ENVIRONMENTAL IMPACT ASSESSMENT OF THE MARINE ENVIRONMENT FOR CONSTRUCTION OF MARINE TERMINAL AND BREAKWATER

FOR BERTHING GAS CARRIERS (METHANE VESSELS) OF UP TO 160,000 m^3 TO LOAD LIQUEFIED NATURAL GAS (LNG) AT PLAYA MELCHORITA

PERU LNG S.R.L.

CAÑETE - LIMA

July 2003

TABLE OF CONTENTS

I. INTRODUCTION

1.1 General Background of the Area

1.1.1 Area

1.2 Justification

1.3 Objectives of the EIA

1.3.1 General Objectives

1.3.2 Specific Objectives

1.4 Methodology Applied

1.5 EIA Schedule

II. PROJECT DESCRIPTION

2.1 Location of study area

2.2 Work to be performed

2.3 Berth services

2.4 Means and equipment to avoid contaminating the water and beaches with organic and inorganic wastes

2.5 Dock safety - means and equipment

2.6 Nautical signaling and navigation safety

III. ENVIRONMENTAL CHARACTERIZATION

3.1 Geomorphology and geology

3.1.1 Geology

3.1.2 Geomorphology

3.1.3 Coastal morphology

3.1.4 Erosion and sedimentation processes

3.2 Hydrogeological aspects

3.3 Seismic characteristics

3.4 Sea bottom

3.5 Currents
3.5.1 Methodology
3.5.2 Results
3.5.3 Discussion
3.6 Waves
3.6.1 Wave assessment methodology
3.6.2 Analysis of waves
3.6.3 Types of waves
3.6.4 Results of wave analysis
3.6.5 Calculation of wave heights
3.6.6 Calculation of wave height, in a southwesterly direction
3.6.7 Calculation of wave height, in a southerly direction
3.6.8 Calculation of total kr
3.6.9 Calculation of wave height within swash zone (hb)
3.6.10 Calculation of wave depth when it breaks
3.6.11 Distance at which wave breaks from the beach
3.6.12 Characteristics of waves at Playa Melchorita and action of breakwater
3.7 Tides
3.8 Tsunamis
3.9 Meteorology
3.10 Physical aspects of climate changes
3.11 Characterization of water quality and sediments in the receiving body
3.11.1 Materials and methods
3.11.2 UTM Coordinates (WGS 84) from sampling point
3.11.3 Water quality, results and discussion
3.11.4 Sediment quality, results and discussion
3.12 Biological conditions: habitats and biodiversity
3.12.1 Materials and methods
3.12.2 Results and discussion
3.13 Current and future uses of the sea and beaches
3.14 Socio-economic factors
3.14.1 Project location

3.14.2 Use and possession of land
3.14.3 Social profile
3.14.4 Population
3.14.5 Poverty
3.14.6 Infrastructure Services
3.14.7 Communication routes and transportation
3.14.8 Electric power
3.14.9 Economic profile

IV. ENVIRONMENTAL IMPACTS
4.1 Impacts
4.1.1 Construction Phase
4.1.2 Operations Phase
4.2 Impacted Factors
4.2.1 Construction Phase
4.2.2 Operations Phase
4.2.3 Risk of marine contamination
4.3 Determination of Critical Points
4.4 Foreseeable Impacts
4.4.1 During the Construction Phase
4.4.1.1 Impacts on the Marine Environment within the loading area
4.4.1.2 Impacts on marine dynamics and the coastal profile
4.4.1.3 Impacts on the transit of vessels and fishermen
4.4.1.4 Aesthetical Impacts
4.4.2 During the Operations Phase
4.4.2.1 Impacts on the Marine Environment within the loading area
4.4.2.2 Impacts on marine dynamics and the coastal profile
4.4.2.3 Impacts on the transit of vessels
4.4.2.4 Aesthetical Impacts

V. ENVIRONMENTAL MANAGEMENT PROGRAM
5.1 Mitigation Measures

5.2 Complementary Mitigation Measures

VI. IDENTIFICATION OF PARAMETERS FOR ENVIRONMENTAL AUDITS

6.1 Monitoring Program

VII. CONCLUSIONS AND RECOMMENDATIONS

7.1 Conclusions

7.1.1 Condition of the Marine Environment

7.1.2 Characteristics of the Terminal

7.1.3 Characteristics of the Breakwater

7.2 Recommendations

7.2.1 Condition of the Marine Environment

7.2.2 Characteristics of the Terminal

7.2.3 Characteristics of the Breakwater

***TEAM MEMBER COMPOSITION**

VIII. ANNEXES

1. Certificates
2. Photographs
3. Drawings
4. Glossary of Terms
5. Bibliography

ENVIRONMENTAL IMPACT ASSESSMENT OF THE MARINE ENVIRONMENT FOR CONSTRUCTION OF MARINE TERMINAL AND BREAKWATER FOR BERTHING METHANE VESSELS OF UP TO 160,000 m^3 TO LOAD LIQUEFIED NATURAL GAS (LNG) AT PLAYA MELCHORITA - CAÑETE

I. INTRODUCTION

PERU LNG S.R.L. (**PERU LNG**) is a company engaged in the performance of hydrocarbon activities in Peru, which includes the implementation of a project to export Liquefied Natural Gas ("LNG") to the western coast of North America, using for such purpose Natural Gas extracted from the Camisea fields.

To prepare the Environmental Impact Assessment according to the "Guidelines for the performance of Environmental Impact Assessments related to berth, wharf and similar construction projects", in keeping with the provisions set forth in Directorial Resolution No. 0283-96/DCG, dated October 21,1996, PERU LNG contracted with "Servicios de Monitoreo Ambiental e Investigación de Impactos", a company that has been duly registered with the General Bureau of Harbor Masters' Offices and Coastguards, as evidenced by Certificate No. 44-97, dated November 26, 1997, currently valid (Certificate evidencing the Registration of Companies and Associations related to Water Activities).

To undertake the aforementioned project, PERU LNG is planning to build a natural gas liquefaction plant and other facilities required to export the liquefied natural gas, on a tract of uncultivated land that includes nearly 521 hectares along the Pacific Ocean directly off the South Panamericana Highway, between km. 167 and Km. 170, in the district of San Vicente, province of Cañete, department of Lima.

PERU LNG, as part of the marine facilities required for the Export Project, is planning to build, in front of Playa Melchorita (Melchorita Beach), a Marine Terminal to accommodate 277 m. long x 43.4 m. wide methane tankers to load Liquefied Natural Gas (LNG).

The Project will provide Peru with capital investment, employment opportunities, infrastructure, revenues through the payment of royalties and taxes, and a positive foreign currency balance resulting from the export of energy.

The Project includes the construction and operation of a Natural Gas Liquefaction and Export Plant with a nominal capacity of 4.4 million metric tons per year (MMTY). The plant will process natural gas produced from the Camisea gas fields, located in Cusco, 500 km. east of Lima. The detailed engineering and construction component is planned to commence in 2004, with the first LGN export project production in 2007. Project facilities include a LNG tanker (methane) berth, a dredged navigational channel, and a breakwater aligned parallel to the coast, protecting both facilities. Drawing A-1 shows the location of both the Project and adjacent areas.

The Project consists of the following components:

- Liquefaction Plant;
- Marine facilities;
- Administration, Housing, Infrastructure and Services.

Related projects include a high-pressure gas pipeline to transport feed gas from the Camisea Gas Project to the plant. The competent regulatory authorities have already approved the EIA for the main gas pipeline to Lima. The branch pipeline from the main gas pipeline to the plant site, which will be approximately 2 km. long, will be the subject matter of a separate EIA.

LNG is produced when natural gas is cooled to approximately minus 163 degrees Celsius (-163°C) at atmospheric pressure. Since there are economic limitations because of the distance natural gas is to travel through onshore or offshore gas pipelines, the liquefaction of natural gas to LNG makes natural gas transportation and storage more economical and safer. LNG occupies a volume of approximately 1/600 of an equivalent volume of natural gas, which facilitates the storage and transportation of a bulk supply of LNG using methane vessels for this purpose.

LNG weighs less than water, is odorless, colorless, non-corrosive, and non-toxic. LNG vapors are only flammable under certain specific conditions that require a methane gas concentration of between 5.3% and 15% in air and an ignition source. One of the characteristics of LNG is that it is not explosive.

The Project has been designed to be economically and environmentally efficient, while providing an alternative source of non-contaminating fuel for the international market.

Nature of the Project

The LNG Export Project calls for the design and construction of a plant to convert Natural Gas into Liquefied Natural Gas (LNG). This plant will have a nominal capacity of 4.4 million metric tons per year.

Due to its location, characteristics and components, different entities will become involved in the project, like the Ministry of Energy and Mines (DGAAE, DGH), the Peruvian Navy (DICAPI), the Ministry of Transport and Communications (DGTA), the Ministry of Agriculture (INRENA), OSINERG, the Health Ministry (DIGESA), among others. The company will obtain the authorization of the corresponding entities, in accordance with the applicable laws and the legal and institutional framework described in Chapter I of the EIA prepared for the LNG Export Project.

Objectives

The Camisea Project has recoverable gas reserves estimated at 3.11 x 1011 m., the maximum production rates being approximately 13.0 x 109 m / year. The natural gas reserves will be used to the largest extent possible in Peru, to meet both domestic and industrial consumption.

The plant will process the excess natural gas produced from the Camisea gas fields at a rate of 6.7 x 109 m/year, in order to export this gas to meet the world's growing LNG demand.

Besides the economic benefits mentioned above, such as capital investment, employment generation, development of infrastructure, generation of income through the payment of royalties and taxes, and a positive foreign currency balance as a result of the export of energy, this Project will also provide other key benefits, as follows:

- The Camisea Project will foster development by supplying a larger amount of natural gas and liquids to Peru, such as propane, butane, naphtha, diesel, and other products;
- There will be new employment opportunities and foreign investment during the construction and operation of the new facilities, which will in turn encourage other foreign companies to look for and develop additional natural gas reserves in Peru;
- The price of natural gas will have greater stability and the government of Peru will receive more revenues from the long-term export of LNG, with which Peru will become an energy exporter; and
- It will have an economic impact on the area and there will be a reliable and constant flow of natural gas, which is a clean fuel and also a raw material that will support the expansion of industrial and commercial projects.

Life Cycle of the Plant

The life cycle of the Plant has been estimated at nearly 30 years, although this term can be extended if the plant is properly operated and receives appropriate maintenance based on the company's broad international experience in the construction and operation of plants.

At the end of the useful life of the plant, the equipment will be dismantled and sold on the free market, and the area will be restored in order to be used for other industrial purposes.

Future Growth Plans

The LNG plant will be built as a single-train facility with a nominal capacity of 4.4 million metric tons per year. In spite of the fact that there is enough room to build a second train, no plans or additional investments have been forecasted for the LNG plant in the short term.

1.1 General Background of the Area

1.1.1 Area

The Peruvian coast is a strip of land that runs parallel to the coastline and includes different landscapes, like fluvial valleys that cross the coast transversally from East to West and interfluvial deserts between the valleys, giving rise to sub-landscapes like plains or "pampas", mountains, and dry ravines.

The Peruvian coast is situated between parallels 03°23' and 18°20' Latitude South. The coastline extends for over 3,080 km. The coast, in spite of being the smallest region in the country, is home to the largest part of the population, Lima being the most important center and home to 27.2% of the national population.

The Liquefaction Plant Marine Terminal for the export of Liquefied Natural Gas will be located on the central coast of Peru, on a tract of uncultivated land, 167 km. south of Lima, in an area called Playa Melchorita, at the southernmost end of the district of San Vicente de Cañete, province of Cañete, department of Lima, 17.1 km. south of the Cañete River.

Playa Melchorita is a beach with fine sand that extends in a straight line, its average width ranging between 50, 80 and 100 m. The beach is long and lacks coastal-related geographical irregularities, like overhanging formations, sharp ends, rocky systems, or other relevant morphological features. The back or inland side of the beach includes two terraces of non-consolidated material (cliffs), one of them being 30 to 40 m. high and the other one, 80 to 130 m. high.

There is a large amount of firewood, consisting of ditch reed, branches and sticks, on the edge of the lower cliff, there being two beach berms. The swash zone is relatively wide, with 3 to 4 waves breaking in this area. Two kinds of breakers have been observed: surging breakers (70%) and plunging breakers (30%). Overall, wave action is relatively intense and waves can be as high as 4.0 m. when they break. There are no natural shelter areas for vessel mooring, for which reason the project contemplates the construction of a breakwater aligned parallel to the coast, adjacent to the loading platform.

The District of San Vicente de Cañete has a surface area of 513.15 km^2 and a population of 38,057 inhabitants.

It is bounded as follows:

- On the North: By the Districts of San Luis and Imperial
- On the East: By the Districts of Nuevo Imperial and Lunahuaná
- On the South: By the District of Chincha
- On the West: The Pacific Ocean

Playa Melchorita is located between the following parallels:

- Latitude South: 13°19'24.5"
- Longitude West: 76°14'31.7"

From a geographical standpoint, the area where the plant and its marine facilities may be located is 20 km. away from Cañete, in the department of Lima, and 20 km. away from Chincha, in the department of Ica. See Location Drawing A.

1.2 Justification

PERU LNG, in order to have the necessary infrastructure in place to load and export liquefied natural gas (LNG) from the marine area off Playa Melchorita, is planning to build a marine shipping terminal where ONE (01) 277 m. long x 43.4 m. wide 160,000 m^3 tanker is expected to be moored at the berth at a time. To cover the entire circuit (Peruvian coasts – US coasts), 4 methane tankers might be required.

The Terminal is made up of FIVE (05) main structures, as follows:

- Trestle bridge;
- LNG loading platform built on piles;
- Breasting dolphins;
- Mooring dolphins; and
- Breakwater.

The entire structure has been designed to withstand horizontal loads caused by seismic events and, on the west side of the platform, withstand the impact of vessels. To this end, tilted piles will be strategically located to reduce undesired deformations and stress.

The trestle bridge will be 1,300 m. long. It will first run perpendicular to the coastline, to be followed by a 30 m. long x 30 m. wide platform that will run perpendicular to the trestle bridge.

As regards the breakwater, it will be aligned parallel to the coast and, therefore, will run perpendicular to the loading platform access bridge. It will be built of rock to protect the mooring berth and the vessel against the strength of the waves. The breakwater will be 250 m. away from the mooring berth, on the seaward side, and will be 14 to 16 m. deep. Studies recommend that the breakwater be 800 m. long and 96 m. wide.

Selecting the location of the plant and its marine facilities

Extensive studies were performed along the central coast of Peru to identify an appropriate location for the project. Potential locations were identified and evaluated during the site selection process, bearing in mind the following parameters and criteria:

- Evaluate potential coastal locations within a radius of 200 km. south of Lima. The initial selection criteria required a minimum plot of land of 100 hectares;
- Rule out places that showed high environmental sensitivity;
- Rule out densely populated areas;
- Identify clear areas of land on the coast, with a minimum distance from shore to at least 15 meters water depth and an elevation of at least 20 m. to mitigate the effects of tsunami hazard;
- Exclude areas where land preparation could involve considerable difficulty;
- Exclude areas where soil liquefaction could occur by earthquake shaking, or soil instability could result from soil movements and, most importantly, avoid proximity to faults and seismically unstable soils due to the presence of highly seismic areas (earthquakes) in Peru;
- Give preference to ocean conditions suitable for safe tanker mooring;
- Give preference to proximity to commercial centers that could provide raw materials and labor; and
- Give preference to areas that were big enough to accommodate possible expansions.

In keeping with the above criteria, 17 specific sites were identified between the cities of Pisco and Lima in 2001. All these sites were visited to gather additional information. The main options considered, and their respective distances, included: Sarapampa (106 to 110 km. south of Lima); 12 beach areas (113 to 131 km. south of Lima), Punta Corriente (123 km. south of Lima), Cerro Azul (130 km. south of Lima), Pampa Clarita (154 km. south of Lima), and Pampa Melchorita (167 km. south of Lima) (See Figure 4).

Based on the above studies, two sites were initially selected to carry out more detailed evaluations: Pampa Clarita (154 km. south of Lima) and Punta Corriente (122 km. south of Lima). The Front End Engineering Design revealed that the Project needed more than 150 hectares, for which reason Punta Corriente was ruled out due to its limited land area, coupled with the fact that it was located in a heavily developed zone. Pampa Clarita, 154 km. south of Lima, was considered the best option due to the greater availability of land and the smaller cost involved in the preparation of the land. This is why this site was evaluated more thoroughly, and offshore and onshore engineering studies, baseline environmental assessments, and archaeological, geotechnical and socio-economic studies were conducted at Pampa Clarita. However, Pampa Clarita was ruled out based on the results of the studies performed in said area which, among other things, revealed the presence of swelling clays, which create unstable foundation conditions for LNG storage tanks, and also because of the socio-cultural and archaeological impacts that the construction of the proposed Facility could have in this area.

Pampa Melchorita was considered the third option, although it was not initially selected as a preferred site because of its elevation, 135 meters above sea level, which requires a major access road to the coast. In addition, it was initially thought that due to its elevation the amount of LNG to be loaded could decrease because of the additional gas vapor that would build up as a result of an increase in temperature during the transportation of LNG by the gas pipeline from 135 meters above sea level to the sea-level marine facilities where the LNG would be loaded onto the tankers. However, additional engineering studies resulted in the design of a safer and more economical configuration for this site. This new configuration involves gravity drainage to a remote secondary containment sump at an elevation of 70 m. As a result, two (2) 110,000 m. single-containment double-wall tanks will be used for LNG storage, compared with the initial configuration of a 185,000 m. full-containment tank, thus offsetting the disadvantages posed by the elevation of this site. According to this new configuration, Pampa Melchorita was selected as the site for the installation of the LNG Export Project and the site for the performance of the EIA subject matter of this report.

1.3 Objectives of the EIA

1.3.1 General Objectives

Prevent, identify, evaluate, and mitigate negative effects, while strengthening the positive effects of the construction of PERU LNG's terminal, the main premise being the fulfillment of national and international legislation and compliance with the highest environmental standards and criteria to guarantee sustainable management.

1.3.2 Specific Objectives

- Establish a Baseline.

- Identify the different environmental impacts during the fitting-out, installation and operation of the wharf.

- Establish a program to mitigate negative impacts and strengthen positive impacts during the Project construction and operations phases.

- Establish an environmental management program consisting in providing:

  - ❖ Permanent supervision of the different environmental factors involved in the project (monitoring program).
  - ❖ Compliance with the different National and International Environmental Regulations.

1.4 Methodology Applied

The following methodology was applied for the following stages:

1) Environmental Characterization: Field prospecting at the Project site, where the following work was carried out:

   a. Characterization of water quality: water samples were taken from surface, intermediate and bottom water levels to evaluate the following parameters: Temperature; Nitrogen in the form of Nitrites, Nitrates, and Total Nitrogen; Phosphates and Total Phosphorous; Biochemical Oxygen Demand; Total Suspended Solids; Hydrocarbons; Dissolved Oxygen.

b. Characterization of bottom sediments: sediment samples were taken to evaluate: granulometric composition, heavy metals, organic matter percentage (%).

c. Characterization of aquatic flora and fauna: phytoplankton and zooplankton samples were taken for the qualification and quantification of the different components. Bottom sediment samples were also taken to identify the benthonic fauna and flora.

d. Hydrographic evaluation: current and bathymetric studies were performed, waves were observed, etc.

e. Socio-economic assessments of the area of influence.

2) Environmental Characterization: Cabinet-based Meteorological and Hydrographic studies, based on historical data on climatology and hydrography, current and future sea and beach uses, complementing this information with socio-economic data.

3) Identification of Environmental Impacts:

- Descriptive control lists that, besides describing the role played by environmental parameters, provide some type of guidance to analyze environmental impacts.

- Prediction and evaluation of environmental impacts:

a. Identification of project contaminants.

b. Description of existing quality levels.

c. Determination of the dispersion potential of contaminants in the area.

d. Basic hydrographic data.

e. Development of relevant sea water quality standards and emission standards.

f. Identification of the concentration of contaminants in the water, both at a surface and bottom level.

g. Evaluation of measures to mitigate water contamination if regional environmental quality standards are exceeded.

1.5 EIA Schedule

WEEKS	1ST	2ND	3RD	4TH
Field sampling	---------			
Analysis of samples at the laboratory		----------	----------	
Cabinet analysis		----------	----------	
Evaluation of environmental impacts			----------	
Final report				-----------

All this work complements the work carried out by GOLDER ASSOCIATES as part of the comprehensive Environmental Impact Assessment that includes the plant and marine facilities.

II. PROJECT DESCRIPTION

2.1 Location of Study Area

The Marine Terminal forecasted to be built by PERU LNG COMPANY will be located in the maritime area of Playa Melchorita, around 15 km. south of the city of Cañete, province and department of Lima.

The UTM coordinates, WGS 84, of the axis of the trestle bridge are the following:

- Start E 358,666 N 8’534,727
- End E 357,259 N 8’533,320

The UTM coordinates, WGS 84, of the platform axis, including breasting and mooring dolphins, are the following:

- Start E 357,198 N 8’533,359
- End E 357,248 N 8’533,274

2.2 Work to be performed

See Drawing B-2, showing the bathymetry for the project area, at a scale of 1:7500.

Trestle bridge.-

A 1,300 m. long structure from the shore to the LNG loading platform, capable of bearing the weight of loaded vehicles of up to 25 ton capacity. Transverse piles will be 18 m. apart.

Transverse piles and beams will be built of steel elements, while the platform will be built of concrete, steel or a combination of both elements.

To fit out the trestle bridge, the space available on both ends of the transverse beams will be used to install pipelines and other elements that will hang from the structure.

The trestle bridge has been designed to be 1,300 m. long to provide the necessary water depth for the berthing of vessels at critical tide conditions, bearing in mind the fact that there will be a 250 m. wide x 3 m. deep dredged navigational channel that begins at the Northwest end of the Terminal, on the 15 m. isobath, and ends at the Southwest end of the Terminal, also on the 15 m. isobath. See Drawing B-2.

This structure has not been designed to exceed this length because of a number of technical reasons related to the characteristics of the LNG.

Loading Platform.-

Is the main structure that will allow the berthing of ONE (01) vessel at a time, with a storage capacity of up to 160,000 m2, for loading Liquefied Natural Gas (LNG).

The wharf-platform will be 30 m. long and 30 m. wide.

Below the platform, the sea will be 18 m. deep, it being part of the dredged channel.

Transverse piles and beams will be made of steel elements, while the platform will be built of concrete, steel or a combination of both elements.

The platform will be 9 to 11 m. high on the mean low water springs (MLWS)

Breasting and mooring dolphins.-

Secondary structures for berthing and mooring vessels. Four (4) breasting and mooring dolphins will be used to withstand the tractive force when vessels are berthed. Each such structure will consist of a breasting dolphin and quick-releasing hooks. Six (6) mooring dolphins will be installed to withstand mooring loads. Each such structure will in turn include a quick-releasing hook system.

Breakwater.-

The proposed project site provides some sort of natural protection against waves. The Paracas Peninsula, to the south, provides this protection but the project site is still exposed to long-period swells, with waves coming primarily from the southwest.

To provide appropriate mooring conditions and reduce the tension applied to the mooring lines by the wave-induced motion, a breakwater specifically designed for such purpose should be constructed.

See hydro-oceanographic study, particularly the chapter that deals with waves (refraction and diffraction of waves) a summary of which is included later on in this report.

An island-shaped berm-type breakwater design has been selected. The breakwater will be located offshore, in front of the LNG loading wharf, and will have no connection whatsoever to the coast. The proposed breakwater will be located near the 14 m. isobath and will be 800 m. long and 96 m. wide. It will be aligned more or less parallel to the coastline and the corresponding isobath, its azimuth being 135 degrees.

The breakwater will be built with a crest elevation of 8.5 m. above mean low water springs to allow the 100-year design wave to overtop with very little damage to the structure.

The nucleus of the breakwater will be made of quarry rock, ranging from very small rocks to 3 tons of filter rock and exposed layers consisting of 3 to 10 tons of rock. The smallest rock will weigh nearly 5 kg in the nucleus.

No limestone, sand or gravel material will be used in the breakwater. As regards total volume, the structure will require appropriately 1,200,000 m. of rock, which will be extracted from a quarry the use of which will be specifically requested for such purpose.

<u>Access Navigational Channel for LNG Tankers.-</u>

The access channel for LNG tankers will be constructed by dredging a channel that will be approximately two to three meters deep, 250 m wide, and 800 m long to provide the required water depth for the berthing of vessels 18 m on MLWS.

The berthing facility approach channel will require a depth of 18 m on MLWS to provide sufficient under-keel clearance during long-period swells, in order for the tanker to turn into and later out of the wharf.

LNG tankers can approach the berth from the north or south, depending on prevailing environmental conditions; additionally, they will need to maneuver to turn into and later out of the wharf due to the open horseshoe shape of the approach channel.

The approach and departure channels (navigational channel) will be dredged approximately 3 m to a depth of 18 m., 250 m. in width and approximately 2,700 m. in length.

Tanker Berth and LNG Loading Wharf

The LNG berth structures consist of a 30 m. x 30 m. loading platform, four breasting dolphins on the sides and six mooring dolphins. These berth structures consist of open grid steel decks on steel beams supported by steel-lined steel piles.

The loading platform has enough room to accommodate the loading arms, the operator's station, energy supply, control systems, emergency systems, and access to a mobile crane or other equipment that might be needed to provide maintenance to these facilities.

The platform area has also been designed to be surrounded by a ditch system and a containment chute located below the loading arms.

No facilities have been contemplated for the treatment of ballast water, as LNG carriers will be required to dispose of ballast water in accordance with the provisions set forth in the MARPOL 73/78 agreement.

LNG tankers have dedicated tanks specifically used for ballast water storage. Only clean seawater is stored therein, and this water never comes into contact with any contaminant.

According to the MARPOL requirements and other conditions set forth in Peruvian Directorial Resolution No. 0178-96-DCG, tankers will empty-refill their ballast water storage tanks 12 miles off the Peruvian coast. Said tanks will contain 48,000 m^3 of ballast water originating from the port of departure.

As recommended by the IMO guidelines, this is the best practice available to reduce the risk of transferring counter-productive aquatic organisms. Ballast water refilled 12 miles off the coast will be used as a water curtain during the performance of loading operations.

As a control mechanism to check that ballast water has been emptied-refilled 12 miles off the coast, the logbook of each vessel entering the terminal will be checked.

For the LNG transportation circuit, 4 methane vessels exclusively engaged in the rendering of this transportation service will be used. These vessels will be specifically built for this project.

Methane vessels will comply with the applicable maritime regulations in force in Peru. To this end, ballast water will be emptied-refilled 2 or 3 days before the date of arrival of the vessel and at least 12 miles off the coast, in accordance with the provisions set forth in the MARPOL Agreement ratified by Peru.

Tug Berths

Permanent tug berthing facilities will be provided to keep three tugs on location on a full-time basis. The tug berths will be located immediately adjacent to the mooring dolphins to the north of the loading platform.

Several drawbridges located between the loading platform and the tug berth mooring structures will provide access to the tugboats. The location of the tug berths in relation to the breakwater has been carefully chosen to provide the greatest possible protection against the motion of waves.

Utility Dock

A small utility dock will be installed on the southern side of the trestle bridge, approximately 90 m. from the loading platform.

This utility dock will be used to: temporarily berth a tug for refueling, install seawater intake equipment, provide a deck area for vehicle parking, and provide a working area for a mobile crane to support routine maintenance and tug operations.

The utility dock, which will include facilities for tug refueling, just like the loading platform, will also include a fuel spill containment system.

Tugboat wastes will be stored in drums and taken to the utility dock. Then, using wheeled containers, they will be taken to the plant in order to be processed through its waste treatment and management systems. A drawbridge between the loading platform and the berth will provide access to the tugs from the utility dock.

The location of the utility dock in relation to the breakwater has been carefully chosen to provide protection to tugs or service vessels, and also to provide high berthing availability.

Methane vessel.-

The methane vessels to be constructed in order to be specifically used for this project will have the following characteristics:

Capacity : 160,000 m^3

Type of tanks	:	Prismatic
Overall length	:	277 m.
Length between perpendiculars	:	266 m.
DWT	:	66,500 tons
Breadth	:	43.4 m.
Depth	:	26 m.
Load draught	:	11.4 m.
Light draught	:	09.5 m.

Tugboats.-

3 tugboats with the following characteristics are required:

Overall length	:	32 m.
Breadth	:	14 m.
Draught	:	05 m.
Static force	:	50 t.
Pushing force	:	40 t.
Tugging force	:	40 t.
Winch force	:	133 t.
Vertical line force	:	150 t.
Engine power	:	4000 HP
Crew	:	3 people

This type of tugboat can develop great engine power within a short distance and provides great friction force, being able to do a great job with a short line. It includes 200 m. of coiled cable, there being 100 m. of free cable to work independently of the ship.

Its turning circle is completed within a radius of 450 m., at an average of 12° per minute at 3 knots.

This tugboat needs 3 crewmembers. At least two of them should be trained and in a capacity to perform all the maneuvers ordered by the pilot. Besides, two of them will be duly trained to perform deck work and cable maneuvering. All of them will know how to respond to an emergency.

One tugboat will be equipped with ecosounders, positioning systems and automated cartographic systems to evaluate the progress made in relation to dredging operations.

2.3 Dock Services

a) Gas loading system.-

There will be FOUR (4) cranes with their respective hoses. TWO (2) of them will be used to load the liquids into the vessels, ONE (1) will be used to remove vapor from the vessels, and ONE (1) will be kept on standby to provide any of these services.

b) Electric power.-

An electric generator set installed at the plant will supply the electric power (220 and 480 volts, 60 Hz) required to perform different jobs at the platform.

c) Water.-

Potable water will be made available to tugboats at the dock and will also be available for the rendering of dock services. There will also be a water supply for the fire-fighting system.

Potable water will be obtained after making seawater go through a desalting process (inverse osmosis). To this end, seawater will be collected from the utility dock area, at a rate of 80 m3 per hour, using for this purpose a 15 cm pipeline.

Process water will be discharged into the middle section of the swash zone (3 to 4 m. in depth) at a rate of 50 m3 per hour (0,0222 m3 per second), without changing the temperature of the sea, using for this purpose a 7,5 cm. pipeline.

2.4 Means and equipment to avoid contaminating the water and beaches with organic and inorganic wastes

The Pampa Melchorita Marine Terminal will have the following means and equipment in place to avoid and prevent contaminating the area:

- For oily wastes, there will be a wheeled tank at the utility dock. This tank will be regularly taken to the plant in order for the wastes stored therein to be disposed of in authorized disposal sites. Liquid wastes with hydrocarbons and/or lubricants will be sent to the API separating tanks for pre-treatment and final storage in slop oil tanks. Solid-liquid wastes will be sent to the CPI separating tanks. Following the respective separation process, hydrocarbons will be finally sent to the slop oil tanks, and clean solids will be sent to the plant for their disposal.

- There will be portable toilets at the marine terminal. Sanitary wastes will be stored in septic tanks and these wastes will be regularly vacuum-carried to the water treatment plant located at the LNG Plant, or to the place indicated by the company that provides this service, to the extent it holds the respective disposal authorization.

- Solid wastes will be separated according to waste type and placed in a wheeled container at the utility dock. This container will be regularly taken to the plant in order for the solid wastes stored therein to be incinerated or, whenever necessary, will be carried outside of the terminal area to the place designated by the municipality.

2.5 Dock safety - Means and Equipment

a) Fire-fighting and rescue

The following fire-fighting and rescue methods and equipment will be available at the Marine Terminal:

Fire-Fighting Equipment.-

The dock will have TWO (02) elevated lookout towers for monitoring purposes. Remote-control, electrical or electrical-hydraulic monitors will be installed therein. These monitors will operate conveniently according to the applicable electrical classifications, in keeping with Class I, Group D, Division 2 quality standards.

TWO (2) monitors will be installed on the rear side of the cranes.

TWO (2) fire extinguisher boxes will be installed in the loading area of the wharf. They will include fire-fighting equipment (hoses, peg, control valves, etc). This equipment will complement the equipment to be carried by the fire-fighting truck.

Wheeled fire extinguishers with dry chemical powder will be installed in TWO (2) remote places along the dock. Dry chemical powder fire extinguishers will be provided and located in keeping will all 10 NFPA requirements.

Rescue equipment, communications, and first-aid services

a) Rescue

- EIGHT (08) 30 m. long hanging scaffolds secured with …" cables, located as follows:
  - TWO (02) in the middle section of the access bridge.
  - TWO (02) at the end of the loading platform access bridge.
  - TWO (02) at the utility dock

- TWO (02) at the tug berth

b) Communications

- VHF (FM) radio transreceiver for the marine terminal.
- UHK (FM) radio transreceiver for the plant.
- FIXED telephones.
- Emergency telephone.
- Telephone with loud telephone ringer.
- VHF ship frequency designated by the port.
- VHF frequency designated by the harbor master´s office
- Portable UHF radio for loading operations
- Cell phones and beepers

c) Fist-aid services

- First-aid kit in the middle section of the bridge.
- First-aid kit at the loading platform.
- Sickbay at the plant.

2.6 Nautical signaling and navigation safety

The relevant provisions that deal with this subject are contained in the HIDRONAV-38 Nautical Signaling Regulations, 1985 edition, issued by the National Bureau of Hydrography and Navigation.
(see Drawing B-2, Melchorita Hydrographic Study)

Terminal Signaling

The relevant provisions that deal with this subject are contained in the HIDRONAV-38 Nautical Signaling Regulations, 1985 edition, issued by the National Bureau of

Hydrography and Navigation. The proposed signal satisfactorily complies with the provisions set out in Chapter III, Article 301, of the Regulations.

The following nautical signaling equipment will be installed on both seaward ends of the Terminal:

S-1(J) MD1 mooring dolphins (northern end of the berth)
S-2(K) MD-6 mooring dolphins (southern end of the berth)

Navigation lanterns with tower assembly

Day signal

Type	:	Navigation lanterns with tower assembly
Color of tower assembly	:	Fluorescent white
Height of tower assembly	:	8 m. above the platform
Elevation above sea level	:	15 m.
Shape of tower assembly	:	Cylindrical

Tideland ML-155 or similar night signal

Type	:	Navigation lantern with tower assembly
Light	:	White
Elevation above sea level	:	15 m.
Light period	:	A group of 2 flashes of light, to be confirmed by the National Bureau of Hydrography and Navigation (DHN).
Effective range	:	03 nautical miles (trans. factor 0.74).
Visibility	:	The whole horizon

Breakwater signaling devices

The relevant provisions that deal with this subject are contained in the HIDRONAV-38 Nautical Signaling Regulations, 1985 edition, issued by the National Bureau of Hydrography and Navigation. The proposed signal satisfactorily complies with the provisions set forth in Chapter III, Article 301, of the Regulations.

As stated earlier in this report, in order to have a sheltered area for loading liquefied natural gas at the proposed Marine Terminal, the Project calls for the construction of a 800 m. long and 80 m. wide rock breakwater parallel to the coast.

Signaling lanterns will be installed on the northern and southern ends of the breakwater to define its location, according to the following characteristics:

Breakwater lanterns

S-3 (H) Northern side
S-4 (I) Southern side

Day signal

Location	:	Northern end of the breakwater
Type	:	Lantern with tower assembly
Color of tower assembly	:	Fluorescent white
Height of tower assembly	:	8 m. above the platform
Elevation above sea level	:	15 m.
Shape of tower assembly	:	Cylindrical

Tideland ML-140 or similar night signal

Location	:	Northern end of the breakwater
Type	:	Lantern with tower assembly
Light	:	White
Elevation above sea level	:	15 m.

Light period	:	Flashes of light, to be confirmed by DHN.
Effective range	:	05 nautical miles (trans. factor 0.74).
Visibility	:	The whole horizon

Dredged channel – signaling devices

The relevant provisions that deal with this subject are contained in the HIDRONAV-38 Nautical Signaling Regulations, 1985 edition, issued by the National Bureau of Hydrography and Navigation. The proposed signal satisfactorily complies with the provisions set forth in Chapter III, Article 301, of the Regulations.

General

- To install signals along the proposed Marine Terminal entry and exit dredged channel, the project calls for the installation of a system consisting of TWELVE (12) signaling buoys. TWO (02) of them will be positioned ONE (01) mile off the coast, on the seaward side, both at the entry to and exit from the channel, EIGHT (08) will be placed in the channel itself, of which SIX (06) will be placed on the sides of the dredged channel (4 buoys and 2 piles), and the remaining TWO (02) piles will be positioned in such a way that, together with TWO (02) channel buoys and TWO (02) approach buoys, will define the entry to and exit from the channel. See Drawing B-4.

- The TWO (02) approach buoys will be painted white and will have a white light and will be pen or crowbar-shaped.

- From the EIGHT (08) channel buoys, FOUR will be painted green and will have a green light, and FOUR (04) will be painted red and will have a red light.

- From the FOUR (04) green buoys (portside), ONE (01) will be pile-shaped and THREE (03) will be pen- or crowbar-shaped and will have a conical green mark on top.

- From the FOUR (04) red buoys (starboard side), ONE (01) will be pile shaped and THREE (03) will be pen- or crowbar-shaped and will have a conical red mark on top.

- The TWO (02) complementary leading buoys (piles) will be made of fiberglass-cased concrete piles.

Characteristics of channel approach and exit buoys

S-7 (A) Approach buoy, heading angle 060°
S-8 (B) Exit buoy, heading angle 220°

Tideland SB-285P or similar pen-shaped buoys (crowbar-shaped)

Buoy description:

Shape	:	Cylindrical, double nun
Total height	:	2.50 m.
Height of tower assembly	:	1.23 m.
Cylinder height	:	0.585 m.
Height of lower nun	:	0.685 m.
Greatest diameter	:	0.87 m.
Material	:	Plastic reinforced with fiberglass
Color	:	White

Light description:

Color	:	White
Type	:	Bell-shaped self-sustained light with X –shaped attachment

Energy source	:	Built-in solar panels
Range of Light	:	2 nautical miles (Atmospheric Transparence Factor 0.75)
Rate	:	Flashes of light the characteristics of which are still to be confirmed with the DHN.
Ignition	:	Automatic switch with built-in photovoltaic cell.
Visibility	:	The whole horizon
Anchorage	:	20 m. of ½¨galvanized steel cable with ½" shackles and an anchor weight of 200 kg.

Notes:
The characteristics of the blinking lights of the different buoys that will be used for signaling purposes in the dredged channel are still to be confirmed with the DHN. Different blinking lights will be used in order to make it easier to identify the different buoys.

Characteristics of channel buoys

a. Pen-type buoys (spar) in the dredged channel:

A-1 (C) Entrance buoy, northern side.
A-24 (D) Entrance buoy, southern side.
A-17 (O) Exit buoy, northern side.
A-16 (P) Exit buoy, southern side.
A-22 (G) Channel buoy, curved path on southern end, entrance side
A-19 (L) Channel buoy, curved path on western end, exit side

Buoy description:

Shape	:	Cylindrical, double nun
Total height	:	2.50 m.
Height of tower assembly	:	1.23 m.

Cylinder height	:	0.585 m.
Height of lower nun	:	0.685 m.
Greatest diameter	:	0.87 m.
Material	:	Plastic reinforced with fiberglass
Color	:	Red light on the starboard side and green light on the port side of the channel.

Description of Tideland SB-285P or similar light:

Color	:	Red light on the starboard side and green light on the port side of the channel.
Type	:	Bell-shaped self-sustained light with X –shaped attachment
Energy source	:	Built-in solar panels
Range of light	:	2 nautical miles (Atmospheric Transparence Factor 0.75)
Rate	:	Flashes of light the characteristics of which are still to be confirmed with the DHN.
Ignition	:	Automatic switch with built-in photovoltaic cell.
Visibility	:	The whole horizon
Anchorage	:	20 m. of ½¨galvanized steel cable with ½” shackles and an anchor weight of 200 kg.

Notes:

The characteristics of the blinking lights of the different buoys that will be used for signaling purposes in the dredged channel are still to be confirmed with the DHN. Different blinking lights will be used in order to make it easier to identify the different buoys.

b. Dredged channel piles:

A-2 (E) Channel buoy, curved path on northern end, entrance side

A-14 (M) Channel buoy, curved path on eastern end, exit side

Pile description:

Shape	:	Cylindrical
Elevation above sea level	:	5.0 m.
Material	:	fiberglass-cased concrete
Color:	:	Red on the starboard side and green on the port side of the channel.

Description of Tideland ML-140 or similar light:

Color	:	Red light on the starboard side and green light on the port side of the channel.
Type	:	Bell-shaped self-sustained light with X –shaped attachment
Energy source	:	Built-in solar panels
Range of light	:	2 nautical miles (Atmospheric Transparence Factor 0.75)
Rate	:	Flashes of light the characteristics of which are still to be confirmed with the DHN.
Ignition	:	Automatic switch with built-in photovoltaic cell.
Visibility	:	The whole horizon

Notes:
The characteristics of the blinking lights of the different buoys that will be used for signaling purposes in the dredged channel are still to be confirmed with the DHN. Different blinking lights will be used in order to make it easier to identify the different buoys.

Dredged channel entry and exit leading buoys
S-5 (F) entry leading buoys, includes RACON

S-6 (N) exit leading buoys

Buoy description

Shape	:	Cylindrical piles
Elevation above sea level	:	13.0 m.
Material	:	Fiberglass-cased concrete
Color	:	White

Light description:

Color	:	White
Type	:	Bell-shaped self-sustained light with X –shaped attachment
Energy source	:	Built-in solar panels
Range of light	:	3 nautical miles (Atmospheric Transparence Factor 0.75)
Rate	:	Flashes of light the characteristics of which are still to be confirmed with the DHN.
Ignition	:	Automatic switch with built-in photovoltaic cell.
Visibility	:	The whole horizon

Notes:
The characteristics of the blinking lights of the different buoys that will be used for signaling purposes in the dredged channel are still to be confirmed with the DHN. Different blinking lights will be used in order to make it easier to identify the different buoys.

Signals to be installed in the dredged material storage area

In order to install signals in the square-shaped area (having 2 km. on each side) to be used to store the material dredged from the navigation channel at the proposed Marine

Terminal, the project calls for the installation on a temporary basis while dredging operations are carried out of ONE (01) signaling buoy at each vertex, as per the following characteristics:

Buoy description:

Shape	:	Cylindrical, double nun
Model	:	P-2ST
Total height	:	2.50 m.
Height of tower assembly	:	1.23 m.
Cylinder height	:	0.585 m.
Height of lower nun	:	0.685 m.
Greatest diameter	:	0.87 m.
Material	:	Plastic reinforced with fiberglass
Color	:	Yellow
Marks on the hull	:	M-1 through M-4, in black

Description of Tideland SB-285 or similar light:

Color	:	Amber
Type	:	Bell-shaped self-sustained light with X –shaped attachment
Energy source	:	Built-in solar panels
Range of light	:	2 nautical miles (Atmospheric Transparence Factor 0.75)
Rate	:	Flashes of light the characteristics of which are still to be confirmed with the DHN.
Ignition	:	Automatic switch with built-in photovoltaic cell.
Visibility	:	The whole horizon
Anchorage	:	25 m. of ½¨galvanized steel cable with ½” shackles and an anchor weight of 200 kg.

Notes:

The characteristics of the blinking lights of the different buoys that will be used for signaling purposes at the vertices of the square-shaped storage area are still to be confirmed with the DHN. Different blinking lights will be used in order to make it easier to identify the different buoys.

The above-described nautical signaling devices comply with the provisions set forth in Articles 108, 205.a.4 and 205.b of the Nautical Signaling Regulations, HIDRONAV-38, 2nd edition, 1985, and will be installed in order to serve as a point of reference to avoid the performance of trawl fishing and other activities that may be affected by the material deposited at the bottom of the sea within the area indicated above.

III. ENVIRONMENTAL CHARACTERIZATION

3.1 GEOMORPHOLOGY AND GEOLOGY

3.1.1 GEOLOGY

According to the information contained in the EIA prepared by Golder Associates for the Pampa Melchorita LNG export project, in general the Peruvian coast is made up of fluvial and alluvial sediments arranged in the form of fluvial and alluvial terraces or dejection cones (Téves, 1976). Covering large areas, wind-transported sand layers extend as fans from the beaches on the coastline to the interior of the continent, covering distances that in some cases exceed 60 km. (Gagliano & Teves, 1970).

The study area is located in the middle section of the Peruvian coast, south of Lima, in the province of Cañete, district of San Vicente.

This area has well-defined geomorphologic features. Between Punta Aguja and Pisco, including the study area, the area features a large gap on the coastline, where short valleys transversely intersect the narrow coastal strip with cultivated areas on both sides of the rivers. It is mainly formed by coastal massifs and isolated mountains made of Mesozoic volcanic rock and Cretaceous sedimentary rock. To the East, the western spurs of the Andes mountain range form part of the coastal batholiths.

Between 12° and 13° Latitude South, the geophysical investigation of submarine areas reveals that the rocky basement is a few hundred meters deep between the coastline and the external edge of the Continental Shelf. The sediment cover may belong to the Tertiary-Quaternary.

Arid climate conditions have prevailed during the entire Quaternary period. There have been regular changes in the dynamics of rivers and slopes, owing to major modifications in the upper areas, like glaciations and, at shorter intervals, other events like the El Niño phenomenon.

3.1.2 GEOMORPHOLOGY

According to the information contained in the EIA prepared by Golder Associates for the Pampa Melchorita LNG export project, the geomorphologic features of the study area are the result of the tectonic and plutonic processes that resulted from the geodynamical processes that gave rise to the existing morphostructural features in the region. A number of structural processes have controlled the structural features of the area, like alluvial deposits, faulted blocks resulting from throws, erosion, incisions caused by drainage (mainly from the Lurín, Mala and Cañete rivers) and the accumulation of Aeolian sand over vast land areas. Following we will define and identify some of them within the study area:

Littoral Edge: Includes the firm-land area adjacent to the coastline, which is exposed to wave action. It runs from the Northeast to the Southeast forming a narrow strip that extends from the coastline to the interior of the continent over a distance that may fluctuate between 1 and 2 km.

It includes bays, coves, headstreams, etc. and has formed open beaches as a result of the accumulation of sand transported by littoral currents or littoral drifts. From some of these beaches the sand is transported to the continent by the action of wind, forming a continuous unit with coastal plains. Underwashing and erosion have given rise to cliffs, mostly sub-vertical, as a result of the destructive action of waves.

Coastal Plains and Dejection Cones: Is the area included between the littoral edge and the spurs of the western Mountain Range. It consists of a narrow strip of land running parallel to the coastline, although it becomes wider in the Lurín, Mala and Cañete valleys. They include vast areas covered with gravel and sand originating from the transportation and sedimentation of rivers, including sand transported from the beaches by the wind.

Salt Marsh Areas: Geomorphologically speaking, salt marsh areas are low areas with a maximum elevation of 5 to 6 meters above sea level, the minimum elevation being 1 meter above sea level. There are salt marsh areas in the Villa sector, to the south of Chira and Puerto Viejo and possibly at Las Salinas. Salt marsh areas are currently being affected by a partial soil clogging process, with sand transported by the wind from nearby beaches. Those areas that are not being affected by this partial clogging process are usually boggy areas or humid surfaces covered by vegetation that in some cases is up to 1 m. high.

Salt marsh areas are actually beaches abandoned because of the gradual emergence of the littoral edge. Initially, they may have originated from the development of a littoral bar or cord that gradually controlled the advance of the sea towards the continent, until a salt marsh area or lagoon area was finally formed. These areas were gradually filled in with beach sand.

Recent Marine Deposits: They consist of sand, silt and boulderstone accumulations reworked and distributed by currents along the littoral edge as a result of the erosion and disintegration of cliff rock, but mainly as a result of material carried by rivers into the ocean. These deposits are mainly made up of medium to fine-grained sands containing quartz, mica, and ferromanganese.

Rocky ridges associated with the spurs of the Andean mountain range that reach the coastline, forming very high and steep cliffs, interrupt the continuity of these strips of land. In some cases, rough slopes have been formed in old alluvial deposits.

Alluvial Deposits: Alluvial Deposits are accumulations of materials carried by the rivers that run down the western Andes slopes, intersecting Tertiary and Mesozoic rocks and the coastal batholiths, and covering valley soils. Part of this material has been deposited along the way, but most part spreads over alluvial fans.

These deposits also include desert-like alluvial accumulations originating from ravines and tributaries that are now dry and look like deserts. For instance, Pucará, Malanche, Cruz de Hueso, Chamaure, Honda, etc. When rains have been heavy in the secondary Andean mountain range, muddy currents and mud landslides ("huaycos") have resulted. At Qda. Honta, these desert-like alluvial cones reach the Naplo bay.

From a lithological standpoint, these alluvial deposits, seen through terraces, cuts and borings, consist of accumulations of different types of boulderstones, particularly intrusive and volcanic rock, subangular gravel in the case of desert-like alluvial cones because of lack of transport, sands of different grain sizes and, to a smaller extent, silts and clays. Interbedded layers form beds of substantial thickness that can be observed on the coastal cliffs.

Aeolian Deposits: Aeolian deposits can be found almost in all areas that are close to the coast and extend into continental areas, following the local topography and prevailing wind direction. These deposits accumulate both in rock formations *in situ* and in alluvial plains, but the greatest thickness is usually found in slopes and areas with depressions.

Aeolian materials originate from sand beaches formed by the action of waves, mainly sediments carried by rivers into the sea and distributed by littoral currents.

Sand is continuously carried inland by predominant winds, penetrating around 13 km. into the continent. Aeolian sands are distributed over the land surface forming thin layers or sheets that evolve into longitudinal dunes and barchans.

Old Aeolian deposits consist of accumulations that have already stabilized, forming hillocks and sand hills like the "Lomo de Corvina", which extends into the "Tablada de Lurín" where the people of "Villa El Salvador" live. Farther south, these deposits can be found to the northwest of Pucusana.

The most recent Aeolian deposits consist of mobile sands widely distributed along the study area. These sands originate from different beaches along the coast, and are carried by the wind, forming sand sheets, dunes and barchans.

In the study area, regional and local soils have been classified as follows: soils of recent origin (Entisoils) and arid soils that have no water during most part of the year (Aridsoils). These soils are characterized by the lack of distinct changes resulting from earth movements (pedogenic processes) and are commonly associated with recent floodplains, erosion of steep slopes, dunes, and wind-deposited sands. These soils are highly susceptible to wind erosion and remain dry during most part of the year. These soils contain calcium carbonate, silicates, salts, and gypsum.

Soils have been grouped together into the following groups, according to the geomorphological characteristics of the region:

Beach Group (Py)

The Beach Group soils are made up of gravel and sand along a narrow beach strip that is subject to the effects of waves, according to climate conditions. This beach strip consists of intermediate terrace soils formed by the influence of rising and falling tides and wind erosion.

Cliff Group (T)

The Cliff Group soils complete the steep cliffs that are the result of old and recent landslides and erosion.

Mountain Group (CR)

The Mountain Group consists of sands carried by winds and deposited in the upper part of the cliffs, and is characterized by smooth plains and steep cliffs that contain 8% to 15% of rock that forms the cliffs' walls, and dunes.

Both the productivity and potential use of soils are limited by a high salt content, drainage, erosion, and the lack of irrigation water.

The agricultural value of land in the study area ranges from medium to low. Low-quality land is found in this area, if compared with other plots of land in other parts of the region.

3.1.3 Coastal morphology

Punta Centinela: (13° 01 48.5 S, 76° 29 25.7 W)

Closing by the South the "Cerro Azul" cove, the coast forms a small promontory known as "Punta de Fraile", which is around 80 m. high, coming down from a group of hills that end very abruptly at the sea. In front of the "Punta de Fraile", there is a dark-colored vertical rocky outcrop spattered with whitish spots that are actually manure from sea birds droppings, which includes several overhanging or projecting rocks known as Ciriaco.

From "Punta del Fraile", the rocky cliff that ends abruptly at the sea travels around 660 m. in a southwesterly direction, forming "Punta Centinela". There is a Navy beacon on top of the hill that forms "Punta Centinela".

Cañete River Outlet: (13° 07 36.5 S, 76° 23 55.7 W)

From "Punta Centinela", the coast extends in a southeasterly direction for 9.25 miles until reaching "Punta Iguana". Along this coastal strip we can find both boulder and sand beaches, but they are inaccessible. Behind we find Cañete valley, with cultivated lowlands. The Cañete River flows into the ocean through the southeastern end of the Cañete valley.

The Cañete River flows down the Yauyos mountain range, specifically from the Pariacaca and Pampacocha lakes. The river level is usually very low because of seepage losses and the vast areas it irrigates along its way; however, during summertime, the river level is usually high because of the rainy season in the Sierra (mountain region). From May through November the water level in the river is low.

Playa Jaguay: (13° 19 24.5 S, 76° 14 31.7 W)

A rocky promontory with marly clays begins at “Punta Iguana”, extending along narrow sand beaches for approximately 21.75 miles until reaching the “Tambo de Mora” cove, with variable heights ranging from 50 to 173 m. These beaches are called: Cóndor, Mulata, Melchorita, Zorro, El Turno, Jaguay and Carrizal.

At Playa Jaguay (Jaguay Beach), 13.5 miles away from “Punta Iguana”, there is a summer resort, called “Wakama”, with a few summer houses. The “Topara” river flows close to this beach. It usually has no water, for which reason the local population call it “Rio Seco” (Dry River). This river divides the Cañete plains from the Chincha plains, and also divides 2 provinces and the departments of Lima and Ica.

No marine facilities exist within a radius of 20 km. The closest port is “Tambo de Mora”, in Chincha, 26 km. away, and “Cerro Azul”, in Cañete, which is the second closest port, 40 km. away.

3.1.4 Erosion and sedimentation processes

To give the most accurate explanation about the sedimentation and/or erosion processes that currently take place in the study area, we should make reference to and identify the different processes that have taken place in the past, mainly the changes that have occurred in the coastline, either because of sea level changes or basically because of tectonic processes. In this way we will be in a position to know more in detail what could be the evolution or trend of a given coastline in the future.

Sea Level Variations

Throughout the years, the level of the sea has shown significant fluctuations. Deep submarine depressions and large mountain ranges at the bottom of the sea reveal that tectonic processes have resulted in uplift and sinking events that have affected the sea bed over very vast areas, therefore modifying the content capacity of ocean basins. In addition, during the Pleistocene period, the level of the sea changed quickly as a result of the formation and merger of continental glaciers. Evidence exists that the sea level dropped almost 140 m. as continental glaciers expanded during the last glaciation period (Wurm). When glaciers began to melt, some 15,000 to 18,000 years ago, the sea level began to rise. Around 6,000 years ago, it reached its current level. Since then, both the changes detected as well as a comparison of tidal data collected from several places around the world seem to indicate that during the first half of the XX Century the level of the sea began to rise, although slightly, at a rate of 1 to 2 millimeters per year.

Tectonic Processes

According to the information contained in the EIA prepared by Golder Associates for the Pampa Melchorita LNG export project, the continental borders of the oceans are subject to elevation changes. The tectonic processes that took place in the Pleistocene period, which have continued to date, have resulted in uplift and sinking events that have affected littoral areas along several coasts.

In the case of Peru, the current coast has been exposed throughout its long geological history to uplift and sinking events. In the middle coastal area, which runs from “Punta Aguja” to the Paracas Peninsula and includes the study area, the littoral has a very particular surface configuration. There are numerous islands close to the coast. Metamorphic rocks and remains of the coastal mountain range or one of its branches have been found in some of said islands. During the Miocene, some sections that then belonged to the continent began to sink and, as a result, the coastal mountain range was gradually destroyed (Schweiger, 1964).

However, the marine terraces formed as a result of several coastal uplift events can be found in several places along the study area. For instance, in Lurin, marine abrasion platforms extend from “Punta Casjacal” to “San Bartolo” and “Santa María del Mar”, forming terraces ranging from 5 to 15 m. above sea level. These terraces reveal the continuous uplift of the continental massif during the Quaternary period. Its reduced exposure is probably due to significant destruction in present times, or to its limited development during the deposition process.

Other features, like a rocky promontory close to the Conchán refinery, around 600 m. away from the coastline, which includes a cave at its toe that has been typically eroded by the sea, also reveal that the sea has “receded”. This recession may be due not only to a sedimentation or sand filling process, but also to the uplift of the coast as a result of the subduction of the Nazca plate under the continental part of the South American plate.

Overall, the study area falls within the morphotechnical categorization of the coast and the western edge of the Andes, and has been affected by polyphase tectonic processes that occurred during Andean orogenesis and resulted in a deformation with successive folds that began during the Cretaceous and continued throughout the Lower and Upper Tertiary and even probably during the Quaternary (Palacios et. al., 1992).

Slopes that form part of vast alluvial plains and valleys, and alluvial plains pertaining to the recent Holocene characterize the Melchorita region.

The regional stratigraphy shows that the rocky layer below the alluvial deposits consists of sedimentary rocks and granite – diortic belonging to the Lower Cretaceous period.

The study region features narrow beaches between the rocky layer of the coastal cliffs (ranging between 60 and 170 m. in height) formed by a series of old deposits and landslide areas, and the littoral erosion. Steep cliffs drop vertically down into the beach, forming terraces that are approximately 300 m. wide and 50 to 70 m. high.

The alluvial formations comprising the plains are about 2 km. wide between the sea and the coastal rocky elevations, from km. 153 to km. 180 of the South Panamericana Highway. These smooth formations look like cones and can reach up to 30 m. in height. The layers of sand deposited by the wind cover the rocky layer or alluvial plains, forming dunes. Below the dunes, the soils consist of partially consolidated and densely compacted and cemented material that belongs to the Cañete Pleistocene formation. Several old and recent drainage valleys form part of the plains that reach the coastal cliffs.

Satellite images show a series of rocky faults parallel to the Andes mountain range running in a northwest – southeast direction. These faults usually run parallel to the subduction zone. Three fault systems were observed at the following points: N 340°-350° O; N 290° -310° O; y N 70°-75° O. Another fault, which crosses the above-mentioned faults, runs parallel to the rivers that flow into the Pacific Ocean and was observed at point N 40°-50° E.

Identification of Areas affected by Erosion and/or Sedimentation Processes

It has been determined that the changes that have taken place as a result of sea level fluctuations do not reveal recent high or low tides that may have left traces, mainly inland, close to the coastline, like terraces. Instead, the tectonic processes that have resulted in coastal uplifts have left clear traces. In fact, terraces of tectonic origin (faults) can be identified at the littoral edge, as well as other morphological features (salt marsh areas).

However, we should take into account current estimates on the increase of the level of the sea at a global level, potentially attributed to weather warming. Consensus currently exists among members of the International Scientific Community in the sense that it is necessary to design and implement action plans to be in a better position to cope with the negative effects of this phenomenon in the future. Experts have designed six possible scenarios. A great majority believes that we could expect a global air temperature increase of 2° C during the next 90 years and, as a result, we could also expect a sea level increase that may range between 0.30 and 1.00 m. Therefore, this sea level increase, in the relatively near future, should be taken into account in future plans for coastal areas.

On the other hand, we have seen that the coast is currently affected by the tectonic uplifting of the coastal area, which is in turn forming terraces and salt marsh areas and, therefore, making the water "recede", although the effects of this process might only be perceived after many years.

3.2 HYDROGEOLOGICAL ASPECTS

According to the information contained in the EIA prepared by Golder Associates for the Pampa Melchorita LNG export project, the study area is located between two main rivers: the Cañete River and the Topara ravine, located 17 km. northwest and 12 km. southeast of the proposed project site, respectively. They flow perpendicular to the coastline into the Pacific Ocean. Both rivers have their source in the Andes mountain range, rainwater being the source of water supply.

The Cañete river is fed with water all year round, while the Topara ravine is only fed with water during the rainy season, that is, when it rains in the Sierra, from December through April. In view that the study area is located in a low-rainfall region (50 mm per year), no water is fed into these rivers in the lower region. On the other hand, some of the water of both rivers seeps into underground formations.

Water flows sporadically in the Topara River, for which reason it is called dry river or dry ravine by people living in nearby localities and described as such on national Drawings. This river serves as a natural boundary between the Cañete plains and the Chincha plains, and also as a limit between two provinces and the departments of Lima and Ica.

The Cañete River basin comprises 3 583 km2 (358.300 Ha), of which 61.7% are located within the wet basin, more than 2500 meters above sea level, and actually contribute to the annual surface seepage. The rest of the basin is arid land.

The Cañete River has an irregular flow regime, with an annual mean flow of 55.541 m3/sc, which accounts for an accumulated volume of 47,485.7 m3/sc between 1960 and 1986.

The gauging station, Imperial, is located at 13°00´S and 76°10´W, at 250 meters above sea level. From this water volume, most part is lost in the sea through surface and underground discharges; a major part is used as potable water by different communities; it is collected both on the surface as well as through wells built all over the area.

There are several other small dry ravines that are only fed with water during high rainfall periods. There are no other water bodies in the area.

The Cañete River is an important source of water supply in the region. It has its source in the highlands of the Peruvian Andes, specifically in Laguna Ticllacocha, 4600 meters above seal level. The river flows down the Andes to the Pacific coast, for around 230 km., forming a basin of 6189 km2. As regards rainfall distribution in the basin, it ranges between 50 mm/year on the coast and over 1000 mm/year in the Sierra.

Like all other coastal rivers, Cañete is a torrential river that feeds with water bodies associated with seasonal rains that fall in the upper basin section. The largest flows occur 3 to 4 times a year (usually between December and March). These large water flows, within a relatively short period of time, can carry large amounts of suspended material.

The Cañete River has a low water level between May and September, the minimum flow level being reported in September. Starting in December, the water volume begins to increase due to the rains that fall in the Sierra, the largest water flow being reported during February and March. From 1994 to 1998, the maximum flow was 334.8 m3/sec and the minimum flow was 7.8 m3/sec. These flows were reported in February 1994 and September 1997, respectively. However, maximum flow records show a flow level of 946 m3/sec, reported in March 1975. Likewise, the average flow was 62.2 m3/sec from 1965 through 2000.

Underground water

During the geochemical and geophysical research work carried out in the proposed plant site, no subsurface water was found within the explored depth, that is, 100 m., for which reason the only source of potable water is associated with sea water.

3.3 SEISMIC CHARACTERISTICS

According to the information contained in the EIA prepared by Golder Associates for the Pampa Melchorita LNG export project, the Peruvian coast is located on the Fire Belt of the Circumpacific and consists of fault systems and active volcanic chains bordering the Pacific Ocean. This area is considered the most active seismic zone on Earth (over 80% of earthquakes have taken place in this area).

Earthquakes have plagued the lives of Peruvians for centuries, resulting in both casualties and property damage.

Seismicity in Peru is associated with the Fire Belt of the Circumpacific, which is the most active belt worldwide.

In Peru, the most destructive seismic events occurred in 1552. A regular seismic activity during the last century resulted in casualties and property damage in central Peru.

Table No. 1 shows the most destructive seismic events that took place in the XX Century on the central coast of Peru.

TABLE No.1: DESTRUCTIVE EARTHQUAKES OCCURRED ON THE XX CENTURY IN THE CENTRAL REGION OF PERU

Year	Month/Day	Richter Scale	Estimated Casualties	Estimated property damage to all affected areas, including Lima (US$)
1940	May 24	8.4	1 394	120 000.00
1966	October 17	7.5	Unknown	Unknown
1970	May 31	7.6	70 000	900 000.000
1974	October 3	7.6	137	200 000.000

Earthquake risks

The project site is located on the central coast of Peru, in a seismically active region where the Nazca plates subduct under the South American plates along the subduction zone. Consequently, Peru is one of the countries that poses that highest seismic risk in South America because of the aforesaid subduction process. Along the South American coast from Colombia to Chile, the Nazca Plate, which is heavier, subducts under the South American plate, which is lighter. This tectonic process has made the edge of the Nazca Plate dive down under the South American plate, giving rise to volcanic eruptions and high seismic activity and the Andes mountain range.

Tsunami hazards

The coastal area of Peru, including the project area, has experienced the effects of several destructive tsunamis (Silgado, 1974), with wave heights that have ranged between 2 and 20 meters.

As a result of studies conducted, it has been determined that if a seismic event comparable to the earthquake that took place in Camaná in 2001 occurred on the coast, but closer to Pampa Melchorita, it would have a 60-year return period and would bring about floods that could reach 2 m. high at a flow rate of 1.5 m/sec. Also according to modeling work performed, if a big event occurred after the earthquake that took place in Pisco in 1687, it would have a 110-year return period and would bring about floods that could reach 8 m. high at a flow rate of 2.5 m/sec.

Cliff hazards

Steep cliffs are exposed to landslides because of the effect of seismic activity. This is why they are considered potentially unstable areas. A tsunami in the project site could bring about beach erosion and increase the instability of cliffs.

Flood hazards

The area is not exposed to flooding because of the absence of rainfall and the distance to the nearest basin associated with the Cañete River, 17 km. northwest of the project site, and the Topara River, 12 km. southeast of the project site.

3.4 Sea bottom

Bathymetric studies reveal regular sea bottom conditions and smooth slopes with isobaths running parallel to the coast. Overall, no major unevenness has been detected in the sea bottom, as it basically consists of vast plains. The 10 m. isobath is approximately 1,250 m. away from the loading area, gradually moving away as it moves towards the North.

Based on the granulometric analysis of the samples collected during the performance of fieldwork (fieldword carried out by GOLDER in October 2002 and observations conducted in March 2003 as part of the ENVIRONMENTAL

MONITORING), no major granulometric changes have been observed. For any given beach profile, the size of sediments decreases as the area becomes deeper, reflecting a typical beach sediment size distribution pattern, where the size of grains gradually decreases as they move farther away from the beach and waves have a smaller impact on the mobility of material at the bottom of the sea, because of the greatest depth, thus allowing the sedimentation of finer material.

3.5 Currents

Currents off the Peruvian coast move in a northerly direction. This current system is different from the shore system, where some variability is observed mainly due to the coastal profile itself.

Specifically within a bay, the current system is also associated with other factors like tides, bathymetry, local winds, etc. As a result, currents within bays show a very variable pattern, so characterizing these currents is a difficult task.

Besides, overlying these currents, we find the current generated by waves that, in coming closer to the coast, mainly from the south and southwest, generate littoral currents that become more actively involved in the transport of sediments.

Overall, these littoral currents also travel in a northerly direction. Great care should be taken at the time of identifying and characterizing these littoral currents because in some cases, for being highly dynamic, they could bring about major erosion and sedimentation processes, if interrupted in their path.

Another important current generated when the wave breaks on the beach is the "bottom" or "rip" current, that is, the return flow of water that reaches the shores because of the action of waves.

As we know, during wintertime, trade winds become stronger. As a result, Peru's currents, which travel north, specifically the Peruvian coastal current, just like waves, become stronger and, as a result, the northerly current prevails in coastal regions. However, it is worth bearing in mind the influence of tides that, in the case of the study area, come from the north, bringing about circulation changes between high and low waters.

3.5.1 Methodology

To analyze currents, different equipment and procedures are used, which are usually based on the following two measuring methods:

The **Lagrangian** method, which consists in following an object or substance that travels with the current, and the **Eulerian** method, which consists in measuring the flow of the current from a fixed point.

The Eulerian method, which consists in measuring the flow of the current from a fixed point, was used to measure currents in the study area. To locate the measuring stations, the method that consists in aligning two obstacles inland and measuring the depth of the measuring site was used. Once the stations were located in the area, their position was determined using a Magellan 310 GPS. A Valeport current meter was used to measure surface, intermediate, and bottom currents.

In addition to the information gathered by Golder Associated in 2002, other current measurements were taken between March 24 and 29 and between March 30 and April 12, 2003, 10 m. deep. These measurements were taken at a point located 1,500 m. away from the coast, following the wharf axis, 15 m. deep. Likewise, in the afternoon of April 12, some more measurements were taken from the same place, at three different depth levels (1, 7 and 14 m).

On April 13, 2003, sea currents were measured at three different depth levels (5, 15 and 25 m), following the wharf axis, at the loading area, at a point where water is 26 m. deep.

See the following Drawings:

1. Drawing B-2, showing the project area bathymetry at a scale of 1:7500.
2. Drawing C, showing currents, sediment samples, winds and sea bottom drillings, at a scale of 1:7500.

3.5.2 Results

Measurements taken 10 m. deep: Between March 24 and 29, and between March 30 and April 12, 2003, sea currents basically showed two directions: towards the Northwest and towards the Southeast, following the isobath lines in a parallel direction, just like the coastline. Both directions were followed on an alternate basis, for periods of 3 to 4 days.

Between March 24 and 26, the current traveled predominantly in a Northwesterly direction, and sometimes traveled northward. This latter direction became slightly predominant on March 27 and 28. Then, on March 30 and 31 and on April 01, the current traveled predominantly in a Southeasterly direction. The following days, that is, on April 03, 04 and 05, the current turned again towards the Northwest, to then turn again towards the Southeast on April 07, 08, 09, 10 and 11.

It is worth pointing out that the greatest distribution of directions occurred on March 29 and on April 02 and 06, coinciding with opposite changes towards the Southeast and Northwest. However, during these days the current flowed towards the Southeast and South on a slightly predominant basis. On April 12, there was also a greater distribution, although the currently traveled predominantly, although slightly, towards the South.

Daily speeds fluctuated on average between 22.0 to 08.0 cm/sc, the average value between March 24 and April 12 being 13.0 cm/sec. Maximum daily speeds fluctuated between 33.0 and 18.0 cm/sec, while minimum speeds ranged between 08.0 and 01.0 cm/sec. The greatest current speeds were reported on March 31.

Measurements at three different depth levels: In the same place where sea current measurements were taken between March 24 and April 12, measurements were taken at three different depth levels in the afternoon of April 12th. The measurement of each level lasted 20 minutes. At 1 m. water depth, the surface current flowed predominantly in a Westerly and Southwesterly direction, with speeds that fluctuated between 25.0 and 7.0 cm/sec., the average value being 15.0 cm/sec. At 7 m. water depth, the current flowed predominantly in a Southeasterly direction, with speeds that fluctuated between 38.0 and 10.0 cm/sec, the average value standing at 18.0 cm/sec. At 14 m. water depth, the sea current showed great variability, reaching speeds that fluctuated between 23.0 and 7.0 c m/sec, the average value being 15.0 cm/sec.

Measurements at three different water depth levels at the Loading Area: On April 13, current measurements were taken from the loading area at three different water depth levels, for approximately 40 minutes at each level. At 05 m. water depth, the current flowed predominantly in a Southeasterly direction, with speeds that fluctuated between 28.0 and 16.0 cm/sec., the average value being 20.0 cm/sec. At 15 m. water depth, the current mainly flowed towards the South and Southeast, with speeds that fluctuated between 26.0 and 11.0 cm/sec, the average value standing at 17.0 cm/sec. Close to the bottom, at 25 m. water depth, the current flowed predominantly in a Southeasterly direction, just like the current that was close to the surface, with speeds that ranged between 27.0 and 12.0 cm/sec, the average value being 18.0 cm/sec.

3.5.3 Discussion

Based on the measurements taken at Playa Melchorita, the circulation pattern shows speeds expected to be encountered in the area, that is, in an elongated straight coastal strip deprived of the natural protection found in other areas of the Peruvian coast. As regards direction, currents mainly flow parallel to the coastline and the isobath lines, a common feature on Peruvian coasts. It is thought that the change of direction to an opposite direction is owed to the influence of the coastline, which exerts friction on the current, making it turn around, mainly when the Peruvian current circulation system experiences intensity changes.

Observations conducted by GOLDER from January through July 2002 show current speeds near the sea bottom ranging from 8.78 to 10.63 cm/sec, it being estimated that the drop speed of fine sediments like those found in the study area will be smaller than 5 cm/sec in calm waters.

3.6 Waves

To make designs, assess port work, perform dredging activities, etc., it is important to have information available about sea waves. For this reason, it is necessary to become familiar with the nature of waves and the frequency of wave occurrence, defined by their period, height, and direction.

In measuring coastal waves, another important aspect to be borne in mind is the change in the direction, height and speed of waves as they approach the beach, due to reduced sea bottom depths and the presence of obstacles (islands, wharfs, breakwaters, etc.), which result in the refraction and diffraction of the waves.

3.6.1 Wave assessment methodology

In the study area, wave measurements have been taken by the Ministry of Fisheries, using equipment (wave meters) that reports accurate values during long observation periods (more than three years). Likewise, waves have been visually observed using wave meters that do not include any mechanism or device to automatically record wave heights. In these cases, it was necessary for a person to make these observations from time to time for approximately 20 minutes.

3.6.2 Analysis of waves

The size of waves on the coast depends on the height of waves in deep waters and the swash zone; therefore, it is necessary to become familiar with the areas of wave incidence in the study area.

In view that the calculation of wave data is based on statistical techniques, it is not necessary to record wave data on a continuous basis 24 hours a day.

It is usually assumed that the statistical characteristics of sea waves are constant over a given number of hours. Within this time period, a sample that includes a sufficient number of waves in order for characteristic parameters (Hs and Ts) to be both stable and representative of this period, is taken.

In other words, the Hs and Ts of a sufficiently large number of waves should be calculated in order to eliminate the irregularities that occur over a given period of time. In addition, the daily calculation should include a sufficient number of sample waves in order to determine the variation of parameters in the long run.

3.6.3 Types of waves

There are two types of waves, depending on their origin:

- Sea waves (wind waves).-

Waves that are generated locally by local winds. These waves are usually short but very steep and choppy. They occur quite frequently in the study area because of the winds generated by the difference in temperature between the sea and the desert, although they have very short periods and small heights.

- Swell waves (open-ocean waves).-

Waves generated far away in the open ocean. These waves travel for long distances across the ocean and are the main source of wave height. Their incidence determines coast dynamics in the study area.

3.6.4 Results of wave analysis

Based on studies and data compilations for the coastal region, we are in a position to describe the behavior of waves in the open sea.

Overall, along the Peruvian coast, waves mainly come from the South and Southwest. The following table shows a summary of predominant wave directions and heights for the region included between 10° and 15° South (information obtained from Sailing Directions for South America).

The following table gives us a rough idea of average wave heights and predominant wave approach directions.

Wave height and direction

(10° - 15° South)

Height (m)	South (%)	South-West (%)
0.30	35.40	0
1.80	25.20	06.70
3.60	02.30	01.00

Based on this information, we can see that the predominant wave direction is from the South and Southwest, while the remaining directions show very low occurrence rates.

3.6.5 Calculation of wave heights

The wave assessment conducted is based on information recorded at Ventanilla, statistical information obtained from Sailings Directions, and data on visual observations conducted in the study area. The method consists in calculating the height and period of waves in deep waters. Based on this information and on bathymetric data obtained for the area of interest, waves were forecasted using the orthogonal method up to the Western side of the breakwater to generate the diffraction diagrams and, based on refraction diagrams, applying Snell's law (Wiegle), calculate wave heights at Playa Melchorita using different refraction and depth change coefficients.

The height of a wave in shallow waters is given by the following formula:

$H = Kr \cdot Ks \cdot Kd \cdot Ho$

Where:

Kr = Refraction coefficient
Ks = Depth Change Coefficient
Kd = Diffraction coefficient
Ho = Wave Height in Deep Waters

In Ventanilla, the Refraction Coefficient 20 m. deep is: 0.8940
Kd = 1
Ks = 0.982

From the classification of maximum average periods, T = 14 sec.

The wavelength is given by Lo in deep waters.

If we replace the above figures with the maximum height observed in Ventanilla, which corresponds to a sea roughness of 3.41 m. and a significant height of 1.51 m, recorded in June, the following figures are obtained:

Ho = 3.41 / 0.894 * 0.982 = 3.88 m

Ho = 1.51 / 0.894 * 0.982 = 1.72 m

3.6.6 Calculation of wave height, in a southwesterly direction

a) At 30 m. water depth:

H = (0.9759) (0.9344) (1) (3.88) = 3.54 m

H = (0.9759) (0.9344) (1) (1.72) = 1.57 m

b) At 20 m. water depth:

H = (0.9759) (0.9805) (1) (3.88) = 3.71 m

H = (0.9759) (0.9805) (1) (1.72) = 1.65 m

c) At 10 m. water depth:

H = (1.0174) (1.1010) (1) (3.88) = 4.35 m

H = (1.0174) (1.1010) (1) (1.72) = 1.93 m

d) At 05 m. water depth:

H = (1.0197) (1.2850) (1) (3.88) = 5.08 m

H = (1.0197) (1.2850) (1) (1.72) = 2.25 m

3.6.7 Calculation of wave height, in a southerly direction

a) At 30 m. water depth:

H = (0.8973) (0.9344) (1) (3.88) = 3.25 m

H = (0.8973) (0.9344) (1) (1.72) = 1.44 m

b) At 20 m. water depth:

H = (0.8803) (0.9805) (1) (3.88) = 3.35 m

H = (0.8803) (0.9805) (1) (1.72) = 1.48 m

c) At 10 m. water depth:

H = (0.8471) (1.1010) (1) (3.88) = 3.62 m

H = (0.8471) (1.1010) (1) (1.72) = 1.60 m

d) At 05 m. water depth:

H = (0.8439) (1.2850) (1) (3.88) = 4.21 m

H = (0.8439) (1.2850) (1) (1.72) = 1.87 m

3.6.8 Calculation of total kr

Kr (Total) = 0.8439 (0.7833) + 1.0197 (0.2167) = 0.8820

3.6.9 Calculation of wave height at swash zone (hb)

Calculation of H'o

H'o / Ho = Kr

Where:

Ho = 1.72 and 3.8

Kr = 0.8820

H'o = Kr . Ho

H'o = 0.8820 x 1.72 = 1.52 m

H'o = 0.8820 x 3.88 = 3.42

We evaluated: $H'o / gT^2 = 1.52 / 1920.8 = 0.00079$

$H'o / gT^2 = 3.42 / 1920.8 = 0.00178$

Calculation of Slope (m) :

of: 5 / 300 = 0.017

Then: Hb / H'o = 1.69 = = = Hb = 1.69 x 1.52 = 2.57 m.

Hb / H'o = 1.36 = = = Hb = 1.36 x 3.42 = 4.65 m.

3.6.10 Calculation of wave depth when it breaks

Hb / gT^2 = 2.57 / 1920.8 = 0.00134

Hb / gT^2 = 4.65 / 1920.8 = 0.00242

M = 0.017

We evaluated: db / Hb = 1.12

db = 2.57 x 1.12 = 2.88 m

db / Hb = 1.07

db = 4.65 x 1.14 = 5.29 m

3.6.11 Distance at which wave breaks from the beach

The wave breaks at: 2.88 / 0.017 = 170 m

5.29 / 0.017 = 310 m

3.6.12 Characteristics of waves at Playa Melchorita and action of the breakwater

In the study area, the height of waves when they break, calculated on the basis of data obtained during a period of one year in Ventanilla, which apply to the Melchorita area after making the appropriate wave refraction calculations, is 2.57 and 4.65 m. for significant wave heights and maximum significant wave heights, respectively, the swash depth being 2.88 and 5.29 m., respectively, and the distance waves break from the beach being 170 and 310 m., respectively.

Wave parameters

H Hs Hmax Ts

1.20 m.	1.80 m	4.00 m	13.0 sec

See the following Drawings:

1. Drawing B-2 showing the bathymetry of the project area at a scale of 1:7500.
2. Drawing D-1 showing the refraction of waves in shallow waters at a scale of 1:7500.
3. Drawing D-3 showing the diffraction of waves from the South at a scale of 1:5000.

Comments on waves diffracted by the breakwater

Waves coming in from both ends of the breakwater will meet at a given point. This point of encounter is located on the East side, that is, within the area protected from open sea waves. For waves coming from the South, this point will be located in the middle section of the protected area, which coincides with the place where the proposed Liquefied Natural Gas (LNG) loading platform will be located, thus guaranteeing an uninterrupted operation of the Marine Terminal consistent with weather and sea conditions.

According to the positions shown on the Drawing, the isolines of diffraction index K' = 1.00, that is, the limit of influence of the breakwater upon waves, asymmetrically delimit the southern section, using the trestle bridge as an axis, due to the incidence angle of 90°. In this area, between both limits, the breakwater has an impact upon waves, diffracting and reducing the energy intensity of waves.

As a collateral consequence, this calm sea area generated by the breakwater will foster sedimentation (deposition of sediments) on the coast, favoring the development of a small sandy projecting zone the growth of which will be limited by the swash zone, which will always tend to lift suspended sediments and usually carry them towards the north because of the combined effect of waves, currents and tides. The dynamics of this sandy formation will be the subject matter of monitoring and assessment work as part of the activities to be carried out in relation to the corresponding Environmental Impact Assessment; however, a first approach suggests that this growth might not be significant.

3.7 Tides

The importance and study of tides lies in the need to have datums in place in order to calculate the height of hills and valleys and sea depths, besides delimiting riverside land for purposes of fixing boundaries and designing structures in coastal areas, defining the dynamics of the area, basically supported by the range of tides.

The characteristics of ocean tides in the study area have been obtained from the Tide Tables published by the National Bureau of Hydrography and Navigation. Tides are semi-diurnal in nature, that is, there are two high tides and two low tides during each tidal day (24 hours 50 minutes). The mean tidal range is on the order of 0.55 m., while the tidal range during syzygy is on the order of 0.73 m. The common establishment (tidal ports) is 05 hours 36 minutes.

3.8 Tsunamis

Tsunamis or sea quakes are a succession of ocean waves that have long periods, typically between 15 to 40 minutes, and are imperceptible on the open sea but, when they approach the coast, the large kinetic energy they carry becomes potential energy and the waves may grow to reach several meters in height. Tsunamis are frequently generated by earthquakes measuring over 7.5° on the Richter scale. Volcanic eruptions and submarine landslides can also generate tsunamis.

Once a tsunami is generated, it propagates in all directions. The propagation speed depends on the depth of the sea. For example, a tsunami that travels part of an ocean that is 4,000 m. deep will have a speed of 720 km/h. Then, if we know the depth of the sea, we can calculate the approximate time of tsunami arrival in any part of the coast. For instance, if a tsunami is generated off the coasts of Alaska, it may reach Peruvian coasts in about 16 hours.

The height of a tsunami at sea is only a few centimeters. On the open sea a tsunami may pass under a ship unnoticed. However, it has a wavelength of about 350 km. Then, the tsunami poses no hazard at sea, but when it approaches shore it slows and grows in height upon encountering increasingly shallow waters.

In many islands of Indonesia and Japan, where unfavorable bathymetric and topographic conditions prevail, tsunamis can reach over 30 meters above sea level.

In the case of Peru, a tsunami may not reach the coast as a big wave, but rather as a flood wave that may range between 6 to 9 m. in height.

Fortunately, Peru has not suffered the effects of tsunamis as frequently as other places on Earth. However, history shows that the destructive effects of several tsunamis have impacted our coasts in the past.

In Peru, the most destructive tsunamis occurred on October 28, 1746 and August 13, 1868. The first one struck the coasts of Callao and reached a height of 7 m. This tsunami resulted in the death of 5 to 7 thousand people, and is probably the most destructive tsunami that has ever taken place in Peru. The second one occurred on August 13, 1868 and caused substantial damage from Trujillo (Peru) to Concepcion (Chile). In Arica, a war vessel was washed ashore and left grounded 400 m. inland. The effects of this tsunami were felt in ports as remote as Hawaii, Australia and Japan. Finally, the last destructive tsunami occurred on June 23, 2001, off the coasts of Camaná, destroying the “La Punta” summer resort almost completely, leaving more than 1,000 houses destroyed, 28 casualties, and over 65 people unaccounted for.

International and National Tsunami Warning System

In April 1964, a strong earthquake hit Alaska, generating a tsunami that affected the coasts of several Pacific Rim countries, causing both substantial casualties and property damage. The tsunami reached the Pacific Rim countries several hours after the earthquake had hit Alaska. The authorities of these countries could have warned the population and make them evacuate coastal areas; however, there was no tsunami alert system in place.

As a result, the International Tsunami Warning System was created in 1965.

This International System has its headquarters in Hawaii and is supported by information received from seismographic and mareographic stations (stations that measure earthquakes and sea water levels, respectively).

For instance, if a strong earthquake occurs in the Pacific Ocean area, the seismographic station that is closer to the epicenter will give Hawaii notice thereof, for the latter to retransmit the information to all countries that form part of the system. As no certainty exists as to whether or not the earthquake has generated a tsunami, then the mareographic station that is closer to the epicenter checks whether there has been a sudden sea level change, that is, whether or not a tsunami has been generated. If so, it will give notice thereof to Hawaii, for the latter to send a warning to all Pacific Rim countries.

Each Pacific Rim country has its own National Tsunami Warning Center, which coordinates the issuance of warnings with the International System. In Peru, this center is run by the General Bureau of Hydrography and Navigation (DHN), with headquarters in Chucuito, Callao.

The National Tsunami Warning Center receives information from the International Center through the International "Jorge Chavez" Airport, via a modem and/or magnetic telephone. Upon receipt of the warning, the DHN contacts the International System to assess the possible effects that the tsunami could have upon our coasts. If a risk does exist, a warning is issued to the National Institute of Civil Defense, which is in charge of activating the corresponding evacuation plans.

The Peruvian Geophysical Institute also forms part of the National Tsunami Warning System and reports the location of the epicenter and the earthquake intensity to properly assess the tsunami risk.

In order to properly send tsunami warnings to all communities along Peru's coast, the DHN is connected through the Naval Communications System with all harbormaster's offices all along the coast.

It is worth bearing in mind that if a tsunami occurs at a remote location, the National Tsunami Warning System will give notice thereof to the population through the Civil Defense authorities (mayor of the district – province). However, if a tsunami occurs at a nearby location, the natural warning will be the earthquake that occurs 15 to 25 minutes before the tsunami probably strikes the coast, for which reason workers should move away from the coast onto higher ground immediately after being hit by a strong earthquake (>7.0°).

Tsunamis have affected the coastal areas of Lima-Callao in the past. The largest tsunamis, particularly off the coast of Lima-Callao, are usually caused by earthquakes, close to the coast, triggered by the abduction of the Nazca Plate under the South American Plate. Callao has repeatedly been struck by tsunamis that have resulted in substantial casualties and property damage.

If a Tsunami that could affect the Playa Melchorita area occurs, then as soon as an earthquake that could generate the Tsunami occurs, the International Tsunami Warning System will be activated. Peru is an active member of this System and the National Bureau of Hydrography and Navigation is the national link.

The Marine Terminal Contingency Plan and the Environmental Impact Assessment deal with this issue in further detail.

The recommendations to respond to a Tsunami warning include: bring all operations at the Terminal to a halt, move all vessels away from the coast to a minimum depth of 20 m., and evacuate all workers to higher ground, to a minimum elevation of 20 m. above sea level or 1 km. away from the coast.

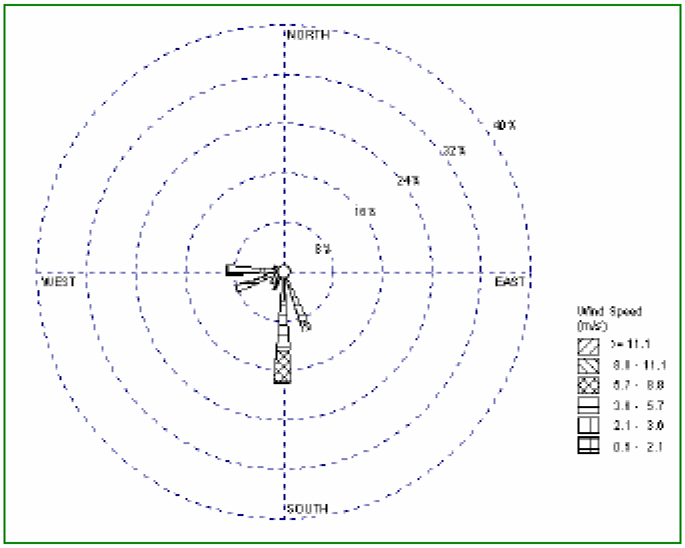
3.9 Meteorology

Overall, climatological conditions in the study area are influenced by the dynamics of the Southeastern Pacific Anticyclone and, during summertime, by the dynamics of the Atlantic Anticyclone that, in its westernmost position, results in the transfer of moisture to the Pacific Ocean side.

According to its geographical position, the study area is also influenced by the cold Peruvian current, which serves as some sort of thermo regulating mechanism, and by the Andean mountain range the orography of which regulates the persistence of trade winds and, therefore, coastal outcrops and the climate regime prevailing on the Peruvian coast.

From a statistical standpoint, winds mainly come from the SSE, their multiannual monthly mean speed ranging between 6 and 8 knots and their average directional stability being 80%. The wind component usually varies slightly towards SSW in the afternoon, with a speed increase to 12 knots. During some months of the year, the wind shows a NW to N component, which remains steady for a few hours and, in extreme cases, for 2 to 3 days. At dawn and in the early morning, winds are weak and tend to remain calm.

By way of example, following please find a Compass Rose that shows the annual average winds reported in the Pisco airport in 1996, where we can see the predominance of southerly and southeasterly winds. This Compass Rose applies to the study area because of its nearness to the area of interest.



Compass Rose for Pisco, Peru, 1996 (Station No. 846910)

Macroscalar influence of the ocean-atmosphere system

From a macroscalar standpoint, the climatological conditions in the study area are influenced by geographical, oceanographic, and meteorological factors.

The geographical factors are associated with the latitudinal position of the study area; the oceanographic factors are associated with the cold Peruvian current, which serves as some sort of thermo regulating mechanism; and the meteorological factors are associated with the Southeastern Pacific Anticyclone, which has an influence on weather and conditions the stability of trade winds as an external agent that generates irregular waves.

Mesoscalar and local influence

From a mesoscalar standpoint, circulation patterns are modified along the coastline due to existing orographic conditions; similarly, flow patterns are slightly modified by the difference in temperature between sea and land, particularly in littoral areas comprising large desert zones and areas with elevated and/or depressed land (bays, coves, peninsulas, etc.). Air circulation patterns are also modified due to the effect of friction on winds and the change in the amount of movement between the airflow on the sea and land.

Climatological assessment

Overall, climatological conditions in the study area are influenced by the dynamics of the Southeastern Pacific Anticyclone and, during summertime, by the dynamics of the Atlantic Anticyclone that, in its westernmost position, results in the transfer of moisture to the Pacific Ocean side.

According to its geographical position, the study area is also influenced by the cold Peruvian current, which serves as some sort of thermo regulating mechanism; by the Andean mountain range the orography of which has an impact on free circulation, conditioning the stability of trade winds; and the occurrence of the El Niño phenomenon, which alters the climate regime.

From a statistical standpoint, winds mainly come from the SSE, their multiannual monthly mean speed ranging between 6 and 8 knots and their average directional stability being 80%. The wind component usually varies slightly towards SSW in the afternoon, with a speed increase to 12 knots. During some months of the year, the wind shows a NW to N component, which remains steady for a few hours and, in extreme cases, for 2 to 3 days. At dawn and in the early morning, winds are weak and tend to remain calm.

From a mesoscalar standpoint, circulation patterns are modified along the coastline due to the difference in temperature between sea and land, particularly in littoral areas comprising large desert zones like, for instance, interfluvial areas.

Also because of the difference in temperature, air circulation is slightly modified offshore due to the presence of pockets of warm water and also because of the horizontal thermal gradient vis-à-vis its periphery.

Elevated and depressed land (peninsulas, bays) along the coastline, in view that the flow is not aligned parallel to the coastline, also modifies air circulation due to the effect of friction and the change in the amount of movement between the air flow on the sea and land.

The multiannual monthly average air temperature fluctuates between 16.6° and 21.9° C, the minimum mean temperature being 15.4° C (September) and the maximum mean temperature being 26.8° (March). Furthermore, mean relative humidity fluctuates between 77 and 90% per month. Average monthly sunlight hours range between 2.3 and 5.9 hours per day, which correspond to August and March, respectively.

Stratiform cloudiness prevails in the study area. During wintertime, skies are covered in the mornings by stratus and stratocumulus clouds, gradually changing to cloudy at noon. During summertime, skies are cloudy to partially cloudy because of the presence of stratocumulus and altocumulus clouds and in the afternoon by cirrostratus and altostratus clouds as a result of the transfer of moisture from the central Amazon Jungle to the Pacific Ocean side.

Rainfall is scarce in the study area. There are only scattered drizzles during winter and slight rains during summer, originating from stratus and altostratus clouds, respectively.

However, fine fogs or mists that reduce horizontal visibility to less than 9 km. are more frequent during most part of the year, particularly at dawn and in the early morning. During summertime, radioactive mists ranging from moderate to dense are frequent in the early morning, reducing visibility to less than 1,000 m. During wintertime, the frequency of fogs is mainly associated with the inflow of humid air from the ocean, as a result of the intensification of the Southeastern Pacific Anticyclone and sea surface cooling in coastal areas.

Each time the El Niño phenomenon occurs, the temperature of air increases by 2° to 4° C and the wind increases by 20 to 50% over the monthly average, particularly in the afternoons. Rainfalls are a bit stronger and cover a broader area.

3.10 Physical aspects of climate changes

Sunlight is the main source of energy on Earth. Continents, seas, oceans and the atmosphere absorb the sun's radiation according to their latitudinal distribution, and weather and climate are the result of ocean-atmosphere interaction. However, some climate changes occur at a geological level and involve thousands and even millions of years. The causes of these changes continue being discussed by scientists and include: variations in the Earth's position, sunspot activity, volcanic activity, concentration of carbon dioxide in the atmosphere, etc.

IPCC scientists (Inter Government Panel on Climate Change) entrusted with the study of sea level rises have developed, as a result of the increasing emission of gases with a greenhouse effect into the atmosphere, six possible scenarios. IPCC scientists predict an increase in global temperature during the next 100 years and, as a result, a sea level increase that may range between 0.35 to 0.85 m., although uncertainty still exists regarding these estimates.

Consensus currently exists among international scientists that climate changes are bringing about global changes, and that it is necessary to prepare qualitative and quantitative estimates of the effects these changes could have.

Global warming will strongly affect existing ecosystems in our coastal area and territorial sea; however, it is difficult to grasp the true magnitude of these consequences. Any climate change and any sea level change will affect several aspects of our marine environment.

Temperature, salinity, sea currents, turbulence, the characteristics of waves and the frequency of storms can be modified. Floods along with seaquakes and erosion will reduce the size of the coastal strip and its habitats.

Marine intrusion, coupled with climate effects, such as increased runoff, could modify the salinity of estuaries and, therefore, affect their ecosystems.

Models developed to simulate the effects of global warming on atmospheric circulation make us foresee significant changes. Atmospheric circulation changes occurred during warm periods in the past give us an idea of future circulation changes.

Some scientists have analyzed climate changes and atmospheric circulation for both cold and warm years during the XX century, developing some scenarios that define the main characteristics of climate changes.

Overall, temperature variations will be stronger at the poles and less stronger near the Equator. For low latitude areas, a global warming of 25°C is expected to take place, which may result in an increase of 2 to 2.5° during summertime and 3 to 3.7° during wintertime. On a worldwide, regional and national basis, it is difficult to accurately predict how will the coastal area respond to global warming; however, it is accepted that the probable consequences will be far-reaching and will affect different aspects.

On the other hand, although the El Niño phenomenon may be a good simulation of the effects that a climate change may have upon the Peruvian ecosystem (air and sea temperature rises, increased rainfalls, sea level rises, etc.), it is worth stressing that:

The temporary changes associated with the El Niño phenomenon are only the initial part of a longer process known as ecological succession, which will take place once the new environmental conditions become permanent. Therefore, the apparent "beneficial and harmful" aspects of the El Niño phenomenon are only temporary, so it is still not possible to predict, based on the current scientific knowledge available about the ecology, the new condition that the ecosystem will adopt in the long term.

3.11 Characterization of water quality and sediments in the receiving body

To determine the quality of water and sediments in the receiving body, samples were taken from nine sampling points aligned parallel to the coastline, using as a reference the project axis with the following points: E1, E2 and E3 from the nearest coastal point in a seaward direction, three towards the south and three towards the north, parallel to this axis with a separation of 770 m. from the first coastline, at intervals of 500 m. as from this line and with a lateral separation of 500 m, at water depths of 10 m, 12 m, and 14 m (see Drawing C1). Sediment samples were taken from these same points.

3.11.1 Materials and Methods

On a prior date, specifically on July 14, 2002 and October 6, 2002, Golder Associates carried out some sampling work within the framework of the comprehensive project, taking water and sediment samples and performing biological control work.

To carry out the above sampling work, Golder used a vessel, water sampling equipment at three levels (surface, middle section and bottom), electrochemical pH, OD, temperature and salinity meters, a dredger, and bottles to collect water and sediment samples.

The samples taken and stored in the respective containers, according to the nature of the essay that was to be conducted, were refrigerated and sent immediately to

Envirolab – Peru S.A.C. and to the National “Federico Villarreal” University Laboratory, School of Oceanography, Fisheries and Food Sciences.

3.11.2 UTM Coordinates (WGS 84) of sampling points

Sampling date: March 26, 2003

Code	NORTH	EAST
E-1	8 534 207,394	358 156,136
E-2	8 533 853,872	357 802,551
E-3	8 533 500,350	357 448,966
E-4	8 534 560,979	357 802,614
E-5	8 534 207,457	357 449,029
E-6	8 533 853,934	357 095,444
E-7	8 533 853,809	358 509,658
E-8	8 533 500,287	358 156,073
E-9	8 533 146,765	357 802,488

3.11.3 Water quality – results and discussion

A) Temperature in °C (vertical temperature profile)

M. Depth	E7 (North)	E1 (Center)	E4 (South)
0	21.7	21.8	21.9
1	21.7	21.8	21.8
2	21.7	21.7	21.8
3	21.6	21.7	21.7
4	21.6	21.7	21.7
5	21.6	21.7	21.7
6	21.5	21.5	21.6
7	21.0	21.1	21.4
8	20.5	20.8	21.0
9	20.3	20.5	20.5

M. Depth	E8 (North)	E2 (Center)	E5 (South)
0	21.7	21.8	21.8
1	21.7	21.7	21.7
2	21.7	21.7	21.7
3	21.6	21.6	21.6
4	21.6	21.6	21.6
5	21.6	21.5	21.5
6	21.5	21.3	21.4
7	21.0	21.0	21.3
8	20.2	20.2	20.5
9	19.7	19.8	19.9
10	19.4	19.5	19.5
11	19.0	19.3	19.0

M. Depth	E9 (North)	E3 (Center)	E6 (South)
0	22.0	22.0	22.0
1	21.9	21.9	21.9
2	21.8	21.9	21.9
3	21.8	21.7	21.8
4	21.7	21.7	21.8
5	21.6	21.6	21.7
6	21.3	21.3	21.3
7	21.1	21.1	21.1
8	20.7	20.8	20.8
9	20.5	20.6	20.6
10	19.9	20.0	20.0
11	19.0	19.3	19.3
12	18.7	18.8	18.8
13	18.2	18.3	18.3

The temperatures recorded on the sampling date show the same trends for the warm season.

B) Dissolved oxygen in mg/l (vertical profile of dissolved oxygen)

M. Depth	E7 (North)	E1 (Center)	E4 (South)
0	9.42	9.41	9.53
1	9.33	9.38	9.42
2	9.26	9.25	9.38
3	8.72	9.24	9.20
4	8.65	8.73	8.70
5	6.58	6.36	6.40
6	6.12	6.02	6.20
7	5.61	5.76	5.90
8	5.08	5.20	5.30
9	4.40	4.36	4.70

M. Depth	E8 (North)	E2 (Center)	E5 (South)
0	9.85	9.96	9.90
1	9.76	9.82	9.82
2	9.60	9.72	9.42
3	8.91	9.62	9.12
4	7.63	8.63	8.25
5	7.30	7.42	7.63
6	6.54	6.25	6.70
7	5.70	5.62	5.24
8	5.40	5.59	5.02
9	4.75	4.30	4.61
10	4.12	4.05	4.22
11	3.42	3.56	3.64

M. Depth	E9 (North)	E3 (Center)	E6 (South)
0	1.10	9.70	9.90
1	10.03	9.25	9.70
2	9.69	9.10	9.30
3	9.06	9.08	9.12
4	8.20	9.16	8.82
5	7.76	8.42	8.23

6	7.47	8.24	7.94
7	6.71	6.42	6.72
8	6.40	6.29	6.12
9	5.72	5.70	5.93
10	5.32	5.21	4.93
11	4.68	4.74	4.12
12	4.12	4.02	3.70
13	3.70	3.61	3.24

On the sampling date, there was an oversaturation owing to the high concentration of phytoplankton prevailing in this area. Similarly, there was a good level of oxygenation within the entire water column.

C) Salinity S%o (Vertical profile of Salinity)

M. Depth	E7 (North)	E1 (Center)	E4 (South)
0	33.3	33.2	32.6
1	33.3	33.2	32.9
2	33.3	33.2	32.9
3	33.3	33.2	33.0
4	33.3	33.3	33.0
5	33.3	33.3	33.1
6	33.4	33.3	33.1
7	33.4	33.4	33.2
8	33.4	33.4	33.2
9	33.5	33.4	33.3

M. Depth	E8 (North)	E2 (Center)	E5 (South)
0	33.4	33.4	33.4
1	33.4	33.4	33.4
2	33.4	33.4	33.4
3	33.4	33.5	33.4
4	33.4	33.5	33.4
5	33.4	33.5	33.5

6	33.5	33.5	33.5
7	33.5	33.6	33.5
8	33.6	33.6	33.6
9	33.6	33.6	33.6
10	33.6	33.7	33.6
11	33.7	33.7	33.7

M. Depth	E9 (North)	E3 (Center)	E6 (South)
0	33.6	33.6	33.6
1	33.6	33.6	33.6
2	33.6	33.6	33.6
3	33.6	33.6	33.7
4	33.7	33.6	33.7
5	33.7	33.7	33.7
6	33.8	33.7	33.8
7	33.8	33.8	33.8
8	33.8	33.8	33.8
9	33.8	33.9	33.9
10	33.9	33.9	33.9
11	34.0	34.0	34.0
12	34.0	34.0	34.0
13	34.1	34.1	34.1

On the sampling date, the influence of fresh water coming in from the Chincha River was clearly distinguished. The greatest effect was noticed in the coastal surface areas in view that the mixture processes result in water with a smaller density. For this reason, the water remains in the coastal surface area.

D) Biochemical oxygen demand:

Code	Surface	Middle Section	Bottom
E1	3.81	3.46	3.10
E2	2.60	2.16	2.32
E3	2.06	1.19	1.71

The BOD values found are slightly higher than those detected for non-contaminated waters due to the presence of a large amount of plankton all along the water column.

E) Total Suspended Solids in mg/l (TSS):

Organic

Code	Surface	Middle Section	Bottom
E1	26.87	23.90	24.00
E2	24.70	26.10	25.73
E3	18.20	29.30	29.75

Inorganic

Code	Surface	Middle Section	Bottom
E1	10.05	11.50	13.00
E2	11.10	8.76	9.37
E3	16.10	2.63	10.38

Total

Code	Surface	Middle Section	Bottom
E1	36.92	35.40	37.00
E2	34.80	34.86	35.10
E3	34.30	32.02	40.13

Total suspended solids mainly consist of organic material (plankton) and inorganic particles (silts and clays).

F) Hydrocarbons (gas chromatography) in mg/l:

Code	Surface
E1	0.00
E2	0.00
E3	0.00

Hydrocarbons were not found in seawater in the study area.

G) Nitrogen:

Nitrites, nitrates, nitrogen and organic nitrogen are the different forms of nitrogen found in water. This time, the analysis included nitrites, nitrates, and total nitrogen.

Nitrites

Code	Surface	Middle Section	Bottom
E1	0.007	0.004	0.043
E2	0.005	0.008	0.028
E3	0.009	0.004	0.023

Higher concentrations of nitrites were found at the bottom, which is consistent with the low amount of oxygen reported, owing to the high plankton density that prevents plankton from performing photosynthesis at the bottom. This is why nitrite is not oxidized.

Nitrates

Code	Surface	Middle Section	Bottom
E1	0.004	0.012	0.241
E2	0.006	0.023	0.343
E3	0.016	0.141	0.493

As in the case of nitrites, the highest concentrations of nitrates are found at the bottom and seaward, for the same reasons explained above. Similarly, it can be observed that almost all the sea surface nitrate has been exhausted owing to the effect of phytoplankton.

Total Nitrogen

Code	Surface	Middle Section	Bottom
E1	0.817	0.733	1.004
E2	0.752	0.814	1.143

E3	0.571	1.027	1.409

This value is associated with the nitrogen content of plankton, nitrites and nitrates.

H) Phosphorous

Phosphates

Code	Surface	Middle Section	Bottom
E1	0.085	0.106	0.157
E2	0.108	0.116	0.226
E3	0.114	0.173	0.343

As in the case of nitrite and nitrate, the highest concentrations are found at the bottom and seaward, for the reasons explained above.

Total phosphorous

Code	Surface	Middle Section	Bottom
E1	0.891	0.823	0.877
E2	0.849	0.899	0.998
E3	0.660	1.055	1.236

The pattern shown by total phosphorous was similar as that shown by organic nitrogen.

3.11.4 Sediment quality, results and discussion

Three sediment samples were taken at the same points were water samples were taken.

A) Composition

Mesh (um)	E1	E2	E3	E4	E5	E6	E7	E8	E9

>500	0,23	0,38	0,14	0,00	0,53	0,82	0,02	0,22	0,42
>354	0,26	0,36	0,49	0,09	0,35	0,75	0,13	0,41	0,25
>250	0,41	0,57	0,78	0,11	0,30	0,97	0,33	0,42	0,88
>177	1,31	2,01	0,73	0,23	0,29	0,59	0,86	0,73	1,69
>125	3,70	2,91	23,29	0,39	1,42	2,37	6,21	19,62	13,99
>88	80,85	67,07	46,35	69,03	73,38	42,69	67,85	62,43	71,22
<88	13,24	26,70	28,17	29,64	23,74	51,62	24,63	16,17	11,54

Sediments are made up of very fine sand and mud.

B) Metals in mg/kg (Cu, Pb, Cd, Hg and Fe):

Metals the fraction of which was smaller than 80 um were evaluated.

Code	Copper	Lead	Cadmium	Mercury	Iron
E1	11.4	7.1	2.19	0.052	11730
E2	12.3	11.1	3.56	0.070	14595
E3	22.73	10.2	3.60	0.052	14810

In the study area, the anthropic contribution of metals is insignificant and could be associated with the material dragged along and deposited by the Chincha River, south of the area of interest. Furthermore, at the Chincha River basin there is no mining activity that could contaminate the sediments dragged along by the river, for which reason minerals are naturally present in the area.

3.12 Biological conditions: habitats and Biodiversity

3.12.1 Materials and Methods

To evaluate the existing biological conditions, namely habitats and biodiversity, plankton networks were used and water samples were taken to conduct microbiological (total and faecal coliforms) and intestinal parasite exams. Sediment samples were also taken for this purpose.

Biologist Juan Acosta, an expert phycologist, was in charge of the sampling and sample analysis processes.

3.12.2 Results and Discussion

The results of the microbiological and parasite exams conducted on water samples were negative, which confirms what we have stated above in the sense that there has been little anthropic intervention in the study area.

A) Plankton

This part of the surface water sample analysis considered three samples stored in bottles L1, L2 and L3, which correspond to stations E1, E2, and E3. Through this study, it is possible to evaluate primary productivity conditions and the density of species included in the first trophic level of this marine ecosystem.

9 diatom species and 7 dinoflagellate species were found in the phytoplankton. The most representative one was the Dinoflagellate Ceratium reflexum the quantitative aspect of which is determined by 3,333 cells per millimeter. From the samples analyzed, Bottle L1 is, from a qualitative standpoint, the most important one owing to the largest diversity of diatoms, which in turn are very small and serve as food for other species.
The marine zooplankton is represented on a disperse basis by three forms of Crustacean larvae (COPEPODAS), Order CALANOIDA, CYCLOPOIDA and HARPACTICOIDA.

Bottle I1
Marine phytoplankton

DIVISION CHRYSOPHYTA (golden brown or greenish brown algae)

Class Bacillariophyceae (Diatoms)

Sub-Class CENTRICAE

- Coscinodiscus excentricus Ehr.
- Rhyzosolenia alata Brightw.
- Planktoniella sol (Wall.) Schutt
- Ditylum brighwellii (West) Grun.
- Chaetoceros gracilis Schutt
- Stephanopyxis turris (Grev. and Arn.) Ralfs

Sub-Class PENNATAE

- Nitzchia sp.
- Gyrosigma sp.
- Thallassiothrix nitzschoides Grun.

DIVISION PYRROPHYTA (Dinoflagellates)

Class Dinophyceae

- Prorocentrum micans Her.
- Dinophysis caudata Saville Kent

Peridinials

Peridiniaceae

- Peridinium crassipes Kofoid
- Ceratium furca (Ehrenberg) Claparide et. Lachmann
- Ceratium fusus (Her.) Clab. And Lachm.

Gymnodinials

Gonyaulaceae

Gonyaulax minima Matzenauer

From a quantitative standpoint, the most representative species is the Dinoflagellate Ceratium reflexum Cleve, the percentage of which stands at 3,333.33 cells per millimeter.

Marine Zooplankton

- Larvae studies of Copepods of Suborder CALANOIDEA and CYCLOPOID.

Bottle 12

Marine Phytoplankton

DIVISION CHRYSOPHYTA (golden brown or greenish brown algae)

Class Bacillariophyceae (Diatoms)

Sub-Class CENTRICAE

- Coscinodiscus excentricus Ehr.
- Planktoniella sol (Wall.) Schutt
- Chaeotoceros gracilis Schutt
- Rhizosolenia alata Brightw.
- Ditylum brighwellii (West) Grun.

DIVISION PYRROPHYTA (Dinoflagellates)

- Ceratium reflexum
- Ceratium furca (Ehrenberg) Claparide et Lachm.
- Ceratium fusus (Her.) Clab. and Lachm.
- Peridinium divergens Ehrenberg
- Peridinium diabolus Cleve
- Gonyaulax minima Matzenauer
- Dinophysis caudata Saville Kent

From a quantitative standpoint, the most representative species is the Dinoflagellate Ceratium reflexum Cleve, the percentage of which stands at 2,222.22 cells per millimeter.

Marine Zooplankton

Copepod larvae (CRUSTACEAN) , Order CALANOIDA and CYCLOPOIDA.

Bottle L3

Marine Phytoplankton

DIVISION CHRYSOPHYTA (golden brown and greenish brown algae).

Class Bacillariophyceae (Diatoms)

Sub-Class Centricae

- Coscinodiscus excentricus Ehr.
- Chaetoceros gracilis Schutt
- Planktoniella sol (Wall) Schutt
- Rhizosolenia alata Brightw.
- Ditylum brighwellii (West.) Grun.

Sub-Class PENNATAE

- Gyrosigma

DIVISION PYRROPHYTA (Dinoflagellates)

- Ceratium reflexum Cleve and frustule remains
- Ceratium tripos forma tripodioides (Joergensen) Paulsen
- Peridinium divergens Ehrenberg
- Dinophysis caudata Saville Kent

The most frequent and representative species is the Dinoflagellate Ceratium reflexum Cleve, the quantitative percentage of which stands at 2,222.22 cells per millimeter.

Marine Zooplankton

- Presence of copepod larvae (CRUSTACEAN), Suborder CALANOIDA, CYCLOPOIDA and HARPACTICOIDA.

B) Benthos

The benthos samples analyzed hereunder were taken at different sea depths, 10 m., 15 m., 20 m. and 25 m., to determine diversity for MICROBENTHOS and MACROBENTHOS.

The MICROBENTHIC COMMUNITY is composed of CYANOPHYTA (1 species), CHRYSOPHYTA (Diatom group) (5 species), PYRROPHYTA (2 species). The zooplankton is composed of a Copepod larvae, Suborder Calanoida.

The MACROBENTHIC COMMUNITY is composed of MOLLUSKS (2 species) and CRUSTACEANS (1 species).

From all samples taken from different depths, the 2 Molluscan species, Mulinia edulis and Nassarius dentifer are not used by man. The Crustacean, Pleuroncodes monodon, is a nomadic Benthopelagic species that lives at the bottom of the sea and on the surface and is eaten by some fish like the "cabrilla" Paralabrax humeralis, "chita" Anisotremus scapularis and, apparently, the "pota" Dosidicus gigas, which is always establishing communities with this crustacean.

C) Fish

List of fish unloaded at the Tambo de Mora wharf

(2002 catch, artisan or small-scale fishing) Data obtained by the Fishing Terminal Biologists' Team from the Tambo de Mora Fish Market and based on statistical data furnished by the Regional Fisheries Bureau.

- "Raya" (Urotrygon ssp.) Demersal.170-280, 117-400 kg/journey.

- "Tembladera" (Torpedo tremens), Fam. TORPEDINIDAE. Demersal. 150-200, 82-250 kg/journey.

- "Guitarra" (Rhinobatos planiceps), Fam. RHINOBATIDAE. Demersal. 20-80, 82-200 kg/journey.

- "Ayanque" (Cynoscion analis), Fam. SCIAENIDAE. Pelagic. 75-120, 40-88 kg/journey.

- "Bobo", "mis mis", "misho", "zorro", "chula" (Menticirrhus ophicephalus), Fam. SCIAENIDAE. Pelagic. 50-94, 32-74 kg/journey.

- "Peje zorro", "tiburón zorro" (Alopias vulpinus), Fam. ALOPIIDAE. Demersal. 40-80 kg/journey.

- "Coco" (Paralonchurus peruanus), Fam. SCIAENIDAE. Pelagic. 28-98, 33-73 kg/journey.

- "Lisa" (Mugil cephalus), Fam. MUGILIDAE. Demersal. 29-50, 20-80 kg/journey.

- "Mojarrilla" (Stellifer minor), Fam. SCIANIDAE, 20-50, 15-40 kg/journey.

- "Tollo fino", "tollo blanco" (Mustelus mento) and "tollo común" (Mustelus whitneyi), Fam. TRIAKIDAE. 17-60 kg/journey.

- "Lorna" (Sciaena deliciosa), Fam. SCIANIDAE.

- "Cabinza" (Isacia conceptionis), Fam. POMADAYIDAE

- "Pejerrey" (Odontesthes regia regia), Fam. ATHERINIDAE

D) Coastal flora and fauna

On Monday, March 24, 2003, a reconnaissance trip was made to Playa Melchorita, which included several kilometers of ecological areas located in supralittoral and intertidal zones, within an absolutely sandy – muddy environment characteristic of the coastal area (according to the studies conducted by KOEPCKE, 1952), observing:

Mollusks, like the "choro" Aulacomya ater (MITILIDAE), "almeja de fango" Mulinia edulis (MACTRIDAE).

Crustaceans, "carretero" Ocypode gaudichaudii (OCYPODIDAE), which is characteristic of this environment and feeds on detritus, "cangrejo peludo" Cancer setosus (CANCRIDAE).

Mammals, like "lobo marino comun" Otaria byronia.

Birds, which, from an ecological standpoint, are typical of this environment, like the "gallinazo" Coragyps stratus, "chuita" Phalacrocorax gaimardi (PHALACROCORACIDAE), "cuervo del mar" or "cushuri" Phalacrocorax olivaceus (PHALACROCORACIDAE), "tijereta de mar" Eregata magnificens, "Ostrero comun" or "Pitanay" Haematopus ostralegus pita (HAEMATOPODIDAE), "gaviota dominicana" Larus dominicanus (LARIDAE), "piquero comun" Sula variegata (SULIDAE).

Vegetable remains of phanerogamic plants originating from riverside mountains that are very close to this area, which are dragged along by tides and beached onto the supralittoral area, have been constantly observed in this zone.

3.13 Current and future uses of the sea and beaches

The area is currently used for small-scale fishing which, due to the characteristics of the area (accessibility), is performed on a limited basis.

The Wakama summer resort is more than 5 km. south of the Plant site. It was developed several years ago, but new rustic cottages are being built now.

As regards future uses, the installation of a gas-shipping terminal may create development expectations among the local population, like terminal-related services to be provided from nearby areas and outside the project's restricted zone.

3.14 SOCIO-ECONOMIC FACTORS

3.14.1 Project Location

The area selected for the construction of the Natural Gas Liquefaction and Export Plant is located 168 km. south of the city of Lima, on the western side of the South Panamericana Highway, in the District of San Vicente de Cañete, Province of Cañete, Department of Lima.

According to the information contained in the EIA prepared by Golder Associates for the Pampa Melchorita LNG export project, and based on the geographical and political location of the area selected for the project, it is estimated that the impacts that the construction and operation of the project will have upon social and economic aspects, such as use of goods and services, manpower, fishing and agricultural activities, payment of taxes, permits and municipal approvals, etc., will be allocated as follows:

- A direct area of influence, defined as the area located between the districts of San Vicente de Cañete and Cerro Azul in the Province of Cañete (Department of Lima), and the districts of Grocio Prado, Sunampe, Tambo de Mora, Pueblo Nuevo, and Chincha Alta in the Province of Chincha (Department of Ica).

- An indirect area of influence to be composed of the remaining provinces of Cañete and Chincha, which form part of the departments of Lima and Ica, respectively.

3.14.2 Use and possession of land

The area selected for the project consists of untilled land owned by the Peruvian State. The property is located in the district of San Vicente de Cañete and comprises an area of approximately 521 hectares, which will be directly acquired from the Superintendency of Public Property (SBN). An application will be filed with the competent entity to obtain a concession over the beach area and the marine surface. To this end, the appropriate procedure will be followed.

There are no permanent occupants in the area selected for the project. However, when the baseline studies were conducted, it was noticed that some people from neighboring communities use the area of interest to gain access to the fishing areas, or fish on the beach on a seasonal basis.

The company has carried out the necessary archaeological studies and has already obtained the corresponding Certificate evidencing the Non-Existence of Archaeological Remains (CIRA), which is issued by the National Institute of Culture (INC).

3.14.3 Social Profile

The project area is located in the Province of Cañete, Department of Lima; however, it is so close to the limits of both the province and the department that the area of interest extends to the south, making the province of Chincha, Department of Ica, involved in the project.

3.14.4 Population

According to the information contained in the EIA prepared by Golder Associates for the Pampa Melchorita LNG export project, the Province of Cañete is one of the 11 provinces that form part of the Department of Lima. In the year 2002 (INEI), it had an estimated population of 173.872 inhabitants, which may account for 2,1% of the total number of people who live in the Department of Lima. Concerning population density, the figure stands at 38 inhabitants per km2, and the urban population account for 73,4% (127.695 inhabitants) of the total, while the remaining 26,6% (46.177 inhabitants) are scattered along the rural area. The figures for male and female population stand at 87.410 (50,3%) and 86.462 (49,7%), respectively.

The Province of Cañete, with a total surface area of 4.577 km2, is divided into 16 districts.

In turn, the District of San Vicente, with jurisdiction over the area where the proposed project will be built, has an estimated population of 38.057 (accounting for 22% of the population of the Province of Cañete) distributed over 513,15 km2, equivalent to a population density of 74,2 inhabitants per km2. 68,3% (26.009 inh.) of the population lives in the urban area and 31,7% in the rural area (12.048 inh). The urban population of the district account for 21% of the urban population of the Province of Cañete and 26% of the rural population. As regards total male and female population in the district, the figures stand at 18.689 and 19.368, respectively. In the province, the districts of San Vicente de Cañete, Imperial and Lunahuaná have the highest figures as regards female population, with 51%, 51%, and 50%, respectively.

The Province of Chincha, which is part of the direct area of influence of the project, is one of the 5 provinces that form part of the Department of Ica, together with Pisco, Ica, Palpa, and Nazca. In the year 2002 (INEI), it had an estimated population of 176.732 inhabitants, which account for 27% of the total number of people living in the department. The province comprises a total surface area of

2.988,27 km2, which means that the population density stands at 59 inhabitants per km2. The urban population account for 82,3% (145.417 inh.) of the total population, while the remaining 17,7% (31.315 inh.) live in the rural area. The figures for male and female population stand at 86.087 (49%) and 90.645 (51%), respectively.

In the Province of Chincha, out of the 5 districts considered as direct area of influence, the district with the highest population density is Chincha Alta as 32% of the total number of people living in the province live in Chincha Alta, followed by Pueblo Nuevo, with 26%. The largest population densities (inh./km2), according to data projected by INEI as of the year 2002, are found in Chincha Alta, with 241 inh./km2, Pueblo Nuevo, with 223 inh./km2, Sunampe, with 211 inh./km2, and Tambo de Mora, with 210 inh./km2. The lowest population density is found in the district of Grocio Prado, with 88 inh./km2.

As regards urban population, the districts that show the highest percentages are: Chincha Alta (100%), Grocio Prado (90%), and Tambo de Mora (79%). Sunampe has the highest population density in the rural area, with 41%.

Coastal districts show the following figures with respect to female population (in order of importance): Chincha Alta, with 52%, and Grocio Prado, Sunampe and Tambo de Mora, with 51%.

The following Table contains a summary of the different aspects considered in the demographic component, as regards the districts covered by the direct area of influence of the project.

Table - Demographic characteristics of the population within the direct area of influence.

3.14.5 Poverty

According to the information contained in the EIA prepared by Golder Associates for the Pampa Melchorita LNG export project, the province of Cañete is ranked No. 172 at a national level as regards unmet basic needs, based on information obtained from the Strategic Development Plan (1998). 65,8% of the rural population and 37,4% of the urban population living in the province of Cañete do not manage to meet their basic needs. Close to 50% of households in the Province of Cañete are ranked poor, and this percentage increases in the countryside, where it stands at 69%, due to the precarious condition of their dwellings, overcrowding, and deficient water and sewage services.

Provinces	**Districts**	**Population**	**Surface (Km2)**	**Population Density (inh./km2)**	**Distribution of the Population**		**Distribution by Sex**	
					Urban	**Rural**	**Male**	**Female**
Cañete	San Vicente de Cañete	38057	513.15	72.2	68.3%	31.7%	49.1%	50.9%
Chincha	Grocio Prado	16834	190.5	88.4	89.6%	10.4%	49.3%	50.7%
	Chincha Alta	57354	238.3	240.7	100.0%	0.0%	48.0%	52.0%
	Sunampe	20301	16.76	1211.3	58.8%	41.2%	49.2%	50.8%
	Tambo de Mora	4612	22	209.6	78.5%	21.5%	49.0%	51.0%

Those districts that form part of the Province of Chincha, are located within the direct area of influence, according to the classification made by FONCODES (National Compensation and Social Development Fund) on the 2000 Poverty Drawing, and are ranked regular are: Tambo de Mora, Sunampe, Pueblo Nuevo, and Chincha Alta. Grocio Prado is ranked poor.

3.14.6 Infrastructure Services

Dwelling

According to the information contained in the EIA prepared by Golder Associates for the Pampa Melchorita LNG export project, the district of Cañete, according to data obtained from the 1993 Census (INEI), had 7,278 private dwellings, of which 37% had water services, 34% had sewage services, 58% had electricity, and 9,5% had no water, sewage or electricity services. Dwellings are mostly made of adobe (40%) and brick (29%). Roofs are mainly made of palm matting (58%).

Education

According to the information contained in the EIA prepared by Golder Associates for the Pampa Melchorita LNG export project, in the Province of Cañete there are 328 schools ([1]), of which 286 are State schools and 42 are private schools. 55.013 children currently attend different schools in the province (Educational Services Unit USE-08,2001), of which 27.429 are male and 27.854 are female. 2.445 teachers are in charge of educating this population. The number and percentage of school age children enrolled in the year 2000 was 53.329. The USE has estimated that the drop-off rate is 19% (based on the total number of school children enrolled).
Concerning access to higher education, the data obtained from the census conducted in 1993 (INEI) show that 8.505 people had pursued non-university higher education, while 6.050 had pursued university education, which accounts for 8,4% of the people living in the province.

The Province of Chincha, specifically the 5 districts covered by the direct area of influence, has 277 centers of regular basic, employment and higher technical education. There are 152 educational centers in the capital of the district, that is, Chincha Alta, 7 in the district of Tambo de Mora, 26 in Grocio Prado, 34 in Sunampe, and 58 in Pueblo Nuevo (District Municipalities, 2001).

As regards illiteracy rates among the population aged 15+, the following figures were obtained from the 5 districts that form part of the Province of Chincha and are located within the direct area of influence: Pueblo Nuevo, 5,7%, Grocio Prado, 7%, Chincha Alta, 4%, Sunampe, 5,6%, and Tambo de Mora, 5%. All these rates are below the national level (INEI, 1993).

Health

According to the information contained in the EIA prepared by Golder Associates for the Pampa Melchorita LNG export project, the Province of Cañete, according to the Poverty Drawing (FONCODES, 2000), has a high malnutrition rate, 22,2%. At a district level, the highest malnutrition rates were found in Pacarán, 38%, Zúñiga, 31%, Nuevo Imperial, 27%, and Quilmaná, 26%. The District of San Vicente de Cañete stands at 20%. Based on information provided by medical centers located in this area, there is no nutritional education program in place in order for the people to learn how to make good use of food resources available in the area. People in these areas do not eat the vegetables they grow, as they prefer to sell them to the local market.

Other health indicators in the Province of Cañete include (MINSA, 2000):

- Total Population — 144,436 inhabitants
- Overall Fertilization Rate — 2.45% of all women aged 15-49
- Crude Birth Rate — 0.69% of total population
- Crude Death Rate — 1.39% of total population
- Child Mortality Rate — 7.25% of all newborns (3.448)

A health problem in this province is the increase in the fertility rate among adolescents, as 13% of women aged 13-19 already have a child or are pregnant for the first time. At 19, 25% have had a child and 6% have at least two children. One of the reasons why there has been an increase in the fertility rate among adolescents in the Province of Cañete is the lack of a reproductive health program for women and pregnant women and another program designed for women of fertile age, dealing with responsible fatherhood and risks in the frequency of wanted and unwanted pregnancies.

Concerning women aged 20 to 49, the main causes of mortality in the Province of Cañete, according to data provided by MINSA (2000), are associated with respiratory and digestive diseases, skin diseases (mycosis) and mouth diseases.

The main basic health services in the Province of Cañete are provided through the San Vicente health micro network, which consists of 2 health centers and 8 health posts ran by 80 health professionals who look after the health of 30.385 people (MINSA, 2002).

The existing medical services are insufficient to meet the needs of the population. Health professionals are in high demand and there is a shortage of health professionals. According to Health Ministry calculations, there is one medical doctor for every one thousand people (MINSA, 2000). Furthermore, there are many problems associated with the people's lack of knowledge about health care and illness prevention. These problems are aggravated by the low quality of the services which, according to the health sector, is attributed to the lack of funds and the lack of appropriate medical equipment.

In the Province of Chincha, the malnutrition rate stands at 20%, and, at a district level, the highest malnutrition rates are found in Tambo de Mora (29%), Grocio Prado (29%), and Sunampe (22%), and, to a lesser extent, Pueblo Nuevo (18%) and Chincha Alta (17%) (FONCODES, 2000). This situation might be favorably reverting because in the year 2000 the malnutrition rate among children aged 5- dropped from 10% to 7%.

The main causes of mortality in the poorest districts like Grocio Prado are associated with digestive, respiratory, infectious and parasitary diseases, diseases of the genital and urinary tracts, diseases of the skin and subcutaneous tissue, and deaths resulting from complications of pregnancy, childbirth, and the puerperium (District Health Centers, 2002).

To deal with these problems, Chincha Alta has 2 hospitals and 1 health center, while Grocio Prado has 2 health centers and Sunampe only has 1 (FONCODES, 2000).

The following chart summarizes the characteristics of the most relevant social services provided within the area of influence of the project.

Province	District	Dwelling (1993)					Education (2001)				Health (2000)	
		Total Private Dwellings	W/ Water Service %	W/ Sewage Service %	W/ Electricity Service%	W/O Water Sew & Electr %	Second. Educ. Enroll.	Higher Educ. Enroll.	Ed. Centers	Illit. rate	Maln rate	Health Center
Cañete	San Vicente de Cañete	7278	37	34	58	9,5	13182	113(*)	55	7,6	20	10
Chincha	Pueblo Nuevo	9864	52	57	35	3.4	3022	970	58	5,7	18	-
	Grocio Prado	3274	47	65	11	2,0	575	0	26	7,0	29	2
	Chincha Alta	1153	63	75	747	4,3	15104	9535	152	4,1	17	3
	Sunampe	3778	33	70	14	3,9	555	0	34	5,6	22	1
	Tambo de Mora	888	35	67	30	4,5	122	0	7	5,0	20	-

Despite the fact that the number of people who lack water services in the province of Chincha is slightly lower than Cañete, we may find that the existing potable and sewage services fail to meet the needs of all the population, as potable water is only supplied two hours a day in each district. This is due to the operation and functioning of only 2 out of the 7 wells that supply water to all districts in the province.

3.14.7 Communication routes and transportation

According to the information contained in the EIA prepared by Golder Associates for the Pampa Melchorita LNG export project, there is only one main road in the Province of Cañete, the North-South axis of the South Panamericana Highway. The Panamericana Highway is an express highway for all sorts of vehicles, from heavy trucks to cars. Following is a description of the project site access points from the following two important points:

- Northern Route: from LURIN to PAMPA MELCHORITA, a road section that goes from Km. 25 to Km. 169 of the Panamericana Highway.
- Southern Route: from PISCO to PAMPA MELCHORITA, a road section that goes from Km. 246 to Km. 169 of the Panamericana Highway.

This road section includes only one lane up to Pampa Melchorita. There are several fog zones (like Km. 171) and the signaling system is poor.
There are 4 bridges with a load carrying capacity of 36 tons. These are:
From Km. 231 to Km. 225 the road crosses the urban area of Pisco and San Clemente.
From km. 201 to km. 192, the road crosses the urban area of Chincha.

The districts with the highest percentage of urban population engaged in commercial activities, like San Vicente de Cañete, have paved road sections. Interdistrict roads are dirt roads used by public transportation vans (combis), motorcycle-driven taxis (mototaxis), taxis and jitneys (colectivos). In most cases, these vehicles are owned by one person (an old employee of an estate (hacienda) / cooperative / public entity) who rents them to different persons, who drive the cars.

72% of roads in the province are not in a good condition, as maintenance is limited to the South Panamericana highway, which is the responsibility of the Ministry of Transport and Communications Sector Office.

The Province of Chincha, like Cañete, has only one main road, the North-South axis of the South Panamericana Highway. The main access roads to the five districts located within the direct area of influence of the project are fully asphalt-coated due to the passage of the South Panamericana Highway, which serves as an axis to integrate the Province of Chincha into the Department of Ica. Dirt roads that start on the Panamericana Highway connect this district with other districts located in the Sierra. At a department level, Ministry of Transport and Communications data reveal that the Ica Department road network system includes 2.201 km. of roads, of which 654 km. are asphalt-coated roadways, 144 km. are paved roadways, 156 km. are unpaved roadways, and 1.246 km. are wagon roads.

3.14.8 Electric Power

According to the information contained in the EIA prepared by Golder Associates for the Pampa Melchorita LNG export project, since 1970 Electro Peru has installed two electric power sub-transmission lines.

The 60.000-volt transmission line located south of Cañete, its starting point being the Independencia transformation substation, in the province of Pisco, supplies electricity to the districts of San Vicente de Cañete, Imperial, Nuevo Imperial, Cerro Azul, San Luis, Quillamaná, Lunahuaná, Pacarán, and Zúñiga. EDE Cañete supplies electricity to 9 districts in the Cañete Valley: San Vicente de Cañete, Imperial, Lunahuaná, Nuevo Imperial, Pacarán, Cerro Azul, San Luis, Quilmaná, and Zúñiga.

Based on data obtained for the Province of Chincha from the Poverty Drawing (FONCODES, 2000), electricity reaches 80% of the population, except for the districts of Tambo de Mora, where this figure drops to 76%. The same occurs in

Sunampe. Instead, in the district of Grocio Prado, 82% of the population is connected to the electricity network.

3.14.9 Economic profile

Employment

According to the information contained in the EIA prepared by Golder Associates for the Pampa Melchorita LNG export project, in the Province of Cañete, according to the census conducted in 1993, the economically active population (EAP) aged 6+ reached 50,048 people, of which men and women accounted for 72% and 28% thereof, respectively. The economic activity rate reported for the EAP aged 15 and above was 51,5%, broken down as follows: agriculture (43%), services (43%), and wage and salary earners (50%). As regards agriculture, the most economically active districts are Coayllo, Pacarán, Calango and Lunahuaná, while in the service field San Vicente de Cañete, Mala and Imperial rank first. The districts with the largest number of wage and salary earners were Quilmaná, Chilca, and Asia.

The district of San Vicente de Cañete, according to the census conducted in 1993 (INE), had an EAP of 10.403, of which 69% were men and 31% were women. In the district, the economic activity rate was 50%, broken down as follows: agriculture (36%), services (52%), and wage and salary earners (57,5%).

In the Province of Chincha, according to the census conducted in 1993 (INEI), the EAP aged 6 and above included 47.463 people, of which 38.827 (82%) correspond to the districts located within the direct area of influence of the project, as per the following breakdown: 69% men and 31% women.

Concerning EAP, the district of Chincha Alta showed the largest percentage, with 43%, as shown on the table. Regarding the economic activity rate, it fluctuates between 43% and 50% and mainly focuses on service providers and wage and salary earners within ranges that are close to 50%, except for people engaged in the rendering of services in Chincha Alta and Pueblo Nuevo, who exceed 60%. People engaged in agriculture account for 11% in Chincha Alta and 29% in Grocio Prado.

Table. Economically Active Population by Activity. Province of Chincha

Districts	EAP[5] (inh.)	EAP Study Area %	EAP (inh.)		Economic Activity Rate[6] %	Engaged in Agriculture %	Engaged in Services %	Wage and Salary Earners %
			Men	Women				
Chincha Alta	16654	43	11055	5599	50	11	65	56
Pueblo Nuevo	11260	29	7521	3739	49	10	64	50
Sunampe	4979	13	3769	1210	43	23	50	53
Grocio Prado	4703	12	3423	1280	49	29	40	48
Tambo de Mora	1231	3	935	296	47	25	39	52
Total Study Area	38827		26703	12124				

Source: INEI, 1993

<u>Economic activities</u>

According to the information contained in the EIA prepared by Golder Associates for the Pampa Melchorita LNG export project, from the 16 districts that form part of the Province of Cañete, according to data obtained from the 1999 National Survey on Social and Economic Infrastructure at a District Level, 14 are mainly engaged in agriculture and animal husbandry, and only 2 are mainly engaged in fisheries.

At Chincha Valley, the economy focuses on subsistence agriculture. Products grown include beans, corn, yucca, and fruit trees, like orange, mandarin and grape. However, there are some agro industries related to the cultivation of asparagus for export purposes and grape byproducts, like wine and pisco. Notwithstanding, another revenue-generating activity in the area is fishing. Around 500 people perform small-scale fishing activities and are basically engaged in inshore fishing and line fishing. They fish not only on the coasts of Chincha, but also (depending on their needs and the season) on the coasts of Cañete. They also perform other activities, like agriculture (grape growing) or business activities. In the district of Tambo de Mora, boat fishing is another important revenue-generating activity.

Agriculture and Animal Husbandry

According to the information contained in the EIA prepared by Golder Associates for the Pampa Melchorita LNG export project, the Province of Cañete has narrow valleys where agriculture is basically performed on an intensive basis. Upland soils have moderate to steep slopes that are exposed to erosion by the effect of rains and other factors. As regards agricultural land, the Province of Cañete has the largest number of hectares, as it accounts for 20% of all agricultural land within the Department of Lima, in view that it does not depend on the rainfall regime and has a mild and steady weather almost all year long.

The Province of Cañete as a whole includes 157.581 hectares of agricultural land, as shown on the table, which accounts for 34% of the total surface of the province. From this figure, 25% correspond to agricultural land (38.909 ha.). From this 25%, 98,8% corresponds to irrigated land (38.425 ha.) and 1,2% to unirrigated or rainfed land (483 ha.). The remaining 75% correspond to non-agricultural land (118.672 ha.), of which only 0,7% correspond to natural pastureland and mountains and the remaining 99,3% to other lands, such as sand, salt marshes and rock (INEI, III National Census of Agriculture and Livestock, 1994).

As regards animal population in the study area (Ministry of Agriculture, 1999), it is mainly made up of poultry, as evidenced by the large number of poultry farms in the Pampa Clarita and Jaguay sectors.

Table – Animal Population in the Province of Cañete (1999)

Species	Number of Animals
Poultry	3,380.000
Horses	11200
Sheep	4300
Pigs	5300
Cows	11300

Source: Ministry of Agriculture, 1999

According to forecasts prepared in connection with the National Census of Agriculture and Livestock, the Province of Chincha included 81.333 hectares of agriculture and livestock land, of which agricultural land accounted for 38% and non-agricultural land accounted for the remaining 62%.

Commercial Activities

According to the information contained in the EIA prepared by Golder Associates for the Pampa Melchorita LNG export project, until 1994 the District of San Vicente de Cañete had 1,200 commercial establishments, a formal market, and 320 people informally working as street vendors. At present, commercial activities in the province focus on retail trade. There are 657 commercial establishments, including formal markets, street markets and stores, besides street vendors.

In the District of San Vicente, 6 gas stations supply fuel both to public transportation vehicles (combis, mototaxis and taxis), as well as to cargo and passenger transportation vehicles. In addition, there are 52 commercial establishments engaged in the hotel, guesthouse and restaurant business. (Municipality of Cañete, 2002).

Concerning Chincha, its historical past proves that it was a culture whose commercial role and maritime domain were quite outstanding. Today, its commercial operations, although local, are still outstanding, particularly in the urban area of the province. As we may see on the table, the District of Chincha Alta has the largest number of commercial establishments (without considering shops or grocery stores), which proves its importance as a local commercial center (District Municipalities, 2002).

Regarding lodging services, the district of Chincha has the largest number of lodging establishments and restaurants, which is good for tourism if we bear in mind its various tourists attractions.

Fishing Activities

According to the information contained in the EIA prepared by Golder Associates for the Pampa Melchorita LNG export project, in the Province of Cañete fishing focuses on small-scale fishing. Unlike industrial fishermen, small-scale fishermen have a subsistence economy and very little technology (mechanical). Their production volumes are low, have very little specialized knowledge, and use low-tonnage vessels. Some small-scale fishermen use small fishing vessels, particularly oar boats and, to a lesser extent, motorboats; others don't have any fishing boat and, therefore, fish on the shore or from rocks, and basically collect mussels.

The main socio-economic characteristics of small-scale fishing include:

- Fishing is the source of livelihood and sustenance for the family;
- Small-scale fishermen complement their economy, particularly during wintertime, with other economic activities, the most important ones being agriculture, trade, carpentry, bricklaying, among others;
- Small-scale fishing is mainly destined for direct human consumption; however, they have fish conservation and management systems in place (cold storage) that help them show a better performance when marketing their products;
- Fishermen travel to places other than their place of origin during short periods of time, looking for resources that are in higher demand, particularly by tourists, and therefore are more profitable;

- They follow a community – family production and sales pattern where men engage in fishing and women in the sale of fish; and
- Their commercial system is based on associations, which become engaged in the distribution and sale of the fishermen's catch to non-local markets.

Fieldwork conducted within the area of influence of the project between April and September 2002 proved that in the Province of Cañete most fishing activities are carried out in the district of Cerro Azul, there being 150 fishermen with small fishing boats and 250 fishermen engaged in inshore fishing. The area is considered a minor cove, its production being less than 2 tons per year. All loading and unloading operations are reported to the Harbor Master's Office of Pisco. Other districts in the province that are also engaged in fishing are Herbay Bajo, Santa Bárbara, Asia, Mala and Bujama, there being close to 400 small-scale inshore fishermen in this area.

Small-scale fishermen use small fishing boats to travel from Cañete to the north, to the Pucusana area (south of Lima), dragged along and assisted by the current that travels south-north.

According to the survey conducted, some fishermen do not live close to the project site. They come from places as distant as Huacho (north of Lima) to fish in the Pisco area during times of short supply. These fishermen use minor motor vessels to fish, reaching areas that are even 300 nautical miles off the coast (despite the currents) during summertime, with detrimental effects upon inshore fishermen.

Concerning small-scale line fishermen, they mostly come from Chincha and, to a lesser extent, Cañete. There are at least 20 small-scale line fishermen in Cañete. They live in Herbay Bajo and travel to the south, reaching the mouth of the Cañete River, Mulato and Cinco Cruces, where they fish with other fishermen coming from Chincha.

Most line fishermen in the district of Cerro Azul travel to the north, following the Herbay Bajo – Sarapampa route. When the study was conducted, around 6 Cerro Azul line fishermen who were traveling to the south, towards the Jaguay area, to fish "tollo" and "raya" during the high season or summertime, were found.

Unlike Cañete, fishing activities are carried out at an industrial level in the Province of Chincha.

As regards small-scale fishing, fishing operations focus on 3 ports: Pisco, Tambo de Mora and San Juan de Marcona, where species like anchovy and sardine are caught during high season. However, fishermen also fish on beaches, coves and landing areas like Tambo de Mora (Jaguay and Cruz Verde).

Between 1966 and 1968, Tambo de Mora was considered the leading fish meal producing port worldwide. It is currently a minor port because it does not have a Harbor Master's Office but only a Control Office. 5 private companies are currently engaged in the transformation of anchovy into fish oil and fishmeal, which is both exported and used as balanced meal on the domestic market.

IV. ENVIRONMENTAL EFFECTS

4.1 Impacts

4.1.1 Construction Phase.

No land will be reclaimed from the sea.

Earthworks: It will be necessary to carry out some earth removal work to build both an access road from the upper end of the plot of land (130 meters above sea level) to the beach area to carry the material and equipment required for the trestle bridge and platform. The adoption of dust control measures has been foreseen for all activities related to the plant's construction. See Monitoring Program in paragraph 6.1.

Land to be occupied: The surface area required for the operation of: administrative facilities, a gas storage and treatment plant, shops, camp, gardens, parking areas, etc.; and the sea area required for the installation of the trestle bridge, the platform built on piles, the breakwater, the navigational channel, and the area where dredged material will be stored.

Vessel traffic: Close to the terminal area, specifically within a radius of approximately 1 km., vessel traffic will be restricted as a safety measure to protect both people as well as the marine terminal facilities and the breakwater. This issue has been discussed in detail in the EIA prepared for the Pampa Melchorita LNG export project.

Fencing system: To provide security both to the plant and the marine facilities, the plant's perimeter and the upper section of the trestle bridge that provides access to the loading platform will be fenced in. For safety reasons, fencing the beach area to restrict access to unauthorized people has also been considered. This issue has been discussed in detail in the EIA prepared for the Pampa Melchorita LNG export project.

Transportation of material: Material will be transported using the access road to the plant, and then from the plant to the Terminal.

Landfill: No significant landfill areas have been contemplated.

Dust erosion: No dust will be generated during the construction of the Marine Terminal.

Marine terminal: Heavy-duty machinery, such as cranes and hydro pneumatic hammers, will be used for the transportation and sinking of piles and floating platforms and the installation of prefabricated structures, front-end loaders, lifters, trucks for the transportation of prefabricated structures, dredging equipment, etc. On a temporary basis, there will be noise and seawater turbidity.

4.1.2 Operations Phase

Navigation: The breakwater and the Marine Terminal, including the navigational channel, will be conveniently delimited both with day and night signals in order to be easily identified. Besides, these will be the only facilities erected within a radius of 20 km., as stated in the preceding paragraphs.

Anchoring place for tankers: Around 4.5 km. from the Terminal, in a northwesterly direction, there will be an anchoring place for vessels, and also for the harbor pilot to wait there, in order not to interfere with small-scale fishing vessels and other types of vessels, because one vessel will come in at a time.

Vessel traffic: Close to the terminal area, specifically within a radius of approximately 1 km., vessel traffic will be restricted as a safety measure. This issue has been discussed in detail in the EIA prepared for the Pampa Melchorita LNG export project.

Fencing system: To provide security both to the plant and the marine facilities, the plant's perimeter and the upper section of the trestle bridge that provides access to the loading platform will be fenced in. For safety reasons, fencing the beach area to restrict access to unauthorized people has also been considered. This issue has been discussed in detail in the EIA prepared for the Pampa Melchorita LNG export project.

Activities generating noise and vibration: Noise will be limited to the entry and exit of tankers and tugboats for gas loading purposes.

Particle emission: Gas loading operations at the Terminal will not generate particles.

Solid and liquid wastes generated: The Terminal will be equipped with appropriate systems to receive hydrocarbon and oil wastes from the tugboats and the dredger, including wastewater originating from said vessels or from toilet facilities located at the dock. To this end, there will be wheeled tanks at the utility dock to transport the wastes to the plant for their final disposal, in keeping with the MARPOL 73/78 regulations.

The proposed project foresees the installation of a seawater return line to be used to pump back the seawater used to produce potable water at the plant. After being pumped in at the utility dock, the water will be discharged with a 60% increase over its initial salinity level, around 250 meters away from the coastline where the sea is 3 to 4 meters deep. This area corresponds to the middle section of the swash zone. The idea is to optimize commingling in order to substantially reduce the concentration, avoiding any impact upon the marine flora and fauna.

Breakwater: As a result of the construction of a breakwater parallel to the coast, waters will be calmer in this area and, as a collateral effect, there will be an increase in the sedimentation rate towards the leeward side of the breakwater.

LIST OF POTENTIAL IMPACTS

A) Construction Phase

POTENTIAL IMPACTS	SCOPE	TYPE OF IMPACT	POTENTIAL IMPACT BEFORE MITIGATION	MITIGATION MEASURES
Impact of the terminal construction on the sea environment	Local, temporary	Negative impact	Slight	See Chapters 4.4 and 5
Impacts of the breakwater construction on the sea environment	Local, temporary	Negative impact	Slight	See Chapters 4.4 and 5
Noise increase in the area due to the wharf construction (sinking of piles, barge – crane and tugboats)	Local, temporary	Negative impact	Slight	See Chapters 4.4 and 5
Noise increase in the area due to the breakwater construction (barge-crane, cargo barge and	Local, temporary	Negative impact	Slight	See Chapters 4.4 and 5

tugboats)				
Aesthetical impacts	Local, temporary	Negative impact	Slight	See Chapters 4.4 and 5

B) Operations Phase

POTENTIAL IMPACTS	SCOPE	TYPE OF IMPACT	POTENTIAL IMPACT BEFORE MITIGATION	MITIGATION MEASURES
Impact of the operation of the terminal on the sea environment.	Local, temporary	Negative impact	Slight	See Chapters 4.4 and 5
Noise increase in the area due to the operation of methane vessels.	Local, temporary	Negative impact	Slight	See Chapters 4.4 and 5
Impacts of the construction of the breakwater and terminal upon marine dynamics and the coastal profile.	Local, temporary	Negative impact	Moderate	See Chapters 4.4 and 5
Aesthetical impacts	Local, temporary	Negative impact	Slight	See Chapters 4.4 and 5

Rating:

Territorial

A. Local: Identifies the area directly impacted by the project.

B. Regional: Identifies locations that are close to the project (provinces/department)

C. National: Identifies locations that are beyond the local and regional environment.

Duration

A. Temporary: Less than one (1) year.

B. Medium-term: Between one (1) year and five (5) years

C. Long-term: More than five (5) years

Intensity

A. Nill: No effect
B. Slight: Slightly perceptible effect
C. Moderate: perceptible effect of not much importance
D. Medium: perceptible effect of considerable importance
E. Strong: perceptible and serious effect of great importance
F: Very strong: perceptible and extremely serious effect of great importance

4.2 Impacted Factors

4.2.1 Construction Phase

No marine facilities that could be impacted by the project exist within a radius of 20 km. On the coast, the closest facility is Wakama, a summer resort that is about 6 km. south of the proposed plant site.

Vessel traffic: As a safety measure, the traffic of vessels will be restricted close to the Terminal, within a radius of about 1 km.

Fencing system: To provide security both to the plant and the marine facilities, the plant's perimeter and the upper section of the trestle bridge that provides access to the loading platform will be fenced in. For safety reasons, fencing the beach area to restrict access to unauthorized people has also been considered.

Atmosphere: During the construction phase, noise and dust will be generated in mobilizing equipment for the transportation of heavy cargo, preparing the land, sinking the piles, and building the breakwater. The effects will be noticed close to the project site.

Soil: During the construction phase there will be no topographic or bathymetric changes with respect to the coastal profile.

Marine environment: The marine dynamics will not be impacted because there will be no significant barriers to impact the flow of water, for which reason the transportation of sediments will not be affected. As regards turbidity, it will be affected on a temporary basis by an increase in suspended solids during the whole construction phase (land preparation, rock filling, pile sinking, breakwater construction, etc.). There will be no contamination by oils, greases and oil byproducts. It is absolutely forbidden to discharge these substances either from vessels or from any place on land.

Flora: Due to its sand bottom and sand shoreline, there is no flora adhered to the substratum, and existing flora is dragged along by the sea current the presence of which is only occasional, associated with rough waters. Therefore, construction operations (land preparation, rock filling, pipe sinking, breakwater construction, etc.) will have a temporary and local impact.

Fauna: The fauna is scarce, a typical feature of sandy bottoms. As regards the benthos community, which will be directly affected by the construction of the terminal and the breakwater, the impact will only be temporary, until construction work is completed. Concerning fishing, while construction operations are carried out, there will be an unusual movement that will temporarily drive fish away from the area, due to impacts on its environment. This impact will also be temporary and fishing conditions will be restored as soon as these impacts come to an end.

Perceptual impact: During the construction phase, there will be a perceptual impact upon the area, due to the presence of machinery and equipment and construction work itself. This impact is also temporary.

4.2.2 Operations Phase

Land use: The construction of the Terminal also includes the construction of the liquefaction plant itself and a camp for plant workers. Gardens will also be grown using wastewater previously treated at the treatment plant contemplated under the proposed project.

Infrastructure: The construction of the Terminal will result in the installation of related businesses in the localities of Cañete and Chincha, such as hardware stores, shops, service companies, etc.

Human impacts: The standard of living and living style of workers working at the Terminal, including surrounding communities, will improve.

Economy and Population: The project will make it possible to offer temporary and permanent direct and indirect employment opportunities to workers, either through the company or its subcontractors, both during the construction phase as well as during the operations phase, while pumping revenues into the local and national economy and increasing the value of land.

Flora: Due to its sandy bottom and shoreline, there is no flora adhered to the substratum; however, the presence of breasting dolphins and the breakwater create a sub-ecosystem consisting of a rocky substratum where algae and sea plant communities will develop, increasing the area's flora biodiversity and, with it, the trophic chain components.

Fauna: The fauna is scarce, a typical feature of sandy bottoms. The terminal and the breakwater create some sort of shelter zone (shadow between piles and the terminal itself and cracks in the breakwater) for all kinds of sea animal species, like fish, crustaceans, mollusks, etc. As stated in the previous paragraph, the flora will attract herbivorous organisms, thereby increasing the trophic chain components. Furthermore, fishing restrictions in the area will result in an increase in fish and other organisms in the area. This increase will have obvious impacts outside the restricted area, and will benefit small-scale fishermen, as there will be a greater availability of fish in the surrounding environment. It is worth pointing out that several species manage to adapt themselves to impacts like loading operations in ports.

Perceptual Impact: During the project construction and operations phases, the area will be affected by the presence of machinery and equipment, as well as by the performance of construction work. This will be a temporary impact.

Coastal profile: The construction of a breakwater parallel to the coast will calm ocean waters, it being a collateral effect. As a result, there will be an increase in sedimentation on the side of the shadow (that will have a water drop shape, inverted towards the coast) to be projected by the breakwater. This process is not expected to cause substantial sedimentation due to a number of reasons, like the distance between the breakwater and the coast and manner in which the terminal will be built (on piles), which will not affect marine dynamics, and will allow the continuation of coastal transport of sediments. In general, it depends on a series of factors that make it advisable to implement a monitoring plan in order to take the necessary corrective action.

4.2.3 Risk of marine contamination

There is a high risk of contamination from fire and petroleum and gas leaks and spills, especially during loading operations. Contamination will be avoided by complying with the safety regulations and procedures established by the company and with National and International regulations, in order to prevent contamination.

There will be a Contingency Plan in place to respond to a spill of hydrocarbons/lubricants into the sea.

4.3 Determination of Critical Points

- The marine environment, in the area where LNG is loaded into methane vessels.
- The marine dynamics and coastal profile.
- Vessel traffic.
- People moving along the beach.
- Aesthetics

4.4 Foreseeable Impacts

4.4.1 During the construction phase

4.4.1.1 Impacts on the Marine Environment within the loading area

Impacts of hydrocarbon wastes discharged by the dredger and tugboats: During the performance of operations, there may be undesired discharges into the sea due to an operating error or a failure in the systems.

Both the sinking of piles as well as the rock filling work required for the construction of the breakwater will bring about turbidity and noise during a relatively short period of time.

Flora: Due to its sandy and shoreline bottom, there is no flora adhered to the substratum in this area. The sea current the presence of which is only occasional, associated with rough waters, drags along existing flora. No impacts are expected upon this component.

Fauna: The fauna is scarce, a typical feature of sandy bottoms. As regards the benthos community, which is directly affected by the construction of the terminal and the breakwater, the impact will only be temporary, until construction work is completed.

Concerning fishing, while construction operations are carried out, there will be an unusual movement that will temporarily drive fish away from the area, due to impacts on its environment. This impact will also be temporary and fishing conditions will be restored as soon as these impacts come to an end.

This impact is considered moderate.

4.4.1.2 Impacts on marine dynamics and the coastal profile

As regards marine dynamics (waves, currents and tides), no impacts are expected from the construction of the marine terminal, in view that both the bridge that provides access to the loading platform, as well as the breasting and mooring dolphins and the utility dock will be built on piles, which are transparent to the action of the sea.

During the construction phase, no impacts are expected on the coastal profile.

This impact is considered moderate.

4.4.1.3 Impacts on the transit of vessels and fishermen

For safety reasons, the transit of vessels and small-scale fishing will be restricted in the area where the terminal and breakwater will be built. Further details about this issue are provided in the EIA prepared for the Pampa Melchorita LNG Export Project.

4.4.1.4 Aesthetical impacts

The construction of the terminal and breakwater will have a slight impact on the natural landscape because of the operation of dredges, tugboats, barges and floating cranes during a relatively short period of time.

The impact is considered slight.

4.4.2 During the operations phase

4.4.2.1 Impacts on the Marine Environment within the loading area

Impacts of hydrocarbon wastes discharged by methane vessels and tugboats: During the performance of operations, there's a possibility that undesired wastes might be discharged into the sea, either because of an operating error or a failure in the systems, mainly of tugboats because, in the case of methane vessels, the risk is only associated with the use of ancillary equipment as their engines are gas-driven.

This impact is considered moderate.

4.4.2.2 Impacts on marine dynamics and the coastal profile

As regards marine dynamics (waves, currents and tides), no impacts are expected from the construction of the marine terminal, in view that both the bridge that provides access to the loading platform, as well as the breasting and mooring dolphins and the utility dock will be built on piles, which are transparent to the action of the sea.

The impact of the breakwater has been estimated based on the study of waves and marine sediments, which reveals that although it is true that on the land side of the breakwater waters will be calm, thus favoring the deposition and accumulation of sediments along the coastal profile, on the shadow side of the breakwater, aligned in the direction of predominant waves, the impact is expected to be more moderate according to the following assessments:

1. Distance between the breakwater and the coast: approximately 1550 m.
2. Permanent action of the swash zone which, although with calmer waters, will continue keeping sediments suspended.
3. Permanent action of currents, which will continue traveling parallel to the coast, usually in a northward direction.

On the leeward side of the breakwater waters will be calm, thus favoring the deposition of sediments along the coastal profile. For this specific issue, a motoring program has been proposed (see paragraph 6.1).

The impact is considered moderate.

4.4.2.3 Impacts of the Transit of Vessels

To guarantee the safety of people and small-scale fishing vessels and avoid acts of sabotage against the facilities, the transit of vessels and small-scale fishing will be restricted in the area where the terminal and breakwater will be built.

This impact is considered moderate.

4.4.2.4 Aesthetical impacts

The construction of the terminal and breakwater, with modern infrastructure, will have a slight impact on the natural landscape, for which reason every possible effort will be made to have colors harmonize as much as possible with the surrounding environment, without neglecting safety issues, to help vessels coming into the port from the sea to locate the terminal under thick fog conditions or visual difficulties. To this end, a nautical signaling system will be installed, in accordance with the rules contained in the regulations published by the Bureau of Hydrography and Navigation.

The impact is considered slight.

V. ENVIRONMENTAL MANAGEMENT PROGRAM

The company wishes to mitigate the negative impacts that project activities could bring about. For the specific case of the Terminal, the following measures will be taken:

- There will be a permanent surveillance system in place to supervise the loading of gas into methane vessels and the use of containers at the utility dock for the proper disposal of liquid and solid wastes.
- Personnel using the terminal will receive training on environmental safety issues.

5.1 Mitigation Measures

- Impacts of hydrocarbon wastes discharged by tugboats and the dredger: To prevent hydrocarbon wastes from contaminating the sea, each vessel will have its own quality control and contingency plan in place. In the case of methane vessels, these plans will deal with their ancillary equipment, as their main engines are gas-driven.

On the other hand, the construction project foresees the installation of a collection system for oily wastes, which will include a series of wheeled tanks installed all along the utility dock. These tanks will be regularly taken to the plant in order for the wastes stored therein to be disposed of in authorized disposal sites. Liquid wastes will be sent to the API separating tanks for their previous treatment and final storage in slop oil tanks. Solid-liquid wastes will be sent to the CPI separating tanks where hydrocarbons and clean solids will be separated, the former to be finally sent to the slot oil tanks and the latter to the disposal site.

- There will be a permanent surveillance system in place to supervise the loading of gas into the vessels and the use of containers for the proper disposal of wastes.
- Personnel using the terminal will receive training on environmental safety issues.
- There will be a contingency plan in place to respond to spills and fires caused by LNG loading operations.

5.2 Complementary Mitigation Measures

Information disclosure and awareness campaigns will be carried out at a national, regional and local level to inform the population about the operations carried out at the Terminal, their importance, and the environmental management programs in place.

Informative meetings will also be held with fishermen associations to explain the need to restrict access to the area to protect the safety of people and the terminal.

VI. IDENTIFICATION OF PARAMETERS FOR ENVIRONMENTAL AUDITS (Surveillance and Control)

6.1 Monitoring Program

Objectives:

Closely supervise the project's impacts on the marine environment, both during the construction phase as well as during the operations phase.

Sampling points, frequency, and control parameters:

Atmosphere: During the construction phase, sampling will be performed according to the information contained on Card SM-3, Air Quality Monitoring, page 102, Chapter V, Environmental Management and Monitoring Plan, of the main Environmental Impact Assessment prepared by Golder Associates.

During the construction phase, sampling will be performed according to the information contained on Card SM-4, Noise Level Monitoring, page 104, Chapter V, Environmental Management and Monitoring Plan, of the main Environmental Impact Assessment prepared by Golder Associates.

During the operations phase, sampling will be performed according to the information contained on Card SO-5, Air Quality Monitoring, page 143, Chapter V, Environmental Management and Monitoring Plan, of the main Environmental Impact Assessment prepared by Golder Associates.

During the construction phase, sampling will be performed according to the information contained on Card SO-6, Noise Level Monitoring, page 148, Chapter V, Environmental Management and Monitoring Plan, of the main Environmental Impact Assessment prepared by Golder Associates.

Coastal Sand Filling and/or Erosion: Sampling will be performed both during the construction and operations phases for a period of 5 years, renewable if the then prevailing conditions so require it.

Sampling should cover the beach area included between 1 km. south of the southern boundary of PERU LNG's property and 3 km. north of the northern boundary of the property. To this end, transect lines perpendicular to the coast will be distributed every 500 m. within the aforesaid coastal land strip. Transects, which will be parallel to each other and perpendicular to the coast, will be 50 m. long in the beach area and 100 m. on the sea side. Frequency: on a semi-annual basis.

COORDINATES OF THE INTERSECTIONS OF THE PERPENDICULAR STARTING AT THE VERTIX OF THE NORTH-WESTERN BOUNDARY WITH L.A.M. EVERY 500 M. IN THE DIRECTION OF RUN 228° 45 (WGS-84 System)

Northern side (3000 m)

STATION	NORTH	EAST
1N	8’535,951.721	357,648.540
2N	8’536,327.640	357,318.866
3N	8’536,703.560	356,989.193
4N	8’537,079.479	356,659.519
5N	8’537,455.398	356,329.846
6N	8’537,831.318	356,000.173
7N	8,538,207.237	355,670.499

COORDINATES OF THE INTERSECTIONS OF THE PERPENDICULAR STARTING AT THE VERTIX OF THE SOUTH-WESTERN BOUNDARY WITH L.A.M. EVERY 500 M. IN THE DIRECTION OF RUN 228° 45 (WGS-84 System)

Southern side (1000 m.)

STATION	NORTH	EAST
1S	8,533,589.407	359,720.239
2S	8,533,213.488	360,049.913
3S	8,532,837.568	360,379.586

COORDINATES OF THE INTERSECTIONS OF THE PERPENDICULAR LINE AT THE FRONT SIDE OF THE PLOT OF LAND WITH L.A.M. IN THE DIRECTION OF RUN 228° 45 (WGS-84 System)

Central side

STATION	NORTH	EAST
1C	8,535,558.002	357,993.823
2C	8’535,164.283	358,339.106
3C	8,534,770.564	358,684.390
4C	8,534,376.845	359,029.673

Sampling will be performed during the project operations phase. See Card SO-7, Beach Line Monitoring, page 150, Chapter V, Environmental Management and Monitoring Plan, of the main Environmental Impact Assessment prepared by Golder Associates.

Coastal and marine flora and fauna:

Beach area, including observations of behavior and distribution on the beach strip.
During the project construction phase, sampling will be performed according to Card SM-6, Marine Ecosystem Monitoring, page 109, Chapter V, Environmental Management and Monitoring Plan, of the main Environmental Impact Assessment prepared by Golder Associates.
During the project operations phase, sampling will be performed according to Card SO-4, Marine Ecosystem Monitoring, page 141, Chapter V, Environmental Management and Monitoring Plan, of the main Environmental Impact Assessment prepared by Golder Associates.

Water quality:

During the project construction phase, sampling will be performed according to Card SM-2, Water Quality Monitoring, page 93, Chapter V, Environmental Management and

Monitoring Plan, of the main Environmental Impact Assessment prepared by Golder Associates.

During the project operations phase, sampling will be performed according to Card SO-2, Water Quality Monitoring, page 132, Chapter V, Environmental Management and Monitoring Plan, of the main Environmental Impact Assessment prepared by Golder Associates.

Marine sediments:

During the project construction phase, sampling will be performed according to Card SM-5, Marine Sediment Monitoring, page 107, Chapter V, Environmental Management and Monitoring Plan, of the main Environmental Impact Assessment prepared by Golder Associates.

During the project operations phase, sampling will be performed according to Card SO-3, Marine Sediment Monitoring, page 139, Chapter V, Environmental Management and Monitoring Plan, of the main Environmental Impact Assessment prepared by Golder Associates.

See Drawing C-3 showing the location of monitoring stations.

All this information will be reported on a regular basis to DICAPI through the Harbor Master's Office in and for the port of Pisco.

VII. CONCLUSIONS AND RECOMMENDATIONS

7.1 Conclusions

7.1.1 Condition of the Marine Environment

The marine environment in the Melchorita area is in a good condition.

Its distance from the Cañete River on the north and the Chincha River (Rio Chico) on the south (17.1 km. and 26.5 km., respectively) makes us foresee that there will be no significant impacts, except for El Niño phenomenon events, when the flow of water, and therefore the volume of sediments, are expected to increase substantially.

In order to foresee and minimize the potential effects of fuel spills, mainly from service tugboats, in view that methane vessels will be gas-driven, a Contingency Plan has been prepared to respond to hydrocarbon spills in general.

Based on an assessment of the different biological communities that live at the bottom of the sea along the Marine Terminal axis, it has been determined that there are no major communities, the most abundant species being a crustacean (Munida) that is very common to Peruvian seas and is capable of moving to other areas if sea conditions (particularly turbidity) are no longer appropriate.

During the terminal construction phase (pile sinking, dredging, and installation of the breakwater), these communities will be temporarily driven away from the project area, but they are expected to come back upon completion of construction work.

During the operations phase, the only expected impacts are associated with the dredged zone and the area used to unload dredged material. These areas will be continuously monitored to minimize the impacts.

There is no flora at the bottom of the sea within the direct area of influence of the terminal because the bottom is sandy.

7.1.2 Characteristics of the Terminal

No marine facilities exist within a radius of 20 km. On the coast, the closest facility is Wakama, a summer resort that is about 6 km. south of the proposed plant site.

Appropriate design conditions have been developed, both for the construction and operations phases, in order not to interfere with the transportation of sediments and avoid contaminating the sea with hydrocarbons and solid wastes.

As regards marine dynamics (waves, currents and tides), no impacts are expected from the construction of the marine terminal, in view that both the bridge that provides access to the loading platform, as well as the breasting and mooring dolphins and the utility dock will be built on piles, which are transparent to the action of the sea.

7.1.3 Characteristics of the Breakwater

The breakwater, which will be around 800 m. long and 96 m. wide and will be 1,550 m. away from and running parallel to the coastline, has been designed in such a way that it will provide a shelter zone on the windward side of the breakwater where the marine terminal for LNG loading will be located.

The impact of the breakwater has been estimated based on the study of waves and marine sediments, which reveals that although it is true that on the land side of the breakwater waters will be calm, thus favoring the deposition and accumulation of sediments along the coastal profile, on the shadow side of the breakwater, aligned in the direction of predominant waves, the impact is expected to be more moderate according to the following assessments:

- Distance between the breakwater and the coast: approximately 1550 m.
- Permanent action of the swash zone which, although with calmer waters, will continue keeping sediments suspended.
- Permanent action of currents, which will continue traveling parallel to the coast, usually in a northward direction.
- Permanent action of tides, which will continue affecting the transportation capacity of waves and currents.

On the coastal area, the dynamics of this sandy formation will be monitored and evaluated on a regular basis, as part of the Environmental Impact Assessment activities.

7.2 Recommendations

7.2.1 Condition of the Marine Environment

The project site's distance from the Cañete River on the north and the Chincha River (Rio Chico) on the south (17.1 km. and 26.5 km., respectively) makes us foresee that there will be no significant impacts, except for El Niño phenomenon events, when the flow of water is expected to increase substantially. As a result, sediments should be the subject matter of monthly bathymetrical studies in the terminal area and the dredged channel from December through April in those years where the El Niño phenomenon occurs.

7.2.2 Characteristics of the Terminal

As a safety measure to guarantee the safety of people and the integrity of the plant and the marine terminal, it is advisable to restrict access to the beach area to both small-scale fishermen and visitors, as well as fishing, recreational and commercial vessels (within a radius of 1 km.).

It is advisable to monitor the coastal profile on a regular basis to make sure that the Marine Terminal is not actually changing the coastal profile. See Monitoring Program, paragraph 6.1.

7.2.3 Characteristics of the Breakwater

To evaluate the possible changes to the dynamics of the coastal profile, regular monitoring and assessment has been proposed as part of the Environmental Impact Assessment activities. See Monitoring Program, paragraph 6.1.

*** TEAM MEMBER COMPOSITION**

- Study Head: César Del Carmen De la Torre
  Commander, Hydrographer of the Navy
  CIP 03724281

- Marine Contamination: Ignacio Hinojosa Blanco
  Fishing Engineer, specialized in Marine Contamination
  CIP 30029

- Geology: Dr. Néstor Teves Rivas
  Master of Geology
  CIP 4868

- Hydrobiology: Dr. Juan Acosta Polo
  Master of Biology, specialized in phycology
  CBP 393

VIII. ANNEXES

1. Certificates
2. Photographs
3. Drawings
3.1 Drawing A-1, Project Location, at a scale of 1:75000.
3.2 Drawing B-2, Bathymetry for the Project Area, at a scale of 1:7500
3.3 Drawing C, Currents, Sediment Samples, Winds, and Sea Bottom Drillings, at a scale of 1:7500.
3.4 Drawing C-3, Location of Monitoring Stations, at a scale of 1:25000.
4. Glossary of Terms
5. Bibliography