoxide Concentrations, CO

Station		Date	Time of Sampling	Hourly concentrations (µg/m³) Maximum (1 hour)
P0	Beginning of the Access Road to the GNL-2 quarry	09/10/04	22	583
P1	Top of Topara Creek	01/03/05	24	9,998
P2	Half way the access road to GNL-2 quarry	02/03/05	24	4,819
P3	GNL 2 Quarry – Pto. 1	04/03/05	24	5,223
P4	GNL 2 -Quarry– Pto. 2	05/03/05	24	10,475
Standard D.S. 074-2001 PCM				**30,000**
WBG Standard (µg/m³)				**NL**

NL: No limit established

Sulfur Dioxide (SO_2)

Table 5.1.7-14 shows the hourly averages of SO_2 recorded in each of the monitoring stations. The average SO_2 values measured do not exceed any of the standards, with a range between 0.405 and 8 µg/m³. The higher value was located close to the Panamerican highway where diesel truck traffic occurs.

Table 5.1.7-14 Sulfur Dioxide, SO2, concentrations

Station		Date	24-hour Average µg/m³
P0	Beginning of the Access Road to the GNL-2 quarry	09/10/04	**8**
P1	Top of Topara Creek	01/03/05	**0.679**
P2	Half way the access road to GNL-2 quarry	02/03/05	**0.519**
P3	GNL 2 Quarry – Pto. 1	04/03/05	**0.408**
P4	GNL 2 -Quarry– Pto. 2	05/03/05	**0.405**
Standard D.S. 074-2001 PCM (24 hours)			**365**
WBG Standard (µg/m³)			**125**

Nitrous Oxides (NOx)

Table 5.1.7-15 shows the 24-hr averages for NOx recorded during monitoring. All NO_x concentrations are below the 200 μg/m^3 standards set for this parameter, with concentrations ranging from 0.000 to 14.7 μg/m^3.

Table 5.1.7-15 Nitrous Oxides, NO_x, Concentrations

Station		Date	24-hour Average μg/m^3
P0	Beginning of the Access Road to the GNL-2 quarry	09/10/04	**5**
P1	Top of Topara Creek	01/03/05	**11**
P2	Half way the access road to GNL-2 quarry	02/03/05	**12**
P3	GNL 2 Quarry – Pto. 1	04/03/05	**15**
P4	GNL 2 -Quarry– Pto. 2	05/03/05	**0.0**
Standard D.S. 074-2001 PCM (24 hours)			**200**
WBG Standard (μg/m^3)			**150**

Noise

Table 5.1.7-16 presents the average and maximum noise levels (Leq) measured at the monitoring points. All noise levels recorded at the monitoring points are lower than the standards.

At the Beginning of the Access Road to GNL-2 Quarry station, an average noise level of 67.0 dB (A) and a maximum of 81.2 dB (A) was recorded during the measuring period from 07:01 to 22:00. Noise measured from 22:01 and 07:00 had average and maximum levels of 67.4 and 88.88 dB(A) respectively. This station has a heavy influence from the Panamerican Highway traffic.

The noise recorded at the inland monitoring points presents relatively low levels, which are mostly caused by the wind in the area.

Table 5.1.7-16 Noise level monitoring results

Measuring point		Measuring data		Sound Pressure Level (Noise) dB (A)	
		Date	**Schedule**	**Leq**	**Lmax**
P0	Beginning of the Access Road to the GNL-2 quarry	09-Oct-04	Between 07:01 and 22:00	67.0	81.2
		10-Oct-04	Between 22:01 and 07:00	67.4	88.8
P1	Top of Topara creek	01-Mar-05	03:15 p.m.	35.3	37.8
P2	Half way the access road to GNL-2 quarry				
	P2-1	02-Mar-05	11:00 a.m.	41.2	46.3
	P2-2		11:10 a.m.	37.5	40.1
	P2-3		11:30 a.m.	41.0	44.3
	P3-4		11:45 a.m.	44.1	48.6
P3	GNL 2 Quarry – Pto. 1				
	P3-1	04-Mar-05	01:40 p.m.	30.6	32.0
	P3-2		02:00 p.m.	36.5	40.6
	P3-3		02:20 p.m.	36.3	40.5
	P3-4		02:32 p.m.	29.0	30.2
	P3-5		03:04 p.m.	28.8	29.9
	P3-6		03:17 p.m.	32.8	36.2
	P3-7		03:31 p.m.	32.9	36.6
	P3-8		03:55 p.m.	29.9	31.8
	P3-9		04:12 p.m.	30.3	32.3
	GNL 2 Quarry – Pto. 2				
P4	**P4-1**	05/03/05	01:07 p.m.	27.8	30.1
	P4-2		01:23 p.m.	27.2	29.6
	P4-3		01:45 p.m.	27.3	29.5
	P4-4		02:05 p.m.	28.8	30.7
Noise Standard (receptors outside the boundaries of the property): 70 dB*					

* Pollution Prevention and Abatement Handbook – World Bank - 1998

5.2.1 VEGETATION

5.2.1.1 GENERAL ASPECTS

The project zone is located in the Subtropical Pacific Desert, which is characterized by coastal plains containing scarce vegetation, and dense vegetation in areas adjacent to rivers. The Peruvian Current allows the formation of a foggy cloud layer. The moisture collects on the ground, allowing, in certain areas, the development of temporary and seasonal vegetation communities called lomas. Lomas formations are unique vegetation communities that are largely confined to localities where recurring fogs meet the near shore terrain. The fogs supply moisture for the development of the plant community. Over 100 of these communities have been identified and they exist as terrestrial islands within the ocean of arid habitat ranging over 3500 kms from northern Peru to north-central Chile. Endemism reaches over 40% at some localities. The habitats within the project influence area are typical of desert zones and harbor a variety of wild fauna and flora species.

The information in this chapter compiles existing data and information from two field visits. The methodology is described in Annex 3-1. The first field visit took place in September 2004, during the wintertime, also known as the wet season or lomas formation season. During this visit, the field team expected to observe a large vegetation coverage due to an increased moisture availability in coastal areas. However, the field team did not locate any seasonal lomas in the zones where the probability of occurrence was evident based on preliminary map interpretation. The second field trip was made in February 2005, during the summer time or dry season.

The quarry area is located on a peripheral lomas formation zone or also known as the lomas formation/desert transition zone. Lomas formations contain seasonal herbs and small shrubs, are expected to be observed at over 1100 m, and are sporadic formations from exceptionally humid years when strong El Niño events occurred. Additionally, some traces of river channels, assumed to be run-offs resulting from rains during the last El Niño Event (1997-1998), can be seen in parts of the valley within the planned quarry area.

Due to the desert characteristics of the project zone, the project will not significantly influence vegetation. For this reason, the Biological Base Line in the zone is not as complex as it would be in other regions.

5.2.1.2 DESCRIPTION OF VEGETATION UNITS

The vegetation quantity and diversity increases with altitude, ranging from completely desertic zones in lower parts, to zones supporting shrubby herbaceous species and cactaceae in the upper parts in the quarry zone. The vegetation is xerophytic throughout the project area - it has an open composition adapted to extremely dry environments (few species and few individuals in desert soils).

The study area includes six units or vegetation formations, in addition to the crop zones described in the Actual Use of Land section. Described below and shown in Table 5.2.1-1 are these units along with the zones established for the project. The complete list of documented species is found in Table 5.2.1-2.

Table 5.2.1-1 Elevation and dominant vegetation formations in Sampling Zones (SZ)

Sampling Zone (SZ)	Approximate elevation (m.)	Dominant Vegetation Formation
Access road	200 – 700	Sparse Tillandsias desert
Access road and GNL-2 Quarry	400 - 800	River channels for occasional run-offs, sparse shrubby herbaceous species.
	700 – 1100	Cactáceas desert, sparse shrubs and herbs
Topará Valley	700 – 900	River vegetation and seasonal crops
GNL-2 Quarry neighboring areas	1100 – 1600	Cactáceas desert
	1600 - 2000	Thorny cactáceas matorral and seasonal herbs on mountains

5.2.1.2.1 Plains desert and sparse Tillandsias on hills

Along the area where the future access road will be located, plains stretch with mostly desert sandy hills and irregular stands of vegetation formations of one or several species of the genus *Tillandsia* spp. (Family Bromeliaceae), known as "cardo de lomas" or "cardo de las rocas." This is a typical community occurring in a large part on coastal grounds and some islands off the coastline. This is a unique vegetative community due to its lack of root system, and the resistance it puts up against drought. *Tillandsia* spp. survives at the expense of its rosy foliage whose morphology allows it to capture nocturnal atmospheric humidity and dust particles stored in the limbs (Ferreyra, 1983).

Species like *Tillandsia latifolia var. latifolia, Tillandsia latifolia var divaricata* and *Tillandsia paleacea* have been documented in this unit. *Tillandsia latifolia var. latifolia* is endemic to Peru and is fairly common in the coastal desert in most of the country.

5.2.1.2.2 River channels for occasional run-offs support sparse shrubby herbaceous species.

During the field trips, it was possible to see the growth of shrubs like *Trixis cacaloides* (Asteraceae), *Heliotropium pilosum* (Boraginaceae), *Hoffmannseggia viscosa* (Fabaceae) and herbs such as *Tiquilia paronychioides* (Boraginaceae) in some dry river channels that bear sporadic run-offs like those in several small valleys down the mountain and in front of the location of the planned quarry. These species remain green even during dry seasons, in contrast with the sands devoid of vegetation around them.

5.2.1.2.3 Cactaceae desert, spare shrubs herbs

At the foothills of the Andes, from between 500-700 m up to 1200 m, there are sparsely distributed xerophyte plant communities dominated by column cacti belonging to the genera *Armatocereus, Neoraimondia* and *Haageocereus*.

The documented cactaceas in the area belong to *Neoraimondia arequipensis var. roseiflora* and *Haageocereus pseudomelanostele var. carminiflorus*. The species *Neoraimondia arequipensis* is endemic to Lima, Ica and Arequipa; however, pink flowers characterize the variety that has been documented. This species is distributed within Lima and Ica and was described by Ostolaza (Mercedes Flores, personal communication).

There are two sparse shrubby herbaceous species of particular importance - *Presliophytum incanum* (Loasaceae) and *Nolana weberbaueri* (Solanaceae). The first is endemic to the departments of Arequipa, Cajamarca, Lima and Piura; the second is endemic to the department of Ica only. The complete list of species is shown in Table 4.2.1-2.

5.2.1.2.4 Cactaceae desert

"Column cacti" of up to 4 meters tall are the dominant vegetation growing over 1,200 meters. It is also possible to observe stands of xerophyte shrubs of up to 0.8 m tall in the cactaceae desert. The cactaceae identified during the field visits were the same as described in the section above, but did not include the shrubby species. In contrast to the “cactaceae desert, spare shrubs herbs,” the cataceae desert contains only sporadic stands of *Trixis cacaloides*.

5.2.1.2.5 Thorny cactaceas matorral and seasonal herbs on mountains

Between 1600–2000 m stand cactaceae species, spiny shrubs, and ephemeral herbs that survive due to seasonal rain water. This formation is farther from the quarry area, at a distance of approximately 4 km.

5.2.1.2.6 Riparian vegetation and seasonal crops

Along the coastal rivers, the presence of ever-humid soils allows the development of riparian vegetation ("monte ribereño"). This vegetation formation is made up of shrubs, herbs and some perennial trees (year-round foliage) that grow adjacent to riversides (Ferreyra 1983). The riparian vegetation areas have decreased over the years as they have been largely replaced by seasonal crops.

In the study zone, there is riparian vegetation in Topara Valley. In areas where the soils are better drained, vegetation is comprised of woody plants (even trees like *Acacia macracantha* “Huarango”) and is often dominated by *Baccharis salicifolia*. The mountains are rocky and do not support extensive vegetation, but the existence of crops can be observed.These formations are far from the project influence area, hence, they will not be affected by the project.

Table 5.2.1-2 Main characteristics of vegetation species in the study area

Family	Scientific Name	Type*	Distribution	E**
Amaranthaceae	*Alternanthera pubiflora*	SA	Apurímac, Arequipa, Ayacucho, Cajamarca, Cuzco, Junín, Lambayeque, Lima, Loreto, Piura, San Martín, Tumbes	No
Asteraceae	*Baccharis salicifolia*	A	Apurímac, Cajamarca, Junín, Huánuco, Lambayeque, Lima, La Libertad, Loreto, San Martín	No
Asteraceae	*Trixis cacalioides*	A	Ancash, Arequipa, Cajamarca, Ica, Lima, La Libertad, Piura.	No
Boraginacea	*Heliotropium sp.*	A	Coast	No
Boraginacea	*Tiquilia paronychioides*	H	Ancash, Arequipa, Junín, Lambayeque, Lima, La Libertad, Piura, Puno, Tacna	No
Boraginacea	ND***	H	ND	No
Bromeliaceae	*Tillandsia latifolia var divaricata*	H	Amazonas, Ancash, Cajamarca, Lima, La Libertad, Tumbes	No
Bromeliaceae	*Tillandsia paleacea*	H	Ancash, Apurímac, Arequipa, Cuzco, Huancavelica, Ica, Lima, San Martín	No
Cactaceae	*Haageocereus pseudomelanostele var. carminiflorus*	S	ND	No
Cactaceae	*Neoraimondia arequipensis var. rosiflora*	S	Lima, Ica.	No
Fabaceae	*Acacia macracantha*	AL	Cuzco, Huánuco, Lambayeque, Lima, La Libertad, Piura, Tumbes.	No
Fabaceae	*Hoffmannseggia viscosa*	A	Ancash, Apurímac, Arequipa, Huancavelica, Lambayeque, Lima, Piura, Tumbes	No
Loasaceae	*Presliophytum incanum*	H	Arequipa, Cajamarca, Lima, Piura	Yes
Polygalaceae	*Monnina pterocarpa*	H	Ancash, Cajamarca, Ica, Lima, La Libertad, Piura, Tumbes	No
Solanaceae	*Lycium americanum*	A	Huánuco, Lambayeque, Lima, La Libertad, Loreto , Tumbes	No
Solanaceae	*Nolana weberbaueri*	H	Ica	Yes
Sterculiaceae	*Waltheria ovata*	A	Ancash, Ayacucho, Huánuco, Lima, Piura	No

* Types: SA: Sub-shrub; H: Herb; A: Shrub; AL: Tree; S: Succulent; E**: Endemic, ***ND: Non-evaluated

5.2.1.3 SAMPLING ZONE TRANSECT RESULTS

Seventeen (17) transects in three sampling areas were established in the study area (Table 5.2.1-3) to identify diversity index, vegetation coverage, abundance, frequency, dominance index and importance value index (IVI). The results for the three sampling areas (access road, quarry area and upper Topara Valley) are shown below.

Table 5.2.1-3 Main characteristics of transects established within study area

Transect	Altitude (msnm)	Sampling Zone	S*	N**	H'***	Coverage (m^2)
1	750	Access road	5	10	1.50	1.40
2	812	Access road	3	6.00	1.01	1.04
3	953	GNL-2 Quarry	3	14	0.96	2.62
4	939	GNL-2 Quarry	1	17	0	3.92
5	1061	GNL-2 Quarry	1	8	0	0.23
6	1079	GNL-2 Quarry	3	11	0.76	10.24
7	931	GNL-2Quarry	1	4	0	0.61
8	938	GNL-2 Quarry	1	2	0	0.2
9	1001	GNL-2 Quarry	1	10	0	0.01
10	981	GNL-2 Quarry	3	16	0.95	2.04
11	718	Access road	3	5	0.95	2.69
12	671	Access road	1	8	0	4.87
13	462	Access road	1	9	0	5,20
14	423	Access road	2	4	0.56	0,82
15	832	Topara Valley	2	3	0.64	5.69
16	747	Topara Valley	2	10	0.5	14.79
17	663	Topara Valley	2	8	0.66	2.86
18	270	Access road	1	5	0	4.61

*S: Number of species; **N: Number of individuals; ***H': Shannon-Wiener Index

5.2.1.3.1 Access road

This zone contained the highest diversity value index (H') and number of species per transect. Both values are, however, considered low due to the desert characteristics of the zone. The cactus *Haageocereus pseudomelanostele var. carminiflorus* stands out as the species with the highest coverage and dominance. The *Nolana weberbaueri* yielded high density (number of individuals/m^2) in the transects. In the Tillandsia zone, the dominance of *Tillandsia sp* was evident. The results yielded for the established transects are shown in Table 5.2.1-4.

Table 5.2.1-4 Results for the transects established in the sampling zone for the access road.

Specie	Number	Coverage (Ci/Ct)*	Frequency	Density (Ind./m^2)	Dominance	IVI**
Transect 1						
Hoffmannseggia viscosa	3	0.04	0.33	49.70	0.43	22.55
Nolana weberbahueri	3	0.00	0.67	1005.70	0.04	32.29
Heliotropium sp	1	0.01	0.33	56.62	0.04	14.86
Alternanthera pubiflora	2	0.14	0.33	10.19	0.93	22.44
Haageocereus pseudomelanostele var. Carminiflorus	1	0.80	0.33	0.89	2.67	41.19
TOTAL	10	1.00	2.00	1123.09	4.12	133.33
Transect 2						
Boraginacea	3	0.61	0.67	4.72	20.45	59.34
Hoffmannseggia viscosa	2	0.38	0.67	0.39	8.42	45.96
Tiquilia paronychioides	1	0.01	0.33	0.01	0.04	16.92
TOTAL	6	1.00	1.67	5.12	28.91	122.22
Transect 11						
Nolana weberbaueri	1	0.00	0.33	127.39	0.02	17.87
Haageocereus pseudomelanostele var. Carminiflorus	3	0.34	0.67	3.27	13.64	53.59
Neoraimondia arequipensis var. Roseiflora	1	0.66	0.33	0.57	4.37	39.64
TOTAL	5	1.00	1.33	131.22	18.04	111.11
Transect 12						
Haageocereus pseudomelanostele var. Carminiflorus	8	1.00	1.00	1.64	100.00	100.00
Transect 13						
Haageocereus pseudomelanostele var. Carminiflorus	9	1.00	1.00	1.73	100.00	100.00
Transect 14						
Tillandsia latifolia	1	0.09	0.33	14.15	0.71	22.30
Haageocereus pseudomelanostele var. Carminiflorus	3	0.91	0.33	3.98	22.86	66.59
TOTAL	4	1.00	0.67	18.14	23.57	88.89

Specie	Number	Coverage (Ci/Ct)*	Frequency	Density (Ind./m^2)	Dominance	IVI**
Transect 18						
Tillandsia paleacea	5	1.00	0.67	1.08	66.67	88.89

*Ci: specie coverage. Ct: Total coverage
** IVI: Importance Value Index

5.2.1.3.2 GNL-2 Quarry neighboring areas

This zone contained the greatest number of individuals per transect, but the diversity of species was not the highest. The diversity index value (H') was zero (0) for most of the transects established in this zone. This is because, in most cases, the documented individuals belonged to only one species. The composition of species documented was similar to that of the access roads, where sparse herbs, shrubs and cactaceae or succulent vegetation stands could be observed. The shrub *Heliotropium sp*. and the herb *Presliophytum incanum* are particularly common. The first was frequently documented in the transects, therefore, its higher dominance value and IVI (Table 5.2.1-5).

Table 5.2.1-5 Results for the transects established in the sampling zone for the GNL-2 Quarry

Species	Number	Coverage (Ci/Ct)	Frequency	Density (Ind./m^2)	Dominance	IVI
Transect 3						
Presliophytum incanum	2	0.70	0.33	1.09	3.34	39.23
Hoffmannseggia viscosa	8	0.22	0.33	13.96	4.16	37.44
Heliotropium sp	4	0.08	0.33	18.87	0.77	23.33
TOTAL	14	1.00	1.00	33.92	8.27	100.00
Transect 4						
Heliotropium sp	17	1.00	1.00	4.34	100.00	100.00
Transect 5						
Hoffmannseggia viscosa	8	1	1	35.14	100	100
Transect 6						
Lycium americanum	1	0.31	0.33	0.32	0.93	24.37
Hoffmannseggia viscosa	8	0.31	0.67	2.52	15.02	56.79
Heliotropium sp	2	0.38	0.33	0.51	2.32	29.95
TOTAL	11	1.00	1.33	3.35	18.27	111.11
Transect 7						
Heliotropium sp	4	1.00	0.67	6.53	66.67	88.89
Transect 8						
Heliotropium sp.	2	1.00	0.67	9.80	66.67	88.89
Transect 9						
Nolana weberbaueri	10	1.00	1.00	1088.79	100.00	100.00
Transect 10						
Heliotropium sp	5	0.38	0.33	6.37	4.01	34.35
Hoffmannseggia viscosa	9	0.06	0.67	76.43	2.16	42.90
Neoraimondia arequipensis var. Rosiflora	2	0.56	0.67	1.76	4.65	44.98
TOTAL	16	1.00	1.67	84.56	10.82	122.22

5.2.1.3.3 Topara Valley

Three sampling transects were established in upper Topara Valley. This zone yielded the highest vegetation coverage, mainly due to the high number of specimens of *Baccharis salicifolia* and *Acacia macracantha* "Huarango". Yet, this zone is outside the project operations influence area.

Table 5.2.1-6 Results for transects established in the sampling zone for Topara Valley

Specie	Number	Coverage (Ci/Ct)	Frequency	Density (Ind./m^2)	Dominance	IVI
Transect 15						
ND	2	0.69	0.67	0.51	30.65	67.43
Acacia macracantha	1	0.31	0.33	0.57	3.45	32.57
TOTAL	3	1.00	1.00	1.08	34.10	100.00
Transect 16						
Acacia macracantha	2	0.03	0.33	5.10	0.18	18.66
Baccharis salicifolia	8	0.97	1.00	0.56	77.88	92.45
TOTAL	10	1.00	1.33	5.65	78.05	111.11
Transect 17						
Waltheria ovata	3	0.39	0.67	2.71	9.66	47.60
Acacia macracantha	5	0.61	0.67	2.84	25.57	63.51
TOTAL	8	1.00	1.33	5.55	35.23	111.11

5.2.1.4 RESULTS ANALYSIS

The project influence area can be described as a desert and semi-desert zone. The scarce xerophyte vegetation in the quarry zone comprises species that are highly adapted to very dry environments and are somewhat common in the central coastal desert.

Nonetheless, the restoration of vegetation in the areas where project operations have ceased will be very important. Monitoring the restoration effort will probably not be necessary because of the semi-desert nature of the zone and the existence of vegetation species that are relatively common for the coastal desert. However, it is recommended that representative samples of cactaceae be transplanted if they will be affected by quarry exploitation activities. Such cacti are important because they are highly adapted to arid and semi-arid conditions, therefore possess valuable genetic information regarding their resistance to hydric stress. In addition, they possess high ornamental and economic values, and play a critical role in many ecosystems they serve as the basis for primary productivity. The cactaceae also provide the habitat for *Asthenes cactorum* "Canastero de los cactus," a bird that whose distribution is limited (though it is not listed under a conservation category).

5.2.2 BIRDS

5.2.2.1 GENERAL ASPECTS

The first ornithological expeditions in Peru were carried out by experienced collectors (Tschudi, Sclater & Salvin, Jelski, Taczanowski, Count von Berlepsch, Kalinowski and Baron), who explored mostly the high Andean and Andean valleys in the country. The Koepckes, a husband and wife team, studied the distribution of birds on the Pacific flank in detail from 1951 to 1971.

The study of birds is critical because some bird species are good indicators for measuring the quality of environments. Birds are particularly sensitive to changes in habitats or climatic conditions.

The field assessment reported in this chapter is based on two field trips. The first was carried out during the wintertime from September 17-19, 2004. The second occurred during the summertime from February 10-17, 2005.

In winter (September), the sampling zones were distributed into two (2) main areas: the GNL-2 Quarry neighboring area and the access road. The sampling completed in February comprised the GNL-2 Quarry area, the access road and the upper Topara Valley.

The September assessment pertains to the winter season (lomas formation season) when there is more moisture available in the air, and consequently, larger vegetation coverage. However, lomas formations were not located on the ground.

5.2.2.2 CHARACTERISTICS OF SAMPLING ZONES

Seven (7) sampling points (SP) were established in September 2004 (Table 5.2.2-1). They were located in the following areas: tree (3) close to the access road and four (4) in GNL-2 Quarry neighboring areas.

Forty-five sampling points were established in February 2005. Nineteen were in the GNL-2 projected area, 15 were along the access road and 11 were in the upper Topara Valley.

The Annexes section describes the sampling methodology, details on the characteristics of the sampling points, and a summary of the results for each sampling effort.

Table 5.2.2-1 Main characteristics of sampling points (September 2004)

Sampling Zone (SZ)	Sampling Points (SP)	Habitat	Elevation (m)
Close to Access Road	05 and 06	Sparse Tillandsias zone stands on sandy desert	200 – 300 m
	07	Sandy desert, across from the quarry mountain	
GNL-2 Quarry Neighbouring Area	08	Narrow rocky valley, abundant cacti	600 – 1150 m
	09	Rests of herbaceous vegetation, cacti dominate	
	10	Close to rocky mountain top, cacti dominate	
	11	Rocky slope, herbaceous vegetation rests and abundant cacti	

Table 5.2.2-2 Main characteristics of Sampling Points (February 2005)

Sampling Zone (SZ)	Sampling Points (SP)	Description of place	Elevation (m.)
Future Access Road (Cansa Caballo Valley)	01, 06	Rocky valley, cactáceas stands and owl nests	200 – 300 m
	02, 08, 09	Stony valley, dry river channel, no vegetation	
	04, 05, 14	Stony slope, rests of herbaceous vegetation and/or cactaceae stands	
	03, 07, 10, 11, 12,13	Rests of herbaceous vegetation and/or cactáceas stands	
	15	Sandy loma with sparse stones	
Future GNL-2 Quarry	16, 17, 18, 22, 23, 28, 29, 33, 32	Rocky valley, no vegetation	600 – 1150 m
	19, 20	Stony slope	
	21, 34	Narrow rocky valley, cactaceae stands	
	24, 25, 26, 27	Narrow valley, very sparse vegetation	
	30, 31	Rocky valley, dry river channel	
Upper Topará Valley	35	Stony mountain slope, close to valley and crop zone	600 – 1050 m
	36, 37, 38	Close to fruit trees and sugar cane plantations. Dry river channel and/or unsown crop fields	
	39, 40, 41, 42, 43	Huarango forest, close to empty crop fields	
	44, 45	Close to cotton and/or maize crops	

5.2.2.3 RESULTS AND DISCUSSION

5.2.2.3.1 Documented Species

Two (2) bird species belonging to the same family and genus (Table 5.2.2-3) were identified during the sampling carried out in winter (September 2004). In February 2005, 14 species belonging to 11 families and 13 genera were documented (Table 5.2.2-4).

The differences in the number and composition of species identified are mostly the result of the search effort and the characteristics of the habitats encountered. Thus, for instance, the researchers visited the upper part of the valley, a zone that gives shelter to a greater variety of species compared to the others, only in February 2005.

Table 5.2.2-3 Species documented in the assessed zones in September 2004.

Family	Species	Common name	Access Road	GNL-2 Quarry neighboring area
FURNARIIDAE	*Geositta peruviana*	Pampero peruano		X
	Geositta maritima	Pampero gris		X

Table 5.2.2-4 Species documented in the assessed zones in February 2005.

Family	Species	Common name	Access Road	GNL-2 Quarry	Upper Topara Valley
ACCIPITRIDAE	*Geranoaetus melanoleucus*	*Aguilucho grande*			X
BURHINIDAE	*Burhinus superciliaris*	*Huerequeque*	X		
COLUMBIDAE	*Zenaida auriculata*	*Madrugadora*			X
	Zenaida meloda	*Cuculí*			X
	Columbina cruziana	*Tortolita peruana*			X
STRIGIDAE	*Speotyto cunicularia*	*Lechuza de los arenales*	X		
CAPRIMULGIDAE	*Chordeiles acutipennis*	*Chotacabras trinador*			X
FURNARIIDAE	*Geositta maritima*	*Pampero gris*	X	X	
	Asthenes cactorum	*Canastero de los cactus*		X	
TYRANNIDAE	*Camptostoma obsoletum*	*Mosqueta silbadora*			X
TROGLODYTIDAE	*Troglodytes aedon*	*Cucarachero común*			X
MIMIDAE	*Mimus longicaudatus*	*Chisco*			X
THRAUPIDAE	*Conirostrum cinereum*	*Mielerito cineréo*			X
ICTERIDAE	*Dives warszewiczi*	*Tordo de matorral*			X

GNL-2 Quarry Access Road

The study area for September 2004 was located in desert zones of scattered Tillandsias. The occurrence of species of avifauna was not documented because food resources and potential refuge zones in the area were scarce. Other factors to be taken into consideration are the schedule and intensity of the sampling.

In February 2005, the study area comprised desert rocky valley zones (Quebrada Cansa Caballo) with and without cactaceae stands as well as dry river channels of occasional run-off sheltering rest of herbaceous vegetation. During the second field season, researchers identified three species of avifauna: *Burhinus superciliaris* "Huerequeque", *Speotyto cunicularia* "lechuza de los arenales" and *Geositta maritima* "pampero gris".

Burhinus superciliaris and *Speotyto cunicularia are* characterized by their ability to survive in the desert environment and use it for nesting. This species is important because it is representative of arid coastal environments. *Speotyto cunicularia* is a nocturnal bird of prey and is widely distributed in America. *Burhinus superciliaris* is an endemic species of the Pacific coastal desert of Ecuador, Peru and northern Chile (Salinas et al., 2003).

Geositta maritima inhabits rocky terrain (Koepcke, 1964). Its distribution extends from Peru to Chile (from Ancash to Antofagasta).

GNL-2 Quarry and neighboring areas

In September 2004, two (2) species were documented in the quarry and neighboring areas: *Geositta peruviana* "pampero peruano" and *Geositta maritima* "pampero gris." Both species are typical of lomas formations and coastal desert areas. They favor valleys and riparian vegetation ("montes ribereños") communities. *Geositta peruviana* "pampero peruano", in particular, inhabits sandy semi-desert lands and nests in ground galleries (Koepcke, 1964).

Two species were also identified in February 2005: *Geositta maritima* "pampero gris" (also identified in September 2004) and the "Canastero de los cactus" *Asthenes cactorum*. The latter has a limited distribution and its presence is very sensitive to anthropogenic changes. This species is somewhat inconspicuous, can be difficult to observe and therefore its population density may be underestimated.

Upper Topara Valley

The largest variety of species was documented here due to the greater availability of habitats for birds in the zone such as crops, forests and fruit trees. It should be noted that this zone is very far from the project area.

Among the documented species, it is worth mentioning *Geranoaetus melanoleucus* "aguilucho grande," a widely distributed bird that usually inhabits open semi-arid spaces where steep lands with some rocky formations dominate (Fjeldsa & Krabbe, 1990). The rest of the birds can be considered more common, and some are inhabitants to parks and gardens in coastal cities such as common doves (*Zenaida meloda*, *Zenaida auriculata*, *Columbina cruziana*), the "chisco" *Mimus longicaudatus*, the "tordo de matorral" *Dives warszewiczi* and the "cucarachero común" *Troglodytes aedon*.

5.2.2.3.2 Diversity

The diversity index used in this study is the Shannon-Wiener Diversity Index, which expresses the uncertainty of a system (Smith, 1986).

The diversity index for the access road yielded a zero (0) value for both samplings. For the first sampling, the value was null because no species had been documented. For the second sampling, the value was null, because, in the best scenario, only one species was documented per sampling point.

The average diversity in the GNL-2 quarry was 0.11 bits/individuals in February 2005. The September 2004 were a zero diversity for the quarry zone because there was only one species per sampling point.

The highest diversity index values were collected in the upper Topara Valley where the average H' is 0.48 bits/individuals.

In conclusion: all diversity values were low.

Table 5.2.2-5 Diversity recorded per sampling zone for the bird assessment.

Zone	Date	Number of species	Shannon Wiener Index (H')
Access road	Sept 2004	0	0
	Feb 2005	3	0
GNL-2 quarry and neighboring areas	Sept 2004	2	0
	Feb 2005	2	0.11
Upper Topara Valley	Feb 2005	10	0.48

5.2.2.3.3 Species of importance

Species of importance belong to a conservation category classified by the International Union for Nature Conservation (IUCN), the National Institute for Natural Resources (INRENA) and the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). (Table 5.2.2-6). None of the fifteen identified species in the study zones belong to a protected or endangered category according to the national legislation (DS 034-2004-AG). Likewise, none of the documented species belong to a threatened category in any international conservation list.

Two species are important from an endemism perspective, however (Table 5.2.2-7). Two Peruvian endemic species that belong to the Furnaridae family stand out in most coastal departments - *Geositta peruviana* from Tumbes to Ica and *Asthenes cactorum* between Lima and Arequipa. *Geositta peruviana* has been included in two Endemic Bird Areas (EBA): EBA 32 (Pacific Coast, Southern Peru and Northern Chile) and EBA 20 (Tumbes Region, Western Ecuador and Peru). Endemic Bird Areas are zones where there is a high degree of endemism and, therefore, the birds included in these areas are considered a priority in conservation efforts. The other species are more widely distributed and can be found in Central and South American countries like Costa Rica, Ecuador, Colombia, Chile, Peru, Argentina, as well as worldwide.

Geositta peruviana and *Asthenes cactorum* are known for stopping by semi-desert lands where they display land habits, and for their poor flying abilities. Note that *Geositta peruviana* was not documented in the GNL-2 Quarry zone but in the neighboring areas which will not be affected by project activities. These species are thought not to be able to fly long nor in a sustained way, and therefore cannot easily escape dangers such as habitat destruction. This is why it is necessary to appraise the need for capturing and relocating *Asthenes* *cactorum* from the project area. Such an action is feasible and could be assessed after getting the results of the biological monitoring foreseen in the Environmental Monitoring Program.

Table 5.2.2-6 List of species and the level of protection required according to the conservation lists of INRENA, UICN and CITES.

FAMILY	SPECIES	INRENA*	CITES	IUCN
ACCIPITRIDAE	*Geranoaetus melanoleucus*	NI	NI	LC
BURHINIDAE	*Burhinus superciliaris*	NI	NI	LC
COLUMBIDAE	*Zenaida auriculata*	NI	NI	LC
	Zenaida meloda	NI	NI	LC
	Columbina cruziana	NI	NI	LC
STRIGIDAE	*Speotyto cunicularia*	NI	NI	LC
CAPRIMULGIDAE	*Chordeiles acutipennis*	NI	NI	LC
FURNARIIDAE	*Geositta peruviana*	NI	NI	LC
	Geositta maritima	NI	NI	LC
	Asthenes cactorum	NI	NI	LC
TYRANNIDAE	*Camptostoma obsoletum*	NI	NI	LC
TROGLODYTIDAE	*Troglodytes aedon*	NI	NI	LC
MIMIDAE	*Mimus longicaudatus*	NI	NI	LC
THRAUPIDAE	*Conirostrum cinereum*	NI	NI	LC
ICTERIDAE	*Dives warszewiczi*	NI	NI	LC

*DS. 034-2004-AG; EN: Endangered; LC: Least Concern; NI: not included

Table 5.2.2-7 Geographic distribution of documented species

FAMILY	SPECIES	DISTRIBUTION
ACCIPITRIDAE	*Geranoaetus melanoleucus*	Cosmopolitan
BURHINIDAE	*Burhinus superciliaris*	Ecuador, Perú andy Chile
COLUMBIDAE	*Zenaida auriculata*	Cosmopolitan
	Zenaida meloda	Cosmopolitan
	Columbina cruziana	Ecuador, Perú and Chile
STRIGIDAE	*Speotyto cunicularia*	Cosmopolitan
CAPRIMULGIDAE	*Chordeiles acutipennis*	Cosmopolitan
FURNARIIDAE	*Geositta peruviana*	Perú (Tumbes through Ica)
	Geositta maritime	Perú and Chile (From Ancash through hasta Antofagasta, Chile)
	Asthenes cactorum	Perú (Lima through Arequipa)
TYRANNIDAE	*Camptostoma obsoletum*	Costa Rica through northern Argentina and Uruguay
TROGLODYTIDAE	*Troglodytes aedon*	Cosmopolitan
MIMIDAE	*Mimus longicaudatus*	Ecuador and Perú
THRAUPIDAE	*Conirostrum cinereum*	From Colombia through northern Chile and western Bolivia
ICTERIDAE	*Dives warszewiczi*	Ecuador and Perú

5.2.2.3.4 Results analysis

It can be concluded that the difference in sampling numbers can be explained by the extensiveness of the sampling method that was used, as well as the time of the year in which samples were taken (September 2004 – winter, and February 2005 – summer). The occurrence of species not documented in winter, like *Burhinus superciliaris* and *Speotyto cunicularia,* is thought to be the consequence of the presence of more attractive conditions of the desert zones assessed in the summer, since they offer nesting areas, food and resting places. There is no indication of any of the identified species being under threat or being endangered. It is therefore that no recommendation is made to put special measures in place to protect one or more of the identified species. (See Tables 5.2.2-3 to 5.2.2-6.)

5.2.3 MAMMALS

5.2.3.1 GENERAL ASPECTS

The coastal region of Peru is characterized by extreme aridity and sparse vegetation. Four-hundred and sixty (460) species of mammals have been recorded in Peru (Pacheco et al., 1995) including three (3) genera and 49 endemic species (Pacheco, 2002). Endemism is the result of topographical, biological and other variables that influence on the animal populations for long periods of time in particular locations. According to Pacheco, 14% of endemic mammal species are found on the coast and western slopes, but despite the uniqueness of the fauna in this region, few studies have been carried out to determine the diversity and biogeographical patterns along and throughout the coast.

Mammals are extremely important for and within ecosystems. They occupy an array of niches and fulfill ecological functions. They can be seed scatterers, predators, pest controllers and so forth, thereby influencing a large number of ecological processes within the ecosystems they inhabit. The presence of certain kinds of species in an ecosystem is, therefore, an indication of its health, hence, the likelihood to use certain mammals as indicators of habitat quality.

Little information is available on the diversity and distribution of mammals along the coast. Some of the studies in lomas formations, deserts, and valleys have emphasized murid rodents (rats) and marsupials (Zuñiga, 1942), Brack Egg, 1974; Pearson, 1972, 1975, 1982; Aguilar, 1985; Dávila et al., 1987; Luna, 2000). The records of bat species in coastal regions have been provided in studies by Ortiz de la Puente (1951), Tuttle (1970), La Val (1973), Koopman (1978) and Mena & Williams (2002). Ascorra (1996) and Pacheco (2002) state that there is a high degree of endemism in chiroptera (bats) in the coastal region, and mark the region as an information gap zone. There are two genera of bats that are endemic to the Peruvian coastal region: *Tomopeas* and *Platalina*.

As far as large mammals along the coastal zone are concerned, the only information available seems to be in the lists presented by Grimwood (1969), Brack Egg (1974), Aguilar (1985) and Dávila et al. (1987). The first two studies consider species that occur in coastal lomas formations only, and not in other habitats.

There is a paucity of information on the distribution and condition of habitats and populations of mammal species along the coast. There are two conservation areas in the region - the Lachay National Reserve (Chancay-Lima) and Paracas National Reserve (Pisco-Ica) – but they do not cover sufficient land area for the conservation of the said systems.

The field assessment reported in this chapter is based on two field trips: the first during the winter (September 17-19, 2004) and the second during the summer (February 10-17, 2005).

5.2.3.2 DESCRIPTION OF SAMPLING ZONES

Two sampling zones (SZ) were assessed in September 2004: one within the access road area and the other within a GNL-2 Quarry neighboring area. Three zones were assessed in February 2005: the access road, the GNL-2 Quarry area and the upper Topara Valley.

Sampling sites (SS) varied in number and were placed within each sampling zone (SZ) (Table 5.2.3-1). The sampling zone is presented in the monitoring map (M 5-9) of the Volume III of maps. The methodology has been detailed in Annex 3-1. The characteristics of the habitats are described below:

5.2.3.2.1 Access road

- **SS 1 (September 2004)** Tillandsias cover this area. They are randomly distributed, with specimens between 1 and 10 meters apart. The tillandsias lie isolated in the desert habitat like a vegetation island. A transect was established in this zone.

- **SS 2 (February 2005)** Dry rocky valley with column cacti and sparse shrubs. The base camp was located in this sector. The valley slopes are rocky and support cacti. The sector where 15 traps to capture mammals were placed (Transect A) was part of a small slightly-steep slope valley with a scarce vegetation coverage and abundant rocks.

- **SS 3 (February 2005)** Rocky valley supporting shrubs and cacti, very similar to SS2, but with little vegetation coverage.

- **SS 4 (February 2005)** Dry valley with big sparse stones. Column cacti and shrubs scarcely occur. The valley widens westward and becomes a plain.

- **SS 5 (February 2005)** Wide valley with the characteristics of a coastal desert. The vegetation coverage is small and supports some shrubby species along with sparse column cacti. Medium and large rocks are scattered throughout the zone and serve as refuge to small and medium-sized mammals.

- **SS 6 (February 2005)** Zone with typical coastal desert dunes. Vegetation diminishes considerably in the northern part of the access road. Small rocks can be found scattered within this zone.

- **SS 7 (February 2005)** Characterized by sand dunes and scarce vegetation. Similar to the previously described zone where the presence of a patch (island) of Tillandsias stands out amidst the desert area.

5.2.3.2.2 GNL-2 Quarry neighboring area

- **SS 8 (September 2004)** This site was placed at the lower part of the main valley towards the southern zone of the Quarry. Cacti dominate the middle part of the valley. Some herbaceae are likely to be found there. To date, the valley exhibits traces of a stream from a recent period (months). The mountain slopes support sparse cacti.

- **SS 9 (September 2004)** Placed in the middle part of the main valley, this site comprises the central and northern part of the zone. At the base of the valley, cacti dominate the landscape. They are sparsely distributed on the mountain slopes. Only a few individuals of shrubby species could be observed. Vegetation coverage increased slightly up the rocky valley; however, it was never abundant. The valley exhibits traces of a streamflow from a recent period (several months back).

- **SS 10 (September 2004)** Located in the lower part of the west valley, in the south-eastern section of the sampling zone. The lowest part is a wide valley that narrows upstream. Abundant cacti and some dry herbaceae dominate the middle part of it. This rocky valley is expected to provide refuge for high numbers of small mammals.

5.2.3.2.3 GNL-2 Quarry Zone

- **SS 11 (February 2005)** Rocky valley of big rocks and 45-degree slopes. This is the zone where the largest vegetation coverage, especially shrubs, was observed. A transect with 31 traps was established along the valley.

- **SS 12 (February 2005)** Rocky valley of approximately 45-degree slopes. Rocky slopes with scarce cacti in the middle and upper valley. Occurrence of shrubs along the valley. The 30-trap transect was placed in the central part of the valley.

- **SS 13 (February 2005)** Rocky valley with a gentle slope and big stones. Vegetation coverage was scarce, with some shrubs but no cacti. 15 trap transects were placed in the central part of the valley.

- **SS 14 (February 2005)** Very steep-walled rocky valley with scarce cacti in the valley. 13 trap transects were placed in the central part of the valley and a fog net put up perpendicular to the valley.

5.2.3.2.4 Upper Topara Valley

- **SS 15 (February 2005)** The slopes in this area are steep and large rocks are present. Vegetation coverage is scarce. Column cacti and shrubby species stand out among the rocks. The central part of the valley is part of an agricultural zone for avocados, limes, and other produce. Cattle and goats also graze this land. Typical mountain valley vegetation is located in this zone.

- **SS 16 (February 2005)** This site has rocky slopes of lesser height and incline than SS 15. Large rocks stand throughout the area. Vegetation decreases dramatically. In the central part of the valley, the land is used for temporary crops and grazing. Riparian vegetation can also be found in this zone.

- **SS 17 (February 2005)** The slopes are less steep at this site and riparian vegetation is present. Eucalyptus trees and low shrubs are scattered around the central part of the valley. The few cacti that could be seen at other sampling sites zones do not occur in this zone. Small and medium-sized rocks lie throughout the area.

Table 5.2.3-1 Main characteristics of sampling sites (SS)

ZONE	SS	SAMPLING DATE	ELEVATION (m)	MAIN/ HABITAT
Access road	1	Set 04	200-300	Tillandsias desert
	2	Feb 05	800 – 950	Sparse cactaceae zone
	3	Feb 05	700 – 800	Desert bushs
	4	Feb 05	600 – 700	Sparse cactaceae zone
	5	Feb 05	550 – 750	Desert bushs
	6	Feb 05	400 – 650	Coastal desert
	7	Feb 05	250 – 400	Coastal desert
GNL-2 Quarry neighboring area	8	Sept 04	600 – 700	Cactaceae zone
	9	Sept 04	750 – 1150	Cactaceae zone
	10	Sept 04	500 – 650	Cactaceae zone
GNL-2 Quarry	11	Feb 05	920 – 1150	Desert bush
	12	Feb 05	1000 – 1200	Scattered cactaceae zone
	13	Feb 05	900 – 1050	Scattered cactaceae zone
	14	Feb 05	930 – 1050	Scattered cactaceae zone
Upper Topará Valley	15	Feb 05	750 - 1050	Desert mattorals
	16	Feb 05	700 – 1000	Desert bushs
	17	Feb 05	600 – 700	Desert bushs

5.2.3.3 RESULTS AND DISCUSSION

5.2.3.3.1 Species documented

Eleven (11) species belonging to six (6) families and ten (10) genera, as shown in Table 5.2.3-2, were identified in the September 2004 assessment. The February 2005 assessment identified four (4) species belonging to three (3) families and four (4) genera (Table 5.2.3-2). Twenty (20) species could potentially inhabit the zone permanently, seasonally or during an El Niño event.

Table 5.2.3-2 Documented species in the assessed zones. R: Recorded;: Data not confirmed.

Sampling Zone	**Access road**		**GNL-2 Quarry neighboring area**			**GNL-2 Quarry**	**Topará Valley**
Sampling Site (SS)	**1**	**2,3,4,5,6,7**	**8**	**9**	**10**	**11,12,13,14**	**15,16,17**
ORDER DIDELPHIMORPHIA							
Family Didelphidae							
Didelphys marsupialis							**R**
ORDER CHIROPTERA							
Family Vespertilionidae							
Myotis atacamensis			**R**				
ORDER CARNIVORA							
Family Mustelidae							
Conepatus sp.				**R**			
Family Canidae							
Lycalopex sechurae	**R**	**R**	**R**	**R**		**R**	**R**
ORDEN RODENTIA							
Family Muridae							
Oryzomys xantheolus					**R**		
Phyllotys amicus			**R**	**R**	**R**		
Phyllotys andium		**R**		**R**	**R**	**R**	**R**
Phyllotys spp.*							
Mus musculus	**R**	**R**				**R**	
Family Chinchillidae							
Lagidium peruanum				**R**			

** Phyllotys andium and P. amicus grouped into this one category*

Access Road

SS 1 (September, 2004)

With the use of a small mammal trap, the exotic mouse *Mus musculus* was documented in a Tillandsia stand, close to the electric transmission line that crosses ConCon Topara Plains. An individual belonging to the same species was found dead in a 5-cm wide gap between two rocks in the Tillandsias. At this specific site, no tracks of the "zorro costero" *Lycalopex sechurae* could be seen, but tracks were indeed recorded along the access road's influence area.

SS 2, 3 and 4 (February, 2005)

Three (3) species were documented at these scarcely vegetated sites. The "zorro costero" *Lycalopex sechurae* was documented six times by tracks (trails), feces and two lairs. Fresh traces were observed along the slopes of the valleys.

Very close to a fox lair, many pellets from “lechuza de los arenales” *Speotyto cunicularia* (an owl species) with parts of rodents and lizards were found. The occurrence of the mouse *Phyllotis andium* was documented only because the owl pellets contained its remains. Four (4) individuals of the introduced mouse *Mus musculus* were captured using traps at the transects at base camp and Transect A. Remains of this species were also found in a *S. cunicularia* pellet.

SS 5, 6 and 7 (February, 2005)

Because of the scarce vegetation and the presence of few refuges, only two species were documented in this zone. Nonetheless, stands of rodent feces could be observed. This is evidence that there was a larger density of this species in the zone in an earlier period – probably, during an El Niño event. The remains found in the pellets belonged to a rodent *P. andium* specimen.

Also documented were two lairs of the "zorro costero" *L. sechurae* with fresh tracks as well as feces in which only rodent hairs were found. Judging from the length and color pattern of the hair bands, it could have been a rodent Phyllotis specimen.

GNL-2 Quarry neighboring area

SS 8 (September, 2004)

The *Phyllotys amicus* was documented at this site. Also, at the valley slopes "zorro costero" *Lycalopex sechurae* tracks and feces in the central part were documented. It was also clear that *L. sechurae* used a rock as a resting site.

An Atacama *Myotis* cf. *Atacamensis* was collected using a fog net. . It was identified based on its hair and bone structure using the Simmons and Geisler key (1998). It was one of the few occurrences of this species.

SS 9 (September, 2004)

Tracks of *Lycalopex sechurae* could be seen along the valley along with three sites carrying feces of this species. The evidence was located in the central part of the valley, not on the slopes, most likely because of the incline. The feces contained bones of *Phillotys andium* and *P. amicus*, as well as vizcacha *Lagidium peruvianum* and zorrillo *Conepatus* sp. hair. Also analyzed was a stand of owl pellets, which did not contain mammal remains.

SS 10 (September, 2004)

Tracks of the Andean Fox could be seen from the lower to the central parts of the valley. Fox feces contained remains of *Phillotys andium* that could be collected from the central part of the valley. Owl pellets containing remains of *Oryzomys xantheolus* and *Phillotys andium* were also collected in two nests. The large number of medium and large rocks in this area provide potential refuge for mammals.

GNL-2 Quarry

This zone was more arid than the access road zone and contained a larger number of rocks that could provide refuge for rodents. Nonetheless, not many occurrences were documented, most likely due to the scarce vegetation coverage. It is possible that these species occur in low densities. Three (3) species of mammals were identified: *Lycalopex sechurae* (tracks, feces and a lair were identified), *Phyllotis andium* (only one captured during the assessment and parts found in pellets) and *Mus musculus* (captured in a trap in Transect B). Four transects were established in this sector. The aridity of this habitat apparently keeps the density of these species at low levels. Remains of *P. andium* were found only in zorro costero's feces.

No species were captured in the fog net that was placed at SS 14. Species of chiroptera were not documented in this zone, probably due to the scarce vegetation, mainly column cacti.

Upper Topara Valley

Small-scale agricultural activity has been developed in this zone. Three species were documented: the "muca" *Didelphis albiventris*, the "zorro costero" *L. sechurae* and the rodent *Phyllotis andium*. The introduced rodents *Rattus rattus* and *Mus musculus* may occur too, for this is a zone with high human impact. The "muca" was identified based on some hairs and a bone that were found in the central part of the valley. The "zorro costero" was documented because feces were found on a slope. In the same area, rodent hair, very likely to belong to *Phyllotis sp.,* was also found. Some owl pellets contained the remains of *P. andium*.

5.2.2.3.2 Diversity

During the winter sampling, diversity was very low in the two assessed transects (Table 5.2.3-3). Since only one species (*Mus musculus*) was documented in the access road sector, the Shannon-Wiener Index (H') yielded a zero (0) diversity. Also, during the sampling in the GNL-2 Quarry neighboring area, only one species was documented (*Phyllotys amicus*), and the H' value was zero (0). The low number of species documented in the zone was probably due to the scarce precipitation and consequently sparse vegetation.

The diversity indexes were also very low during the February 2005 sampling (Table 5.2.3-3). The H' diversity index was zero (0) for the access road zone, because only one species (*Mus musculus*) was identified. The diversity index for the GNL-2 Quarry zone was 0.69 due to the presence of only two species with two individuals each.

Table 5.2.3-3 Diversity documented for the assessment transects for small land mammals.

Zone	Sampling dates	Number of Species	Number of individuals	Shannon Wiener H'
Access road	Sept. 2004	1	1	0
	Feb. 2005	1	4	0
GNL-2 Quarry Neighboring area	Sept. 2004	0	1	0
GNL-2 Quarry	Feb. 2005	2	2	0,69

Note that the feces and most of the pellets containing mammal bones and hairs found in the GNL-2 Quarry area were not fresh. They probably belonged to a strong El Niño event period (maybe that of 1997-1998) which left traces of water in the central part of the valleys. Precipitation increases during such periods caused the vegetation coverage grow significantly, and, as a result, increase the availability of food. This in turn lead to increases in the populations of rodents and marsupials and migration of species of mammals from nearby less arid areas (*Didelphys albiventris*, *Lagidium peruanum, Lycalopex culpaeus, Oncifelis colocolo* and *Conepatus* sp.), which can temporarily settle in the area, and by doing so, change the diversity values. In short, the colonization and extinction of species in this area result in part from events such as El Niño.

5.2.2.3.3 Species of importance

Species of importance include the endemic and threatened species identified by the International Union for Nature Conservation (IUCN), the National Institute for Natural Resources (INRENA) or the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). Of the 20 species in the project area, twelve (12) are included in one or more of these three lists (Table 5.2.3-4).

As for the IUCN list, only one of the documented species (el “zorro costero” *Lycalopex sechurae*) is listed under the Data Deficient category (DD). Among the potentially occurring species, the “guanaco” *Lama guanicoe* and six (6) bats (*Artibeus fraterculus, Platalina genovensium, Amorphochilus schnablii, Myotis atacamensis, Mormopterus kalinowskii* and *Tomopeas ravus*) are listed under the Vulnerable category (VU). Also, the “gato montés” *Oncifelis colocolo* is in the Near Threatened (NT) list, while two (2) potentially occurring bats (*Histiotus macrotes and Tadarida brasiliensis*) are in the Low Risk category (LR).

The CITES Convention protects the "gato montés" *Oncifelis colocolo* and the “guanaco” *Lama guanicoe* from all kinds of trade, and puts them in Appendix 2 of its list.

According to national legislation (Supreme Decree D.S. Nº 034-2004-AG), the Peruvian Ministry of Agriculture declares that the potentially occurring species *Platalina genovensium* and *Tomopeas ravus* are in the Critically Endangered category (CR) and the *Amorphochilus schnablii* in the Vulnerable (VU) category.

Of the endemic species in the coast and western flank from Lambayeque through Arequipa, the mouse *Phyllotys amicus* occurs in the study area. It is also possible that other endemic species such as *Platalina genovensium* (Piura, Lima, Arequipa and Huánuco) and *Tomopeas ravus* (Piura, Cajamarca, La Libertad, Lima), occur in the study area.

Table 5.2.3-4 List of documented species and potentially present mammal species, according to IUCN, INRENA and CITES and including endemism.

SPECIES	IUCN *LR=Low Risk* *VU=Vulnerable.* *NT=Near Threatened* *DD=Data Deficient*	INRENA *CR=Critically Endangered* *EN Endareged* *VU=Vulnerable*	CITES	ENDEMISM *X = Endemic*
ORDER DIDELPHIMORPHIA				
Family Didelphidae				
Didelphis albiventris				
Thylamys elegans				
ORDER CHIROPTERA				
Family Phyllostomidae				
Artibeus fraterculus	**VU**			
Desmodus rotundus				
Platalina genovensium	**VU**	**CR**		**X***
Family Furipteridae				
Amorphochilus schnablii	**VU**	**VU**		

SPECIES	IUCN *LR=Low Risk* *VU=Vulnerable.* *NT=Near Threatened* *DD=Data Deficient*	INRENA *CR=Critically Endangered* *EN Endareged* *VU=Vulnerable*	CITES	ENDEMISM *X = Endemic*
Family Vespertilionidae				
Histiotus macrotis	**LR**			
Myotis atacamensis	**VU**			
Family Molossidae				
Mormopterus kalinowskii	**VU**			
Tadarida brasiliensis	**LR**			
Tomopeas ravus	**VU**	**CR**		**X****
ORDER CARNIVORA				
Family Mustelidae				
Conepatus sp.				
Family Canidae				
Licalopex culpaeus				
Lycalopex sechurae	**DD**			
Family Felidae				
Oncifelis colocolo	**NT**		**Appendix 2**	
ORDER ARTIODACTYLA				
Family Camelidae				
Lama guanicoe	**VU**	**EN**	**Appendix 2**	
ORDER RODENTIA				
Family Muridae				
Oryzomys xantheolus				
Phyllotys amicus				**X*****
Phyllotys andium				
Phyllotys spp.				
Family Chinchillidae				
Lagidium peruanum				

*Endemic to the western flank: Piura, Lima, Arequipa and Huanuco.
**Endemic to the coast and western flank: Piura, Cajamarca, La Libertad, Lima.
***Endemic to the coast and western flank: from Lambayeque to Arequipa.

5.2.2.3.4 Results Analysis

Overall, no high risk areas for mammal communities were identified; that is, no zones would be severely or irreversibly affected by project-related activities. The fieldwork did not identify any threatened mammals that permanently inhabit the project zone. Non-threatened mammal communities are found in low-density populations and develop cycles of large population increases and reductions as a result of changes in natural environmental conditions (El Niño and the non-Niño cycles). These cyclical changes could favor mammalian recovery after a temporary impact. However, it is necessary to take into account that resource conditions (food and refuge) may decrease at least temporarily. One important condition is to maintain the orientation and incline of slopes to ensure condensation of fog collection during winter.

5.2.4 HERPETOLOGY

5.2.4.1 GENERAL ASPECTS

Herpetofauna in the Peruvian Coastal Desert is highly endemic to the region (Icochea y Carrillo, 1995), and is therefore a vulnerable animal group that warrants attention. That being said, scientific knowledge about the coastal herpetological fauna is limited and little information has been published. In 1970, Dixon and Huey completed a taxonomic review of the genus *Phyllodactylus* on the South American continent and provided data on morphological variations, habitats, natural history, as well as distribution maps and photographs of most species. Dixon and Wright (1975), also carried out a taxonomic review of the Peruvian species considered at the time to belong to the genus *Tropidurus* and provided information on morphological variations, habitats, natural history and distribution for each of the species. At a later stage, Frost (1992) included the *Tropidurus* species distributed along the Pacific coast (including the Peruvian species) into the genus *Microlophus*.

The assessment provided in this chapter has been made on the data taken from two field trips or "field campaigns"; the first being carried out from 17-19 September 2004, during the winter period, and the second from 10-14 February 2005, during the summertime.

5.2.4.2 CHARACTERISTICS OF SAMPLING ZONES

A total of five sampling routes (SR) in two zones – the future access road and a neighboring GNL-2 Quarry zone – were assessed during the field trip made in the winter period (Table 5.2.4-1). For the summertime assessment, on the other hand, 25 sampling routes distributed into three sampling zones were established: the projected zone for the GNL-2 Quarry, the future access road to the quarry and the upper Topara Valley (Table 5.2.4-2).

Table 5.2.4-1 Main Characteristics of Sampling Routes (September, 2004)

SR	Elevation (m)	Habitat	Zone	Date
02	200-300	Sandy plains with slightly steeped mountains; cacti and tillandsias occur.	Access road	09/17/2004
03	300-800	Sandy plains, dry and rocky valley floor. Sparse cacti and herbaceous vegetation.	Access road	09/18/2004
04	600–700	Rocky valley. Herbaceous vegetation and cactaceae	Neighboring GNL-2 Quarry zone	09/18/2004
06	200-300	Sandy plains with gentle rocky dunes. Tillandsia vegetation.	Access road	09/19/2004

Table 5.2.4-2 Main Characteristics of Sampling Routes (February, 2005)

SR	Elevation (m)	Habitat	Zone	Date
01,02,03,04	610 – 850	Column cacti desert	Access road	02/10/2005
05,06,07,08	940 – 1280	Desert, vegetation-free stony mountains	Quarry	02/11/2005
09,10	910 – 1160	Desert, vegetation-free stony mountains	Neighboring GNL-2 Quarry zone	02/11/2005
11,12,13	930 – 1220	Desert, vegetation-free stony mountains	Quarry	02/11/2005
14,15	950 – 1010	Desert, vegetation-free stony mountains	Quarry	02/12/2005
16	810	Column cacti desert	Access road	02/12/2005
17,18,19	380 – 460	Sandy substrate desert, some bromeliads	Access road	02/12/2005
20,21,22	690 – 850	River mountain, farms, rocky mountains	Upper Topara Valley	02/13/2005

5.2.4.3 RESULTS AND DISCUSSION

5.2.4.3.1 Species Composition

The 2004 assessment identified 20 individuals of five (5) reptile species (Table 5.2.4-3). The 2004 and 2005 assessments combined identified seven (7) species - one (1) amphibian and six (6) reptiles (Table 5.2.4-3). Including *potential* species increases richness to 13 species - one (1) amphibian and 12 reptiles.

During the summer assessment in February 2005, the species most frequently found was *Microlophus tigris,* a coastal desert sauria (gecko), which is typical of vegetation-covered habitats such as lomas formations (Dixon and Wrigth, 1975; Pérez, 2003; Pérez *et al.*, 2000). Another typical species for this habitat is the "gecko" *Phyllodactylus lepidopygus* (Dixon and Huey, 1970; Pérez, 2003), documented once during this assessment. *Microlophus thoracicus icae* and *Dicrodon heterolepis* also occur in vegetation-related habitats. *D. heterolepis* was documented only in the sampling routes along Topara Valley. The coastal river valleys are the main distribution points for this species. The *Bufo limensis* frog also occurred in river valleys and crop areas. *Microlophus theresiae* and *Ctenoblepharis adspersa* inhabit areas with little or no vegetation (Dixon and Wrigth, 1975; Pérez, 2003; Pérez *et al.*, 2000). These species were observed a few times. *Phyllodactylus microphyllus* and *P. gerrhopygus* are also associated with sandy substrate areas devoid of vegetation. The distribution and natural history of the snakes is not well known so a relation to a specific habitat is not evident.

Note that environmental conditions influence the occurrence of ectothermic animals (that regulate their body temperature largely by exchanging heat with their surroundings; coldblooded), such as amphibians and reptiles (Pianka, 1986). The skies on 10 and 11 February were cloudy with low temperatures (22 °C approximately). Such temperatures likely decreased the activity of herpetofauna, which resulted in the identification of limited occurrences. Sixty (60) individuals were documented – 41 of them were identified along sampling routes (Table 4 Anexo 3-3) and the remaining 19 were identified through opportunistic sampling.

The correlation between air temperature and herpetofauna activity can be observed in Table 4, Annex 3-3. The number of individuals is higher along the sampling routes with clear skies compared to the sampling routes with cloudy skies. Thus, it is extremely important to include some of the general environmental characteristics in the field data, such as cloud coverage and wind, in order to ensure the correct interpretation of data.

5.2.4.3.2 Species of Importance

Four of the documented species (Table 5.2.4-3) are included in an INRENA conservation category (DS Nº 034-2004-AG). Three species of reptiles are under the Vulnerable category (*Ctenopleharis adspersa*, "Cabezona", *Dicrodon heterolepis* "Lagartija de cabeza roja" and *Bothrops pictus* "Jergón de costa") while *Microlophus tigris* is considered to be Near Threatened. None of the documented amphibian or reptile species belong to any IUCN and/or CITES conservation category. Also, none of the documented herpetofauna species in the area are used or traded by local villagers.

It is expected that the quarry and access road activities will cause the greatest impacts to *C. adspersa* and *M. tigris*. These species use rocks and/or stones for feeding, thermoregulation and refuge (Pérez, 2003; Pérez *et al,* 2000). Therefore, the movement of rocks and stones would alter these species' habitats. The activity-affected area of the planned quarry should be minimized in order to reduce the negative effects on these species. . This is also the case for *P. lepidopygus,* sort of "gecko" of restricted distribution related to vegetation habitats (Dixon and Huey, 1970; Pérez, 2003), which also makes frequent use of rocky and stony micro-habitats.

The effect on *D. Heterolepis* "Lagartija de cabeza roja" would be less significant, because the distribution of this species is limited to coastal valleys like Topara Valley. The impact of quarry activities these habitats is expected to be minimum, for they are relatively far from the project area. This is also the case for the "Sapo de lima" *B. limensis,* whose distribution is limited mainly to coastal valleys.

Table 5.2.4-3 List of documented and potentially occurring reptiles and amphibians. Endemism and conservation categories are also included.

Scientific Name (Common Name)	Documentation type [1]		Sampling Zone		Distribution [2]	Conservation Category
	Set 2004	Feb 2005	Set 2004	Feb 2005		
CLASS AMPHIBIA						
Order Anura						
Family Bufonidae						
Bufo limensis ("sapo de Lima")	-	R	-	Topará Valley	Wide (La Libertad-Arequipa)	-

Scientific Name (Common Name)	Documentation type [1]		Sampling Zone		Distribution [2]	Conservation Category
	Set 2004	Feb 2005	Set 2004	Feb 2005		
CLASS REPTILIA						
Orden Sauria						
Familia Gekkonidae						
Phyllodactylus gerrhopygus (“geko”)	R	R	Access road	Access road	Wide (Lima-Tacna)	-
Phyllodactylus lepidopygus (“geko”)	R	R	Access road	Quarry	Limited (Ancash-Ica) *	-
Phyllodactylus microphyllus (“geko”)	P	P	-	-	Wide (Tumbes-Lima) *	-
Family Teiidae						
Dicrodon heterolepis (“Lagartija de cabeza roja”)	-	R	-	Topara Valley	Wide (Tumbes-Ica) *	VU - INRENA
Family Tropiduridae						
Ctenoblepharis adspersa (“cabezona”)	R	R	Access road	Access road	Limited (Lima-Arequipa) *	VU - INRENA
Microlophus theresiae (“Lagartija de los arenales”)	R	R	Access road	Access road	Limited (Lima-Ica)*	-
Microlophus tigris (“Lagartija de lomas”)	R	R	Access road	Access road, quarry and Topará Valley	Limited (Lima-Arequipa) *	CA - INRENA
Microlophus thoracicus icae (“Lagartija de gramadales”)	P	P	-	-	Limited (Lima-Ica) *	-
Order Serpentes						
Family Colubridae						
Alsophis elegans (“Culebra”)	P	P	-	-	Wide (Tumbes-Ica)	-
Oxyrhopus fitzingeri (“Culebra”)	P	P	-	-	Wide (Piura-Ica)	-
Family Elapidae						
Micrurus tschudii (“Coralillo”)	P	P	-	-	Wide (Tumbes-Lima)	-
Family Viperidae						
Bothrops pictus (“Jergón de costa”)	P	P	-	-	Wide (La Libertad-Arequipa)	VU - INRENA

(1) R: Recorded, P: Potentially present.
(2) Distribution data based on Rodriguez et al. (1993), Carrillo and Icochea (1995), Dixon and Huey (1970), Dixon and Wright (1975).
*Endemic to Peru (according to Rodriguez et al. (1993), Carrillo and Icochea (1995))
Vulnerable (V), Near Threatened (NT).

5.2.4.3.3 Diversity

The highest value for the Shannon-Wiener index for the 2004 assessment was 1.05 bits/individuals (Table 5.2.4-4). During the summer assessment, sampling route 7 displayed 0.69 bits/individuals as the highest diversity value, followed by SR 17 and SR 21 – both with 0.64 bits/individual (Table 5.2.4-4). Only one species was documented for most of the sampling routes, yielding a zero diversity value in such cases.

Table 5.2.4-4 Shannon-Wiener Index (H’) by Sampling Route (SR) and Sampling Zone

	Sampling Zones						
	Upper Topara Valley			Access road			Quarry
September, 2004 Sampling							
SR	**-**	**-**	**-**	**2**	**3**	**6**	**4**
H’	-	-	-	1.05	0,50	0	0
February, 2005 Sampling							
SR	20	21	22	17	1;2;3;4;16;18;19	7	5;6;8;11;12;13;14;15
H’	0.45	0.64	0	0.64	0	0,69	0

5.2.4.3.4 Results analysis (seasonal comparison)

The study zones pertaining to the GNL-2 Quarry were not assessed in winter; nonetheless, it is possible to compare these results with the results obtained at that time in neighboring areas (GNL-1), because they are relatively similar areas and are relatively close in proximity (3 km). The comparison has been made between the future access road and the quarry areas and their corresponding sampling routes. For this comparison, the sampling routes assessed at Topara Valley have not been considered, because this kind of habitat (coastal valley) was not assessed during the study made in 2004.

Table 5.2.4-5 shows that the species documented during both field campaigns were the same. The results, thus, confirm the similarities between these two zones, but with a higher number of occurrences documented for GNL-2. This can be explained because GNL-2 was assessed during the dry season or summertime, and it is during this period with high air temperatures that the number of active reptiles is also higher, as compared to the wet season. In addition, the search effort for sampling routes was higher during the second assessment (GNL-2) (Table 5.2.4-5), which could also explain the higher number of occurrences documented.

Another observation that was made was the difference in most frequently documented species (Table 5.2.4-5). During the winter assessment, occurrences of *M. theresiae* were most common. During the summer assessment, *M. tigris* was the most documented reptile. This difference is not likely to be due to a seasonal variation in herpetofauna, but due to differences in sampling. The search effort in the GNL-2 Quarry neighboring areas zone (GNL-1) was more extensive in sand and stone substrate desert areas where *M. theresiae* occurs more commonly, while the search effort in the GNL-2 Quarry zone was more intense in areas with soil substrate and rocky mountains covered with some vegetation – the typical habitat for *M. tigris*.

In summary, the assessed zones for both field campaigns are similar because the same species of reptiles occur. Sampling variations – not seasonal variations – caused the differences in the number of occurrences. The absence of occurrences of some species during the wet season is not thought to be due to the absence of the species in the area, but to the lesser probability of documenting occurrences as a result of the diminished activity of the species when air temperatures are low.

Table 5.2.4-5 Comparison of documented species, number of individuals and search effort between field campaigns for the quarry and access road zones.

Species	Sampling Field Campaign	
	September 2004	**February 2005**
Phyllodactylus gerrhopygus	3	3
Phyllodactylus lepidopygus	1	1
Ctenoblepharis adspersa	1	1
Microlophus theresiae	11	2
Microlophus tigris	4	25
Total number of individuals	**20**	**32**
Search effort (Man/Hours)	**8**	**19**

5.3 CULTURAL BASELINE

5.3.1 ARCHEOLOGY

The GNL-2 Quarry is situated between the Cañete river basin and the Culebrilla gorge (Pisco). The Cañete valley spreads south of Lima, between Parallels 11° 58’ and 13° 09’ Latitude South. The other coastal valleys consist of irrigated land, which use water brought by the main rivers, which descend from the highlands. The Cañete river basin originates from Lake Ticllacocha where it divides with the Mala river, at an altitude of approximately 4,800 m.

5.3.1.1 RESEARCH BACKGROUND

Archaeological prospecting in the GNL-2 Quarry area has been undertaken only recently, in contrast to the number of studies performed in the Cañete valley. Cañete is situated on the cultural border between the large ancient cultures of the central coast and the southern coast.

By the Late Intermediate, the Cañete river valley became important to local ethnic groups such as the Guarco and the Lunaguana. The Guarca dominated the lower valley while the Lunaguana controlled the middle part of the Cañete valley. The towns of the Yauyos confederation lie toward the highlands (Rostworowsky: 1989). The Tahuantinsuyo Empire later annexed these towns.

Over the past five years, the area identified for the GNL-2 Quarry has been extensively studied as part of the archaeological evaluations conducted for the Camisea project and for the Concon – Topará irrigation project. Both projects have identified a series of settlements of they have proposed to demarcate the remains discovered.

5.3.1.2 RESULTS OF THE STUDY

Prior to the fieldwork, a review was performed of bibliographical information on the study area. The strategy for field work was based on the review of available data and maps on the area. The archaeology team systematically surveyed the surface of the future access road and quarry in order to ascertaining the existence or absence of archaeological evidence. Where archaeological evidence was present, the team identified its nature, surface boundaries, cultural ties and degree of impact. The sites were identified with the help of global positioning satellite (GPS) equipment, recorded in the respective maps, and delimited with the assistance of small sampling pits.

Archaeological Potential

The access road to the site runs from the Panamerican Highway at kilometer 168 and crosses hilly terrain that is characterized by the presence of sand dunes. The road then crosses the Camisea gas pipeline and two high tension lines until it reaches the desert area to the south of the Lomas Negras hills and north of the Topará gorge. The Culebrilla gorge forms the entrance to the quarry area. The road runs through the gorge until it reaches its mouth, where it meets the exploitation area. The hills in the quarry area feature some escarpments and very large rocks over the slopes. The bottom of the gorge is filled with the remains of water rushes which left an abundance of very large rocks, plus a bed that changes from superficial to relatively deep depending on the width of the gorge's bottom.

The archaeological study revealed that the Cinco Cruces desert plain, Pampa Cañete and the southern part of Lomas Negras contain scattered evidence of ancient human groups. The sites contain shell deposits, temporary hunter and collector camps and even burial areas. A pre-Hispanic trail is located in the section directly linked to the works. According to the review made of the corresponding documentation and the prospecting work carried out on the land, the road runs from the Topará gorge – where the Huaquina archaeological site is situated – to the Culebrilla gorge, through the gorge, then up the mountains north towards the Lunahuaná valley. According to the records, the road travels as far as the Incawasi site, located in Lunahuaná, Cañete. As is the case with many findings from the pre-Hispanic period, especially if associated with the Late Intermediate Horizon (Incas), the road is connected to a series of small settlements and construction works, which catered for the needs of ancient travelers. In addition to the trail, the archaeology team identified construction works of a formal and ritual nature inside the Culebrilla gorge.

The sites identified during the fieldwork are as follows:

A. Windbreak:

UTM Reference: 364331 E 8538294 N

The windbreak comprises the remains of a small construction site made of rounded stone, arranged on a non-mortared wall. It is semi-circular and includes some ceramic fragments and shell material. The windbreak has a length of 1.20 meters and a width of 80 centimeters. It is located 40 meters from Vertex 9, between Sites 12 and 15, eight meters from the axis of the access road leading to the quarry.

Impact: It is eight meters from the axis of the access road leading to the quarry – adjacent to the road.

Mitigation: Generate a protection area for the windbreak of at least 10 square meters considering the close distance to the site, the small size of the archaeological evidence and the type of vehicles that will be used in the area. The recommendation is to move the present location of Vertex 9 to twenty or thirty meters to the north or south of the current position, with the objective to move it away from the archaeological evidence. Install a sign to identify the location of the site.

B. Pre-Hispanic trail:

UTM Reference: 375017 E 8545878 N; 376239 E 8547064 N; 376055 E 8548224 N; etc.

This is comprised of an ancient pre-Hispanic trail, which, seemingly dates back to periods prior to the Late Horizon (Inca – 1,400 A.D.). This trail was in by the residents of the present Topará area and its vicinity until the last century.

The road's width ranges from 3.5 meters to 5 meters. It is straight in the flat sections and readily identifiable by visual observation. Small stones line the sides of the road. In steep sections – the gorge with a huayco (mudflow) – large and medium size rocks line the road on both sides. Containment walls have also been built for huayco crossings. Steps are present in areas where the road runs through land with quick vertical changes. The road appears to starts at the Huaquina archaeological site in the Topará gorge, travels north through the La Capilla site, then turns to the northwest going into the Culebrilla gorge (this is where it meets the access road leading to the quarry), moves northeast through the gorge, then moves up in elevation traveling towards the north, finally reaching the Inkawasi site in the Lunahuaná valley (according to the INC Cápac Ñam Project's records). The road can only be observed in certain stretches, since it has been cut off by the huayco that descends along the Culebrilla gorge's base. However, it can be observed in at least six areas.

Impact: the road is affected by the access road leading to the quarry in at least four stretches and by the exploitation area in at least two stretches.

Mitigation: Give the archaeological road a protection area of seven meters on each side of the course. Change the course of the access road to steer clear of the archaeological road – at least 10 meters in the narrowest sector of the gorge. For the sectors affected by the exploitation area exclude the area occupied by the archaeological road of the exploitation area; maintain the area occupied by the archaeological road as an protected zone; and place signs (at least three in each stretch of the archaeological road) in the area with an archaeological evidence during quarry operations.

C. Site 01:

UTM Reference: 373697 E 8543852 N.

This site is comprised of a set of quadrangular and circular structures that are in poor condition. There are three structures located over the alluvial plain at the foot of hills. The structures are made of partially rounded or rounded stone, arranged on short double-row walls without concrete. Towards the southeast end, there is also a wall made of 120-centimeter long double-faced stone. Ceramic fragments and a modern circular structure on the foot of the hill are observable on the surface.

Impact: It is adjacent to the southeastern side of the access road.

Mitigation: This is not affected by the route of the access road. The recommendation is to demarcate the area and to place signs during the period that the quarry will be in operation.

D. Rectangular Structure:

UTM Reference: 373674 E 8544454 N.

This is a rectangular structure with sides of approximately 4.80 meters by 3 meters. It has a possible access point opening towards the north. The walls are 60 centimeters thick and the height has not been determined. They are made of angled stones arranged in a double line. The structure is deteriorated to a great extent; it is possible that this structure, which appears to be isolated, may be associated with the pre-Hispanic trail going along the entire Culebrilla gorge.

Impact: It is not presently affected by the access road route – it is adjacent to the road.

Mitigation: The recommendation is to delimit the area and to place signs during the implementation of the quarry project. If changes are made to the route of the access road, the road should be kept as far away from the archaeological site as possible.

E. Geoglyph:

UTM Reference: 373899 E 8544656 N, 682 m elevation.

This is a geological glyph structure with a diameter of approximately five meters, located between Vertices 27 and 28 of the access road, approximately 100 meters from the axis. The glyph lies over an alluvial plain, on which slightly flat stones are arranged in a concentric form, forming a spiral. It has associated ceramic material spread over the surface. Apparently, this geoglyph has been recorded by the Capaq Ñam Project in July 2004 and is called "Culebrilla Geoglyph."

Impact: At present, it is not affected by the access road route. The geoglyph is adjacent to the road.

Mitigation: The recommendation is to delimit and to place signs during the implementation of the quarry project. If changes are made to the access road route, the road should be kept as far away from the archaeological site as possible.

F. Possible Tambo:

Meter: 376437 E 8547072 N

The possible tambo is comprised of the remains of a possible rectangular or quadrangular structure with a length of approximately nine meters. This is a possible Inca "tambo" because of the size of the structure, its presence near the road, and the construction techniques used. The wall is made of edged stones arranged on a double row, joined by concrete. The wall's width is approximately 70 centimeters and its height is 80 centimeters at the best-preserved sections. The wall's inner and outer sides have an even surface and associated ceramic material.

Impact: It is affected, since it is within the area defined as the exploitation zone.

Mitigation: Delimit and post signs on the works. Exclude the archaeological evidence area from the exploitation area, so as to guarantee its preservation.

Site 2:

UTM Reference: 376885 E 8547706 N; 376743 E 8547920 N, 1021 and 1040 m.a.s.l.

This site is located in the initial part of a boxed-in gorge. The gorge curves and then joins the Culebrilla gorge. At least seven sites can be found in the curve area. They are comprised of small spaces of quadrangular shape, small terraces, a possible "chulpa" underneath a large rock and several containment walls to support the structures. . These sites are adapted to the surface's terrain (quite steep) or, vice-versa, the surface adapted to the structures. Towards the high part of the hills, one can see a series of containment walls and small terraces going up the slope. They appear to comprise a control point to monitor entry to the initial part of the gorge. At the source of the gorge, there is a formation in the shape of a cave, located in the middle lower section of the rocky escarpment. The cave is formed by large rocky, quite high escarpment, which goes as far as the highest parts of the mountain chain. Because of the cave shaped formation and the surface of the rocky walls, water existed in the cave at some point.. Over the rocky escarpment there are containment walls and steps forming an upward trail that goes towards the highest part of the escarpment. The containment walls have been renewed at least three times, and they are made of semi-edged stones from the area. The walls' outer faces are rather flat and the containment fill is quite thick. This site may be associated with some sort of an ancient rite.

Impact: It is directly affected by the quarry area.

Mitigation: As much as 30% of the site is within the area defined as the exploitation area, and the remaining 70 percent (cave section and certain construction sites) is located within the quarry area. The recommendation is to delimit and to post signs during the period of the quarry operation, and to exclude the archaeological evidence zone from the quarry area which would guarantee the preservation of the site.

The archaeology team also identified fragmented ceramics, but in most of these cases they are related to the archaeological trail. The archaeological trail is protected, so the isolated ceramics would be protected too.

5.3.1.3 CONCLUSIONS AND RECOMMENDATIONS

The most important archaeological evidence identified is the pre-Hispanic trail which may possibly be associated with the Inca culture (according to existing records). It is with respect to this trail that there is associated evidence, such as Site 1, the rectangular structure and the possible tambo. This statement is made on the basis of published studies for Inca trails that exist. In addition, Site 2 and the geoglyph apparently function differently, although they are also related to inter-valley access route control.

There are few records of inter-valley pre-Hispanic trails on the Coast. Therefore, the existence of this trail through the Culebrilla gorge, joining the Topara gorge and the Lunahuana valley has importance in the archaeological world. This also forms the basis for the protection policy of the INC as well as the registration of the Inca trail system; therefore, it is essential to render protection and preservation of the pre-Hispanic trail sections identified within the associated area of the study.

It is recommended that the project's technical personnel adopt the necessary measures to preserve the archaeological evidence and prevent any type of deterioration which may occur as a result of the exploitation of the GNL-2 Quarry. This specifically refers to the vibration problem experienced as a result of the use of explosives and heavy equipment in the area, as well as the erosion that will be generated in the exploitation area.

It is also recommended that the archaeological sites be adequately signed in the quarry work plans so that the technical personnel will be fully aware of their locations.

5.4 SOCIAL BASELINE

The social baseline for the GNL-2 Quarry Project, was compiled using quantitative techniques (focus groups, in-depth interviews, participative evaluation workshops, TEP) and quantitative techniques, such as the surveying of the socio-economic profile of the population in the area of influence. Secondary sources from several institutions were reviewed, i.e. information from the National Institute of Statistics and Information Technology, the Ministry of Employment and Promotion, the Ministry of Education, the Local Education Management Units (UGELs) the Ministry of Health, and the EIA for the Liquefied Natural Gas Exportation Plant.

Proir to fieldwork and data collection, informative workshops took place in the districts of San Vicente de Cañete and Grocio Prado (November 2004) and also in the Buenavista settlement of the Topará Creek (April 2005). In these workshops, the population was informed about the Project and the activities that would be carried out to develop the Social and Environmental Impact Assessment (See Annexes 5.1, 5.2, 5.3).

Four focus groups were organized for the social baseline fieldwork. Two of them were carried out in the district of San Vicente de Cañete and two in Grocio Prado. In these areas, the participants were inhabitants of the settlements and urban areas associated with the district capital cities. A more detailed description of these tools can be found in the Methods section (5.4.5, technical sheet No.2) of the document. These TEP's were carried out in Grocio Prado, San Vicente de Cañete and Topará. (See Technical Sheet No.3)

Interviews with local leaders and to municipal representatives took place in both San Vicente de Cañete and Grocio Prado districts (See Technical Sheet No.1)

Because there was no current information regarding the districts and smaller geographical units, 480 homes in the area were surveyed. The sample represents the project area of influence, and has a 95% level of trust and a calculation error of 5%.

In order to account for the socio-demographic differences among the population and the interest variables of different populations, the area of influence was divided into four areas (Table 5.4-1).

Table 5.4-1 Working zones in the area of influence

District	Areas
San Vicente de Cañete	**San Vicente Pueblo** Urban and semi-urban population around the district capital.
	Outskirts of San Vicente de Cañete Settlements of Nuevo Ayacucho, Cinco Cruces, Asociación Colonizadora de la Costa, Brisas del Concón and Trébol del Pacífico
Grocio Prado	**Grocio Prado Pueblo** Urban, semi-urban and rural population around the district capital.
	Quebrada de Topará. Villa Sol, Buenavista, Conoche and Capilla.

The outskirts of San Vicente de Cañete include areas of land located between kilometer 164 and 175 of the South Pan American Highway. This land belongs to the Peruvian Ministry of Agriculture. Currently, it is inhabited by several groups of migrants (Annex 5.6). With the exception of Nuevo Ayacucho (which holds the category of Minor Urban Center), and the Asociación Colonizadora de la Costa - ACC, these groups are not permanent residents. During weekdays, these settlements are guarded by security guards. Every Sunday, migrants travel to the area and hold meetings in order to define their activities and express their interest in staying.

5.4.1 SCOPE OF THE STUDY

5.4.1.1 PROJECT LOCATION

The GNL-2 Quarry is located in the Culebrilla Ravine, approximately 20 km east of mile-marker 168 on the South Pan-American Highway. It is in the District of San Vicente de Cañete, Region of Lima.

The rocky massif to be exploited is a granodioritic crest, which runs from north to south. The rock required is located at an altitude of 1,130 meters in a quarry with an area of 50 hectares (500m x 1 000m).

5.4.1.2 DIRECT AND INDIRECT AREAS OF INFLUENCE OF THE PROJECT

The direct and indirect areas of influence have been chosen in accordance with the geographic location of the project. The project's economic, social and environmental impact on the area was also taken into account. The areas of influence are defined as follows:

Direct Area of Influence: This area is made up of the San Vicente de Cañete district in the Lima Region and the Grocio Prado district, in the Province of Chincha (the Ica Region.) The area includes human settlements located in San Vicente de Cañete and the Topará Ravine in Grocio Prado, Chincha.

Indirect Area of Influence: This area is defined as the area encompassing the Imperial district in the Province of Cañete (the Lima Region), and the Chincha Alta and Pueblo Nuevo districts in the Province of Chincha (the Ica Region.)

5.4.1.3 HISTORICAL BACKGROUND OF THE PLACES LOCATED IN THE DIRECT AREA OF INFLUENCE OF THE PROJECT

5.4.1.3.1 PROVINCES OF CAÑETE AND CHINCHA

The Province of Cañete is one of the 10 provinces of the Lima Region. The Province is also home to Lima (the capital of Peru), which is located in the southern end of the Region. The Province of Cañete has an area of 4 581 km² and its altitude fluctuates between 3 (Chilca or Cerro Azul) and 802 meters (in Zúñiga).

The Province of Cañete and its eight districts were created, along with the Lima Region, by General San Martin in 1821, when the political independence from Spain was declared.

During the first decades of the 20th Century, a few families controlled the land ownership in the area. These families formed an important, dominating, social order. Cotton production began to increase in 1930, due to a rise in demand and better prices that were a result of the 1929 world economic crisis. The high profitability of cotton encouraged and accelerated the concentration of land ownership. This resulted in the formation of monopolies. Another consequence of this concentration of land ownership was the strengthening of certain dominating families' political power, as with the Asin family of Mala[1].

In response to the strong demand for cotton, the landowners decided to lease their lands, machinery, peons, and "yanaconas"[2] for periods of 10 to 12 years. According to documents, the owners resided outside of the capital and only returned on weekends or once yearly to collect their rental money,

Between 1920 and 1930, the peons, who earned the wages, appeared. The peons are defined as a sector of workers who were obliged to work in the valleys or who settled in the valleys in order to work. This wage earning class developed at the same time as the *cotton boom*, which created a demand for temporary labor inside and outside the valleys.

Beginning in 1940, the urbanization phenomenon accelerated the growth of cities. In the case of Cañete, the districts of Imperial and Mala attracted migrants, especially those from the central part of the country.

The Province of Chincha was the first city founded in the region of Ica by Diego de Almagro in 1534. It was created by law on October 30, 1868. On October 13, 1900, the

1 Arroyo A.: La Hacienda Costeña en el Perú: Mala Cañete: 1532-1968. Editorial Horizonte, Lima 1981.

2 Indians who where assigned a plot of land to cultivate and live on its production. In exchange for this, they had to deliver to the landowner a part of the crops or work in the land directly controlled by him for a number of days per week.

province was divided to form the provinces of Pisco and Chincha Alta (the capital of the province.) The city was also given the title of "Benemerita a la Patria" (Worthy of the Nation) on November 11, 1950.

5.4.2 DEMOGRAPHICAL CHARACTERISTICS OF THE POPULATION OF PROJECT AREAS OF INFLUENCE

5.4.2.1 TOTAL POPULATION BY DISTRICTS

The table 5.4.-2 shows the total population of Cañete and Chincha. By 2000, the population in Cañete was 170,985, and by 2005, it had increased to 177,925. The regional density is 38 inhabitants per square meter. The population in Chincha in 2000 was 171,709, and by 2005, it had increased to 184,349.

Table 5.4-1 Total population: projection of years 2000-2005

Region / Province / District	Years	
	2000	2005
Lima	**7,485,958**	**8,143,950**
Cañete	170,985	177,925
Ica	**665,180**	**720,691**
Chincha	171,709	184,349

Source: INEI, Instituto Nacional de Estadística e Informática (National Institute of Statistics and Data)- PERÚ. Population Estimates and Projections per Calendar Years according to Departments and Provinces, 1990-2005.
Prepared by: Social and Environmental Management Team, Walsh Perú, April 2005.

The Province of Cañete is divided into 16 districts. Table 5.4-3 illustrates the population projection for the Province of Cañete. San Vicente de Cañete (part of the area of influence of the GNL-2 Quarry Project) shows a population increase from year 2000 (37,368 inhabitants) to 2005 (38,964 inhabitants).

The population of the province of Cañete represents 2.2% of the total population of the Lima region. The population of the San Vicente de Cañete district makes up 22% of the total population of the province. This district is also the largest district, which demonstrates how important it is at province level. In contrast, the district of Imperial (which is in the indirect influence area) has an estimated population of 34,525 in 2005, and represents 19.4% of the population of the province of Cañete.

Table 5.4-3 Total population of the Lima Region, Cañete Province and Districts – 2005 projection

Political Division	Population	
Districts	**Population**	**%**
San Vicente de Cañete	**38 964**	**21,9**
Asia	3 980	2,2
Calango	2 300	1,3
Cerro azul	6 237	3,5
Chilca	16 417	9,2
Coayllo	1 079	0,6
Imperial	34 525	19,4
Lunahuana	4 627	2,6
Mala	22 617	12,7
Nuevo Imperial	14 159	8,0
Pacarán	1 642	0,9
Quilmaná	12 449	7,0
San Antonio	3 341	1,9
San Luis	11 922	6,7
Santa Cruz De las Flores	2 326	1,3
Zúñiga	1 340	0,8
Total	**177 925**	**100,0**

Source: INEI Instituto Nacional de Estadística e Informática - PERÚ: Population Estimates and Projections per Calendar Years according to Departments and Provinces, 1990-2005.
Prepared by: Social and Environmental Management Team, Walsh Perú, April 2005.

Table 5.4-4 shows the estimated population for the Province of Chincha. The Province of Chincha (in the Ica Region), had a population of 171,709 in 2000. By 2005, the population had grown to 184,349, or 25.5% of the regions population. The total area of the province is 2 98735 km^2, and the population density is 61.7 inhabitants per km^2.

The district of Grocio Prado, which is also part of the direct area of influence, showed a population of 16,460 in 2000. It is estimated that it will grow to 17,388 inhabitants in 2005 and represent 9% of the province population.

The districts of Chincha Alta and Pueblo Nuevo, which are part of the indirect area of influence as well, are estimated to have 60,073 and 49,088 inhabitants in 2005. This represents 32.6% and 26.6%, respectively,of the Province of Chincha population.

Table 5.4-4 Population. Chincha Province and Districts – 2005 Projection

Political Division	Population	
Districts	**Population**	**%**
Chincha Alta	60 073	32,6
Alto Larán	5 289	2,9
Chapín	852	0,5
Chincha Baja	13 432	7,3
El Carmen	9 810	5,3
Grocio Prado	17 388	9,4
Pueblo Nuevo	49 088	26,6
San Juan de Yanac	1 065	0,6
San Pedro de Huacarpana	1 561	0,8
Sunampe	20 952	11,4
Tambo de Mora	4 839	2,6
Total	**184 349**	**100,0**

Source: INEI Instituto Nacional de Estadística e Informática - PERÚ: Population Estimates and Projections per Calendar Years according to Departments and Provinces, 1990-2005.
Prepared by: Social and Environmental Management Team, Walsh Perú, 2004.

5.4.2.2. POPULATION PER AREA AND GENDER

Table 5.4-5 shows the distribution of the population for the districts that are in the direct areas of influence of the GNL-2 Quarry project. In both San Vicente de Cañete (68.3%) and Grocio Prado (89.6%), a large percentage of the population lives in urban areas. The proportion of the population living in rural area is much smaller for both districts.

With regard to the gender distribution, the same table shows that there is strong similarity between both districts. The gender percentages are very close in San Vicente de Cañete with women accounting for 50.9% of the population and men making up 49.1%. In Grocio Prado, the female to male gender distribution is 50.7% and 49.3% respectively.

Table 5.4-5 Total population for the urban and rural area and gender

District \ Population		Distribution of the Population		Distribution by gender	
		Urban	Rural	Men	Women
Province of Cañete	San Vicente de Cañete	68.3%	31.7%	49.1%	50.9%
Province of Chincha	Grocio Prado	89.6%	10.4%	49.3%	50.7%

Source: INEI Instituto Nacional de Estadística e Informática - PERÚ: Population Estimates and Projections **Prepared by:** Social and Environmental Management Team, Walsh Perú, April 2005.

5.4.3. SOCIO-ECONOMIC PROFILE OF THE PROJECT'S AREAS OF INFLUENCE

5.4.3.1. POVERTY LEVELS IN THE AREAS OF INFLUENCE

According to the Map of Basic Unsatisfied Needs (NBI), prepared by the Instituto Nacional de Estadística e Informática (INEI), in the province of Cañete, the poverty level ranks 172 nationwide. Nearly 50% of the homes in the province of Cañete are considered poor. This situation increases in rural areas, where 69% of the population lives in poverty due to crowded, unstable homes and deficient water and sewage service.

According to the Poverty Map[3], prepared by the Fondo Nacional de Compensación y Desarrollo Social (National Fund for Social Compensation and Development) (FONCODES), the population of the Grocio Prado District is considered "poor."

5.4.3.2. EDUCATION IN THE AREAS OF INFLUENCE

5.4.3.2.1 SCHOOL-AGE POPULATION

Table 5.4-6 shows that in the province of Cañete, the school-age population grew significantly from 1997 to 2003 in both public and private educational institutions.

[3] The Poverty Map is a focalization instrument of social programs aimed at preparing criteria for the allocation of resources and achieving the greatest impact in treating these lacking aspects and achieving an efficient fund allocation and implementation.

Table 5.4-6 Public and private schools enrollment index (1997- 2003) UGEL No. 8 - Cañete

Year	Age Group	School-Age Population	Registration at June of each year	School Enrollment Index %	Deficit %
1997	03-05	20 990	7 800	37,16	62,84
	06-14	53 200	39 150	73,59	26,41
	15-24	31 110	9 532	30,63	69,37
1998	03-05	21 300	8 110	38,07	61,93
	06-14	53 700	39 600	73,74	26,26
	15-24	31 600	9 990	31,61	68,39
1999	03-05	21 620	8 483	39,23	60,77
	06-14	54 130	40 036	73,39	26,61
	15-24	34 823	10 959	31,47	68,53
2000	03-05	21 836	8 737	40,01	59,99
	06-14	54 671	40 436	73,96	26,04
	15-24	35 171	11 945	33,96	66,04
2001	03-05	22 176	9 047	40,8	59,2
	06-14	55 212	40 811	73,92	26,08
	15-24	35 519	12 940	36,43	63,57
2002	03-05	22 516	9 232	41,45	58,53
	06-14	55 753	41 166	73,84	26,16
	15-24	35 868	13 950	38,89	61,11
2003	03-05	22 856	9 590	41,96	58,04
	06-14	56 294	41 514	73,75	26,25
	15-24	36 218	15 030	41,50	58,50

Source: Unidad de Gestión Educativa (Educational Management Unit) N° 8 (UGEL 8 - Cañete)

The 3-5 age group, which corresponds to the first level of basic education (pre-school) has been incorporated progressively into the educational system. This age group has the lowest school enrollment when compared to the other age groups.

The Educational Policy aims at linking 'pre-school' education to the primary levels. This action is considered mandatory in order to promote basic education in the entire country. Its purpose is to encourage positive practices that contribute towards the full development of children. The policy takes into account children's social, emotional, and cognitive, development; oral/artistic expression; and the psychomotor aspect.

The highest school enrollment index is seen in the 6-14 age group. This shows a stable trend for all the years reviewed (1997-2003), and is consistent with the enrollment statistics on basic education nationwide.

The lowest school enrollment index is seen in the 15-24 age group. Yet, it shows an increasing trend during the last 9 years (30.63% in 1997 to 41.50% in 2003). This could be explained by the fact that young people currently need to be trained in order to enter and compete in the labor market.

5.4.3.2.2. COVERAGE AND EDUCATIONAL SUPPLY

The Province of Chincha has a total of 277 educational institutions, encompassing initial, primary, secondary, and technical superior education. There are two types of primary level education; (i) Minors and (ii) Adults, and three types of secondary education: (i) Minors, (ii) Adults and (iii) Occupational. The Grocio Prado District has 26 educational institutions, which accounts for 9.4% of the total institutions in the province. (Table 5.4-7).

Table 5.4-7 Educational Institutions according to district in the Province of Chincha 2004.

District	Educational Institutions
Chincha	152
Pueblo Nuevo	58
Sunampe	34
Grocio Prado	26
Tambo de Mora	7
Total	**277**

Source: Province Municipality of Chincha 2004.
Prepared by: Social and Environmental Management Team, Walsh Perú, April - 2005.

In the Province of Cañete, there are 308 public educational institutions (Table 5.4-8) and 169 private educational institutions (Table 5.4-9).

Table 5.4-8 Student attendance and occupational goals of public educational institutions in the Province of Cañete 2004

Level/Type	Students	Teachers	Educ. Auxiliary Staff	No. of Educational Institutions
Initial	5837	217	42	91
Primary for Minors	24 566	981	3	135
Primary for Adults	622	27	0	9
Special	327	29	16	4
Secondary for Minors	19 020	1 015	69	49
Secondary for Adults	967	60	0	9
Occupational Secondary	1 836	30	0	11
Total	**53 159**	**2 359**	**130**	**308**

Source: UGEL Nº 08- Cañete, 2004.

According to Table 5.4-8, the overall enrollment of students in state-run educational institutions was 53,175 in 2004; with 2,359 teachers and 130 supporting staff. The levels with the highest numbers are: the Primary Level for Minors (24,566 students), followed by the Secondary Level for Minors (19,020 students).

Table 5.4-9 Student attendance and occupational goals of private educational institutions UGEL 08 - Province of Cañete 2004

Level/Type	Students	Teachers	Educ. Auxiliary Staff	No. of Educational Institutions
Initial	1 510	116	28	51
Primary for Minors	3 878	259	38	51
Primary for Adults	67	11	0	8
Special	1 331	234	16	24
Secondary for Minors	559	43	1	11
Secondary for Adults	1 564	94	0	24
Total	**8 909**	**757**	**83**	**169**

Source: UGEL No. 08 Cañete, 2004

Table 5.4-9 presents the attendance goals of the private educational institutions. By 2004, these institutions were educating 8,909 students; with 757 teachers and 83 supporting staff. The levels with the greatest number of students are: the Primary Level for Minors (43.5%), followed by the Occupational Level (17.56%). The Occupational Level within private educational institutions emphasized its tuition in the preparation for work and the development of managerial capabilities. There are no special institutions within the private educational sector in the Province of Cañete. The district of San Vicente de Cañete has a total of 61 educational institutions, with 14,043 students attending and 602 teachers (Table 5.4-10).

Table 5.4-10 Public educational institutions in the San Vicente de Cañete district.

Level		Education Institution	Total Students	Total Teachers
Inicial		20	1 593	57
Primary	Minors	27	6 000	239
	Adults	1	82	4
Secondary	Minors	9	5 952	287
	Adults	2	192	10
Occupational Education		1	185	2
Special Education		1	39	3
Total		**61**	**14 043**	**602**

Source: UGEL Nº 8 - Cañete, 2004
Prepared by: Social and Environmental Management Team, Walsh Perú, April - 2005.

In the district of San Vicente de Cañete, the primary level for minors has the highest attendance in public schools (6,000 students registered), followed by the initial level (1,593 students registered).
The levels with the lowest attendance rates are the occupational level (185 students registered) and special education level (39 students registered).

There are 62 private educational institutions in the district with 4 044 students in attendance and 317 teachers (Table 5.4-11). The levels with the greatest number of students are: primary level for minors, followed by the occupational level. The lowest amount of students are in the primary level for adults, with 15 students.

Table 5.4-11 Private educational institutions. District of San Vicente de Cañete, UGEL No.8

Level		Educational Institution	Total Students	Total Teachers
Initial		17	596	47
Primary	Minors	18	1 388	93
	Adults	2	15	3
Secondary	Minors	9	731	105
	Adults	4	302	19
Occupational Education		12	1 012	50
Total		62	4 044	317

Source: UGEL Cañete N° 8
Prepared by: Social and Environmental Management Team, Walsh Perú, April - 2005.

The district of Chincha Alta has 50 public educational institutions, with 23,155 students in attendance and 1 044 teachers (Table 5.4-12).

In Chincha Alta, the minor secondary school has the highest number of students registered (112,220), followed by the minor primary school, with 8,430 students registered.

Table 5.4-12 Public educational institutions. District of Chincha Alta, Province of Chincha - 2003

Level		Educational institution	Total Students	Total Teachers
Pre-school		18	2 372	81
Primary	Minors	17	8 430	321
	Adults	2	12	3
Secondary	Minors	7	11 220	570
	Adults	3	670	34
Occupational education		1	235	7
Special education		2	216	28
Total		**50**	**23 155**	**1 044**

Source: Ministry of Education, Educational Statistics Unit 2003
Preparation: Socio Environmental Management Team, Walsh Peru, April - 2005.

The educational levels with the lowest number of students registered are the special education level, with 216 students registered and the adult primary school, with 12 students registered.

Table 5.4-13 Private **e**ducational institutions. District of Chincha Alta, Province of Chincha - 2003

Level		Educational institution	Total Students	Total Teachers
Pre-school		31	993	93
Primary	Minors	27	3 528	229
	Adults	1	38	4
Secondary	Minors	14	1 902	215
	Adults	1	81	4
Occupational education		7	426	27
Total		**81**	**6 968**	**572**

Source: Ministry of Education, Educational Statistics Unit 2003
Preparation: Socio Environmental Management Team, Walsh Peru, April - 2005.

There are 81 private educational institutions in this district, with 6,968 students and 572 teachers (Table 5.4-13). The level with the largest number of students is the minor primary school with 3,528 students registered, followed by the minor secondary school with 1,902 students registered. The two levels with the lowest number of students are the adult primary school, with 38 students registered and the adult secondary school, with 81 students registered.

In the district of Pueblo Nuevo, the level with the largest amount of students in public educational institutions is the minor primary school with 3,680 students registered, followed by Pre-school with 1,345 students registered. (Table 5.4-14). The level less attended is occupational education, with 94 students registered. There is no adult primary school, secondary school, or special education in this district.

Table 5.4-14 Public educational institutions. District of Pueblo Nuevo, Province of Chincha - 2003

Level		Educational institution	Total Students	Total Teachers
Pre-school		13	1 345	47
Primary	Minors	9	3 680	145
	Adults	-	-	-
Secondary	Minors	3	1 138	63
	Adults	-	-	-
Occupational education		1	94	5
Special education		-	-	-
Total		**26**	**6 257**	**260**

Source: Ministry of Education, Educational Statistics Unit 2003
Preparation: Socio Environmental Management Team, Walsh Peru, April - 2005.

In the district of Pueblo Nuevo, the minor primary school has the highest registration level, with 1,446 students registered. It is followed by the minor secondary school with 495 students registered. (Table 5.4-15).

The occupational education level has the least amount in attendance, with 20 students registered.

There are no special education institutions in this district.

Table 5.4-15 Private educational institutions. District of Pueblo Nuevo, Province of Chincha - 2003

Level		Educational institution	Total Students	Total Teachers
Pre-school		10	343	28
Primary	Minors	11	1 446	90
	Adults	1	37	3
Secondary	Minors	2	495	26
	Adults	2	160	11
Occupational education		1	20	5
Total		**27**	**2 501**	**163**

Source: Ministry of Education, Educational Statistics Unit 2003
Preparation: Socio Environmental Management Team, Walsh Peru, April - 2005.

5.4.3.2.3. STUDENT REPEATING

In 2004, the Province of Cañete's school population showed a decreased number of students registered in both primary and secondary levels when compared to the previous year (Table 5.4-16).

Table 5.4-11 Situation in public and private Educational Institutions. UGEL No. 8- Cañete 2002-2003

Category Level	Registration		Passed		Failed		Dropouts	
	2003	2004	2003	2004	2003	2004	2003	2004
Primary for Minors	31 215	28 506	28 559	26 437	883	1 004	1 773	1015
Primary for Adults	825	689	607	577	85	51	133	61
Secondary for Minors	21976	20 352	20 050	18 690	796	653	1 130	1 009
Secondary for Adults	1 824	1 526	1 615	1 473	88	26	121	27
Total	**55 840**	**51 073**	**50 831**	**47 77**	**1 852**	**1 734**	**3 157**	**2 112**

Source: Information from UGEL No. 8, Cañete.
Prepared by: Social and Environmental Management Team, Walsh Perú, 2004.

With regard to the school population that failed, there is a significant increase in the number of students at the primary minors level that failed. There is a very high risk that individuals in this group will drop out of school,

Repeating the year causes frustration to the student and the parents. Faced with the propect of failure, they decide to drop out. By doing so, they loose the possibility of completing their education and developing their talents. Dropping out of school increases the prevalence of poverty in families from one generation to the next[4].

5.4.3.2.4. EDUCATIONAL LEVEL

In the San Vicente de Cañete district and the Grocio Prado District, the level of education of the population interviewed is predomintately the full secondary level, with the percentages being 31.9% and 27.1%, respectively (Table 5.4-12).

The findings show that the education level of the average head of the family is relatively high. 33.5% of those interviewed have completed their secondary education, 10.2% have complete non-university superior education, and 16% have not completed primary education.

[4] Estudio de Sistematización de la iniciativa por la Universalización de la Matricula Oportuna, UNICEF, J.L.Encinas, 1996

Table 5.4-17 shows that Grocio Pueblo district has the highest percentage of family heads with completed secondary education (39.3%), followed by the San Vicente Pueblo district (29.9%).

Table 5.4-12 Educational Level of Family Head per Area

	Total	Areas			
		San Vicente Pueblo	Outskirts of San Vicente	Grocio Pueblo	Quebrada Topará
No Education	2.3	2.2	3.9	1.7	3.1
Pre School	0.6	1.5	0	0.4	0
Incomplete Primary	16	8	19.5	17.5	31.3
Full Primary	10.4	4.4	26	7.3	21.9
Incomplete Secondary	16.5	16.8	11.7	17.5	18.8
Full Secondary	33.5	29.9	27.3	39.3	21.9
Incomplete Non-University Superior	4.6	8	0	4.7	0
Complete Non-University Superior	10.2	15.3	7.8	9	3.1
Incomplete University	1	2.2	1.3	0.4	0
Complete University	4.6	10.9	2.6	2.1	0
Post Graduate	0.2	0.7	0	0	0
	480	137	77	234	32
TOTAL 100% BASE: TOTAL NUMBER OF INTERVIEWS					

Source: Socio-economic survey - April 2005.
Prepared by: Social and Environmental Management Team, Walsh Perú, April 2005.

5.4.3.2.5 ILLITERACY

The illiteracy rate of the population ages of 15 and above is 7.6% in the San Vicente de Cañete District and 7% in the Grocio Prado District. These averages are close to the average illiteracy rate for the Province of Cañete of 7.5%.

The National Literacy Program is being implemented in these districts through the literacy committees. These literacy committees are community forums for social participation, decision-making, and surveillance. The local governments, with the technical assistance of local management units, are in charge of establishing and managing these literacy programs.

The duties of these institutions include the following:

- Locate and give priority to assistance areas.
- Encourage the establishment of learning centers.
- Select literacy teachers or facilitators.
- Undertake social surveillance of the literacy process[5].

In the municipality and UGEL No. 8, which is in the Province of San Vicente de Cañete, they are implementing the national literacy program in Mala and Lunahuaná. In both areas, there are 11 'literacy' circles[6].' Each circle has a supervisor in charge and a facilitator.

According to information from UGEL No. 8 from Cañete, there are three circles operating in the San Vicente de Cañete District: the Playa Hermos annex, the Arena Alta, and the Independent Housing Association. The total number of participants is 50 (48 women and 2 men.) Of these 50, 14 participants withdrew from the program, 16 participants were in the process of learning how to read and write, and only 20 participants were considered to have learned how to read and write succesfully[7].

5.4.3.3 HEALTH PROFILE OF THE POPULATION IN THE AREAS OF INFLUENCE

The World Health Organization (WHO) defines health as a full state of physical, mental, and social well-being[8]. This definition can be applied quite broadly, and health can be viewed as synonymous for well-being. For this reason, at any given time, the health of a person does not depend only on medical care, but also on other variables such as basic sanitation, education, nutrition, and housing.

[5] Ministry Resolution No. 030, Ministry of Education 2004
[6] The UGEL refers to the group of participants who are beneficiaries of the program in each Inhabited Center as a **"Circle"**.
[7] Table of consolidated grades of the final evaluation of participants of the Literacy Program per District – Report issued by the zone supervisor of UGEL N° 08
[8] WHO: Cooperation given by the Pan American Health Organization to the Health Sector Reform Processes. Washington DC, March 1997.

5.4.3.3.1. HEALTH ESTABLISHMENTS AND SERVICES

In the San Vicente de Cañete district, the health services are distributed through networks and micro networks (Table 5.4-18). The San Vicente Micro Network is made up of two Health Centers and seven Health Posts, which serve a population of 38,964 people. [9]

Table 5.4-14 Distribution of Health Services established for the Health Network – San Vicente, 2004

Department	Micro Network	Health Center	Health Posts
Lima	San Vicente	San Vicente San Luis Cerro Azul	Herbay Bajo Herbay Alto Señor de los Milagros Laura Caller Santa Bárbara Santa Cruz La Quebrada

Source: Ministry Of Health information, 2005

5.4.3.3.2. MORBIDITY

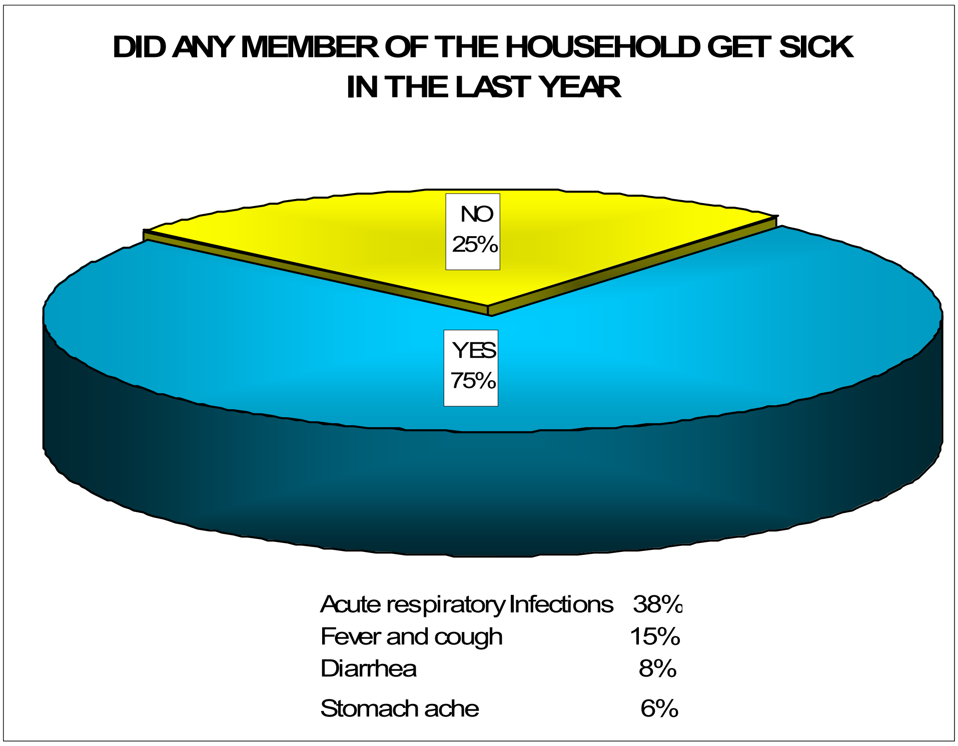
Graph 5.4-1 shows that in 75 % of the interviewed homes, at least one of the family members was sick in the past year. Acute respiratory infections (IRA in Spanish) were the most common illness (38%), followed by fever and cough (15%), and gastro-intestinal ailments (14%). In relation to health, women (54.1%) and children ages of 0 – 10 (37.8%) were the most vulnerable groups.

In connection with the development of the quarry, one of the main concerns of the population (raised both in the focal groups and in the participative evaluation workshops[10]), was the amount of dust that could be generated[12]. They are concerned that it will increase their already-present health problems (IRA and gastro-intestinal problems).

[9] Information: MINSA, 2002

10 Number of participants on TERPs were: 24 in Grocio Prado, 14 in San Vicente de Cañete and 12 in Quebrada de Topará. With regards to Focus Group: 20 people attended the focus group carried out in San Vicente de Cañete and 16 in Grocio Prado.

Graph 5.4-1



Source: Socio-economic survey – Social Baseline GNL-2.
Prepared by: Social and Environmental Management Team, Walsh Perú, April 2005.

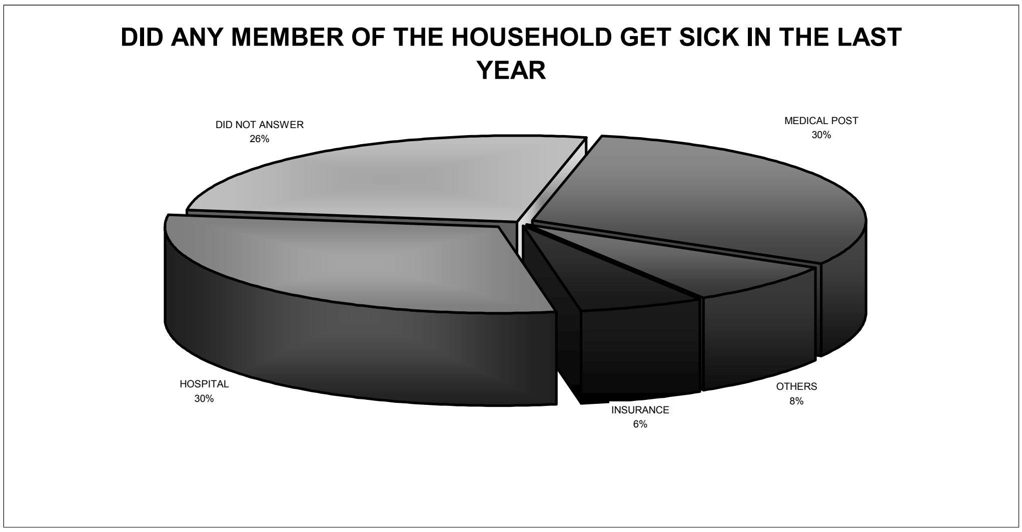
Table 5.4-19 shows the main causes of morbidity in the province of Cañete. Moreover, it shows the correlation between morbidity and the precarious sanitation conditions in the area.

Table 5.4-19 Ten main general causes of morbidity in the province of Cañete, November 2004

N°	Causes
1	Helminiasis
2	Mycosis
3	Symptoms and signs compromising the nervous system
4	Infections as predominant transmissions
5	Diseases of the esophagus, stomach
6	Malnutrition (E40-E46)
7	Non-inflammatory disorders of organs
8	Head traumatism (S00- S09)
9	Dorsopathy (M40 – M54)
10	Conjunctive Tissue Disorder (H10 – H13)

Source: Cañete-Yauyos Health Network, November 2004

Graph 5.4-2



Source: Socio-economic survey – Social Baseline GNL-2.
Prepared by: Social and Environmental Management Team, Walsh Perú, April - 2005.

Among the 480 households interviewed, 60% of the members of those families visit health centers of the Ministry of Health for treatment (medical posts and hospitals), and only 6% have medical insurance.

5.4.3.3.3. MORTALITY

According to data furnished by the statistics office of the Cañete Health Network, the main causes of death during the first quarter of 2004 were vascular-encephalic accident and bronchial-pulmonary infections (bronchial pneumonia) as shown in Table 5.4-21:

Table 5.4-20 Causes of death in the first quarter of 2004

Disease	No of deaths
Non-specific acute vascular encephalic accident	10
Bronchial pneumonia	9
Non-specific diabetes mellitus	5
Cerebral and pulmonary edema	6
Non-specified caloric protein malnutrition	n.e.
Drowning and submerging (asphyxia)	3
Volume depletion	2
Anemia	n.e.
Diarrhea and gastroenteritis	n.e.

Source: Cañete Health Network, 2004

5.4.3.4 SECURITY SENSATION

The charts 5.4-21, 5.4-22, 5.4-23, and 5.4-24 show the results of the survey about security issues, which was carried out within the area of influence of the project. According to the survey, 50.4% of participants felt insecure in the communities where they live. In San Vicente de Cañete, 61.3% of participants had been victims of robbery, while in Quebrada de Topará, 59.4% of participants had been victims as well.

The main security problems mentioned by the people interviewed are robberies (71.5%), assaults (16.7%) and drug use (15.4%). Robbery was the most prevalent security problem among all areas studied. Robbery occurred the most among inhabitants from Quebrada de Topará (87.5%), as well as in San Vicente de Cañete Pueblo (81.0%).

In addition, 54.4% of those interviewed consider their community unsafe, 1.9% consider it to be totally unsafe, and 41.3% feel safe in their communities.

Even though participants perceive security problems within their communities, 69.2% belieive that they are not properly organized to protect themselves from local violence.

Chart 5.4-21 Security concerns within the community

Have you been victim of robbery or assault in your community?					
	Total (%)	**San Vicente Pueblo (%)**	**Outskirts of San Vicente (%)**	**Grocio Prado Pueblo (%)**	**Quebrada Topará (%)**
YES	50,4	61,3	33,8	48,3	59,4
NO	49,4	38,7	66,2	51,7	40,6

Source: Socio-economic survey – Social Baseline GNL-2.
Prepared by: Social and Environmental Management Team, Walsh Perú, April - 2005.

Chart 5.4-22 Main security problems within the community

Main Security Problems	**Total (%)**	**Zones**			
		San Vicente Pueblo (%)	**Outskirts of San Vicente**	**Grocio Prado Pueblo**	**Quebradas Topará**
Robberies	71,5	81,0	55,8	68,8	87,5
Assaults	16,7	29,2	9,1	11,1	21,9
Drug Consume	15,4	43,1	6,5	4,3	0,0
Gangs	5,4	8,8	6,5	3,8	0,0
Alcoholism	1,5	0,7	1,3	2,1	0,0
Land traffic	0,8	0,0	5,2	0,0	0,0
Bad people	0,4	0,0	0,0	0,9	0,0
Car Accidents	0,2	0,7	0,0	0,0	0,0
Fights	0,2	0,0	0,0	0,4	0,0
None	18,8	5,1	31,2	23,5	12,5
Do not know	1,0	0,0	2,6	1,3	0,0

Source: Socio-economic survey – Social Baseline GNL-2.
Prepared by: Social and Environmental Management Team, Walsh Perú, April - 2005.

Chart 5.4-23 Security Perception within the community

Perception about Security	Total (%)	Zones			
		San Vicente Pueblo	Outskirts of San Vicente	Grocio Prado Pueblo	Quebradas Topará
Very safe	0,8	0,7	1,3	0,9	0,0
Safe	41,3	27,0	62,3	43,6	34,4
Unsafe	54,4	67,9	36,4	50,9	65,6
Totally Unsafe	1,9	0,7	0,0	3,4	0,0
Neither safe nor unsafe	1,7	3,6	0,0	1,3	0,0

Source: Socio-economic survey – Social Baseline GNL-2.
Prepared by: Social and Environmental Management Team, Walsh Perú, April - 2005.

Chart 5.4-24 Are there neighbor meetings or other mechanisms to protect inhabitants from local violence?

	Total (%)	Zones			
		San Vicente Pueblo (%)	Outskirts of San Vicente (%)	Grocio Prado Pueblo (%)	Quebradas Topará (%)
YES	29,6	25,5	41,6	25,6	46,9
NO	69,2	73,7	58,4	72,2	53,1
NO ANSWER	1,3	0,7	0,0	2,1	0,0

Source: Socio-economic survey – Social Baseline GNL-2.
Prepared by: Social and Environmental Management Team, Walsh Perú, April - 2005.

5.4.3.4. BASIC SERVICES IN THE AREAS OF INFLUENCE

5.4.3.4.1. CHARACTERISTICS OF THE HOUSING UNITS

Currently, the 1993 census is the most trusted source of information regarding the districts. According to this source, the district of San Vicente de Cañete had twice as many housing units as did the district of Grocio Prado in 1993.

Table 5.4-25 Number of private housing units per the district

District	Total	Occupied	Unoccupied
San Vicente de Cañete	7 278	6 897	381
Grocio Prado	3 474	3 47	127
Total	**10 752**	**10 244**	**508**

Source: IX National Population Census and IV Housing Census, 1993

According to the 480 households surveyed, adobe is the most commonly used material for the construction of walls in the housing units (50.2%). This material is most widely used in the town of Grocio.(72,6%).

In the city of San Vicente de Cañete, brick is most widely used building material (68.6%). In Topará, only l3.1% of housing units have brick walls. They mainly use mud bricks and straw matting (34% in both cases) for construction.

According to intereviews with authorities and local leaders, the inhabitants of these areas expect the price of building materials to decrease with the execution of the project. They state that this price drop would be greatly beneficial for them and may increase the quality of their housing units.

Table 5.4-26 Most commonly used materials for wall construction in existing housing units

	Total	Areas			
		San Vicente City	Outskirts of San Vicente	Grocio Town	Quebrada Topará
Adobe	50,2	30,7	23,4	72,6	34,4
Brick	27,5	68,6	7,8	13,2	3,1
Straw Matting	20	0	67,5	14,1	34,4
Quincha (cane and clay)	2,1	0,7	0	0	28,1
Wood	0,2	0	1,3	0	0
	480	137	77	234	32

Source: Socioeconomic Survey – April 2005.
Prepared by: Socio Environmental Management Team, Walsh Perú, April - 2005.

5.4.3.4.2. WATER AND DRAINAGE SERVICES

According to the survey, 55.6% of the population has a drinking water supply inside their house, and 0.2% use river water.

The inhabitants of the outskirts of San Vicente, as well as the inhabitants of Topara, lack these basic services. Their water supply comes from tankers (98.7%) or from wells (62.5%).

In-depth interviews and qualitative studies show that the inhabitants of Grocio Prado believe their drinking water to have high salinity and to be the cause of health problems.

Table 5.4-27 Types of domestic water supply

	Total	Areas			
		San Vicente Town	Outskirts of San Vicente	Grocio Town	Quebrada Topará
Drinking water at home	55,6	94,2	0	59	0
Tanker	27,5	0,7	98,7	20,9	18,8
Public sink or fountain	6,7	4,4	0	11,1	0
Well	4,8	0	0	1,3	62,5
Purchase from neighbor	2,5	0,7	0	4,7	0
Ns/nc	1,3	0	1,3	2,1	0
Irrigation channel	1	0	0	0,4	12,5
Ditch	0,4	0	0	0,4	3,1
River	0,2	0	0	0	3,1
Total	480	137	77	234	32

Source: Socioeconomic Survey – April 2005.
Prepared by: Socio Environmental Management Team, Walsh Perú, April - 2005.

Table 5.4-28 shows that 49.6% of the people interviewed have a toilet inside their house, and 34.8% uses septic wells. The district of San Vicente de Cañete has access to most of these services (87.6%), although houses from the outskirts of San Vicente de Cañete and Topara do not.

Table 5.4-20 Toilet facilities used by households

	Total	Areas			
		San Vicente Town	Outskirts of San Vicente	Grocio Town	Quebrada Topará
Bathroom inside the house	49,6	87,6	0	50,4	0
Septic well	34,8	10,9	70,1	33,3	62,5
Latrine	12,9	0	29,9	12,8	28,1
Field	1	0	0	0,9	9,4
Public network outside the housing unit	0,8	1,5	0	0,9	0
River, irrigation channel or canal	0,4	0	0	0,9	0
Ns/nc	0,4	0	0	0,9	0
Total	480	137	77	234	32

Source: Socioeconomic Survey – April 2005.
Prepared by: Socio Environmental Management Team, Walsh Perú, April 2005.

5.4.3.4.3. PUBLIC CLEANING SYSTEM

According to the survey, 57.7% of the total population uses a garbage truck for litter disposal,, 37.7% burn it, and 0.4% dump it into the irrigation channel.

In the rural areas of San Vicente de Cañete, 81.8% of the population burns their garbage because there is no public waste removal service available. In Topará, 100% of the people interviewed burn their waste for the same reason.

Table 5.4-29 Domestic waste disposals

	Total	Areas			
		San Vicente Town	Outskirts of San Vicente	Grocio Town	Quebrada Topará
Garbage collection by regular truck service	57,5	88,3	0	66,2	0
Garbage burning	37,7	11,7	81,8	29,9	100
Garbage burying	2.,9	0	18,2	0	0
Garbage dumping on the field or landfill	1,5	0	0	3	0
Garbage dumping into the irrigation channel	0.4	0	0	0,9	0
Total	480	137	77	234	32

Source: Socioeconomic Survey – April 2005.
Prepared by: Socio Environmental Management Team, Walsh Perú, April 2005.

5.4.3.4.4. ELECTRIC POWER SUPPLY

The Peruvian electric network (Red Electrica del Peru) provides electricity in the area of influence through a power line. The power line to the south of Cañete has a 60,000 volt capacity. The Independencia transformation sub-station, located in the province of Pisco, provides power to the districts of San Vicente de Cañete, Imperial, Nuevo Imperial, Cerro Azul, San Luis, Quilmaná, Lunahuaná, Pacarán, and Zúñiga.

The power line to the north of Cañete also has a 60,000 volt capacity. This power line provides power to the districts of Mala, San Antonio, Asia, Calango, Coayllo, and Omas.

The San Vicente de Cañete power station has a 60-10 KV capacity and it transforms high voltage into medium voltage. It has a capacity of 17.2 MW and an effective power of 13.8 MW[11]. The Cañete Zonal Office that reports directly to EDECAÑETE mangaes these electrical power lines.

Through surveys, it was determined that 67.5% of the population in the area of influence of the GNL-2 Quarry project have electric power at home and that 22.9% still use candles (75.3% on the outskirts of San Vicente de Cañete and 75% among the population at Quebrada de Topará.. (Table 5.4.-30).

11 Cañeta Municipality Strategic Plan, 1998

Table 5.4-30 Domestic lighting

	Total	Areas			
		San Vicente Town	Outskirts of San Vicente	Grocio Town	Quebrada Topará
Domestic electric lighting	67,5	96,4	0	82,1	0
Candle	22,9	2,9	75,3	10,3	75
Kerosene lamp	5,4	0,7	16,9	2,6	18,8
Car battery	1,9	0	6,5	1,3	3,1
Electric generator	1,5	0	1,3	2,1	3,1
Purchase from neighbors	0,8	0	0	1,7	0
Total	480	137	77	234	32

Source: Socioeconomic Survey – April 2005.
Prepared by: Socio Environmental Management Team, Walsh Perú, April 2005.

5.4.3.4.5. CHARACTERISTICS OF THE ROAD AND TRANSPORTATION SYSTEM

The North-South axis of the Southern Pan American Highway is the main transpotation route in the province of Cañete. This highway serves all kinds of vehicles, from heavy trucks to light cars.

The northern route stretches from Lurín to Pampa Melchorita. It runs from km 25 to km 169 of the Southern Pan American Highway. Along this stretch, the highway is three lanes from the beginning until km 35. After that, it merges into two lanes until km 131.5, and it then narrrows down to one lane until km 169.

The highway has 12 overpasses; four being for vehicles and eight for pedestrians. The height of the overpasses ranges from 4.20 m to 4.70 m. The bridges found along this stretch have a load carrying capacity between 30 and 36 tons.

From km 131.5 to km 154, the road is one lane in each direction, and runs through a semi-urban area (the area from Cañete to Pampa Clarita). Between km 154 and km 171, the road runs through an area that is state-owned and is invaded by unauthorized settlers. In this area, plots for housing have been defined, but very few houses have been constructed. Because of the lack of housing, there are few pedestrians in the area, although some may be found crossing the road early in the morning and between 5 and 6pm in the afternoon. This area is also known for its foggy weather conditions.

According to the survey, in the district of San Vicente de Cañete, "combis" and "coasters" (69.1%) and the so-called mototaxis (auto rickshaws) (20.7%) are the most commonly used forms of transportation. In the district of Grocio Prado, the population interviewed indicated that they mostly use 'Tico' (a small car) taxis for transportation (50.6%), shared taxis (25.9%), and mototaxis (11.5%) (Table 5.4-23).

Table 5.4-23 Urban means of transportation by district

Type of Transportation	San Vicente de Cañete	Grocio Prado
Combis (Coasters)	69,1	7,2
Taxis (Tico)	13,3	50,6
Colectivos	8,0	25,9
Mototaxis	20,7	3,6

Source: Socioeconomic Survey – GNL Baseline April 2005.
Prepared by Socio Environmental Management Team, Walsh Perú, April 2005.

The use of mototaxis is gradually increasing and is becoming an important source of employment for the population.

5.4.3.4.6. MEANS OF COMMUNICATION

The province of Cañete has local radio stations, such as Radio Imperial and Radio Cañete. There are also local papers. There is a newspaper called "La Voz de Cañete" and a journal called "Matices" that has been in circulation since 1993. These are distributed together with national newspapers.

According to the survey, within the area of influence the most popular radio station is Radio Programas del Perú (47.2%); the most popular television broadcast organization is ATV (53.7%); and the preferred newspaper is El Popular. (Table 5.4-32).

Table 5.4-32 Principal means of communication

Means	Name	San Vicente de Cañete (%)	Outskirts of San Vicente (%)	Grocio Prado (%)	Quebrada de Topará (%)	Total
Radio	RPP	44,9	91,8	33,7	54,8	47,2
	Panamericana	21,3	4,9	13,8	0	13,7
	Radio Mar	14,2	1,6	17,3	12,9	13,7
Television	ATV	22,5	57,1	75,4	16,7	53,7
	Panamericana	26,4	57,1	63,6	16,7	48,4
	América T.V.	43,4	28,6	12,8	16,7	24,9
Newspapers	El Popular	20,4	6,5	30.,8	18,8	23,1
	Correo	13,9	14,3	7,7	12,5	10,8
	El Comercio	19,7	13	6,8	0	11,0

Source: Socio Environmental Management Team, Walsh Perú , April 2005.
Prepared by: Socio Environmental Management Team, Walsh Perú, April 2005.

5.4.3.5. ECONOMIC SITUATION OF THE POPULATION IN THE AREA OF INFLUENCE

5.4.3.5.1. LEVELS OF OCCUPATION OF THE ECONOMICALLY ACTIVE POPULATION (EAP)

Based on information from the 1993 National Population and Housing Census (Table 5.4-33),, the economically active population (EAP) makes up 32.4% of the total population in the districts of the project area of influence. In the district of San Vicente de Cañete, the EAP is 31.9% and in the district of Grocio Prado, is it 32.8%.

Table 5.4-25 Total EAP per District

District	Total	PEA
San Vicente de Cañete	12 983	31,9
Grocio Prado	8 818	32,8
Total	**21 801**	**32,4**

Source: IX National Population Census and IV Housing Census, 1993
Prepared by: Socio Environmental Management Team, Walsh Perú, April 2005

According to the survey regarding family income level given to 480 families within the area of influence, 20.2% of the population has a weekly income of S/. 100 or less. 51.9% of the people living in the outskirts of San Vicente and 40.6% in Quebrada de Topará, belong to this group.

40.4% of the homes surveyed have a weekly income between S/. 101 and S/. 200. And while some residents may have incomes as high as S/. 800, this amount is said to be insufficient to cover the basic needs of an average family.

Table 5.4-34 Weekly family income (In Nuevos Soles)

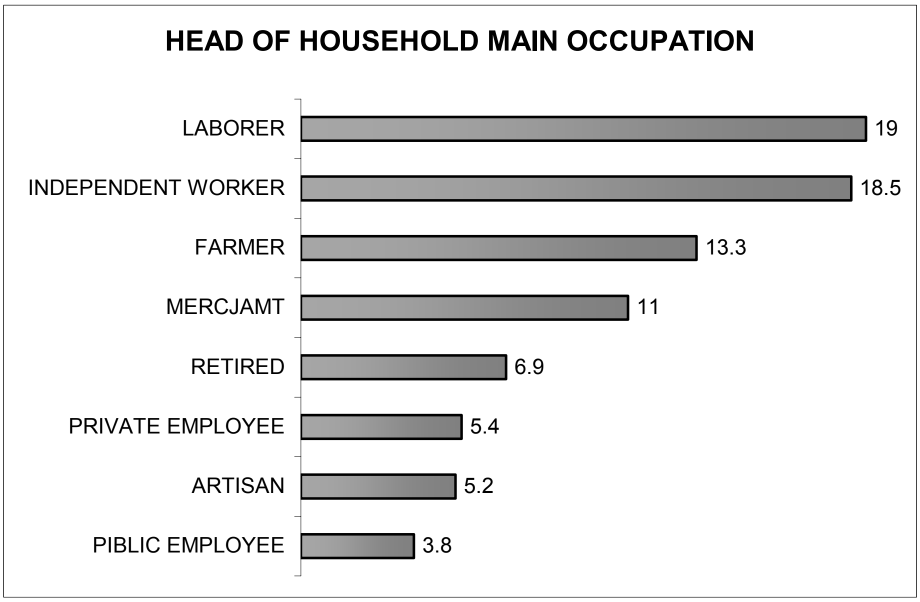
	Total	Areas			
		San Vicente Town	Outskirts of San Vicente	Grocio Town	Quebrada Topará
Up to 100 soles	20,2	6,6	51,9	15	40,6
101-200 soles	40,4	36,5	29,9	47,4	31,3
201-300 soles	18,5	20,4	5,2	22,2	15,6
301-400 soles	9,8	13,1	5,2	9	12,5
401-500 soles	5	11,7	2,6	2,6	0
501-700 soles	4	5,8	3,9	3,4	0
More than 700 soles	1,9	5,1	1,3	0,4	0
No answer	0,2	0,7	0	0	0
Total	480	137	77	234	32

Source: Socio Environmental Management Team, Walsh Perú , April 2005.
Prepared by: Socio Environmental Management Team, Walsh Perú, April 2005.

5.4.3.5.2 ECONOMIC ACTIVITY

According to the survey regarding occupation, the majority of the heads of households are laborers (19%), 18.5% are independent workers, and 13.3% are farmers.

Graph 5.4-3 Economic Activities



Source: Socioeconomic Survey – GNL Baseline April 2005.
Prepared by Socio Environmental Management Team, Walsh Perú, April 2005.

5.4.3.6 PRODUCTION SYSTEM IN THE AREAS OF INFLUENCE

5.4.3.6.1 Agricultural Activity

Table 5.4-35 indicates that there are 3,315 agricultural producers in the areas of influence of the project. The district of San Vicente de Cañete supports the largest cultivated area with 23,405.59 cultivated hectares that make up 47.7% agricultural units. Grocio Prado has the second highest amount of cultivated area with 5,426.51 cultivated hectares, which make up 52.3% agricultural units. Because of this information, it can be inferred that cultivated areas in Grocio Prado are more parceled.

Table 5.4-35 Agricultural producers, per district

District	Agricultural Producers	Cultivated Area (ha)	Agricultural Unit
San Vicente de Cañete	1,589	23,405.59	1,562
Grocio Prado	1,726	5,426.51	1,713
Total	3,315	28,832.1	3,275

Source: INEI: Censo Nacional Agropecuario, 1994.

According to the poll results, 51.8% of farmers own the lands they cultivate while 33.7% are employed. (See Table 5.4-36).

Table 5.4-36 Land Ownership

Land Ownership	Total (%)	Zones			
		San Vicente Pueblo (%)	Outskirts of San Vicente (%)	Grocio Prado Pueblo (%)	Quebrada de Topara (%)
Own	51.8	37.5	68.8	54.1	40.9
Is an employee	33.7	37.5	12.5	40.5	36.4
Rented	6	25	0	2.7	9.1
Possession	3.6	0	18.8	0	0
Shared	2.4	0	0	2.7	4.5
Ns/nc	2.4	0	0	0	9.1
Total	83	8	16	7	22

Source: Encuesta Socio Económica - GNL-2 Base Line.
Prepared by: Socio-Environmental Management Team. Walsh Perú. April, 2005.

The main cultivated crops in the Grocio Prado district are grapes, corn, asparagus, cotton, avocado, citrus, and lima beans. In the district of San Vicente de Cañete, the main cultivated crops are sweet potatoes, yellow corn, grapes and lima beans.

The main markets for the exportation of Grocio Prado crops are in the cities of Lima and Chincha. Lima and Cañete itself also house the main markets for the exportation of San Vicente de Cañete crops (TEP-April, 2005).

5.4.3.6.2 Livestock Breeding Activity

Livestock breeding in the province of Cañete is an activity that complements farming. Livestock breeding has a high potential for success in the area due to the farming resources (e.g. fodder), water, climate, and proximity to the city. Many small farm owners possess goats, sheep, pigs and cattle, and small farm animals. The genetic quality of the cattle is poor and, in some cases, the cattle are crossbred with better breeds. This makes industrialization impossible.[12]

Cattle (34.7%) and goats (14.3%) are among the main animals reared by farmers in the area. (Table 5.4-37). Some farmers (18.4%) also use their livestock to produce cheese and milk.

Table 5.4-37 What kind of animals do you rear?

Animal reared	Total (%)	Zones			
		San Vicente Pueblo (%)	Outskirts of San Vicente (%)	Grocio Prado Pueblo (%)	Quebrada de Topara (%)
Poultry	44.9	0	85.7	68.2	5.6
Cattle	34.7	100	0	22.7	55.6
Goats	14.3	0	0	4.5	33.3
Pigs	4.1	0	14.3	0	5.6
No answer	2	0	0	4.5	0
Total	49	2	7	22	18

Source: Encuesta Socio Económica - GNL-2 Base Line.
Prepared by: Socio-Environmental Management Team. Walsh Perú. April, 2005.

5.4.3.6.3 Fishing Activity

In the province of Chincha, fishing takes place mostly between January and March because of the greater demand during that time. The main fishing products are *Raya, Cachema, Pámpano, Mis Mi,s and Tiburón Zorro*.

The main fishing port is Tambo de Mora. This is where the Association for Artisan Fishing of Tambo de Mora is established, with 135 fishermen. There are 44 vessels at this port which unload an average of 20 TM[13] of fish per month. The fish caught from this area are exported to the Mercado Mayorista de Lima.

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[12] Ministry of Agriculture: Annual Report 2002

In the province of Cañete, the main fishing products are *chita, lenguado, tramboyo pequeño, tramboyo grande, liza (big and small), pejerrey, corvina, zorro, toyo, raya, atún, bonito, perico, lorna, cabrilla, borracho, and conchita*. Most fishing activity takes place in Cerro Azul, Herbay Bajo, and Santa Bárbara.

In Herbay Bajo (Cañete), high season occurs between April and October. December through May is high season for Santa Bárbara. And in Cerro Azul, the high season is between January and March. This area is famous for its freshwater crawfish.

There are 165 unionized fishermen in the Cerro Azul Artisan Fishermen Union (Sindicato de Pescadores Artesanales de Cerro Azul - SUPACA). They posses 58 vesels and produce a monthly average of 25 TM[13] fish.

5.4.3.7 INVOLVED PARTIES

Within the area of influence there are families as well as community, social, and political organizations. The following have been identified as involved parties[14]: municipalities, fishermen associations, farmers' associations in the Valley of Cañete, human settlements of San Vicente de Cañete, human settlements of Topara Stream, social community organizations, NGO's, religious organizations, and regional governments.

Below is a description of each of these parties:

5.4.3.7.1 Local Governments

Province of Chincha

The local government of the province of Chincha is represented by the municipality of Chincha. Each district within the province is represented by its corresponding district municipality. There is also a Mayors' Assembly in which the mayors from each of the 11 districts of the province take part.

According to the Ministry of Economy and Finance (MEF), the Provincial Municipality of Chincha, had a budget of S/.94'737,728 for 2005. Until March, the amount of S/.18'085,109[16] had been delivered.

Between January and April, the local government of the district of Grocio Prado had produced S/.265, 774. This was due to the mining canon concept (3.4%), fishing license fees (4.0%), mining royalties (4.8%), and distrital FONCOMUN[15] (87.9%)[16].

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[13] FONDEPES, 2005.

[14] Ministry of Energy and Mines (MEM): Guía de Relaciones Comunitarias, Lima Perú 1998.

[15] FONCOMUN (Fondo de Compensación Municipal) is a fund established in the Political Constitution of Peru with the aim of promoting investment in the various municipalities throughout the country with a redistribution criteria in favour of the poorest and far-away zones and giving budget priority to marginal rural and urban localities in the country. Ministry of Economy and Finance. Transparencia Económica, 2005.

Province of Cañete

The local government for this province is represented by the Municipality of Cañete. Each district is represented by its respective district municipality.

According to the Ministry of Economy and Finance (MEM), the initial budget for 2005 earmarked for the province of Cañete is S/.129'629,987. Until 31 March 2005, S/. 23'297,442[16] had been delivered.

Public revenues in the District Municipality of San Vicente de Cañete amounted to S/.1'246,796 between January and April. They came from the following financial sources: mining canon (2.2%), hydroenergy canon (12.9%), fishing licence fees (4.8%), mining royalties (0.9%), provincial FONCOMUN (42.7%,) and sistrital FONCOMUN (36.6%)[16].

According to information provided by the Provincial Municipality of Cañete, FONCOMUN produced S/. 2'736,482 in 2004. Its own revenues for the year 2004 amounted to S/.5'826,400. Total revenues for the Municipality were S/.9'501,825.

5.4.3.7.2 Farmers' Association in the Valley of Cañete

The Farmer's Association brings together private owners and former cooperative land parcel owners. The association owns an experimental station, bearing the same name, which develops farming research projects and extension activities in the area.

The association is active in the areas sanitation, biological control, genetic improvement/ production, and trade of cotton seeds. The experimental station has an area of 100 hectares and uses most of its land for the production of cotton seeds.

The association has 50 members, each contributing US$8 Dollars a year. In exchange, they receive technical assistance and special discounts on the purchase of plague-controlling insects.

5.4.3.7.3 Community organizations

COMEDORES POPULARES AND VASO DE LECHE COMMITTEES

Province of Chincha

There are 95 Vaso de Leche committees in the District of Chincha Alta. They serve 12,000 beneficiaries from all over the district. , There are also 51 Vaso de Leche committees in Pueblo Nuevo, 44 in Sunampe, and 15 in Tambo de Mora[17].

There are 32 Vaso de Leche committees in the district of Grocio Prado with approximately 4,412 beneficiaries. It also has 8 comedores populares (people's diners) and one comedor infantil[18] (children's diner).

[16] Source: Consejo Nacional de Descentralización-CND January-April, 2005.
[17] Source Chapter 3 EIA GNL Export Projecto. July, 2003
[18] Source Municipalidad Distrital de Grocio Prado, abril 2005

In the district of Pueblo Nuevo, there are 23.3 people's diners in Sunampe, 5 in Grocio Prado (direct area of influence of the project), and 6 in Tambo de Mora[19].

Province of Cañete

At the provincial level, there are 80 people's diners serving over 4,430 beneficiaries. They mostly attend the district of San Vicente de Cañete (direct area of influence of the project) with 1,200 beneficiaries. The district of Pacaran does not have any people's diners. There are also children's diners in the districts of San Vicente de Cañete, Imperial, Nuevo Imperial, and Mala, benefiting, altogether, over 300 boys and girls.

There are more than 79 Vaso de Leche committees in the province of Cañete with beneficiaries ranging from 3,800 and 4,000, depending on the Municipality. 70 Vaso de Leche committees belong to San Vicente de Cañete[20].

5.4.3.7.4 Junta de Usuarios de Riego

The Junta de Usuarios de Riego (Irrigation Water Users Board) is an organization joining users of hydrolic resources from the valley. The Board is composed of an Irrigators' Commission, whose role is to distribute hydrolic resources efficiently, after approval from the Technical Administration of the Irrigation District (ATDR).

In the Chincha-Pisco ATDR, there are 14 Irrigators' Commissions (Comisiones de Regantes) in the Valley of Chincha and 20 in Pisco[21]. They are estimated to have 5,942 users and an area of influence of 24,865 ha[22].

The ATDR Mala - Omas - Cañete has 34 irrigation blocks. These are groups within an Irrigators' Commission that were formed as a result of the formalization project for water use rights in 2004[23].

There are 7 committees of Irrigation Channels in the Province of Cañete: Nuevo Imperial Channel, Viejo Imperial Channel, María Angola Channel, San Miguel Channel, Huanca Channel, Pachacamilla Channel, and Palo Herbay Channel. Altogether, their area of influence is made up of to 23,865 m^2[24].

5.4.3.7.5 Non-Governmental Organizations (NGO´s)

There are several NGO's in the Province of Cañete that work mainly in agriculture:

- Centro de Formación Profesional para la Mujer - Condoray[25] (Women's Center for Professional Training). This organization's works to qualify women in technical careers, integral literacy, and labour training.

[19] Source capítulo 3 del EIA Proyecto de Exportación de GNL, julio 2003
[20] Information provided by the Project Management of Vaso de Leche, Social Developmment and Community Participation Area at the Municipalidad Provincial de Cañete
[21] Source ATDR Office, Chincha-Pisco, April 2005
[22] Ministry of Agriculture, 2000
[23] Source ATDR Technical Management, Malas – Omas – Cañete, April, 2005
[24] Idem
[25] Condoray, located at Avenida Condoray N° 140

- Instituto Rural Valle Grande[26] (Valle Grande Rural Institute). This NGO promotes and integrates the training of farmers in Cañete and Yauyos through training programs, technical assistance, and financial credit for the agrarian sector.

- IPID[27]. This organization is dedicated mainly to coating irrigation channels.

- Instituto Huayanay[28] (Huayanay Institute). This organization provides technical assistance and soil tests for farmers.

There are also NGO's in the Province of Chincha.. Among them, the following can be mentioned:

- Asociación de Promoción Agraria – ASPA (Agriculture Promotion Association). This organization's acts in the Valley of Chincha and its activities are oriented towards research and technical assistance for farmers.

- Centro de Investigación del Sur Medio - CIDE SUR (Mid South Research Centre). The main activities of this organization focus on the organic management of vineyards, cutting out, and biological control.

- Centro de Capacitación Técnica – CEDECH (Centre for Technical Training). This organization's area of influence comprises the entire Valley of Chincha. They offer consulting services, advising, land expertise and advice on legal issues.

- Centro de Investigación y Desarrollo de Poblaciones Rurales del Perú – CIDEPORF (Centre for Research and Development of the Rural Population in Peru). This organization's activities are oriented towards studying rural settlements in the country, specially "African culture"

5.4.3.7.6 Religious Organizations

Catholicism is the predominant religion in the provinces of Cañete and Chincha. Other religions in the area include Evangelists, Mormons, Jehovas Witnesses, and Israelies of the New Universal Pact. The followers of these churches usually come from the highlands.

There are 4 catholic chapels and one church in the district of Grocio Prado, province of Chincha.

There are 12 parishes and three chaplaincies in the province of Cañete. Also in this province are the Hermanas Carmelitas Descalzas del Convento de San José, an enclosed monastery. Hermanas de Santa Ana and Madres Misioneras de Jesús Verbo y Víctima are located there as well. They carry out pastoral and educational activities for the poor living in the area.

[26] Valle Grande, located at km 44 Panamericana Sur Highway
[27] IPID, located in Mala, km 86 Panamericana Sur Highway
[28] Instituto Huayanay, located in Mala

5.4.3.7.7 Human Settlements

People have inhabited some of the land between kilometers 164 to 175 of the Panamericana Sur Highway. They have put up their huts on lands which belong to the Ministry of Agriculture of Peru[29]. At this time, PROINVERSIÓN[30] is in charge of promoting investment on these lands, which have been taken in some areas.

Some of the first to inhabit these lands were from Ayacucho. Since it was made known that the Instituto Nacional de Desarrollo – INADE (National Institute for Development) had done studies for the Irrigation Project Concón-Topara (which incorporated thousands of hectares of dry lands into the irrigation system), inhabitants organized themselves and registered in the city of Ayacucho[31].

One of the first human settlements that settled on these lands in early 2002 is “Nuevo Ayacucho.” They are located at km 176.5 of Panamericana Sur Highway. This human settlement has been made known as **Centro Poblado Menor “Nuevo Ayacucho”**, under Resolution from the Municipality of Cañete[32].

UGEL No. 8 of Cañete built and operates a public educational center which offers education at the initial, primary and secondary levels to approximately 200 school aged boys and girls.

According to information provided by community leaders, at this time, 400 families live in Nuevo Ayacucho. They do not have basic commodities such as electricity, potable water, or sewerage. Their water comes from an underground well, which is transported in a tanker. This was confirmed during the interviews.

Most of the houses are made of simple building materials like wood, plastics and “*esteras*” (straw mats). But some houses are being built out of adobe blocks and/or brick, which leads to the assumption that people are planning to build a long-term establishment here.

Other emerging human settlements besides Nuevo Ayacucho have been identified between km 164 and 179 off the Panamericana Sur Highway. An important characteristic for these settlements is that they have guards, who are paid by the people who reside there only on weekends. These settlements are mostly located on the left hand side of the Panamericana Sur Highway, except for one that is located on the right hand side near the shoreline.

The map showing these human settlements can be seen in Volume 3 M5-11 and their status can be viewed in Annex 5.6. This information can be confirmed with an IKONOS image of the area from March 2003 (Volume 3 M5-12). This map shows that there was not a single settlement at that time.

[29] In accordance with oficio No. 749-2005-PP/AG, by means of Supreme Resolution No. 001-99-AG, the definite maps and descriptive memoire were approved: 23 680,5 ha of arids lands are located in the District of San Vicente, Provincia of Cañete, Department of Lima, being set apart in favour of the Ministry of Agriculture 22 499,93 ha on certificate No. 21002758 at the Registrar Office in Lima – Callao. Cañete Branch.

[30] Known before as Comisión de Promoción de la Inversión Privada – COPRI, created by Legislative Decree Nº674 – Ley de Promoción de la Inversión Privada en las Empresas del Estado, an entity in charge of designing and conducting the process of private investment promotion in Peru.

[31] According to remarks collected in Semi-structured Interviews with local people.

[32] Ordinance N° 02-2004-MPC of 06 January, 2004.

These new human settlements are:

- Asociación de Productores Agroindustriales El Trébol del Pacífico, located at 164.5th km right hand side off the Panamericana Sur Highway.

- Asociación Agrícola Las Brisas de Concón (formerly known as José María Escribá), located at 164.5th km on the left hand side off the Panamericana Sur Highway.

- Asociación de Vivienda de Trabajadores Eventuales de Cañete (CETEC), known as Nuevo Cañete, located at 170th km on the left hand side off the Panamericana Sur Highway. This settlement has shown faster growth, with a third phase of invasion being divided into lots (26 x 36 square meters approximately).

- Asociación Agropecuaria Villa Apóstol Santiago, located at 170th km on the left hand side off meter 400 of the Panamericana Sur Highway.

- Asociación de Colonizadores de la Costa (ACC), located at 174th km on the left hand side off the Panamericana Sur Highway. This settlement occupies approximately 23 hectares of land belonging to the Ministry of Agriculture. The Association is facing a legal process dealing with possession charges before the Third Criminal Court of Cañete. The process ended with a final judgment from the Criminal Court Division of the Superior Court of Cañete that imposed a sentence on the offenders and ordered the restitution of the lands seized in favour of the offended party. Currently, the sentence is under appeal (Recurso de Revisión[33]). This information differs from what the Asociación advertises in its flyers. However, the leaders recognize as their own the lands currently invaded in the Nuevo Ayacucho and Nuevo Cañete settlements.

- Human Settlement Cinco Cruces.

- Asociación de Vivienda y Defensa de los Moradores del Centro Poblado Nuevo Ayacucho (called Nuevo Ayacucho), located from 175th to 177th km on the left hand side off the Panamericana Sur Highway. It has an area of 208 hectares. To this date, the case has not been sentenced by the First Criminal Court of Cañete (File: No. 0569-2002).

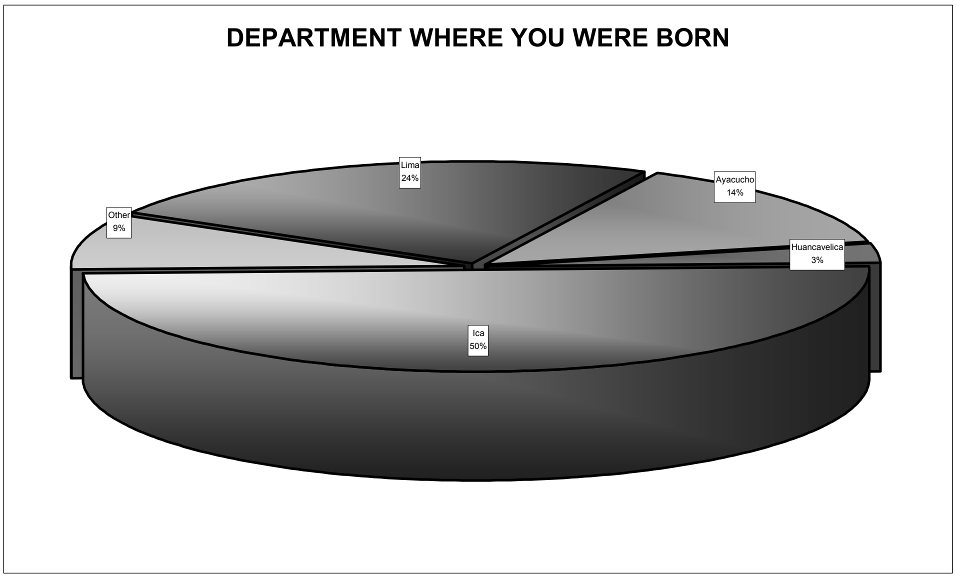
The *in-depth interviews* given to community leaders and representatives of local governments show the lack of social networks reaching other organizations both in and outside the area. There are land possession conflicts among invasion groups occurring as well. The divisions within these groups are due to political issues, such as the boundary separation between the provinces of Cañete and Chincha. This has divided the settlers of C.P.M. Nuevo Ayacucho into two distinguishable groups: Nuevo Ayacucho Cañete and Nuevo Ayacucho Chincha.

[33] See Oficio No. 749-2005-PP/AG, attached as Annex 5.6. Additional information on “Brisas de Concón”,”El Trébol del Pacífico “and “Centro Poblado Nuevo Cañete” is contained there.

5.4.3.8 RESIDENT PROFILE IN THE AREA OF INFLUENCE

Figure 5.4-4 shows that of the people interviewed, 50% were born in Ica, 24% in Lima, and 14% in Ayacucho. The latter percentage is important because migrants from that part of the country form the settlement Nuevo Ayacucho. This settlement is comprised of 71% of the inhabitants on the outskirts of San Vicente de Cañete (see Numeral 5.4.6 for more information).

Figura 5.4-4 Departament where you were born



Source: Socioeconomic Survey – GNL Baseline April 2005.
Prepared by Socio Environmental Management Team, Walsh Perú, April 2005.

In San Vicente Pueblo, 71% of the population was born in the department of Lima and 52% were born in the surrounding areas. Similar figures can be seen in Grocio Prado Pueblo with 84% of the population being born in the department of Ica and 51% being born in Grocio Prado.

With respect to time of residency, 37.3% affirm they have always lived in the locality. On average, the people who migrated have resided in the area of study for 13 years. (Figure 5.4-5)

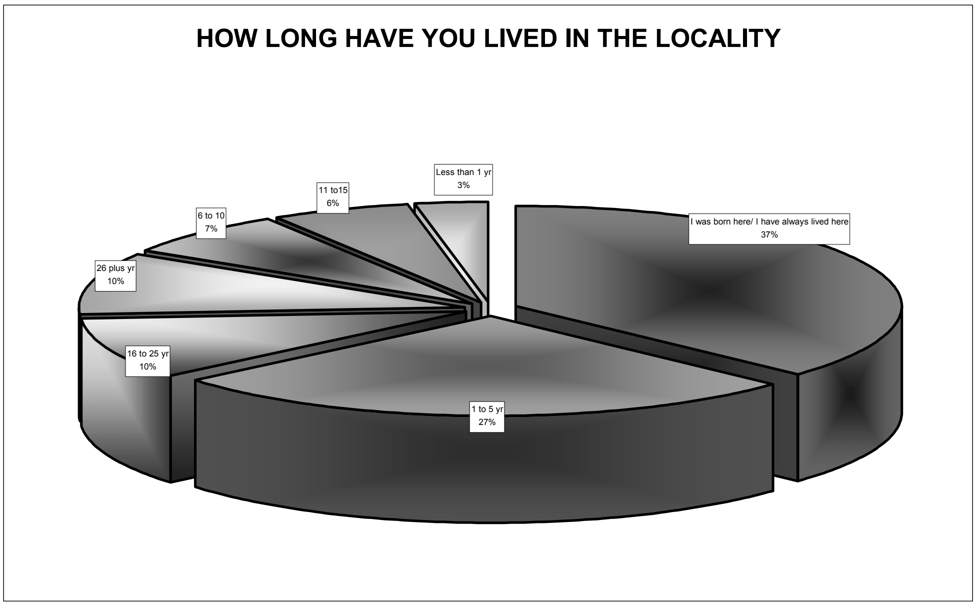
On the other hand, migrants to San Vicente de Cañete have lived there for an average of 15 years and in Grocio Prado for an average of 13 years.

Based on interviews conducted in the area, the human settlements of Nuevo Ayacucho and Asociación Colonizadora de la Costa have been in the area for an average of 4 years.

Information obtained from the focus group revealed that Asociación Colonizadora de la Costa was formed in 1992 and first acted to claim posession of the lands in 1995 (Annex 5.5).

During survey work in the area, information related to the earliest invasions was collected. The residence time for El Trébol del Pacífico dates back to December 2004 and Santiago Apóstol dates back to January 2005.

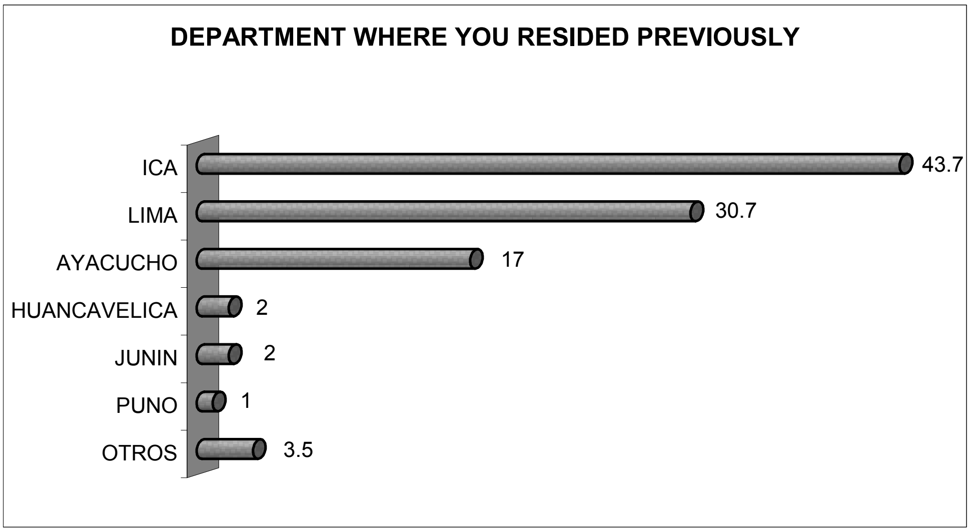
Figure 5.4-5 How long have you lived in the locality



Source: Socioeconomic Survey – GNL Baseline April 2005.
Prepared by Socio Environmental Management Team, Walsh Perú, April 2005.

Interviewed residents state that they have lived in the areas of Ica (43.7%), Lima (30.7%), and Ayacucho (16.9%) before residing in their current locality. This coincides with the figures shown for native departments (Figure 5.4-6)

Figura 5.4-6 Departament where you resided previously



Source: Socioeconomic Survey – GNL Baseline April 2005.
Prepared by Socio Environmental Management Team, Walsh Perú, April 2005.

Of those surveyed, 42.3% state not having a place of their own as the main reason for leaving their previous place of residence and 40.2% relocated in search for a job.

For the inhabitats of San Vicente de Cañete, the main reason for relocation was to avoid political violence experienced mainly in the central and southern parts of the country (29.9%). (Table 5.4-38).

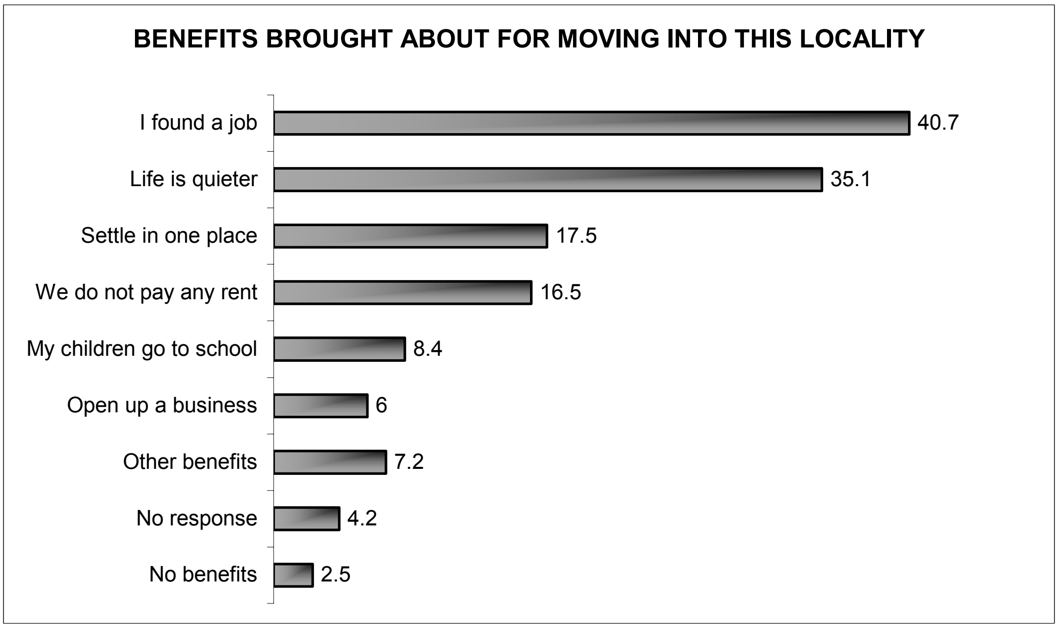
Table 5.4-38 Main reasons for leaving previous place of residence

Main reason for leaving previous place of residence	Total (%)	Zones			
		San Vicente Pueblo (%)	Outskirts of San Vicente (%)	Grocio Prado Pueblo (%)	Quebrada de Topara (%)
Did not have own house	42,3	34,2	41,6	56,4	7,4
Seek employment	40	50,6	46,8	20,5	74,1
Family living in the area	15	15,2	3,9	24,8	3,7
To avoid political violence	9	2,5	29,9	1,7	0
To Stara a new business	5	5,1	7,8	4,3	0
No money to rent a house	3,3	5,1	2,6	3,4	0
To study/ education of their children	3,3	5,1	6,5	0,9	0

Source: Socioeconomic Survey – GNL Baseline April 2005.
Prepared by Socio Environmental Management Team, Walsh Perú, April 2005.

Migrants who have moved to a new area state that the main benefits of their relocation include: getting a job (43.2%); living a more peaceful life (33.2%), and settling in one place (16.6%) (See figure 5.4-7).

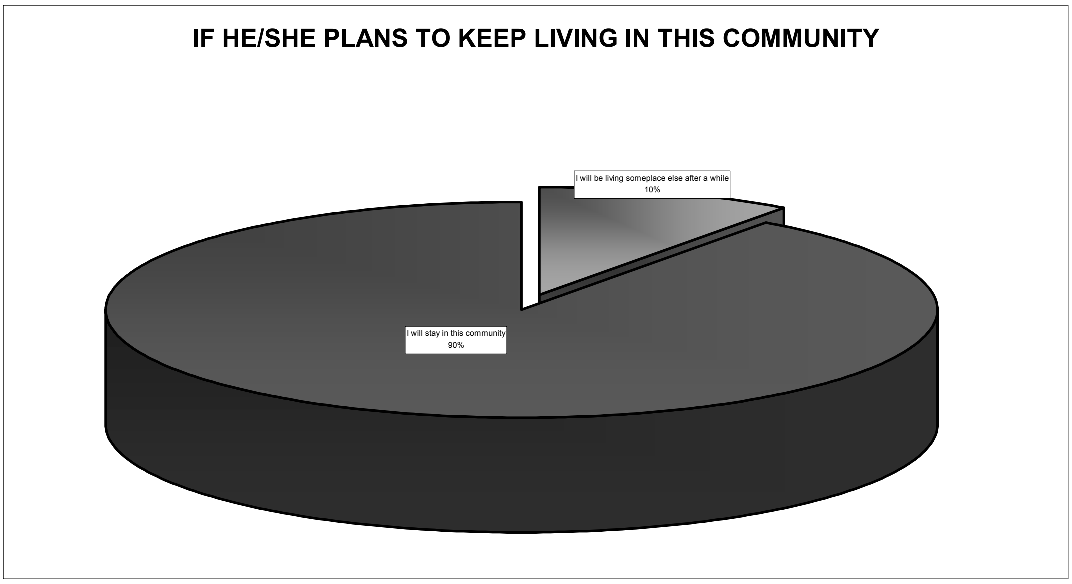
Figure 5.4-7 Benefits brought about for moving into this locality



Source: Socioeconomic Survey – GNL Baseline April 2005.
Prepared by Socio Environmental Management Team, Walsh Perú, April 2005.

According to the survey, 89.8% of those interviewed declared they will keep living in their current locality, while only 10.2% had plans move elsewhere in the future. The people most reluctant to leave their locality were the inhabitants of Grocio Prado city (92.7%) (Figure 5.4-8).

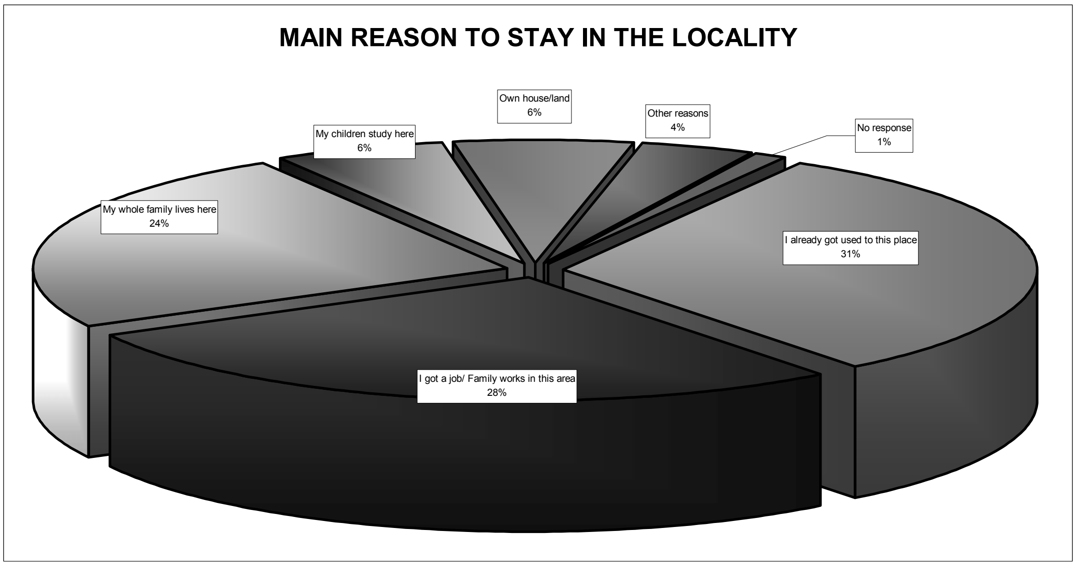
Figure 5.4-8 Decision to stay in the locality



Source: Socioeconomic Survey – GNL Baseline April 2005.
Prepared by Socio Environmental Management Team, Walsh Perú, April 2005.

The main reasons for people to continue living in their current locality are that they are acccustomed to it (30.9%), they hold a job (27.6%), and because their family resides there as well (23.9%) (Figure 5.4-9).

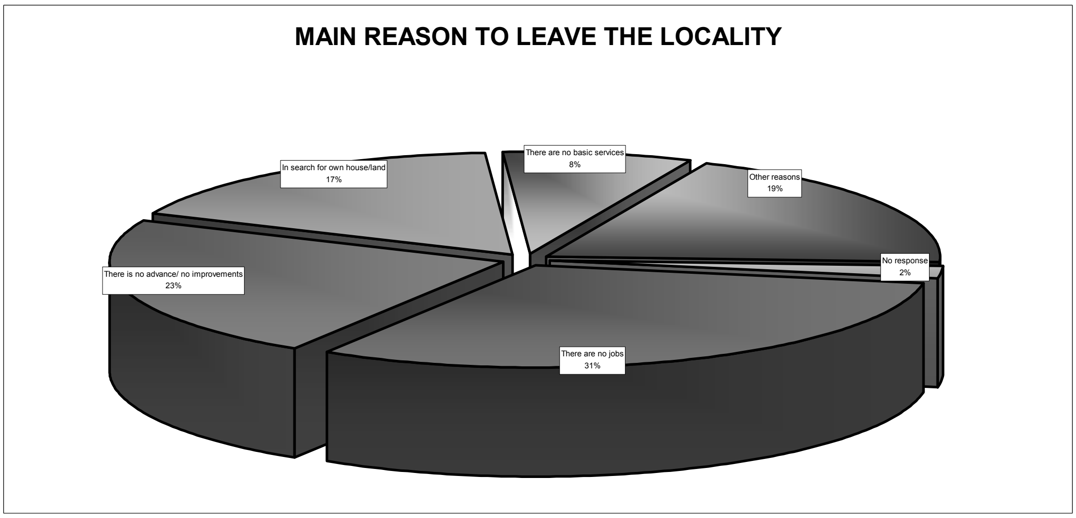
Figure 5.4-9 Main reason to stay in the locality



Source: Socioeconomic Survey – GNL Baseline April 2005.
Prepared by Socio Environmental Management Team, Walsh Perú, April 2005.

The main reasons for people to change their place of residence are unemployment (31%) or the fact that there is no perceived lifestyle improvement (23%) (Figure 5.4-10).

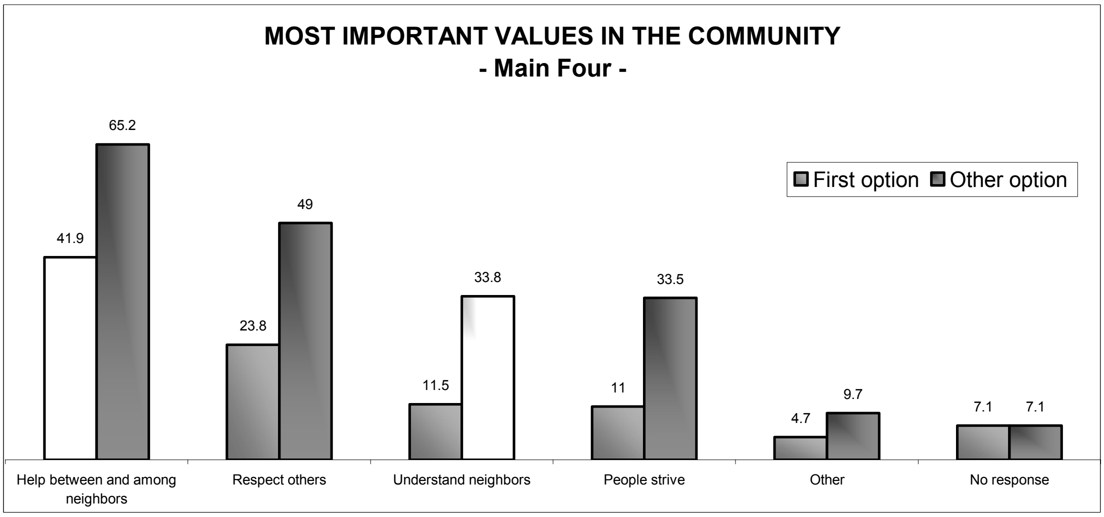
Figure 5.4-10 Main reason to leave the locality



Source: Socioeconomic Survey – GNL Baseline April 2005.
Prepared by Socio Environmental Management Team, Walsh Perú, April 2005.

Among the interviewed, help between and among neighbors was the number one practiced value (41.9%). Those who practiced this value were more often are the people of the human settlements in San Vicente de Cañete (57.1%) (Figure 5.4-11).

Figure 5.4-11 Most important values in the community



Source: Socioeconomic Survey – GNL Baseline April 2005.
Prepared by Socio Environmental Management Team, Walsh Perú, April 2005.

5.4.3.9 Cultural Aspects in the Areas of Influence

5.4.3.9.1 Province of Chincha

The province of Chincha is known in Peru as the cradle of Afro-Peruvian folklore. It is friendly and has natural as well as cultural attractions. Chincha is one of the most visited provinces in the Ica Region, especially during the summertime (February) when the "Festival del Verano Negro" (Black Summer Festival) takes place. Other traditional attractions are the Chincha Alta and Señor Crucificado Tourism Week, commemorated during the month of October.

A great number of archeological artifacts have been found in Chincha. ,It was also the home of important pre-inca cultures. It supports the largest number of archeological sites (huacas) in the Ica Region, such as Huaca Centinela, Huaca La Cumbre, and Huaca Tambo de Mora.

One of the most important districts in the province of Chincha is El Carmen. The ex-farm house San Jose is located here. The house was past property of Jesuits. San Jose is currently a hotel which attracts tourists all year long.

Grocio Prado is another tourist district in the area. It was the place where Melchora Saravia Tasayco, known as Sister Melchorita Saravia, was born and raised. She was a woman widely known for her Christian qualities and great catholic faith while she was alive. This sister (or Beata) inspires religious devotion beyond regional boundaries. In January and October, thousands of pilgrims visit the place, where she is thought to have performed numerous miracles. There are also two commemorative festivals related to wine production in the area: the Vendimia Festival, which takes place in March and the Cachina and Native Dishes Festival, in July.

5.4.3.9.2 Province of Cañete

The most important festivities in Cañete are linked to the agrarian cycle. This explains why the regional culture possesses rural features. The current migration process that this province is experiencing has generated a cultural fusion that mixes mainly afro-peruvian and Andean features. Traces of the Asian culture can also be seen in the Chinese descendants living in the area.

Another significant area festivity is the one devoted to the Señor de Cachuy. Due to the Catholic faith of the regions inhabitants, it attracts pilgrims from all over the region.

The “Semana de Cañete (Week of Cañete) is one of the most important attractions in the area. The main day is August 30th. It coincides with Spanish establishment of the area, which took place in 1556. Also held this week is the “Festival del Arte Negro” (Negro Art Festival), an occasion for people to remember their African origins.

5.4.4 PERCEPTIONS AND EXPECTATIONS OF THE MAIN SOCIAL STAKEHOLDERS

Perceptions and expectations of the project stakeholders have been analyzed through the use of qualitative and quantitative tools.

The qualitative method was applied through: *focus groups* (4) in the localities of Grocio Prado, and San Vicente de Cañete; *participative evaluation workshops* (3) in Buenavista – Topara, San Vicente de Cañete, and Grocio Prado; and *in-depth interviews* with the main leaders and local authorities within the Project’s area of influence. (See Technical Briefs).

With reference to the quantitative method, a sample was drawn and 480 *surveys* were taken among the target population.

The social investigation tools have coincided in its findings, enriching and strengthening the results obtained.

Furthermore, in order to facilitate the analysis, five variables were considered in order to allow the exploration and analyzation of each group of stakeholders’ position with respect to the project. These variables are as follows:

- **Prior Experience**
  By taking prior experience into account the knowledge and understanding of past occurrences and/or insights of the stakeholders can be considered.

- **Knowledge of the Project**
  This variable is necessary for understanding the reactions and attitudes of the stakeholders towards the project.

- **Fears**
  Through this variable, possible fears and concerns of the stakeholders,in respect of the project, can be heard.

- **Benefits**
  This variable aides in learning the opinions of the population in regards to possible benefits arising from private investment in the area.

- **Expectations**
  This variable takes into account the social conflicts that may arise if the population expects too much out of the project.

Prior Experience

The prior experience of the stakeholders, with regards to other projects carried out in the area, is related to the construction of the Transportation System by Pipelines (STD Camisea) and the Cementos Lima Project.

The municipalities of Chincha and Cañete provinces as well as the municipalities of Grocio Prado and San Vicente de Cañete districts, respectively, have focused their interest on the revenues produced by this type of project. These provinces and districts state that the project earnings that can be obtained will, in turn, be invested in services benefitting the population.

Although, due to a land dispute that has still not been resolved, the inhabitants of some human settlements have mentioned that they have had problems with the Cementos Lima factory.

Awareness of the GNL-2 Quarry Development Project

The inhabitants to Nuevo Cañete human settlement have some information on the projects that the company PERU LNG will carry out in the area. This is an interesting aspect of this human settlement in that their established social networks (inside and outside the area) allow them to be informed of the situation.

Although the municipal authority of Grocio Prado district is aware of the project (Informative Workshops, November 2004), it has denied having any detailed information about it, but stated they are open to dialogue. It is notable that a commission from the municipality is taking the respective steps to declare Grocio Prado an ecotourism destination. The municipal authority of San Vicente de Cañete declared that they were aware that the project is still in the study stage and that they have met with representatives of PERU LNG. This information was obtained through interviews with representatives of the respective municipalities (Technical Brief No. 1).

The members of the Farmers' Association of the Cañete Valley are not familiar with the scope of the project. In order to be able to assess both positive and negative aspects of the project, they have requested more information on it.

The grassroots organizations wish to have more information on the project so they may assess the possible collective and organizational benefits they may obtain from it.

According to results obtained through surveys and qualitative techniques (focus groups and in-depth interviews with opinion leaders), the authorities are familiar with the GNL-2 Quarry project, but the interviewed inhabitants are generally not aware of it (Annex 5.5)

Fears regarding the GNL-2 Quarry Development Project

In spite of the information furnished during the communication and consultation process, the authorities of the Cañete Province municipality and of the Grocio Prado district municipalities still fear the possible non-compliance by the company PERU LNG because of their commitments to the Peruvian State. They have stressed the importance of the company remaining in contact and in coordination with them.

As well, the Cañete Valley Farmers stated their concern for the dust they believe will result from the development of the quarry. They fear the environmental contamination that will surely affect their crops.

The inhabitants of the human settlements are concerned that the noise from the explosions could scare away wild fowl, goats, birds, and cattle from the area. They also fear that their health will be affected by environmental contamination. Another fear of the inhabitants is being evicted from the land they currently occupy by the Ministry of Agriculture.

The grassroots organizations are also concerned about the dust from the development of the quarry that would mainly affect children.

According to the surveys taken, 12% of those interviewed have a negative perception of the project. Of those polled, 46% consider environmental contamination to be the main negative impact of the project while 11% consider the lack of support for their locality to be the main negative factor.

Benefits Expected from the Project

The Cañete and Grocio Prado municipalities expect to obtain more revenues from taxes (payments described in the TUPA) than from this project (Technical Brief No. 1). In San Vicente de Cañete, it was believed that the only positive effect of this project would be the generation of employment for the inhabitants.

The human settlements also expect that the development of the quarry to create jobs for the local residents (Technical Brief No. 1).

According to the surveys made in the area of influence, 82.7% of the homes polled said that the main benefit would be increased employment opportunities. A much smaller percentage (6%), considers district development to be another benefit.

Future Expectations from the Project

The Cañete and Grocio Prado municipalities have stated their concern about compliance with the contracts. They also want to be satisfied with private investments that could positively affect the regional and national economy (Technical Brief No. 1).

Because they believe the company is only after its own benefit, the human settlements do not have great expectations regarding the project. They also think that they will not gain employment through the project because they are considered to be unskilled labor. Despite these beliefs, they still hope that preference will be given to local labor, which would somewhat boost the area's economy. Nonetheless, they believe that the project will improve the access roads (Technical Brief No. 1).

During the performance of the participative evaluation workshops, the participants hoped that in the future the different localities will have full services and green areas in place. They also anticipate that there will be more business and employment opportunities for the inhabitants of Cañete and Chincha.

5.4.5 METHODOLOGICAL ASPECTS

The following methodological processes have been employed to prepare the GNL-2 Social Baseline: Qualitative Methodology, Participative Survey, and Quantitative Methodology.

5.4.5.1 Qualitative Methodology

The qualitative methodology places emphasis on individuals and their subjective experiences. It stresses the way in which people experience and give meanings to reality and takes into account the cultural differences of the different social groups. In this sense, this methodological perspective can explain the actions and behaviors of individuals[34] by gaining access to the world of culture and the search for sense.

Semi Structured Interview (SSI)

The semi structured interview is a guided conversation in which the topics are defined and new questions or knowledge arises from the discussion.

This technique has been used mainly with key informers (local authorities and local leaders) in order to learn their opinions of the GNL-2 Quarry project and the possible impacts it may cause.

Through the SSI, information is obtained on the community organizations in their localities through the activities they are engaged in, through their relationships with other stakeholders in the area, and by the degree of support they have from the inhabitants. Information is also obtained on their knowledge of the project and the perception they have of it. The changes in the dynamics of their localities after the implementation of the project are also recorded, as are as the project's positive and negative effects in each area.

[34] Fanny Muñoz; Módulo de Métodos Cualitativos, Curso de Verano. Red para el Desarrollo de las Ciencias Sociales en el Perú, Cieneguilla, Lima 2002.

Technical Brief No. 1 Participants in Semi Structured Interviews

LOCALITY	PERSON INTERVIEWED	POSITION	DATE
Grocio Prado	José Levis Picón Saguna	District Mayor	(04/21/05)
Grocio Prado	Elizabeth Valencia Torres	Municipal Management	(04/21/05)
San Vicente de Cañete	Rufina Lévano	Provincial Mayoress	(05/03/05)
Nuevo Ayacucho	Ulises Orrego Bergman	President of the Populated Center	(04/20/05)
	Fernando Miguel Eliasares	Vice President of the Association for the Defense of the Inhabitants of Nuevo Ayacucho	(04/20/05)
	Juan Aunque Tenorio	ATEC Secretary	(04/20/05)
	Vilma Ramos	Association Secretary	(04/20/05)
Nuevo Cañete CETEC	Mario Huarcaya	CETEC President (*)	(04/21/05) (**)

(*) Did not agree to a formal interview.
(**) The discussion with Mr. Mario Huarcaya was on general matters and without the use of the questionnaire prepared for this purpose

Focus groups

Focus groups are made up of a group of eight to ten people who belong to the population under study, and are used to obtain – through dialogue[35] - the information required. These meetings are moderated by an investigator who has prepared guidelines in advance (a list of topics that have motivated the study). In order to simplify and steamline the opinions, the meetings are held among groups of people that have some factors in common.

This technique was used to obtain in-depth information that could be used to characterize the group of inhabitants in the study area. It allowed us to learn the inhabitant's perceptions and expectations with regards to the Project.

The information sought through this technique was as follows: knowledge about migration and the activities carried out in the project's area of interest; the degree of knowledge of the organizations their localities (the active participation within the organizations and importance of these actions, and the level of knowledge of the leaders of their communities/organizations and their perception of them); the perceptions of the work carried out by public institutions within their localities; and information on the population's knowledge of the project and how they perceive it.

[35] It has been proved that when people give their opinion through dialogue, they do not have limits; this enriches the technique as regards the completeness of the information.

Technical Brief No. 2 Focus Group Participants

The four focus groups were implemented with the participation of non-leader inhabitants from the project's areas of interest. The groups were held on April 2 and 3 in the cities of Cañete and Grocio Prado. The groups had the following characteristics:

- Group 1: 9 invitees, 4 women and 5 men inhabitants of the Nuevo Ayacucho and of the Asociación Colonizadora de la Costa in San Vicente de Cañete. The majority is unemployed and holds temporary jobs. This group mainly comes from the central and southern Andes, especially Ayacucho.
- Group 2: 11 invitee, 8 women and 3 men from the urban area of San Vicente de Cañete. Most of them are teachers, small-scale merchants, or field workers. They come from the same area or from neighboring areas.
- Group 3: 11 invitees, 6 men and 5 women from the localities of Buenavista and urban area of Grocio Prado. Most of them are originally from Chincha and Ica. They area engaged in agriculture, trade, and crafts.
- Group 4: 5 invitees, 4 women, 1 man from the localities of Topara and El Porvenir. The majority were born in the province. They are engaged in agriculture, trade, and crafts.

Focus groups met for approximately one hour in school classrooms in each of the cities analyzed (Results in Annex 5.6)

5.4.5.2 Evaluation Workshop

The Participative Evaluation Workshop (PEW) was made up of random group of inhabitants. The workshop's main focus was to develop different tools and obtain, evaluate, and quickly analyze, relevant information on the rural and urban reality of the areas of influence. The local population is also involved in the analysis of the possible project impacts in their locality.

The following tools were applied in order to gather data regarding the development activities in the GNL-2 Quarry:

a. Activity Schedule
A matrix that allows the detailed month-by-month description of the main activities carried out in the locality. It includes information obtained on the economic, religious, cultural, tourist activities, etc. as well as on the climate, main diseases, and festivities of the area.

b. Economic Flow
A tool obtained from the economic activities carried out in the area.that describes the trade processes of the main products.

c. Venn Diagram
A scheme that recognizes the main bodies and institutions working in the area, whether or not they are based there. It also records the views that the community members have of local organizations and their relationships with them.

d. Maps
A tool used to describe the physical space and location of the different geographical and social elements of the area. Includes housing zones, roads, farming areas, etc.

e. Resource Analysis Matrix
A template used to determine the pre-existing resources in the community. It also shows their sufficiency and quality.

f. FODA Analysis
This tool includes the opinions of the community in respect to an objective that influences their development in each aspect (strengths, opportunities, weaknesses and strengths).

g. Life Cycle
A recording that recognizes the different phases that women and men undergo from birth until death. It tracks their different positions in the home and their control over the resources. All of this is linked to the different cultural patterns passed on from generation to generation. This is a gender analysis of roles within the family.

h. Use of Time or 24 hours
This tool describes activities performed by men and women throughout the day. These activities are related to the structure of homes and their financial income, the division of work within them, and the power and control over the distribution of resources within such homes.

i. Brainstorming
This consists of analyzing "ex ante" within the members of the community and the probable consequences of the implementation of a project or specific action.

Participative Evaluation Workshops were held in April as shown in Technical Brief No. 3. During the information workshops held in November, the following tools were applied: Activity Schedule, Economic Flow, and Venn Diagrams used to obtain preliminary information to allow planning the Social Baseline activities.

Technical Brief No. 3 Participative Evaluation Workshops

Province	Place	PEW	Day	Starting Time	Duration	No. Participants
Chincha	Grocio Prado	01	April	4:20 p.m.	3 hours 30 minutes	24
Cañete	San Vicente de Cañete	01	April 15	4:30 p.m.	3 hours	14
Chincha	Topará (Buenavista)	01	April 16	4: 50 p.m.	2 hours 30 minutes	12
03	**03**	**03**				**50**

Source: Walsh Peru Social and Environmental Management Team - Participative Evaluation Workshop - April 2005.

Details of these Workshops may be found in Annex 5.4

5.4.5.3 Quantitative Methodology

The quantitative methodology seeks to make a socio-economic profile of the populations inhabiting the project's area of interest. It is also used to obtaining information on the population's knowledge and perception of the project.

This methodology was used within the population of the GNL-2 Quarry project area of influence; in the districts of San Vicente de Cañete (Lima), Grocio Prado (Chincha), and Quebrada de Topará.

Based on a simple random design, 550 polls were initially used and had a 95% reliability level and a 4.3% accuracy error. The size of the sample was calculated assuming a value of p=0.5, using the correction for finite samples:

$$\mathbf{n=} \frac{Npq}{(N-1)D+pq}$$

Where: $D=(d/z)^{\wedge 2}$; $q=1-p$ d: Accuracy error
Z: Normal value for a given reliability level

Due to problems encountered in working with the CETEC-Nuevo Cañete human settlement, 70 interviews were not applied[36]. The accuracy parameters were recalculated and the current sample is representative of a 95% reliability level and a 5% accuracy error.

The final sample of 480 homes is shown as follows in table 5.4-39.

Table 5.4-39 Sample distribution according to district and locality

District	Locality	Sample	Description
San Vicente de Cañete		**214**	**The accuracy error of the sample in this district is 7%**
	San Vicente de Cañete (Town)	137	Includes urban and semi urban population located in the surroundings of the district capital
	Outskirts of San Vicente de Cañete	77	Formed by Human Settlements Nuevo Ayacucho, Brisas del Concón, Trébol del Pacífico, Cinco Cruces
Grocio Prado		**266**	**The accuracy error of the sample in this district is 7%**
	Grocio Prado (Town)	137	Includes urban and semi urban population located in the surroundings of the district capital
	Quebrada de Topará (*)	32	Includes Villa Sol, Capilla, Buenavista, and Conoche.

Source: Walsh Peru Social and Environmental Management Team - April 2005.
(*) In this area there are estates, the number of which was not established. Furthermore, in view of the little population permanently living in the area, a descriptively valid sample size was considered and not one to make inference.

[36] As in the case of the in-depth interviews, authorization was not given to enter this Human Settlement. The leaders persuaded the inhabitants not to respond to the interviews since they feel threatened by the project.

An exact figure is not available for the number of homes existing in the human settlements outside San Vicente de Cañete. During the investigation activities prior to the field work, an approximate number of homes was obtained, as described in table 5.4-40.

Table 5.4-40 Sample distribution in the outskirts of San Vicente de Cañete

Human Settlement	Approximate Total of Inhabited Homes	Sample
Nuevo Cañete	380	70
Cinco Cruces	50	20
ACC	18	6
Nuevo Ayacucho	400	56

Source: Walsh Peru Social and Environmental Management Team - April 2005.

The homes of the GNL-2 Quarry project area of influence were the target population in this study, with the participation of the head of the family being crucial. If the head of the household was not present, the wife or eldest child in the home was surveyed.

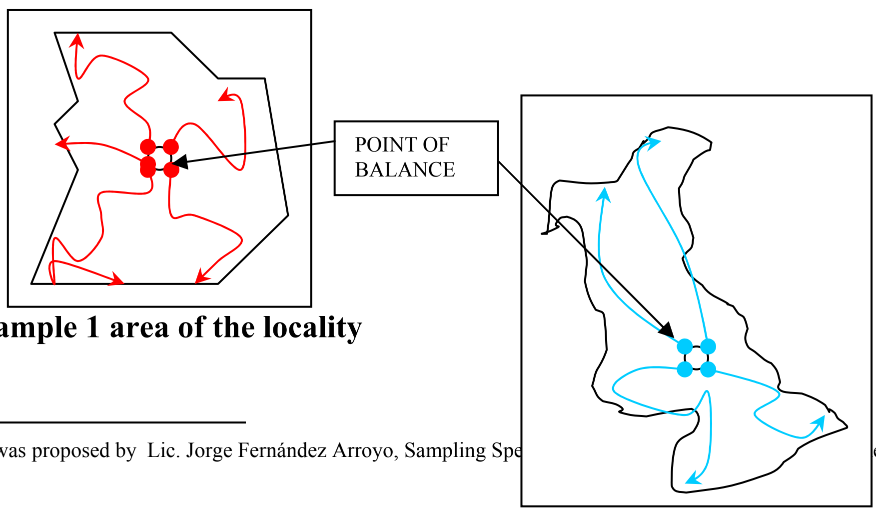
In the homes, structured, direct interviews, with both open and closed questions, were implemented to obtain information.

In homes located in urban areas, the K-2 block method was used, with no more than three interviews per block. In semi-urban and rural areas, the homes were selected using the irradiation procedure[37], which ensures the dispersion of the sample. This is a method of semi-probabilities. It consists of making an initial selection of four blocks, in the intersection of which the home will be selected.

The homes were selected systematically, which for this study was fixed at 2 (K=2).

This method was used in areas that did not have a land management system. The goal was to find a balance point (center of the locality). Starting from this point, the movement was in a direction diametrically opposed to the team of interviewers. ***The "irradiation"*** of the procedure will randomly cover homes that are difficult to access in semi-urban and rural areas (hacienda houses, homes with farming land, etc.)

SCHEME OF THE "IRRADIATION" PROCEDURE



Example 1 area of the locality

[37] This scheme was proposed by Lic. Jorge Fernández Arroyo, Sampling Spe e San Marcos
Lima - Peru

Example 2 area of the locality

At least 30% of the work of each interviewer was supervised at the time of the interview or afterwards (recall).

5.4.6 HUMAN SETTLEMENTS

5.4.6.1 Place of Birth

As seen in Table 5.4-41, 81.3 % of the inhabitants of Topará were born in the department of Ica, while 75.3% of the inhabitants of the San Vicente de Cañete Human Settlement are from Ayacucho.

Table 5.4-41 Birth Regions

Regions	San Vicente Outskirts	Quebrada Topará
Ica	0	81,3
Lima	5,2	3,1
Ayacucho	75,3	0
Huancavelica	3,9	6,3
Apurimac	6,5	3,1
Junín	1,3	0

Source: Socio Economic Survey- GNL-2 Baseline.
Prepared by: Walsh Peru Social and Environmental Management Team, April - 2005.

5.4.6.2 Languages or Tongues

According to the interviews made, most of the family heads of San Vicente de Cañete (100%) and Topará (96.9%) human settlements speak and read Spanish. The second most common language is Quechua. 85.7% and 59.4% of inhabitants speak Quechua in San Vicente de Cañete and Topará human settlements, respectively. (Table 5.4-42).

Table 5.4-42 Languages spoken / written by the family head

Languages	San Vicente Outskirts (%)	Quebrada Topará (%)
Spanish	100	96,9
Quechua	85,7	59,4
Aymara	2,6	3,1
English	1,3	0
Italian	0	0

Source: Socio Economic Survey- GNL-2 Baseline.

Prepared by: Walsh Peru Social and Environmental Management Team, April - 2005.

5.4.6.3 Religion

According to the surveys, the majority of inhabitants of the outskirts of San Vicente de Cañete (72.7%) and Topará (56.3%) were Catholic. They are followed by Evangelists, with 51% in both places (Table 5.4-43).

Table 5.4-43 Religious beliefs of the head of the family

Religious Beliefs	San Vicente Outskirts (%)	Quebrada Topará (%)
Catholic	72,7	56,3
Evangelical	10,4	40,6
None	1,3	0
Pentecost	7,8	3,1
Protestant	2,6	0
Christian	1,3	0
Jehovah Witness	1,3	0
Adventist	1,3	0
Mormon	0	0
Israelite	1,3	0
Buddhist	0	0
Atheist	0	0
Total	77	32

Source: Socio Economic Survey- GNL-2 Baseline.
Prepared by: Walsh Peru Social and Environmental Management Team, April - 2005.

5.4.6.4 Residence in the Locality

As it may be noted in Table 5.4-44, San Vicente de Cañete human settlements may be formed by migrants (heads of families not born in the locality). Of these, 92.2% stated having lived in the locality between 1 and 5 years. At the time of the surveys, information was obtained to the existence of newer human settlements that had been in the area for only 4 months.

Table 5.4-44 Time living in the locality

	San Vicente Outskirts (%)	Quebrada Topará (%)
> 1 year	1,3%	0
1 to 5 years	92,2	12,5
6 to 10 years	2,6	0
11 to 15 years	3,9	9,4
16 to 25 years	0	21,9
26 to more	0	40,6
I was born/always lived here	0	15,6

Source: Socio Economic Survey- GNL-2 Baseline.
Prepared by: Walsh Peru Social and Environmental Management Team, April - 2005.

Topara differs with 15.6% of its inhabitants being born locally and 40.6% having lived there for more than 26years.

According to the socio-economic survey, the inhabitants of San Vicente outskirts state that they previously resided in the department of Lima (23.4%); while those of Topará have mostly lived in the department of Ica (81.5%). (Table 5.4-45).

Table 5.4-45 Former Place of Residence

Region-	San Vicente Outskirts (%)	Quebrada Topará (%)
Ica	2,6 %	81,5
Lima	23,4%	7,4
Ayacucho	61%	0
Huancavelica	1,3	3,7
Junín	3,9	0
Puno	0	3,7

Source: Socio Economic Survey- GNL-2 Baseline.
Prepared by: Walsh Peru Social and Environmental Management Team, April - 2005.

The reasons for migrating to both areas were varied. For the inhabitants of the San Vicente outskirts, the main reasons for migrating were to seek employment (46.8%), to own a house (41.6%), and to evade political violence (29.9%). In contrast, for the inhabitants of Topara, the main reason for migrating was to seek employment (74.1%) or to solve housing problems (7.4%). (Table 5.4-46).

Table 5.4-46 Main reasons for migrating

Reasons for migrating	San Vicente Outskirts (%)	Quebrada Topará (%)
Lack of own home	41,6	7,4
Seek employment / work	46,8	74,1
My family/ of my spouse are from this area	3,9	3,7
Terrorism	29,9	0
To set of a business	7,8	0
No money to pay for rental	2,6	0
Study/children's education	6,5	0

Source: Socio Economic Survey- GNL-2 Baseline.
Prepared by: Walsh Peru Social and Environmental Management Team, April - 2005.

With regards to the main benefits of migrating to the area, the socio-economic survey stated that to the new migrants are living more peacefully in their new locality (38.2%). The greatest benefit obtained by the inhabitants of Topará has been finding a job (92%). (Table 5.4-47).

Table 5.4-47 Benefits gained by moving to this locality

Benefits	San Vicente Outskirts (%)	Quebrada Topará (%)
I got a job	34,2	92
We live more peacefully	38,2	0
Stable life in a single place	26,3	8
We do not pay rent	14,5	4
My children go to school	10,5	4
Open a business	5,3	4
Did not respond	0	12
No benefit	6,6	0

Source: Socio Economic Survey- GNL-2 Baseline.
Prepared by: Walsh Peru Social and Environmental Management Team, April - 2005.

The inhabitants of San Vicente de Cañete moved mainly because they were unable to find work in their locality (50%) and those of Topara did so in order to improve their economic situation (66.7%). (Table 5.4-48).

Table 5.4-48 Main reason to move from the locality

Reasons to migrate	San Vicente Outskirts (%)	Quebrada Topará (%)
No work	50	33,3
No progress / no improvement seen	16,7	0
Seek own land / own home	16,7	0
No basic services	0	0
Transfer of workplace	0	0
No room	0	0
Seek economic improvement	0	66,7
Family unity	0	0
End of rental agreement	0	0
No basic services	16,7	0
To study	0	0
Did not respond	0	0

Source: Socio Economic Survey- GNL-2 Baseline.
Prepared by: Walsh Peru Social and Environmental Management Team, April - 2005.

Of the people interviewed in the human settlements on the outskirts of San Vicente de Cañete, 51% indicated that they temporarily migrate to other departments of the country due to reasons such as trade or temporary employment. In the case of Quebrada Topará, the temporary migration percentage was 22%. The departments that chose to migrate in search for work were Lima and Ayacucho (41%), for the inhabitants of human settlements, and Ica (85.7%), for the inhabitants of the Quebrada Topara (Table 5.4-49).

Table 5.4-49 Region of temporary migration

Region	San Vicente Outskirts (%)	Quebrada Topará (%)
Lima	41	0
Ica	10,3	85,7
Ayacucho	41	0
Arequipa	0	0
Junín	5,1	0
Cusco	0	0
La Libertad	0	0
Tacna	0	0
San Martín	2,6	0
Piura	0	14,3

Source: Socio Economic Survey- GNL-2 Baseline.
Prepared by: Walsh Peru Social and Environmental Management Team, April - 2005.

5.4.6.5 Education

According to the socio-economic survey, 27.3% of the inhabitants of the outskirts of San Vicente have completed their secondary education. In contract, most of the inhabitants of Topara (31.3%) have not finished primary school (Table 5.4-50).

Table 5.4-50 Educational level of the head of the family

Educational Level	San Vicente Outskirts (%)	Quebrada Topará (%)
No education	3,9	3,1
Pre School	0	0
Incomplete primary education	19,5	31,3
Complete primary education	26	21,9
Incomplete secondary education	11,7	18,8
Complete secondary education	27,3	21,9
Incomplete non-university superior education	0	0
Complete non-university superior education	7,8	3,1
Incomplete university education	1,3	0
Complete university education	2,6	0
Post graduate studies	0	0

Source: Socio Economic Survey- GNL-2 Baseline.
Prepared by: Walsh Peru, Social and Environmental Management Team, April - 2005.

5.4.6.6 Age

According to the socio-economic survey, the largest percentage of inhabitants of San Vicente (19.6%) is 10 to 14 years old and the largest percentage of Topará (14.1%) is 20 – 24 years old. (Table 5.4-51).

Table 5.4-51 Age of the household members

Age	San Vicente Outskirts (%)	Quebrada Topará (%)
Up to age 4	11,4	13
5-9 years	17,6	9,8
10-14 years	19,6	9,8
15-19 years	15,7	13
20-24 years	7,5	14,1
25-29 years	8,2	2,2
30-34 years	3,1	9,8
35-39 years	2,7	4,3
40-44 years	2,7	5,4
45-49 years	4,3	3,3
50-54 years	1,6	5,4
55-59 years	2,4	3,3
60-64 years	1,2	2,2
65-99 years	2	4,3
Total	77	32

Source: Socio Economic Survey- GNL-2 Baseline.
Prepared by: Walsh Peru Social and Environmental Management Team, April - 2005.

5.4.6.7 Basic Services in the Locality

According to the socio-economic survey, in these localities the inhabitants have no basic services.

The predominant construction material of homes in the outskirts of San Vicente is straw mats (67.5). In Topara, adobe (34.4%) and straw mats (34.4%) predominate. (Table 5.4-52)

Table 5.4-52 Predominant construction material of house walls

Material	San Vicente Outskirts (%)	Quebrada Topará (%)
Adobe	23,4	34,4
Brick	7,8	3,1
Straw mats	67,5	34,4
“Quincha” (straw and mud)	0	28,1
Wood	1,3	0

Source: Socio Economic Survey- GNL-2 Baseline.
Prepared by: Walsh Peru Social and Environmental Management Team, April - 2005.

6.0 ENVIRONMENTAL & SOCIAL IMPACTS ASSESSMENT

6.1 GENERAL POINTS

This chapter identifies, assesses and describes the environmental and social impacts that will arise during the proposed construction of the access road and exploitation of GNL-2 Quarry for rock to be used for the construction of a breakwater at the liquefaction plant. A check list has been drawn up for the environmental analysis which identifies the main activities, from which the environmental aspects and impacts of the project were defined together with their influence on the physical, biological, socioeconomic and cultural-archaeological environment.

The environmental analysis uses as a method of evaluation the interaction of project actions and/or activities with environmental elements, using a cause–effect criterion and evaluating the adverse or favorable character of the impact. The impacts are grouped in accordance with their significance in order to establish priorities for mitigation. Potential impacts have also been identified and will be prevented by compliance with environmental, health and safety regulations. The impacts are included in a table showing the probability of the environmental effect/impact versus its significance for the environmental element in question.

The development of the environmental and social impact assessment (ESIA) took into account those environmental and social elements or components that are liable to be affected. *Environmental components* means any element of the physical, biological and social environment and the elements of an activity that interact with the environment are called *environmental aspects*[1]. Environmental aspects enable possible impacts on the environment to be identified. Impacts are considered significant when they exceed the environmental quality standards or maximum permissible limits established by current environmental legislation.

Conventionally, an environmental impact is defined as the net change in mankind's health, welfare or surroundings caused by the interaction of human activities with natural systems. According to this definition, an impact can be favorable or adverse. They are considered significant when they exceed the environmental quality standards, technical criteria, scientific hypotheses, empirical proofs, professional judgment, economic or social valuation, among other criteria.

This ESIA employed environmental quality standards established by Peruvian and international environmental legislation[2]. When there were no specific standards, reference indicators used by national and international institutions linked to conservation of the environment were employed.

[1] *INDECOPI (PERU). 1998. Environmental management systems. General Guidelines on Principles, Systems and Support Techniques. NTP-ISO 14001. Lima, INDECOPI; page 12 of 50*

[2] World Bank guidelines and standards

6.2 METHOD OF ENVIRONMENTAL ANALYSIS

The assessment of the environmental and social impacts was carried out through identification of the project activities. The identification of potential impacts was carried out using the check list technique combined with systemization of the results in matrices. In order to obtain an integrated list of impacts, valuation, probability of occurrence and application of environmental control measures required in each case, these aspects have been presented in an environmental management plan (EMP).

The methodological procedure followed in the identification and evaluation of the environmental impacts of the project in question was planned in the following manner:

- Analysis of the project.
- Analysis of the environmental situation of the area of influence.
- Identification of environmental and social aspects and impacts.
- Description of the principal environmental and social impacts.

Once the aspects and impacts were identified, they were interacted with the environmental elements to determine whether they were adverse (negative) or favorable (positive).

6.2.1 ASPECT / COMPONENT INTERACTION MATRICES

Positive impacts were classified using an *index or numerical value of favorable significance,* whilst negative impacts were classified using an *index or numerical value of adverse significance*. The method applied is an adaptation of the relevant criteria method[3], in which a series of impact indicators are calculated, which are then globalized using a function that provides a single index known as the environmental impact value (EIV).

These indices are based on awarding points for magnitude, duration and extent of the impacts, without losing sight (for interpretation purposes) of the fact that such numerical values correspond to an ordinal scale, from which the significance of the environmental and social impact is determined.

6.2.1.1 Classification by favorable or adverse nature

Each impact was classified as favorable or adverse; that is, whether it improves or reduces environmental quality. It is favorable if it improves the quality of an environmental component. It is adverse, however, if it reduces the quality of the component. The interaction table uses a positive or negative sign, as the case may be, for this classification.

[3] SWECO – INGENDESA – CAI consortium (1997). Impact study of the Gualaca hydroelectric project - Panama. Chapter VII –1

6.2.1.2 Classification by significance

This classification method includes a global analysis of the impact and determines its degree of significance for the environment. It is the most important classification of the impact and requires the most interdisciplinary discussion. The significance of an impact was taken to be a characteristic associated with the magnitude, extent and duration of the impact as well as the sensitivity of the environment.

A "significance index (S)" was used to classify environmental and social impacts. This index or numerical value was obtained as a function of the magnitude of the impact (m), its extent (e) and duration (d); as well as the fragility of the environmental component affected (f). The magnitude, duration, extent and fragility of the environment were awarded points between 1 and 5. The numerical value of environmental significance was obtained using the following formula[4]:

$$\text{Significance index} = [(2m + d + e)/20]*f.$$

The numerical values obtained enabled the impacts to be grouped in accordance with their favorable or adverse significance value, in 5 ranges**:** of very little significance (0,00 to 1,00), of little significance (>1,00 to 2,00), significant (>2,00 to 3,00), very significant (>3,00 to 4,00) or highly significant (>4,00 to 5,00). Table 6-1 gives a summary of the criteria and classifications used in this evaluation.

Table 6-1 Summary of criteria and classifications

Criteria Ranges	Magnitude (*m*)	Duration (*d*)	Extent (*e*)	Fragility (*f*)
1	Very small	Days	Isolated areas	Very slightly fragile
2	Small	Weeks	Sectors of the concession	Slightly fragile
3	Medium	Months	Area of the concession	Moderately fragile
4	High	Years	Indirect influence	Fragile
5	Very high	Decades	District, regional and national	Extremely fragile

The criteria for estimating the numerical significance indices or values were defined as follows:

[4] Methodology for the assessment of environmental impacts in the EIS for the Camisea - Lima natural gas and liquids transport system, 2002

Magnitude (m)

This characteristic indicates the degree of incidence or effect of an activity upon a given environmental component in the specific ambit in which it takes place. Refers to the dimension of the impact; that is the quantitative or qualitative change of an environmental parameter, caused by an action. The following classifications were used: (1) very minor magnitude, (2) minor magnitude, (3) medium magnitude, (4) high magnitude and (5) very high magnitude.

Duration (d)
This is the time an impact is presumed to last. The impact may be of very short duration if it lasts for a few days (1), short if it lasts weeks (2), moderate if it lasts for months (3), extensive if it lasts for years (4) and permanent if it lasts several decades after the project (5).

Extent or area of influence (e)

This is a spatial evaluation of the location of the effect under analysis. It relates to the area affected. Classifies an impact in accordance with the area of influence of its effect and can be "isolated" if restricted to very small areas adjacent to the internal roads, camps or the quarry (1); "local" if its area of influence extends to sections of the access road and beyond the quarry or camps (2); "concession area" if it extends to the whole of the area of exploitation or concession (3); "indirect area of influence" if it extends beyond the project area and may include neighboring settlements (4) and widespread if it extends well beyond the indirect area of influence (5).

Fragility of the component (f)

The fragility of the component is the degree to which the component is susceptible to deterioration caused by the quarrying operations. Those areas classified as having high biological sensitivity and geodynamically unstable areas are more sensitive to impacts. Naturally, the fragility is linked to the concept of the physical and biological sensitivity used in the base line.

The difference is that sensitivity is a property inherent in the environment or component as a whole, whilst fragility refers to the way a component reacts to a specific environmental aspect. Thus, a component can have only one value for sensitivity, independent of the environmental aspect it affects, but several indices of fragility for different aspects of the operation.

The numerical values are as follows: (5) extremely fragile, (4) fragile, (3) moderately fragile, (2) slightly fragile (1) very slightly fragile. The maps divide the study area into regions with the sensitivity types indicated. The fragility of the environment is considered a determining factor in evaluating the significance of an impact, such that it acts on the other aspects as an adjustment factor or coefficient.

6.2.1.3 Classification by probability of occurrence

This analysis differentiates the impacts that will inevitably occur and those with certain probabilities of occurrence. An impact can be inevitable or it may have a high probability of occurrence or moderate probability (it is not certain whether it will occur), a low probability or a very low probability (the likelihood of occurrence is remote but cannot be discounted). Preventive measures are suggested for effects with a high probability of occurrence; corrective measures are associated with inevitable impacts, when it is necessary to reverse adverse effects and mitigation measures are used to reduce an impact's effect or extent when it is not possible to restore the environment to its original condition. The occurrence of an impact is also associated with the degree or level of response to the generation of an impact, incorporating preventive measures and environmental control criteria.

6.2.1.4 Classification as direct or indirect

This analysis recognizes the incidence of the impacts, classifying them as direct or indirect impacts. Direct impacts are the immediate consequences of the quarrying operations, trucking and transport of the material. The indirect impacts consist of the secondary effects of direct impacts. This analysis guides the prevention, correction or mitigation measures principally to the direct impacts, which, in turn, have mitigating or corrective effects on the indirect impacts.

6.3 ENVIRONMENTAL AND SOCIAL IMPACTS OF THE PROPOSED EXPLOITATION OF GNL –2 QUARRY

The environmental assessment identifies the potential severity of impacts generated by the project activities, forecasts the most critical series of events that could take place and, using this information, prepares management and monitoring plans to reduce the effects of these impacts. These plans involve the use of control and administrative techniques to reduce exposure to acceptable levels or permissible limits.

The evaluation and description of the environmental impacts generated by the quarrying operations at the GNL-2 Quarry took into account its location in a rural area where there are no nearby human settlements or ecologically sensitive areas. The impacts were grouped in accordance with the environmental components or elements, according to the identification carried out in the matrices.

In accordance with the methodology described above, identification of environmental impacts uses a check list for each of the proposed activities or actions of the project. This list was used to determine the condition of the environmental and social impacts as well as those processes or activities that general them. Table 6-2 contains the check list used to identify environmental and social impacts and aspects.

Once the environmental and social impacts and aspects were identified, the project activities were related to the environmental elements in the cause-effect matrix shown in table 6-3.

The purpose of this matrix is to identify the positive and negative impacts that could occur during execution of the project, as well as the environmental elements that will require most attention. This matrix was used to classify the impacts by significance (the classification chart is given in annex 7). Table 6-4 is a summary of project impacts grouped in accordance with their degree of positive or negative significance.

Table 6–2 Check list for environmental and social impacts of the projected exploitation of GNL-2 Quarry

Activity	Environmental aspect	ENVIRONMENTAL EFFECT / IMPACT	Condition
SITE PREPARATORY STAGE (PRELIMINARY WORK)			
Diamond drilling in the concession area	Operation and movement of the diamond drilling machine	Generation of particulates (PM_{10}, PTS and solids capable of sedimentation).	A
		Generation of combustion gasses such as CO, CO_2	A
		Noise	A
		Displacement of fauna	A
	Construction of drilling and access platforms	Modification of the relief	A
		Alterations to the soil	A
		Reduction in vegetation	A
	Use of water (for cleaning, consumption, sprinkling access roads)	Reduction of available water	A
	Use of hydrocarbons (diesel, oils and grease)	Risk of soil contamination	A
	Particles in suspension, noise, combustion gases	Effects on health	A
	Contracting personnel	Job creation	F
		Increase in trade and services	F
Construction of access ramp to quarry	Operation and movement of heavy equipment (tractors, backhoes, loading shovels, tipper trucks, graders, tanker, etc.)	Generation of particulates (SP_{10}, PTS and solids capable of sedimentation).	A
		Generation of combustion gasses such as CO, CO_2	A
		Noise	A
		Displacement or perturbation of fauna	A
	Cuttings and embankments	Modification of the relief	A
	Construction of the access to the quarry	Alterations to the soil	A
		Reduction in vegetation	A
		Modification to drainage	A
		Risk of affecting archaeological sites	A
		Alteration of the visual quality of the local landscape	A
	Use of water for dampening access road and materials removal	Reduction of available water	A
	Use of hydrocarbons (diesel, oils and grease)	Risk of soil contamination	A

Activity	Environmental aspect	ENVIRONMENTAL EFFECT / IMPACT	Condition
SITE PREPARATORY STAGE (PRELIMINARY WORK)			
	Particles in suspension, noise, combustion gases	Effects on health	A
	Contracting personnel	Job creation	F
		Increase in trade and services	F
Construction of the first platform	Operation and movement of heavy equipment (tractors, loading shovels, tipper trucks, graders, tanker, etc.)	Generation of particulates (SP_{10}, PTS and solids capable of sedimentation).	A
		Generation of combustion gasses such as CO, CO_2	A
		Noise	A
		Displacement or perturbation of fauna	A
	Formation of working faces	Modification of the relief	A
	Use of hydrocarbons (diesel, oils and grease)	Risk of soil contamination	A
	Consumption of water (for sprinkling of access roads and removal of material)	Reduction of available water	A
	Construction of the platform as such	Alterations to the soil	A
		Reduction in vegetation	A
		Modification to drainage	A
	Particles in suspension, noise, combustion gases	Effects on the health and safety of personnel	A
	Contracting personnel	Job creation	F
		Increase in trade and services	F
Creation of “landfills” and access roads	Operation and movement of heavy equipment (tractors, loading shovels, tipper trucks, graders, tanker, etc.)	Generation of particulates (SP_{10}, PTS and solids capable of sedimentation).	A
		Generation of combustion gasses such as CO, CO_2	A
		Noise	A
		Displacement or perturbation of fauna	A
	Waste disposal (from site clearing and selected materials)	Modification of the relief	A
	Construction of landfills and access roads as such	Soil loss	A
		Reduction in vegetation	A
		Modification to drainage	A
		Risk of affecting archaeological sites	A
		Alteration of the landscape	
	Use of hydrocarbons (diesel, oils and grease)	Risk of soil contamination	A

<table>
<tr><th>Activity</th><th>Environmental aspect</th><th>ENVIRONMENTAL EFFECT / IMPACT</th><th>Condition</th></tr>
<tr><td colspan="4">SITE PREPARATORY STAGE (PRELIMINARY WORK)</td></tr>
<tr><td rowspan="4"></td><td>Particles in suspension, noise, combustion gases</td><td>Effects on health</td><td>A</td></tr>
<tr><td>Water consumption (for spraying roads and material removal</td><td>Reduction of available water</td><td>A</td></tr>
<tr><td rowspan="2">Contracting personnel</td><td>Job creation</td><td>F</td></tr>
<tr><td>Increase in trade and services</td><td>F</td></tr>
<tr><td rowspan="14">Construction of the selection and storage zone</td><td rowspan="4">Operation and movement of heavy equipment (tractors, loading shovels, tipper trucks, graders, tanker, etc.)</td><td>Generation of particulates (SP_{10}, PTS and solids capable of sedimentation).</td><td>A</td></tr>
<tr><td>Generation of combustion gasses such as CO, CO2</td><td>A</td></tr>
<tr><td>Noise</td><td>A</td></tr>
<tr><td>Displacement or perturbation of fauna</td><td>A</td></tr>
<tr><td>Waste disposal (from site clearing and selected materials)</td><td>Modification of the relief</td><td>A</td></tr>
<tr><td rowspan="3">Construction of the accumulation and selection zone as such</td><td>Soil loss</td><td>A</td></tr>
<tr><td>Reduction in vegetation</td><td>A</td></tr>
<tr><td>Risk of affecting archaeological sites</td><td>A</td></tr>
<tr><td>Use of hydrocarbons (diesel, oils and grease)</td><td>Risk of soil contamination</td><td>A</td></tr>
<tr><td>Particles in suspension, noise, combustion gases</td><td>Effects on health</td><td>A</td></tr>
<tr><td rowspan="2">Contracting personnel</td><td>Job creation</td><td>F</td></tr>
<tr><td>Increase in trade and services</td><td>F</td></tr>
<tr><td rowspan="10">Construction of complementary installations (mess room, stores, workshops and chemical toilets)</td><td rowspan="4">Operation and movement of heavy equipment (tractors, loading shovels, tipper trucks, graders, tanker, etc.)</td><td>Generation of particulates (PM_{10}, PTS and solids capable of sedimentation).</td><td>A</td></tr>
<tr><td>Generation of combustion gasses such as CO, CO_2</td><td>A</td></tr>
<tr><td>Noise</td><td>A</td></tr>
<tr><td>Displacement or perturbation of fauna</td><td>A</td></tr>
<tr><td>Use of hydrocarbons (diesel, oils and grease)</td><td>Risk of soil contamination</td><td>A</td></tr>
<tr><td>Particles in suspension, noise, combustion gases</td><td>Effects on health</td><td>A</td></tr>
<tr><td rowspan="4">Installations as such</td><td>Reduction in vegetation</td><td>A</td></tr>
<tr><td>Alterations to the soil caused by effluent</td><td>A</td></tr>
<tr><td>Risk of affecting archaeological sites</td><td>A</td></tr>
<tr><td>Alteration of the visual quality of the local landscape</td><td>A</td></tr>
</table>

Activity	Environmental aspect	ENVIRONMENTAL EFFECT / IMPACT	Condition
SITE PREPARATORY STAGE (PRELIMINARY WORK)			
	Contracting personnel	Job creation	F
		Increase in trade and services	F
EXECUTION STAGE			
Drilling	Operation of the track drill	Generation of particulates (SP_{10}, PTS and solids capable of sedimentation).	A
		Generation of combustion gasses such as CO, CO_2	A
		Noise	A
		Displacement and perturbation of fauna	A
		Reduction of available water	A
		Risk of affecting archaeological sites	A
	Generation of suspended particles, noise, combustion gases	Effects on health	A
	Contracting personnel	Job creation	F
		Increase in trade and services	F
Blasting	Charging shot holes (handling explosives)	Effects on health	A
	Removal of materials	Generation of particulates (PM_{10}, PTS and solids capable of sedimentation).	A
		Generation of gases (CO, CO_2)	A
		Noise	A
		Modification of the relief	A
		Vibration	A
		Risk of destabilizing slopes	A
		Modification to surface drainage	A
		Risk of affecting the water table	A
		Displacement or perturbation of fauna	A
		Risk of affecting archaeological sites	A
		Modification of the landscape	A
	Contracting personnel	Job creation	F
		Stimulation of trade and services	F
Trucking	Operation of heavy equipment (loading shovels, tipper trucks)	Generation of particulates (SP_{10}, PTS and solids capable of sedimentation).	A
		Generation of gases such as CO, CO_2	A
		Noise	A

Activity	Environmental aspect	ENVIRONMENTAL EFFECT / IMPACT	Condition
SITE PREPARATORY STAGE (PRELIMINARY WORK)			
		Displacement and perturbation of fauna	A
	Use of water to dampen the material	Reduction of available water	A
	Particles in suspension, noise, combustion gases	Effects on health	A
	Contracting personnel	Job creation	F
		Increase in trade and services	F
Transport (from the quarry to the selection and storage zones and landfills)	Operation and movement of heavy equipment (tipper trucks)	Generation of particulates (SP_{10}, PTS and solids capable of sedimentation).	A
		Generation of gases such as CO, CO_2	A
		Noise	A
		Displacement and perturbation of fauna	A
	Waste disposal (unwanted material)	Modification of the relief	A
	Particles in suspension, noise, combustion gases	Effects on health	A
	Contracting personnel	Job creation	F
		Stimulation of trade and services	F
Closure			
Stabilization of embankments	Profiling and preparation of working faces	Generation of particulates (PM_{10}, PTS and solids capable of sedimentation.	A
		Ensuring and improving the physical stability of gradients	F
	Contracting personnel	Job creation	F
		Stimulation of trade and services	F

A	Adverse	F	Favorable

Table 6-3 Cause-effect interaction matrix for the exploitation of GNL-2 Quarry

CAUSE-EFFECT		ASPECTS OF THE PROJECT											Results	
		Preparing the site						Execution				Closure		
		Diamond drilling	Access to quarry	Platform	Spoil heaps and access	Selection and accumulation zor	Complementary installations	Drilling	Blasting	Loading	Transport	Stabilization of embankment	Adverse (A)	Favorable (F)
ENVIRONMENTAL ELEMENTS	**AIR QUALITY**													
	Generation of particulates	A	A	A	A	A	A	A	A	A	A	A	11	0
	Generation of combustion gases	A	A	A	A	A	A	A	A	A	A		10	0
	Noise	A	A	A	A	A	A	A	A	A	A	A	11	0
	RELIEF AND GEODYNAMICS													
	Modification of the relief	A	A	A	A	A		A	A				7	0
	Generation of spoil								A		A		2	0
	Vibration								A				1	0
	Risk of destabilizing slopes	A		A					A				3	0
	Ensuring and improving the stability of embankments											F	0	1
	SOIL													
	Alterations to the soil	A	A	A	A	A	A						6	0
	Risk of pollution	A	A	A	A	A	A	A	A		A	A	10	0
	DRAINAGE AND GROUND WATER													
	Modification to surface drainage		A	A	A				A				4	0
	Low risk of alteration to the water table	A							A				2	0
	Reduction in available water	A		A	A		A	A					5	0
	VEGETATION													
	Reduction in vegetation		A	A	A	A		A	A				6	0
	FAUNA													
	Displacement or perturbation of fauna	A	A	A	A	A	A	A	A	A	A		10	0
	SOCIAL													
	Risks to health and safety	A	A	A	A	A	A	A	A	A	A		10	0
	ECONOMIC													
	Job creation	F	F	F	F	F	F	F	F	F	F	F	0	11
	Stimulation of trade and services	F	F	F	F	F	F	F	F	F	F	F	0	11
	CULTURAL - ARCHAEOLOGICAL													
	Risk of affecting archaeological sites		A		A	A	A	A	A				6	0
	LANDSCAPE													
	Alteration of the visual quality of the local landscape		A		A	A			A				4	0
	TOTAL													
	Summary												108	23
	PERCENTAGE (%) ADVERSE & FAVORABLE													
	PERCENTAGE												82.4	17.6

A	Adverse
F	Favorable

Table 6-4 Summary of environmental and social impacts – GNL-2 Quarry

	CAUSE - EFFECT	ASPECTS OF THE PROJECT												
		Preliminary work						Operation				Closur		
		Diamond drilling	Access to quarry	Platform	Spoil heaps and access	Selection & accumulation zone	Complementary installations	Drilling	Blasting	Loading	Transport	Stabilization of embankment	**Maximum significance**	**Mode**
ENVIRONMENTAL ELEMENTS	**AIR QUALITY**													
	Generation of particulates	1.65	1.95	1.50	2.25	1.80	1.65	2.25	2.40	2.10	2.25	1.50	2.40	2.25
	Generation of combustion gases	1.65	1.65	1.50	1.95	1.80	1.65	1.95	1.80	1.80	1.80		1.95	1.80
	Noise	1.65	1.65	1.50	1.95	1.80	1.65	1.95	1.80	1.80	1.80	1.50	1.95	1.80
	RELIEF AND GEODYNAMICS													
	Modification to the relief	1.35	1.35	1.50	1.95	1.50		1.80	3.60				3.60	1.50
	Generation of spoil								2.40		2.10		2.40	2.40
	Vibration								2.25				2.25	2.25
	Risk of destabilizing slopes	1.65		1.65					2.25				2.25	1.65
	Ensuring and improving stability of embankments											1.80	1.80	1.80
	SOIL													
	Alterations to the soil	1.65	1.65	1.20	1.50	1.65	1.35						1.65	1.65
	Risk of pollution	1.20	1.35	1.20	1.35	1.50	1.50						1.50	1.20
	DRAINAGE AND GROUND WATER													
	Modification to surface drainage		1.20	1.20	1.20				1.95				1.95	1.20
	Low risk of alteration to the water table	0.90							0.90				0.90	0.90
	Reduction in available water	1.20		1.20	2.25		2.25	1.95					2.25	1.20
	VEGETATION													
	Reduction in vegetation		1.65	1.65	1.80	1.80							1.80	1.65
	FAUNA													
	Displacement or perturbation of fauna	1.35	1.65	1.65	1.35	1.35	1.35	1.20	1.80	1.20	1.20		1.80	1.35
	SOCIAL													
	Risks to health and safety	1.20	1.20	1.20	1.35	1.35	1.20	1.20	1.20	1.20	1.20		1.35	1.20
	ECONOMIC													
	Job creation	2.10	2.10	1.95	2.40	2.10	2.10	2.10	2.10	1.80	1.80	1.80	2.40	2.10
	Stimulation of trade and services	2.10	1.80	2.10	1.95	1.95	2.10	2.10	2.10	1.95	2.10	2.10	2.10	2.10
	CULTURAL - ARCHAEOLOGICAL													
	Risk of affecting archaeological sites		1.50		1.65	1.65	1.65	1.95	2.40				2.40	1.65
	LANDSCAPE													
	Alteration of the visual quality of the local landscap		1.65		1.80	1.80	1.80		1.95		1.65		1.95	1.80

Rango	Significancia
0.00 a 1.00	Muy poca
>1.00 a 2.00	Poca
>2.00 a 3.00	Moderada
>3.00 a 4.00	Alta
>4.00 a 5.00	Muy alta

N.B.
The significance is determined by the highest classification assigned to an environmental element. The mode is the most frequent value of an impact with respect to the activity generating it.

6.3.1 ORDER OF ENVIRONMENTAL AND SOCIAL IMPACTS

Table 6-5 shows the ordering of the impacts in accordance with their maximum environmental and social significance. Table 6-6 shows the probability of occurrence and significance of the environmental and social impacts of the project, grouped in accordance with the degree of positive or negative significance and probability of occurrence. The impacts are also identified as direct or indirect. This analysis is aimed at establishing the impacts that require higher priority in prevention, correction or mitigation.

The maximum significance values (S) are shown in order from least to greatest severity or favorable nature of the impacts. These numerical values are not a quantification of the impact, rather they are indices used to order the impacts in a less subjective manner or to group them by level of significance.

The environmental assessment determined that the exploitation of GNL-2 Quarry will generate adverse and favorable impacts, both direct and indirect, from inevitable to those with a very low probability of occurrence. For a better interpretation of the results and considering the priority that should be given to them, the impacts have been grouped from the lowest to the highest environmental significance.

The temporary creation of employment is a direct and beneficial impact which will in turn have a positive effect on the local economy. In addition to this, the medium and small scale benefits have been considered during the project logistics determined by the mobilization of personnel, equipment, goods and services that will generate an increase in trade and services. These positive impacts are considered moderately environmentally significant and represent 10% of the total impacts identified.

Among the adverse impacts, modification of the relief is considered highly significant and inevitable and represents 5% of the total of impacts identified (see Table 6-5).

Adverse impacts of moderate environmental significance are the change in air quality caused by particle emissions, destabilization of slopes by vibration, generation of spoil and reduction in available water, which represent 30% of total impacts identified.

Most adverse impacts are classified as of slight environmental significance and represent 45% of total impacts. The risk to the health of the local population is very limited and has a low probability of occurrence as there are no formal settlements in the zone or adjacent to the project. The risk of affecting archaeological sites will have a very low probability of occurrence as the company will take all necessary measures to define and protect these sites. Modification to surface drainage, the risk of pollution and soil loss, generation of combustion gases and an increase in environmental noise; reduction in vegetation, displacement and perturbation of fauna within the biological environment and alterations to the visual quality of the landscape are other impacts identified as having slight significance.

Table 6-5 Order of environmental and social impacts - GNL-2 Quarry

Environmental impact	Maximum significance		Percentage
Risk of changes to the water table	-0.90	(-)Very slight significance	5.0%
Ensure & improve stability of embankments	1.80	(+) Slight significance	5.0%
Risks to health and safety	-1.35	(-) Slight significance	45.0%
Risk of soil contamination	-1.50		
Alterations to the soil	-1.65		
Reduction in vegetation	-1.80		
Displacement or perturbation of fauna	-1.80		
Generation of combustion gases	-1.95		
Noise	-1.95		
Modification to surface drainage	-1.95		
Alteration of the visual quality of the local landscape	-1.95		
Stimulation of trade and services	2.10	(+) Moderate significance	10.0%
Job creation	2.40		
Generation of spoil	-2.25	(-) Moderate significance	30.0%
Vibration	-2.25		
Reduction of available water	-2.25		
Risk of destabilizing slopes	-2.25		
Generation of particulates	-2.40		
Risk of affecting archaeological sites	-2.40		
Modification of the relief	-3.60	(-) High significance	5.0%

Table 6-6 Probability of occurrence and significance of environmental and social impacts – GNL-2 Quarry

Significance Favorable or Adverse	Inevitable	Probability of occurrence			
		High probability	Moderate probability	Low probability	Very low probability
V Very high significance					
IV High significance	• Modification of the relief (-) (d)				
III Moderate significance	• Job creation (+) (d) • Generation of particles (-) (d) • Generation of rubble (-) (d) • Stimulation of trade and services (+) (ID 1033 0 1)	• Vibration (-) (d)		• Risk of destabilizing slopes (-) (ID 1033 0 1) • Reduction of available water (-) (d) • Risk of affecting archaeological sites (-) (d)	
II Slight significance	• Generation of combustion gasses (-) (d) • Noise (-) (d) • Displacement or perturbation of fauna (-) (d)	• Ensuring and improving the stability of embankments (+) (d) • Alteration of the visual quality of the local landscape (-) (d)	• Soil loss (-) (d) • Reduction in vegetation (-) (d)	• Risk of soil contamination (-) (ID 1033 0 1) • Modification to surface drainage (-) (d) • Risk of effects on health and safety (-) (d)	
I Very slight significance					• Low risk of altering the water table (-) (ID 1033 0 1)

(+) favorable impact; (-) adverse impact; (d) direct impact, (ID 1033 0 1) indirect impact

Priority for addressing environmental and social impacts

	High priority
	Medium priority
	Low priority

6.3.2 FAVORABLE IMPACTS

6.3.2.1 Economic impacts

Job creation

This impact consists of the hiring of local labor during exploitation of the GNL-2 Quarry in all stages. The labor required will depend on the characteristics and duration of each project activity and may be skilled and unskilled. Hiring of labor for the quarrying operation will be the responsibility of the contracting company. Most of the local labor to be hired will be unskilled.

It is envisaged that during the exploitation of the quarry approximately 231 people will be required, including those working in the support and logistics functions. It is estimated that the local labor requirement will be a maximum of 75 people, representing 33% of the work force necessary for the development of the project.

Hiring labor from the area will increase local incomes, generating improved access to goods and services which, in turn, will translate into an improvement in living standards for the population in question. Those living closest to the project who will benefit from this impact are the inhabitants of the districts of San Vicente de Cañete and Grocio Prado.

Stimulation of trade and services

The increase in the demand for goods and services (supplies for construction and operation of the camp, leasing of machinery and equipment, supply of food and lodgings, etc.), required during the project activities will stimulate local and regional trade. In this regard it should be kept in mind that the project will last approximately 24 months, so during this period a greater demand for local products is expected.

6.3.2.2 Physical environment

Ensuring and improving the physical stability of gradients

When quarrying is completed and as part of the closure stage of the quarry, it will be necessary to carry out restoration work in the zone, such as profiling the working faces, strengthening security barriers, providing channels for possible surface water runoff and other tasks. This impact will be associated with the restoration of the working areas in order to improve the visual quality of the landscape.

During the abandonment stage of the open pit, the following design parameters will have to be monitored: face height, safety embankments, final slope of the quarry, static and pseudo-static safety factors. This impact will ensure sustainable abandonment, that is, without risk of slumping or settlement.

6.3.3 ADVERSE IMPACTS

Adverse impacts are described in this section grouped by environmental component. The significance and probability of occurrence of each impact can be reduced through the application of environmental preventive and mitigation measures.

6.3.3.1 Air quality and noise

Generation of particulates

Change in air quality because of particle emissions

The preparation of the site, operation and closure of the GNL-2 Quarry will generate particles smaller than 10 microns (PM_{10}) which will be airborne as the quarry will be operated as an open pit. It is envisaged that dust generation will be localized and limited to the quarry area, because the rock to be extracted is very competent (hard) and will be extracted in large blocks (maximum 10 tons).

It is blasting that will generate most of the particulate matter and, to a lesser extent, drilling, accumulation, loading, transport and discharge of material in the waste rock site. In the study zone the wind speed in normal years is between 6-10 m/s (summer) and 4-8 m/s (winter) and the prevailing wind is south westerly. This means that the particulate materials generated will be dispersed towards the higher land behind the quarry at the edge of the concession area and away from populated areas.

The results of the air quality baseline contained in chapter 5.0 of the ESIA and conducted in the environs of GNL-2 Quarry, showed that the concentrations of PM_{10} under existing conditions (33,70 $\mu g/m^3$ and 41,30 $\mu g/m^3$) are below the figures contained in Peru's National Air Quality Standards. [5] (150 $\mu g/m^3$) and the World Bank standard[6] (70 ug/ m^3). The effect of the generation of particulates on air quality will be temporary and will depend on how the project is carried out, particularly during blasting.

[5] Approved by S.D. Nº 074-2001-PCM (Peruvian legislation)
[6] World Bank Pollution Prevention and Abatement Handbook (PPAH) – July 1998

__Generation of combustion gasses__

Alteration to air quality by combustion gas emissions

This impact will be generated by the emission of combustion gasses (CO, NO_x, SO_2 and HC) associated with the operation of diesel-engined machinery and vehicles (trucks, graders, tractors, loading shovels, hydraulic drilling machines, tank and tipper trucks) during exploitation of the quarry. Gas emissions will be at ground level (immissions) and will be dispersed by the wind. The results of the air quality monitoring in the quarry area (March 2005), show that concentrations of sulfur dioxide (SO_2), carbon monoxide (C_O) and nitrogen oxides (NOx) are well below the limits contained in the National Air Quality Standard.

Blasting will also generate combustion gases such as: nitrogen oxides (NOx); carbon oxides (C_O, CO_2) and sulfurous gases (SO_2). These gases will not be permanent, a given volume will be generated initially, remain for a short period and will dissipate in the form of innocuous gasses such as CO_2 and NO_2.

This effect will be confined to the quarry area with its main influence on the workers, the possible risk being occupational. Because of the distance of the concession area from population centers (approximately 20 Km) combustion gases will have no direct effect on any settlements. As a preventive measure, the machinery and equipment will be kept in a good state of repair in accordance with the manufacturer's recommendations.

In addition, the quarrying zone is protected by high ground which acts as a barrier and disperses the emissions, minimizing the risk to the health of the local population.

__Noise__

Temporary increase in environmental noise levels

This environmental impact will be generated locally in the quarrying zone where shallow blasting will be carried out. Noise levels will be significant though of short duration and restricted mainly to the quarrying area. Given that the quarry area is far from populated areas and recipients (20 Km approximately) and because of the presence of high ground which will act as an acoustic barrier, it is thought that this impact will have a low significance for the wellbeing of the population.

The noise confined to the quarry area will be heard by the workers so this impact will be considered as an occupational hazard. The use of heavy machinery and vehicles will also generate low to moderate intensity noise. Therefore the personnel working in the quarries must obey the instructions contained in PERU LNG's Industrial Hygiene and Safety Regulations, which specifically include the use of ear protectors. The contractor shall be responsible for providing ear protectors and ensuring that they are used correctly at all times during working hours. Blasting will be programmed for specific times of the day, will be instantaneous and confined to the quarry area.

The measurements of environmental noise made in the quarry area (March 2005) and included in the environmental baseline (see chapter 5.0 of the ESIA) recorded average levels of 30 dB and 34.5 dB. Both values are below the environmental noise standard established in the World Bank guidelines (79 dB).

Table 6-7 shows typical noise levels generated by the equipment and machinery that will be used in the project.

Table 6-7 Principal sources of noise

Source of noise	Source of contribution	Regular noise level (dB)
Crawler tractor, loading shovel, excavators, trucks	Engine, air inlet and exhaust (the noise impact may increase the levels by 5 to 10 dB)	110 - 120
Hydraulic drilling equipment	Compressed air exhaust. Drilling noise	120
Pneumatic drilling equipment	Compressor noise Drilling noise	130
Vibrating screens	Flow of material over screen Motors	100 - 110

Source: Environmental Guide for the Management of Noise Problems in the Mining Industry – MEM Mining Sub-sector

6.3.3.2 Relief and geodynamics

Modification of the relief

Alteration of the relief in the project zone

The modification of the relief generated by removal of rock is the most common impact of open pit non-metallic mining operations. The quarrying operations and disposal of spoil will cause changes to the relief such as the creation of working faces in the area. The quarry and spoil heap will be inside the concession area and on the property of PERU LNG, far from populated areas and higher than the access road, so the effect on the relief will be principally visual.

A secondary effect of modifications to the relief will be changes to the surface drainage in both the quarry and the spoil heaps.

Given that the surface where blasting will take place covers 50 ha and the spoil heaps cover 17 ha, this impact has been classified as of high environmental significance, mainly due to the extent and duration of the work.

Vibration

Changes in the project zone caused by vibration

Blasting to break up the rock will generate vibration within the project area. This vibration, depending on the geological structure of the area, creates a low probability of destabilizing slopes.

The effect of vibration on the local population will be unnoticeable as their settlements are located more than 20 Km. Within the concession area buildings will be single story only, so the effects of resonance increasing the magnitude and velocity of the vibrations can be discounted.

As a preventive measure, the quarrying operation will be conducted adequately using suitable netting, controlled blasting and complying with the requirements for working face angle and the final gradient of the quarry face in accordance with the results of the geological studies.

Risk of destabilizing slopes

Drilling and blasting to break up the rock will generate vibrations which, under certain conditions, could make the faces unstable.

The quarrying plan will be aimed at trying to keep the quarry face similar to the natural gradient of the terrain, to the extend possible. The characteristics or qualities of the rock to be extracted will allow very steep faces and limits the risk of rock falls. The geological inspection confirmed that there is no significant structural discontinuity and that, in general, there are no structural problems in the zone.

The possible effect on the stability of the faces and potentially unstable terrain is a common risk in all mining operations, especially during drilling and blasting. As a preventive measure PERU LNG will plan the blasting using reduced explosive charges and longer fuses and will reduce confinement of the explosives to reduce vibration.

Generation of spoil

The removal of colluvial overburden and weathered rock before quarrying of the high quality rock begins will generate spoil which will be placed in landfills previously defined and authorized by the competent authority. The thickness of the layer of spoil will be between 10 and 15 meters.

The effect on the relief and visual quality of the landscape caused by the spoil heaps will also be considered.

6.3.3.3 Soil

Alterations to the soil

Soil is one of the most sensitive environmental elements to the actions of nature and mankind. Erosive action, when severe, can deteriorate it in a short time, with effects on the existing ecosystem. Also, when human activities do not contemplate adequate protective measures, this can accelerate the deterioration of the soil.

The surfaces to be affected by the work of preparing the site consist principally of soil of no economic utility because of the steep gradient and the very stony nature of the upper slopes. According to the soil classification and land use capacity, this land corresponds to Unit Xse, which includes the Bolivar edaphic unit on very steep gradients (50-75%). The impact is associated with the potential use of the soil such as productive activity, nevertheless, according to information contained in the baseline, there is no productive activity in the concession area, so this impact is low.

Some parts of the Jacaya soil (of colluvial and alluvial origin) contain sparse vegetation composed principally of cacti. This soil is slightly developed and contains some organic material. It is found on the steeper slopes in the western part of the study area and it has a limited potential for agricultural use. If earth moving takes place here, these soils will be removed and stored for use during closure.

Risk of soil contamination

Spillages of hydrocarbons are possible sources of soil contamination. This risk is directly associated with the environmental quality of the soil where the activity is taking place. Productive capacity in the quarry zone is very limited and there are severe limitations to agricultural production as well, according to the information contained in the environmental baseline (see chapter 5.0 soils of the ESIA).

In addition, the environmental baseline establishes that in the quarry area there is no likelihood of an aquifer being present, because: the basin is very small; the difference in height between the basin and the river Cañete is low; and, because the underground consists of impermeable igneous rock.

The effluent generated by the cleaning and maintenance of equipment in the machinery workshop will be treated in soak ways or reused for irrigation after treatment, so this is not expected to be a source of potential contamination.

The risk of pollution from spillages will be prevented through the use of secondary barriers, and rendering the area of the workshop, machinery parking area and fuel store impermeable to reduce the risks. Waste hydrocarbons from machinery maintenance will be disposed of by a solid waste services company (EPS-RS) in compliance with the provisions of the Waste Materials Act (Law 27314) and its executive regulations (S.D. 057-2004-PCM). Adequate maintenance of the drilling and loading machinery and vehicles will reduce the risk of leaks from them. Strict compliance with preventive measures will reduce the risk of soil contamination.

6.3.3.4 Drainage and ground water

Modification to surface drainage

The concession area includes important areas of dry creek beds. During the field observations evidence of torrential runoff and the formation of water courses was found linked mainly to atypical rainfall and exceptional periods, so it can be inferred that under such conditions the creeks will contain water. At present the concavities or micro basins are natural deposits of weathered materials.

Modifications to natural drainage will occur during the construction of the access ramp to the quarry, construction of the drilling platform and blasting. In order to prevent water seepage in the production areas, the construction of channels to divert runoff water, among other work, is envisaged.

Given that the creeks are dry and that there are no settlements nearby, no significant effects of changing the natural flow of surface water are expected. Nevertheless, exceptionally heavy rain could cause runoff that could flow along an altered surface drainage pattern.

Low risk of alteration to the water table

The information given in the environmental baseline (chapter 5.0 of the ESIA) states that the aquifer in the project zone is found at a considerable depth (>70 meters). Given that the quarry will be an open pit, the risk of affecting the water table is minimal, changes in the location or capacity of the aquifer as a result of the blasting and quarrying operations can be ruled out.

Reduction of available water

The activities during the preliminary and operations stage (human consumption, quarrying, maintenance of chemical toilets, vehicle washing) will require the consumption of 7 500 gallons of water a day. It is planned to transport water from Cañete and/or Chincha by tank trucks to tanks located in the concession area. These trucks will have a capacity of 8 000 to 9 000 gallons.

This water consumption could reduce the amount of water available in the supplying area. The necessary permits must therefore be obtained and the water supply to the populated areas mentioned and the productive activities carried on there must not be affected.

6.3.3.4 Vegetation and fauna

Reduction in vegetation coverage

The project area of influence consists of desert and semi-desert terrain with very little vegetation. Xerophyte vegetation within the concession is sparse and includes species that are highly adapted to very dry conditions and are commonly found in the central coastal desert.

The species recorded in the baseline consist of scattered grasses, bushes and cacti, particularly *Heliotropium sp*. and *Presliophytum incanum*.

Cacti recorded in the area are *Neoraimondia arequipensis var. roseiflora* and *Haageocereus pseudomelanostele var. carminiflorus*. *Neoraimondia arequipensis* is endemic to Lima, Ica and Arequipa. Among the Tillandsials, *Tillandsia latifolia var. latifolia* is prominent; it is endemic to Peru and is very common in almost all parts of the country's coastal desert.

The removal of the surface layer of soil during the preliminary work on the site (drilling, construction of the access ramp, platform, selection zone and complementary installations) will destroy some species and cause a limited loss of vegetation because of the limited coverage in the area.

The loss of vegetation, from the point of view of current economic significance is not critical as no economically significant individuals will be lost. From the ecological point of view, cacti are the primary productive species in this habitat. Natural recovery of the vegetation must be allowed as far as possible and removal should be restricted to the minimum necessary. It is proposed to rescue and move representative samples of cacti that could be affected by the quarrying operations.

Displacement or perturbation of fauna

Earth moving during the preliminary activities, quarrying and the presence of humans, will cause a loss of habitats and drive fauna away from the area. This effect, added to an increase in noise (blasting or explosions) during daylight hours, will affect birds, small mammals (rodents), large mammals (foxes) and reptiles, which will migrate to similar habitats around the concession area that are capable of providing them with refuge and food. The effect will be greater on small invertebrates, especially those living in the quarry area.

The biological baseline (chapter 5.0 of the ESIA) has determined the existence of birds such as: *Asthenes cactorum;* mammals such as: *Lycalopex sechurae*, *Phyllotis andium* and *Mus musculus* as well as reptiles such as: *Ctenopleharis adspersa* “Cabezona” and *Dicrodon heterolepis* the “red-headed lizard” which are classed as vulnerable, whilst *Microlophus tigris* the “lomas lizard” is classified as almost threatened (see the INRENA list established in S.D. 034-2004-AG).

The saurians *C. adspersa* and *M. tigris* may suffer disturbance to their environment caused by the quarrying activities. These species use rocks and/or stones as microhabitats for food, heat regulation and refuge (Perez, 2003; Pérez *et al,* 2000). Consequently, the area affected by the quarrying activities should be kept to the minimum possible, to reduce the negative effects on these saurians.

Effect on *D. Heterolepis* “red-headed lizard” will be less as the distribution of this saurian is restricted to the coastal valleys such as Topara creek, to the south and at a considerable distance from he study area.

6.3.3.5 Social aspects

Risks to health and safety

Risks to health and safety will apply to the personnel during execution of the project, because of an increase in noise levels (which can create hearing problems) and the generation of combustion gases and particulate materials (which can create breathing problems) in the quarry area. These effects on the health of the personnel will be prevented and mitigated by adequate measures that are included in the environmental management plan which prescribes the use of personnel protection equipment (ear protectors, face masks, hard hats, gloves, safety harness, etc.) in accordance with the level of risk of the activity in question, as well as compliance with established health and safety procedures (safe working permit, training, etc.)

The risk to the health of the local population is limited because of the distance from the area of operations (approximately 20 Km). In addition, this presence of high ground surrounding the concession area will act as a barrier to the dispersion of contaminants.

6.3.3.6 Cultural aspects

Risk of affecting archaeological sites

The archaeological baseline, chapter 5.0 of the ESIA, identified certain archaeological evidence, with the following being the most important: a pre-Hispanic road, possibly dating from the Inca period, the possible site of a tambo and site 2 (see archaeological map in the maps volume).

Quarrying operations such as blasting may generate vibration that could affect the nearest archaeological sites. Additionally, transport of rock to the selection area and spoil heaps could cross these sites and affect them. The construction of the access ramp, spoil heap and complementary installations may also compromise the original structures on some archaeological sites.

To avoid effects and impacts on cultural heritage, all the areas of interest will be marked out and signposted; there will be a plan to preserve archaeological sites (see chapter 7.0, environmental management plan) which will ensure the protection of archaeological sites in accordance with Peruvian legislation.

6.3.3.7 Perceptual environment

Changes to the quality of the landscape

Alteration of the visual quality is an impact generated by the incorporation and/or modification of unnatural elements into the environment as a result of excavation, earth moving and the extraction of materials, because of the depressions that will be generated. The landscape is an important component in a set of factors that define an ecosystem and is the visible expression of its surroundings.

The importance of the expected modifications to the landscape because of the project activities, was expressed in a landscape quality assessment, which is included as Annex 2.0. The conclusions of this study show that the quarry zone is not a complex one, containing views that are very common and typical of the central coast of Peru, it does not contain landscape of any special significance. There is also a sense of monotony in the zone; which in turn limits its aesthetic potential.

The modified relief after exploitation of the quarry, accumulation of spoil and vehicle traffic will change the appearance only of the zone within the concession area. Given that the project activities will take place far from populated areas and for a short time, it is thought that the impact will be limited.

Table 6-8 gives a summary of the environmental and social impacts described above.

Table 6-8 Summary of environmental and social impacts –of GNL-2 Quarry development

Environmental elements	Environmental and social impacts	Causes	Location	Effect	Condition	Probability	Significance
Economic	Job creation	Preparation work and quarrying.	San Vicente de Cañete and Grocio Prado	Positive	Direct	Inevitable, temporary	Moderate
	Stimulation of trade and services	Purchase of goods and supplies for the construction and operation of the camp, leasing of machinery and equipment, food, lodgings, etc.	San Vicente de Cañete, Grocio Prado and Chincha	Positive	Direct	Inevitable - temporary	Moderate
Air quality	Generation of particulates	Preparing the site, operation and closure.	GNL-2 Quarry	Negative	Direct	Inevitable – temporary	Moderate
	Generation of combustion gasses	Operation of machinery and equipment during construction of the access road and tipper truck traffic for transport of materials.	GNL-2 Quarry	Negative	Direct	Inevitable – temporary	Slight
Noise	Noise	Operation of machinery and equipment during the activities. Blasting, loading and transport of material.	GNL-2 Quarry	Negative	Direct	Inevitable – temporary	Slight
Relief and geodynamics	Ensuring and improving the physical stability of gradients	Profiling quarry faces, reinforcing security berms, deviation of possible surface water runoff, among others.	GNL-2 Quarry	Positive	Direct	High probability of occurrence	Slight
	Modification of the relief	Extraction of material, spoil heap.	GNL-2 Quarry	Negative	Direct	Inevitable	High
	Generation of spoil (excess and waste material)	Extraction of material, spoil heap.	Area of the concession and material dumping zone	Negative	Indirect	Inevitable	Moderate
	Vibration	Blasting in order to break up the rock.	GNL-2 Quarry immediate area	Negative	Direct	High probability of occurrence	Moderate
	Risk of destabilizing slopes	Drilling and blasting.	GNL-2 Quarry	Negative	Direct	A low probability of occurrence	Moderate
Soil	Effect on soils	Preparing the site and extraction of material.	GNL-2 Quarry	Negative	Direct	Moderate probability of occurrence	Slight
	Risk of soil contamination	Operation and movement of machinery and equipment, transport of fuels, storage and refueling. Operation of the access road.	GNL-2 Quarry and immediate access	Negative	Indirect	A low probability of occurrence	Slight
Drainage and ground water	Modification to surface drainage	Construction of access ramp to quarry, construction of drilling platform and blasting in the quarry.	Dry creek beds in the concession area	Negative	Direct	A low probability of occurrence	Slight

Environmental elements	Environmental and social impacts	Causes	Location	Effect	Condition	Probability	Significance
	Low risk of alteration to the water table	Discharge or spillage of contaminants: waste, oils and grease, lubricants, etc. Modification to sub-surface drainage.	Quarry area	Negative	Indirect	Very low probability of occurrence	Very slight
	Reduction of available water	Consumption of water for quarrying operations environmental control (irrigated).	Mouth of the river Cañete	Negative	Direct	A low probability of occurrence	Moderate
Vegetation and fauna	Reduction in vegetation	Removal of the surface layer of soil (drilling, construction of access ramp, starting face, spoil heaps, selection zone and complementary installations).	Quarry area and spoil dump	Negative	Direct	Moderate probability of occurrence	Slight
	Displacement or perturbation of fauna local	Noise generated by the quarrying operations, preparation of the terrain, trucking and transport of materials.	Quarry area and spoil dump	Negative	Indirect	Inevitable	Slight
Social	Risks to health and safety	Increase in noise levels, emissions dust and gases, blasting.	Quarry area and spoil dump	Negative	Direct	A low probability of occurrence	Slight
Cultural-archaeological	Risk of effects on archaeological zones	Quarrying operations such as blasting.	Pre-Hispanic road, possibly Inca, possible site of a tambo and site 2.	Negative	Indirect	A low probability of occurrence	Moderate
Landscape	Alteration of the visual quality of the local landscape	Quarrying and disposal of excess materials.	Quarry area and excess material dump	Negative	Direct	High probability of occurrence	Slight

6.4 ENVIRONMENTAL AND SOCIAL IMPACTS - ACCESS ROAD

The access road will cross part of the coastal desert region where there are no settlements or ecologically sensitive areas in the direct area of influence. The assessment and description of the environmental impacts of the construction and operation of the access road considered a direct area of influence consisting of the right of way or easement and its effects on environmental elements. The route of the access road covers 21,5 Km from the concession area of GNL-2 Quarry to the 168 kilometer marker on the Pan American Highway.

In accordance with the methodology described in previous sections, the environmental analysis used a check list for each project activity to identify the environmental effect/impact. Table 6-9 includes the check list used as part of the environmental assessment process.

This check list was used to interact the project activities with the environmental elements in a cause-effect impact matrix which is shown in table 6-10. This matrix identifies the positive (favorable) and negative (adverse) impacts that may occur during execution of the project, as well as the environmental elements that could be affected and which will require the application of preventive measures and environmental control. This matrix was used to classify the environmental and social impacts; according to their significance (the classification matrix is included in Annex 7). Table 6-11 sows the summary of project impacts, grouped in accordance with their degree of significance, either positive or negative.

Table 6–9 Check list of environmental and social aspects and impacts of the proposed access road

Stage	Activity	Environmental aspect	ENVIRONMENTAL EFFECT / IMPACT	Condition
Building	Preparation of the terrain (general clearing)	Clearing vegetation	Reduction in vegetation	A
		Generation of particulate materials	Increase in particulate material in the air (PM_{10} and solids capable of sedimentation)	A
		Noise	Displacement or perturbation of fauna	A
			Increase in environmental noise	A
		Earth moving	Alterations to the soil	A
			Risk of affecting archaeological sites	A
			Alteration of the visual quality of the local landscape	A
	Extraction of material and infilling	Generation of particulate materials	Increase in particulate material in the air (PM_{10} and solids capable of sedimentation)	A
		Noise	Displacement or perturbation of local fauna	A
			Increase in environmental noise	A
		Earth moving	Modification of the relief	
			Risk of affecting archaeological sites	A
			Alteration of the visual quality of the local landscape	A
	Construction of the sub-base	Generation of particulate materials	Increase in particulate material in the air (PM_{10} and solids capable of sedimentation)	A
		Noise	Displacement or perturbation of local fauna	A
			Increase in environmental noise	A
	Transport of materials	Generation of particulate materials	Increase in particulate material in the air (PM10 and solids capable of sedimentation)	A
		Noise	Increase in environmental noise	A
			Displacement or perturbation of fauna	A
	Laying ballast and compacted layer	Noise	Displacement or perturbation of fauna	A
			Increase in environmental noise	A

Stage	Activity	Environmental aspect	ENVIRONMENTAL EFFECT / IMPACT	Condition
		Compacting and laying compacted surface	Modification to surface drainage	A
	Mobilization of equipment and machinery	Noise	Displacement or perturbation of fauna	A
			Increase in environmental noise	A
		Generation of combustion gases	Changes in air quality through gaseous emissions, (CO, CO_2, H_2S, NO_X)	A
		Generation of particulate materials	Increase in particulate material in the air (PM_{10} and solids capable of sedimentation)	A
		Use of fuel	Risk of soil contamination	A
	Elimination of excess materials	Arrangement of excess materials dump	Modification of the relief	A
			Alterations to the soil	A
			Reduction in vegetation	A
			Risk of affecting archaeological sites	A
			Alteration of the visual quality of the local landscape	A
		Generation of particulate materials	Increase in particulate material (PM_{10}, and solids capable of sedimentation)	A
		Noise	Displacement or perturbation of fauna	A
			Increase in environmental noise	A
	Construction process	Development of construction activities	Risk of changes to the water table	A
		Use of water	Reduction of available water	A
		Use of labor	Increase in family incomes	F
			Stimulation of trade and services	F
			Risks to health and physical safety of the personnel	A
Operation	Road maintenance	Maintenance work	Without significant physical and biological effects	A
		Use of labor	Increase in family incomes	F
			Stimulation of trade and services	F

Stage	Activity	Environmental aspect	ENVIRONMENTAL EFFECT / IMPACT	Condition
	Tipper truck traffic	Increase in vehicle traffic and/or congestion	Perturbation of inhabitants	A
			Risk of traffic accidents	A
		Noise	Displacement or perturbation of fauna	A
			Increase in environmental noise	A
		Generation of combustion gasses	Changes in air quality through gaseous emissions, (CO, CO_2, H_2S, NO_X)	A
		Generation of particulate materials	Increase in particulate material (PM_{10} and solids capable of sedimentation)	A
		Use of fuel	Risk of soil contamination	A

A = Adverse; F = Favorable

Table 6-10 Cause-effect matrix for the construction and operation of the access road

CAUSE-EFFECT		ASPECTS OF THE PROJECT										Results	
		Construction								Operation			
		Preparation of the terrain	Extraction of material and infilling	Preparing the subgrade	Transport of materials	Road surface	Mobilization of equipment and machinery	Elimination of excess materials	Construction process	Maintenance of the road	Tipper truck traffic	Adverse	Favorable
ENVIRONMENTAL ELEMENTS	**AIR QUALITY**												
	Generation of particulates	A	A	A	A		A	A	A		A	8	0
	Generation of combustion gases						A				A	2	0
	Noise	A	A	A	A	A	A	A	A		A	8	0
	RELIEF AND GEODYNAMICS												
	Modification of the relief		A					A				2	0
	SOIL												
	Alterations to the soil	A	A					A				3	0
	Risk of pollution						A		A		A	3	0
	DRAINAGE AND GROUND WATER												
	Modification to surface drainage					A						1	0
	Risk of alteration to the water table								A			1	0
	Reduction of available water								A			1	0
	VEGETATION												
	Reduction in vegetation	A						A				2	0
	FAUNA												
	Displacement or perturbation of fauna	A	A	A	A	A	A	A	A		A	9	0
	SOCIAL												
	Risk of traffic accidents				A				A		A	3	0
	Disturbance of local residents.				A		A		A		A	4	0
	Risk to the health of personnel	A	A	A	A		A	A	A		A	8	0
	ECONOMIC												
	Job creation	F	F	F	F	F	F	F	F	F		0	9
	Stimulation of trade and services	F	F	F	F	F	F	F	F	F		0	9
	CULTURAL												
	Risk of affecting archaeological sites	A	A					A	A			4	0
	LANDSCAPE												
	Alteration of the visual quality of the local landscape	A	A					A				3	0
	TOTAL												
	Summary											62	18
	PERCENTAGE (%) ADVERSE & FAVORABLE												
	Percentage (%)											77.5	22.5

A	Adverse
F	Favorable

Table 6-11 Summary of environmental and social impacts – access road

	CAUSE - EFFECT	ASPECTS OF THE PROJECT										Maximum significance*	Mode**
		Construction								Operation			
		Preparation of the terrain	Extraction of material and infilling	Construction of sub-grade	Transport of materials	Road surface	Mobilization of equipment and machinery	Elimination of excess materials	Construction process	Road maintenance	Tipper truck traffic		
ENVIRONMENTAL ELEMENTS	**AIR QUALITY**												
	Generation of particulates	1.00	1.20	0.80	0.90		0.90	0.70	1.20		2.85	2.85	
	Generation of combustion gases						0.80				1.50	1.50	
	Noise	1.00	1.00	0.80	0.90	0.90	0.90	0.80	1.00		1.80	1.80	0.90
	RELIEF AND PHYSIOGRAPHY												
	Modification of the relief		0.90					0.90				0.90	0.90
	SOIL												
	Alterations to the soil	1.10	1.10					0.90				1.10	0.90
	Risk of pollution						0.40		0.50		0.90	0.90	
	DRAINAGE AND GROUND WATER												
	Modification to surface drainage					0.80						0.80	
	Risk of changes to the water table								0.30			0.30	
	Reduction of available water								1.10			1.10	
	VEGETATION												
	Reduction in vegetation	0.90						0.90				0.90	0.90
	FAUNA												
	Displacement or perturbation of fauna local	1.00	0.80	0.80	0.90	0.90	0.90	0.80	0.80		1.00	1.00	0.90
	SOCIAL												
	Risk of traffic accidents				1.10				1.10		1.95	1.95	1.10
	Disturbance of local residents.				1.30		1.10		1.50		1.95	1.95	
	Risk to the health of personnel	0.80	1.00	0.80	0.70		0.80	0.90	1.00		1.10	1.10	0.80
	ECONOMIC												
	Job creation	1.60	1.80	1.40	1.40	1.40	1.80	2.00	2.60	2.00		2.60	1.40
	Stimulation of trade and services	1.20	1.40	1.80	1.80	1.60	1.60	2.20	2.60	2.00		2.60	1.80
	CULTURAL												
	Risk of affecting archaeological sites	2.20	3.00					2.60	2.40			3.00	3.00
	LANDSCAPE												
	Alteration of the visual quality of the local landscape	1.10	1.00					1.00				1.10	1.00

N.B.
* Highest value. ** Most frequent value

Rango	Significancia
0.00 a 1.00	Muy poca
>1.00 a 2.00	Poca
>2.00 a 3.00	Moderada
>3.00 a 4.00	Alta
>4.00 a 5.00	Muy alta

The significance is determined by the highest classification assigned to an environmental element. The mode is the most frequent value of an impact with respect to the activity generating it.

6.4.1 ORDER OF ENVIRONMENTAL AND SOCIAL IMPACTS

Table 6-12 presents the order of the environmental and social impacts in accordance with their maximum environmental and social significance. Table 6-13 shows the probability of occurrence and significance of the environmental and social impacts of the project, grouped in accordance with the degree of positive or negative significance and probability of occurrence. They are also identified as direct or indirect. This analysis establishes the impacts to which greater priority should be given for prevention, correction or mitigation.

The environmental assessment revealed that the construction of the access road will generate adverse and favorable effects and impacts, both direct and indirect and from the inevitable to those having a very low probability of occurrence.

The favorable impacts include an increase in family incomes through job creation and stimulation of the local economy through the acquisition of goods and services. These positive impacts are considered to be of moderate environmental significance and represent 11,7% of the total impacts identified.

The adverse impact of highest environmental significance is the risk of affecting archaeological sites. It is considered to have a high probability of occurrence because of the existence of archaeological remains in the area of influence. The generation of particulates is considered of moderate environmental significance, caused by tipper truck traffic between the GNL-2 Quarry to the liquefaction plant. Of the total impacts identified, 6% are of high to moderate significance.

Most of the adverse impacts identified are classified as being of little environmental significance, and represent 41,2% of the total impacts identified. The adverse impacts identified are perturbation of inhabitants, risk of traffic accidents, alteration to the visual quality of the local landscape, an increase in environmental noise and others. The probability of occurrence of these impacts varies from inevitable (combustion gas and particulate material emissions) to very low (health risks).

The impacts of very little significance, which will be given a low priority, make up 39% of the total impacts identified. The impact of lowest significance is alteration to the water table, which has a very low probability of occurrence. Other impacts having a low probability and very slight environmental significance are modifications to natural drainage and reduction in available water.

Table 6-12 Order of environmental and social impacts – access road

Environmental impact	Maximum significance		Percentage *
Risk of changes to the water table	-0.30	(-) Very slight significance	35.3%
Modification to drainage	-0.80		
Modification of the relief	-0.90		
Risk of soil contamination	-0.90		
Reduction in vegetation	-0.90		
Displacement or perturbation of fauna	-1.00		
Generation of combustion gases	-1.10	(-) Slight significance	41.2%
Alterations to the soil	-1.10		
Risk to the health of personnel	-1.10		
Alteration of the visual quality of the local	-1.10		
Noise	-1.20		
Risk of traffic accidents	-1.95		
Perturbation of inhabitants	-1.95		
Generation of particulates	-2.85	(-) Moderate sig.	5.9%
Stimulation of the local economy	2.60	(+) Moderate significance	11.7%
Increase in family incomes	2.60		
Risk of affecting archaeological sites	-3.00	(-) High significance	5.9%

(*) The percentage stated has been estimated as a function of the total number of impacts generated by the project.

Table 6-13 Probability of occurrence and significance of environmental and social impacts – access road

Significance Favorable or Adverse	Inevitable	Probability of occurrence			
		High probability	Moderate probability	Low probability	Very low probability
V Very high significance					
IV High significance		• Risk of affecting archaeological sites (-) (ID 1033 0 1)			
III Moderate significance	• Generation of particulates (-) (d) • Stimulation of the local economy (+) (ID 1033 0 1) • Increase in family incomes (+) (d)			• Reduction in available water (-) (d) • Risk of traffic accidents (-) (d)	
II Slight significance	• Generation of combustion gases (-) (d) • Noise (-) (d) • Alteration of the visual quality of the local landscape (-) (ID 1033 0 1)		• Perturbation of local inhabitants (-) (ID 1033 0 1)		• Risk to the health of personnel (-) (d)
I Very slight significance	• Modification of the relief (-) (d) • Reduction in vegetation (-) (d) • Displacement or perturbation of local fauna (-) (d) • Alterations to the soil (-) (d)		• Risk of soil contamination (-) (ID 1033 0 1)	• Modification to surface drainage (-) (d)	• Risk of altering the water table (-) (ID 1033 0 1)

(+) favorable impact; (-) adverse impact; (d) direct impact, (ID) indirect impact

Priority for addressing environmental and social impacts

(blue)	High priority
(white)	Medium priority
(grey)	Low priority

6.4.2 FAVORABLE IMPACTS

6.4.2.1 Economic aspects

Job creation

The construction and operation of the access road to GNL-2 Quarry will generate skilled and unskilled jobs. It is estimated that the labor requirement will be 91 workers (technical personnel, equipment operators and assistants, surveyors, mechanics, camp personnel, aggregate plant and security personnel and traffic controllers) during the construction stage. The demand will be mainly for unskilled labor and, to a lesser extent, skilled labor.

The use of local labor will increase the incomes of the families benefiting and, therefore, their welfare. The nearest people to the project area are the inhabitants of the districts of San Vicente de Cañete, Grocio Prado and Chincha. In principal these communities could be affected, but because of the distance and the very limited expected impacts generated by the road construction, this impact has been classified as of moderate significance during the construction stage of the road.

Stimulation of trade and services

An increase in income levels for some local people associated with job creation, the demand for goods and services (supplies, leasing of equipment, supply of food, lodgings, etc.), during construction and operation of the access road to GNL-2 Quarry, will have a stimulating effect on the local economies (principally Cañete, Chincha and even Ica). This effect will be generated during the time (approximately 2 years) that the quarry will be in operation. It is therefore, that this impact has been classified as of moderate environmental significance.

6.4.3 ADVERSE IMPACTS

6.4.3.1 Air quality and noise

Generation of particulates

Change in air quality because of particle emissions

The environmental air quality baseline (chapter 5.0 of the ESIA) revealed PM 10 concentrations below Peru's National Air Quality Standards. [7] ECA-Aire (150 $\mu g/m^3$), with the concentration falling from the start of the road at km 168 of the Southern Pan American Highway (97,0 $\mu g/m^3$), to the quarry (33,7 $\mu g/m^3$). The reduction in particulate material concentrations coincides with a reduction in the percentage of fine materials in the air. Nevertheless, the measurement taken at where the road branches off the Pan American

[7] Approved by S.D. Nº 074-2001-PCM (Peruvian legislation)

Highway South exceeds the World Bank's standard[8], which is 70 ug/ m^3. This is because of the natural presence of particulate material from the desert environment.

The generation of dust and an increase in particulate material in the air during construction of the access road, will occur during preparation of the terrain, cutting and infilling work and extraction of material from the quarry for the infilling and road surface. During operation of the road, the increase in particulate material in the air will be caused by tipper truck traffic during transport of materials from GNL-2 Quarry to the liquefaction plant.

The impact is of moderate environmental significance during the operating stage of the access road due to the continual traffic of tipper trucks carrying rock over a distance of 21,5 Km. The quantity of material generated will depend directly on the traffic level. The maximum traffic will be 440 journeys a day using a maximum of 40 trucks. The particulate materials emissions scenario considers the maximum daily traffic of tipper trucks. The atmospheric dispersion model was used to assess emissions of particulate materials and the point of maximum concentration[9]. Table 6-14 includes an inventory of emissions used for modeling particulate materials (PM_{10})

Table 6-14 Inventory of emissions on the access road to GNL-2 Quarry expressed in grams per second (g/s)

Activity	Scenarios modelled	
	Desert stretch (0 to 15 Km)	Hilly stretch (15 to 21 Km)
Loaded truck	2,307	0,705
Loaded truck	1,810	0,553

(*) The moisture content of the soil was assumed to be 5% using a rate of irrigation of 0,56 l/m^2 on an area of 60 000 m^2 over a distance of 7,5 Km. It was assumed that the irrigated areas were well compacted and that the water penetrated 1 cm below the surface.

Atmospheric dispersion model

The environmental effect on air quality was determined using the atmospheric dispersion model, which is attached as Annex 8. The parameter modeled was particles below 10 microns (PM_{10}) because these are the main contaminants. The results of the modeling were compared with Peruvian Air Quality Standards and with the World Bank's Contamination Prevention and Mitigation Manual.

Table 6-15 shows the maximum concentration of $PM_{10,}$ according to the air quality model used for the scenarios described.

[8] World Bank Pollution Prevention and Abatement Handbook (PPAH) – July 1998
[9] ISC3 stands for "*Industrial Source Complex Model*", which meets the requirements for air quality models established by USEPA.

Table 6-15 Maximum concentration of PM_{10} using the atmospheric dispersion model

Parameter	Maximum concentration (µg/m^3), 24 hour average	ECA – Aire Peruvian Standard, 24 hour average (µg/m^3)	World Bank Standard, 24 hour average (µg/m^3),
SP_{10}	574,4	150	70

In accordance with Table 6-15, the maximum concentration obtained was higher than Peru's ECA – Aire and the World Bank standard. The maximum concentration of PM_{10} considering the proposed 5,0% moisture content occurs near to the route at UTM coordinates WGS84 363 000E 8 538 000, some 200 meters from the road. This point of maximum concentration is located 2,5 Km from the Nuevo Cañete 3rd Stage development; 4,8 Km from M.S. Brisas de Concón; 4,7 Km from M.S. Trébol del Pacífico; 6,9 Km from M.S. Eliane Karp. Annex 8 gives a map of the dispersion isolines of particulate materials drawn up for this study (M A8-1).

The analysis of the effect of particulate material emissions (PM_{10}) on the population in the area of influence calculated the fourth maximum concentration value in 24 hours, in accordance with Peruvian legislation, using the atmospheric dispersion model. The results of this concentration are shown in Table 6-16.

Table 6-16 Fourth maximum value of average concentration over 24 hours for PM_{10}, in inhabited areas in the area of influence

Inhabited area	UTM coordinates WGS84		Concentration of PM_{10} (µg/m^3)
	East	North	
Nuevo Cañete 3rd Stage development	360 000	8 537 500	194,46
M.S. Trébol del Pacífico	357 900	8 537 700	11,10
M.S. Las Brisas de Concón	358 000	8 537 900	9,34
M.S. Eliane Karp	356 135	8 538 632	10,85
C.P.M. Nuevo Cañete	361 800	8 535 800	47,85
M.S. Asoc. Agrop. Apóstol Santiago	362 200	8 532 000	3,47
M.S. Cinco Cruces	362 800	8 531 000	4,62
Asoc. Colonizadora de la Costa	363 000	8 530 800	6,99
C.P.M. Nuevo Ayacucho	364 000	8 530 000	2,89
Avícola	372 000	8 538 200	44,06

The previous table shows that the maximum concentration of PM_{10} occurs at the Nuevo Cañete 3rd Stage development and exceeds Peruvian air quality standards as well as those of the World Bank. Nevertheless, there is no resident population in the zone yet, only parcels of land ready for building. It is expected that once the project is under way these parcels can be occupied progressively.

To mitigate and control the generation of particulates and their effects on air quality, it is planned to irrigate the access road using tank trucks having a capacity of between 8 000 and 9 000 gallons. The water requirement for this stage will be approximately 65 000 gallons a day.

In addition it is planned to take monthly measurements at the start of the operations to confirm that the actual levels caused by the traffic comply with Peruvian and international regulations. The environmental management plan (chapter 7.0 of the ESIA) gives details of the measures to control emissions of particulate materials.

The study area is located in an open area where the wind speed varies between 6 - 10 m/s in Summer and 4 - 8 m/s in Winter, the prevailing wind is SW. This favors the dispersion of particle emissions, substantially reducing their concentration and, therefore, their effects on air quality.

Generation of combustion gasses

Changes to air quality caused by combustion gas emissions

Operation of equipment, machinery and other vehicles during construction of the access road will generate combustion gas emissions such as sulfur dioxide (SO_2), carbon monoxide (C_O) and nitrogen oxides (NOx), increasing the presence of these gases in the air. These emissions will also occur during the operation of tipper trucks for the transporting of material from the GNL-2 Quarry to the liquefaction plant.

The concentration of these parameters in the air around the proposed access road is well below the ECA-Aire standard, according to the results obtained from air quality monitoring. Only vehicles, machinery and equipment that have been properly tuned will be used so that emissions will be minor and dispersed along the 21,5 Km of the access road. This, together with the wind conditions described above, indicate that emissions will not cause severe perturbation to the air quality in the area.

For these reasons, this impact has been classified as of slight environmental significance in the construction and operation of the access road.

Noise

Temporary increase in environmental noise levels

This impact will be produced by the preparation of the terrain, extraction of material and infilling, mobilization of equipment and machinery during construction of the access road and by the tipper truck traffic carrying rock during operation.

Measurements indicated noise levels below the limits established in Peruvian air quality standards (S.D. No. 085-2003-PCM). The noise levels registered show a decreasing tendency from the start of the road at Km 168 of the Pan American Highway South (67,0 dBA), where it is influenced by traffic on that road, towards GNL-2 Quarry (30,6dBA) where the noise levels are caused by the wind blowing in this zone.

The noise levels along the proposed access road will increase during construction and operation of the road. However there area no human settlements in the area. There is an area known as the Nuevo Cañete 3rd Stage development where parcels have been defined for housing. It is estimated that the increase in noise levels will not cause severe perturbation in the area, other than the risk of displacement of the fauna found in this desert environment.

6.4.3.2 Relief and geodynamics

Modification of the relief

The extraction of materials from the quarry in order to construct the access platform and spoil heap from the road will cause a slight modification to the relief. The spoil dumps will conform to the design established for them.

It is estimated that the modifications to the relief during the operations described above will not cause serious environmental disturbance as the project area is stable and a desert with little value as landscape or for use according to the land use capacity categories. This impact, therefore, has been classified as of very little significance.

6.4.3.3 Soils

Alterations to the soil

The construction of the access road, which is approximately 21,5 Km long and 12 m wide on average, will affect approximately 25,33 ha of land. The baseline (chapter 5.0) showed that the soils do not meet the minimum ecological conditions required for cultivation, pasture or forestry, and are located in small undulations between 3,0 and 5,0 Km from the start of the road and on the final 8 Km. These soils have a low productive capacity, among others, because of the gradient, excessive permeability (sandy soils), the presence of salts and the lack of organic material.

Risk of soil contamination

There is a possibility that small spillages of fuel, grease and oil may occur in the areas where machinery and equipment will operate during construction of the access road. All equipment and machinery used on the project must be kept in good operating condition and will be subject to preventive maintenance in accordance with the manufacturer's specifications. Initial inspection and preventive maintenance of machinery and equipment will reduce and prevent minor spillages.

Because the soils are not productive, this impact has been classified as having a moderate probability of occurrence and very slight environmental significance, during both the construction and operation stages.

6.4.3.4 Drainage and ground water

Modification to surface drainage

Compacting of the soil during the placement of ballast and construction of the compacted surface of the access road and the barrier effect that this will cause, could alter the flow of rain water in the small creeks in the area (Culebrillas and Cansa Caballo creeks principally), where the access road crosses. Considering the lack of surface water runoff associated with the very slight precipitation on the Peruvian coast (except during an El Niño event), culverts will be built where the road crosses creek beds so that any water can flow normally. In the event of an El Niño, it is believed that the presence of the road (according to the design envisaged) will not seriously affect the local drainage. This impact has therefore been classified as having a low probability of occurrence and of very slight environmental significance.

Low risk of alteration to the water table

The aquifer in the area where the access road is to be built is at a considerable depth (> 70 m). Chances that there will be a substantial alteration of the water table as a result of the construction of the road are very limited. Therefore this impact, even if it occurs, will be of very slight environmental significance.

Reduction of available water

Dust mitigation measures will require water for sprinkling the roads. The construction activities will also use water. Water for dust mitigation can be sea water or fresh water. In the latter case, there may be a disruption to the water supply in the zone where the water is extracted, as it is not very plentiful. The water requirement is estimated at approximately 65 000 gallons a day and will be transported with tank trucks from Cañete and/or Chincha to tanks located in the concession area. These trucks will have a capacity of 8 000 to 9 000 gallons.

This water consumption could reduce the amount of water available in the supplying area. The necessary permits must therefore be obtained and the water supply to the populated areas mentioned and the productive activities carried out there must not be affected.

6.4.3.5 Vegetation and fauna

Reduction in vegetation

Along the access road, plant species known as Tillansiales can be found. They are characterized by the presence of *Tillandsia sp*, which is widely distributed throughout the coast, as well as species alike *Tillandsia latifolia var. latifolia, Tillandsia latifolia var divaricata* and *Tillandsia paleacea*.

On the last 4 Km of the proposed access road, before it reaches GNL-2 Quarry, the cactus *Haageocereus pseudomelanostele var. carminiflorus* was the dominant species and there is a high density of *Nolana weberbaueri.*

Preparing the terrain for the construction of the access, principally the stretch next to the quarry and elimination of excess material could cause the loss of individuals of the species described. Whereas the space occupied by the access road and spoil heap will be relatively small and the vegetation is sparsely distributed in the affected area, it is thought that the reduction in vegetation will be of very slight environmental significance and would occur mainly during the construction of the road.

Displacement or perturbation of fauna

The noise generated by the activities (preparation of the terrain, extraction of material and infilling, transport of rock and other activities) during construction of the access road and operation of tipper trucks, could cause the displacement of terrestrial fauna living in the zone.

The biological baseline (chapter 5.0 of the ESIA) identified the reptiles *Ctenopleharis adspersa* “Cabezona” and *Dicrodon heterolepis* “red-headed lizard”, which are classified as vulnerable, whilst *Microlophus tigris* “lomas lizard” is considered almost threatened (see INRENA list in S.D. 034-2004-AG).

The saurians *C. adspersa* and *M. tigris* will have their habitat disturbed by the construction and operation of the access road as they use rocks and/or stones as micro habitats for food, temperature regulation and refuge (Pérez, 2003; Pérez *et al,* 2000). Therefore, movement of rock and stone during the construction will, in addition to altering the landscape, affect the habitat of these species.

The effects upon *D. Heterolepis* “Red headed lizard” caused by the construction of the access road would be minimal as this species is restricted to the coastal valleys such as Topara creek located to the south, which is at a relatively great distance from the proposed access road.

Whereas the access road will be relatively narrow (no more than 20 meters wide) and linear, displacement of fauna as a result of the factors described, will not affect large areas.

6.4.3.6 Social environment

Risk of traffic accidents

The frequency of approximately 40 to 240 tipper trucks carrying rock from the quarry along the access road will create an increased risk of traffic accidents. However, there are no settlements adjacent to the road. There is a zone where parcels have been marked out but none has yet been occupied. The marginal settlements of Las Brisas de Concón and Trébol del Pacífico are also in the area of influence (close to the Pan American Highway South).

Where the access road crosses the Pan American Highway South there will be no risk of accidents as a bridge will be built.

To minimize the risk of accidents, truck drivers will be trained on the existing risks. Speed limit signs will be erected to reduce the risk of accidents. The EMP describes the safety measures to be taken, with the objective of reducing the risk of accident taking place.

Disturbance of local residents

The Nuevo Cañete 3rd Stage development is close to the beginning of the access road, but is not yet inhabited. Other settlements are located 3 Km to the north (M. S. Las Brisas de Concón and Trébol del Pacífico) and 2 Km to the south of the first stretch of the road (C.P.M. Nuevo Cañete).

The marginal settlements consist of houses made of bamboo matting and timber. The houses are built one from another and located on land belonging to the Ministry of Agriculture. They are mostly unoccupied and are looked after by a few watchmen. Only during the weekends there are people present. Part of this informal population may be affected by particulate material emissions and noise during construction of the access road and transport of materials from the quarry. It is also possible that there could be conflicts between construction personnel and local people.

However, measures to reduce particulate material emissions and noise as well as the conduct of the personnel during work will reduce the magnitude of the impact. This has been classified as of slight environmental significance for both stages of the project, but has a moderate probability of occurrence.

Risk to health

Emissions of gases, noise and particulate materials during construction of the access road and transport of material from the quarry could affect the future inhabitants of the Nuevo Cañete 3rd Stage development adjacent to the proposed road, and those of M.S. Las Brisas de Concón, Topara and Nuevo Cañete, if they expand towards the proposed access route and/or the permissible limits are exceeded. Nevertheless, considering the very small human population of these settlements it is estimated that the risks related to health are of little significance and have a very low probability of occurrence.

6.4.3.7 Cultural environment

Risk of effects on archaeological zones

The archaeological studies of the surface identified archaeological evidence of ancient human habitation, such as a wind break, rectangular stone structures and a geoglyph. A pre-Hispanic road was also identified and this could be affected in at least four places by the proposed access road. Despite the redesigning of the original route to avoid damage to archaeological remains close to it, if the boundaries of these sites are not respected there could be an effect on the archaeological remains mentioned.

6.4.3.8 Perceptual environment

Alteration of the visual quality of the local landscape

Clearing carried out during preparation of the terrain for the construction of the access road and disposal of excess material will cause changes to the immediate landscape and surroundings. The assessment of landscape quality shows that the area around the future access possesses little variety in form, color and texture, making it a low quality landscape.

The impact of the road construction activities on the visual quality of the landscape will depend on the dimensions and perceived quality of the affected areas; it has been classified as being of slight environmental significance for the construction of the access road and of very slight environmental significance for the spoil heaps and quarry.

Table 6-17 gives a summary of the environmental and social impacts grouped according to their condition, probability of occurrence and environmental significance.

Table 6-17 Summary of environmental and social impacts – Access road

Environmental elements	Environmental impacts	Causes	Location	Effect	Condition	Probability	Significance
Economic	Job creation	Increase in income levels, job creation and demand for goods and services	San Vicente de Cañete, Chincha and Ica	Positive	Indirect	Inevitable, temporary	Moderate
	Stimulation of trade and services	Acquisition of goods and services and an increase in family incomes	San Vicente de Cañete, Grocio Prado and Chincha	Positive	Direct	Inevitable - temporary	Moderate
Air quality	Generation of particulates	Preparation of the terrain, extraction of material and infilling, quarrying. Operation of the access road	From GNL-2 Quarry to the Pan American Highway. Nuevo Cañete 3rd Stage development	Negative	Direct	Inevitable – temporary	Moderate
	Generation of combustion gasses	Operation of machinery and equipment during construction of the access road and tipper truck traffic for transport of materials.	From GNL-2 Quarry to the Pan American Highway	Negative	Direct	Inevitable – temporary	Slight
Noise	Noise	Operation of machinery during the activities.	From GNL-2 Quarry to the Pan American Highway. Nuevo Cañete 3rd Stage development	Negative	Direct	Inevitable – temporary	Slight
Relief	Modification of the relief	Extraction of materials from the quarry, excess materials dump	Quarry, excess material dump	Negative	Direct	Inevitable	Very slight
Soil	Alterations to the soil	Construction of the access road	From GNL-2 Quarry to the Pan American Highway, over an area of approximately 25,33 Ha.	Negative	Direct	Inevitable	Very slight
	Risk of soil contamination	Operation and movement of machinery and equipment, transport of fuels, storage and refueling. Operation of the access road.	From GNL-2 Quarry to the Pan American Highway	Negative	Indirect	Moderate probability of occurrence	Very slight
Drainage and ground water	Modification to surface drainage	Compacting of the soil, building the access platform and the barrier effect to surface runoff water.	Culebrillas and Cansa Caballo creeks mainly (under exceptional conditions)	Negative	Direct	A low probability of occurrence	Very slight
	Low risk of alteration to the water table	Discharge or spillage of contaminants: waste, oils and grease, lubricants, etc. Modification to sub-surface drainage	From GNL-2 Quarry to the Pan American Highway	Negative	Indirect	Very low probability of occurrence	Very slight
	Reduction of available water	Consumption of water for dampening and construction of access road	Mouth of the river Cañete	Negative	Direct	A low probability of occurrence	Slight
Vegetation and fauna	Reduction in vegetation	During preparation of the terrain and elimination of excess materials	Sector near to the quarry	Negative	Direct	Inevitable	Very slight
	Displacement or perturbation of fauna local	Noise generated by the installation and operation of the camp, preparation of the terrain, cutting and infilling, quarrying and transport of material.	From GNL-2 Quarry to the Pan American Highway	Negative	Indirect	Inevitable	Very slight

Environmental elements	Environmental impacts	Causes	Location	Effect	Condition	Probability	Significance
Social	Risk of traffic accidents	Tipper truck traffic carrying rock	From GNL-2 Quarry to the Pan American Highway. Principally sectors of the Nuevo Cañete 3rd Stage development and M. S. Las Brisas de Concón, El Trébol del Pacífico and C.P.M Nuevo Cañete	Negative	Direct	A low probability of occurrence	Slight
	Disturbance of local residents.	Emission of particulate materials and noise during construction of the access road and transport of material from the quarry	Nuevo Cañete 3rd Stage development, M. S. Las Brisas de Concón and Nuevo Cañete.	Negative	Indirect	Moderate probability of occurrence	Slight
	Risk to the health of personnel	Emission of gases, noise and particulate materials during construction and transport of materials	From GNL-2 Quarry to the Pan American Highway. Effect on sectors of the Nuevo Cañete 3rd Stage development, Las Brisas de Concon and Nuevo Cañete.	Negative	Indirect	Very low probability of occurrence	Slight
Cultural-archaeological	Risk to archaeological sites	Earth moving and disposal of excess material	From GNL-2 Quarry to the Pan American Highway	Negative	Indirect	High probability of occurrence	High
Landscape	Alteration of the visual quality of the local landscape	Clearing during the construction of the access road, disposal of excess material and operation of the access road.	From GNL-2 Quarry to the Pan American Highway	Negative	Direct	Inevitable	Slight

7.0
ENVIRONMENTAL MANAGEMENT PLAN

This Environmental Management Plan contains measures to avoid, correct or mitigate the environmental impacts that could be created as a result of rock extraction in GNL-2 Quarry and those impacts resulting from the access road construction and operation. Preventive measures are designed to avoid potential impacts or reduce their severity. Corrective measures promote recovery of the environmental quality of the affected area over a period of time. Mitigation measures correspond to irreversible impacts for which it is not possible to recover the original environmental conditions.

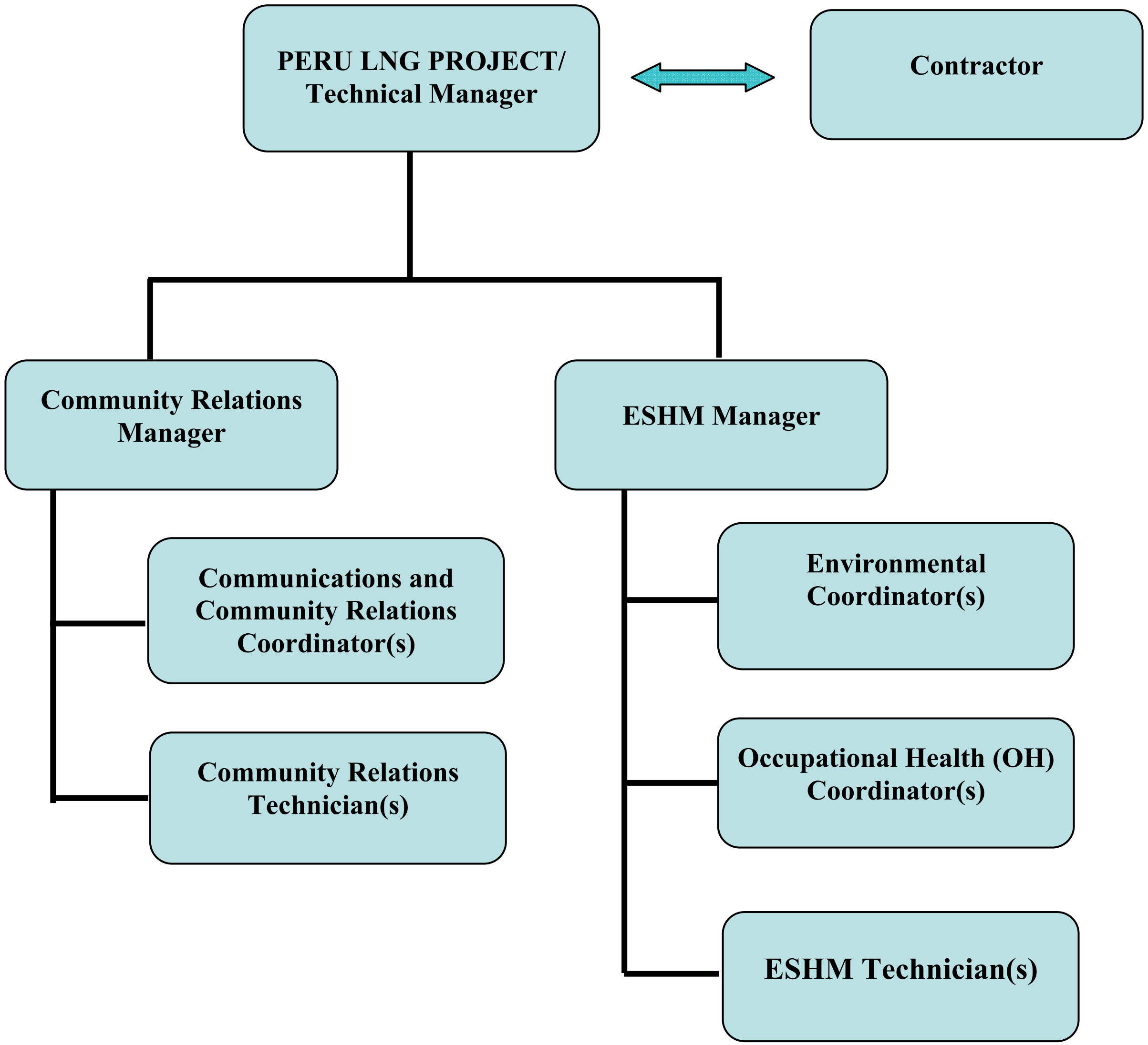
The Environmental Management Plan is an executive document that shall be available to the personnel managing the quarry exploitation. This plan is divided into three programs: the "Impacts Prevention, Correction and Mitigation Program for the Quarry and the Access Road", the "Environmental Monitoring Program," and the "Environmental Follow Up and/or Surveillance Program". The first program contains operative and preventive regulations to be implemented during all phases of the Project to minimize environmental damage through appropriate action. The second describes the sampling and analysis needed to detect possible changes in environmental quality resulting from quarry operations and from use of the access road. The third will ensure the compliance of measures set forth in the Prevention, Correction and Mitigation Program, for operations at both the quarry and the access road.

The Environmental Management Plan objectives are as follows:

- Detailing the action required to avoid, correct or mitigate the environmental impacts resulting from the quarry development and its access road construction and operation (GNL-2 Quarry).
- Creating the guidelines to apply the measures contained in the action lines.

PERU LNG, through its Environmental, Safety and Health Management (ESHM), shall carry out the implementation, surveillance and compliance of the plans and programs proposed in the EIA during the Project execution. Figure 7-1 shows this Management organization chart.

Figure 7-1 PERU LNG Environmental, Safety and Health Management Organization Chart



7.1 PREVENTIVE AND MITIGATION MEASURES

The prevention, correction and mitigation program for the quarry and its access road is subdivided into action lines to facilitate its implementation and follow-up. Each action line has been designed to prevent, correct or mitigate the most significant environmental and social impacts (identified in Chapter 6.0, Impacts Assessment).

7.1.1 FUEL SPILL POLLUTION PREVENTION

Oil and fuel spills prevention shall be achieved by the appropriate control of their storage and use. PERU LNG shall supervise storage and handling procedures in the Project Area and the correct implementation of preventive measures. These measures are as follows:

- Oil and fuel storage or handling shall only occur in places designed and equipped for that purpose (machine room).
- Fuel storage tanks shall be periodically inspected for leaks and corrosion.
- Storage tanks shall be installed on ponds or contention berms with a minimum of 110% capacity (according to Rule 052-93-EM) of the largest tank capacity.
- Fuel transportation vehicles shall be inspected for tank integrity, joints and terminals as well as fuel discharge processes shall be supervised.
- Vehicles shall be periodically inspected for minor leaks. If detected, any leaks shall be immediately repaired.
- Fuel supply for heavy machinery shall be conducted in the work site using tank trucks which are appropriate for that purpose. Light machinery over tires shall be supplied in the area with a fixed fuel tank or in the machine room. In both cases, anti-spill inspected sleeves shall be used.
- All tank trucks supplying fuel to equipment in the work site shall be equipped with anti-spill kits to clean any spill that does occur. Operators shall be trained in the appropriate use of this equipment and the preventive measures established for the Project.
- Cylinders for used fuel storage shall be placed in a suitable storage area. This fuel will be removed as waste or recycled. None of the cylinders use for fuel storage shall ever be available for use by the local population.
- In the event of a spill, liquid fuel shall be recovered using hydrocarbon absorbent pads, to be disposed of in appropriate sealed containers. These shall be placed in the storage area and arranged for their removal and final disposal by a solid waste services supplying company (EPS-RS) duly authorized by DIGESA.
- Contaminated soil shall be removed and stored in cylinders for further remediation or disposal. In the event of remediation, a place within the Project Area will be designated as a treatment site where remediation techniques may be applied. In the event of disposal, the removal and final impoundment shall be completed by a solid waste services supplying company (EPS-RS) duly authorized by DIGESA.

- Washing of equipment to remove oils or greases shall be carried out over cement tiles with closed channels, allowing the recovery of polluted water. These effluents shall be stored in non-removable capped cylinders of 55 gallons and stored in places suitable to that effect. The cylinders shall be labeled with "Water with Oils and Grease Contents". A solid waste services supplying company (EPS-RS) authorized by DIGESA shall collect the marked cylinders for their appropriate treatment and final disposal. In the event of local disposal, an oil and grease and sediment trap shall be used. Final disposal shall be carried out by means of a well or percolation field, or by road irrigation. If the treated wastewater is used for road irrigation, samples shall be taken every two months to determine if it complies with the criteria for water used for irrigation purposes.
- The operations center warehouse shall contain all necessary equipment and material for an efficient and effective response in the event of a spill.
- Training and practices for response in the event of a spill shall be carried out.

7.1.1.1 Prevention of Effects on Groundwater

According to the baseline analysis, the groundwater table is below 70 m in the quarry operation area. Therefore, the groundwater table is not expected to be effected in any way as a result of drilling and blasting during development.

Also, groundwater pollution is not likely to occur due to fuel spills. The strict compliance of the above prescribed handling measures for fuels within the Project Area should prevent this impact.

7.1.2 SOLID WASTE HANDLING

Quarry extraction operations do not create significant amounts of organic waste, sanitary waste or other compostable waste. The major waste component shall be waste from operating machinery maintenance activities. Blue cylinders shall be used for organic waste; green for recyclable inorganics; and black for non-recyclable waste.

The Project does not comprise camp facilities; however, PERU LNG has arranged the implementation of a fixed dining room for workers with a safe and clean space to eat food supplied by an authorized catering company. This shall create waste of disposable containers, bags, plastic bottles, etc. Waste shall be temporarily stored in appropriate containers and removed to a landfill authorized by the province municipality.

Used Fuels

Cylinders containing used fuels shall be stored in designated rooms. Cylinders shall be stored over wood grids (pallets), with a maximum of 2 levels. The storage area shall have a waterproof floor, including a dike or contention bar with a capacity of at least 110% (Rule 052-93-EM) of the total stored capacity.

The used fuel from the machinery oil changes shall be stored in cylinders of 55 gallons. Cylinders with removable caps shall not be used. A contractor shall periodically collect cylinders for their final disposal or reuse. In the event of a spill, measures detailed in the Contingence Plan regarding pollutants shall be followed (see Chapter 9 of this ESIA).

Industrial Waste

Full containers of industrial waste shall be sent for their final disposal to the nearest authorized landfill. Plastic, glass and paper shall be recycled if facilities are available. Used oil filters and other waste from motor maintenance shall be stored in 55 gallon cylinders with removable caps. Dissolvent and paint containers shall be separately stored in 55 gallon cylinders with removable caps. Hazardous waste shall be stored and delivered to a solid waste services supplying company (EPS-RS), authorized by DIGESA, for its treatment and final disposal. Uncontaminated scrap metal and wood shall be stored in the final disposal area for industrial waste until removed for commercialization or donated to third parties.

7.1.3 LIQUID WASTE SUITABLE HANDLING

Domestic effluent (sewage) created in the portable chemical restrooms shall be handled and removed by an authorized solid waste services supplying company (EPS-RS). According to PERU LNG policies, this waste is not to be disposed of in the environment, even if treated. This sewage shall always be removed from the Project Area for proper disposal.

Machinery and equipment maintenance and cleaning activities during the Project construction and operation stage are expected to create liquid effluents with residual grease and solids. The machine room shall have an area for machinery and equipment washing with a contention system, sumps and grease traps. Changing rooms with showers and sinks for the staff personal care shall be made available. The approximate amount of water resulting from these activities is anticipated to be 7,000 gallon/day.

Water from the machine room, after passing through the grease trap, as well as waters from the showers and sinks shall be collected in a sedimentation pond, and then sent to percolation ponds or filtration beds. This is not expected to affect the water table as it is located 70 m below the surface and is naturally protected by an impervious layer of igneous rock. As an alternative to this arrangement, water may be used for roads irrigation to reduce dust emissions, once it has been analyzed and meets water quality criteria.

7.1.4 ATMOSPHERIC EMISSION AND NOISE REDUCTION PROGRAM

The quarry construction, operation activities and transportation of the quarry material along the access road will create particulates and gas emissions. Emissions will also be created by the machinery used to extract or transport material. Also, the operations area office intends to use a small electric generator of 75 kW, which would release particulate material and gases.

The following measures to avoid or reduce effects in the air quality shall be applied:

Particulate Material Emissions

- Road surfaces shall be periodically irrigated using tank trucks in order to maintain soil humidity levels at approximately 5%. Dust control shall be more extensive in the area of the access road closest to the local population. For this activity, it is estimated that approximately 65,000 gallons/day of seawater or freshwater will be required, with a higher volume in the summer months and a lower volume in the winter.
- Vehicles' speed shall be limited to a maximum of 30 km/h in the quarry and 60 km/hr on the access road.
- If monitoring results show dust values exceeding the applicable standards, speed limits shall be reduced; the use of sea or freshwater shall be increased, or binding material shall be used in order to ensure that air quality standards are met.
- Blasting shall be carried out twice a day at 12:00 and 16:00 hours. This schedule is intended to optimize use of available atmospheric dispersion and is based on the fact that the strongest winds occur in the afternoon.
- The Contractor shall supply masks and goggles to work staff, in addition to the basic personal protective equipment, whenever workers are in areas where dust cannot be sufficiently controlled.

Combustion Gas Emissions

- Before commissioning a machine for construction or operation activities, it shall be subject to inspection to determine that it operates correctly. The result of this inspection shall be kept in files for future reference.
- All mobile combustion sources used during Project activities shall receive regular mechanical maintenance in order to prevent excessive emissions. A maintenance control sheet shall be made available and kept current for each combustion source. These control sheets shall be part of the Contractor's monthly report.
- Vehicles exhibiting high opacity (black smoke) shall be repaired or adjusted before they may be operated. Documentation of this maintenance activity shall be included in the contractor's reports.

Noise Creation

- All vehicles, combustion motors, generators and machinery in general shall be equipped with accessories for noise reduction.
- The installation or use of any kind of appliances or accessories designed to produce noise, such as valves or resonators adapted to air brake systems, in any vehicle for circulation on public roads is prohibited.

7.1.5 ARCHAEOLOGICAL SITES PRESERVATION

The contractor in charge of the access road construction and GNL-2 quarry development shall take the following measures:

- Existing sites along the access road and within the quarry area shall be clearly signed with posts or boundaries and posters to make the sites easily recognized by the machinery operators and other workers.
- The staff shall be trained for recognizing and respecting the signals placed for sites' protection.
- If during the Project construction and operation stages evidence is found of any archeological site not identified in the archaeology study, work shall be immediately suspended in that area and notice shall be given to the authorities of the National Institute of Culture (INC).
- Contractors shall immediately report to PERU LNG any possible archaeological evidence or findings.
- In the event of finding additional remains, a specialist shall carry out the following actions:
  - The archaeological site boundaries shall be determined and polygon zoning shall be established. This zoning shall be verified by bore holes excavation techniques.
  - Placement of posts or boundaries in the zoning field shall indicate the area and degree of protection. This will be done following the guidelines of the National Institute of Culture.
  - Signs shall be put in place to ensure that the operators are able to recognize the site.
- PERU LNG shall assess the feasibility of including in this Management Plan the recommendations as proposed in the INC Supervision Report.

7.1.6 VEGETATIVE COMMUNITIES NATURAL RECOVERY

Vegetation is scarce in the quarry and the access road area. Rock blasting and road construction shall affect areas supporting the presence of Cactaceae and Tillandseas or herb and shrub vegetation (scrub), potentially damaging soil and vegetation.

To reduce vegetation loss, the most practical measure is to minimize excavation areas strictly to those that are necessary, and to promote natural vegetation recovery in the areas where quarry operations have been completed.

As part of the effort to promote the Project Area vegetation development, the following measures shall be taken during development of the waste rock pads:

- Leave stable steep slopes. The natural colonization procedure will begin in stable areas exhibiting suitable soils and oriented to receive the highest amount of exposure to humidity from fog.
- Cover with sandy substratum (landfill with colluvial-alluvial material in the area) in the slopes with rocky waste. Surface soil removed for construction of roads and waste pads could be placed in the areas where vegetation recovery is being promoted. If these soils supported plant species before they were originally removed for construction, then they

are likely to contain seeds and other material to propagate vegetation. Once sections of the waste pads are constructed to the designed dimensions, surface leveling and conditioning shall be carried out. Before final closure of the waste pads, conditions should be met for vegetation development.

- Designate restricted areas to protect established vegetation. Seeds from these protected plant communities are expected do disseminate and colonize the vegetation development areas. In addition to accelerating vegetation recovery, this measure shall also help maintain a suitable habitat for the micro fauna displaced.
- Once the area is abandoned, machinery and peasant access shall be limited.

Cactaceae preservation

Considering the semi-arid desert classification of the area and the existence of common plant species for the coastal desert, it is not necessary to continuously monitor vegetation. Two low cover cacti species are found in the Project Area with dispersed distribution. Neither of these is under any protection category. Due to their adaptation to arid and semi-arid conditions, cacti contain valuable genetic information of resistance to field stress. Also, cacti in this ecosystem play an important role representing the main flora basis of the primary productivity.

Before clearing vegetation from the quarry, plant material shall be collected to create an experimental plot that can be studied to predict the development process of cacti species existing in the quarry area. Adjacent habitats that exhibit suitable characteristics to place the experimental plot shall be identified to simulate the conditions to which cacti shall be exposed before the quarry closure.

Handling of cacti during abandonment shall be determined based on the results obtained in this experimental plot.

Tillandseas Recovery and Removal

Tillandseas are bromeliads located near the quarry access road in areas exposed to fog. This species does not have roots and grows in groups. The access road goes through places where this vegetation would be affected. In order to reduce impacts on this species, Tillandseas located along the road shall be removed, once the boundaries for the operations area of the access road have been established. This vegetation shall be relocated to areas with similar habitat characteristics to continue their development.

7.1.7 MITIGATION MEASURES FOR FAUNA DISPLACEMENT

The impact analysis identified a possible fauna migration (birds, reptiles, and mammals), as an effect with low significance. The environmental baseline assessment identified the following land habitat birds in the Project Area: *Geositta peruviana* "pampero peruano," *Geositta maritima* "pampero gris," and *Ashtenes cactorum* "cacti canastero". These birds show a restricted distribution from Tumbes to the North of Chile; however, they are not listed under any protected or endangered species category. In the study area, lizards *Microlophus theresiae* (endemic for Lima and Ica) and *Microlophus tigris* (almost endangered, as per S.D.

034-2004-AG) were found. It is estimated there is a low presence of minor mammals, as most of the excrement and regurgitated material containing mammal bones and hair that were found in the quarry area were not fresh. These would probably belong to a period of strong Niño Phenomena (1998), when the availability of food notably increased, resulting in a population increase.

Fauna displacement shall be avoided by minimizing the areas used for quarry material exploitation and transportation and by taking measures to restore vegetation.

Vegetative cover and rocky habitat in the area should provide some protection for most minor vertebrates from the effects of noise, dust and vehicle transit.

7.1.8 VISUAL QUALITY IMPROVEMENT

Development in the Project Area shall create a depression, material accumulation in the waste pad and the development of access roads to the interior of the Project Area. Visual quality improvement shall mean favoring the natural vegetation in those areas where this is possible.

7.1.9 EXPLOSIVES HANDLING

Explosives shall be stored in a building designed for that purpose in an area away from other facilities within the Project Area. It shall be kept closed and under 24-hour a day surveillance by private security staff. Explosives handling and use shall be made according to the regulations from the Ministry of Internal Affairs and the General Directorate of Security Services, Gun Control, Munitions and Civil Use of Explosives (DICSCAMEC). Only trained staff shall be in charge of the handling of explosives.

The authorization for explosives handling in mining activities shall be available, and obtained, according to the Consolidated Text for Administrative Procedures (TUPA) from DICSCAMEC and its amendments in S.D. No. 002-98-IN dated 04-25-98.

Some of the preventive measures to be implemented are:

- Staff evacuation 500 m around the shooting area.
- Explosives handling only by trained staff bearing a DICSCAMEC license.
- Continuous surveillance of explosives building.
- Safety procedures regarding explosives handling followed according to the legislation in effect.
- Procedure to remove explosives from the place of origin to the Project Area (escorted).

7.1.10 CODE OF CONDUCT FOR THE STAFF IMPLEMENTATION

The Community Relations Guidelines shall regulate the company relations with the communities and towns neighboring the Project Area. These Guidelines shall contain Internal

Rules or Code of Conduct for workers directly hired by PERU LNG or the contractors. Thorough knowledge of the Guidelines and the Code of Conduct will be required for all workers.

The Guidelines shall include the following:

- Restricted entry to the settlements of neighboring communities adjacent to the Project Area.
- Prohibition of alcoholic beverages consumption or other intoxicants within the premises of the Project Area.
- Prohibition of fauna hunting activities in the neighboring areas and within the premises of the Project Area.
- Creation of environmental consciousness among all the Project personnel, specifically with regard to the wild fauna and vegetation species of importance in the area and their conservation.

7.1.11 WORK STAFF SAFETY

- The contractor in charge of operation and construction shall comply with the provisions for occupational health, industrial safety and accidents prevention prepared by the Ministry of Labor.
- The contractor shall train the staff by giving daily 5 minute speeches. These will be specific speeches about the most sensitive and risky aspects of the daily activities and other topics related to daily occurrences. All speeches shall be registered in the PERU LNG training form. PERU LNG in turn, shall supervise its compliance.
- The contractor shall have an Occupational Health, Industrial Safety and Accidents Prevention Plan to be approved by PERU LNG, who shall establish the necessary policies and the staff's obligation to know, comply with, and respect these policies. To that effect, PERU LNG shall appoint an exclusive director, with authority allowing him/her to make decisions and implement them.
- The contractor shall oblige its employees, suppliers and agents related to the contract execution to comply with all conditions relating to occupational health, industrial safety and accident prevention, as established by the contract documents.
- Whenever the Environmental Supervising Entity requires, the contractor shall review and adjust the Occupational Health, Industrial Safety and Accidents Prevention Plan. Work may be suspended when the contractor does not comply with the occupational health requirements or does not follow PERU LNG instructions.
- The contractor shall inform PERU LNG in writing of any accident occurring at the work sites. The contractor shall also keep a register of all occupational illnesses occurring amongst personnel and damages caused to property or public goods. Monthly reports on these topics shall be prepared.
- Workers and employees shall be subject to a medical examination before being hired to verify their health condition. A medical examination shall be carried out annually.

- Hiring minors for any kind of labor in the work sites is strictly prohibited.
- The contractor's personnel shall be equipped with personal and mass protection equipment appropriate for the risks they face (proper clothing, helmet, gloves, boots, goggles, ear protection, etc.). The protective equipment shall be of good quality and shall be periodically checked to guarantee their proper condition.
- The work staff shall be informed about the risks of every task, the proper way to use the material, tools and equipment available, and the way to timely and suitably aid any injured person. The contractor shall supply the working areas with stands, workshops, warehouses and all other temporary premises, stretchers, first-aid kits and other equipment to enable the provision of first aid assistance.
- The contractor shall supply equipment, machinery and tools suitable for each type of work. These shall be operated by qualified and authorized personnel and used only for the purpose for which they were designed. They shall be periodically inspected and then repaired or returned, and shall be provided along with the devices, instructions, controls and safety signals as required or suggested by the manufacturers.
- The contractor is obliged to use only automotive vehicles in perfect operating condition, to appropriately and safely transport people, material and equipment, according to the transportation and transit authorities' regulations. Vehicles shall be driven by trained personnel, shall be duly marked and shall have the necessary warning labels.
- All vehicles shall be checked by the driver before being operated and a Check List shall be completed. This form shall report the vehicle condition, possible defects in their operation and detect any leakage.
- Work sites shall maintain appropriately lighting in such a way that all activities can be carried out safely. Lightning sources shall not limit the visual spectrum nor produce dazzles.
- Warning and informative signals shall be placed at important places within the Project Area to avoid accidents on the access roads, hazardous slopes and, in general, in places representing any kind of hazard.

7.1.12 OCCUPATIONAL DAMAGES PREVENTION

The contractor shall comply with the exposure maximum limits of 85 dB(A) for an 8-hour period as established in the Mining Safety and Health Regulations of the Ministry of Energy and Mines (S.D. No. 046-2001-EM). The use of ear protection in the most exposed areas (nearby drilling machines, electric generators, motors) will be permanently enforced and obligatory.

In the event of exposure to gases and particles, workers shall have access to and use breathing protection equipment with special filters for gases and dust.

PERU LNG Industrial Safety and Health Regulations sets out the measures to be implemented in the event of effects related to health. Among other issues, these regulations include measures referred to as personal visual, hearing and respiratory protection. Following is a list of measures relevant to the environmental management plan, which are described in detail in the above regulations.

- The personnel shall wear a helmet, safety shoes and goggles.
- The personnel carrying out operations, during which the material may affect their eyes, shall use suitable safety glasses.
- Workers exposed to significant levels of dust (nearby drilling machines, roads, places near rock loading) shall have breathing protection equipment with special filters for solid particles.
- For activities in the blasting areas, only duly trained staff shall be hired. Also, they shall bear their pertinent authorization to handle explosive material issued by DICSCAMEC.
- The staff in general shall be continuously trained to carry out construction and operation activities in the quarry and access roads, taking into account all risks and effects on health and being aware of the consistent use of their personal protection equipment.
- The Industrial Safety and Health area shall verify that workers' exposure levels do not exceed permissible levels.
- The staff shall pass a yearly pre-occupational medical examination. Also, at quarry closure the staff shall undergo an examination.
- Before any primary or secondary firing of explosives, the quarry staff shall be removed to a distance not less than 500 meters from the shooting place.
- Previously established warning signals and the pertinent authorization are required before firing the fuse for explosives. Once the blasting is done, the explosive shall be verified to have completely detonated.
- Entry to the quarries is prohibited once the blasting is done until it has been verified that the explosion gas and dust dispersion are in concentrations within the established limits.
- After every explosion, unstable material shall be removed.

7.1.13 PUBLIC HEALTH PROTECTION

- All workers assigned to field operations (most important for foreign staff) shall pass a pre-occupational medical examination that will include laboratory analysis.
- Reinforce health preventive measures among the local personnel.
- During the construction stage, posters related to good practices of health and hygiene shall be placed in visible locations, explaining practices such as: washing of hands, waste disposal, the use of portable restrooms, etc.

7.1.14 SLOPES PROTECTION IN QUARRIES AND WASTE ROCK PADS

When possible, slopes in quarries and waste rock pads shall use angles designed to avoid landslides and favor revegetation and soils formation. Waste rock pads during the winter time shall be exposed to humid winds (fogs), which supply the necessary humidity that is required for vegetation recovery.

The characteristics of the rock to be extracted will allow the presence of very steep slopes without the presence of landslide risks. The stability of slopes in rock is generally limited by the presence of discontinuities which may potentially create unstable blocks due to the intersection between them and the slope face. For this reason, geological inspection and geotechnical studies shall be carried out to verify that there are no structural discontinuities. Once this has been accomplished, the landslide risk will be very low.

Due to the fact that the Project Area is located relatively far from human settlements, there should not be a need for special measures to control vibrations. Blasting design shall be carried out to reduce the risk to civil infrastructure and to prevent slope destabilization in the least stable areas and in sectors with known faults. The measures to implement are as follows:

- Maintain slopes according to the specified design parameters.
- Slope angles shall assure their stability.
- Frequent slope and bank inspections in final dimension.
- Construct seepage ditches and crested ditches
- Condition the slope crests (remove ridges and any supporting rock structures).
- When possible, facilitate natural vegetation (concurrent closure).
- Carry out controlled blasting and reduce load in unstable segments or segments with known faults.
- Clearly mark areas where slopes are not stable as a preventive measure in the event of a landslide.

Considering the possible event of a mudflow, seepage ditches and one crested ditch shall be built, immediately close to the waste pads and the quarry. The waste pads and the quarry shall not occupy the main channel where a potential mudflow would be expected to flow. The waste pads shall be placed on minor creek slopes and backgrounds at an altitude where fluvial-torrential phenomena are not aggressive. Natural drainages shall be kept open by culverts or riverbeds diversion maintaining the natural flow volumes.

7.1.15 ROAD BORROW AREA MANAGEMENT AND SURPLUS MATERIAL DISPOSAL (SMD)

The access road construction and quarry access constructions shall require borrow material to fill or improve the foundation or sub-foundation quality. In some cases, cut surplus material may be required to be placed (material which cannot be used for construction in the accesses may sometimes be used as fill material). These shall be small areas along the road and the quarry. It is the responsibility of the contractor to apply these measures during the extraction of borrowing material and the depositing of surplus material.

The following mitigation and prevention measures shall be implemented in the borrow areas:

- The soil surface layer (5 to 30 cm), together with vegetation, shall be carefully removed and placed adjacent to the borrowing area to save for use in the affected area restoration.

- Material extraction shall be carried out in such a way that unexpected landslides are not produced.
- Once the extraction has been completed, the area shall be refurbished, leaving stable slopes and placing a surface layer to facilitate natural vegetation, whenever possible.
- The contractor shall supply workers with necessary personal protection elements, according to the activities performed and make first aid equipment readily available.

Mitigation and prevention measures to be implemented in the surplus material deposit (SMD):

- Surplus material shall be placed in stable areas. Surplus material shall not be placed in environmentally sensitive areas, agricultural lands, or watercourses without respecting their hydraulic capacity.
- Soil surface layer (5 to 30 cm) from every surplus material deposit together with vegetation shall be carefully removed and placed adjacent to the temporary use area to be saved for further use in the affected area restoration.
- Once the surplus materials are placed in the SMD, these shall be compacted with at least four (4) caterpillar tractor runs with suitable thickness (0.50 – 1.00 m) layers.
- Once the deposit is stabilized, the area shall be refurbished, leaving stable slopes and placing a surface layer to facilitate natural vegetation, when required.

7.1.16 TRANSIT SIGNALING AND MAINTENANCE

During the access road construction and use stages, transit signals and warnings shall be placed. Signaling shall comply with the Guidelines of the Automotive Transit Control Provisions for Streets and Roads approved by Ministerial Resolution No. 210-2000-MTC/15.02. Signal selection and location shall procure efficiency and contribute to the best road use. Vertical signaling shall include preventive, regulatory and informative signals as well as transit control through working areas.

Preventive signals are to be designed and located according to the road alignment in areas representing a real or potential hazard (blind curves, foggy areas, slopes) which may be avoided by limiting the vehicle speed or by taking certain precautionary measures.

Preventive signals shall have a dimension of 0.75 x 0.75 m, with a background of reflective material that is yellow and high intensity. Symbols, letters and the framework edge shall be painted with black xerographic ink. Fixing posts for these signals shall be made in concrete, painted in 0.50 m strips, with black and white enamel. The location of these signals shall be defined so as to give the necessary time to identify and respond to the dangers.

Regulatory signals shall create order in the access to and use of the access road, and the quarry terrain, by informing drivers of the existence of certain limitations and prohibitations. The location of the regulatory signals shall depend on the type of message and the inherent construction activities.

Informative signals shall be mainly used to guide the driver through a given road, orienting him/her towards the destination. Dimensions vary according to the message intended and shall be located no less than 60 m and no more than 100 m before intersections. Informative signals may be rectangular, with variable dimensions, depending on the inscription they shall bear. The signal background shall be made in reflective plate, “green color engineering” grade. The message on the signal, as well as the edges, shall bear reflective material in high intensity white.

A summary of the measures for each of these action lines is included in Table 7-1, where they appear in order of the potentially affected environmental impact, the activity that could cause it, the objective of the measure, the type of measure, the measure proposed, the application scope and the period. The table also contains measures for preventing or mitigating the most significant social and environmental impacts, as identified in Chapter 6.0, Impacts Assessment.

Table 7-1 Prevention, Correction and Mitigation Measures

Components	Environmental Impacts	Originating Elements	Measures Objective	Type of Measure	Suggested Measure	Application Scope	Implementation Period
AIR QUALITY	Air quality change due to particulate material emission	Machinery and equipment mobilization. Blasting. Material removal and load. Heavy vehicle transit	Keep PM_{10} concentrations under MPL	Preventive	Keep accesses in good condition. Roads irrigation Speed control 60 km/hr in the access road and 30 km/hr in the quarry Controlled blasting	Along the access, quarry, wastes	During all construction and development
	Air quality change due to combustion gas emissions	Gas emission due to machinery operation	Keep combustion gas concentration under MPL	Preventive	Polluting gases monitoring Machinery maintenance in good condition	Machinery operation and maintenance areas	During all development
	Temporary noise level increase	Noise due to machinery operation	Keep noise level within suggested range	Preventive	Noise monitoring Machinery maintenance in good condition	Machinery operation and maintenance areas	During all construction and development
SOILS	Soils loss	Quarry and waste pad areas	Favor natural vegetation in areas where possible without changing the area characteristics	Mitigation	Favor natural vegetation where possible Leave leveled angle of repose	Waste pad	During all access construction and quarry development
	Pollution risk	Fuel spill due to machinery operation or maintenance operations In transit vehicles with fuel	Reduce pollution risks	Preventive	Machinery maintenance Fuel and oil leakage inspection Fuel and oil changed only in the maintenance area	Maintenance workshop	During all access construction and quarry development
				Corrective	Polluted soil removal, use of absorbent pads to remove hydrocarbons; contingency measures application.	Soils in fuel tanks, quarry and wastes	During all development

Table 7-1 Prevention, correction and mitigation measures

Environmental Components	Environmental Impacts		Originating Elements	Measures Objective	Type of Measure	Suggested Measure	Application Scope	Implementation Period
RELIEF	Relief change	Depression creation	Pit opening (or banks)	Give alternative use to depression	Mitigation	Leave slopes as designed. Conditions slopes crests	Quarry	During development
		Waste material pile creation	Waste disposal	Area conditioning landscape wise	Corrective	Leave angle of repose Favor vegetation	Waste pads	As waste pads are closed
	Vibrations increase		Blasting	Reduce infrastructure affecting risks	Mitigation	Special care in blasting design in areas nearby faults	Quarry	During development
	Slopes destabilization		Blasting	Reduce landslide risks	Mitigation	Leave angle of repose Controlled blasting, reduce load in known faults areas	Quarry and waste pads	During development
DRAINAGE AND GROUND WATER	Surface runoff change		Sterile material disposal in the waste pads	Reduce flood risks due to severe occasional rainfall	Mitigation	Design waste pads with runoff structures for severe rainfall Keep waterways free	Waste pads	During development
	Pollution risk of groundwater table due to oils and fuels		Machinery operation in lowlands close to watercourses Oil or fuel spills during transit	Reduce groundwater table pollution risk due to oils and fuel spills	Preventive	Suitable maintenance to machinery Fuel handling rule submission Fuel recharge and oil change in maintenance area using contention systems.	Machinery operation areas	During development
					Corrective	Removal of polluted soils, use of absorbent pads to remove hydrocarbons; application of contingency measures	Quarry and accesses	During development

Table 7-1 Prevention, Correction and Mitigation Measures

Components	Environmental Impacts	Originating Elements	Measures Objectives	Type of Measure	Suggested Measure	Application Scope	Implementation Period
VEGETATIÓN	Vegetation cover reduction	Quarry development and waste pad creation	Facilitate natural vegetation restoration in areas where possible	Preventive	Minimize area to be removed Restrict access to protect areas with established vegetation	Quarry, roads and waste pads	Before and during quarry development
				Mitigation	Favor natural vegetation in waste pads	Quarry and waste pads	Installation and use of waste pads
FAUNA	Temporary fauna migration	Quarry development and waste pad use	Revert the original fauna migration	Mitigation	Restrict access to areas with established vegetation and rocky areas used as shelter.	Waste pads, Project neighboring areas	Continuous as waste pads are abandoned
CULTURAL	Risk of affecting archaeological remains	Blasting, road construction, waste pads	Abate alteration risks in archaeological areas	Preventive	Archaeological prospecting and certification (CIRA) Stop mining operations when archaeological remains are found and give notice to INC	Throughout the Project area	During development and operations closure stages, if needed
				Preventive	Signaling archaeological areas and train staff in their reconnaissance	Throughout the Project area	Throughout the Project
				Corrective	Rescue archaeological remains in coordination with INC, if needed.	Throughout the Project area	Whenever needed
	Landscape alteration	Cut, blasting, waste pads and road construction	Restore landscape quality	Mitigation	Favor natural vegetation in areas where possible without altering area characteristics	Waste pads	Development and operations closure
HEALTH	Health affected	Polluting noise and gas created by machinery operation	Reduce hearing and breathing illnesses risks	Preventive	Use of ear plugs,anti-dust/pollutants mask, health control according to Mining Safety and Health Regulations	Quarry and waste pads staff	During development
				Corrective	Facilitate medical assistance of proved cases according to the Mining Safety and Health Regulations	Quarry staff	As cases arise

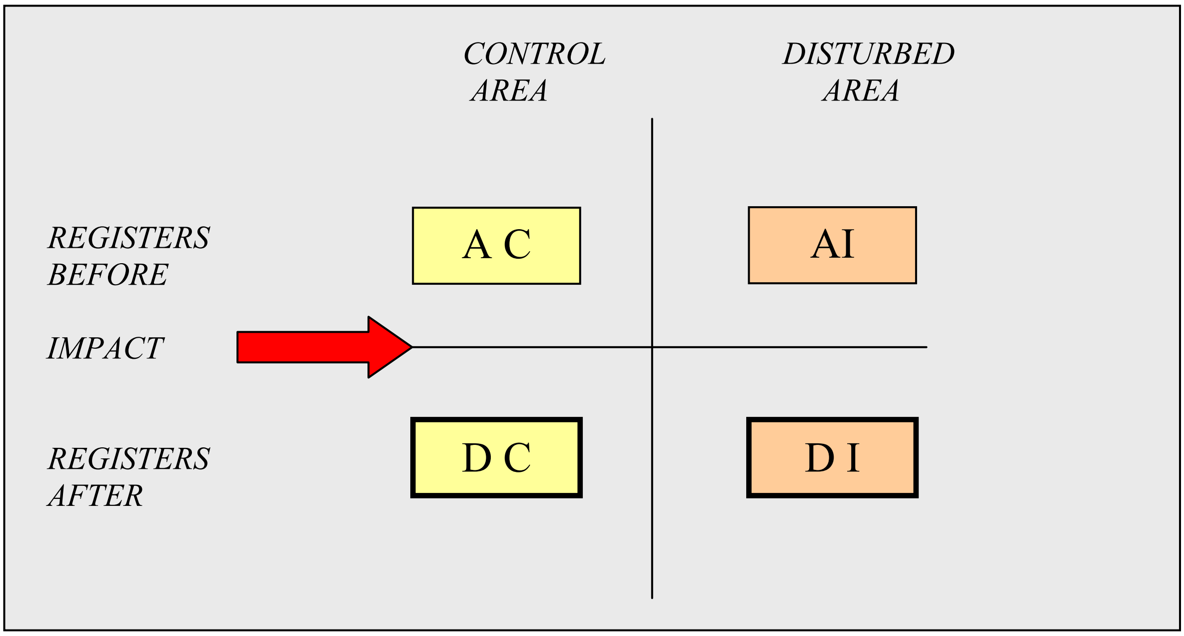
7.2 ENVIRONMENTAL MONITORING PROGRAM

The Environmental Monitoring Program measures the impacts that the access road and the quarry construction and operation activities have on the environmental components, by a periodic data register. Data obtained is compared to data obtained in the baseline and those effects identified in the Environmental Impacts section.

7.2.1 ENVIRONMENTAL MONITORING PROGRAM[1] THEORETICAL FRAMEWORK

The Environmental Monitoring Program is a follow-up plan that responds to sensitive ecologic indicators. These indicators will allow the successful analysis of the Management Plan measures or the establishment of supplementary measures to this Plan to reduce environmental effects.

To detect changes induced by the Project on environmental indicators, the data series to be registered shall be arranged considering a design of "before commencement of the quarries development extension" (A) and "after the extension commencement" (D); also, "control or undisturbed area" (C) and "disturbed area" (I). This design (ADCI) is as follows:



The ADCI design seeks information from the area where the environmental effects shall be registered (mining area) and from a control area, free from impact influence. For both areas, before and after the effects registers shall be required.

The monitoring program is a tool that, by means of the so-called adaptability handling, allows detecting ecosystem responses and modifying the activities to keep an ecosystem "healthy".

[1] Guidelines developed by Dr. Edgar Sánchez, Ecologist, Universidad Nacional Agraria La Molina.

This system shall be capable of accepting specific changes in the Project design. Therefore, a control area to register the same variable is necessary.

7.2.2 OBJECTIVES

- Verify that the quarry development and the access road operation and construction activities do not create environmental changes exceeding the environmental quality standards.
- Supply updated information to supplement the mitigation or corrective measures, if necessary.
- Comply with the local and international environmental legislation.

7.2.3 AIR QUALITY AND NOISE MONITORING

Air quality monitoring shall measure particle and gas concentrations and compares it to the Air Quality National Standards (S.D. No. 074-2001-PCM, 24-06-2001) and the World Bank's General Environmental Standards of the Guidelines for Pollution Prevention and Mitigation. For noise monitoring, the values obtained shall be compared to the maximum permissible values as established by the Noise Environmental Quality National Standards (S.D. No. 085-2003-PCM, 10-30-03) and the World Bank's Environmental General Standards

The monitoring parameters and frequency are shown in Table 7-2. Particulate material monitoring shall first be made on a monthly basis, for a period of 6 months, then the frequency may be reduced to once every three months, complying with established standards. Particulate material monitoring stations shall be located at the beginning of the access road, in the entrance to the quarry and in one access road medium point. As for gases, sampling shall be carried out at the beginning of the access road and at the entrance to the quarry.

Table 7-2 Air Quality Monitoring Frequency and Parameters

Parameter	Period	Standard		Method of Analysis
		D.S. No. 074-2001-PCM	PPAH WBG	
Particulate material less than 10 microns (PM10)	Monthly for 6 months, then quarterly	150μg/m^3 24 hr	70 μg/m^3 24 hr	Inertial separation/filtration (Gravimetric)
Carbon monoxide (CO)	Quarterly	10 000 μg/m^3 8 hr	Non-established	Non-dispersive infrared (NDIR) (Automatic Method)
	Quarterly	30 000 μg/m^3 1 hr	Non-established	
Sulphur dioxide (SO_2)	Quarterly	365 μg/m^3 24 hr	125 μg/m^3 24 hr	UV Fluorescence (automatic method)
Nitrogen dioxide (NO_2)	Quarterly	200 μg/m^3 1 hr	150 μg/m^3 24 hr	Chemiluminescence (automatic method)

If the particulate material values exceed the established standards, mitigation measures such as speed reduction or polymer binder shall be used.

Noise measurement frequency and comparison standards are shown in Table 7-3. The quarry and the access road are far from the town, therefore, only industrial areas measurement applies. If there is a change in the area use, the residential standard shall apply. Noise monitoring shall be carried out monthly for a 6-month period to then be reduced to a quarterly frequency, if the established standards are met. Monitoring stations shall be located at the beginning of the access road, at the entrance to the quarry and at the access road medium point.

Table 7-3 Noise Measurement Frequency and Comparison Standards Expressed in LaeqT (Noise Equivalent Level)

Application Areas	Frequency	D. S. Nº 085-2003-PCM		PPAH – WBG	
	Measurement	Daytime (1)	Evening (2)	Daytime(1)	Evening (2)
Special Protection Area	N/A	50	40	N/A	N/A
Residential Area	N/A	60	50	55	45
Residential Area	N/A	70	60	70	70
Residential Area	Quarterly	80	70	70	70

(1: From 07:01 to 22:00
(2) from 22:01 to 07:00

7.2.4 EFFLUENT MONITORING IN THE EVENT OF REUSE

The EMP has considered the possibility to reuse waters from machinery washing after being treated in an oil and grease trap. If so, the oil and grease content in the water shall be analyzed for two consecutive periods and, if the standards are met, monitoring shall be performed every two months.

Water shall meet the value of 10 mg/L for Oils and Greases, which is established for discharges to water bodies in the World Bank's Pollution Abatement Handbook.

7.2.5 FAUNA MONITORING

Due to the *Microlophus tigris* (Nearly Endangered as per S.D. 034-2004-AG) reptile condition, reptile monitoring shall be carried out in two stations located in the quarry and one undisturbed adjacent station serving as control. The method to be used shall be the same as in the baseline, as detailed in the Appendix.

Due to the fact that there is a continuous fog in central and southern Peru, between May and October, semester assessments shall be carried out, to which effect February (as one of the driest months) and August (as one of the wettest months) have been proposed.

The results are to be interpreted in the same way as the fauna baseline. Considering that the sampling shall determine capture frequency by species, the Shannon-Wiener biodiversity index shall be calculated.

7.2.6 VEGETATION LATENT PERIOD FOLLOW UP

Considering that arid characteristics in the area do not account for continuous monitoring of vegetation, during the first year after the quarry development activities, a follow up of the cactaceae representative samples latent period percentage shall be carried out, as will be done in the experimental plot.

7.2.7 ARCHAEOLOGICAL MONITORING

PERU LNG shall study the possibility of undertaking continuous archaeological monitoring during the GNL-2 quarry and the access road construction.

One of the INC Supervisor recommendations during an on-site visit was to send an INC Archaeologist after one year of the quarry operation to monitor and supervise the quarry development works that will be carried out.

Both the PERU LNG Archaeologist and the INC Supervisor shall identify potential archaeological sites along the access road, according to the information supplied by the archaeological baseline, to protect them from accidental damages during the construction period.

7.3 ENVIRONMENTAL SURVEILLANCE AND/OR FOLLOW-UP PROGRAM

The Environmental Surveillance and/or Follow-Up Program (ESP) is a technical report of environmental control to guarantee the compliance of measures provided in the Prevention, Correction and Mitigation Programs in order to attain the preservation and sustainable use of natural resources and the environment during the quarry development, the construction and operation of the access road. Thus, during the development and construction stage, the following objectives shall be met:

- Outline the impacts detected in the Environmental and Social Impact Assessment (ESIA) and make sure the proposed corrective or preventive measures are being implemented and are efficient.
- Detect unpredicted impacts in the ESIA and propose suitable corrective measures and verify their execution and efficiency.
- Check and verify the predicted impacts occurrence.

Environmental Surveillance Operations

To meet the ESP objectives, operations that ESIA recognizes as those likely to create larger environmental impacts shall need to be controlled.

Actions requiring control are as follows:

- Location of machine room facilities in low vegetation areas. Without a suitable handling, these sites may turn into toxic or hazardous material weirs.
- Excavation activities along the access, in the quarry and surplus material deposits, which shall affect the area relief and landscape as well as a continuous dust creation.
- Closure stage including those activities preparing closure for a given operation.
- Solid waste and used oils handling. These shall be disposed of in previously selected sites to that effect.

ESP execution shall be performed by environmental coordinators included in the ESHM flow chart. They shall inspect the quarry development activities and the permanent access road construction. The coordinator shall advise the contractor, communicating with him/her directly and enabling him/her to comply with environmental standards and solve any non-compliance or unpredicted situation.

8.0
SOCIAL MANAGEMENT PLAN (SMP)

The Social Management Plan predicts and plans responses for certain common and specific social impacts that may occur throughout the operation activities of the GNL-2 Quarry Exploitation Project, Cañete – Peru. A Social Management Plan (SMP) is necessary for adequate management of these social impacts.

This SMP contains the measures to be implemented in the different stages of execution or operation of the Project, in order to promote positive outcomes and decrease or minimize the adverse impacts that may arise. This Plan has been developed in accordance with Annex 2 of the "Regulations for Environmental Protection in Mining and Metallurgical Activities", Supreme Decree No. 016-93-EM.

Table 8-1 Forecast of direct and indirect social impacts

Phase	Likely Direct Impacts	Likely Indirect Impacts	Likely Management Measures
Building of the Access road to Quarry - Exploitation of GNL 2 Quarry	Demand for labor[1]	Frustration of not being included in the building activities.	▪ Advise the contractors about the criteria for selecting workers, prioritizing the people in the Project Area (San Vicente de Cañete and Grocio Prado) as long as they meet the technical requirements. ▪ Inform the community in the Project Area about the job vacancies, identifying the number of available positions and the application requirements. This information will be given by the offices that will be opened for this purpose. ▪ The salaries will be identified by the contractor according to the qualifications of the worker and in strict compliance with labor legislation. ▪ PERU LNG or their contractors will train the local workers in the application of environmental, safety, and occupational health provisions, as well as in the knowledge and mandatory compliance of the Workers Code of Conduct. ▪ The project will make it possible to generate new productive skills, especially for local workers.

[1] The building of the access road to Quarry GNL-2 will generate jobs, for skilled as well as for unskilled labor. Approximately 91 workers (technical staff, equipment operators, equipment assistants, topography, machine shop, camp operations, aggregate production, security and traffic controllers) will be hired during the construction stage. For the population within the scope of the Project, the demand for labor will basically be for unskilled labor, and to a lesser extent for skilled labor, and will depend on the characteristics of each activity for the building of the road from Km. 168 of the Southern Pan America Highway to the Quarry.

The population potentially benefited from this positive impact of the Project is mainly the population of the Districts of San Vicente de Cañete, Grocio Prado and Chincha.

It is anticipated that during the building of the access roads and the provisional facilities approximately 50 workers will be needed. At the exploitation stage, about 231 people will work in the Quarry and its facilities, 70-90 of which will be local inhabitants, mainly in unskilled jobs.

Phase	Likely Direct Impacts	Likely Indirect Impacts	Likely Management Measures
		Increase in the expectations of local population and stakeholders.	▪ Design and implement a Temporary Hiring Program for the local population that will anticipate the demand of skilled and unskilled work force, the time the employment will last and the requirements the applicant will have to meet to be accepted. This plan will be provided to the authorities, the local populations and stakeholders by the offices that will be opened for that purpose. ▪ Inform local stakeholders, through local and regional communication media on the location of the offices where they may learn about job opportunities for laborers and the priorities that will be given to local workers.
		Migration to the project area in order to seek employment	▪ To decrease and control the flow of population or people seeking employment in the Project area, it must be made clear through the mass media that any people who arrive at the Project area seeking employment will not be hired, because priority will be given to the people who live in the Project area. ▪ Foreign workers will be committed not to have their families migrate to the area, and not to infringe on the company facilities.
	Generation of jobs, as well as an increased demand for goods and services (raw materials, equipment rental, food supply, accommodations, etc.) during construction and operation of the access road to the Quarry GNL-2 and during the time the	Increased level of income in the Project area Stimulation of local economy	▪ The company may consider mechanisms to allow purchasing local products, as long as the local market prices remain competitive and are not affected by the company's interest. ▪ Offer training to local economic agencies for the development of small and micro enterprises.
		Conflicts and quarrels between suppliers and contractors	▪ Implement a sales system to determine the best offer regarding competitive products and services. In other words, implement a sales system designed to locate goods and services at competitive prices, good quality and in amounts required by the company.

Phase	Likely Direct Impacts	Likely Indirect Impacts	Likely Management Measures
	materials are extracted from the Quarry. (Approx. 2 years)	Prostitution, and the sale and consumption of liquor may appear or increase.	▪ The workers and the contractors must at all times commit to maintaining honest behavior with a high level of personal and professional responsibility, both within and outside of the Project Area. They must show respect to the local populations, their culture, their social rules, the environment, and others, in compliance with the standing legal regulations in the country and PERU LNG Code of Conduct. ▪ It is important to prepare training programs for workers and contractors regarding measures to avoid environmental and social impacts. Likewise, the wide diffusion of the Project Workers Code of Conduct.
	The possible arrival of foreign workers in the area	Interaction between the Project workers and the women from local populations.	▪ Wide diffusion of the Project Workers Code of Conduct and the establishment of sanctions for offenders. ▪ All workers and subcontractors must be subject to a Social Code of Conduct. ▪ Documentation and diffusion of training and educational programs. ▪ For industrial safety and security reasons, the workers are not to leave the Project Area without an authorization. The local workers will be transported to their city of origin in the Project own transportation units, which are unable to make unauthorized stops.

Phase	Likely Direct Impacts	Likely Indirect Impacts	Likely Management Measures
	Increase in the levels of dust, occupational diseases, etc.	Hearing disorders caused by increased levels of noise and generation of combustion gases and particulate matter within the Concession (potentially causing respiratory disorders)	▪ All workers shall go through a complete physical examination before starting any work on the Project. ▪ It is necessary and important to train all personnel and to inform them of sanitary and health matters, and on the emergency evacuation procedures. ▪ Even though the risk of health disorders is very low, because of minimal levels of polluting gases, personnel shall use the adequate personal protection equipment to ensure hearing and respiratory protection. ▪ Provide training for workers with regard to the measures to prevent the transmission of sexually transmitted diseases shall be given. ▪ Provide periodic medical checkups for the workers. ▪ Paramedic personnel shall be stationed and prepared to respond to any emergency in the construction area. ▪ The nearest settlement is beyond the area affected of mining operations (around 15 km), and is not assumed to be at risk for any health hazard. Additionally, the direction of the wind towards these villages is not predominant.

Phase	Likely Direct Impacts	Likely Indirect Impacts	Likely Management Measures
	Risk of traffic accidents	Traffic accidents caused by dump trucks transporting Quarry material (rocks) along the project access between the quarry and Playa Melchorita, with a daily average of approximately 200 vehicles.	▪ Provide training for the project working force (contractors and subcontractors) on the Security and Health Plan. ▪ Correct traffic signals in the critical areas of the Project. ▪ Provide informative talks for the local population on security measures to reduce risk of accidents. ▪ Build a overpass crossing where the projected access road meets the Pan American Highway. This activity is not included within the scope of this EIAS. ▪ Establish and inform drivers of the speed limits for the vehicles that transport material, pointing out the fines for failure to comply with them in the Workers' Code of Conduct. ▪ Ensure that contractors and subcontractors implement measures to reduce or avoid potential accidents that may affect the population in the area and the Project workers themselves. ▪ Hire and train security personnel devoted exclusively to preventing accidents in the access road and controlling the speed of the vehicles transporting quarry material.
	Disturbance to the population	The inhabitants of areas near the crossing of the Pan American Highway and the access road may be affected by the emission of particulate matter and the generation of noise during the construction and operation of the Project.	▪ The measures described in the Environmental Management Plan to reduce particulate matter emissions and noise should be adhered to in order to reduce their potential impacts.

9.0
CONTINGENCY PLAN

9.1 BACKGROUND

The Contingency Plan is intended to outline appropriate responses to emergencies that may occur during the project and to identify and manage potential risks such as accidents, death or injury, property loss, natural disasters, fires, and environmental damage from spills of fuel or chemicals. It is important to emphasize that contingency planning includes identification and management of risks, but equally important is effective training of project personnel. Proper training should result in proper handling of hazardous substances, waste classification, security awareness and response to dangerous or threatening situations, such as fires, earthquakes, floods, etc.

A Contingency Plan for the area of influence of the project is presented in this section and includes the actions that should be implemented where emergencies cannot be managed through existing mitigation measures. Based on the type of project proposed and the location, there is a need for contingency planning, specifically because of the occupational accidents that could occur.

The Contingency Plan must include all elements within the direct scope of influence of the project. PERU LNG is responsible for the implementation of the Plan. The quarry contractor will be responsible for executing the elements of the Plan.

9.1.1 OBJECTIVES

The objectives of the Contingency Plan are as follows:

- Outline the steps necessary to prevent and control natural events and occupational accidents that may occur within the project area of influence, mainly during the construction stage.
- Minimize the potential effects produced by emergencies, failure of safety systems, failure of equipment, or human error during quarry operation.

9.1.2 SCOPE AND STRATEGIES

This Plan shall apply to all personnel involved in and activities associated with the operation of the GNL-2 quarry, contractors, and others systems of PERU LNG. The scope ranges from the moment an emergency has been identified and notification has been made, till the moment at which all the elements that threaten safety, facility integrity, and the environment are controlled.

As a preventative measure, during the execution of the Project, the following shall be taken into account:

- Identification of project locations with the highest risk and vulnerability.
- Specification of security areas and their status.
- Proper signs and notification of safety issues and locations in the quarry and along the access road.
- Ongoing evaluations of safety issues for prevention.
- General plan for evacuation in case of accidents, disasters, etc.
- Identification and register of internal and external contact names.
- Communication protocol.

9.2 GENERAL TERMS

9.2.1 INCIDENTS

An incident is defined as an unplanned and undesired event that caused a loss, or had the potential to cause a loss.

9.2.2 NEAR MISS INCIDENTS

Near miss incidents are incidents that have not caused injury to workers, property damage, or environmental contamination. Investigation of near miss incidents can identify situations where an unknown or underestimated risk exists and corrective measures can be taken to reduce future risk.

9.2.3 EMERGENCY LEVELS

ALERT	
Definition	On-site incidents where immediate control of the hazard is achieved through the application of normal operating procedures that result in the progressive resolution of the situation.
Criteria	Meets all of the following: • Immediate control of the hazard is established using onsite resources. • All control and relief systems and equipment are functioning normally. • Impact to public or worker safety is confined to the site itself. • Public safety is not threatened. • Environmental impacts are confined to the site.
Examples	• Any controlled situation, outside normal operating conditions, which has the potential to affect the production, pipeline or facility operations and has the potential to escalate in severity • Minor injuries to personnel requiring first aid only. • A spill or controlled flow of hydrocarbons or hazardous substance on Company property. • Public concern, inquiry, complaint or observation of an incident that does not result in the escalation of the incident beyond an alert level.
Initial Required Actions	• Ensure the protection of life safety. • Immediately implement control and corrective actions using established procedures and onsite/local resources • Notify the Incident Commander. • At the discretion of the Incident Commander, notify area users and/or the regulatory agency. • Complete a Company Incident Report as soon as practical.

LEVEL ONE		
Definition		
	• Immediate control of hazard is becoming progressively complex because of deteriorating conditions. • Control and relief systems are functioning correctly. • Impact to public or worker safety confined to the site itself, with possible impact off-site. • Environmental impact is confined on-site with some potential off-site impact. • The situation is minor or short-term in nature. • Low potential for it to escalate. • No immediate threat to workers. • The situation can be handled entirely by on-site personnel. • Little or no media interest.	
Example	• A spill or partially controlled flow of hydrocarbons or hazardous substance. • Small hydrocarbon fire in a non-critical area. • Non-hydrocarbon fed fire controlled on site. • Controllable fire that could result in the release of toxic gases if not contained. • Missing person or minor injury accident. • Incident with a potential for loss/damage resulting from natural causes, accidents or criminal activity.	
Actions Company	• Assemble all site personnel and equipment. • Notify appropriate Incident Commander and area plant/office. • Provide support as required to control the incident. • Prepare to provide all resources as required (e.g., safety). • Initiate monitoring if required. • Block access road. • Evaluate and initiate public notifications as appropriate, based on the nature of the incident. • Report all spills and product releases to the General Directorate of Hydrocarbons.	
Actions Government	• No action required. • Monitors response once, or if advised.	

LEVEL TWO	
Definition	• Imminent and/or intermittent control of hazard is possible. • Some control and/or relief systems not operational. • Impact to public or workers' safety confined to site, possible impact off-site. • Impact to environment on-site with some impact off-site. • The situation is minor or short-term in nature. • Government agencies must be alerted. • External assistance required to control the situation. • Local/regional media interest, proactive approach is required.
Example	• A potential well problem posing threat to worker/public or environment. • Partial control of flow of hydrocarbons or hazardous substances • Explosion or fire (including deliberate ignition). • An uncontrolled flow of hydrocarbons or hazardous substances that has impact beyond company property. • Incidents placing public/company/contract personnel at risk. • Any potential for significant loss/damage resulting from natural causes, accidents or criminal activity.
Actions Company	• Fully activate company emergency response procedures with Command Centers established and on standby. • Inform Government agencies of situation and incorporate support as required. • Identify the emergency planning zone and emergency operating areas and establish roadblocks. • Evacuate defined emergency planning zone, shelter actions may be undertaken for safety considerations, and transportation might be appropriate. • Residents who are considered as the 'Special Needy' will be offered evacuation assistance. • Establish pro-active media communication procedures in consultation with Local Government Authorities. • Prepare for potential escalation of the situation to Level Three. • Record activities, keep Government and municipal agencies informed and advise them accordingly.
Actions Government	• Government Authority to notify other agencies that may be affected. • Agencies to establish direct contact with company and provide guidance and assistance as necessary. • Government agencies to activate their Emergency Response Plans and prepare establishment of Emergency Operations Center.

LEVEL THREE		
Definition	• Control of imminent hazard is not possible. • Key control and/or relief systems not operational. • Public/personnel safety potentially in jeopardy. • Significant and ongoing/long term environmental impacts. • Outside assistance is required to control situation. • Immediate multi-government agency involvement.	
Example	• Gas or oil well out of control (well, pipeline, facility). • A flow of hydrocarbons or hazardous substances released into the atmosphere, which requires evacuation of the public, or, release of these substances into any water systems that would require oil spill cooperative involvement. • Explosion with extensive damage to public/company property • Major accident impacting on the public's or workers' safety • A major potential for explosion. • Extended impact from natural causes, accidents or criminal activity.	
Actions Company	• Corporate Emergency Response Plan and Command Centers are fully operational and continue with Level Two actions. • All internal support positions are to be manned. • Maintain the security by monitoring and adjust hazard and emergency operating areas as required. • Mobilize additional people and resources as required. • If applicable ignite a sour gas release if ignition criteria are met. • Continue the implementation of external media communication procedures as established with Local Government Authorities. • Continue to advise company and government accordingly.	
Actions Government	• Government Authority initiates an action plan • Appropriate government representatives will be dispatched to command Centers • Emergency Operations Centers and media information capability will be established as required.	

9.3 IDENTIFICATION OF RISK FACTORS AND ELEMENTS AT RISK

In Table 9-1 risk factors, the project location, the elements under risk, as well as the preventive measures, are shown. It is important to note that there are several agents (natural, technical and human) that may increase the probability of any of the identified risks to occur. Examples of these are earthquakes, unexpected geotechnical conditions, inadequate operating procedures, inferior equipment, etc.

From the identification of these elements, proposed preventive and response measures for contingencies that may arise during the development and implementation of the project are presented.

Table 9-1 Potential Risks in the Area of Influence of the Project

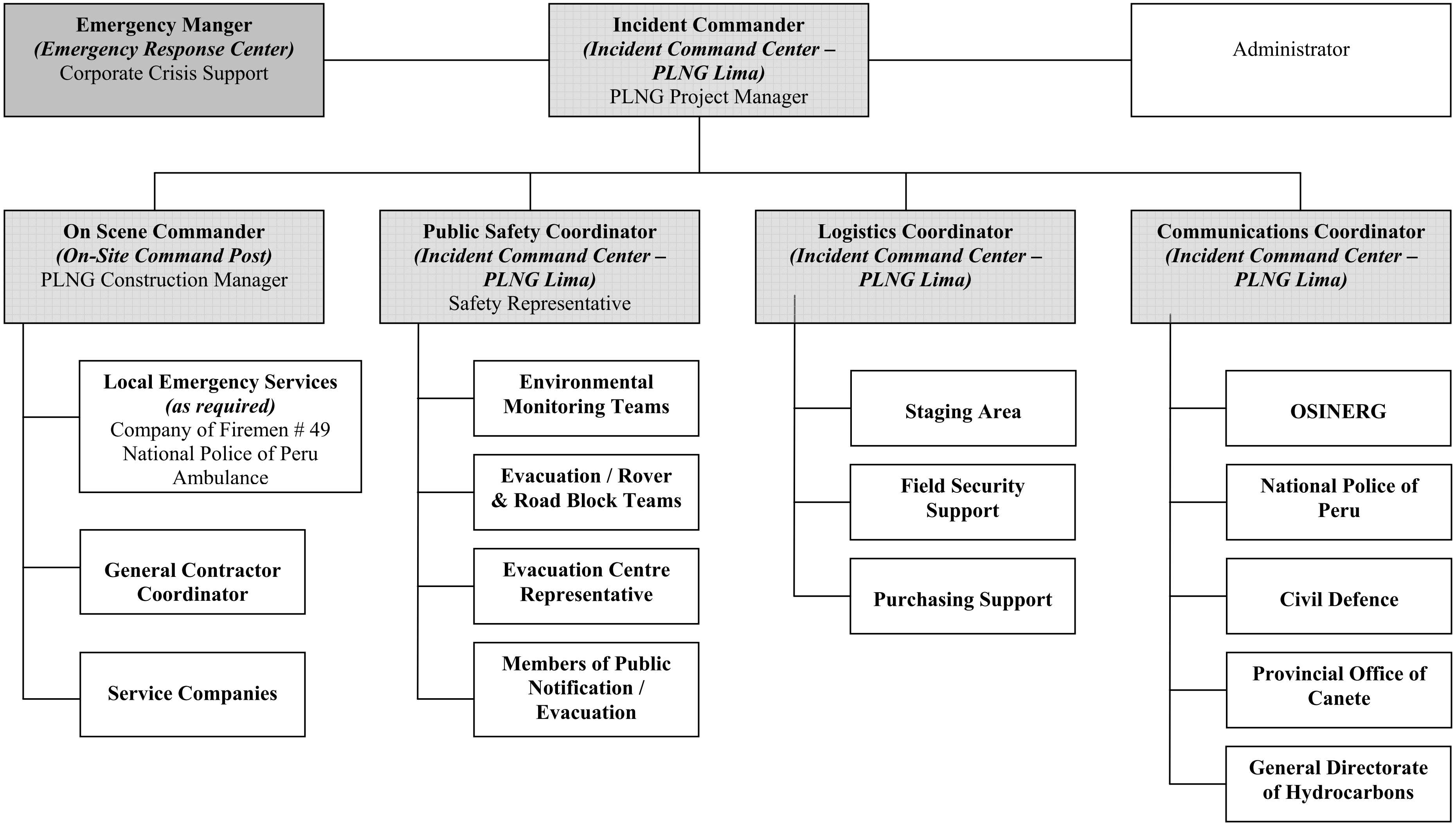
Risk Factor	Location	Element Under Risk	Preventive Measures
Fuel spills	Areas for storage and handling of fuel.	Personnel, ecosystems (soils, groundwater).	Storage areas must meet all the industrial safety standards. Preparation of Spill Contingency Plans. Training and drills.
Use of explosives	Areas for the storage and handling of explosives.	Personnel, ecosystems, material properties, quarrying process, construction of the access road, and rock transportation.	Storage areas must meet all the industrial safety standards. Training in explosive storage and handling.
Earthquake movements	The area of the project is located in an active earthquake zone.	Personnel, ecosystems, material properties, quarrying process, construction of the access road, and rock transportation.	Compliance with all safety regulations. Coordination with relief institutions in the neighboring cities and the participation in rescue operation practices that they may organize. Posting of evacuation routes and instructions in enclosed areas (offices, workshops, warehouses, dining halls, etc.) and identification of the mustering locations. Training on contingency plans.
Fires	Areas for storage and handling of fuel.	Personnel, ecosystems, material properties, quarrying process, construction of the access road, and rock transportation.	Careful compliance of security regulations with regard to handling and storing fuel.
Floods and Mudflows	The quarry is located in an area dissected by creeks that presents evidence of flood events. It also has steep slopes and a lot of fragmented material with little consolidation which make up the ideal conditions for mud flows in years with unusually heavy precipitation.	Personnel, ecosystems, material properties, quarrying process, construction of the access road, and rock transportation.	Posting of evacuation routes in enclosed areas (offices, workshops, warehouses, dining halls, etc,) and identification of the mustering locations. Training on contingency plans.
Occupational Accidents	May occur in any working area.	Personnel, quarrying process, construction of the access road, and rock transportation.	Careful compliance with safety regulations. Clear signs to warn personnel and the public on risks, use of reflective tape, mesh and barriers, etc.
Protests or social disturbances that may interrupt access roads or threaten the safety of the personnel in the works.	In proximity of the project.	Quarry exploitation process, construction of the access road, and rock transportation.	Establish a good relation with the authorities and monitor the possible impact of the activities taking place. Develop a plan of communitarian relations.

9.4 ORGANIZATION OF THE CONTINGENCY RESPONSE SYSTEM

9.4.1 GENERAL ORGANIZATION FOR CONTINGENCIES

The Contingency Plan provides a structure / plan of action for the initial control of an emergency. It is aimed at maintaining control or mitigating the effects of the emergency until external support has arrived. Figure 9-1 presents the organization for addressing contingencies during the operation of the GNL-2 Quarry.

Figure 9-1 Contingency Plan Organization Chart



9.4.2 DUTIES OF THE CONTINGENCY TEAM

The main duties of the contingency team and its members are described in this section. The organization of the emergency intervention staff is shown in Figure 9-1.

9.4.2.1 Emergency Management

The Emergency Management is the principal advisor to the Incident Commander. The team consists of PERU LNG senior staff and a legal counselor. They provide assistance to the Incident Commander, particularly on legal issues and on aspects related to the handling of public information with external entities and agents.

9.4.2.2 Incident Commander

This person is in charge of managing the communications with the media, regulatory entities and directors of PERU LNG when an emergency exceeds the response capabilities of the available resources. He or she is responsible for:

- The establishment of the Emergency Control Center
- Leading the Response Teams.
- The actions taken during the emergency.
- Deciding when to call for external aid (ambulances, firefighters, civil defense, etc.) when available resources of the quarry might exceed what is needed.
- Reporting to the main office on the status of the emergency until it has officially been declared that the emergency is over.

9.4.2.3 On Scene Commander

The PERU LNG Construction Manager will hold this position. This person's main duties are:

- To immediately on site in case of an emergency.
- To assess and characterize the emergency.
- To take over the direction and coordination of the responders at the site where the emergency takes place.
- To report to the Incident Commander on the development and control of the emergency.
- To be part of the Incident Command System
- To report to the Incident Commander in Lima
- To coordinate the logistic and human supports with the aim to control and mitigate the emergency
- To manage the internal and external communications
- To coordinate and report to the Responsible Authority.
- To manage and directly supervise all field response efforts.
- To control all PERU LNG resources on site.

9.4.2.4 Public Safety Coordinator

The Public Safety Coordinator will be responsible for the public's and workers' safety. This person's main duties are to:

- Assess the situation and extent of health hazards or injuries.
- Establish communications with the Incident Commander
- Discuss remedial actions with the On Scene Commander and Incident Commander and provide direction with regard to potential public safety issues.
- Assist with procurement of materials, equipment and manpower as required.
- Ensure communication is maintained with all involved.
- Designate Reception Center Coordinator and establish Reception Center, if required.
- Evaluate requirements for telephone teams or Telus IVR initiation.
- Confirm Public Notification Statements (concerning, e.g.: shelter and evacuation) with Incident Commander.
- Establish required security measures.
- Ensure proper spill reporting procedures are followed.
- Document all activities.

9.4.2.5 Logistics Coordinator

The Logistics Coordinator will be responsible for the timely procurement of equipment and supplies.

9.4.2.6 Internal Support Group

The Internal Support Group consists of personnel that is responsible for service activities such as security, logistics, stock keeping, and maintenance.

9.4.2.7 External Support Group

Institutions that belong to the External Support Group are institutions that give support in the case of an emergency situation. For example: the National Police Department, the Fire Department and the Army.

9.4.2.8 Communications Coordinator

The Communications Coordinator ensures that establishes and maintains contacts with Government agencies. He or she verifies notification as required and provides updates as required or requested by the Incident Commander. He or she liaises with Public Safety Coordinator in order to prepare required communication.

9.4.2.9 General Contractor Coordinator

The Contractor Construction Manager will be in charge of this position and his or her main duties are to:

- Coordinate the logistics and human resources needed to control and handle the emergency.
- To manage and directly supervise all field response efforts.
- Coordinate with the Scene Commander.
- Improve/Update the contingency plan; and
- Activate the Fire Department, as required.

9.4.2.10 Fire Brigade

The responsibilities of the Fire Brigade are as follows:

- To follow up on the Intervention Group Manager's directives.
- To go to the place where the emergency occurred upon hearing the alarm or the radio alert.
- Not to enter the area of emergency before making sure the response equipment is properly installed.
- To control or extinguish fires.
- To deploy the firefighting teams when needed.

9.4.2.11 Rescue and First Aid Brigade

- To locate possible injured people or people left behind during the emergency.
- To carry out first aid and to transport personnel that needs to be moved to a safe area or to the Muster Location.

9.4.2.12 Duties of the Brigade Team

<u>During an emergency:</u>

- To follow up on instructions from the Response Manager.
- Not to enter the emergency area before ensuring the intervention equipment is properly installed.
- To check and secure the affected area (cut the electrical power, control the fire, etc.) in order to avoid more serious injuries or material damages.
- To provide assistance to injured people.
- To protect and save the property in order to reduce losses.

<u>As soon as the emergency is under control</u>

- To restore the affected areas within the quarry.
- To clean the equipment after an emergency.

- To reassemble the fire-equipment, fix the hoses, refill the fire extinguishers, refill the foam concentrate containers, put hoses back in place, leave the controls in operative conditions, return ignition keys, etc.
- To move empty fire extinguishers to the warehouse.

9.4.2.13 Surveillance Service

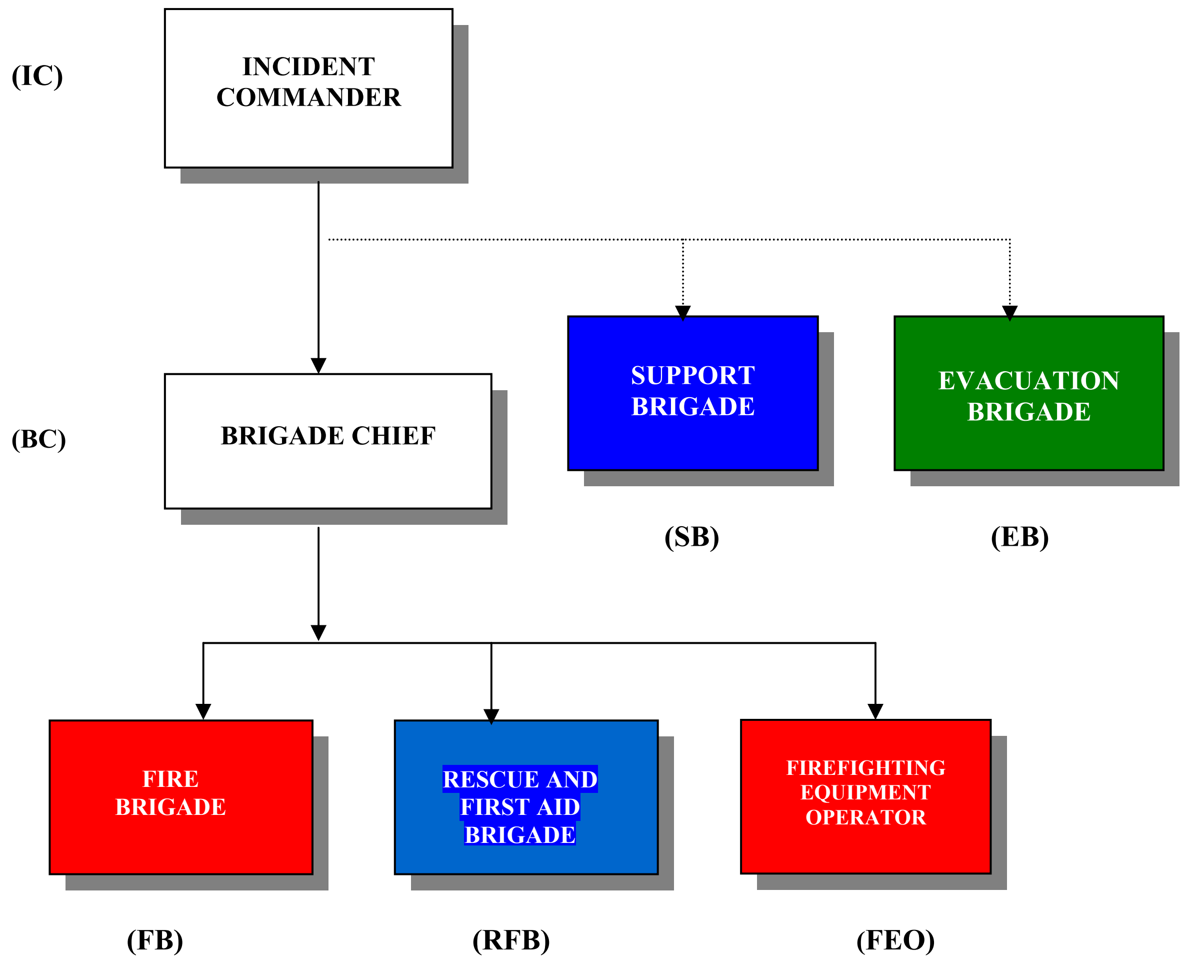
The Surveillance Service is in charge of:

- The access to the quarry, the management of the parking lot, and other coordinating tasks.
  - Reporting incidents immediately and in detail to the Quarry Manager or the Supervisor on duty (also outside regular working hours).
  - Controlling contingencies by making use of the available materials, without risking his or her personal physical integrity.

9.4.2.14 Control Center

The Control Center is the place where all the information and decision-making will take place during an emergency.

Figure 9-2 Brigade Team (Intervention Group) Organization Chart



9.4.3 SUPPLY AND MANAGEMENT OF RESOURCES

The available logistical resources and response equipment has to correspond with the needs of the fire protection systems (fixed and portable), medical emergency needs and possible chemical or hydrocarbon product spills. The Contingency Unit will be put in place right from the start of the quarry project activities, and it should cover the following:

Mobile rapid deployment units
The contractor will select one or two vehicles from his fleet that will be part of the contingency equipment. These vehicles will be equipped with emergency material so that they, besides its normal activities, can quickly respond to and be used in contingency situations. This emergency equipment should be light so that it can rapidly move to the place where an emergency has taken place. The emergency vehicles will be registered as such, and have to be in a proper working condition: in case any mobile unit is damaged, it should immediately be replaced by another vehicle that is in good condition.

Telecommunication equipment
Telecommunication equipment is needed to allow a good communication with the health centers of the neighboring cities (Cañete, Grocio Prado or Chincha). The health centers should be informed about the quarry project at the start of its operation, so that they are better prepared when an accident occurs.

The assistance communication system (portable radios) will be a real-time alert system; in other words, the work groups will have mobile communication units that will be in contact with the Central Contingency Unit and this, in turn, will be connected to the Assistance Units.

The Contractor in charge of the quarry exploitation or construction activities is the body responsible for carrying out the Contingency Plan. This includes, installing an alert and message system, as well as assisting affected inhabitants of the area near the quarry, by providing them with medication, food or other supplies.

Paramedic assistance equipment
The personnel prepared to provide first aid care will be equipped with the following:

- Fire extinguishers.
- Medication and material for treating, amongst others, severe burns, hemorrhage, and bruises.
- A proper first aid kit depending that can be used for different emergencies.
- Stretchers.
- Dressings and splints.

Fire-fighting equipment
The mobile fire-fighting equipment will consist of chemical powder fire extinguishers. These will be installed in all the mobile units of the project. The fire brigades will be provided with fire-protection suits, helmets, boots, gloves, axes, picks and sticks. In addition, ancillary facilities will have fire extinguishers and sand boxes.

Mud flows control equipment
When contingency generating mud flows ("huaycos"), soil or stone slides, or similar events occur, vehicles such as tractors, front-loaders and dump trucks will be used to clean the affected zone(s). They can also be used for transporting or rescuing people or the removal of equipment that might be or get affected.

Muster Station
The designated muster station is the quarry office; however, an alternate site has to be determined prior to commencement of the project.

9.5 OPERATIONAL CONTINGENCIES RESPONSE PLAN

A particular procedure for each of the contingency types that might happen during the lifetime of the project has been recommended and is presented below:

9.5.1 MEDICAL EVACUATION CONTINGENCIES

Medical evacuation (MEDEVAC) considers the general guidelines and procedures to ensure a proper and timely evacuation of the injured or ill personnel from the place of the accident to the adequate medical assistance center.

General Procedures

- Every worker and employee shall be subjected to a medical examination before commencing work in the quarry operation.
- Workers will follow (certified) basic first aid courses.
- Workers will report to their superior the occurrence of any on-site injury, even minor ones, in order to ensure injured workers will be provided with the required medical treatment.
- The condition of the injured and the need to transfer the person to a medical center will be evaluated
- A social worker of the company will make the necessary arrangements for the transportation of the injured to the medical center.
- The causes of the accident and the injuries that have occurred will be evaluated.

9.5.2 CONTINGENCY: PETROLEUM SPILL

Preventive measures

Warehouse sites should comply with all the industrial safety standards. The preventive measures to be implemented are the following:

- The storage area will be leveled to facilitate the access and easy fuel handling.

- Fuel and lubricants will be stored or handled not closer than 50 meters from any inhabited structure.
- The soil of the storage area has to be isolated with a concrete slab to prevent liquid filtration into the underlying soil.
- The storage area will be surrounded by a cement berm that may hold 120% of the maximum capacity of stored fuel.
- The storage tanks will be checked on a daily basis.
- All the cylinders used to store fuels and lubricants will be placed in an enclosed area, over wood platforms until they are removed to be discarded or destroyed.
- The fuel transportation vehicles, owned by the fuel supplier, will be thoroughly inspected in order to ensure the good condition of the tank as well as its proper performance during the supply of fuel for the operations.
- The fuel supply to the light machinery will only take place at the maintenance or the fuel storage area. It will never, under any circumstance, take place at the working areas.
- The fuel supply to the heavy machinery or equipment will take place in the working place itself, taking all the required preventive measures.
- The fire extinguishers and hydrocarbon absorbents will be kept indicated and visibly at accessible points in every area where fuels are handled or unloaded. The contractor will put in place minimum absorption equipment at the entrance of the fuel warehouse, inside a roofed cabin, and easy identifiable by a sign. The minimum equipment that will be available to control and prevent fuel or oil spills will be: absorbent cloths, shovels, polyethylene bags, gloves, protection glasses and rubber boots.
- In the storing, handling and supply areas of the fuel, informative signs or fixed signposts with specific instructions for the personnel on different security aspects will be placed. Amongst others:
    - Maximum speed 20km per hour
    - Danger, inflammable fuel.
    - Do not start any fire inside the working areas.
    - Prohibited for unauthorized vehicles or personnel.
    - Turn off the vehicle engine, the radio and other electronic equipment.
    - Place a wedge under the vehicle tires to immobilize it during loading and unloading.
    - Prohibited to smoke.
- The signs should be prepared according the color rule, for example:
    - Red; fire prevention
    - Orange; alert
    - Green; security
    - Blue; precaution
    - White; traffic.

If a fuel or lubricant spill occurs, the following measures should be taken:

- The Chief or Superintendent of the Quarry will assess the event to determine its extent.
- The spilled fuel will be recovered using absorbent cloth for hydrocarbons.

- The spilled fuel will be entirely removed, as well as the contaminated soil. The absorbent cloths and the contaminated soil will be stored in adequate and sealed storage facilities, to be finally disposed of in an authorized landfill.
- The effects on the soil will be evaluated and the affected area will be restored.

9.5.3 CONTINGENCY: ACCIDENTS CAUSED BY THE USE OF EXPLOSIVES

Preventive measures

PERU LNG will demand from the Contractor in charge of storing the explosives, to submit a plan with preventive safety measures for explosives. Among the safety preventive measures that have to be considered in view of any possible emergency produced by the use of explosives, the following will be considered:

- The explosives will be stored in an area far away from the exploitation area and lodging facilities, under private custody.
- The handling and use of explosives will be carried out in accordance with the standards issued by the Ministry of Defense and the DISCAMEC.
- There will be sufficient water available to cool any fire that may occur.
- Small ammonium nitrate spills will be collected in adequate and sealed containers to be then withdrawn from the Concession area following the correspondent safety measures.
- Every bag and recipient containing “ANFO” will be properly labeled.
- In the storing, handling and supply areas of explosives, informative signs or fixed signposts with specific security instructions for personnel will be placed. The signs or signpost will provide the following information:
    - Maximum speed 20km per hour.
    - Danger, explosive material.
    - Do not start any fire in the working areas.
    - Prohibited for unauthorized vehicles or personnel.
    - Turn off your vehicle engine, the radio and other electronic equipment.
    - Place a wedge under the vehicle tires to immobilize it during loading and unloading.
    - Prohibited to smoke.
- The signs should be prepared according the color rule, for example:
    - Red; fire prevention
    - Orange; alert
    - Green; security
    - Blue; precaution
    - White; traffic

9.5.4 CONTINGENCY: ACCIDENTS CAUSED BY EARTHQUAKES

Preventive measures

- Compliance of industrial safety regulations.

- Coordination with relief institutions in the cities of Cañete, Grocio Prado or Chincha and participation in rescue operation practices that they may organize.
- Periodic earthquake, evacuation and rescue drills.
- Periodic inspection of alarm devises that will alert workers in case an event occurs.
- Signaling of evacuation routes and safe areas inside and outside the quarry facilities.
- Establish a Mustering Point in a safe area within the Concession.
- Disseminating information about the region being located in an area of earthquake risk.

In the event of the occurrence of a strong earthquake, the procedure will be as follows:

The administrative and operating personnel must be efficiently familiar with the safety and evacuation rules.

The personnel has an evacuation area inside and outside the facilities, for which there will be an evacuation map available showing all the escape routes for each area of the plant.

Other instructions that are to be followed:
- Appoint a single person in charge. In this case it is the qualified person named in this plan.
- Verify alarm devices.
- Verify that evacuation signals for the personnel have been properly posted and are visible.
- Verify that the evacuation and escape areas are clear. This is a constant duty of the safety crew.
- Hold drills twice a year.
- Delimit the evacuation areas.

❖ DURING THE EARTHQUAKE

- Keep calm and control panic.
- Immediately stop all loading activities if these are being undertaken.
- Inside offices: head towards previously designated safe areas.
- Remember that an earthquake causes loud noise, dust, and falling objects. Keep away from glass doors and windows.
- Prepare to evacuate.
- Keep calm and orient visitors in the plant.

❖ AFTER THE EARTHQUAKE

- The personnel working at the quarry must verify the condition of equipment and machinery in order to avoid possible hydrocarbon leaks.
- The head of the safety group will order a careful inspection of the entire plant once the earthquake has stopped, in order to detect, leaks, seepage or other damages to the plant, provided the earthquake's intensity has been moderate (3 to 4 degrees on the Richter Scale). If the earthquake has been of a greater intensity (6 to 7 degrees on the Richter Scale), he will order the evacuation of all personnel.

- Every worker will proceed in accordance with the instructions as specified in the table of duties and responsibilities.
- Meeting with personnel in the established Concentration Point.
- Inspection of damages to the facilities performed by trained personnel.
- If the earthquake movement produces fires, accidents and/or damage to structures, the steps as described in the previous part of this section will be followed.

9.5.5 CONTINGENCY: ACCIDENTS CAUSED BY FIRE

Preventive measures

The industrial safety regulations will be carefully followed with regard to the handling and storage of fuel and explosives. The following preventive measures have to be taken care of:

- Make sure that sufficient water to extinguish any fire that may occur is available.
- Ensure there are enough fire extinguishers and hydrants to control fires.
- Put in place an alarm system.

In the event of a fire, the following measures have to be taken:

- When the fire involves common combustible material (paper, wood or rubber), it may be extinguished with water.
- When the fire involves liquids or flammable materials, the supply will be cut and the fire will be suffocated with Dry Chemical Powder, or sand or earth.
- Water will never be used to suffocate fires caused by gasoline or any other petroleum product. In this case, fluorine-protein foams or other agents shall be used to combat fire in combustible liquids.

9.5.6 CONTINGENCY: ACCIDENTS CAUSED BY FLOODS OR MUDFLOWS

Preventive measures

- Coordination with relief institutions in the cities of Cañete, Grocio Prado or Chincha and participation in rescue operation practices that they may organize.
- Signaling of evacuation routes and safe areas, inside and outside the facilities.
- Make known that the quarry is located in an area where mudslides or huaycos can take place.
- Performance of periodic drills.
- Periodic inspection of alarm devises that will alert the workers in case floods or mudflows may occur.

If a torrential event occurs, the measures to be taken are the following:

- Immediate and orderly evacuation to open areas and gathering of the personnel at the Concentration (or Emergency) Point.
- Inspection of damages in the facilities by skilled personnel.

9.5.7 CONTINGENCY: ABSENTEEISM CAUSED BY THE OUTBREAK OF AN EPIDEMIC

Preventive measures

- Carry out continuous educational campaigns to prevent infectious, venereal diseases, or diseases produced by water or contaminated or decomposed food.
- Periodical medical checkups of the personnel involved in the Project.

In case of any event, such as massive health problems within the group of workers of the Project (intoxication, epidemics), the following measures will be taken:

- The Contractor shall immediately communicate with the proprietor and the technical supervisor, explaining the causes of the problem and the possible impact on the performance of the work.
- Additionally, he will be obliged, when necessary, to provide solutions such as the hiring of temporary workers to support the most affected working units.

9.5.8 CONTINGENCY: OCCUPATIONAL ACCIDENTS

Preventive measures

- Ensuring compliance with industrial security regulations.
- Using clear signs that inform personnel and the community about the risks to which they are exposed.
- Mark with reflective tape, mesh and block places that are susceptible to accidents.

The following procedures shall be followed in case a person has been involved in an accident:

- Inform the engineer in charge of the work front, who in turn will inform the Quarry Chief or Superintendent.
- Communicate the event to the Emergency Response Brigade, who will decide whether or not an emergency attention plan should be activated. Their decision will depend on the extent of the event and can involve two immediate actions: sending an ambulance to the site of the accident and sending the necessary personnel to provide first aid and help in the rescue procedures.
- Depending on the extent of the case, communication will be established with the health centers in the cities of Cañete, Grocio Prado or Chincha to request for the necessary support.
- Simultaneously the person in charge of the works can start evacuating the work force.
- Once the emergency is controlled, the Contractor will evaluate the facts that initiated the event, the way it was handled and the procedures used with the objective to optimize the emergency operating plan for future events.

9.5.9 CONTINGENCY: CONFLICTS WITH WORKERS

Preventive measures

- Strict compliance with working regulations established by the Peruvian legislation.

- Guarantee good physical and psychological conditions of personnel at work.
- Maintain good communication between the workers and the Contractor.

In case this kind of contingencies occurs, the following action should be taken:

- In the event of protests or strikes that directly compromise the work of the Contractor, he shall immediate notify PERU LNG management about the outset of the anomaly and its causes. In such a case, the Contractor shall take on the responsibilities for the delays, as well as the extra costs that this situation may produce.
- For cases where the public order has been disturbed (vandalism, common crime) and where the Contractor is one of the affected parties, first of all , he should notify the competent authorities (National Police Force in the cities of Cañete, Grocio Prado or Chincha), so that they may take the appropriate corrective measures. After the evaluation of the damage the conflict has caused (destruction of the works or part of it, damage to the infrastructure, loss of equipment or building materials), the owner of the works through a technical assessment, will calculate what the effect may be to the quarry and construction activities.

9.5.10 CONTINGENCY FOR SOCIAL DISTURBANCES

These contingencies refer to security emergencies for criminal actions (attacks, sabotage), subversive actions, communities or populations that use violence against the quarry company and damage its property.

General Procedures

- Any member of the personnel of the quarry contracting companies in charge of the exploitation activities will notify the Security Supervisor of any social disturbance that occurs.
- The Chief of Emergencies will activate the specific safety plan in accordance with the occurring incident, staying in close contact with the Intervention Group.
- The operating personnel in the Quarry will stay calm at any time, avoiding any attempt to control the situation.
- Any complaint that is put forward will be channeled to the PERU LNG Manager's Office or the Security Office.
- The Chief of Emergency will be responsible for the coordination with the local police authorities.

9.5.11 CONTINGENCY: DISRUPTION OF THE EXPLOITATION AND/OR CONSTRUCTION PROCESS CAUSED BY STRUCTURAL FAILURE

Preventive measures

- Maintain adequate quality control of the material used, as well as of the construction process.

If any structural and/or technical problem is detected during the exploitation of the quarry or the construction of the access road, the following measures will be taken:

- The inspector and/or the engineer in charge of the work force will evaluate the causes, will determine the possible solutions and will define if he has the technical capacity to solve the problem. If the characteristics of the failure do not permit it to be solved, the Technical Supervisor will be informed about the situation. Once the problem is known by the Technical Supervisor, this will immediately lead to the following actions:
- If the Technical Supervisor can solve the situation, the Contractor will be informed about the solution.
- If the situation cannot be solved by the Technical Supervisor, the problem will be presented to the Project Director's Office that will, in turn, inform the problem to the manufacturer, who will study the problem and find a solution. Once a solution has been founded the supervisor will inform the Contractor.
- In all cases the PERU LNG directors will be informed.

9.5.12 NOTIFICATION OF CONTINGENCIES

As soon as the occurrence of an Accident / Disaster has been communicated, all the internal and external communications will be suspended to free all fixed and cellular telephone and radio lines.

All communications will be attended through the Telephone Central or direct telephones in regular timetables on normal working days, and on holidays and after working hours through the Security Service.

The Quarry Chief or Superintendent is responsible for issuing the internal and external communications. Additionally, he is the only authorized person to communicate with the media.

In case of an emergency (accidents or disaster), a contingency notification report will be prepared (See format in Figure 9-3). This report will contain the following information:

- Date and time when the accident or incident occurred.
- Exact place of occurrence of the accident or incident
- Circumstances and brief description of the accident or incident
- If there have been any casualties, indicate the severity and describe the situation.
- In case of intoxication caused by any dangerous substance indicate the amount of such substance that produced the damage.
- The actions taken or planned to control the crisis.

9.5.13 EVALUATION, RESTART OF OPERATIONS AND ISSUING OF REPORTS

Once the contingency is controlled, the Quarry Chief or Superintendent will arrange for the inspection of the place of the emergency to confirm the safety and operative conditions of the place and to resume normal operations. He will also arrange for the preliminary investigation of the accident or disaster and, if necessary, estimate the time and the actions to recover and restore facilities.

9.6 TRAINING AND DRILLS

In order to keep the personnel properly trained on the prevention of emergencies, PERU LNG will implement a training plan for the personnel involved in the resolution of emergency situations. The training plan will include information on existing risks, analysis of risks, approaches to minimizing risk and risk monitoring.

All personnel working on the site will receive trained that will help them to identify risks. In each working group will be appointed who will be in charge of the contingency plan and the initial rescue actions and will inform the person responsible for the specific type of disaster and its extent. The personnel training procedure will consist of compulsory informative lectures about prevention and response measures. These lectures will be organized and given by the person in charge of each working group.

The actions to be adopted are the following:

- Coaching and training in the Contingencies Plan, for the administrative personnel in the different areas as well as for the operational personnel.
- Circulation of the procedures of the Contingencies Plan among the operational personnel.
- Coordination meetings with the Safety Committee Members.
- Training and guidance lectures.
- Publishing of safety bulletins, posters, etc.
- Instructions for the Response Brigades.
- Practices and operation of security devises.
- Practices and training on evacuation, drills and emergency procedures.

The Training Plan will include the following aspects:

a) An Annual Training Program for personnel involved in the implementation of the Contingencies Plan, indicating the kind of emergencies that will be discussed, the possible venue, tentative dates, actions to be taken, and material to be provided for the training.
b) Preparation of a planning and evaluation form for the evaluation of each training activity.
c) Classification of spills of hydrocarbon, oils, solvents, etc. in categories according to the volume and the damaged area.

A list of the personnel that have received training for the control of emergencies will be included, indicating their address and telephone number in order to locate them in the event of an emergency.

To minimize the damages produced by earthquake or torrential events such as “huaycos”, periodic drills will be carried out with the participation of all the administrative and operational personnel.

9.7 SPILL EQUIPMENT REQUIRED (May Require Modification Based on Risk)

EQUIPMENT	QUANTITY	LOCATION
18’ 18 ABSORBING CLOTH	4	Quarry Storage
3/8 PAD 18 18	100	Quarry Storage
ABSORBING ROLL 19 140’	1	Quarry Storage
ABSORBING CHORD 4 40’	25	Quarry Storage
GLOVES, LENGTH 13	4 PAIRS	Quarry Storage
SPECIAL BAGS WITH POLYETHYLENE TIES	100	Quarry Storage
55 GAL POLYETHYLENE DRUMS	2	Quarry Storage
25 LB GRANULAR PEAT BAG	1	Quarry Storage
10’ ABSORBING CHORD 70’ ABSORBING CHORD	10 3	Quarry Storage
55 GALLON DISPERSANT DRUM	1	Quarry Storage

9.8 LIST OF CONTACTS

During the implementation process of the Contingency Plan a list of key contacts (internal and external) will be prepared. This list will include governmental and local entities, suppliers of material and equipment, and the personnel in charge of the operations. The list will be updated when the productive activities in the quarry start. Table 9-2 presents the list of PERU LNG internal contacts, and Table 9-3 presents the external contacts.

Table 9-2 List of PERU LNG Internal Contacts

Positions	Telephone	Extension	Address
General Management	611-5100		Av. Víctor A. Belaunde 147, Via Principal 140. Torre Real 6, of. 503. San Isidro
Environmental Matters Management	611-5100		Av. Victor A. Belaunde 147, Via Principal 140. Torre Real 6, of. 503. San Isidro
Community Relations Management	611-5100		Av. Victor A. Belaunde 147, Via Principal 140. Torre Real 6, of. 503. San Isidro
Engineering Management	611-5100		Av. Victor A. Belaunde 147, Via Principal 140. Torre Real 6, of. 503. San Isidro

Table 9-3 List of External Contacts

Entity	Area	Telephone	Address
Ministry of Energy and Mines	Dirección General de Electricidad. (Office in charge of electricity)	475-0065 – 156 475-0206 / 475-0212	Av. Las Artes 260 San Borja.
OSINERG (Energy Supervising Body)	Gerencia de Fiscalización en Hidrocarburos – Lima (Hydrocarbon Fiscalization Management)	219-3400 - 1201	Av. Las Artes 260 San Borja
INDECI (Civil Defense)	Civil Defense Chief Office	225-9898/ 224-0918	
Compañía de Bomberos (Firefighters)	Emergency Central	222-0222	
Bomberos de Cañete (Firefighters)	Emergency Central	581-2004	Av. 28 de Julio 412
Bomberos Chincha (Firefighters)	Emergency Central	056-262221	José Faustino Sánchez Carrión 1ra. Cuadra
Policía Nacional del Perú National Police	Police Emergencies	225-0402/ 225-0202	
Comisaría de Cañete (Police Station)	Call Center	581-2078	Jr. Santa Rita S/N - San Vicente
Comisaría en Grocio Prado (Police Station)	Call Center	056-266484	Plaza de Armas de Grocio Prado
Comisaría en Chincha (Police Station)	Call Center	056-261391	Plaza de Armas de Chincha Alta
IPSS Cañete (Social Security Hospital)	Call Center	581-2047	Av. Mariscal Benavides 495 - San Vicente
Centro de Salud del Ministerio de Salud - Grocio Prado (Public Health Center)	Emergency Central	056-264207	Av. Centenario 2da. Cuadra
Hospital San José del Ministerio de Salud – Chincha (Public Hospital)	Emergency Central	056-261421	Av. Alba Maurtua No. 600
Cruz Roja Peruana (Peruvian Red Cross)	Head of Emergencies	423-7779	
Desactivación de Explosivos (Bomb Disposing Unit)	Chief of Unit	481-2901/ 481-5118	

Figure 9-3 Incident Report Format

FAX TO ENVIRONMENTAL AND SAFETY DEPARTMENT:
Attention: Senior Safety Representative
FAX TO THE DISTRICT FIELD OFFICE.

GENERAL INFORMATION:

LOCATION:				AFE #:	
DATE OF INCIDENT		TIME:		DATE REPORTED :	
ESTIMATED COST:	$				
PHOTOS TAKEN:	Yes ☐ No ☐	If yes, sent to:			
Company Incident ☐	Other ☐	Company/Contractor: **Name:**			

IDENTIFY INCIDENT:

Physical Injury ☐ First aid: Medical Aid: LTA:	Equipment/Property Explosion/Fire ☐	Spill/Line Break ☐
Burglary/Theft ☐	Downtime (est. hrs):	Other:

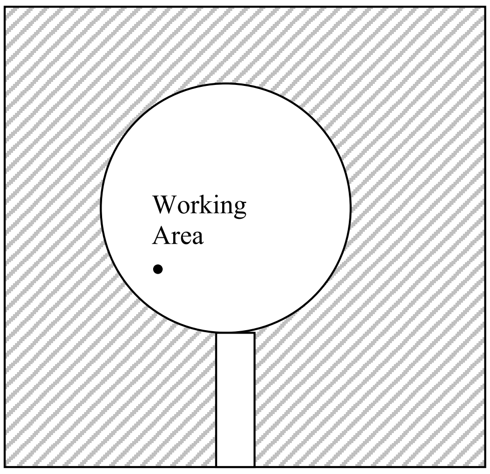
SPILL INFORMATION:

Age of Line:		AEUB Permit:		Line #:	

Gas Discharge:	Sweet/Sour (ppm)	Volume (m^3)	
Water:	Description	Volume Discharged (m^3)	Volume Recovered (m^3)
Liquid Hydrocarbons:	Description	Volume Discharged (m^3)	Volume Recovered (m^3)

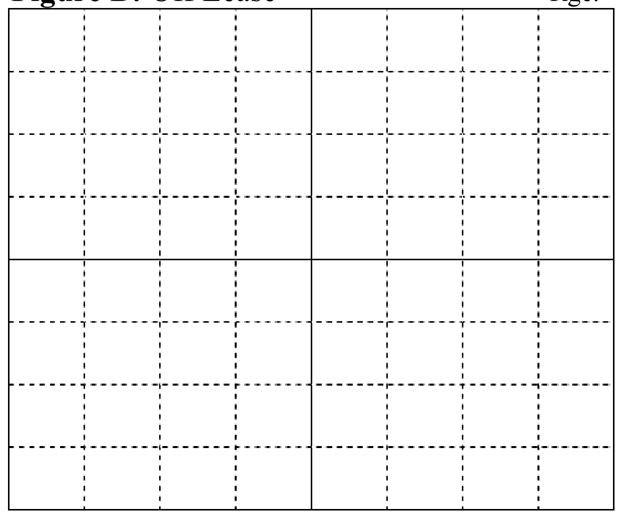
Terrain Affected: Land ☐ Water ☐ Both ☐

Figure A: On Lease



Draw exact location of spill

Figure B: Off Lease



Draw exact location of spill

PERSONNEL / GOVERNMENT AGENCIES NOTIFIED:

DATE	CONTACT PERSON / PHONE #	DEPARTMENT / AREA

Clearly describe how the incident occurred (i.e., who, what, when, where, why and how). Include all relevant information immediately prior to, during, after the incident, and all remedial actions taken in chronological order.
Attach separate sheet if necessary.

Reported by:____Date: (dd/mm/yy):___________________________

10.0

CLOSURE AND ABANDONMENT PLAN

10.1 GENERAL

The objective of this Closure and Abandonment Plan for the GNL-2 quarry is to outline the measures and programs for environmental restoration of the project site and affected areas. This plan is also required by the applicable environmental regulations and was prepared in accordance with the document “Environmental Guide for the Closing and Abandonment of Mines" published by the Ministry of Energy and Mines in July 1995. Applicable provisions in the “Mine Reclamation Plan” section of World Bank Environment, Health and Safety Guidelines: Mining and Milling – Open Pit (1995) have also been incorporated into this Closure and Abandonment Plan.

In preparing the Closure and Abandonment Plan, a principal goal was to include quarry design aspects that account for the future closure of the quarry in order to implement environmental protection measures during the operational stages of the project, increase awareness of the environmental effects of the project, and minimize future abandonment costs.

During quarry closure, PERU LNG S.R.L. will implement this plan as part of their commitment to environmental protection. Modifications to this plan may be made when the quarry is closed in order to include relevant technological improvements, knowledge gained from additional scientific studies, projected future land use, or regulatory requirements in force at the time.

The plan includes all closure and abandonment activities that will be implemented following the operation of the quarry and use of access roads. Project components that will be closed include the quarry, rock staging area, access road, and ancillary structures (quarry roads, offices, warehouses, machinery yards, etc.). The quarry contractor will provide the necessary personnel, machinery and equipment to implement the Closure Plan and will establish the schedule for implementation of the Plan in accordance with company directives.

The Closure Plan considers the desert environment of the project location and the local geologic and tectonic conditions. It has been assumed that the quarry will not generate any acid mine drainage, an assumption that is supported by the baseline studies. Measures for closing the access road from the Pan-American Highway to the GNL-2 quarry will be evaluated at the time the sites are abandoned. There will be different closure alternatives evaluated and the alternative that best meets the requirements for future land use will be selected. The high project standards established by PERU LNG allow for proper closure and abandonment.

10.1.1 OBJECTIVES OF THE CLOSURE PLAN

The objectives of this closure plan are as follows:

- To establish the general requirements for future restoration of the area of rock quarrying and access road to reduce risks to human health and the environment.
- To incorporate measures for the rock quarrying and construction of the access road that can be implemented during operations that contribute to the reduction of risk to human health and the environment following closure and constitute practices compatible with the best future land use.

10.2 CRITERIA FOR CLOSURE

This section presents technical information for design of the closure and abandonment measures for the quarry and access roads. This information can be used as necessary during final closure design and will also guide the mitigation and generation of additional alternatives using the standards and technology that can be best applied at the time when the actual closure takes place.

Since quarrying will be undertaken by use of an open pit or open excavations, closure will be mainly concerned with the physical stability of the slopes in the quarry and the waste rock area. The rock quarry will not generate acid drainage or significant effluent discharges (except for water effluent from personal hygiene, equipment washing, offices and warehouses), and measures to control discharges following closure will not be necessary. However, during El Niño events, it will be important to have adequate measures to control drainage from the quarry area in order to prevent the quarry location from contributing to a mud flow event.

10.2.1 PHYSICAL STABILITY

When removing the amount of rocks proposed from the quarry, it is important to have a good understanding of the geodynamic stability and the geotechnical attributes of the area. In addition, it is necessary to consider extraordinary events such as earthquakes, since the extraction operation may have areas with slopes that could be unstable in the face of large earthquakes.

10.2.2 STORMWATER CRITERIA

The area where the project is located has been classified climatically as semi-arid, with only infrequent torrential rains causing drainage of any magnitude. However, preventative measures will need to by undertaken during closure to construct adequate drainage structures including ditches and other structures. The objective of these measures is to avoid water buildup that affects the physical stability of the slopes. The drainage system will also serve to divert water in the event of El Niño events.

10.3 CLOSURE MEASURES FOR PHYSICAL STABILITY

Methods for closure of the physical condition and stability of the quarry are described in this section.

10.3.1 SLOPES IN THE QUARRY AREA AND WASTE ROCK AREA

At the conclusion of quarry operations slopes will be stable, and unstable blocks will not be present. However, to ensure the long-term stability of the slopes and the waste rock area, the following measures will be implemented:

- The slopes of the waste rock area will be conditioned to conform to an acceptable gradient.
- The working general slope in those areas with faults will have a maximum angle of 40º.
- The weight of the upper part of slopes will be removed when present. This closure measure may require removal of ridges and any supporting rock structures.
- Access will be restricted in locations with risk of landslides by using signs, fences and surveillance.
- Post-closure evaluation of the stability of the slopes will be undertaken to provide information about the success of the closure measures.

10.3.2 WASTE ROCK AREA

Rock produced by the quarry and construction of the access road will be managed in the waste rock area. The location of this area is shown in Figure 4-2. Waste rock will be placed in compacted layers to ensure slope stability. The surface will be covered with native material in order to return the land to conditions capable of supporting the prior land use, to the extent practical and feasible. Managing the volume of rock heaps, the height of rock, and slopes in the land surrounding the waste rock area will control the size of the area.

To assure that the waste rock area is not be affected by exceptional intense storm events, drainage control structures (drainage structures) will be built to support maximum flows of 10 m3/sec and with a period of 150 years return.

10.4 CLOSURE MEASURES FOR ANCILLARY STRUCTURES

Closure of ancillary structures from the quarry is tied to the future land use of the quarry concession. In general, the structures and construction equipment will be dismantled and removed from the area along with any concrete foundations. The access road and other roads will be left in place in a condition of good repair so that they can be used to further the revegetation and monitoring of the site, after which they not be maintained and/or will be closed or otherwise made difficult to use.

Facilities inside the Concession

At the conclusion of quarry operations, all of the surface facilities will be removed (offices, shops, warehouse, dining room, etc.), the area will be cleared completely, demolition debris will be disposed of in an approved landfill or recycled, sumps will be abandoned, and the site will be re-graded to as close as feasible to the original landscape.

Machinery Yard and Equipment

At the end of the quarry operation and use of the access road, the machinery yard and other quarrying equipment will be removed, as will any associated structures. Waste materials and demolition debris will be disposed appropriately in an approved landfill or otherwise managed in accordance with regulatory requirements and good management practices. If soils contaminated with oil, petroleum and grease are present, these must be excavated and removed to a depth of 10 cm below the lowest level of contamination and disposed of with an authorized services company. The excavation will be filled to the level of the surrounding landscape.

10.5 TIMING OF CLOSURE ACTIVITIES

Some activities to be implemented as part of the site closure will be concurrent with quarrying operations and others will be implemented at the conclusion of mining. These activities are detailed in the following sections.

10.5.1 ACTIVITIES CONCURRENT WITH OPERATIONS

The disposition of waste rock in the waste rock repository is part of closure activities concurrent with operations. The waste rock will be placed in lifts, filling the available area will be performed prior to placement of subsequent lifts. Once conformed and stabilized, the banks will be planted with representative samples of cactus from adjacent areas or from other sources.

10.5.2 FINAL ACTIVITIES OF CLOSING

At the end of quarrying activities the following measures will be implemented: clearing of slopes and stabilization of ridges, treatment or removal of soils impacted by fuel spills (if applicable), and monitoring of slope stability. Table 10-1 summarizes the closing measures.

10.6 POST CLOSURE MONITORING

To evaluate the effectiveness of measures implemented during closure, post-closure monitoring will be conducted. Monitoring of the closure will include the physical stability of slopes and the determination of vegetation survival after one year. The quarry does not generate liquid effluent and operational water needs are minimal. For this reason the closure plan does not contain measures to monitor water quality, since the risk of contamination of underground or surface water is not significant. Table 10-2 shows the details of the post-closure monitoring plan.

10.6.1 PHYSICAL STABILITY

The quarry area will be monitored for physical stability by visual inspection. This monitoring will be performed every six months for a period of two years. This will allow for prediction and prevention of possible rock fall and landslides following closure. Periodic maintenance of any drainage structures will also be carried out.

10.7 RESPONSIBILITIES

In order to execute the procedures described in the present document, the following responsibilities have been identified:

10.7.1 QUARRY SUPERINTENDENT

- To ensure that quarry operations are compatible with the Closure and Abandonment Plan.
- To organize the dismantling of facilities, demolition of structures, removal of machinery and handling of waste and debris generated during these activities according to the Plan.
- To supervise works so that they are carried out in agreement with that described in the Plan.
- To manage, as necessary, the removal of waste materials including establishment of a program for companies performing the work to obtain and provide certificates of final disposition or treatment reports for wastes. Provide PERU LNG Environmental Manager with the names and permits of all waste management companies for authorization prior to allowing them to handle waste material from this project.

10.7.2 CONTRACTORS

- To execute the Closure and Abandonment Plan within safety guidelines established by PERU LNG.
- To carry out the dismantling or demolition of structures with respect to the requirements in this Plan.
- To manage the wastes generated as described in this Plan.
- To supervise work and ensure that sub-contractors act in agreement with the principles and procedures established in this Plan.
- To control documents according to that established in the procedures, reporting to PERU LNG as required.

10.7.3 ENVIRONMENTAL SUPERVISOR

- To supervise the execution of the measures for environmental protection and ensure that PERU LNG company policies are being followed.
- To advocate for prevention, minimization and, continuous improvement in the internal and external PERU LNG organization.
- To supervise the cleanliness and final condition of the areas affected by the closure and abandonment of the facilities in agreement with the requirements of the Regulatory Authority.

Table 10-1 Summary of closure measures

Quarry Component	Potential Environmental Issues	Objectives of Closure	Closure Technology	Detailed Closure Measures	Time Period for Implementation
PHYSICAL STABILITY OF QUARRY					
• Unstable slopes	• Landslides. Important if people are in the area • Water erosion (if extraordinary rains are present)	• To restrict access to unstable areas	• Institutional controls	• Fences and warning signs	During quarrying operations
			• Conditioning	• Slope angle modification • Removal of loose debris from rock crests and faces • Construction of drainage structures	
PHYSICAL STABILITY IN WASTE ROCK AREA					
• Unstable slopes • Spoils piles	• Landslides. Important if people are in the area • Delays in the recovery of the native vegetation	• To restrict access to unstable areas • To promote revegetation	• Conditioning • Institutional controls	• Stabilize slopes if necessary • Fences and warning signs	During quarrying operations
LAND USE					
• Waste rock area • Active quarry area • Ancillary structures	• Land use conflicts	• To return to original land use	• Removal of quarry infrastructure	• Dismantle and remove structures and equipment	During quarrying operations

Table 10-2 Post-closure monitoring

Quarry Components	Quarry Location	Monitoring Method
Slopes of quarries	In areas of risk	• Visual inspection of signs and fencing • Evaluation of the stability high risk areas
	Slopes	• Visual inspection of cracking and ridgelines • Identification of fault signals • Inspection of crests and strands
Slopes in rock waste area	Slopes	• Visual inspection of the slopes
Drainage structures	Areas with granodioríte rocks Filling court yard	• Cleaning and maintenance

11.0
COMMUNITY RELATIONS PLAN

11.1 OVERVIEW

The Community Relations Plan (CRP), for the **GNL Quarry Extraction Project, Cañete - Peru**, is designed and implemented according to Peru LNG corporate responsibility policy. The CRP defines responsibilities for implementing prevention measures and management of social aspects related to the project.

The CRP is a socio-environmental management tool that implements processes to allow for socially adequate handling of the company's activities and operations in the area. These processes are implemented through an efficient and transparent relationship with interest groups and the local population within the areas of influence of the project.

- Peru LNG's vision is that project operations, however short-lived they may be (it is not expected to last more than two years), will secure a harmonious relationship with the local population and interest groups in the direct area of influence of the project, and that they may take part, as much as possible, in the positive impacts derived.

Based on this consideration, Peru LNG has developed a prior **information and consulting process**[1], which has allowed all interest groups to properly express their expectations and concerns about the project.

This project started with an adequate relationship and no opposition from the interest groups in the area of influence. Peru LNG intends to conduct its activities using standards that will allow it to continually build trust and involvement with the local interest groups along the project expected life.

11.2 OBJECTIVES

The primary objectives, which make up the design and implementation of the CRP are to identify, analyze and efficiently manage variables and indicators of key social aspects related to the execution of the project, in order to maximize potential positive impacts, and to eliminate possible negative impacts that could arise during the execution of the project.

The specific objectives are:

[1] In accordance with Ministerial Resolution Nº596-2002 – EM/DM, Consulting and Citizenship Participation in the Process of Approval of the Environmental Studies in the Energy and Mining Sector.

- Build and promote communication capacities, both internally and externally, regarding global project activities and the socio-environmental aspects that could be affected by the operations.
- Make sure that aspects previously identified as critical are internalized and dealt with at the decision making levels of Peru LNG's and its contractor.

11.3 APPROACH

The area within Peru LNG that implements the CRP is the Community Relations Department, whose specific function in this context consists of designing and executing the different parts of the CRP. The design of the different programs that make up the CRP is oriented at achieving an efficient management of key points, previously identified during the Environmental and Social Impact Assessment process - E/SIA:

- Management of expectations and perceptions of local interest groups.
- Negotiations and compensation for use of third party’s lands, if it were the case.
- Management of temporary employment during the construction phase.
- Minimizing interaction between workers – local population.
- Minimizing impacts related to project logistics.
- Minimizing impacts related to the project construction stage.

11.4 AREA OF INFLUENCE

In terms of social management, the area of influence is the area affected by some aspect of the project.

The area of influence is dynamic and varies according to the stage of the project. The construction stage creates a larger area of influence due to logistics, labor, and construction activities. During the operational stage of the project, the area of influence is reduced to a much smaller area around the facilities.

If the socio-environmental variable is properly managed, the area of influence should be reduced during the operational stage of the project at a much faster timeframe.

Due to a number of factors, the project's area of influence has two levels:

- **Direct area of influence:** The local population, interest groups, private property owners, populated areas, and others whose land may be affected by the project's activities.
- **Indirect area of influence:** The neighboring districts of the direct area of influence that may be indirectly affected by the project building or operation.

During the construction stage, the districts of San Vicente de Cañete and Grocio Prado will be considered to be inside the direct area of influence.

The largest area of influence will include interest groups in the area where the project will be carried out, as well as those people living near the area where the logistic operations involve transportation of equipment and materials.

The indirect area of influence consists of the district of Imperial, in the province of Cañete, and the districts of Chincha Alta and Pueblo Nuevo in the province of Chincha.

11.5 GENERAL STRATEGIES

Peru LNG will follow several strategies to achieve its objectives and vision:

11.5.1 INFORMATION AND CONSULTING WITH INTEREST GROUPS

The basis for the management of social affairs and community relations is a permanent, clear, and transparent information and consulting process with the different interest groups. The company will communicate proactively with all interest groups related to the project, regarding management of key aspects and human concerns.

Issues and affairs related with communitarian relations will change according to the stages of the project. Adequate planning requires anticipating these changing needs.

11.5.2 INVOLVEMENT OF THE COMPANY'S DIFFERENT LEVELS

Management of social affairs and the maintenance of an adequate community relations policy require the commitment from each area within Peru LNG, as well as each of its contractors.

Other areas within the company will be informed about the actions that the Community Relations Department is carrying out. The coordination performed will, in turn, be used to offer adequate information to the local population.

11.6 MANAGEMENT STRUCTURE

Each Peru LNG department and contractor is responsible for properly maintaining community relations, as each department and contractor will be required to adhere by and observe Peru LNG policies, rules, and standards. Formal subscription to these commitments means insuring, from the beginning, that social affairs are handled properly.

Peru LNG's Community Relations Management responsibility and function includes managing the relationship or interface with local interest groups, advising the rest of the project on the best way to manage these aspects, formally defining strategies for interaction with the local population, and planning the fieldwork in this area. The Community Relations Department should be in permanent contact with the environmental, health and security areas, as well as construction areas, regarding topics directly related to the project's operational activities.

The Community Relations Department will be in charge of establishing the guidelines for a relationship with the local interest groups, which must be observed by construction personnel. It will be necessary to establish a follow-up and documentation process for this purpose.

This interaction is considered to be essential to the social management scope of the project, through the PRC and the PMAS, to complement the proposed provisions in the Environmental Handling Plan that is part of the EIA/S of the project.

11.7 FUNCTIONS OF THE COMMUNITY RELATIONS MANAGEMENT

For the purposes of implementing the full scope of the Community Relations Plan, Peru LNG will have a specialized team put together specifically for this task. They will act as the accepted spokesman between the company and the local population.

The functions of the Community Relations Department are:

- Keep an open-line of communication with Security and Environmental, Operations, Human Resources and Institutional Relations areas as well as with Subcontractors.
- Keep a permanent follow-up of real and potential construction activities through field visits.
- Identify important topics that may be worked on jointly by the local population and the company.
- Direct the communication strategy with the local interest groups and systematize the process.
- Implement the information and consulting process with all local interest groups.
- Update and handle the information regarding the local interest groups.
- Coordinate with construction personnel information to be given to the local interest groups during meetings concerning the project activities.
- Relay strategic information from the relationship with local population.
- Channel the feedback to the company and recommend the corresponding actions.
- Coordinate with the Environmental, Health and Security Areas the process to follow to communicate security, environmental, health and personal protection measures.
- Make sure all workers under the company’s responsibility follow safety, health, environmental and personal protection procedures.
- Anticipate and alert line managers and supervisors about problems (potentially conflictive situations, incidents or other affairs related to the social area) and recommend a plan of action.

- Help with the training process by coordinating with Human Resources Management and the Community Relations Plan.
- Help to establish the identification and methodology for compensating for any damage caused that may be related to construction activities.
- It has been identified that the access road belongs to the Ministry of Agriculture and the company has started the procedures to be granted the right of way, however, in the event that there is any negotiation with a third party about the use of the land, the CRM will participate to support it.
- Advise before any specific problems occur and assist with the mediation between the company and affected people.

Within the Community Relations Plan, the following activities are considered during the planning and construction / operation stage. Table 11-1 details the relative time that will be spent on the different tasks.

Table 11-1 Relative time for different tasks

Activity	Planning stage	Construction – Blasting stage	Relevant programs in the Community Relations Plan
Management of perceptions and expectations of the interest groups	High activity Permanent Information and Consulting	High activity	Communication and consulting program
Negotiations and agreements for the use of lands	Low Activity Writing and negotiation of contracts	Low activity Solving changes in the project areas	Negotiation Agreements to establish the right of way (Use of Land), if necessary.
Temporary employment management	Medium activity Identification of potential workers	Medium activity Monitoring the Program Implementation	Local Personnel Temporary Employment Program
Minimizing Worker and Local Population Interaction	Medium activity Consulting and establishment clear rules for workers with Human Relations.	High activity Monitoring the implementation of the process	Communication and Consulting Program Community Relations Training Program for Project Personnel. Training for complying with Code of Conduct.

Activity	Planning stage	Construction – Blasting stage	Relevant programs in the Community Relations Plan
Minimizing impacts regarding project logistics activities	High Activity Informing the local population and interest groups	High Activity Informing the local population and interest groups	Communication and Consulting Program Emergency Response Plan to be coordinated with the Environmental, Health and Security Managements.
Minimizing impacts regarding the construction stage	High Activity Informing and consulting with the local population and interest groups	High Activity Informing and consulting with the local population and interest groups	Communication and Consulting Program Emergency Response Plan Dust control Plan (see EMP) Noise Management Plan (see EMP)
Socio-Environmental Management Tools (Health Program and Training Program)	High Activity	High Activity Implementing projects	According to the CMP

The Community Relations Plan includes:

- Community Relations Training Program for the Project Personnel.
- Local Personnel Temporary Employment Program.
- Communication and Consulting Program.
- Use of Land Negotiation Program, if necessary.
- Health Program.
- Training Program.

Additionally, the following is attached to the Community Relations Plan:

- Worker Code of Conduct

The Community Relations Plan will be progressively updated, as more information is obtained, to comply with good corporate practice standards and can be applied to the local and regional community.

11.8 COMMUNITY RELATIONS TRAINING PROGRAM FOR THE PROJECT PERSONNEL

The conduct of a project workforce has historically been one of the most serious sources of social impacts. Frequently, the local population of a project intervention area voices their concerns about the conduct of the project work force and how they should be supervised. In order to handle this aspect, Peru LNG will prepare a Training Program for its workers and contractors about the company policies and actions regarding social matters, including environmental education.

The program will be complemented with the scope of the Environmental Management Plan, part of the EIS/A, and will aim to assure that:

- All workers understand the social affairs the come with the project.
- All workers understand Peru LNG's requirements and commitments regarding the project.
- All workers know and understand the consequences of not complying with the rules established under Peru LNG Code of Conduct.

The program applies to all Peru LNG employed workers or its contractors involved in any field activity associated with the project.

The program will include extensive information about:

- The company social responsibility policy.
- The Worker’s Code of Conduct.

In order to implement the Training Program for company workers and contractors, specially prepared information will be distributed to each participant. The content will be presented, questions will be answered and personnel suggestions regarding unforeseen social management measures will be taken into account.

Before beginning the construction stage, project personnel in the field will receive a special induction from the Peru LNG Community Services Department. This initial induction will help establish a training course for the rest of the project.

11.9 TEMPORARY EMPLOYMENT PROGRAM FOR LOCAL PERSONNEL

In the project area, one of the expectations of the local population refers to employment opportunities that the project may generate, as suggested by the local interest groups in the area of influence. However, real opportunities are fewer than the population expects, due to the characteristics of the project. This fact presents additional risks, as unemployed people will move closer to the project areas in search of work, which would generate additional social impacts.

In order to handle these impacts, Peru LNG will develop a Temporary Employment Program for Local Personnel. The objectives of this program are:

- Maximize the number of local personnel hired in the project direct area of influence.
- Minimize local expectations in terms of potential employment.
- Prevent the migration of unwanted people towards the project areas in search of work.

The migration trend depends on the job expectations that may arise in the area and by the benefits derived from the project.

The Communication and Consultation program aims at avoiding the unwanted migration by informing clearly about the scope, goals and action of the project, within its corporative responsibility policy, in order to significantly reduce any excessive distortion or expectation that the population around the project area of influence may have.

This objective will have to be complemented in coordination with the State to minimize obstructions or pressure against the project activities.

This program will have the following guidelines:

- Members of the population directly impacted by the project will be preferred over others, as long as they qualify technically and meet the company requirements and provisions in the SMP.
- Peru LNG will communicate conditions and labor restrictions that will apply to employment of local workers. The local population will be told how many workers will be hired, for how long, the kind of experience required and labor conditions. Such conditions and restrictions will be communicated by the offices that will be opened with this purpose.
- Peru LNG will communicate clearly the limited opportunities for work, so as to adequately manage expectations. This will include a clear explanation of available jobs and its respective duration.
- Peru LNG has been carrying out, and will continue to carry out, a campaign in the project area of influence about restrictions on employment. The objective is to prevent immigration to the area.

Peru LNG will provide a medical exam to workers before work starts.

11.10 COMMUNICATION AND CONSULTING PROGRAM

Permanent communication and consulting with interest groups make up the essential processes for the management of social affairs, as well as promoting and strengthening positive relations with the local population and other interest groups. Peru LNG is committed to making a clear, transparent and continuous consulting process with the interest groups for the duration of the project.

The objectives of the consulting program are the same for the whole Community Relations Plan:

- Build communication channels for internal and external understanding of global activities and aspects that can be impacted by the project.
- Ensure that all topics are understood and dealt with at the management level of Peru LNG and contractors.
- Generate permanent feedback for the CRP and the EMP of the EIA/S, by including local population opinions, concerns and consultation regarding the project activities.

The communications and consulting process began with the Environmental and Social Impact Assessment (E/SIA) for the GNL-2 Quarry Extraction Project

This process has been designed and implemented according to the following guidelines:

a. The Community Relations Guide, proposed by the Ministry of Energy and Mining, (MEM - 2001).
b. The International Financial Corporation's (IFC) guidelines and the World Bank, in the document **Doing Better Business Through Effective Public Consultation and Disclosure, A Good Practice Manual (IFC, 1998),** applicable to projects receiving international agency financing.
c. Ministerial Resolution N° 596 - 2002 - MEM/DM, Consulting and Citizen Participation in the Environmental Assessment Approval Procedure in the Energy and Mining Sector Regulations.

Methodology and Tools

Along this process, INFORMATIVE WORKSHOPS have been carried out in San Vicente de Cañete, Grocio Prado, Jahuay and Topará. PARTICIPATIVE EVALUATION WORKSHOPS (Participative Rural Diagnostics), conduct surveys and interviews with key people in Grocio Prado, San Vicente de Cañete and Topará.

Communication and consulting make up part of a permanent process, and regular meetings are conducted with key local interest groups throughout the duration of the project, to properly inform on the implementation of the Environmental Management Plan and the Community Relations Plan.

The central topics are related to transportation and logistics, local employment, social and environmental impacts monitoring, as well as other topics or general perceptions related to the project.

Many of the impacts refer to the perceptions that people may develop regarding the project. Independently of whether their perceptions are based on facts, they can act upon them, in favor of or against the project. Therefore, these perceptions must also be dealt with.

The Community Relations Management will deal with the Communication and Consulting Program. Representatives of the Community Relations Department will meet with the population and local interest groups to inform and communicate with them. Should it be necessary, the Community Relations Department will call upon other people within the company to provide more detailed information on technical aspects.

Direct meetings with the local population and interest groups are considered by Peru LNG to be the most important in the consulting process, therefore the following guidelines will be taken into account:

- The local population will be called upon to participate in the communication and consulting meetings in order to provide information about the project and environmental and social impact management measures. The local authorities will be invited.
- Communication and consulting mechanisms will be designed to invite consultation. Radio communication will be prioritized.
- Objectives and consulting meetings will be planned and defined beforehand. Such objectives and their agendas will be flexible, so that any unforeseen topics that may come forth can be included in the meeting. The purpose of the meeting and the agenda will be made known to the population before the meeting.

The communication and consultation process will be documented; noting the time, place and number of participants in the meeting, as well as topics discussed and the agreements arrived at. These measures will serve to insure easy monitoring of all activities.

11.11 LAND USE NEGOTIATION PROGRAM

The negotiations for agreements on the use of the soil and the right of way are positive impacts as long as they generate potential benefits. If negotiations are implemented inadequately, they may turn into significant sources of negative impacts and social friction.

It is most likely that the Land Use Negotiation program will not be used for the GNL-2 Quarry Exploitation Project, Cañete-Peru because the access areas currently belong to the Ministry of Agriculture and the company has started the procedures to be granted the right of way.

In the event that some negotiation would become necessary, the guidelines to be included are the following:

- Insure a transparent negotiation process and agree on a fair price.
- Generate trust in the local population so they feel that the process will be carried out in a fair and transparent manner.
- Complete the process on the planned dates, to initiate construction and blasting activities according to the schedule.

11.12 HEALTH PROGRAM

Peru LNG's Health and Safety Department will elaborate a Health and Medical Support Program in case incidents occur, or when preventive campaigns are needed in the project area of influence.

The objective will be to ascertain the presence of a team of health professionals, trained to vaccinate and attend to project workers and the local population when necessary through preventive campaigns, or in the event of accidents that may occur, as a consequence of the project activities.

This program will have the necessary human resources, medicines and equipment to respond to an emergency.

The objective of such measures is to minimize any possible risk to the population, as well as the risk to the workers.

Within the activities to be developed within this program, we suggest:

- Communication about good hygiene, health and prevention of diseases common in the area, such as Acute Respiratory Infections (ARI’s) and Diarrheal Diseases.
- Communication about nutrition for community-based organizations: community kitchens, “vaso de leche” communities and “school breakfast” communities.
- Campaigns to inform about the use and home treatment of water for human consumption.

11.13 TRAINING AND EDUCATIONAL PROGRAM

The purpose of this program is to train and to give basic knowledge to strengthen economic activities performed in these areas, as well as to improve competences of people and organizations by Training Workshops.

By transmitting the necessary knowledge, we are promoting people and companies to allow activities that are not related to short-termed activities such as construction and operation of the quarry.

This program does not substitute the local entities or the Government in promoting development. In the same manner, this program’s actions and activities will include Strategic Development Plans developed by the Municipalities in the project area of influence.

Among the activities to be developed by this program, we suggest:

- A Leadership Workshop: Aimed at the citizens, politicians and social actors to help strengthen their institutions.
- A Creation and Training Workshop: Aimed at companies, for entrepreneurs and micro investors interested in learning about business planning.

- Training for teachers in the area of influence in environmental education and health, the project activities, and impacts and benefits.
- Talks for students and parents,about project activities, impacts and benefits.
- Promotion and encouragement of reading in school.

Additionally, when finally authorized and made viable, during the project we can consider:

- Use some of the quarry material to build the river wall in the Topará sector.
- Other activities to be implemented and coordinated with authorities and within the framework of the Strategic Development Plan.

The general criteria to manage this Program are:

1. It should benefit first and foremost all of the local population in the project area of influence.
2. It should be sustainable and as much as possible should contribute to local and/or regional development.
3. The active participation of the local population or interest groups in the area should be ascertained.

11.14 WORKER'S CODE OF CONDUCT

During the communication and consulting process, the interest groups have expressed their concerns regarding the potential impact the project workforce may produce.

In this sense, Peru LNG has drawn up a Worker Code of Conduct to minimize, and whenever possible, eliminate all negative impacts associated with the project's workforce.

This Code of Conduct applies to the GNL-2 Quarry Exploitation Project, Cañete - Peru.

11.15 WORKER CODE OF CONDUCT PROPOSAL

Introduction

Peru LNG S.R.L ("PERU PLNG") is responsible for the construction and operation of the Liquefied Natural Gas Plant and required marine installations (collectively known as the "Liquefied Natural Gas Exportation Project"), as well as any other associated commercial activities (the "Project").

The Project also includes activities that are carried out to extract rock from the quarry GNL-2, located inside the Peru LNG S.R.L. concession. The mining property involved makes up a total surface of 500 hectares. The point of access is located at Km 168 on the South Pan American Highway, in the Department of Lima.

The areas to be used in the quarry extraction activities include:

- Access roads: to the quarry, to the dump pits, to the magazine,
- Accumulation and selection area (6 Ha),
- Area for damp pit (17 Ha),
- Temporary facilities for mining contractor (4 Ha).

PLNG has identified, with the help of authorities and the local population, a series of topics related to the Worker's behavior. They must be considered, in order to avoid or minimize any adverse effects, either social or environmental regarding any aspect of the project.

The term "Workers" refers to all people directly hired by PLNG and all permanent or temporary personnel hired by any contractor or subcontractor that provides services to PLNG.

The terms "Project Vehicles", "Project Transport Units", or "Project Vessels" mean vehicles, transport units or vessels provided or operated by PLNG or any of its contractors or subcontractors.

The term "Project Area" means the Plant, any connected quarry, any office and any other PLNG owned or operated facilities that work on the Project itself, excluding PLNG operations and offices in the city of Lima.

OBJECTIVE

The objective of this Code is to avoid or minimize, as much as possible, any negative impact that could be produced as a consequence of interrelations between the Workers inside the local areas of influence and the outskirts of the Project Area.

ASSENT

- Each of the Workers will receive a written copy of this Code as a part of the induction process. Additionally, a copy of this Code will be available in a visible place in each Area of the Project.
- As a requirement to be hired, all Workers must sign a copy of this Code, where they acknowledge it and certify they have read it and accepted its terms, promising to comply with its terms thoroughly and at all times.
- Any question related to this Code or any regulation within it must be addressed by a representative designated by Peru LNG Community Relations Manager (CRM).
- The Workers are obliged to comply with the rules and procedures indicated in this Code, so as to maintain good relations with the local communities in the direct area of influence of the Project.
- Any worker may be subject to disciplinary actions and/or may be fired if their behavior while he was employed by PLNG went against the rules stated in this Code.
- This Code can be modified at any moment by PLNG, in which case PLNG will immediately deliver a written copy of said change to each Worker, in accordance with the assent procedure explained before.

Rules regarding the local population

- The local population is defined as all people that live within the direct area of influence of the Project, or in the areas used for the transportation of equipment and materials required for the construction or operation stages of the Project.
- All workers are expected to behave adequately at all times and must avoid improper relations with the local population.
- Any public release about the Project must be approved by the PLNG General Manager or the person he appoints.
- The PERU PLNG Community Relations team has been authorized to interact with the local population and request and receive their comments, suggestions and complaints, according to corresponding procedures created specifically for that purpose. Therefore, the Workers will not interrelate with the local population without the express consent of the PLNG Community Relations team.
- All Workers shall avoid any discriminatory conduct based on gender, age, disability, race, language, culture, political affiliations, philosophy, religion, or any other illegal basis.
- All Workers must comply with, at all times, all applicable environmental rules and regulations, including complying with the social and environmental responsibilities PERU PLNG has implemented based on the applicable Environmental Impact Assessment.
- Should the Worker fail to comply with the present Code, or behave in such a way that he/she creates a problem with the local population, the corresponding action must be communicated to the Community Relations manager, detailing what happened, so that the PLNG Community Relations office can carry out an investigation.

Rules regarding the Project Pre-construction, Construction, and Operations stages:

- All Workers are required to show at all times a transparent and honest behavior, and a high level of personal responsibility and professionalism, either in or out of the Project Area.
- All Workers shall comply with all applicable laws, rules and regulations.
- PLNG requires all Workers to take the medical exams necessary to work and enjoy good health. Workers shall immediately inform medical staff in the Project Area about any kind of sickness or symptom that may affect their ability to carry out their work-related obligations properly.
- Workers shall use adequate personal protection equipment during their activities in any Project Area or property, including Project Vehicles and Vessels.
- Workers are not allowed to smoke or make an open fire within or in the surroundings of the Project Area or near any Project Property, including Project Vehicles and Vessels.
- The medical staff in charge of the project shall authorize possession and use of drugs within the area of influence of the project.
- Workers are forbidden to possess, use or carry any kind or illegal drugs, medical paraphernalia, narcotics or alcoholic beverages within the Project Area or any Project property, including Project Vehicles and Vessels.
- Workers are not allowed to possess or carry weapons, such as firearms, explosives, ammunitions, knives, clubs, etc., within the Project Area or any Project Property, including Project Vehicles and Vessels.
- All Workers shall report any conflicts of interest in writing to their supervisor.
- Workers shall not receive or hand over money, goods or other objects of value in order to obtain benefits, receive favors or influence decisions benefiting PLNG, third parties, or themselves.
- Workers shall not use PLNG funds or equipment or other articles provided by PLNG for their personal benefit or any other unauthorized use.
- Workers shall keep all information related to the project in the strictest confidence.
- Workers shall carry an easily detectable ID card at all times whenever they are inside any Project Area. Workers shall show their ID card to go in or out of any Project Area, or to use transportation provided to the Workers. It is not necessary to carry the ID card when outside of the Project Area, unless the Worker is carrying out a business related task.
- No Worker may possess or withdraw any archaeological remain from the Project Area such as ceremonial jars, pottery, or similar objects. If a Worker were to find such a piece in any Project Area, the Worker shall immediately stop work and notify his supervisor, who in turn will report the finding to the PLNG archaeologist, so as to carry out the proper procedure.
- Pets are not allowed in any Project Area. Fishing is also forbidden.

- Any information or contract related to the work shall necessarily be provided or signed at the offices in Lima, Cañete, Chincha or others. Information on local contracts will not be placed on any entrance door in any part of the Project Area.
- For industrial security reasons, Workers may not approach entrance doors or access points to any Project Area for personal purchases.
- For industrial security reasons, Workers may not abandon any Project Area without permission. Local Workers will be transported to their residence in transport units provided by the Project. Project Transport Units may not make unauthorized stops.

Rules regarding Transportation of Cargo to PLNG Installations or connected businesses:

- Project Vehicles may not make unauthorized stops in towns or cities in any of the routes used to supply construction materials for the construction of operation of the Project or connected business. The only exception is in the case of an emergency.
- Project Vehicles must comply with the schedules and the maximum and minimum speed established by the company.
- Workers operating a Project Vehicle may not carry passengers other than PLNG Workers, unless allowed by a supervisor.
- Workers must comply with all traffic laws at all times, and according to guidelines provided by PLNG.
- Project Vehicles may not use routes other than those designated on the road permit or logistic plan, except in emergencies or when authorized by a PLNG supervisor.
- Workers operating a Project Vehicle may not transport cargo on said vehicle unless he/she has obtained permission and authorization for the transportation of said cargo.
- Workers operating a Project Vehicle must remain in permanent contact with home base and are forbidden to inappropriately use communication devices on any Project vehicle.

Some aspects and situations may have not been described in this Code. In such case, Workers are expected to behave and make decisions in such a way that they reflect the highest ethical standards.

Commitment

I have received, read and understood the Code of Conduct for Peru LNG S.R.L. workers. I agree to adhere to this Code, and I promise to comply at all times, with the rules and regulations established herein.

I am completely aware that I may receive disciplinary sanctions, and may even be fired, if my behavior, on or off the job, does not comply with the established rules.

All of this information has been provided to me during the induction process, thus I sign this agreement.

Cañete, 200_.

<u>Worker's Personal Information</u>

Names:

Last Name:

Place and Date of Birth:

Address:

Position:

Company you work for:

Department:

Signature:

Date:

Supervisor:

Department:

Signature:

Date: