REPUBLIC OF CAPE VERDE

MILLENNIUM CHALLENGE ACCOUNT – CABO VERDE

PREPARATORY STUDIES FOR THE FIRST PHASE OF

THE PORT OF PRAIA EXPANSION AND MODERNIZATION PROJECT

Contract n° MCA-CV/05/INF

# ENVIRONMENTAL IMPACT ASSESSMENT

# FOR THE CARGO VILLAGE,

# THE CONNECTING ROAD AND THE QUAY 2 COMPLEX

BCEOM Société Française d'Ingénierie

Release n°3 – February 2008

This Environmental Impact Assessment (EIA) concerns the whole Port of Praia Expansion and Modernization Project but focuses on three project items which are going to be implemented as a first step: the Cargo Village, the Connecting Road and the Rehabilitation of the Quay n°2 Complex.

The breakwater, the extension of the quay n°1 and the reclaimed container yard will be launched separately, as a second step.

This document consists of the following sections:

A. A description of the institutional and legal framework.
B. A description of the local environment.
C. A description of the port project.
D. A comparison of the various project alternatives with regard to their environmental impacts.
E. An identification and an assessment of all environmental impacts.
F. An identification of mitigation & compensation measures and a monitoring programme.
G. The Environmental Management Plan.

Besides, six annexes are attached to this EIA:

1. An environmental marine survey report
2. An environmental land survey report
3. An environmental report on noise
4. The MCC environmental guidelines
5. The minutes of the Public Workshop held in Praia in August 2007
6. The minutes of the Public Workshop held in Praia in January 2008

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**ANNEXES:**

# A. INSTITUTIONAL AND LEGAL FRAMEWORK

# 1. INSTITUTIONAL AND LEGAL FRAMEWORK

## 1.1. INSTITUTIONAL FRAMEWORK

The state agencies that oversee studies on the environment in Cape Verde are:

- The National Assembly through a special Commission of the Ministry of Agriculture, Food, Environment, Energy and Water,
- The Government through the Ministry of Agriculture, Food and Environment together with the Environment General Office, The National Commission for the Environment, the National Commission for Water and several Non-Governmental Organizations,

Emphasis is placed on the central role played by the Environment General Office (DGA) with its prerogatives and ability to contribute to the definition of the National Environment Policy; to participate in the elaboration of plans, programmes and projects related to activities associated with the environment and natural resources; and to define measures of evaluation of the quality of water and air, and noise.

## 1.2. LEGAL FRAMEWORK

### 1.2.1. Cape Verde regulations

| | |
|---|---|
| **Law n° 86/IV/93** | The Basic Law of Environmental Policy establishes the basis for environment policy development and implementation in Cape Verde, especially concerning prevention of deterioration of environmental quality. Articles 30, 31 and 32 establish the objectives and required content of **environmental impact assessments (EIAs)** with respect to new projects. The EIA must aim at maintaining the balance among various natural environment components. The EIA must include:<br>▪ Analysis of the local environment study,<br>▪ Study of modifications resulting from the implementation of the project,<br>▪ A full inventory of foreseeable impacts, and measures to suppress, reduce and compensate the possible impacts on the natural environment. |
| **Decree-Law n°29-2006, 6 March 2006** | This decree-law sets the framework for the environmental evaluation of the development projects:<br>▪ Chapter 1 gives the general provisions of the evaluation: objectives, concepts, scope of the evaluation.<br>▪ Chapter 2 presents the institutional framework: competent authorities, municipal environmental committees, evaluation committee. |

- Chapter 3 describes the requirements for implementing an environmental evaluation: initialization of the evaluation process, presentation of the evaluation, technical assessment of the competent authority, participation of the public, *ex-post* monitoring.
- Chapter 4 indicates the penalties that will be applied to projects that fail to comply with the provisions of the decree.
- Appendix 1 lists the different types of projects subject to environmental evaluation.
- Appendix 2 is intended to define the structure and content of the environmental impact study.

### 1.2.2. MCC Environmental guidelines[1]

The Millennium Challenge Corporation ("MCC") recognizes that the pursuit of sustainable economic growth and a healthy environment are necessarily related. The purpose of these guidelines is to establish a process for the review of environmental and social impacts1 to ensure that the projects undertaken as part of programs funded under Millennium Challenge Compacts with eligible countries ("Compacts") are environmentally sound, are designed to operate in compliance with applicable regulatory requirements, and, as required by the legislation establishing MCC, are not likely to cause a significant environmental, health, or safety hazard.

These guidelines are primarily intended to describe the principles of environmental impact assessment that Compact-eligible countries will be expected to apply in the context of a Compact.

[1] January 20, 2006

# 2. APPLICATION TO THE PRAIA PORT PROJECT

## 2.1. BRIEF DESCRIPTION OF THE PROJECT

The Government of Cape Verde, acting through the Millennium Challenge Account – Cabo Verde (MCA-CV) and using the proceeds of a grant from the U.S. Government Millennium Challenge Corporation (MCC), intends to undertake a project to upgrade the facilities and operating systems at the Port of Praia to be able to handle forecasted cargo growth efficiently and economically through the year 2020. The project aims to guarantee greater productivity in the terminal, bringing the Port into compliance with International Maritime Organization (IMO) environmental and security requirements and standards, and lowering overall cargo distribution costs in Cape Verde.

The MCC Pre-feasibility Study for Improvements defined a two-phased development program to be implemented over five years.

| | |
|---|---|
| **Phase I** | Phase I will consist of:<br>▪ Construction of a cargo village on the plateau above the port to house an inland container depot (ICD) for storing empty containers, stripping, stuffing and CFS (container & freight station) operations, a Customs Impoundment Area (CIA) and a business park for housing ENAPOR, Customs and agents' offices.<br>▪ Construction of a new port road from the cargo village to the port.<br>▪ At quay n°2, removal of old quayside warehouses, repairs to the quay apron and fenders, and re-pavement of the back-up yard. |
| **Phase II** | By amendment to the contract, the Consultant has been asked to evaluate the possible environmental impacts of Phase II as well. Phase II will consist of:<br>▪ Development of a breakwater to solve the wave problem in the harbor.<br>▪ Extension of quay n°1 to 450 m.<br>▪ Creation of a 4 to 6-hectare container yard behind quay n° 1 using dredged material to reclaim the required land. |

## 2.2. SCOPE OF APPLICATION OF DECREE-LAW N$^{O}$. 29-2006, OF 6 MARCH 2006

The port project is subject to an **environmental impact assessment (EIA)** as per sections 9, 10, 11, 41 and 43 of Appendix I of the decree.

| Section | Type of project concerned | Application to the project | Project phase |
|---|---|---|---|
| 9 | road construction | Road linking the port to the cargo village | I |
| 43 | industrial allotments | Cargo village | I |
| 10 | construction of ports and port facilities | Extension of quay No.1 and/or breakwater, land reclamation from the sea) | II |
| 11 | dredging | Dredging the Bay of Praia to extract sand | II |

**Nota:** Opening quarries – new quarry or extension - for construction materials requires an EIA (cf. section 41. Quarrying).

## 2.3. PROCEDURES AND EXAMINATION OF THE FILES SUBJECT TO THE IMPACT STUDY

| ***Procedures*** | ***Art. of decree-law*** | ***Time (working days)*** |
|---|---|---|
| 1. MCA submits the project authorization request along with the impact study (EIA) | 12-1 | 0 |
| 2. Within 10 days the examining Ministry appoints an assessment committee within 10 days to which the EIA will be submitted.<br>MCA will have to pay a tax to cover the functioning of this committee. | 12-3<br>12-4 et 5 | 10 |
| 3. The committee examines the file and gives its opinion on its conformity within 5 days. The committee can request additions or modifications. | 14-1 | 5 |
| 4. The committee declares conformity of the EIA to legal and regulatory requirements within two weeks, and the project can be submitted to a public inquiry. | 15-1 | 15 |
| 5. Under the authority of the committee in charge of the environmental evaluation, different parts of the project are advertised for two weeks in the national and local press, and possibly on television. | 22 | 15 |

| | | |
|---|---|---|
| 6. The consultation of the public takes place for 20 days from the end of the enquiry advertising period (Art. 22). | 15-9 | 20 |
| 7. The assessment committee gives its opinion within 10 days of the end of the public inquiry. | 16-1 | 10 |
| 8. The minister of the environment gives his opinion within two weeks. | 17-1 | 15 |
| 9. If the project is complex, the minister of the environment submits the project to the cabinet, which gives its opinion within 20 days. | 17-2 | 20 |
| 10. The authority responsible for environmental evaluation informs MCA of its final decision.<br>The decision may be favorable, unfavorable or favorable under certain conditions. | 17-3<br>18-1 | |
| ***Overall time*** | | 110 days |

# B. DESCRIPTION OF THE LOCAL ENVIRONMENT

# 1. CLIMATE

## 1.1. CLIMATIC CHARACTERISTICS OF THE ARCHIPELAGO

The characterization of the climate in the zone being studied was done on the basis of information contained in the Guide to the Cape Verde Archipelago[2]. According to the referred document, the main air masses which occur in the Cape Verde Archipelago are moved by the following driving forces:

- The semi-permanent anticyclone over the Azores,
- The anticyclone which often forms over the north of Africa and the south of Europe,
- The South Atlantic anticyclone, also known as the Saint Helena anticyclone.

The climatic characteristics of the Archipelago are controlled by the following air masses:

- Subsiding modified tropical maritime air circulating on the eastern side of the Azores anticyclone and known as the NE Trade Winds;
- Tropical continental air transported in the circulation of the North African anticyclone, which reaches the archipelago blowing from NE to E and which is called the Harmattan;
- Unstable tropical maritime air coming from the Saint Helena anticyclone which, when it reaches the equator when circulating beside the African continent, is defected to the right by the Coriolis effect and comes towards Africa from the SW. This wind, due to its features, is called the South Atlantic Monsoon or the SW Monsoon.

Modified cold maritime polar air, the presence of which is normally caused by deep depressions between the island of Madeira and the Iberian Peninsula and which, when it affects the archipelago, is known as “Invernada” (“winter wind”). Below, some features of the meteorological and climatic elements of the Cape Verde Archipelago are described:

## 1.2. WINDS

The Archipelago is dominated by the NE Trade Winds which blow strongest from December to May.

From July to November the winds are lighter, usually also coming from the NE, but sometimes coming from the SE and S, and, to a lesser extent, from the SW, accompanied by thunderstorms and rain with strong winds, or blowing weakly from the SE or S or SW for a few days or for just a few hours at any time. During this period it is frequent to have “Kalemas” (wave swells) from the SE or S, mainly in the southern leeward islands.

[2] Published by the Hydrographic Institute, Lisbon,1970

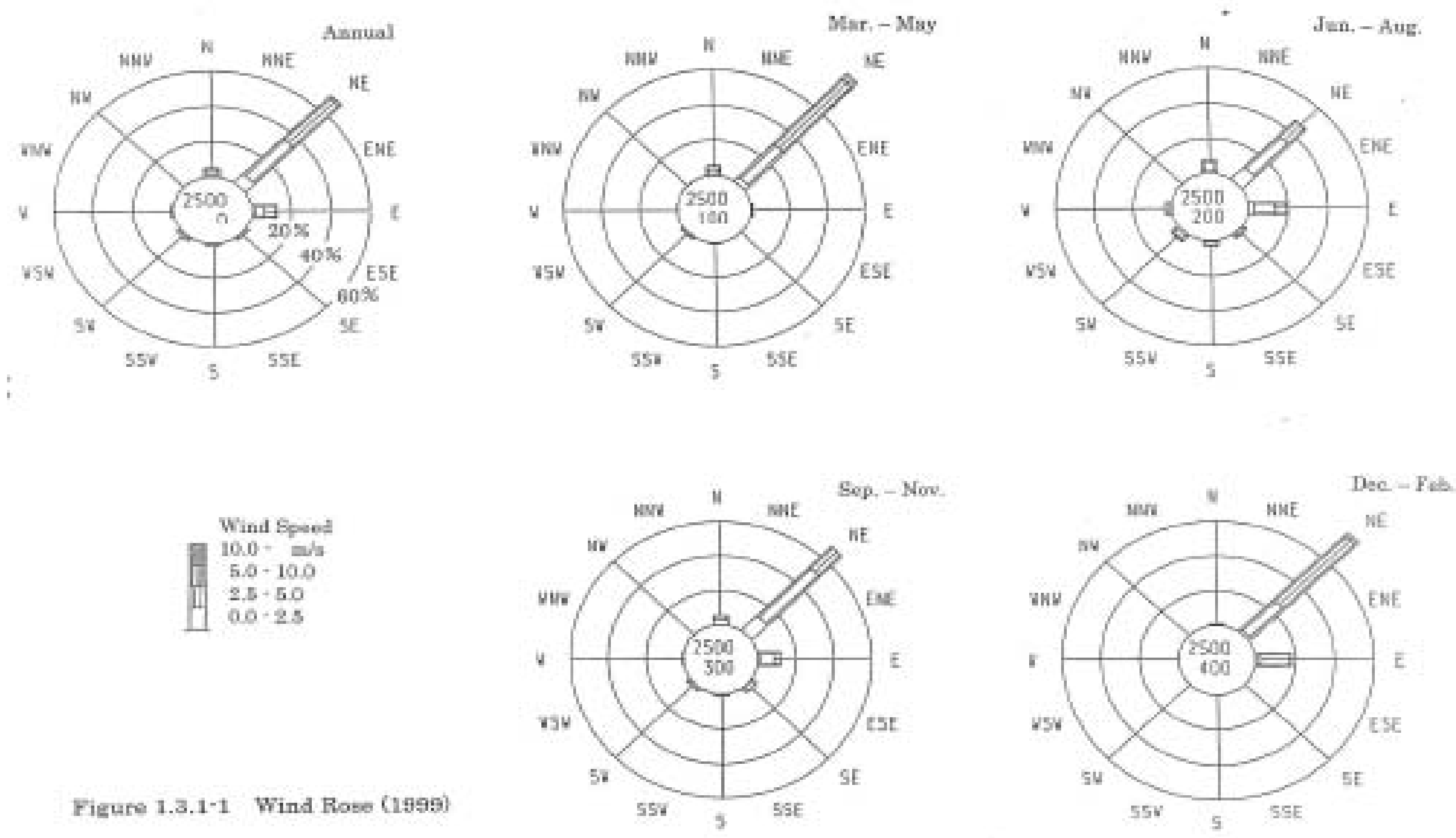



**Figure 1. Annual wind distribution in the Cape Verde Archipelago**

From June to November, depressions form to the SE of the archipelago giving rise to winds of 40 to 50 knots which sometime strike the islands, especially in September. Using the observations taken in Praia airport during the period 1990/1999[3], the breakdown by seasons indicates the following:

- NE winds are the prevailing winds in all seasons,
- The lowest number of NE wind observations was recorded from June to August (about 45 %),
- The largest number of NE wind observations was recorded from December to May.

**Table 1. Average monthly wind velocity (1990 1999)**

| Wind speed | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| m/s | 6.7 | 7.3 | 6.9 | 6.7 | 6.8 | 6.0 | 4.6 | 4.1 | 4.7 | 5.6 | 6.0 | 6.8 |

- The lowest monthly average wind velocity was recorded in August (4.1 m/s) followed by July (4.6 m/s) and September (4.7m/s),
- The highest monthly average wind velocity was recorded in February (7.3 m/s) followed by March (6.9 m/s).

## 1.3. AIR TEMPERATURE

The hottest period occurs between August and October while the coolest period is from January to April. Temperature variations between day and night are small. In the hot season, Praia Port (Santiago) is especially hot, as are the ports of Furna (Brava), Tarrafal de São Nicolau and Tarrafal de Santo Antão. From the observations taken at Praia airport during the period from 1990/1999, annual average temperature is 24.8°C. The monthly average maximum and minimum temperatures are 30.9°C in September and 18.6 °C in March respectively.

**Table 2. Average monthly temperature (1990 1999)**

| Temp | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| °C | 22.5 | 23.0 | 23.0 | 23.5 | 24.7 | 25.4 | 25.7 | 26.7 | 27.1 | 26.8 | 25.8 | 23.7 |

**Table 3. Monthly average of maximum temperature (1990 1999)**

| Temp | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| °C | 26.4 | 27.3 | 27.4 | 28.1 | 29.1 | 29.7 | 29.5 | 30.3 | 30.9 | 30.8 | 29.6 | 27.4 |

[3] Source: INMG, Praia. Weather station of Praia Airport.

**Table 4. Monthly average of minimum temperature (1990 1999)**

| Temp | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| °C | 18.7 | 18.8 | 18.6 | 18.9 | 20.0 | 21.0 | 22.0 | 23.1 | 23.4 | 22.8 | 21.8 | 20.1 |

## 1.4. HUMIDITY

Although the climate is generally dry, higher relative humidity values are found in various places in the interior of the islands of Santo Antão, São Nicolau, Fogo and Brava situated at high altitudes. Sometimes, particularly on the islands of Sal and Santiago there is marked nocturnal humidity and mist. The lowest humidity values are recorded when the Harmattan wind blows. From the observations taken at Praia in the periods from 1921/1930 and 1941/1950, the monthly averages of the daily measurements taken at 0900, 1500 and 2100 hours indicate a minimum in March, at 1500 hours (52,5 %) and a maximum in September, at 2100 hours (79,4 %).

## 1.5. NEBULOSITY

Nebulosity is generally greatest from July to January. The annual average is for about half the sky to have cloud cover. The predominant clouds are stratocumulus between 600 m and 1.500 m in width, being more frequent from October to April. In the rainy season, cumulonimbus clouds also appear, as do altocumulus and cirrus clouds. At the time of the “invernadas” there are horizontally and vertically developed clouds.

## 1.6. PRECIPITATION

The rainy season is from August to October in the north of the archipelago and from August to November in the south. In certain years, however, there are reasonable amounts of rain in November or December in the North and in July or December in the south. When the Intertropical Convergence Zone stays too far away from the archipelago and the rain-bearing air mass of the South Atlantic Monsoon does not reach the islands, there is practically no rain. This happens most frequently in the Windward group.

Rainfall is concentrated in a short wet season between the months of August and October, with a small number of days with torrential rainfall (Table 5). In general the major rainfalls are associated with the monsoons, dominated by a wind from south to southwest. In this type of weather the Port loses its protective capacity due to the “Kalema” and cases frequently occur where boats are driven aground against the coast.

Storms of 29 August 2007: floods in the lower part of the town.

**Table 5. Total monthly and annual maximum rainfall (mm) 1992 2006 (Praia Airport)**

| Year | Jan | Fev | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Total | Max rainfall | Day/ Month |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1992** | 0,0 | 0,0 | 0,0 | 0,0 | 8,5 | 0,0 | 6,9 | 0,9 | 17,6 | 65,3 | 13,1 | 0,0 | 112,3 | 53,2 | 04/10 |
| **1993** | 15,9 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 13,1 | 52,0 | 43,7 | 0,0 | 0,0 | 0,0 | 124,7 | 36,4 | 29/08 |
| **1994** | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 21,3 | 9,1 | 1,5 | 0,0 | 0,0 | 31,9 | 12,0 | 12/08 |
| **1995** | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 14,3 | 16,3 | 111,0 | 11,2 | 0,0 | 123,8 | 276,6 | 94,4 | 03/12 |
| **1996** | 1,4 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 8,1 | 3,0 | 3,0 | 2,3 | 0,0 | 17,8 | 5,6 | 03/08 |
| **1997** | 0,5 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,4 | 96,3 | 55,9 | 1,4 | 0,0 | 0,0 | 154,5 | 25,9 | 23/08 |
| **1998** | 0,0 | 0,0 | 1,8 | 0,5 | 0,0 | 0,0 | 1,2 | 11,9 | 28,6 | 0,0 | 0,0 | 1,8 | 45,8 | 9,2 | 16/08 |
| **1999** | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 3,7 | 67,5 | 94,9 | 50,4 | 0,0 | 0,0 | 216,5 | 44,7 | 22/09 |
| **2000** | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 1,0 | 29,7 | 81,4 | 155,2 | 0,1 | 0,0 | 267,4 | 76,0 | 03/10 |
| **2001** | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 13,2 | 41,1 | 29,2 | 4,1 | 0,0 | 0,0 | 87,6 | 35,0 | 27/08 |
| **2002** | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 8,0 | 20,9 | 12,3 | 0,0 | 0,0 | 41,2 | 8,7 | 12/10 |
| **2003** | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 15,6 | 77,4 | 60,2 | 33,0 | 0,0 | 0,0 | 186,2 | 29,8 | 24/08 |
| **2004** | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 4,9 | 39,9 | 81,0 | 8,2 | 37,5 | 0,0 | 171,5 | 37,0 | 08/11 |
| **2005** | 6,9 | 1,0 | 0,0 | 0,0 | 0,0 | 0,0 | 11,2 | 74,1 | 80,0 | 6,5 | 0,0 | 0,0 | 179,7 | 60,0 | 22/08 |
| **2006** | 0,5 | 10,8 | 0,0 | 0,0 | 0,0 | 0,0 | 4,7 | 65,5 | 203,4 | 3,7 | 0,0 | 0,0 | 288,6 | 58,0 | 03/09 |

Source: INMG – Delegação da Praia
PluMax = Pluviometria máxima annual

Storms of 29 August 2007: flood in the Ribeira de Trindade (Trindade River) around the main bridge.

Hydraulic structures carrying stormwater at the roundabout between the airport road and the port road.

# 2. MARINE ENVIRONMENT

## 2.1. TIDES

Information published by the British Admiralty, contained in the "Admiralty Tide Tables", with forecasts for the North Atlantic zone, give the following characteristics for the tides forecast for Praia Port. These values allow us to attribute a semi-diurnal character to the Praia tides, marked by the occurrence of relatively low amplitudes.

**Table 6. Characteristics of a tide forecast at Praia Port**

| Average full tides (heights in m above ZH level) | | Average full tides (heights in m above ZH level) | |
|---|---|---|---|
| Spring tide | Neap tide | Spring tide | Neap tide |
| 1.3 | 1.1 | 0.2 | 0.5 |

## 2.2. SEA-STATES CLIMATES[4]

### 2.2.1. Context

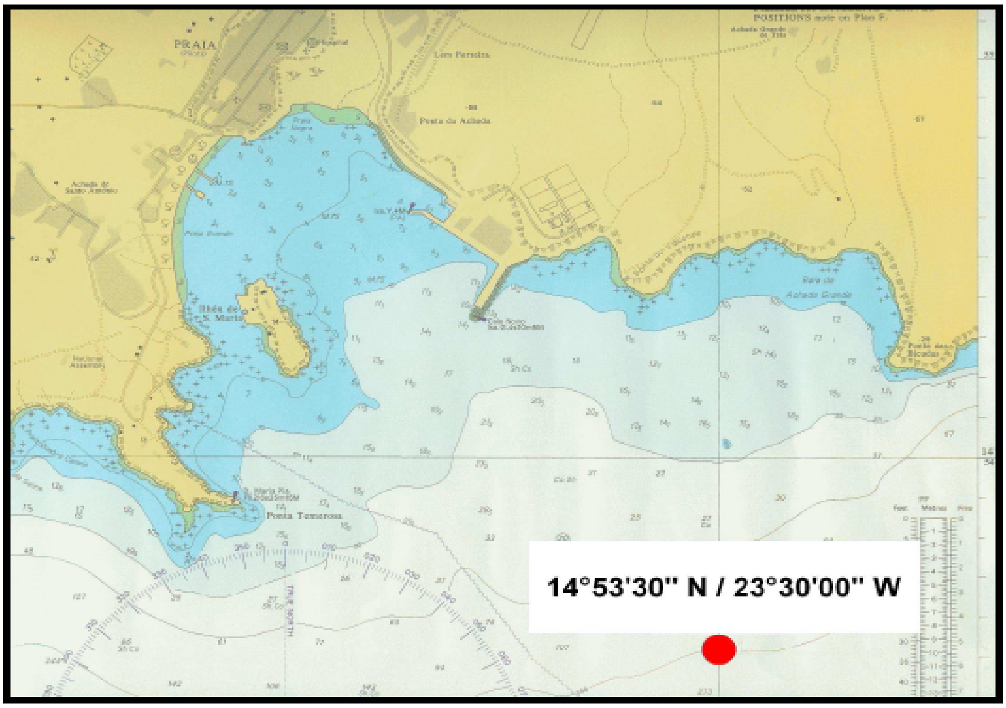
In order to obtain the sea-state climates, GlobOcean developed a meteocean study leading to the elaboration of wave chronologies representative of the conditions at the entrance of Praia Bay, derived from a combined use of meta-ocean models and satellite measurements. The geographical coordinates of this offshore location are 14°53'30''N and 23°30'00''W, in a water depth of around 200 m (Figure 2).

From these wave chronologies covering the time period 1992-2005 (14 years), extreme and operational wave statistics were derived. The cast sea-states off Praia were elaborated through the use of a third generation wave model (WaveWatch III), in nested grids from the global (Atlantic Ocean) to the local (Santiago island) level.

The available satellite sea-state measurements covering the Atlantic Ocean were assimilated in the global hind cast model. This assimilation process, which combines simulations, outputs and measurements, provides a high level of confidence in the quality of the constituted sea-state databases.

[4] GlobOcean. Sea-state climates, Praia Harbor – Santiago Island, Cabo Verde Archipelago, March 2007

**Figure 2. Offshore point location for satellite measurements**




### 2.2.2. Analysis and processing of the wave database

Once the 14-year wave database was developed with respect to the location of interest at the entrance of Praia Bay, data sorting was implemented with respect to the waves coming from the various points of the compass. The different sea conditions possible at the selected reference point are the following:

- The South Atlantic swell (SSE to SSW sector) which reaches Praia after a long propagation distance, strongly attenuated but very frequent. It often becomes the predominant condition during the summer (May-October).
- The trade wind sea (ENE sector) which is generated locally, with relatively short periods, becomes sometimes predominant during the winter (November-April), when strong trade winds prevail.
- The North Atlantic swell (NE or WNW sectors off Praia) which reaches Praia after diffraction around the island of Santiago, mainly by the eastern side and quite rarely by the western side.

The operational statistics were consequently determined for each directional sector.

### 2.2.3. Extreme sea-state values off Praia Bay

The extreme values were determined over 1, 10, 20, 50, and 100-year return periods. For each directional sector defined, the extrapolation tables present, over the defined return periods, the most probable value (mode) of Hs and H max, and the 90% confidence intervals, with their associated periods.

| |
|---|
| Hs: the significant wave height = $4\sqrt{E}$, where E is the energy of the considered spectral peak – *Unit: m,*<br><br>Tp: the peak period defined as the inverse of the most energetic frequency of the considered spectral peak, after direction summing – *Unit: s*,<br><br>$\theta$ p: the peak direction defined as the most energetic direction of the frequency band corresponding to Tp – *Unit: degrees / true North*,<br><br>$H_{max}$: the maximum individual wave height of a sea-state – *Unit: m.* |

**Table 7. Extreme sea-state values determined over 1, 10, 20, 50, and 100-year return periods for NE, ENE and ESE direction sectors.**

<u>North-East directional sector:</u> ] 030°- 045°]

| *Project Duration (yr)* | *Hs max mode (m)* | *Hs-max 90% confidence interval (m)* | *Tp (s)* | *$H_{max}$ mode (m)* |
|---|---|---|---|---|
| 1 | 1.6 | 1.5 – 1.7 | 14 - 20 | 3.0 |
| 10 | 1.9 | 1.8 – 2.2 | 16 - 20 | 3.5 |
| 20 | 2.0 | 1.9 – 2.4 | 17 - 20 | 3.7 |
| 50 | 2.1 | 2.0 – 2.5 | 17 - 20 | 3.8 |
| 100 | 2.2 | 2.0 – 2.6 | 17 - 20 | 4.0 |

<u>East-North-East directional sector:</u> ] 045°- 105°]

| *Project Duration (yr)* | *Hs max mode (m)* | *Hs-max 90% confidence interval (m)* | *Tp (s)* | *$H_{max}$ mode (m)* |
|---|---|---|---|---|
| 1 | 2.2 | 2.1 – 2.3 | 6 - 8 | 4.4 |
| 10 | 2.6 | 2.4 – 2.8 | 7 - 8 | 5.1 |
| 20 | 2.7 | 2.5 – 2.9 | 7 - 8 | 5.3 |
| 50 | 2.8 | 2.6 – 3.1 | 7 - 8 | 5.5 |
| 100 | 2.9 | 2.7 – 3.2 | 7 - 8 | 5.7 |

<u>East-South-East directional sector:</u> ] 105°- 135°]

| *Project Duration (yr)* | *Hs max mode (m)* | *Hs-max 90% confidence interval (m)* | *Tp (s)* | *$H_{max}$ mode (m)* |
|---|---|---|---|---|
| 1 | 1.4 | 1.3 – 1.5 | 8 - 12 | 2.7 |
| 10 | 1.7 | 1.6 – 1.9 | 9 - 12 | 3.3 |
| 20 | 1.8 | 1.7 – 2.0 | 9 - 12 | 3.4 |
| 50 | 1.9 | 1.8 – 2.2 | 9 - 12 | 3.6 |
| 100 | 2.0 | 1.8 – 2.3 | 9 - 12 | 3.8 |

**Table 8. Extreme sea-state values determined over 1, 10, 20, 50, and 100-year return periods for SSE, SSW, WSW and WNW direction sectors.**

<u>**South-South-East directional sector:**</u> **] 135°- 180°]**

| Project Duration (yr) | Hs max mode (m) | Hs-max 90% confidence interval (m) | Tp (s) | $H_{max}$ mode (m) |
|---|---|---|---|---|
| 1 | 1.9 | 1.8 – 2.0 | 10 - 17 | 3.6 |
| 10 | 2.2 | 2.1 – 2.5 | 12 - 17 | 4.1 |
| 20 | 2.3 | 2.2 – 2.6 | 12 - 17 | 4.3 |
| 50 | 2.4 | 2.3 – 2.8 | 12 - 17 | 4.4 |
| 100 | 2.5 | 2.3 – 2.9 | 12 - 17 | 4.6 |

<u>**South-South-West directional sector:**</u> **] 180°- 225°]**

| Project Duration (yr) | Hs max mode (m) | Hs-max 90% confidence interval (m) | Tp (s) | $H_{max}$ mode (m) |
|---|---|---|---|---|
| 1 | 2.0 | 1.9 – 2.1 | 12 - 18 | 3.8 |
| 10 | 2.3 | 2.2 – 2.5 | 14 - 18 | 4.3 |
| 20 | 2.4 | 2.3 – 2.7 | 14 - 18 | 4.4 |
| 50 | 2.5 | 2.3 – 2.8 | 14 - 18 | 4.6 |
| 100 | 2.6 | 2.4 – 2.9 | 14 - 18 | 4.7 |

<u>**West-South-West directional sector:**</u> **] 225°- 270°]**

| Project Duration (yr) | Hs max mode (m) | Hs-max 90% confidence interval (m) | Tp (s) | $H_{max}$ mode (m) |
|---|---|---|---|---|
| 1 | 1.2 | 1.2 – 1.3 | 7 - 14 | 2.3 |
| 10 | 1.5 | 1.4 – 1.8 | 8 - 14 | 2.9 |
| 20 | 1.5 | 1.5 – 1.9 | 8 - 14 | 2.9 |
| 50 | 1.6 | 1.5 – 1.9 | 8 - 14 | 3.0 |
| 100 | 1.6 | 1.5 – 2.0 | 8 - 14 | 3.0 |

**Example**: Considering the waves coming from the WSW sector (180° - 225°), the extreme sea-state over a 100-year return period is characterized with a most probable Hs of 2.6m (in the range 2.4m – 2.9m with a confidence of 90%), a peak period in the range 14-18s, and a most probable extreme individual wave of 4.7m.

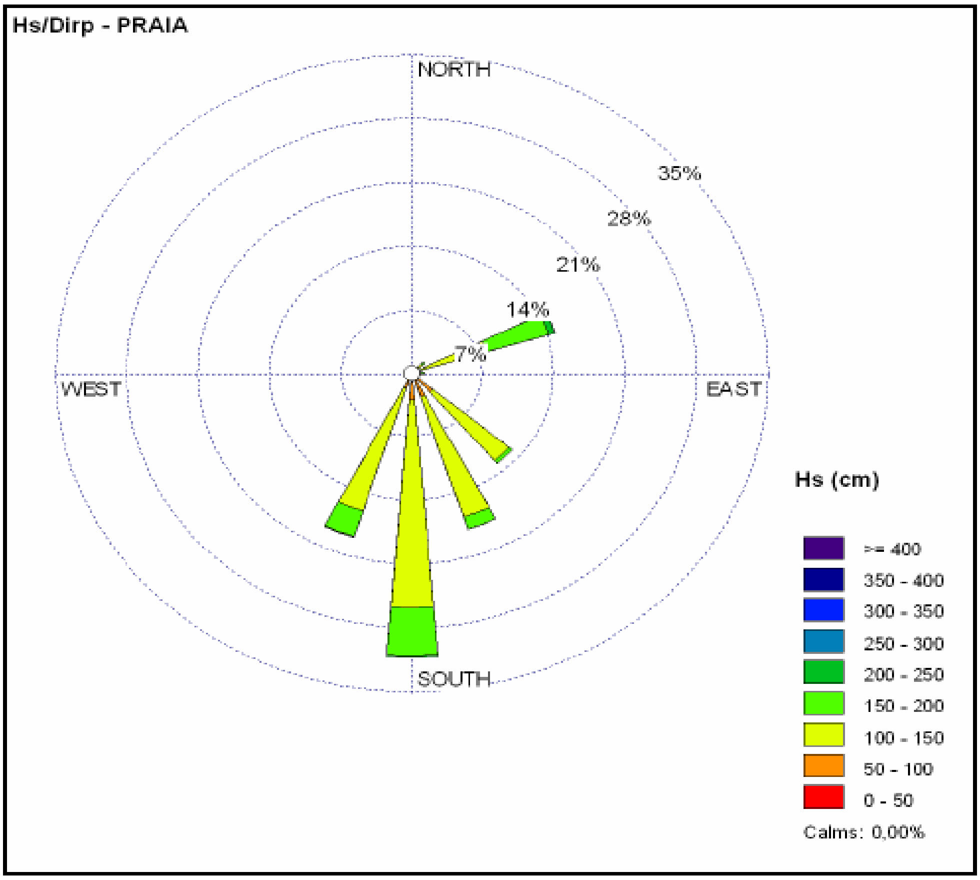
**West-North-West directional sector: ] 270°- 290°]**

| *Project Duration (yr)* | *Hs max mode (m)* | *Hs-max 90% confidence interval (m)* | *Tp (s)* | *$H_{max}$ mode (m)* |
|---|---|---|---|---|
| 1 | 1.3 | 1.3 – 1.4 | 11 - 16 | 2.4 |
| 10 | 1.5 | 1.5 – 1.9 | 12 - 16 | 2.8 |
| 20 | 1.6 | 1.5 – 1.9 | 12 - 16 | 3.0 |
| 50 | 1.6 | 1.6 – 1.9 | 12 - 16 | 3.0 |
| 100 | 1.7 | 1.6 – 2.0 | 12 - 16 | 3.1 |

## 2.2.4. Operational sea-state statistics off Praia Bay

The statistical sea-state conditions are provided in the following rose (for Hs/θ p statistics). The directions are those from which the waves propagate. Sea states are defined as 'calm' when their Hs is lower than 10 cm.

**Figure 3. Statistical sea-state conditions off Praia Bay**



## 2.3. HYDROGRAPHIC, GEOPHYSICAL AND GEOTECHNICAL SURVEYS

Hydrographic, geophysical and geotechnical surveys were required to assess the suitability of the seabed for dredging, identify areas of rock for construction of quay walls and provide seismic velocities for rippability estimates for construction areas on land. The field operations were carried out between April and June 2007 and involve[5]:

- A bathymetric survey of Praia Bay,
- A side scan sonar survey covering the whole of Praia Bay,
- A marine seismic reflection survey also covering the whole of Praia Bay,
- Land seismic refraction surveys along the main beach of the bay.
- Land seismic refraction surveys in the area of the future cargo village and connecting road,
- Vertical mechanical boreholes,
- Standard Penetration Tests (SPTs),
- Open pits,
- Laboratory tests.

### 2.3.1. Bathymetric survey

All soundings were used in the construction of the digital terrain model and to produce the contours. Only selected seabed levels have been shown for clarity. Levels were identified in the range of 3 m below WGS84 Lambert Datum near the coast to the North West gradually increasing to 25 m below WGS84 Lambert Datum offshore to the South East. Figure 4 shows the 2007 bathymetry data in the coordinate system used for the 2004 survey for comparison purposes. The data has been transformed to UTM 27N grid coordinates and the levels adjusted to be relative to Zero Hydrographic (ZH) at the Port of Praia. ZH is 0.4 m below WGS84 – Lambert Datum.

### 2.3.2. Side Scan Sonar Survey

The low reflectivity seabed within the bay area has been interpreted as fine sands and silt. This gradually changes to a medium reflectivity seabed consisting of possible sands and gravels towards the south and west. On approaching the island, the seabed has a high reflectivity indicating exposed rock. This can also be seen in the areas to the south west of the island and towards the coast to the east of the survey area outside the quay wall.

A number of objects have been identified to the North of the island and the mouth of the fish dock including small boulders and several unidentified linear targets. Generally these objects are around 0.4m high. However, within the entrance to the dock there are objects in the range of 1.0 to 3.3m high above the seabed.

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[5] Soil Mechanics Pelorus Surveys. Hydrographic and geophysical survey in and around the Port of Praia, Santiago, Cape Verde. April 2007.

Geosolve / Pengest. Geotechnical survey report. June 2007

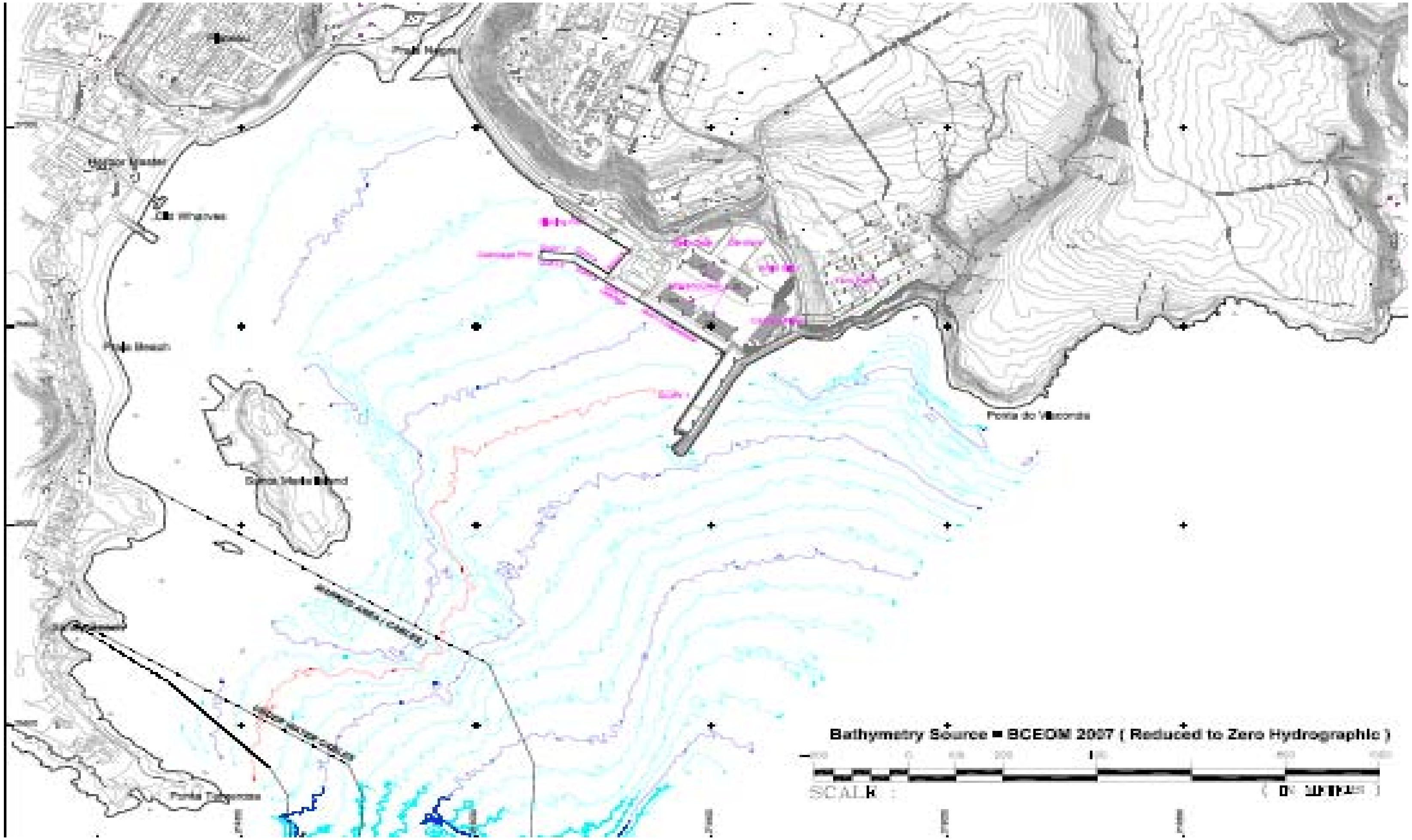


**Figure 4. Bathymetry map (2007)**

Five wrecks were also identified in these areas. Outside the bay area there is an exposed cable / ground tackle to the west and several boulders have been identified in the range of 0.9 m to 3.8 m high. Towards the southeast there are several anchor trawl marks.

### 2.3.3. Marine Seismic Reflection Survey

Two reflectors have been identified within the seismic records which have been categorized as Reflector R1 and R2:

- The first reflector has been interpreted as the base of an infilled river channel and has a reduced level in the range of 7 m to 35 m.
- The second reflector has been interpreted as the rockhead. This has been identified across the whole area with a reduced level in the range of 15 m to 30 m. The exception to this is the buried channel running northwest to southeast. That correlates with the first reflector, where the reduced levels are in the range of 20 m to 45 m. The second reflector also shows a channel towards the south western edge of the data set. Generally the interpreted rockhead dips to the southeast.

### 2.3.4. Main results

The figure on the next page shows the result of a combination of all survey outputs, along 6 profiles crossing the bay from north to south. Three layers are identified below the seabed:

- First superficial layer corresponds to sands and silts as a result of the desegregation and alteration of the sea rock and deposition of alluvial material provided by fresh waters (recent and ancient). This layer shows an inhomogeneous thickness along the cross-sections according with the marine hydrodynamic behavior, since these sediments are not consolidated.
- Second layer was interpreted as weathered and highly altered rock that corresponds to the top level of the Ancient Complex. This layer also shows an inhomogeneous thickness as a result of different response of the rock to the same alteration processes. This fact is related to the different composition shown by the rocks (multiple veins) as a result of different volcanic episodes with different magma composition that provides various geotechnical behavior.
- Third layer corresponds to the sound rocks of the Ancient Complex. The irregular interface (weathered/sound rock, reflector 2) shows some linear development parallel to the upper layer, but also reveals some specific characteristics. The minor degree of alteration revealed by this layer is a consequence of the lower exposition to external factors (i.e. sea water, marine water flow, friction produced by sand movement, etc.) and by a different rock composition (compact basalt) that provides a better response to the same factors.

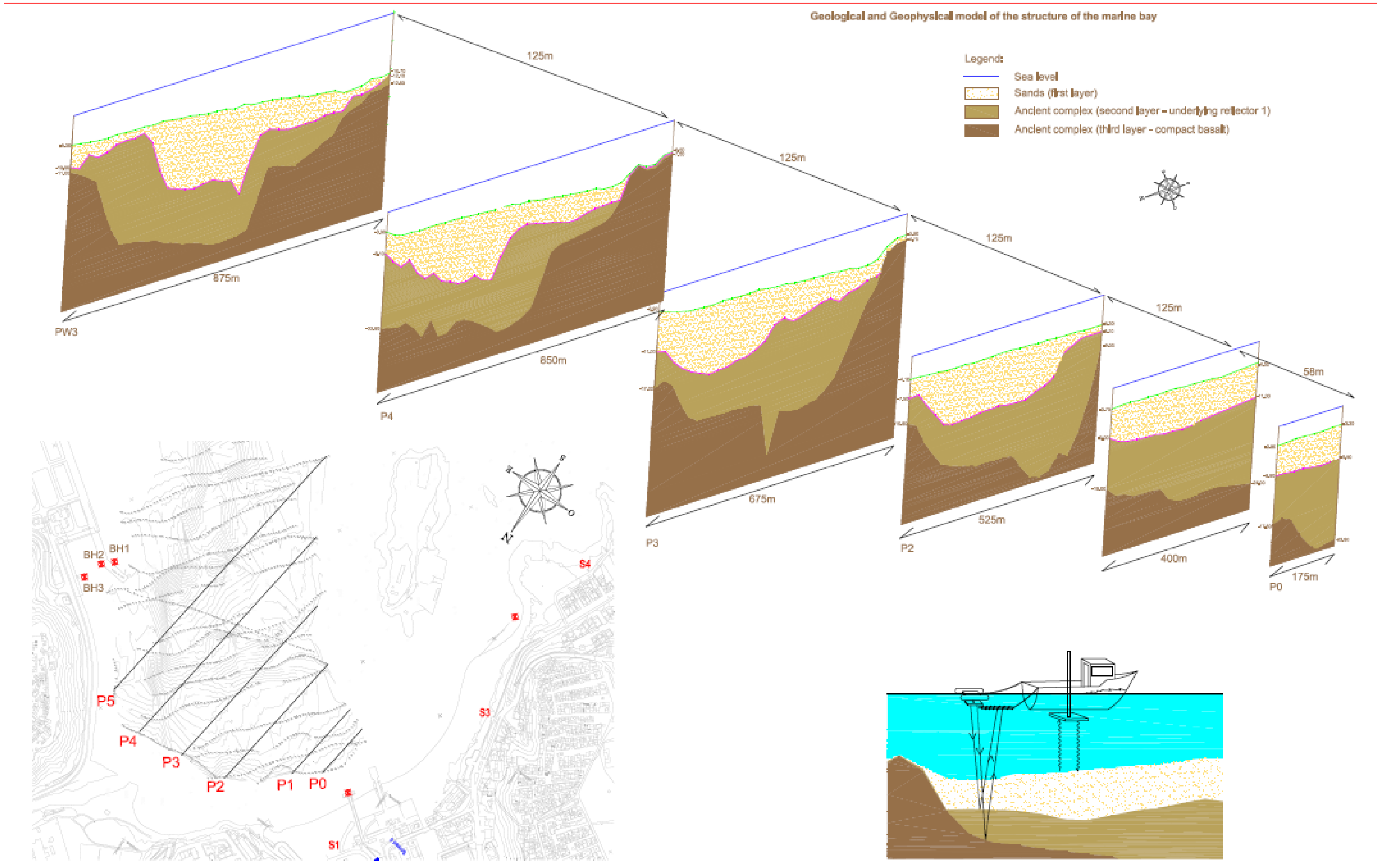


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**Table 9. Layer thicknesses**

| Layer | Cross-section (distance to the land) | Thickness (m) | |
|---|---|---|---|
| | | Minimal | Maximal |
| **Superficial sand** | P0 (131 m) | - | 6 |
| | P1 (188 m) | 6.5 | 7.5 |
| | P2 (313 m) | 3 | 10 |
| | P3 (438 m) | 2 | 12.3 |
| | P4 (563 m) | 3 | 13.4 |
| | P5 (688 m) | 0.6 | 14.5 |
| **Second Layer Weathered rock ancient complex** | P0 (131 m) | 13.5 | 21.5 |
| | P1 (188 m) | 15 | 20.4 |
| | P2 (313 m) | 6 | 23.5 |
| | P3 (438 m) | 4.6 | 22.8 |
| | P4 (563 m) | 3.4 | 24.1 |
| | P5 (688 m) | 1.6 | 23.9 |

The presence of the Santa Maria islet is a proof of the heterogeneous response of the rocks to the external meteoric factors. In fact the islet is composed of a nucleus of the ancient complex (that corresponds to the third layer) that resisted the erosion/alteration and development of the bay. Overlying this nucleus rocks from the "Pico da Antónia" formation still remain.

## 2.4. SEDIMENTOLOGY AND COASTAL DYNAMICS

### 2.4.1. Santiago Island

Santiago Island has an indented coastline with marked points and promontories with steep submarine slopes at the edges of bays of varying sizes. There are a few long stretches which are less steep and less indented where alongshore drift is of importance in transporting sand or gravel along the coast. In most cases the sheltering effect of the points, which limit deeply cut bays, interfere with wave propagation, generating marked localized refraction and diffraction effects and so the sedimentary accumulations in these "sack bottoms" (dead ends) are lined up in crescents at right angles to the direction of the breaking waves, minimizing longitudinal transport.

In this way, most of the coastline of the southern half of Santiago can be considered as a group of virtually independent sedimentary coastal cells in which the seasonal exchanges of each beach predominate over the longitudinal sedimentary transfers in their organization and morphological variability.

These cells are essentially fed locally from the torrential flows of the streams and rivers which flow into them, plus sporadic contributions from localized landslips from the coastal slopes.

### 2.4.2. Geomorphological characteristics of the Bay of Praia

Detailed information on the morphology of the seabed and sediment filling in the Bay of Praia is given in the « Geotechnical Survey Report, BCEOM, June 2007 ».

Three layers can be identified below the seabed:

- First layer (superficial) corresponds to sand and silt as a result of the desegregation and alteration of the sea rock and deposition of alluvial material provided by fresh water (recent and ancient). This layer shows an inhomogeneous thickness along the cross-sections. This layer corresponds to the sedimentary filling of the underground canyon which extends from the Ribeira Trindade thalweg. This sediment must be more or less consolidated.

  Many boulders, of unequal size, are visible at the surface of this layer; they appear on the side scan sonar mosaic, mainly in the north and north-west part of the bay in depths shallower than -6 m CM and north-east of the fishing quay. Recent shipwrecks lying on the seabed also constitute obstacles.

  Only shallow depths of between -6 m CM and -15 m CM between the island of Santa Maria and the port of Praia seem to be free of obstacles according to the side scan sonar survey. However, given the rocky nature of the general environment of Praia Bay and of rock and gravelly material, identified in the shallowest water, it is also possible that such rocky material be found here and there in this soft sedimentary cover. The fact that these materials emerge in greater numbers in the shallows (depths shallower than -6 m CM) is probably linked to the local hydrodynamics (waves) which, through sediment transport, allow these materials to free themselves of the sediment.

- The second layer was interpreted as being weathered, highly altered rock that corresponds to the top level of the Ancient Complex. This layer (and the following one) are too deep to be of any interest as a source of fill material.

- The third layer corresponds to the sound rocks of the Ancient Complex. With the exception of surface sediment situated in the shelter of the port protection breakwater (Stations 1 and 2) which have high rates of fine particles (> 70 %), the sediment sampled in the Bay of Praia is mainly sandy. Nevertheless, sample No.10, situated in the shallows, has between 20 and 40 % of fine particles and a median situated at 150 m, contrary to the other samples from the bay which have a higher median. In comparison to the other sediment stations studied in the bay axis, Station 10 shows different behaviour which could be linked to the sediment transported by water, land or man in the two rivers running into the bay depths.

**Surface sediment sampling**

The particle size analyses carried out on about ten surface sediment samples taken in the bay of Praia in Spring 2007 (cf. location figure below) show that the sediment is mainly sandy.

Only the samples of Stations 1 and 2 show a very high proportion of fine particles (> 70 %). Sample No. 10 taken close to the shore, in shallow depths, also shows a higher proportion of fine particles than the other samples: 20 % in the surface and 37% 20cm below the seabed. The same is observed for Sample No.4 on the surface. Station 9 shows, in the bay axis, the place where the proportion of particles is the lowest; it then increases towards the open sea (which is normal: sediment becomes finer and finer the further away it is from the shore). The lower proportion at Station 3 may reflect the effect of the pierhead of the port protection breakwater which encourages the increase of swell (reflection). The lowest proportion of sandy particles at Station 10 may result from deposits of earth-generated or human origin relating to the two rivers which run into the end of the bay and which are not totally absorbed by coastal currents

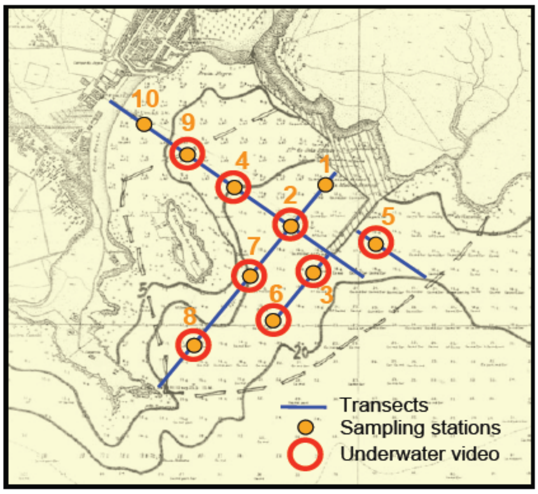
The higher rate of fine particles at Station 10 than in the other samples of sandy sediment in the stations in Praia Bay can also be found through the value of the sediment median which is low (0,15 mm) in comparison to the other stations close by (the median fluctuates between 0.35 and 0.80 mm at Stations 9 and 4 situated in the bay axis).

**Tableau 10. Sediments in Praia Bay: Particle size analysis (%)**

| *Sample* | Gravel | Sand | Silt and clay | Bottom description |
|---|---|---|---|---|
| 1t | 0 | 14.1 | 85.9 | very muddy |
| 1b | 0 | 18.3 | 81.7 | |
| 2t | 0 | 22.1 | 77.9 | very muddy |
| 2b | 0 | 26.3 | 73.7 | |
| 3t | 9.6 | 85.3 | 5.1 | sandy bottom with scattered small boulders |
| 3b | 11.5 | 74.8 | 13.6 | |
| 4t | 3.6 | 63.2 | 33.1 | sand with a fine mud layer |
| 4b | 5.2 | 79.6 | 15.2 | |
| 5t | 6.4 | 85.5 | 8.0 | sand with scattered rocks |
| 5b | 4.9 | 89.9 | 5.2 | |
| 6t | 3.6 | 82.5 | 13.9 | rocky bottom with sandy intervals |
| 6b | 11.2 | 73.8 | 15.0 | |
| 7t | 2.2 | 89.2 | 8.6 | rocky bottom with sandy intervals |
| 7b | 2.1 | 90.1 | 7.7 | |
| 8t | 3.2 | 79.9 | 16.9 | rocky bottom with sandy intervals |
| 8b | 0 | 88.9 | 11.1 | |
| 9t | 1.1 | 89.0 | 9.9 | fine sand/muddy |
| 9b | 0.1 | 86.2 | 13.7 | |
| 10t | 0 | 79.2 | 20.8 | Muddy sands |
| 10b | 0 | 62.7 | 37.3 | |
| Et | 0 | 90.3 | 9.7 | fine sand/muddy |

Gravel > 10 mm 10 mm < Sand < 200 µm Silt and Clay < 200 µm

t = top of the sample b = bottom of the sample




### 2.4.3. Characteristics and changes in the shoreline

**Shoreline characteristics**

The field reconnaissance survey made along the coast of Praia Bay shows three fundamentally different sectors:

- The coast which is north-east of the bay where the port is situated along, with its access road which runs directly into the sea.
- The north coast which is also rocky and corresponds to the foot of the Plateau on which is situated the old town of Praia. The "Ribeira Trindade" river stretches between these two rocky areas. Its mouth, at Praia Negra, is characterised by a shingle beach on both right and left banks. However, the beach situated on the right bank is much more developed. It is characterised by shingle of between one decimetre and one decametre in size which shows a sector with strong hydrodynamics. (cf. photo below).
- The end of the bay, which is oriented north north-east to south south-west, is sandy. The beach, which is about 50m wide in the North, narrows in the South to the sandbar where it is no more than about 10 m wide (at high tide). Around the sandbar which has developed between the shore and Santa Maria Island, the beach is very wide again. The north part of the beach is characterised by two old wharves and the mouth of a small stream often blocked by sand. The direction of the river indicates that the resulting coastal drift in this sector is oriented from north to south.


Shingle beach situated west of the mouth of the Trindade River (Ribeira Trindade) showing strong hydrodynamics in this sector.


The Achada Grande plateau with the Port of Praia at its foot and the access road built along the coast. This sector is the most open to the sea, which explains the strong swell and the presence of surfers and body boarders.

View towards the North end of the beach halfway between the sandbar and the southernmost wharf.

View towards the North of the beach halfway between the sandbar and the southernmost wharf.

View of the beach immediately south of the southernmost wharf. The shore is covered with *Turritela* shells.

View to the south of the beach from the southernmost wharf. The first metres show a strongly sloping beach indicating a sector where the swell is stronger than on the south part of the coast.

View of the stream which runs into Praia Bay. The stream's orientation leads to the supposition that hydrodynamic action is north-south.

View of the beach between the two old wharves.

View of the sand bar between Santa Maria Island the shore, from the Tropico Hotel. The wharves are in the background.

Changes in the shallows and the shore are also significant between 1957 and 2007 as a sandbar grew between the shore and Santa Maria Island. Information currently available does not however allow the start of this sedimentary formation to be dated. The origin of this sedimentary formation could be linked to the creation of the port of Praia breakwater at the end of the 1980s which could have helped to reduce turbulence in the bay and thus increase sedimentation on the edge of the shore linked to hydrological sediment transport at the end of the bay. Residual swell diffracted around Santa Maria Island would therefore have allowed this sandbar to form.

This formation also indicates that sediment deposits transported by the rivers in the bay are sufficient to nourish the sandbar and encourage widening of the beach at the end of the bay (around the wharves). Given the beach morphology, no sediment can be brought in from outside.


## 2.4.4. Bathymetric analysis of the seabed

Bathymetric works were performed on behalf of BCEOM and Pengest by the British Pelorus Company. Site surveys were carried out in April 2007, covering an area limited by Ponta Temerosa on the West and Ponta do Visconda (also called Ponta da Mulher Branca) to the East. In a southerly direction the surveys cover water depths of between 3 m and 25 m.

**Bathymetric characteristics of the seabed**

The bathymetric survey shows that in the central part of the bay the isobaths from out at sea to a depth of –6m CM are almost parallel. These then become concave before running parallel to the shoreline. Around the island of Santa Maria to the west and « Achada Grande », the bathymetric curves are very close together given the rocky nature of the sea bottom and run parallel to the shoreline.

The general slope of the seabed between -3m CM and -10m CM is around 0.9 %. On the other hand, depths of between -4 m and -6 m CM have a gentler slope, of about 0.6%. This reduction in the general slope is related to deposits from the Trindade River which encourages the development of an undersea prodelta after flood episodes.

**Analysis of seabed developments**

A comparative analysis of existing bathymetric maps was made in 2007, 2004 (produced by ENAPOR) and the old bathymetric chart dated 1946.

- Comparison between the 2007 and 2004 maps. To compare the 2007 and 2004 charts, the 2007 chart had to be converted to UTM 27N grid coordinates, to comply with the 2004 surveying system. The comparison then reveals that profiles are very similar:
- North-West to South-East profiles show 2007 seabed levels slightly below 2004 levels, some 30cm underneath,
- West-East profiles also suggest some slight erosion since 2004.

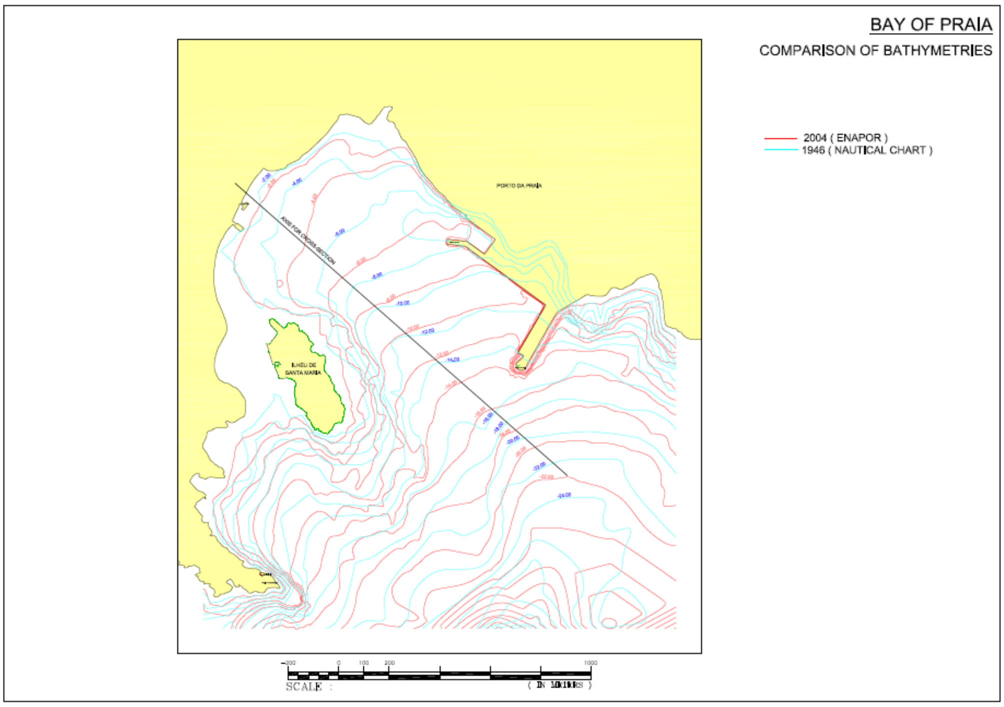
These differences suggest a slight erosion of the sea bottom between 2004 and 2007, the cause of which is unknown as no hydro-meteorological event has taken place during the last three years. Such a slight difference is probably the result of alterations in surveying systems and equipment. It is better to say that the bay seabed has been globally stable over the past three years.

**Comparison of 2007 and 1946 maps**

The comparison of 2004 and 1946 bathymetries reveals greater differences. As shown in the comparison maps of the Topography and Bathymetry Report, Bceom, June 2007, water depths seem to have decreased by some 1 to 2 m between the shoreline and the -15 m/-16m contour lines in the principal bay. However, we suggest handling these global results with great care as the maps do not fully coincide in terms of x and y coordinates.

The only undoubted fact can be seen in the near-shore area, between the old wharves and Santa Maria Islet. Along this stretch, the beach has clearly widened since the 50s and the near-shore seabed has risen as can be seen in aerial photographs from 1957 to 1:7500 scale (cf. aerial photo above).

Photographs taken in June 2007 (following) also show that the water at the foot of the wharves is shallow, indicating sedimentation on the edge of the shore as, previously, these wharves were used for berthing. There is much suspended sediment in the water even though turbulence is low.



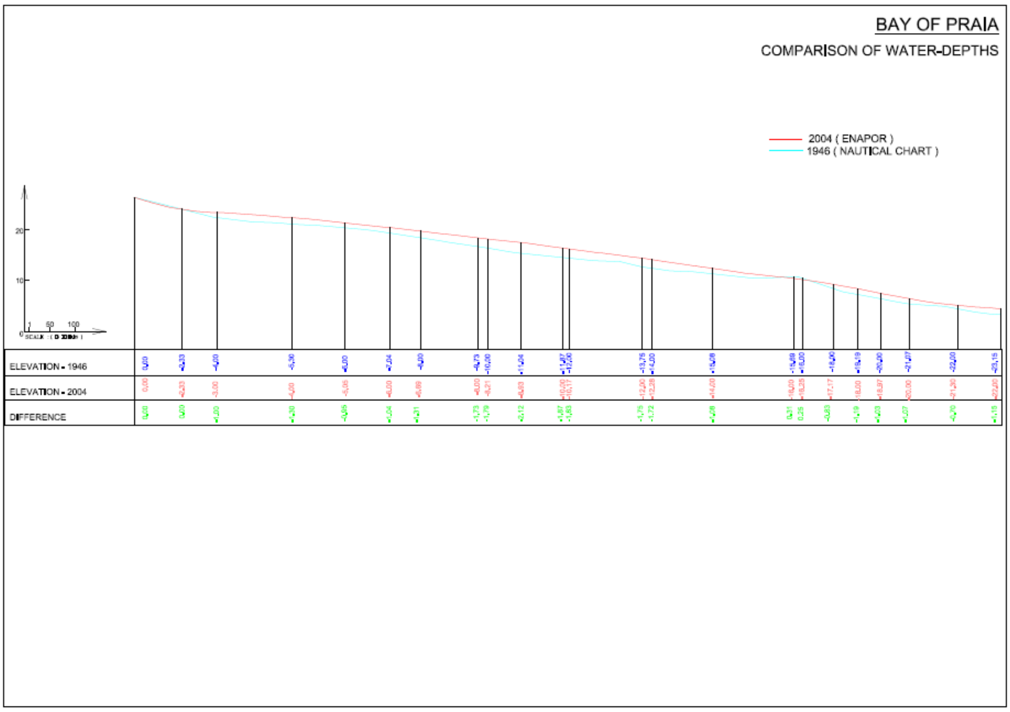




**Figure 5. Comparison between bathymetry in 1946 and 2004**

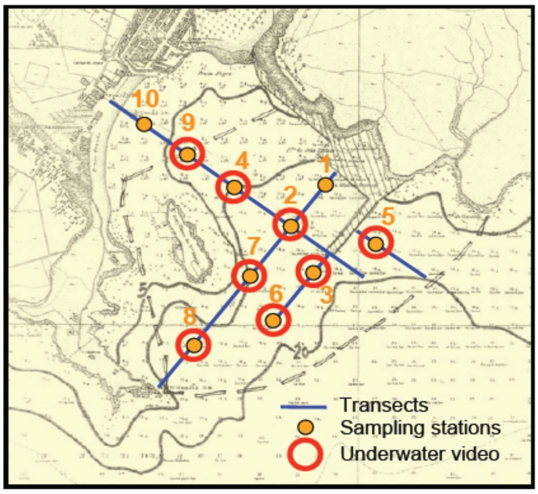
## 2.5. MARINE ENVIRONMENT SURVEY

A marine environment survey was conducted by IMAR – Instituto do Mar, Guia Marine Laboratory, Faculty of Sciences of University of Lisbon[6]. The tasks performed were:

- Underwater video,
- Quality of marine sediments,
- Soft bottom benthic communities,
- Hard bottom benthic communities,
- Qualitative fish census,
- Water analyses.

***Annex 2*** presents the complete methods and results obtained by IMAR during the campaign carried out at Praia Bay, Santiago Island, Cabo Verde.

### 2.5.1. Underwater video




The technical protocol was:

- filming stations were geo-referenced, and depth registered.
- continuous filming was performed, between 8 and 45 minutes according to the bottom level of heterogeneity.
- Hi8 video was converted to DV (Digital Video), and illustrative parts were edited,
- complete filming and photographic records were kept for possible future reference.
- in addition, the referenced wrecks existing in the bay were surveyed and filmed.
- these images are included in a DVD.

[6] Coordinator: José Paula (Associate Professor) ; Researchers: Abel Sousa Dias, David Gonçalves

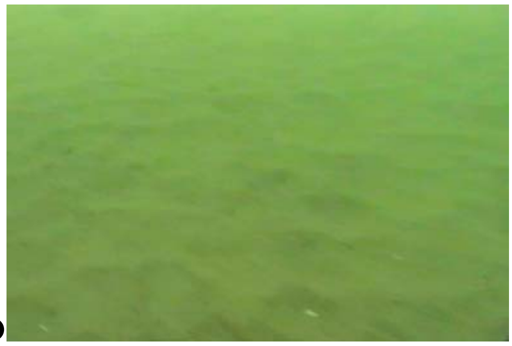
**Table 11. Description of dives and bottom description.**

| Date | Local time | Location | GPS | Objective | Max. depth (m) | Average depth (meters) | Duration (m) | T (ºC) | Bottom description |
|---|---|---|---|---|---|---|---|---|---|
| 29.04.2007 | 11:24 | station #5 | 14º 90854 N 23º 49815 W | fish count and bottom video | 13,4 | 10,9 | 61 | 23 | sand with scattered rocks |
| 30.04.2007 | 10:11 | station #6 | 14º 90319 N 23º 50257 W | fish count and bottom video | 15,8 | 12,3 | 64 | 23 | rocky bottom with sandy intervals |
| 01.05,2007 | 11:00 | wreck # 1 | 14º 54' 41''N 23º 30' 26''W | wreck video | 5,9 | | 8 | 23 | muddy |
| 01.05.2007 | 15:38 | wreck #4 "Fátima" | 14º 54876 N 23º 30201 W | Wreck video | 6,5 | 4,7 | 23 | 23 | muddy |
| 01.05.2007 | 17:09 | wreck # 1 "Federico" | 14º 54' 41''N 23º 30' 26''W | wreck video | 6,5 | 4,2 | 19 | 23 | muddy |
| 02.05.2007 | 8:49 | station #3 | 14º 90663 N 23º50036 W | fish count and bottom video | 17,9 | 14,8 | 36 | 23 | sandy bottom with scattered small boulders |
| 02.05.2007 | 14:26 | station #4 | 14º 91056 N 23º 50570 W | bottom video | 9,2 | 7,2 | 13 | 23 | sand with a fine mud layer |
| 02.05.2007 | 15:02 | station #9 | 14º 91132 N 23º 50671 W | bottom video | 6,8 | 4,7 | 16 | 23 | fine sand/muddy |
| 02.05.2007 | 14:38 | wreck #2 | | wreck video | 5,5 | 3,9 | 25 | 23 | muddy |
| 03.05.2007 | 8:56 | station #8 | 14º 90227 N 23º 50610 W | bottom video | 16,3 | 12,1 | 16 | 23 | rocky bottom with sandy intervals |
| 03.05.2007 | 9:32 | station #7 | 14º 90474 N 23º 50368 W | bottom video | 15,2 | 10,2 | 25 | 23 | rocky bottom with sandy intervals |
| 03.05.2007 | 10:26 | station #2 | 14º 90908 N 23º 50230 W | bottom video | 13,8 | 10,7 | 8 | 23 | very muddy |
| 03.05.2007 | 11:00 | wreck #3 | 14º 91151 N 23º 50788 W | Wreck video | 6,1 | | 12 | 23 | muddy |

Extracts from the video transects are presented here below.


Station 9

Average depth 4.7 m

❶ 

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Near the beach, sediments are 90 % sand (1, 2). Ripple marks are observed in the shallows (1) but the ripples have no marked direction. The sediments show signs of burrowing invertebrates (3). The gastropod *Turritella sp.* is predominant in the benthic communities. Numerous shells of this mollusk are found accumulated on the seabed (4) as well as washed up on the beach. *Turritella sp*. is a detrivore. It finds abundant food resources in the shallows, in the form of organic matter at the surface. The beds in these shallows are littered with macro-wastes from the drainage basin (5).


## Station 4

Average depth 7.2 m

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Station 4 is located at the center of the bay of Praia. The seabed is 63 % sand and 33 % clay.

This central part of the bay, relatively well sheltered by the western harbor wall, can be considered as a ‘settling basin’ in which fine particles decant. The bed bears ripple marks under the influence of the dominant swells (1, 3).


Station 2

Average depth 3.9 m to 5.5 m

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Station 2 is in the outer harbor of Praia. The sedimentary bed is made up of 80 % sand with a clay fraction of around 15 % (1). The area is sheltered from agitation by the ports western harbor wall and therefore acts as 'settling basin' for fines. Some sectors of the bed in the outer harbor show disturbance which may be related to resuspension of sediments during maneuvering by vessels (propeller impacts) (2, 3, 4). Turbidity is fairly high given the relatively high levels of suspended solids (4).


## Station 3

Average depth

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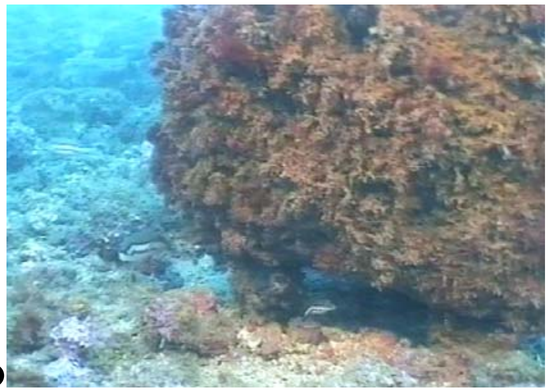

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Station 3 is off the nose of the Praia port harbor wall. It is therefore exposed to ocean swells and to the influence of the high seas. On the day the video was shot, bottom currents where very strong and some fish were observed taking shelter between rocks (6). The bed is relatively flat and made of soft substrates (85 % sand) with small (pluridecimetric) blocks of basalt (1). The habitat for fish is relatively undiversified (2). There are a few scattered large blocks on the bed (3). Sessile organisms are mainly photophilous algae and numerous crust-forming organisms: sponges, bryozoans, ascidians (3, 4). The species richness of fish is 10 species observed (out of a total of 30 species for the station with the greatest richness).


## Station 5

Average depth 10.9 m

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Located to the northwest and in front of the harbor wall, the seabed at Station 3 is varied and provides favorable habitats for numerous marine species. The bed, consists of pluridecimetric basaltic rocks (1) alternating with pluridecimetric blocks (2, 3) forming small, 1−3 m walls. Crust-forming organisms predominate (algae, sponges, ascidians, etc.) due to the presence of relatively strong currents.

The coarse sand beds are favorable to Mullidae (yellow goatfish, 4), and the numerous crags host a variety of species: squirrel fish (5), Atlantic cornetfish (6). Species richness for fish is 15 species observed (out of a total of 30 species for the richest station).


Station 6

Average depth 15.8 m

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Station 6 is outside of the bay in the projection of the western harbor wall. The bed consists of abrasion platforms (1, 3) and large basaltic rocks (2) exposed to frequently renewed offshore waters. Numerous life forms are supported, including several species of algae, sponges, ascidians, bryozoans, etc.). The platform is occupied by some 30 fish species colonizing the bed and rocky crags: Monrovia Doctorfish (3) Large-scaled Scorpionfish (4), Threebanded Butterflyfish (5), Honeycomb Moray (6), the water column is also occupied: Saddled Seabream (7).


## Station 7

Average depth 15.2 m

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Station 7 is located to the south-east of Santa Maria Island. The seabed is rocky (1,2) and forms a sort of basaltic platform interspersed with stretches of sand (3). Some of the walls of the larger rocks attract numerous plankton feeding fish, here a shoal of Brown Chromis (4). The crags form habitats for other species: Spotfin Burrfish (5), Blackbar Soldierfish (6).


Station 8

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Average depth 16.3 m

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Station 8 is located to the south-west of Santa Maria Island. The seabed consists of basaltic lava flows with stretches of fine sand. The clusters of rocks attract shoals of fish: Brown Chromis.

## Modern Wrecks

Average depth 4.2 m (ship wreck) and 15 m (anchors)


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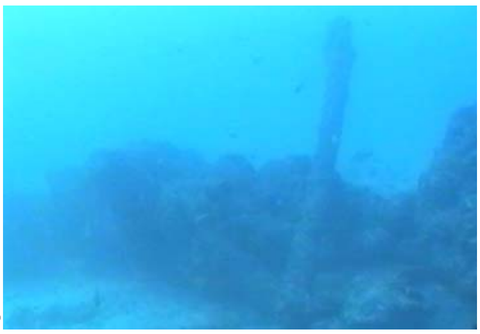
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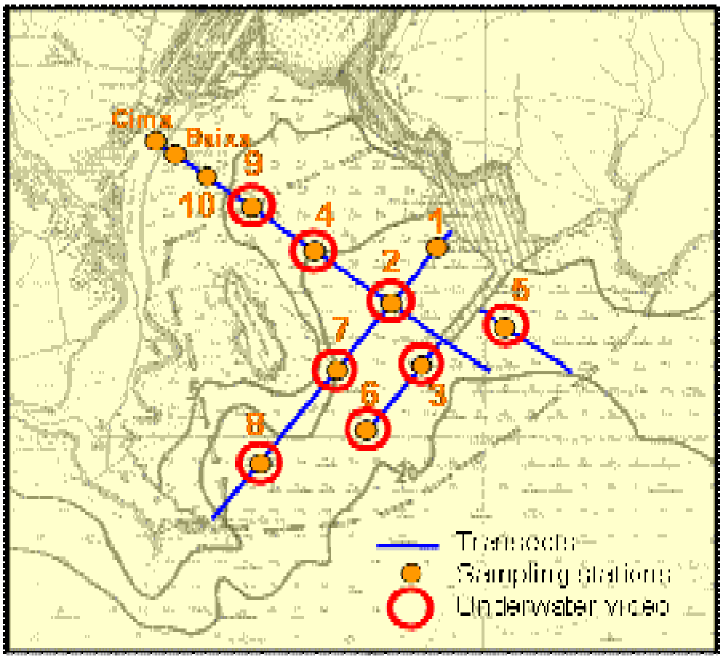
During the marine survey carried out in April 2007, three recent shipwrecks were found in the inner part of the bay of Praia (1 to 5). These wrecks are recent fishing boats and have no additional patrimonial value. No traces of old wrecks were found, except old (not ancient) anchors on rocky bottoms south of Santa Maria Island.

## 2.5.2. Quality of marine sediment

An initial program of analyses of the geochemical quality of sediments was implemented in June 2007. Samples were taken during dives from surface sediments at Stations 1, 2, 3 4 and 6 and two stations between the coast and station 10. The analyses were carried out by EGI AMBIENTE, Lda, a Portuguese laboratory certified for this type of analysis[7].

Table 12 gives the concentrations in marine superficial sediments of Praia Bay for:

- **Geochemical elements** such as dry matter, total organic carbon, nutriments (N Kjeldahl and total P),
- **Trace inorganic elements:** cadmium, copper, chromium, lead, mercury, zinc and iron,
- **Trace organic elements**: PCBs and HAPs
- **Organo-stannic** (MBT, DBT and TBT**)**




[7] EGI-AMBIENTE Portugal is ISO ENIEC 17025 certified Laboratory for analytical determination of soil samples.

**Table 12. Concentrations of organic and inorganic trace elements in the marine sediments in Praia Bay (June 2007)** dw = dry weight na = non avalaible

| Sampling Points | Units | #1 | #2 | #3 | #4 | #6 | Praia Cima | Praia Baixo |
|---|---|---|---|---|---|---|---|---|
| **References** | | 2007/ 01588 | 2007/ 01589 | 2007/ 01590 | 2007/ 01591 | 2007/ 01824 | 2007/ 01592 | 2007/ 01593 |
| **Type of materials** | | Sediment | | | | | | |
| **Dry mat.** | % | 69.8 | 69.1 | 70 | 73.6 | 70 | 99.2 | 78.6 |
| **N-Kjeldahl** | mg/kg N dw | 320 | 110 | 350 | 450 | 380 | 160 | 190 |
| **Nitrates** | mg/kg NO3 dw | <20 | <20 | <20 | <20 | <20 | 530 | <20 |
| **Nitrites** | mg/kg NO2 dw | 7.9 | 61 | 0.32 | 7.7 | 0.1 | 0.2 | 1.2 |
| **Ammonium** | mg/kg NH4 dw | 10 | 4 | 31 | 11 | 25 | 0.67 | 2.9 |
| **Total Organic Carbon** | % | 0.13 | 0.19 | <1.4 | 0.15 | <1.3 | <0.28 | <0.14 |
| **Weight loss at 550ºC** | % | 9.4 | 9.8 | 5.9 | 7.3 | 5.9 | 9 | 6.2 |
| **P total** | % | 0.19 | 0.19 | <0.10 | 0.16 | <0.10 | 0.14 | 0.17 |
| **Orthophosphates** | mg/kg PO4 dw | 5.5 | 2.9 | na | na | na | 2.9 | 2.3 |
| **Cadmium** | mg/kg Cd dw | <0.30 | <0.30 | <0.30 | <0.30 | <0.30 | <0.30 | <0.30 |
| **Lead** | mg/kg Pb dw | 21 | 22 | 3.8 | 23 | 5.5 | 15 | 13 |
| **Copper** | mg/kg Cu dw | 51 | 58 | 3 | 52 | 4.4 | 38 | 37 |
| **Chromium** | mg/kg Cr dw | 160 | 140 | 7.4 | 290 | 19 | 120 | 280 |
| **Iron** | mg/kg Fe dw | 93 000 | 93 000 | 6 900 | 130 000 | 16 000 | 90 000 | 150 000 |
| **Mercury** | mg/kg Hg dw | <0.15 | <0.15 | <0.15 | <0.15 | <0.15 | <0.15 | <0.15 |
| **Zinc** | mg/kg Zn bs | 100 | 100 | 9.9 | 140 | 14 | 88 | 140 |

| Sampling Points | Units | #1 | #2 | #3 | #4 | #6 | Praia Cima | Praia Baixo |
|---|---|---|---|---|---|---|---|---|
| **References** | | 2007/ 01588 | 2007/ 01589 | 2007/ 01590 | 2007/ 01591 | 2007/ 01824 | 2007/ 01592 | 2007/ 01593 |
| **Type of materials** | | Sediment | | | | | | |
| **Naphthalene** | mg/kg dw | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 |
| **Acenaphtylene** | mg/kg dw | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 |
| **Acenaphtene** | mg/kg dw | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 |
| **Fluorene** | mg/kg dw | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 |
| **Phenantrene** | mg/kg dw | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 |
| **Anthracene** | mg/kg dw | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 |
| **Fluoranthene** | mg/kg dw | <0.010 | <0.010 | <0.010 | 0.012 | <0.010 | <0.010 | <0.010 |
| **Pyrene** | mg/kg dw | <0.010 | <0.010 | <0.010 | 0.011 | <0.010 | <0.010 | <0.010 |
| **Benzo(a)anthracene** | mg/kg dw | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 |
| **Chrysene** | mg/kg dw | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 |
| **Benzo(b)fluoranthene** | mg/kg dw | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 |
| **Benzo(k)fluoranthene** | mg/kg dw | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 |
| **Benzo(a)pyrene** | mg/kg dw | <0.010 | <0.010 | <0.010 | <0.010 | 0.027 | <0.010 | <0.010 |
| **Dibenzo(a,h)anthracene** | mg/kg dw | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 |
| **Benzo(g,h,i)perylene** | mg/kg dw | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 |
| **Indeno(1,2,3-cd)pyrene** | mg/kg dw | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 |
| **2-metylnaphtalene** | mg/kg dw | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 |
| **2-metylfluoranthene** | mg/kg dw | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 |
| **∑ PAHs** | mg/kg dw | <0.18 | <0.18 | <0.18 | <0.18 | <0.18 | <0.18 | <0.18 |
| **PCB 28** | mg/kg dw | <0.020 | <0.020 | <0.020 | <0.020 | <0.020 | <0.020 | <0.020 |
| **PCB 52** | mg/kg dw | <0.020 | <0.020 | <0.020 | <0.020 | <0.020 | <0.020 | <0.020 |
| **PCB 101** | mg/kg dw | <0.020 | <0.020 | <0.020 | <0.020 | <0.020 | <0.020 | <0.020 |
| **PCB 118** | mg/kg dw | <0.020 | <0.020 | <0.020 | <0.020 | <0.020 | <0.020 | <0.020 |
| **PCB 138** | mg/kg dw | <0.020 | <0.020 | <0.020 | <0.020 | <0.020 | <0.020 | <0.020 |
| **PCB 153** | mg/kg dw | <0.020 | <0.020 | <0.020 | <0.020 | <0.020 | <0.020 | <0.020 |
| **PCB 180** | mg/kg dw | <0.020 | <0.020 | <0.020 | <0.020 | <0.020 | <0.020 | <0.020 |
| **∑ PCB** | mg/kg dw | <0.14 | <0.14 | <0.14 | <0.14 | <0.14 | <0.14 | <0.14 |
| **MBT** | µg/kg | 1.9 | <1 | <1 | 1.3 | Non available | 2.7 | 6.6 |
| **DBT** | µg/kg | 1.1 | <1 | <1 | <1 | | <1 | 1.2 |
| **TBT** | µg/kg | 2.6 | 1.6 | <1 | <1 | | <1 | <1 |

The legal framework used at the results interpretation follows the criteria defined by Portuguese regulation: Regulamentar Decree 141/1995, 21 June, Environmental

Office, applicable criteria and processes to classify Contaminated Marine Sediments (table 13).

Tableau 13. Limit values for the deposition of contaminated sediments in the sea bottom.

| Parameter | Limit Values for Class 1 | Limit Values for Class 2 | Limit Values for Class 3 | Limit Values for Class 4 | Limit Values for Class 5 |
|---|---|---|---|---|---|
| Arsenic (mg/kg) | <20 | [20-50[ | [50-100[ | [100-500[ | >500 |
| Cadmium (mg/kg) | <1 | [1-3[ | [3-5[ | [5-10[ | >10 |
| Chromium (mg/kg) | <50 | [50-100[ | [100-400[ | [400-1000[ | >1000 |
| Copper (mg/kg) | <35 | [35-150[ | [150-300[ | [300-500[ | >500 |
| Mercury (mg/kg) | <0,5 | [0,5-1,5[ | [1,5-3,0[ | [3,0-10[ | >10 |
| Lead (mg/kg) | <50 | [50 - 150[ | [150 - 500[ | [ 500-1000[ | >1000 |
| Nickel (mg/kg) | <30 | [30 - 75[ | [75 - 125[ | [125-250[ | >250 |
| Zinc (mg/kg) | <100 | [100-600[ | [600-1500[ | [1500-5000[ | >5000 |
| (PAH)Aromatical policiclic hydrocarbons (ug/Kg) | <5 | [300-2000[ | [2000-6000[ | [6000-20000[ | >20000 |
| PCB (polychlorinated Biphenyl's) (ug/Kg) | <300 | [5-25[ | [25-100[ | [100- 300[ | >300 |
| HCB (ug/Kg) | <0,5 | [0,5-2,5[ | [2,5-10[ | [10-50[ | >50 |

| Class | Nature of dredged materials | Conditions de dépôt ou d'immersion en mer |
|---|---|---|
| 1 | clean | Could be deposited in marine environment. Possible use to stock beaches, without special conditions |
| 2 | traces of contamination | Possible in-water disposal, taking account of receptor and its use |
| 3 | slightly contaminated | Could be used as backfill material. In case of in-water disposal, requires in-depth study of disposal site and post-monitoring of possible effects. |
| 4 | contaminated | May be deposited on land, on site with impermeable surfaced site. Covered by impermeable material. |
| 5 | highly contaminated | Should not be dredged. If absolutely necessary treatment similar to that for industrial waste. Disposal at sea or deposition on land forbidden. |

Analyses in table 12 show the main following results:

- Total organic matter and N-Kjeldahl contents in the sediments are moderate whereas contents in total P is relatively high,
- Sediments are free from contamination by HPAs, PCBs and inorganic trace elements as cadmium, mercury and lead.

- Sediments are not contaminated by MBT, DBT and TBT,
- Copper and zinc show some contamination traces, especially in stations 1, 2 and 4.
- Sediments are contaminated by chromium in stations 1, 2, Cima and Baixa.

A second program of analyses of the geochemical quality of sediments was implemented in October 2007 at Stations 2 and 4, to confirm, amongst other things, contamination by chromium.

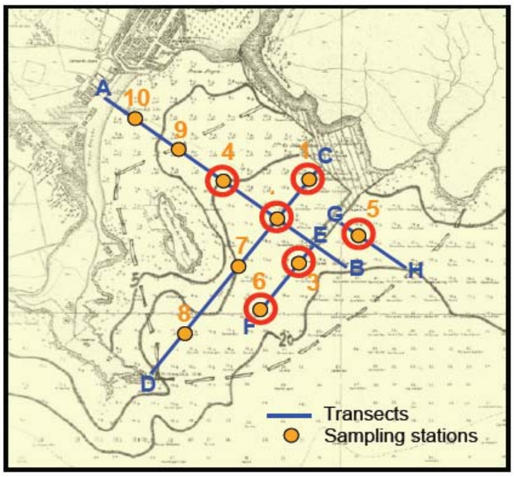
**Table 14. Concentrations of organic and inorganic trace elements in the marine sediments in Praia Bay (June 2007)** dw = dry weight na = non available

| **Sampling Points** | Units | **#2** | **#4** |
|---|---|---|---|
| **Type of materials** | | Sediment | |
| **Total rrganic matter.** | mg/kg | 3 500 | 3 500 |
| **N-Kjeldahl** | mg/kg N dw | 400 | 470 |
| **Nitrites** | mg/kg NO2 dw | 0.29 | 0.19 |
| **Ammonium** | mg/kg NH4 dw | 1.1 | 0.9 |
| **Weight loss at 550ºC** | % | 6.6 | 6.5 |
| **Orthophosphates** | mg/kg PO4 dw | 3.97 | 3.59 |
| **Cadmium** | mg/kg Cd dw | 0.16 | 0.22 |
| **Lead** | mg/kg Pb dw | 12 | 19 |
| **Copper** | mg/kg Cu dw | 15 | 15 |
| **Chromium** | mg/kg Cr dw | 97 | 120 |
| **Mercury** | mg/kg Hg dw | <0.10 | <0.10 |
| **Zinc** | mg/kg Zn bs | 79 | 93 |
| **Naphthalene** | mg/kg dw | <0.010 | <0.010 |
| **Acenaphtylene** | mg/kg dw | <0.010 | <0.010 |
| **Acenaphtene** | mg/kg dw | <0.010 | <0.010 |
| **Fluorene** | mg/kg dw | <0.010 | <0.010 |
| **Phenantrene** | mg/kg dw | <0.010 | <0.010 |
| **Anthracene** | mg/kg dw | <0.010 | <0.010 |
| **Fluoranthene** | mg/kg dw | <0.010 | <0.010 |
| **Pyrene** | mg/kg dw | <0.010 | <0.010 |
| **Benzo(a)anthracene** | mg/kg dw | <0.010 | <0.010 |
| **Chrysene** | mg/kg dw | <0.010 | <0.010 |

| | | | |
|---|---|---|---|
| **Benzo(b)fluoranthene** | mg/kg dw | <0.010 | <0.010 |
| **Benzo(k)fluoranthene** | mg/kg dw | <0.010 | <0.010 |
| **Benzo(a)pyrene** | mg/kg dw | <0.010 | <0.010 |
| **Dibenzo(a,h)anthracene** | mg/kg dw | <0.010 | <0.010 |
| **Benzo(g,h,i)perylene** | mg/kg dw | <0.010 | <0.010 |
| **Indeno(1,2,3-cd)pyrene** | mg/kg dw | <0.010 | <0.010 |
| **2-metylnaphtalene** | mg/kg dw | <0.010 | <0.010 |
| **2-metylfluoranthene** | mg/kg dw | <0.010 | <0.010 |
| **∑ PAHs** | mg/kg dw | 0.16 | 0.16 |
| **PCB 28** | mg/kg dw | <0.020 | <0.020 |
| **PCB 52** | mg/kg dw | <0.020 | <0.020 |
| **PCB 101** | mg/kg dw | <0.020 | <0.020 |
| **PCB 118** | mg/kg dw | <0.020 | <0.020 |
| **PCB 138** | mg/kg dw | <0.020 | <0.020 |
| **PCB 153** | mg/kg dw | <0.020 | <0.020 |
| **PCB 180** | mg/kg dw | <0.020 | <0.020 |
| **∑ PCB** | mg/kg dw | 0.14 | 0.14 |
| **MBT** | µg/kg | <1.0 | <1.0 |
| **DBT** | µg/kg | <1.0 | <1.0 |
| **TBT** | µg/kg | <1.0 | <1.0 |

The results confirm the values measured in June in sediments at the same Stations 2 and 4, especially for concentrations of chromium (some traces of chromium at Station 2 and slight contamination at Station 4).

### 2.5.3. Soft bottom sediment benthic communities



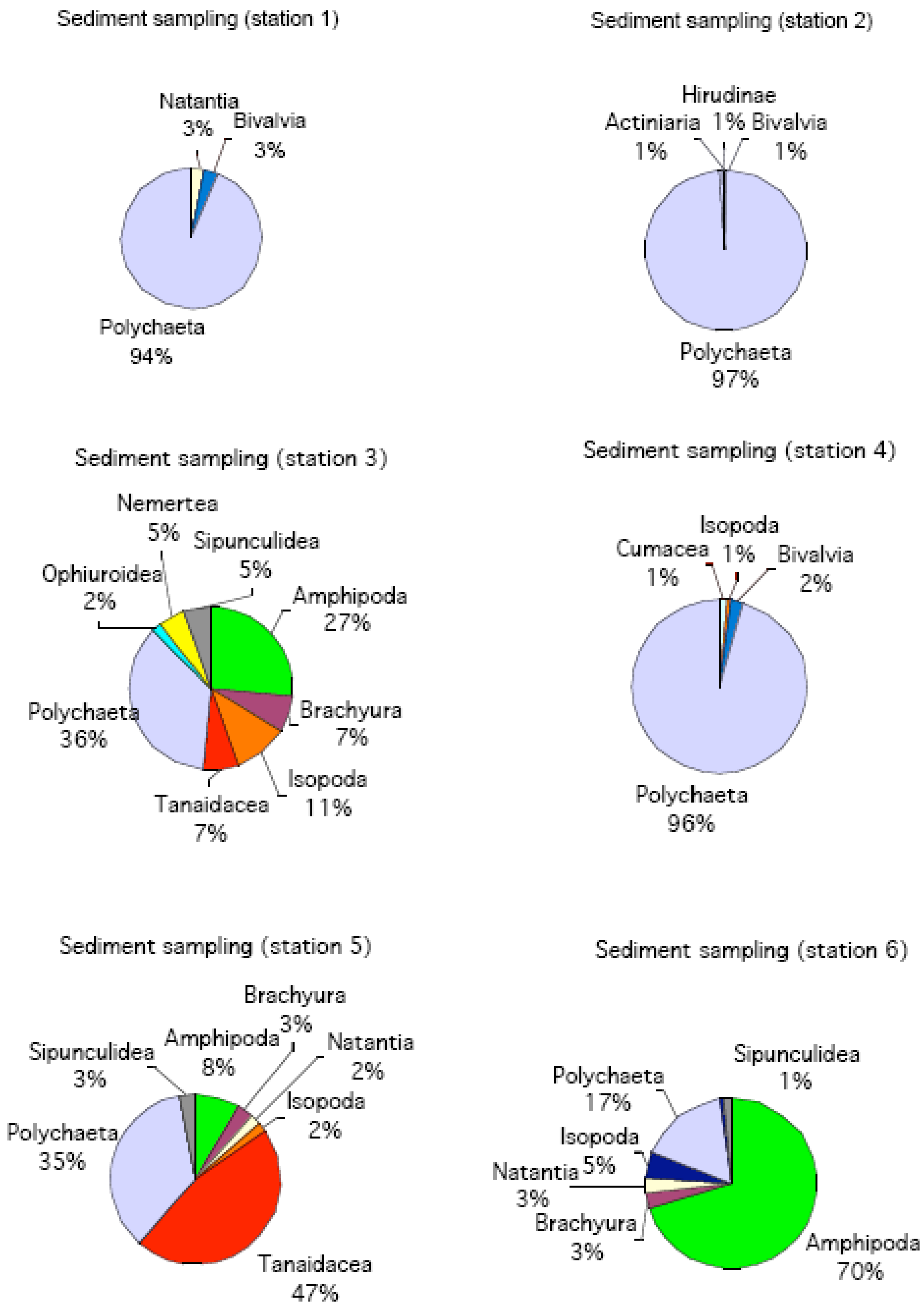

Five replicas of benthic fauna samples were made at stations 1 to 6, using a 15-cm x 15-cm (base) Van Veen dredge. Fauna were separated using a 1-mm sieve and then fixed with buffered (sodium borate) formaldehyde at 4 %, with Bengal rose for a more precise sorting. Organisms were identified and counted in the lab with the help of binocular microscope and taxonomic guides. The determination of macro benthic fauna has been led by IMAR to the taxonomic level, but not to genera or specific level.

| | |
|---|---|
| **Stations 1, 2 and 4** | Stations 1, 2 and 4 are composed by muddy sediments and comprise a macrofauna composed almost exclusively by polychaetes (Figure 5). Bivalves, although showing very low densities, were only present at these stations, probably due to higher food availability in the water mass, as they are suspension feeders. Actinaria and Hirudinea were found only at station 2, and Cumacea only at station 4. |
| **Station 3** | Station 3, composed by sandy bottom, was the more diverse in what refers to its macrofauna, composed by 8 higher taxonomic groups, from which polychaetes and amphipods were the most important, with 36 % and 27 %, respectively. Nemertineans and ophiuroids were found only at this station. |
| **Station 5** | The crustaceans Tanaidacea dominated station 5, composed by sand and gravels, reaching almost half of the overall abundance. Seven higher taxonomic groups were observed in this station. |
| **Station 6** | Station 6 was a sandy bottom clearly dominated by crustacean of the group Amphipoda (70 %). Although this dominance, 6 taxonomic groups were observed at this station. |

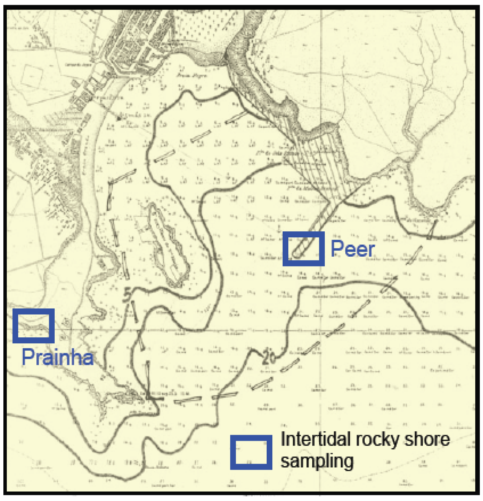
Overall, the macrofaunal assemblies of Praia bay are as roughly expected, namely in view of the present sediment types. Sandy and gravel bottoms are usually more diverse than muddy bottoms, the former being the former dominated by crustaceans and the latter by polychaetes.

Richness, evenness and diversity indexes were used. The results show that muddy bottoms are less diverse than sandy ones. Stations 1 and 2 were the least diverse, although, only relating these stations, Shannon-Wiener and Simpson index of diversity rank them differently. Station 6 had the highest diversity followed by stations 3 and 5, respectively. The fact that these stations are composed of a more heterogeneous bottom type could have influenced the results, especially at station 6, which showed a high value of species richness.

**Figure 6. Relative percentage of taxa present in sediment at the six sampling stations.**



### 2.5.4. Hard bottom benthic communities




Two stations were to be sampled in the intertidal zone: station E, on the extremity of quay 1, and station I, on the outer bay of the harbor. However, practical constraints precluded the use of station I. During the whole period of the field campaign, exposure (wave action) at station I low shore made its use for adequate sampling impracticable, despite a focused effort. Station I was used then substituted by Prainha, which after careful observation showed the same type of biological communities.

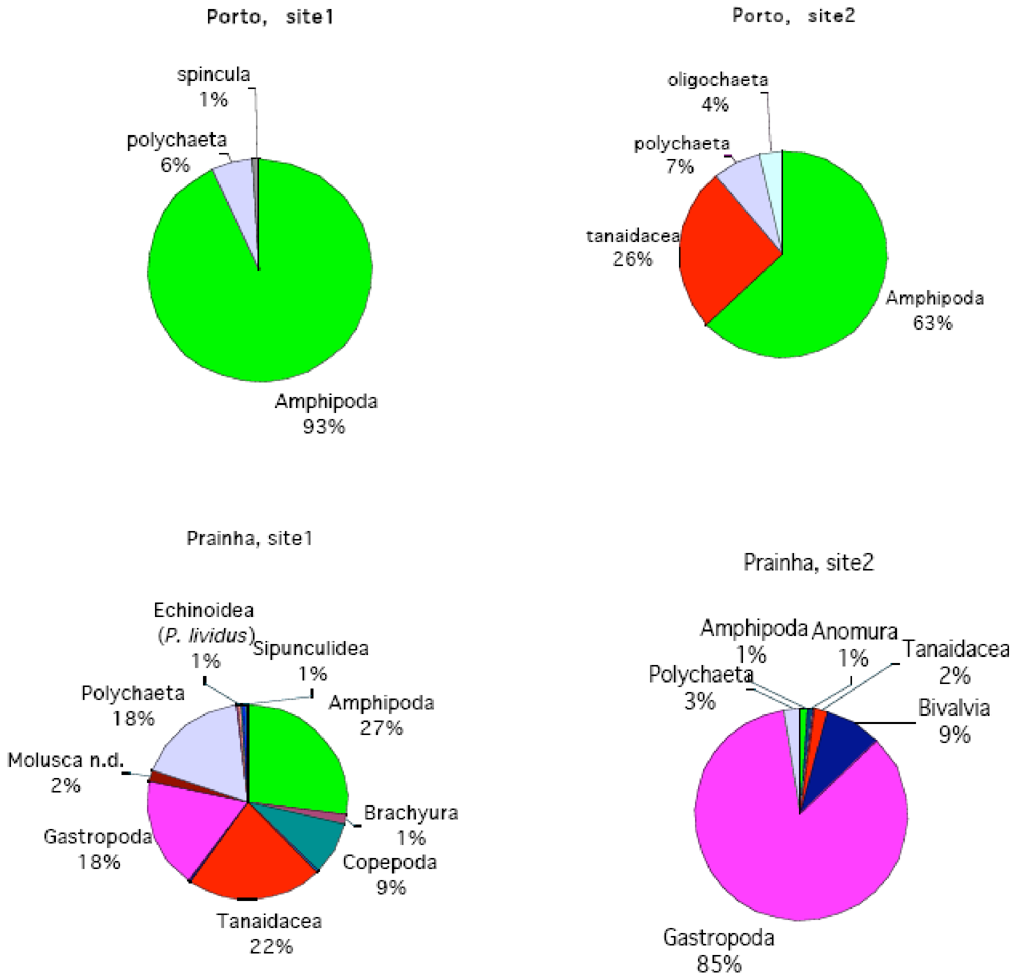


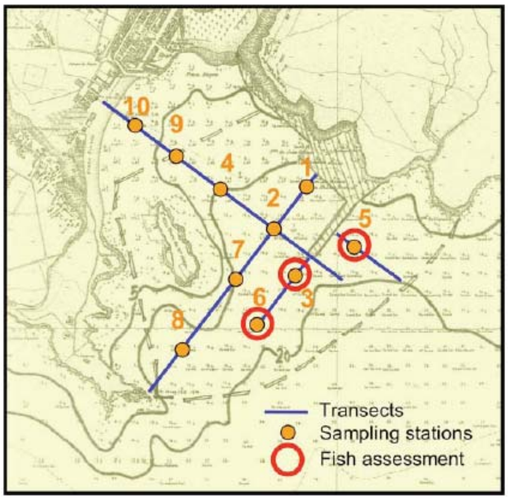

**Figure 7. Relative percentages of taxa at the two sites of each station (Porto and Prainha).**

As shown in Figure 7, amphipods dominated station E (Porto) and gastropods dominated site 2 of station Prainha, with 85%, although at site 1 they represented only 18% of the faunal community. The highest diversity was found on site 1 of Prainha, where no taxa clearly dominated, although crustaceans were more abundant.

Hard bottom benthic communities within the Phase 1 footprint

Concerning hard bottom communities located between the existing jetty and Ponta da Visconde, the collected information describes common benthic communities, with shells and crustaceans, echinoderms, sponges, sea anemones, fixed polychaetes, and seaweeds. Local fishermen use to catch small crabs as bait. Barnacle used to be found there, but has disappeared a few years ago, partly due to overfishing.

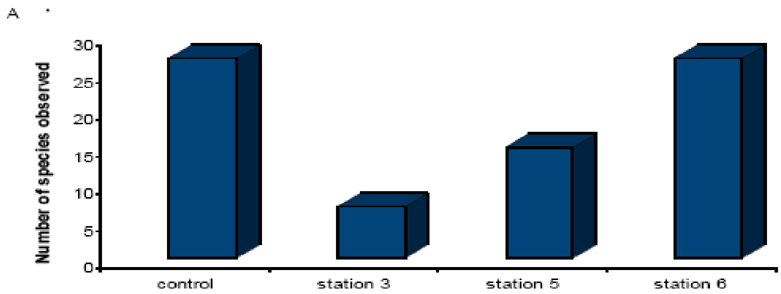
## 2.5.5. Fish qualitative census

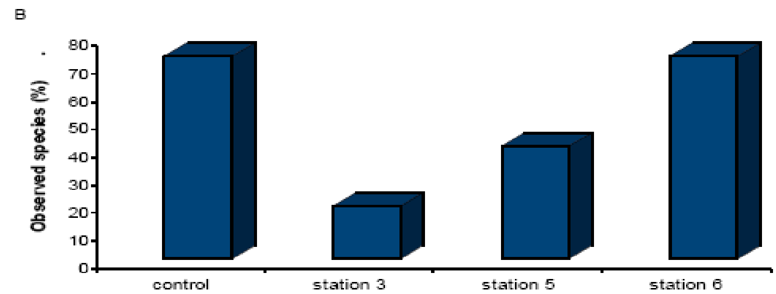



The ichtyofauna was identified at a species level and the species abundance was classified on an ordinal scale from 0 (absent) to 3 (abundant). Three stations close to the harbor were sampled by underwater video recording. The species abundance at each station was classified from video images.

For comparison with the study area, a species survey on a well-preserved coastal section at Tarrafal (north Santiago island), using exactly the same methodology, was also included in the report.

**Figure 8. Total number (A) and percentage of species (B) from the total observed recorded at stations 3, 5, 6 and control (Terrafal)**



| | |
|---|---|
| **Station 6** | The three stations differ in terms of habitat and, consequently, in the associated fish assembly. Mainly large boulders separated by small sandy patches constitute **station 6**. The boulders are piled on top of each other thus increasing the complexity of the rocky habitat. Accordingly, the highest number of species is observed at this station and the mean species abundance is also highest at station 6. The dominant species are the canary damsel, *Abudefduf luridus*, the brown chromis, *Chromis multilineata* and the saddled seabream, *Oblada melanura*. |
| **Station 3** | A sandy bottom covered by a thin sediment layer with small boulders interspersed characterizes **station 3.** The scarceness of rocky substratum and the low complexity of the habitat account for the small number of fish observed. The dominant species are two gobies *Bathygobius soporator* and *B.casamancus*). |
| **Station 5** | **Station 5** presents characteristics between the two previous ones. Medium-sized rocks dispersed in a sandy bottom characterized it. In accordance, species diversity and abundance at this site are higher than at station 3 but lower than at station 6. The dominant species are the canary damsel, *Abudefduf luridus*, the brown chromis, *Chromis multilineata* and the yellow goatfish, *Mulloidichthys martinicus*. |
| **Comparison with Terrafal and conclusions** | The station used for comparison at Tarrafal is dominated by large rocks with interspersed small sandy patches. The dominant species are the brown chromis, *Chromis multilineata*, the Atlantic cornet fish, *Aulostomus strigosus* and the blackbar soldierfish, *Myripristis jacobus*). The habitat structure and complexity are similar to station 6 and both the total number of species and the mean species abundance are similar between these two stations. These results suggest that areas in close vicinity to the harbor are still well-preserved regarding species diversity and abundance. The lower species richness at stations 3 and 5 is probably the result of the present habitats being less complex, and not a consequence of their closer proximity to the harbor. |

### 2.5.6. Biodiversity

**Marine reptiles** are represented in Cap Verde mainly by 5 species of **marine tortoise**, *Dermochelys coriacea* (tartaruga parda), *Chelonia mydas* (tartaruga verde), *Eretmochelys imbricata* (tartaruga de casco levantado), *Caretta caretta* (tartaruga vermelha) and *Lepidochelys olivacea.* These threatened species suffer from intensive over-exploitation for the consumption of their eggs and meat and the production of craftwork and jewellery. Despite past and current efforts made through preservation programmes such as the « Cabo Verde Natura 2000 » project on the island of Boa Vista, the current position of this group of animals remains that described in the first “red list” of Cape Verde.

Marine tortoises are regularly observed by divers in the open sea off the port of Praia.

The presence of **marine mammals** in the waters of Cape Verde is a frequent event close to the coasts of these islands and especially during the normal migratory journey of these species or again during the mating period. In many cases, whales and sperm-whales can be seen to be under stress as they are very vulnerable to large predators (whales). The most frequently observed species belong to three families and eight genera (Table 15).

**Table 15.Whales and dolphins species observed in Cabo Verde Archipelago[8].**

| Family | Species | Common name |
|---|---|---|
| Balaenopteridae | *Balaenoptera musculus* | Baleia Azul |
| Balaenopteridae | *Megaptera novaeangliae* | Baleia-de-Bossas |
| Delphinidae | *Tursiops truncatus* | Corvineiro |
| Delphinidae | *Stenella frontalis* | Chico Jote |
| Delphinidae | *Stenella attenuate* | Toninha |
| Delphinidae | *Delphinus delphis* | Golfinho |
| Delphinidae | *Globicephala melas* | Boca de Panela |
| Delphinidae | *Orcinus orca* | Orca |
| Delphinidae | *Globicephala macrorhynchus* | Baleia |
| Zyphiidae | *Ziphius cavirostris* | Baleia |

Whales follow their migration route on the edge of the slope change on the continental shelf where they find their food (the development of zooplankton facilitated by temperature differences and the acceleration of currents along the slope). Whales frequently come into the bay of Praia. Whales have been observed close to the port basin in Praia.

[8] République du Cap Vert / Ministère de l'Environnement, Agriculture et Pêche. Deuxième rapport national sur l'état de la biodiversité au cap Vert. Juillet 2002.

### 2.5.7. Water quality

Four sampling campaigns were made on 2 May 2007, 30 July 2007, 30 September 2007 and 23 October 2007. Samples were taken at stations 1 to 6.

**Temperature, salinity and pH**

Temperature values were quite homogeneous for each sampling. Temperature is also highly dependent of time of day and wind conditions when sampling was performed at each station. Regarding salinity, values are within the expected oceanic range. Minor anomalies were detected at some stations, such as 2, 3, 4 and 5, with lower values at surface. These may correspond to limited freshwater discharges from port activities. Values for pH also fall within the expected range for these types of marine waters.

**Temperature °C**

| | | Station 1 | Station 2 | Station 3 | Station 4 | Station 5 | Station 6 |
|---|---|---|---|---|---|---|---|
| 02/05/07 | Surface | 24.4 | 24.1 | 24.1 | 24.2 | 24.1 | 23.9 |
| | Bottom | 24.3 | 24.1 | 24.2 | 24.5 | 24.1 | 23.9 |
| 30/07/07 | Surface | 24.4 | 24.0 | 24.1 | 24.3 | 24.2 | 23.9 |
| | Bottom | 24.2 | 23.9 | 24.2 | 24.4 | 24.2 | 23.8 |
| 30/09/07 | Surface | 27.4 | 27.3 | 27.2 | 27.4 | 27.3 | 27.1 |
| | Bottom | 27.3 | 27.0 | 26.1 | 28.0 | 27.5 | 26.7 |
| 23/10/07 | Surface | 28.0 | 27.6 | 28.1 | 27.8 | 27.8 | 28.2 |
| | Bottom | 27.7 | 27.1 | 26.1 | 27.4 | 27.5 | 27.6 |

**Salinity**

| | | Station 1 | Station 2 | Station 3 | Station 4 | Station 5 | Station 6 |
|---|---|---|---|---|---|---|---|
| 02/05/07 | Surface | 35.9 | 35.8 | 35.6 | 35.8 | 35.6 | 35.9 |
| | Bottom | 35.9 | 35.9 | 35.9 | 35.8 | 35.9 | 35.9 |
| 30/07/07 | Surface | 35.9 | 35.8 | 35.6 | 35.8 | 35.6 | 35.9 |
| | Bottom | 35.9 | 35.9 | 35.4 | 35.8 | 35.9 | 35.9 |
| 30/09/07 | Surface | 37.5 | 37.0 | 36.0 | 37.0 | 35.0 | 37.5 |
| | Bottom | 37.5 | (*) | 36.0 | 37.0 | 37.5 | 35.0 |
| 23/10/07 | Surface | 35.8 | 35.1 | 35.9 | 35.2 | 34.9 | 35.6 |
| | Bottom | 35.7 | 35.0 | 35.8 | 35.0 | 34.8 | 35.2 |

(not reliable reading)

**pH**

| | | Station 1 | Station 2 | Station 3 | Station 4 | Station 5 | Station 6 |
|---|---|---|---|---|---|---|---|
| 02/05/07 | Surface | 8.070 | 8.080 | 8.070 | 8.070 | 8.060 | 8.070 |
| | Bottom | 8.070 | 8.090 | 8.020 | 8.070 | 8.020 | 8.080 |
| 30/07/07 | Surface | 8.409 | 8.442 | 8.253 | 8.488 | 8.232 | 8.386 |
| | Bottom | 8.402 | 8.532 | 8.472 | 8.376 | 8.344 | 8.467 |
| 30/09/07 | Surface | 8.004 | 8.087 | 8.008 | 8.106 | 8.197 | 8.17 |
| | Bottom | 8.056 | 8.078 | 8.097 | 8.019 | 8.025 | 8.21 |
| 23/10/07 | Surface | 8.024 | 8.142 | 8.098 | 8.058 | 8.121 | 8.141 |
| | Bottom | 8.078 | 8.021 | 8.199 | 8.101 | 8.149 | 8.134 |

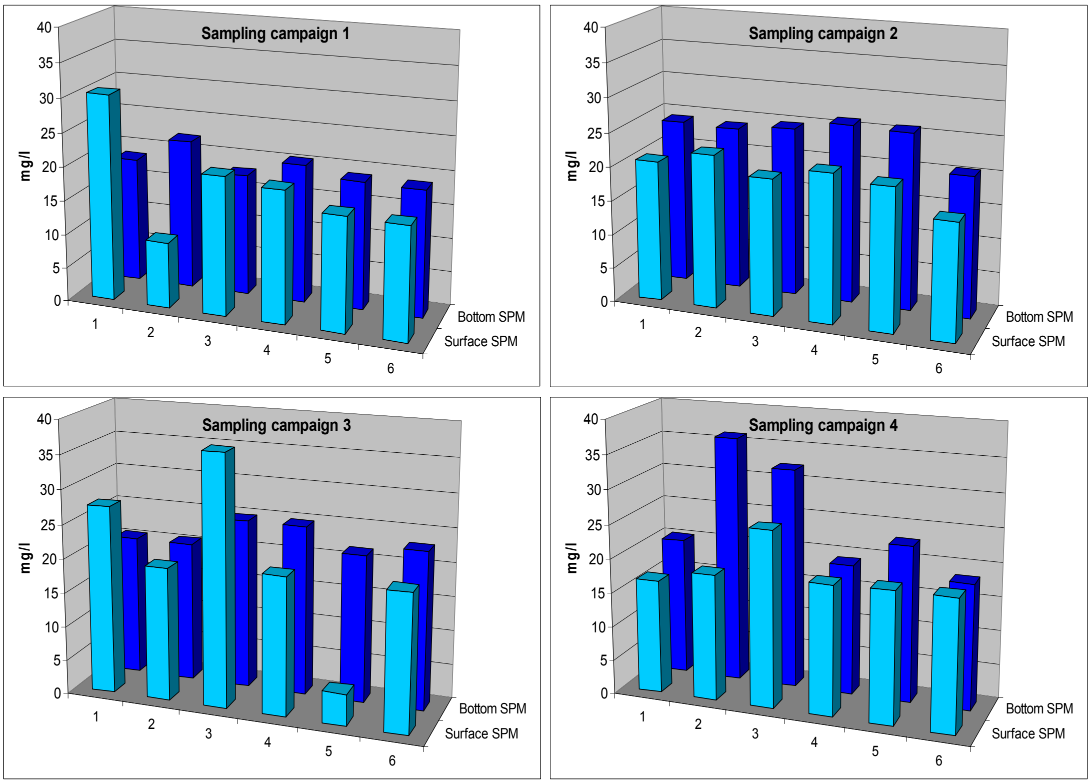
**Turbidity and water suspended matter**

Suspended particulate matter was relatively uniform throughout the sampling stations, especially at the bottom layer, mainly between 16 and 26 mg/l. The lowest value (4.6 mg/l) is encountered at the surface, as well as the maximum (36.6 mg/l). Consequently, SPM variability is higher close to the surface. SPM content in excess of 30 mg/l are found in the port waters (stations 1 and 2), and close to the existing Quay 1 end (station 3). This can be due to port activities (vessel propellers). Stations 5 and 6, influenced by oceanic cleaner waters, have the minimum SPM content means (18.8 and 19.2 mg/l respectively). At the opposite, the highest SPM content mean is for Station 3, with 25.3 mg/l

**Suspended matters (mg / l)**

| | | Station 1 | Station 2 | Station 3 | Station 4 | Station 5 | Station 6 |
|---|---|---|---|---|---|---|---|
| 02/05/07 | Surface | 30.4 | 9.7 | 20.4 | 19.4 | 16.8 | 16.5 |
| | Bottom | 18.5 | 22.1 | 17.9 | 20.4 | 18.9 | 18.7 |
| 30/07/07 | Surface | 20.6 | 22.5 | 20.0 | 21.8 | 20.9 | 17.0 |
| | Bottom | 24.2 | 24.0 | 24.8 | 26.2 | 25.9 | 20.6 |
| 30/09/07 | Surface | 27.5 | 19.5 | 36.6 | 20.2 | (**) | 20.0 |
| | Bottom | 20.5 | 20.5 | 27.6 | 24.8 | 21.5 | 23.0 |
| 23/10/07 | Surface | 16.6 | 18.5 | 25.8 | 19.0 | 19.2 | 19.2 |
| | Bottom | 20.2 | 36.1 | 32.2 | 19.2 | 22.9 | 18.4 |

**Figure 9. SPM content at the six sampling stations**




## Bacteriological water quality

In terms of bacteriological water quality, considering that the sampling area in the vicinity of a port in a semi-closed bay bordering a mid size city, we found a relatively good situation. At most stations bacterial abundance was negligible or very low. At the bottom layer near the port (stations 2 and 4) values were slightly higher in may 07, above maximum recommended but well below maximum admissible. These values are most probably related to fish and other products discards from the fishing terminal and larger ships in the port. It would be interesting to observe the situation when events of land drainage due to rains occur, bringing accumulated materials along the riverine lines.

**Table 16. Water microbiology in Praia Bay**

Total Coliforms (Colonies/ 100 ml)

| | | Station 1 | Station 2 | Station 3 | Station 4 | Station 5 | Station 6 |
|---|---|---|---|---|---|---|---|
| 02/05/07 | Surface | < 10 | 10 | < 10 | 10 | < 10 | < 10 |
| | Bottom | 10 | 178 | < 10 | 192 | 64 | 53 |
| 30/07/07 | Surface | Not available | | | | | |
| | Bottom | Not available | | | | | |
| 30/09/07 | Surface | 20 | 30 | 50 | 70 | 12 | 90 |
| | Bottom | 7 | 10 | 40 | 50 | 20 | 74 |
| 23/10/07 | Surface | 5 | 2 | 10 | 22 | < 1 | 30 |
| | Bottom | 10 | 9 | 10 | 40 | 24 | 10 |

Fecal Coliforms (Colonies/100 ml)

| | | Station 1 | Station 2 | Station 3 | Station 4 | Station 5 | Station 6 |
|---|---|---|---|---|---|---|---|
| 02/05/07 | Surface | < 10 | | < 10 | < 10 | < 10 | < 10 |
| | Bottom | < 10 | < 10 | < 10 | 20 | < 10 | < 10 |
| 30/07/07 | Surface | Not available | | | | | |
| | Bottom | Not available | | | | | |
| 30/09/07 | Surface | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 |
| | Bottom | 4 | < 1 | 2 | 4 | < 1 | < 1 |
| 23/10/07 | Surface | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 |
| | Bottom | 3 | < 1 | 6 | < 1 | < 1 | < 1 |

*E. Coli* (colonies/ 100 ml)

| | | Station 1 | Station 2 | Station 3 | Station 4 | Station 5 | Station 6 |
|---|---|---|---|---|---|---|---|
| 02/05/07 | Surface | < 10 | 10 | < 10 | 10 | < 10 | < 10 |
| | Bottom | < 10 | 150 | < 10 | 178 | 64 | 53 |
| 30/07/07 | Surface | Not available | | | | | |
| | Bottom | Not available | | | | | |
| 30/09/07 | Surface | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 |
| | Bottom | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 |
| 23/10/07 | Surface | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 |
| | Bottom | 3 | < 1 | 4 | < 1 | < 1 | < 1 |

| | Total Coliforms | *E. coli* | Fecal Coliforms |
|---|---|---|---|
| **Maximum recommended** | 500 / 100 ml | 100 / 100 ml | 100 / 100 ml |
| **Maximum admissible** | 10 000 / 100 ml | 2 000 / 100 ml | |

**Nutrients**

The set of data obtained for nutrients does not correspond to what should be expected in these waters. The nitrate plus nitrite values were very low, the majority below detection limit of our system, i.e. < 0.4 µmol/l.

However, phosphate values ($PO_4$) were extremely high. Normally, the molar ratio of Nitrate to Phosphate (N/P) in ocean waters is near 15. According to Kennish (2001), the low values for nitrates obtained are in the range of those reported for Tropical Aquatic Ecosystems, from 0.0 to 2.0 µmol/l, but phosphates should be in the order of 0.0 to 0.4 µmol/l. The results obtained presently for $PO_4$ in Praia Bay, Cape Verde, were above 3 µmol/l, a value higher than values obtained for instance for the Portuguese neritic coast, with the exception of Lisbon Bay (which is influenced by the strong plume in the Tagus Estuary), where $PO_4$ maximum in summer is 0.8 and in winter 9.0 µmol/l (Cabeçadas et *al*, 2000). We cannot explain these results with the available information. A possible hypothesis that should be studied is whether there is any anthropogenic source of phosphate in the bay, or if it was due to any unusual event.

**Table 17. Water nutrients in Praia Bay**

**Nutriments $NO_3^-$ (µmol/l)**

| | | Station 1 | Station 2 | Station 3 | Station 4 | Station 5 | Station 6 |
|---|---|---|---|---|---|---|---|
| 02/05/07 | Surface | < 0.4 | < 0.4 | < 0.4 | < 0.4 | < 0.4 | < 0.4 |
| | Bottom | < 0.4 | < 0.4 | 0.50 | < 0.4 | 2.96 | < 0.4 |
| 30/07/07 | Surface | < 0.3 | < 0.3 | < 0.3 | < 0.3 | < 0.3 | < 0.3 |
| | Bottom | < 0.3 | < 0.3 | < 0.3 | < 0.3 | < 0.3 | < 0.3 |
| 30/09/07 | Surface | < 0.4 | < 0.4 | < 0.4 | < 0.4 | 1.8 | 1.3 |
| | Bottom | < 0.4 | < 0.4 | 1.7 | < 0.4 | < 0.4 | 2.1 |
| 23/10/07 | Surface | < 25 | < 25 | < 25 | < 25 | < 25 | < 25 |
| | Bottom | < 25 | < 25 | < 25 | < 25 | < 25 | < 25 |

**Nutriments $NO_2^-$ (µmol/l)**

| | | Station 1 | Station 2 | Station 3 | Station 4 | Station 5 | Station 6 |
|---|---|---|---|---|---|---|---|
| 02/05/07 | Surface | < 0.4 | < 0.4 | < 0.4 | < 0.4 | < 0.4 | < 0.4 |
| | Bottom | < 0.4 | < 0.4 | < 0.4 | < 0.4 | < 0.4 | < 0.4 |
| 30/07/07 | Surface | < 0.3 | < 0.3 | < 0.3 | < 0.3 | < 0.3 | < 0.3 |
| | Bottom | < 0.3 | < 0.3 | < 0.3 | < 0.3 | < 0.3 | < 0.3 |
| 30/09/07 | Surface | < 0.4 | < 0.4 | < 0.4 | < 0.4 | < 0.4 | < 0.4 |
| | Bottom | < 0.4 | < 0.4 | < 0.4 | < 0.4 | < 0.4 | < 0.4 |
| 23/10/07 | Surface | < 0.02 | < 0.02 | < 0.02 | < 0.02 | < 0.02 | < 0.02 |
| | Bottom | < 0.02 | < 0.02 | < 0.02 | < 0.02 | < 0.02 | < 0.02 |

**Nutriments $PO4^{3-}$(µmol/l)**

| | | Station 1 | Station 2 | Station 3 | Station 4 | Station 5 | Station 6 |
|---|---|---|---|---|---|---|---|
| 02/05/07 | Surface | 3.61 | 3.60 | 3.63 | 3.56 | 3.58 | 4.05 |
| | Bottom | 3.65 | 3.68 | 3.62 | 4.52 | 3.66 | 3.63 |
| 30/07/07 | Surface | 3.816 | 3.857 | 3.720 | 3.853 | 3.806 | 3.764 |
| | Bottom | 3.499 | 3.554 | 3.552 | 3.480 | 3.461 | 3.457 |
| 30/09/07 | Surface | 3.699 | 3.604 | 2.809 | 3.574 | 3.426 | 3.693 |
| | Bottom | 3.681 | 2.957 | 3.586 | 2.978 | 2.727 | 3.172 |
| 23/10/07 | Surface | < 5 | < 5 | < 5 | < 5 | < 5 | < 5 |
| | Bottom | < 5 | < 5 | < 5 | < 5 | < 5 | < 5 |

## 2.6. ARCHEOLOGICAL HERITAGE

### 2.6.1. Shipwrecks in Cape Verde waters and in the bay of Praia

Beginning in 1498, the captains of European ships (Portuguese, Dutch, English, and Danish) took advantage of the northeast trade winds to sail toward Brazil or along the African coast en route to the Cape of Good Hope. However, the ten islands of the Cape Verde Archipelago, lying 629 km off the west coast of Africa, posed a lethal hazard. Ships often ran aground on the shallow offshore reefs. Archival research indicates the presence of more than 300 shipwrecks in Cape Verde waters.

Praia City has grown from a port which was already working at the end of the 15$^{th}$ century. The inclusion of this bay on the routes taken by ships to the South Atlantic, Europe, West Africa and the Americas has made this port a favorable area for the existence of undersea archaeological remains. The occurrence of shipwrecks, naval battles and the landings of corsairs and pirates on various well-identified dates have made this bay a place of great interest for archaeological research.

| | |
|---|---|
| **1497** | Vasco de Gama stopped in the Bay of Praia to repair his ships, which had been damaged in a storm off the Canary Islands. |
| **1544** | In October of 1544, Captain Antonio Correia de Sousa wrote a letter to the King enlightening him about the Frenchmen who were behaving destructively in the archipelago. On the islands of Fogo and Santiago, after stealing up on them, ships were pillaged and sunk in the Bay of Praia, causing two other boats in the bay to run aground. Probably with some overindulgence, the Corregidor Pêro Moniz was accused to have favored the Frenchmen. |
| **1661- S. Bento**<br><br>**Patacho português** | Concerning this shipwreck, the sea Captain of Cacheu, Manoel Dias Quatrim, wrote to His Majesty on 26 November 1661, informing him of the incident: “On 28 August of this present year I sent a vessel that I own, commanded by my nephew Captain and Master Joao Lopez, loaded with niggers to serve as payment to Your Highness…”.<br><br>The letter also informs that the shipwreck occurred in the port of Praia, on 20 or 21 September. As a form of precaution they used two anchors, but these were found to be insufficient. The boat did not survive the bad weather. With the violence of the storm, the ship may have started to accumulate water and then sank. Many people died in this shipwreck including the nephew of the ship-owner, sailors and all the slaves who had worse luck than the rats because they were prisoners chained up without the possibility to escape by swimming. |
| **1662- Portuguese Galleon** | During the rainy season, another fleet heading towards India arrived in Santiago. S. Bento did not resist the strong winds and waves, although the warning of Governor to captain Pablo Gomes not to delay his stay in the port of Praia due to bad weather and the diseases that devastated the island. Taken by surprise by a night storm, the vessel was dragged towards the rocks and completely destroyed. Nine people died and the material loss was total.<br><br>September is the most terrible month in the bay of Praia. Sudden storms blow up and boats have to anchor away from the bay to prevent them from being dragged and jammed against islet of Saint Maria and the beaches. Modern boats still face difficulties in maneuvering in these conditions. This can be confirmed by the owners of Afrima, Witte Bank, the Fandling freighter and other boats that recently suffered from nature’s whims. |

| | |
|---|---|
| **1712 English vessels** | The 12 vessels of Jacques Cassard may have anchored in the bay of Praia and disembarked its men in Praia Negra or Portinho de Achada Grande, from where they spread throughout the island. The Church suffered its fatal blow with the assault. All the bells found in the village, 18 bronze cannon and all the possessions of the wealthiest households were taken. |
| **1809 Urania** | The *Urania:* (AGO-030) a Portuguese ship on its way to Brazil sank in 1809 in the bay of Cidade de Praia [9]. |

*Source: Emanuel Charles D’Oliveira. Cabo Verde, Na rota dos naufragios. 2005*

[9] GPS localisation of the 18th vessel *Uranio* wreck in the South of Santa Maria Island in 4 to 6 m depth (16 iron guns are supposed to be found in this wreck). N 14 54 284 / W 023 30 380 and N 14 54 289 / W 023 30 269

## 2.6.2. Underwater archeological heritage in the bay of Praia[10]

**Local undersea archeological exploration**

To explore the historic and cultural potential of these wrecks, the Republic of Cape Verde signed an exclusive agreement in 1995 with the Portuguese company *Arqueonautas,* licensed to conduct maritime archaeological operations in the territorial waters of Cape Verde from August 1995 to December 2002.

*Arqueonautas'* exploration efforts in the port of Praia were not particularly intense as neither the archive documents nor information obtained from local divers allowed the area to be classified as of high archeological interest, unlike the area of Cidade Velha, the first capital of the Cape Verde archipelago.

It is also revealing that of all of the requests from major archeological researchers (Philipe Delauze, Robert Stenuit, Eric Surcouf) to research and develop knowledge of the wrecks in Cape Verde waters, none relate to the port of Praia area, tending to corroborate and support *Arqueonautas'* strategic choices.

**Types of shipwrecks in the bay of Praia**

Modeling of shipwrecks in Cape Verde waters and the clues found during surveys based on archive documents and the thorough collection of information from local divers do not, at first sight, indicate renowned wrecks in the port of Praia area, at least not at depths of between 0 and 30 m. Most wrecks were due to navigation errors (reefs on northern weather shore) or to vessels moored leeward being driven ashore. This is the picture that emerges from historical reports of wrecks in the port of Praia area. In two cases, wrecking was the result of contact between the hull and the very shallow reefs or rocky coasts in bad weather.
For vessels with deep draft, the first traces of impact of the vessel on the bottom generally appear at between 6 and 10 m, sometimes more if the crew has attempted to delay running aground by using the spare anchors. The vessels then break up over several hundred meters. In bad weather conditions the waves are high enough to strand a vessel.

As the seabed in the port of Praia has no rocks at low depths (10 m), this model does not hold and only an exceptional event such as a naval battle could be the cause of a wreck in the port of Praia expansion and modernization area.

**Archive documents**

The national maritime archives and those of trading companies that have used the Cape Verde waters studied by numerous company members and informants are sufficiently complete to give the names of the wrecked vessels, the value of their cargo and their, even approximate, location. Reports from survivors, royal or colonial commission inquiries and insurance companies

[10] Author: Alain HURTEBIZE, plongeur professionnel résident au Cap Vert depuis 1990. Chef plongeur et responsable la recherche des épaves de la compagnie Arqueonautas de 1999 à 2002 au Cap Vert. Chef plongeur d'expéditions archéologiques au Mozambique 2003 et 2004

indicate that the only wrecks in the port of Praia area were on the shores of Santa Maria Island.

In March 2000, Alain Hurtebize was tasked by Nikki Sandizell Director of *Arqueonautas*, with analyzing all of the archive documents relating to the Praia naval battle in which the French Navy, commanded by le Bailli de Suffren, routed the English Navy on 16 April 1781. No English or French ships were sunk during this engagement.

Numerous archive documents attest to the capacity of underwater engineering companies, especially English, to obtain concessions and then salvage wrecked vessels and their cargoes. Numerous wrecks around the islands of Maio, Sal and Boavista have been salvaged. Canons, anchors, lead ballast weights and different types of cargo and coins have been brought to the surface.

Also, the capacity of local populations to retrieve the remains of stranded vessels, often above the water line after a storm, cannot be under-estimated. It should be borne in mind that the Vila de Maio church was built with the proceeds from the sale of the remains of the *Ernest Schiemelman*, a Danish naval vessel, salvaged by the population of Maio.

It is therefore certain that if ships had come to grief in past centuries in the port of Praia, on the coast of Santa Maria Island, successful attempts would have been made to salvage them.

**Information from local divers**

The port of Praia area has been the subject of thorough investigation by local divers and fishermen, including the older members who began their lobster catching activities in the 1960s. Given the frequency of days of fishing multiplied by the very high numbers active in fishing for lobster, lambis and for fish, whether free-diving or with tanks, the statistical probability of a wreck visible in the area where the bed is at less than 20 m not being located is close to zero. This is all the more probable since the area of extension of Quay n° 1 and its swing circle were, for a long time, highly frequented fishing grounds as they are rich in lambis (the remains of the Urania lie outside of the project area). The only remaining doubt relates to possible mooring anchors.

**Underwater exploration**

In spite of the archive documents and information provided by local divers, which indicated little hope of finding historical wrecks, a grid was nonetheless put in place in the port of Praia area and the area was explored rationally by teams of company divers, in order to establish the GPS coordinates of parts and remains of vessels that could indicate the presence of wrecks. All of the resulting information was entered into the dive logs kept by each diver after each underwater exploration. For exploration in the port of Praia area at between 0 and 30 m the company used conventional means: underwater scooters, exploration charts, metal detectors, sediment probes. With the exception of the *Urania*, no wrecks of historical interest were in the port of Praia area.

The port of Praia area was not therefore classified as a priority archeological zone by *Arqueonautas*. Only the wreck of the *Urania* close to Santa Maria Island was excavated, and then only during periods of bad weather that prevented the archeological exploration vessel the *Polar* from working in the priority zones.

Side-scan sonar reconnaissance carried out in 2007 over the entire project area revealed only five recent wrecks of no archeological value (vessels sunk since the 1980s, of steel, wood and plastic).

During the geophysical survey carried out in April 2007, three recent shipwrecks were found in the inner part of the bay of Praia. They were filmed by divers. These wrecks are recent fishing boats and have no additional patrimonial value. No traces of old wrecks were found, except an old (not ancient) anchor.

### Use of the magnetometer by *Arqueonautas*

The magnetometer is an instrument that is particularly effective for the rational exploration of underwater areas in which visibility is low, such as estuaries or beds of soft deep sediments into which the heavier and denser parts of a wrecked vessel will sink over the centuries; when the seabed is not accessible to SCUBA divers; or in coral seas when the coral have attached to and entirely cover the remains of a wreck. Visual exploration alone is not sufficient to detect the presence of wrecks.

After 1997, magnetometers were no longer used in *Arqueonautas* exploration campaigns as a means to detect steel masses that might be buried in the sediments and that could indicate the possible presence of a wreck. As the campaigns using magnetometers in previous years, overseen by an English technician from the *Aquascan* company had not produced any conclusive results, for a variety of reasons, the company's technical management decided that use of the magnetometer—which had never been used in the search for wrecks in the port of Praia area—was not a determining factor in the search for wrecks in depths of 0 to 50 m.

Moreover, the very nature of the volcanic rocks caused systematic triggering of the magnetometer's alert system and the correlation between ‘hits’ detected and their confirmation by divers did not indicate that this was an effective and reliable means of exploration in the geological context of Cape Verde.

### Conclusions and recommendations

- It is accepted that the historical shipwrecks in the port of Praia area occurred around Santa Maria Island and that the wrecked vessels were totally or partially salvaged. They are not within the project area.

- The possibility of finding a wreck buried in the sediments close to the dredging area cannot be totally excluded. It is therefore recommended that archaeological support be provided during the dredging work in order to identify signs of a wreck and associated historical objects (daily check by qualified and experienced diver).

- In the event of unforeseen discovery during dredging, the wreck should be located and dredging carried out around the position to lower the level of sediment to expose the wreck without it being contaminated. Attention is drawn to the fact that the salvage excavation of a wreck in the sediments in the port of Praia would require very considerable investment in terms of time and resources[11].

The Institute of Research on the Cultural Heritage (Ministry of Culture) intends that archaeological survey or salvage excavation should be carried out in order to protect the underwater cultural heritage potentially affected (cf. *letter from the Ministry of Culture next page*).

## 2.6.3. Land historic heritage

| | |
|---|---|
| **Arriba da Mulher Branca** | The Arriba da Mulher Branca, overlooking the present port, was the site of a defense battery which operated until the end of the 18th Century. This feature was not preserved and so there are no remains to be found. Until the end of the 19th Century, a wharf was located at the base of the Arriba da Praia Negra (Pedra Fernandes), currently occupied by the dock access road. In the final decades of the 19th Century, with the construction of the São Januário dock, the wharf was transferred to Gamboa beach. The silting-up of this dock required other infrastructures to be built at Gamboa. However, all of these are now abandoned. |

| | |
|---|---|
| **Santa Maria island** | Santa Maria island has always functioned as an additional space for the bay's port activities. In the 19th Century it was used as a coal store and later on, in the middle of the 20th Century, it was used as a quarantine station. |
| **Santa Maria da Vitória Plateau** | On the Santa Maria da Vitória Plateau is the historical centre of the City where most patrimonial features which are worth preserving can be found. A proposal has been made for the Santa Maria da Vitória Plateau to be included on the humanity heritage list. |

In the port expansion area there are no features of patrimonial value. The built-up zone of Achada Grande is used for industrial purposes and the rest of the area is wasteland.

[11] It will be recalled that in 1998 and 1999—in the Cidade Velha mooring ground, at a depth of 20 m—*Arqueonautas* salvaged a wreck sunk into the seabed sediment formed by alluviums discharged during the rainy season. The technique used to free the wreck was the airlift. Although this operation yielded a number of artifacts—pottery and ceramics in particular—it did not allow the deep layers of sediment to be reached. As these layers are of very fine grains, the edges of the excavation fall in and the excavation fills up within less than 24 hours.

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REPÚBLICA DE CABO VERDE
MINISTÉRIO DA CULTURA
INSTITUTO DA INVESTIGAÇÃO E DO PATRIMÓNIO CULTURAIS

**Senhor**
**Laurent Mehdi Brito**
**Director do MCA – Cabo Verde**

**N/Refª42/IIPC/07** **Praia, 13 de Março de 2007.**

**ASSUNTO: Dados e informações para o Projecto de Modernização e Expansão do Porto da Praia**

**O Instituto da Investigação e do património Culturais tem a honra de acusar a recepção da nota de V. Excia, datada de 05 de Março, sobre o assunto em epígrafe.**

**Em relação ao conteúdo da mesma, temos a informar o seguinte:**

**O fundo dos mares de Cabo Verde constitui um rico depósito de navios afundados ao longo dos séculos.**

**O Porto da Praia, bastante frequentado, também ao longo dos séculos, serviu de cemitério de navios que, por motivos vários, afundaram nas suas águas.**

**Este Instituto entende que qualquer trabalho a ser realizado no Porto da Praia deverá ser precedido de prospecções arqueológicas para detectar a localização exacta dos naufrágios e consequente levantamento dos objectos/artefactos que neles jazem.**

**O Instituto já comunicou ao Ministério das Infraestruturas os locais a serem protegidos de mergulhos de turistas e outros que poderão servir de base para os trabalhos futuros nos nossos mares.**

**É quanto nos cumpre levar à consideração de V. Excia, estando disponíveis a prestar informações adicionais que se julgar necessárias.**

**Com os nossos melhores cumprimentos.**

MINISTÉRIO DA CULTURA
INSTITUTO DA INVESTIGAÇÃO E DO PATRIMÓNIO CULTURAIS

**O Presidente,**

**Carlos Alberto de Carvalho**

**CC:**

- **SE Senhor Ministro da Cultura**
- **Gabinete do Ministro das Infraestruturas, Transportes e Mar**

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**2005 – Ano do Trigésimo Aniversário da Independência Nacional**

# 3. LAND ENVIRONMENT

## 3.1. GEOLOGY IN THE PRAIA REGION

Cape Verde is situated to the west of the Magnetic Quiet Zone in the middle of the African oceanic lithosphere, dated at 142 and 115 million years, respectively. There is consensus in the geological literature that the formation of the Cape Verde archipelago is associated to a mantle plume and that the islands are the surface expression of a deep hotspot which has intermittently affected the African plate as it expanded to the east. The recent volcanic activity (historical and present-day) in the Fogo strato-volcano (for example, in 1951 and 1995) and the seismic activity felt on Fogo and Brava indicate that the geological processes are still active.

The geology of Santiago is relatively complex and the rocks found there are essentially volcanic in nature; however, terrestrial and marine sediments also occupy relatively extensive areas, although the volume of these sediments is small in comparison with that of the lavas.

The main geological outcrops in the Praia region include eruptive and sedimentary formations.

| | |
|---|---|
| ***Eruptive formations*** | **Internal eruptive complex (pre-Miocene)**, ancient, of which the outcropping rocks are mainly those belonging to the veined complex (CA).On the coast these rocks occur from Ponta da Achada to about 500 m to the east of Ponta da Mulher Branca (or Ponta do Visconde),to the east of Praia bay, on the scarp cut by the sea. Serralheiro (1976) also refers to outcrops of this complex at the bottom of Praia bay, between Achada de Santo António and Ponta da Mulher Branca. |
| | **“Flamengos” Formation (Miocene)**, with outcrops restricted to the periphery of Achada de Santo António (Tira Chapéu and Várzea da Companhia outcrops) and to the coast to the south and west of Praia Port. |
| | **“Pico da Antónia” Eruptive complex (Plio-Miocene)**, which includes basaltic, products of explosive and effusive activities. These are both subaerial and submarine in nature and are responsible for the highest levels and flat structural platforms seen on the island (the “Achadas”). This complex’s outcrops cover most of the surface to the east and north of Praia City (most of the island of Santa Maria and the coastal strip to the west of Praia City, in a belt extending about 800 m inland. |
| | **Monte das Vacas Formation (Quaternary),** which is found in Monte Vermelho and Palmarejo Grande, to the west of Praia City, corresponds to small volcanic structures. |

| | |
|---|---|
| ***Sedimentary Formations*** | **Pre-Flamengos Formation conglomerates (Miocene)**, marine, ancient, not common in this area.<br><br>**Pliocene conglomerates and limestone** – these are marine and continental rocks which occur in small outcrops near to Praia, in Praia Port and on Santa Maria island – sediments pre-dating the upper submarine lavas of Pico da Antónia (old beach deposits, poorly consolidated, comprised of fossiliferous limestone and calcarenite, with a basal conglomerate);<br><br>**Pleistocene gravel beds**<br><br>**Holocene slope deposits**<br><br>**Holocene alluvium**<br><br>**Holocene beach sands and gravels** – found in Praia Bay; the gravel layers are seen in the north part of the bay, at the mouth of the watercourse formed by the confluence of the Trindade, São Filipe and Água Funda streams, closing it off completely; the beach sands are found in a wide continuous strip in the western zone of the bay and in sharp coastal inlets, generally associated with stream mouths, where they form small detrital deposits. such as that of Palmarejo Pequeno stream and Achada Grande. |

## 3.2. GEOMORPHOLOGY OF THE PRAIA REGION

The most important urban nucleus of the town of Praia is built on the Achada de Santo António plateau and also occupies the Achada Grande and Achada de Baixo plateaux and the alluvial depression resulting from the coalescence of the gorges of the Trindade, Safende, São Filipe and Água Funda streams.

The edges of the plateaux are well defined and have single or multiple slopes, scarps or escarpments, which are the transition to a high coastal platform which is relatively flat or which borders the sea. The high coastal platform, with maximum heights of 12-15 m, is clearly visible on the Ponta Temerosa peninsula and on Santa Maria island where it is most developed, and ends in an abrupt cornice over the sea or passes through an escarpment to a lower, narrower platform. In both cases the platform is bordered by rocks and large blocks which protect the base of the slope.

The alluvial depression has a flat base filled with recent deposits and extends to the north and to the interior of the terrestrial margin protection and shelter is offered by Praia bay. The fluvial sedimentation of this (and other) coastal depressions is favored by the transgressive Holocene regime. In other stream mouths and deep coastal inlets, less favored from the point of view of alluvial sedimentation, small rias have developed. The coast line outside Praia bay is generally steeply sloping with fallen rocks and blocks protecting the base of the slope.

Symptoms of instability can be seen on the slope near to the port. These signs include the falling (preceded by slippage) of large rock blocks, released from flows by prismatic jointing as well as by granular disintegration. There are frequent falls of small stones and micro-avalanches related to high fracture density. The occurrence of rain showers leads to the development of gullies and promotes the movement of slope deposits. It should be noted that the plateau next to the top of the slope is already occupied by various types of buildings and more are being put up. There are several examples of constructions which are at risk of collapsing or which are located very near to the slope edge.

On the 2003 aerial photograph, the beaches show reflection characteristics, including beach-cusps at the edges of the larger beaches (Praia Grande and Quebra Canela). The sand crescents, smaller and enclosed, are reduced to low ramps at the edges, indicating sedimentary shortage. The port region is installed on the eastern front of the bay, at the base of the scarp which borders the Achada Grande plateau. A relatively extensive land cutting has developed. The Customs dock defines a trend which, on the 1946 hydrographic map, coincides in a general way with the alignment of the greatest depths in Praia bay. The 10-m isobath comes close to the land outside the mouth of the bay and only inside the bay does it stay a significant distance away from the shore; we can thus conclude that the crags at the edge of Praia Bay extend steeply underwater to a depth of about 10-12 m.

## 3.3. HYDRO-GEOLOGY AND UNDERGROUND WATER QUALITY

| | |
|---|---|
| **Basal Series** | This is comprised of the Internal Eruptive Complex formation (Pre-Miocene) and the Flamengos Formation (Miocene). These formations are very compact. They have a large number of veins and there is a great thickness of more recent ground covering them. In the area being studied they crop out extensively.<br>This series is generally water-bearing. The storage coefficient varies in the various formations, being higher in the breccias of the Flamengos formation than in the ancient complex. Permeability is low and, accordingly, this series is the substratum for the main springs. Wells opened in the internal eruptive complex produce between 5 and 15 $m^3$/day. Bore holes can produce flows between 2 and 7 $m^3$/h to depths in the order of 20 m. |
| **Intermediate Series** | This series includes the Pico da Dona Antónia eruptive complex (Plio-Miocene).This is the main aquifer storage unit of the island as it is very thick, has a relatively high storage coefficient and very low permeability, which avoids quick emptying of the aquifer. The series is composed of lava flows several metres thick with average porosity of 4 to 5 % in some places. Between each flow are essentially impermeable levels of fine-grained, consolidated, and altered ancient soils, alluvium and pyroclastic deposits. At the base of the flows there is a breccia with much higher permeability and porosity levels than the rest of the unit, which is about 2 %. Average permeability is very weak, between $10^{-5}$ and $10^{-6}$ m/s. |
| **Alluvium and other recent deposits** | These are relatively widespread and are nearly always coarse-grained; the most recent levels are, in general, finer grained. They have very high permeability, favoring infiltration and landslips. These aquiferous systems are exploited by wells and |

drill holes which yield between 100 and 1 000 $m^3$/day.The water from the basalts (ashes and pyroclastics) of the intermediate and recent series are poorly mineralized, with a dry residue less than 300 mg/l and a low chloride content of less than 60 ppm. In the breccia formations of the Miocene (FL), the mineralization is slightly higher, with dry residues in the order of 500 to 1 000 mg/l. In the Ancient Complex (CA) mineralization reaches 3 to 6 g/l. The recent series, made up of alluvium and pyroclastics, is characterized by high permeability, and high infiltration occurs in these zones.

## 3.4. BIOPHYSICAL CHARACTERIZATION

***Annex 3*** presents the complete report of the biophysical characterization of the Praia Port expansion area[12].

### 3.4.1. Geomorphology and geological structure

The main land form around Santa Maria Beach bay, as well as the southeast and south areas of Santiago Island, has extensive structural tablelands of columnar lava, locally named as "plateau". Achada Grande is a tableland that on the top has sub aerial lava placed on submarine lava that overlaps with Miocenic marine sedimentation and the anti Miocenic Ancient Complex. On the surface area of the "plateau" there are traces of quaternary marine sedimentation that bear witness to a marine transgression over 40 m high than the present level. This might be counterbalanced by the general rise of the island in recent geological seasons.

Within the project's intervention area Achada Grande ends on a 30-m to 40-m-high cliff. This cliff drops straight down to the sea and has been shrinking fast due to the existence of whitish material on its base, namely extremely changed basalts from the Ancient Complex and calcarenites. At the base of the cliff, however, large blocks pile up and fall off the cornice. Occasionally these blocks protect the cliff against the ocean's erosive force.

[12] GEOSOLVE, June 2005. Aline Rendall, José Maria Semedo, Samuel Fernandes Gomes

The cliff's layer of submarine basalts presents a considerable amount of caves between the lavas. These caves serve as shelter for the avifauna, both marine, being close to their feeding source, and terrestrial, which, due to the steepness of the cliff, are protected from their enemies.

### 3.4.2. Vegetation and flora

Achada Grande, like all the "plateaus" south of the island, is at a dry altitude in the agro-ecological chart and vegetation classification on the island of Santiago. With a rainfall level of less than 300 mm per year in wet years, annual grasses, bushes and trees, which have adapted to dryness, are the dominant vegetation.

Concerning Achada Grande above the cliff, the unauthorized cattle breeding since the beginning of the occupation towards the end of the 1960's has caused considerable reduction of the plant covering due to overgrazing. Wind erosion combined with rain concentrated in the wet season transformed it into a field of stones. For the past few years Achada Grande has been hard pushed by urban sprawl, especially warehouses and other equipment related to harbor activity.

This area is characterized by a degraded vegetation cover with dominance of herbaceous tufts, adding up to 21 (twenty one) species, including those with specific localization such as small shrubs and trees, honey mesquite (*Prosopis juliflora*) and rooster tree (*Calatropis procera*). These plant species are not included in Cape Verde's preservation norms. It's important to point out that only one species, (*Sarcostemma daltinii*), on the top of the cliff, is on the endangered species list. This endemic Cape Verdean plant was found in the investigation zone, but is not located in an area out of the project footprint.

*Sarcostemma daltinii (*gestiba*)*

Among all the 21 species mentioned, this is the only one present that it is considered rare and endemic; it stands out on the cliff and figures on the endangered species list. This endemic plant[13] can also be seen in Santo Antão, São Vicente, São Nicolau, Boavista, Santiago, Fogo and Brava, on the stony, dry areas close to the sea. It is endemic to Cape Verde but the area where it grows is not on the project footprint.

### 3.4.3. Fauna

Achada Grande's faunal community is formed by birds from dry and desert-like regions such as the Sahel and the Sahara, reptiles from Santiago Island's dry areas and insects. Although there are endemic birds from dry areas and reptiles on the archipelago, none of these animal categories are exclusive or endemic to the project area.

Concerning avifauna, the existence of 14 native bird species of Cape Verde was confirmed in the project area, corresponding to 34.1 % of the archipelago's native bird species. Two of them are on the red list: *Phaeton aethereus* (Red-billed tropicbird) classified as an endangered species and *Pandion haliaetus* considered a rare species (Hazevoet, 1996)[14].

*Source: Aline Rendall*

***Phaeton aethereus***

**Red billed tropicbird**

**Preservation:** Catalogued as **endangered** according to Cape Verde's first Red List. Is among the extinction-endangered falcon species worldwide with the IUCN. **It reproduces on the site (cliff).**

One of the endangered species according to the red list (Hazevoet, 1996). Hazevoet (1995) estimated this species' population at 160 pairs. They are 1 m tall (40 cm correspond to the central tail feathers): 30 to 31.5 cm Weight: 650 to 700 g. White with black stripes on the back, the tip of the wing is also black and the beak is red. Young birds have yellow beaks and short tail.

**Distribution**: there are colonies in Santo Antão, Santiago, Brava, Sal and Boavista and on Raso and Rombo islets (Naurois, 1994; Hazevoet, 1995). It is estimated that there are 160 pairs in the whole archipelago.

[13] Endemic plants and indigenous trees of the Cape Verde Islands. Ministry of Environment, Agriculture and Fishery. DGA / UNDP-GEF-CVI/00/G41

[14] Aves de Cabo Verde, 1993. Bird Life International, INIDA.

Source: Natura 2000

### *Pandion haliaetus,*

### Osprey

Uncommon species, according to Cape Verde's first Red List. Extremely sensitive to human presence on nesting sites during reproduction season. Guincho is a reliable indicator of the environmental quality on the coastal region. It is an attractive species interesting to the public, and can therefore attract high-quality tourism.

**This species was seen feeding on the site.**

White face marked by broad dark stripes on either side that cross the eye. Dark dorsum contrasting with the white lower parts. The breast, especially on females, has several dark lines on it. Juveniles (less than a year old) resemble adults, but the dark feathers from the upper parts have a thin white and yellow outline. In flight the wings become slightly arched and slightly bent at the extremities. 43-56 cm wide, 167 cm wingspan, weight: 1.1-2.0 kg. Females are usually 10 % larger than males and weigh about 200 g more.

**Habitat:** since ospreys eat mainly fish, this fishing eagle lives near fresh or salty water

**Distribution**: 76-86 pairs are estimated to live on the archipelago and no more than 3 at Santiago (Palma *et al,* 2004)

***Falco tinnunculus alexandri***

Source: Aline Rendall

***Passer iagoensis***

The presence of three endemic species on the archipelago was also verified: *Falco tinnunculus alexandri, Passer iagoensis, Apus alexandri.* Nonetheless, these are considered to be species abounding on all the islands.

The rocky shore is a reproduction region for *Phaeton aethereus* and *Columba livia*. Most likely, the surrounding grounds are used by other the species: *Cursorius cursor, Ammomanes cincturus* and *Eremopterix nigriceps* for nesting. The *Apus alexandri* specimen, present in the area, probably uses the rock fissures for reproduction.

There are also references of migratory species: *Bubulcus íbis, Ardea cinerea, Numenius phaeopus, Arenaria interpres*, on the port surroundings (Hazevoet,, 1995; Colin & Geiregat, 2003 Krabbe *et al* 2003).

On the Plateau, there are normally at least two terrestrial reptile specimens, a wall lizard *Mabuya spp*, and *Hemidactylus bouvieri.* During a reconnaissance visit to the area on June 9, towards the end of the dry season, no specimens were seen. Although these are endemic species on the archipelago, they are not exclusive to the project area.

## 3.5. LAND USE AND ACCESS

### 3.5.1. Present occupation

The area can be divided into four main landscape units and described as follows:

- Landscape units ❶ and ❷: Industrial and Port Zone
- Landscape unit ❸: Residential Zone
- Landscape unit ❹: Natural Plateau
- Landscape unit ❺: Coastal area

- **Port ❶and Industrial ❷Zone**

The area where the port project is to be implemented is characterized by an industrial and port zone with boats, containers and other support elements for this activity. Thus, on account of its characteristics, Praia Port itself can be classified as a landscape unit.

- **Residential Zone ❸**

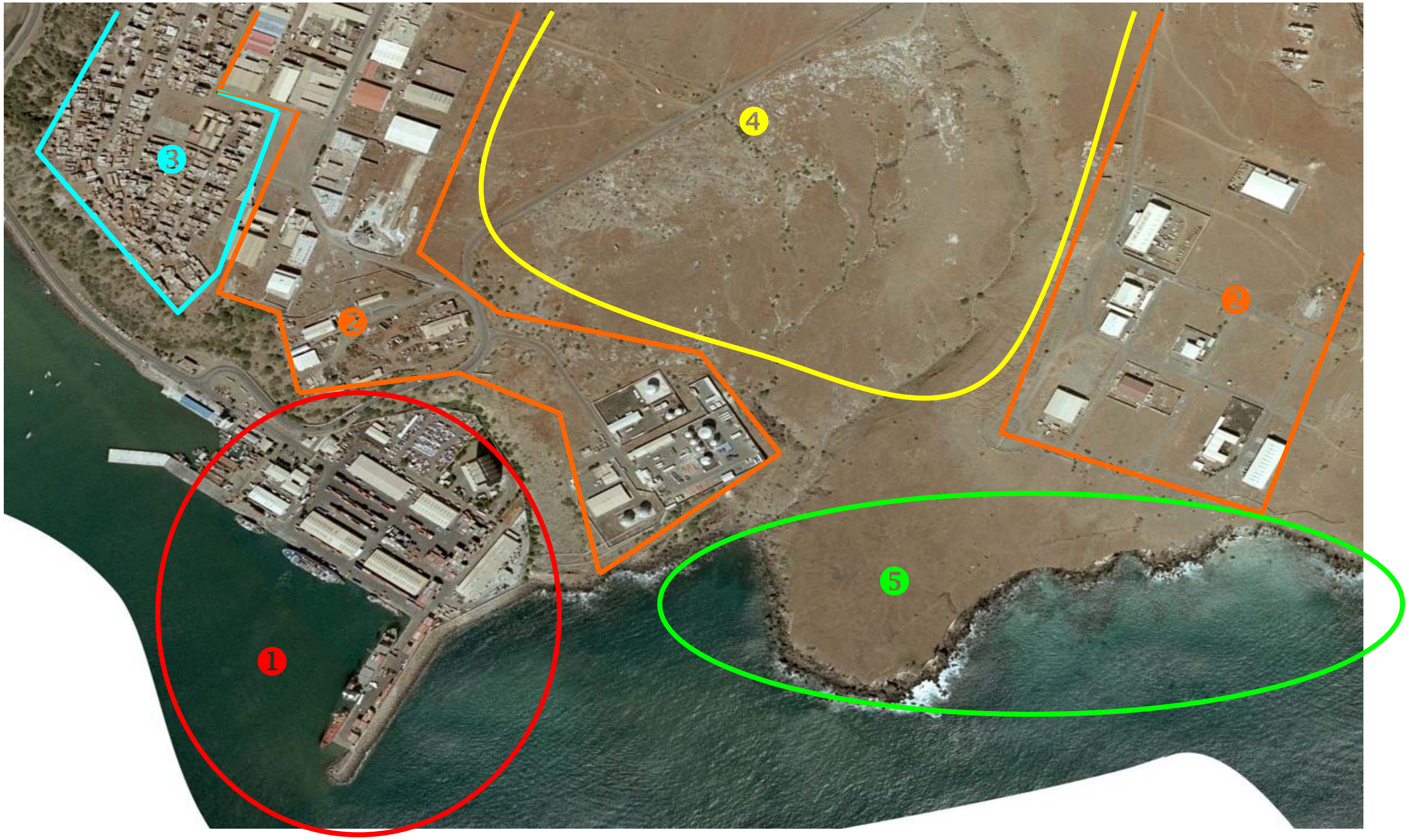
Near the area where the port project is to be carried out there is a residential zone characterized by low houses made of a variety of materials and with different colors.

- **Natural Plateau ❹**

The project area is situated near to the coast and some of the adjoining slopes are covered with creeping vegetation dominated by drought-resistant vegetation. The predominant tree/shrub size vegetation is *Prosopis juliflora* (mesquite) which is an exotic species and contributes greatly to improving the appearance of the landscape in this zone.

- **Coastal Area ❺**

Praia Bay which is a coastal area with a high landscape value.


3
2
4
2
1
5

### 3.5.2. Land use evolution

The Municipality of Praia has developed a development zoning map (PDM - Plano Director Municipal). The draft PDM is shortly to be submitted to a public inquiry. It aims at preserving the space necessary for the development of urban areas and activity zones (industrial, artisanal, commercial and mixed) and for the protection of natural zones. In the study sector, the PDM, currently being developed, aims to adopt the following orientations[15]:

- Enhancing the development of the industrial and commercial activity zone to the south of the airport, which extends on either side of the airport road (former runway),
- Covering the zone by a network of roads allowing exchanges between the east and west of the zone, linked to the airport road by roundabouts,
- Equipping this sector with wastewater (sewerage) and drinking water networks,
- Protection of natural areas (Patrimonio Historico Natural) consisting of small thalwegs and the coastal zone immediately to the east of the port facilities (Punta da Visconde),
- Ensuring that no further construction takes place in the area situated to the south of the airport which accommodates airport equipment (limited height of constructions, electromagnetic ancillaries).

The PDM will have to take into account the developments of the port area, including the cargo village.

### 3.5.3. Roads and access

The road access system leading to the port comprises a main road, the coastal road running alongside the Ribeira de Trindade and then the coast to the main port entrance. The port is also accessible from a road north of the port, from a roundabout where the 4-lane dual carriageway linking Praia to the airport comes to an end.

Praia Assomada highway has been built but is not yet open to traffic. It will link the north of the country to Praia via the airport.

This ring road mentioned above would be the principal part of the intended route for transporting the quarry materials to the port from all three quarries.

No traffic studies exist to enable the development of transit, service and exchange traffic on the road network to be anticipated. In preparation for evaluating the impact of transporting the materials required by the various port construction works, spot traffic measurements (07:00-19:00) were made on 19 July 2007 at two key points in the network:

- The Ribeira de Trindade roundabout (traffic counts between the airport and the town and the airport and the port of Praia, or vice versa),
- The Praia-Assomada road near the main quarries likely to be used for supplies of site material.

[15] Meeting with the Municipality of Praia, 10 July 2007. However no map was available.

Table 18. **Road traffic counts 0700-1900: Ribeira de Trindade Roundabout ↔ Praia Port (Point 1) and Praia ↔ Airport (Point 2)**

| **Point 1** | | | | **Point 2** | | | |
|---|---|---|---|---|---|---|---|
| Up | | Down | | Up | | Down | |
| LV | HV | LV | HV | LV | HV | LV | HV |
| 2 991 | 293 | 3 253 | 311 | 2 951 | 232 | 2 461 | 175 |
| 3 284 | | 3 564 | | 3 183 | | 2 636 | |
| **6 848 v/day** | | | | **5 819 v/day** | | | |

Lv = Light vehicle HV = Heavy vehicle

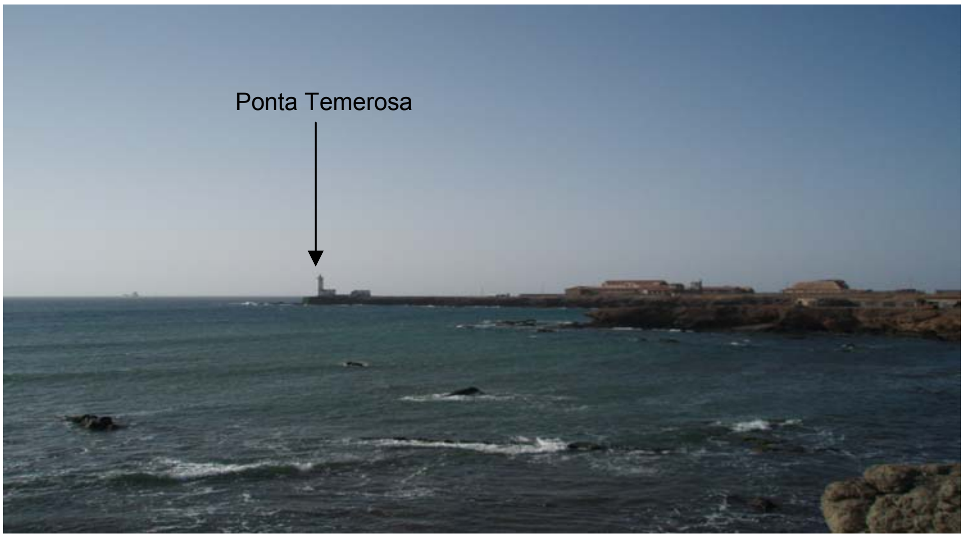
Table 19. **Road traffic counts 0700-1900: Praia ↔ Assomada)**

| **Point 3** | | | |
|---|---|---|---|
| Up | | Down | |
| LV | HV | LV | HV |
| 1 525 | 245 | 1 641 | 190 |
| 1 770 | | 1 831 | |
| **3 601 v/day** | | | |

## 3.6. VISUAL QUALITY OF THE LANDSCAPE

Praia Bay is very sheltered from the prevailing wave motions for two main reasons: it is located on the south coast and it is deeply indented, with more than 1,200 m of alltitude separating the top of the bay from the line of Temerosa and Bicudas points which limit the bay to the west and east. The Bicudas promontory in particular gives protection to the bay against all seas coming from north of east. This bay is, however, opened to the southeast and is thus exposed to the SE “Kalema”, to the rarer south seas and it also receives some diffracted energy from east seas when there are “lestadas” (East winds).

*Ponta Temerosa limiting the bay of Praia to the West*




*Ponta da Bicudas limiting the bay of Praia to the East*

Praia bay is bounded by a beach of fine sand that is growing, particularly near Santa Maria Island (note the "tombolo" effect resulting from the protection against the waves provided by the island). This beach extends to the foot of the plateau of the Old Town of Praia. Beyond this, the beach was done away with when the coastal road was built and protected by riprap.

The Santa Maria da Vitória Plateau is the historical centre of the City and is where we can find most patrimonial features that are worth preserving. A proposal has been made for the Santa Maria da Vitória Plateau to be included on the humanity heritage list.

Santa Maria Island is one of the key features of the maritime landscape of the bay. Santa Maria island has always functioned as an additional space for the bay's port activities. In the 19th century it was used as a coal store and later on, in the middle of the 20th century, it was used as a quarantine station

Praia port is one of the main components of the maritime landscape of Praia Bay. It is partially visible from the Santa Maria da Vitória Plateau, from where one can make out the main port infrastructures, quays and jetties and the movements of the ships. The on-shore facilities however are masked by the plateau facing Ponta da Achada, which is bypassed down below by the only road giving access to the port.

The recent wrecks of trawlers run aground in the Praia Negra Estuary bear witness to the maritime and port vocation of Praia Bay.

View from the exterior (Ponta da Visconde), the jetty of the port marks the entry into Praia Bay delimited to the west by the Ponta Temerosa.


Some port facilities contribute to spoiling the landscape, such as the gas and hydrocarbon storage tanks built on the plateau overlooking the port.

View from the end of the port's long jetty; the port facilities lie between Ponta da Achada and Ponta do Visconde. The absence of maritime constructions closing the bay to the south enables the bay to conserve its natural character.


The port is installed on the eastern front of the bay, at the base of the scarp bordering the Achada Grande plateau. The landscape is marked by the contrast between the industrial-port facilities at the foot of the plateau, which are relatively well masked, and the low town of Praia.

The coast line outside Praia bay is generally steeply sloping with fallen rocks and blocks protecting the base of the slope. Symptoms of instability can be seen on the slope near to the port. These signs include the falling, preceded by slippage, of large rock blocks, released from flows by prismatic jointing as well as by granular disintegration. There are frequent falls of small stones and micro-avalanches related to high fracture density. The occurrence of rain showers leads to the development of gullies and promotes the movement of slope deposits.

View of the Achada Grande plateau. The edges of the plateau are well defined and have single or multiple slopes, scarps or escarpments. They are the transition to a high coastal platform which is relatively flat or borders on the sea. The long dry season, as well as the irregularity of the rainfall, gives rise to creeping vegetation dominated by drought-resistant therophytes and some camephytes, particularly on this plateau open to the trade winds through the year.

## 3.7. NOISE LEVELS

This chapter identifies the main sources of noise as well as the population exposed in the Praia Port area and characterizes noise levels in a qualitative and quantitative form, through measurements near the exposed population and in the project area.

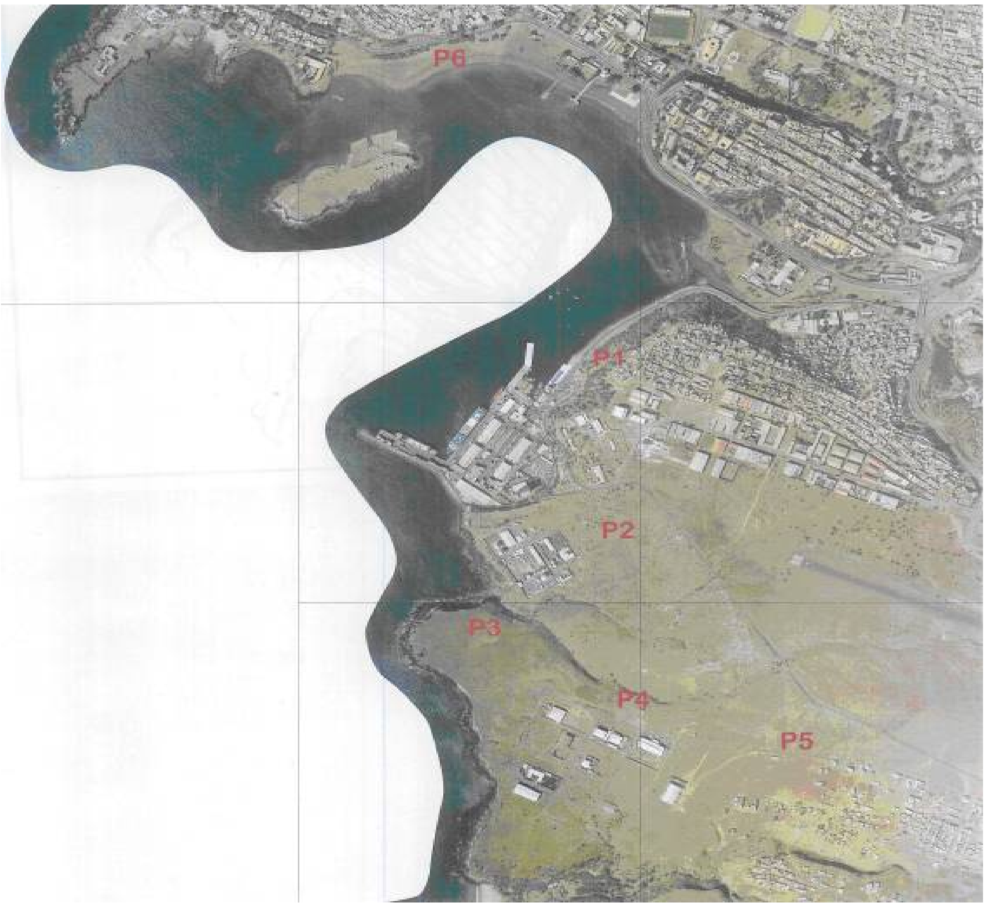
***Annex 4*** presents the complete report including methods and results[16].

### 3.7.1. Noise sources and exposed population

A visit verified that the main sources of noise in the area are Praia Port, access roads, Praia Airport and an industrial area.

The most exposed populations in the study area are houses located on access roads, houses next to the airport, houses and offices near the industrial area and houses next to temporary storage areas for heavy rocks.

Noise measurement points have been selected taking into account the exposed population (stations P1, P2, P4, P5 and P6) and one point without noise interference (station P3).




[16] GEOSOLVE. Environmental noise report, June 2007.

**Table 20. Noise sampling points**

| Noise measurement stations | Localization | Type of area (existing situation) according to the Portuguese Decreto – Lei nº 9/2007 |
|---|---|---|
| **P1** | Houses along Praia Port access roads | Sensitive area |
| **P2** | Houses near Praia Airport | Sensitive area |
| **P3** | Area without noise interference | Without classification |
| **P4** | Industrial Area (offices) | Mixing area |
| **P5** | Houses near Industrial Area | Mixing area |
| **P6** | Houses along Praia Beach sea front | Sensitive area |

**Table21 – Noise Levels according to the Portuguese Decreto – Lei nº 9/2007**

| Noise indicator | Limit levels in dB(A) | | |
|---|---|---|---|
| | Mixing areas | Sensitive areas | Without classification |
| Lden | 65 dB(A) | 55 dB(A) | 63 dB(A) |
| Ln | 55 dB(A) | 45 dB(A) | 53 dB(A) |

**Mixed area** is an area defined in municipal plan of territory order, whose occupation is affected to other uses, existing or foreseen and stops beyond the cited ones in the definition of sensible zone.

**Sensitive area** is an area defined in municipal plan of territory order vacated for housing purposes, or schools, hospitals or similar, or spaces of leisure, existing or foreseen, able to contain small commercial units and services to serve the local population, such as cafés and restaurants, stationery stores and other establishments of traditional commerce, not open during the night.

## 3.7.2. Results and environmental noise situation

**Table 22. Noise Indicator and limit levels according to the Portuguese Decreto – Lei nº 9/2007**

| Location | Noise levels in dB(A) | | Limit levels in dB(A) | |
|---|---|---|---|---|
| | Lden | Ln | Lden | Ln |
| **P1** | 52 | 44 | 55 | 45 |
| **P2** | 55 | 48 | 55 | 45 |
| **P3** | 55 | 43 | 63 | 53 |
| **P4** | 60 | 51 | 65 | 55 |
| **P5** | 60 | 51 | 65 | 55 |
| **P6** | 60 | 55 | 55 | 45 |

Noise level > Limit level

| |
|---|
| **Lden** is the day-evening-night noise indicator, in decibels (dB)A<br>**Ln = Lnight** is the A-weighted long-term average noise level as defined in ISO 1996-2: 1987, determined over all the night periods of a year and P;<br>**Day** covers the period 07:00 – 20:00 hours in any 24 hour period;<br>**Evening** covers the period 20:00 – 23:00 hours in any 24 hour period;<br>**Night** covers the period 23:00 – 07:00 hours in any 24 hour period;<br>In accordance with the General Noise Regulation (DL 9/2007), the classification of sensitive or mixed areas is the responsibility of city councils, having such zones to be delimited and to be disciplined in the respect of the Municipal Plan of Territory Order (n.º 2 of art. 6º). |

In conclusion, in the area under study, noise levels do not exceed the limits stipulated in the law, except for P2 and P6 where respectively the night level and the two limits are exceeded. P2 and P6 are mainly concerned by noise disturbance due to urban traffic (traffic along the seafront for P2 and port traffic for P6).

## 3.8. AIR QUALITY

The air quality assessment for the Praia Port expansion project will be made on a qualitative basis since there is no data available. Meetings with the Cape Verde Environmental General Direction were conducted in March 2007 with the aim of collecting available data regarding air quality. In that meeting the environmental expert team was informed that the network of air quality samplers in Santiago Island was in preparation and would not be implemented before the end of year 2007.

### 3.8.1. Air pollutant sources

During the on-site visits in the area proposed for project implementation the following air pollutant sources were identified:

- Maritime ship traffic (small, medium and large tonnage vessels);
- Cement unloading from the ships in the port;
- Heavy and light road traffic in and around the port access;
- Natural dispersion of dust caused by wind on the Achada Grande plateau;
- Combustion gases emitted by the power station (Electra) located near the Port which operates with diesel fuel;
- Air traffic in the vicinity of the port with the emission of $N_2O$ (from jet fuel) and other combustion gases.

Ship traffic due to normal port activity, associated with the intense circulation of vehicles for (freight purposes), cause emissions of particulate matter and combustion gases. The emissions of pollutants are aggravated due to the fact that traffic around the harbor comprises relatively old vehicles. The main pollutants identified are Carbon Monoxide, Sulphur Dioxide, Nitrogen Oxide, particulate matter and volatile organic compounds.

Particulate matter is caused by cement being unloaded from ships. The wind direction is from NE to SW in the direction of the sea.

The Achada Grande area is characterized by having a low degree of vegetation which contributes to accelerating erosion phenomena due to the action of the winds that blow all year round in this region. In this area, considerable dust emission from natural sources can be found.

### 3.8.2. Observed meteorological conditions

From a climatic point of view, Cape Verde is located in the Sahel region and therefore an arid climate predominates in the archipelago. (Marques, M. Monteiro).

According to Cunha, 1961 and Amaral, 1964, Santiago island is conditioned by latitude oscillations mainly from July to October – classified as the wet season in which irregular rains occur. The rainfall is characterized by high intensity, high quantity and short duration.

From the observations taken in Praia in the periods 1921/1930 and 1941/1950, the average monthly rainfall totals indicate a maximum value in September (112.6 mm), with a maximum monthly total over the period of 219.6 mm obtained in August of one year. (Hidroprojecto, 2004).

Data retrieved from the Instituto Nacional de Meteorologia e Geofísica – Praia Delegation showed the ten year series (1996 – 2005) of the last available meteorological data from the Praia Meteorological Airport Station.

**Table 23. Ten year series (1996 – 2005). Praia Meteorological Airport Station.**

| Parameter | Jan | Feb | Mar | Apr | May | Ju | Jul | Aug | Sep | Oct | Nov | Dez |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Maximum Average Temperature (ºC) | 27,2 | 27,4 | 28,8 | 28,6 | 28,4 | 29,0 | 29,9 | 30,6 | 31,1 | 31,5 | 29,3 | 28,4 |
| Minimum Average Temperature (ºC) | 20,2 | 20,2 | 19,9 | 20,6 | 21,0 | 22,1 | 23,3 | 24,3 | 24,7 | 24,2 | 23,3 | 21,4 |
| Average Temperature (ºC) | 23,4 | 23,3 | 24,1 | 24,2 | 24,7 | 25,7 | 26,5 | 27,2 | 27,5 | 27,5 | 26,1 | 24,5 |
| Mean Relative Humidity (%) | 67 | 63 | 61 | 64 | 67 | 68 | 73 | 77 | 78 | 74 | 71 | 71 |
| Mean Isolation (hr) | 6,0 | 7,2 | 7,6 | 8,9 | 9,3 | 8,3 | 6,6 | 6,3 | 6,6 | 7,3 | 6,7 | 6,6 |
| Total medium Rainfall (mm) | 0,9 | 0,1 | 0,2 | 0,1 | 0,0 | 0,0 | 5,1 | 45,4 | 53,5 | 27,4 | 4,0 | 0,2 |
| Mean Wind Rainfall (km/h) | 24 | 23 | 21 | 23 | 23 | 19 | 16 | 14 | 15 | 18 | 19 | 21 |

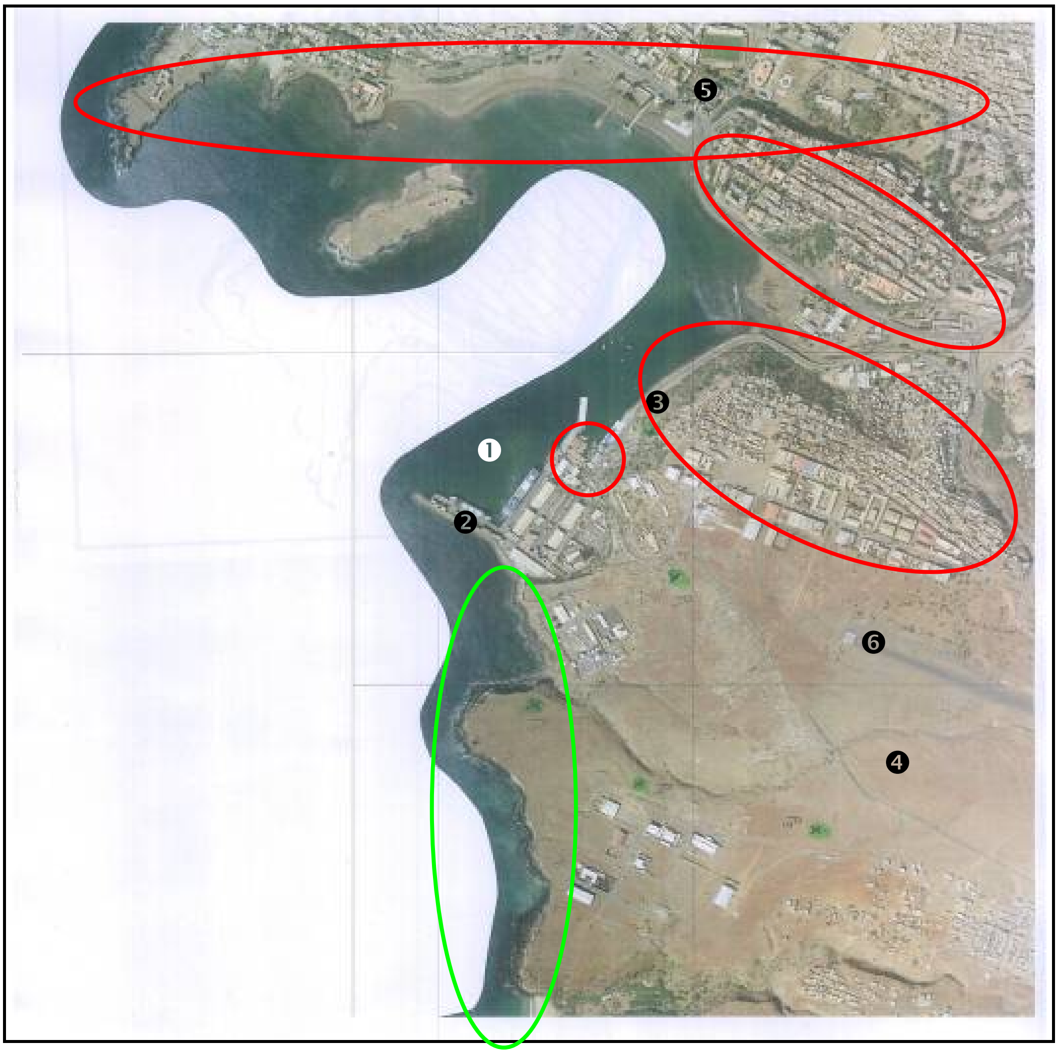
From the data obtained we can find two parameters directly related to air pollutant dispersion (wind intensity and direction) and the total medium rainfall. The direction of the prevailing wind is (NE) which blows in the direction of the sea (SW) and favors the dispersion of the pollutants away from sensitive receptors composed mainly by the houses located in the vicinity of the port.

The scarce rainfall registered on Santiago Island especially during the dry season (December –June) contributes to limiting the vegetation cover in the Achada Grande Area as well on the entire island. This factor associated with the strong winds contributes to considerable particle emission.

### 3.8.3. Sensitive receptors

In the vicinity of the study area the following sensitive receptors were identified. The receptors are composed essentially by the human population that lives in houses located along the access roads, houses next to the airport, houses and offices near the industrial area and houses next to the power station along the beach.

Figure 10. **Air pollution: sources of emissions and sensitive receptors**




### Sources of air pollution

| | |
|---|---|
| ❶ | Maritime ship traffic (small, medium and large tonnage vessels) |
| ❷ | Cement unloading from the ships in the port |
| ❸ | Heavy and light road traffic in and around the port access |
| ❹ | Natural dispersion of dust caused by wind on the Achada Grande plateau |
| ❺ | Combustion gases emitted by the power station (Electra) |
| ❻ | Air traffic in the vicinity of the port |

### Sensitive receptors

| | |
|---|---|
| *Red* | Urban areas and human population that lives in houses located along the access roads, |
| *Green* | Sensitive ecological receptors |

Sensitive ecological receptors were also identified and are constituted by land and marine ecosystems located within the study area. From the land we should emphasize the different species of birds that live in the cliffs and in the plateau area of Achada Grande.

Cliffs in the study area, bird nesting area

Achada Grande plateau, Bird nesting area

### 3.8.4. Actual air quality situation

Since there is no data available on the air quality, no conclusion can be given on the actual air quality situation. The occurrence of strong winds throughout the year should contribute to the dispersion of air pollutants in the direction of the sea away from the existing receptors.

## 3.9. RISK ANALYSIS[17]

### 3.9.1. Risk factors

#### 3.9.1.1. Technological risks

The following hazardous products are transported or handled in the Port of Praia: ammonia, butane, gasoline, petroleum and gas.

| | |
|---|---|
| **Very high risk**<br>**(IV)** | Uncontrolled release of inflammable gas (butane) that can create an inflammable or explosive cloud, the consequences of which could affect all the facilities, ships, personnel in the port and the neighboring areas. The causes may be due to:<br>▪ the rupture of a tank of butane being transported in the port,<br>▪ the rupture of a butane sphere of the Enacol facilities (at the boundary of the port perimeter). |
| **High risk**<br>**(III)** | Release of inflammable gas (butane) that can create an inflammable or explosive cloud, the consequences of which could affect all the facilities, ships, personnel in the port and the neighboring areas. The causes may be due to:<br>▪ Navigation accidents with release of butane, inflammable and combustible liquids in the 1st, 2nd and 3rd category,<br>▪ Rupture of a tank of ammonia,<br>▪ Rupture of a pipeline transporting products from ships to the Enacol storage tanks<br>▪ Explosion during the unloading of powdery products. |
| **Moderate risk**<br>**(II)** | Controlled release of substances transiting via the port of Praia whose intrinsic characteristics are highly dangerous<br>▪ rupture of valves, unloading pipes during transfer of combustible liquids in the 1st, 2nd and 3rd category,<br>▪ rupture of a transport pipeline between the ships and the Shell facilities containing products in the 1st, 2nd and 3rd category. |
| **Low risk**<br>**(I)** | The predictable consequences for the other products are evaluated as being at a low risk level (I). |

[17] ENAPOR, Porto da Praia. Plano de Emergencia interno, novembro 2003.

#### 3.9.1.2. Natural risks

| | |
|---|---|
| **Earthquake** | The places and sites sensitive to earthquakes have been identified. |
| **Storms** | |
| **Torrential rainfall** | These phenomena can cause technological accidents, notably in case of landslides on the cliff, which can cause the rupture of pipelines transporting combustible products. |

| Hazardous points | Critical locations |
|---|---|
| ▪ Quays 1 and 2,<br>▪ Ammonia depot in the refrigerated warehouses,<br>▪ Ammonia depot of the ice-making plant,<br>▪ Storerooms,<br>▪ Hazardous substance transport pipelines of Enacol and Shell,<br>▪ The sectors on the bounds of the port, particularly the Enacol and Shell depot facilities,<br>▪ Gas tanks | ▪ Quays and trailer parking areas,<br>▪ COE operating room,<br>▪ Terminal de cabotage,<br>▪ Port head office and computer room,<br>▪ Offices and equipment pools,<br>▪ Intervention teams storeroom,<br>▪ Backup generator,<br>▪ First aid medical post,<br>▪ Port access and entrance gate. |

### 3.9.2. Accident scenarios

| <u>**Technological risks**</u> | **Level of seriousness** | | |
|---|---|---|---|
| | ***Abnormal*** ***Level 1*** | ***Dangerous*** ***Level 2*** | ***Emergency*** ***Level 3*** |
| Accident of a ship in the port perimeter | | ✷ | ✷ |
| Fire on a berthed ship | | ✷ | ✷ |
| Explosion on a berthed ship | | ✷ | ✷ |
| Accidental spillage from a ship into the port dock or the sea | | ✷ | ✷ |
| Fire in a building (head office, offices, equipment rooms, passenger terminal | ✷ | ✷ | ✷ |
| Fire on a commercial quay or container yard | ✷ | ✷ | ✷ |
| Fire on authorized facilities or facilities under concession | ✷ | ✷ | ✷ |

| | | | |
|---|---|---|---|
| Release of fuel from a conduit | ✸ | ✸ | ✸ |
| Release of butane from a tanker truck | | ✸ | ✸ |
| Emission of toxic substances (ammonia) from the refrigerated or ice-making facilities | | ✸ | ✸ |
| Explosion of dust | | ✸ | ✸ |
| Release of fuel from the equipment facilities or tanker trucks around the port perimeter | ✸ | ✸ | ✸ |
| Aircraft ditching in the port | | | ✸ |

| **Natural risks** | **Level of seriousness** | | |
|---|---|---|---|
| | ***Abnormal Level 1*** | ***Dangerous Level 2*** | ***Emergency Level 3*** |
| Earthquake | | ✸ | ✸ |
| Storm | ✸ | ✸ | ✸ |

| **Social risks** | **Level of seriousness** | | |
|---|---|---|---|
| | ***Abnormal Level 1*** | ***Dangerous Level 2*** | ***Emergency Level 3*** |
| Bomb threat, act of terrorism | | | ✸ |
| Social unrest | ✸ | ✸ | ✸ |

| | | Analysis of the consequences | | | |
|---|---|---|---|---|---|
| **Product concerned** | **Conditions** | **Inflammation** | **Radiation** | **Explosion** | **Toxicity** |
| Butane | Accidental rupture of an Enacol sphere, release of 705 t | Death probable within a radius of 3,700 m | Injury by burning up to 90 m<br>Death probable up to 50 m | Injury from shattered glass within a circle of 17 km<br>Death in destroyed buildings within a radius of 2,450 m | |
| | Explosion of a sphere | | Injury by burning up to 900 m<br>Death probable up to 250 m | Injury from shattered glass within a circle of 1,600 m<br>Death in destroyed buildings within a radius of 550 m | |
| | Rupture of a connecting pipe of an Enacol sphere | Death probable within a radius of 200 m | Injury by burning up to 140 m<br>Death probable up to 50 m | Injury from shattered glass within a circle of 435 m<br>Death in destroyed buildings within a radius of 400 m | |
| | Accidental rupture of a 22 t tank | Death probable within a radius of 700 m | Injury by burning up to 100 m<br>Death probable up to 50 m | Injury from shattered glass within a circle of 1,750 m<br>Death in destroyed buildings within a radius of 1,270 m | |

| | | Analysis of the consequences | | | |
|---|---|---|---|---|---|
| **Product concerned** | **Conditions** | **Inflammation** | **Radiation** | **Explosion** | **Toxicity** |
| | Explosion of a 22-tonne container | | Injury by burning up to 250 m | Injury from shattered glass within a radius of 500 m<br>Death in destroyed buildings within a radius of 170 m | |
| Essence | Accidental explosion of a tank | Death probable within a radius of 160 m | Injury by burning up to 60 m<br>Death up to 20 m | | |
| Ammonia | Rupture of a tank of the 340-kg refrigeration equipment | Death probable within a radius of 50 m | | Injury from shattered glass within a radius of 115 m<br>Death in destroyed buildings within a radius of 50 m | Irreversible toxic effects (T> 30 mn) up to 540 m<br>Death possible in 5 mn at distance of up to 205 m |
| | Explosion of a tank of the 340-kg refrigeration equipment | | | Injury from shattered glass within a radius of 90 m<br>Death in destroyed buildings within a radius of 30 m | |

# 4. SOCIO-ECONOMIC ISSUES

## 4.1. ECONOMY AND DEVELOPMENT PRIORITIES

The 2000 census indicated that Cape Verde had a population of 434,625 persons. An estimated 55 % lived in urban areas, primarily in the principal towns of Praia and Mindelo. The island of Santiago was the most populated island with 54 % of the country's resident population. The population growth rate was 2.4% per year and 68.7 % of the population were under 30 years old. The unemployment rate currently hovers around 22 %. In 2002 the per capita GDP was US$ 1,420 and the human development index (HDI), a measure of life expectancy, income, and education, increased from .578 to .670 between 1990 and 2002.

The Cape Verdean economy has grown rapidly in the last decade. The overall GDP grew 142 % during the period 1994 – 2003 and is projected to grow another 58 % by the year 2009. Banking and hotels were the fastest growing sectors with growth rates of 392 % and 296 % respectively. However, they constituted less than 7 % of the total economy in 2003. Commerce, transportation and fishing which constituted 47.4 % of the nation's economy grew by a robust 179 %, 167 %, and 158 % respectively during the same period. The slowest growing sectors were rental income, construction, and agriculture, with less than 95% growth rates.

Between 1994 and 1999, the country experienced an average annual growth rate of 7.8 % which dropped to 4.7% as a result of a government financial crisis in 2000. It has hovered around the 5.0% level the last two years. The 5-year forecasts predict an average annual 6% growth rate.

Overall, this strong growth has been led by the tertiary or services sector of the economy. Tourism, transportation and the commercial sectors have been the driving force in this growth. The transportation sector is critically important to Cape Verde's economic health because of its inordinate dependence on imports which represent nearly 40 % of the GDP. In addition taxes on international trade represent 42.6 % of the government's revenue and 7.9% of the total GDP. Consequently the country's economic health is highly vulnerable to changes in the market environment affecting the sector and the pricing or costs of its services. The Port of Praia is a significant component of this system and must be considered as a key economic driver for the country. Therefore, it needs to be carefully developed to reduce overall throughput cost to the user.

## 4.2. THE SOCIOECONOMIC ENVIRONMENT OF PRAIA

| Population | According to the 2000 census, the population of the town of Praia was about 94,161 inhabitants, 89.7 % of which is the whole population of the Municipality, the highest concentration of the population in an urban space. |
|---|---|

**Table 24. Population in the Municipality of Praia**

| | Population |
|---|---|
| **Municipality of Praia** | 104,953 |
| **Urban Praia** | 94,161 |
| **Rural Praia** | 10,792 |

Data from the same census points to youth as the greatest portion of the population. In fact, the majority of the population focuses on the 0-29-year age group, which represents big potential for the development of economic activity. In the period between 1990 and 2000, the population of Praia increased from 61,644 to 94,161 inhabitants giving a difference of 32,517 inhabitants, at an average growth rate of about 42 % a year. Taking into account this growth tendency, it is thought that in 10 years, the town of Praia will have a population of about 167,217.

This population growth tendency motivated by the rural exodus towards the town, together with migrations from the country's other municipalities and islands, has been contributing to the aggravation of Praia's unsustainable growth problem, increasing pressure on the town's resources. Rapid measures are therefore required to safeguard the conservation and sustainable management of the town's resources designed to reinforce and provide assurance in the provision of goods and services such as housing, drinking water, energy and sanitation.

## Economic activities

Commerce, both wholesale and retail, associated with automobile and motorcycle repairs, maintenance and goods for domestic consumption, is the economic area which provides jobs for the highest number of people: 8,352 jobs representing 26 % of the total generated jobs.

Fishing, likewise, is an important activity creating about 388 jobs which is equivalent to about 1.2 % of the total number of jobs created in the urban space.

As already stated, the employment situation in Praia is characterized by high rates of unemployment, low school-attendance levels and a large number of families without the minimum resources needed to cover their basic needs.

Service activities have traditionally been the most important in the locations closer to Lem-Ferreira and Achada Grande. The Achada Grande zone still presents itself as an important trade and industrial zone, strategically located in the neighborhood of the port and the airport of Praia.

**Table 25. Employment**

| Economic activity branch | Total | % |
|---|---|---|
| Agriculture, animal production and sylviculture | 321 | 1.0 |
| Fishing | 388 | 1.2 |
| Mining industry | 98 | 0.3 |
| Transformation industry | 2,269 | 7.1 |
| Production and distribution of electricity, gas and water | 196 | 0.6 |
| Construction | 3,789 | 11.9 |
| Commerce - wholesale and retail | 8,352 | 26.2 |
| Accommodation and restaurant services | 803 | 2.5 |
| Transport, department stores and communication | 2,774 | 8.7 |
| Financial activities | 419 | 1.3 |
| Construction of buildings, renting and services | 798 | 2.5 |
| Public administration, social safety and security | 4,198 | 13.1 |
| Education | 1,944 | 6.1 |
| Health and social action | 666 | 2.1 |
| Other collective/industrial services and activities | 1,443 | 4.5 |
| Families with domestic servants | 2,192 | 6.9 |
| International organizations | 361 | 1.1 |
| Not available | 909 | 2.8 |
| **TOTAL** | **31,916** | **100.0** |

## 4.3. HEALTH AND DEVELOPMENT

The health indices of Cape Verde are above the average for the African continent: life expectancy is 70 years, and the current under-five mortality rate is 35 per 1 000 live births. Similarly, the maternal mortality ratio is 76 per 100 000 live births which is significantly less than the average for the region. Many factors have contributed to this rapid improvement in the health status of the population, including a concerted interest by government in health development, including liberalization of the economy, community participation and mobilization and democratization of the administrative system.

Table 26. **Health Statistics (source: WHO, 2005).**

| | |
|---|---|
| Total population | 507,000 |
| Gross national income per capita (PPP international $) | 6,000 |
| Life expectancy at birth m/f (years) | 67/72 |
| Healthy life expectancy at birth m/f (years, 2002): | 59/63 |

| | |
|---|---|
| Probability of dying under five (per 1 000 live births): | 35 |
| Probability of dying between 15 and 60 years m/f (per 1 000 population): | 288/132 |
| Total expenditure on health per capita (Intl $, 2004): | 225 |
| Total expenditure on health as % of GDP (2004) | 5.2 |

## 4.4. SOCIOECONOMICS IN RELATION WITH MARINE ACTIVITIES

### 4.4.1. Port activities

The principal facilities at the Port of Praia were first constructed between 1985 and 1987. At that time there was no thought of handling containers, liquid petroleum gas (LPG) and cement as the primary cargo. The focus was on the handling of multi-purpose general cargo and grain, primarily wheat and corn.

As tourism increased, in tandem with the continued containerization of break-bulk cargo, the port began to handle more and more containers. ENAPOR responded to this demand by purchasing additional container handling equipment (2 reach-stackers and a 40-t fork lift) and stacking containers wherever space was available. The cabotage operations (domestic inter-island small boat traffic) also experienced a significant growth in cargo handled and quickly used up the space allotted for the operation. To complicate the matter further, the International Ship and Port Facility Security Code (ISPS) regulations required that the port physically separates the domestic cabotage from the international cargo operations. Consequently, the domestic operation could no longer borrow berth space from the international cargo area when required.

Between 1990 and 2006, Praia Port traffic increased at an average yearly rate of 6.2 %, growing from 235,400 t to 616,500 t. The port traffic consists of two broad categories: international traffic, amounting to 444,000 t in 2006 (72 % of total, almost exclusively imports) and inter-island traffic, reaching 172,800 t in 2006, 18 % of the total.

**Existing situation**

Within the international share, in year 2006 containers represented the largest category with 173,000 t, or 24,700 TEU. They were followed by dry bulks (mainly import of cement, but also grain) with 137,000 t, and then break bulk with 123,000 t, lastly liquid bulk (essentially liquid petroleum gas), totaling 11,000 t.

The following major trends have been identified:

- The share of international traffic stabilizes at about 72 % of the overall port traffic.
- The share of general cargo traffic (containers plus break bulk) within the total international traffic amounts to 65 %.
- The share of containers within the general cargo traffic has

stabilized between 50 % and 60 % since 1998.

- Eighty per cent of containers handled in Praia are currently twenty-footers, whilst twenty per cent are forty-footers. The share of forty-footers is slightly growing.

The Port of Praia's operational personnel, mainly ship-handling personnel, comprises about 300 persons.

**Traffic projections**[18]

Three scenarios were developed for the project time period, running through year 2020:

- **Scenario n°1** (optimistic, GDP growth of 6.7 % per annum): the government's projects are carried out on time, notably those concerning tourism, which drive faster growth and favor the construction and transport sectors. Projections indicated by the government services are achieved.
- **Scenario n°3** (pessimistic, GDP growth of 5.5 % per annum): the projects fall behind schedule or tourism does not develop as rapidly as planned (sudden rise in the price of fuel or a wave of terrorist attacks in the world, or inadequate airline services, particularly from European capitals).
- **Scenario n°2** (intermediate scenario, GDP growth of 6 % per annum): commercialization of tourism projects is slower than planned. GDP grows at the same rate as in the past.

In 2020, provided that port facilities and port operations are rapidly improved, overall traffic in the port of Praia should reach:

- Scenario 1: 1,475,000 t.
- Scenario 2: 1,345,000 t.
- Scenario 3: 1,240,000 t.

In agreement with MCA-CV it was then decided to undertake the Port Operation Study using figures from the medium scenario n°2.

The 60 % ceiling that has been reached since the end of the 90s should soon move upwards but is not likely to exceed 70 % at the 2020 horizon. The new ceiling should only be reached slowly, transfer to containers continuing for many years. Thus, compared to the container traffic forecast that appears in the "Preliminary Market Study Report", i.e. 54,000 TEU with the 60 % ceiling, the Consultant now recommends the following ceilings and container figures:

Container penetration ceiling in 2020:

- High scenario 70 % 63,000 TEU
- Medium scenario 65 % 58,500 TEU
- Low scenario 60 % 54,000 TEU

[18] Part of the following is a summarized extract of the "Preliminary Market Study Report" issued in April 2007.

The container traffic figure considered in this Port Operations Study is therefore 58,500 TEU, whilst the remaining part of the general cargo, the break-bulk share, is 220,500 t (the complement to 630,000 t).

The rest of the total 1,345,000 t is broken down as follows:

- on the international market: 325,000 t of dry bulk, 90 % of which being cement, the rest being grain and 14,000 t of liquid bulk.
- on the inter-island market: 377,000 t, including 8,000 TEU.

### 4.4.2. Fishing activities

The fishing port, situated near the commercial port, is a port of discharge for coastal and commercial fishermen. Some fishing boats are attached to this port, but the majority comes from Boa Vista or Maio.

**Fishing in Cape Verde**

The Cape Verde islands are characterized by the presence of deep water, a fairly narrow continental shelf, and a wide variety of marine species with an overall potential estimated at between 33,000 and 37,000 tonnes per year, currently fished by an artisanal and commercial fishing fleet.

In 1997 the artisanal fishing fleet comprised 1,400 small boats of between 4 m and 6 m, with an average of 4 fishermen per boat, and 77 commercial fishing boats of between 7 and 22 m in wood or fiberglass. The 5 670 artisanal fishermen use line, beach seine, purse seine and gillnets to catch fish in the tuna family (albacores, skipjack, bigeye tuna, frigate tuna), demersal fish (groupers, sargo breams, morays), and small pelagic fish (horse mackerel, mackerel). In 1998, 5,100 tonnes of fish were caught, comprising 40 % from the tuna family, 24 % other pelagics and 36 % miscellaneous.

The commercial fishing boats comprise tuna/pole-and-line boats, lobster boats and seiners, and use the rod and live bait to catch tuna, purse seines for the small pelagic fish, and creels for the deep-lying lobsters. In 1998 the industrial fishing fleet caught 3 900 tonnes of fish, including 62 % small pelagics and 30 % in the tuna family.

The lobster boats catch the pink spiny lobster in creels off the islands of Sal, Maio and Boavista from October till June. The lobsters are kept alive on board the boats then stocked in crawls in Sal before being exported by air to Europe. Some 400 fishermen-divers use surface-supplied breathing apparatus and diving gear to fish for surface lobsters (green and brown).

**Fishing in and around the Bay of Praia**

In and around the Bay of Praia, there is a small informal fishing activity comprising several communities of fishermen, many of whom are not registered as maritime professionals. Three fishing communities, Achada, Brazil and Tirachapeu, work in the bay. They probably comprise about 100 more or less occasional fishermen. These coastal fishermen pull their boats out of the sea onto Praia beach.

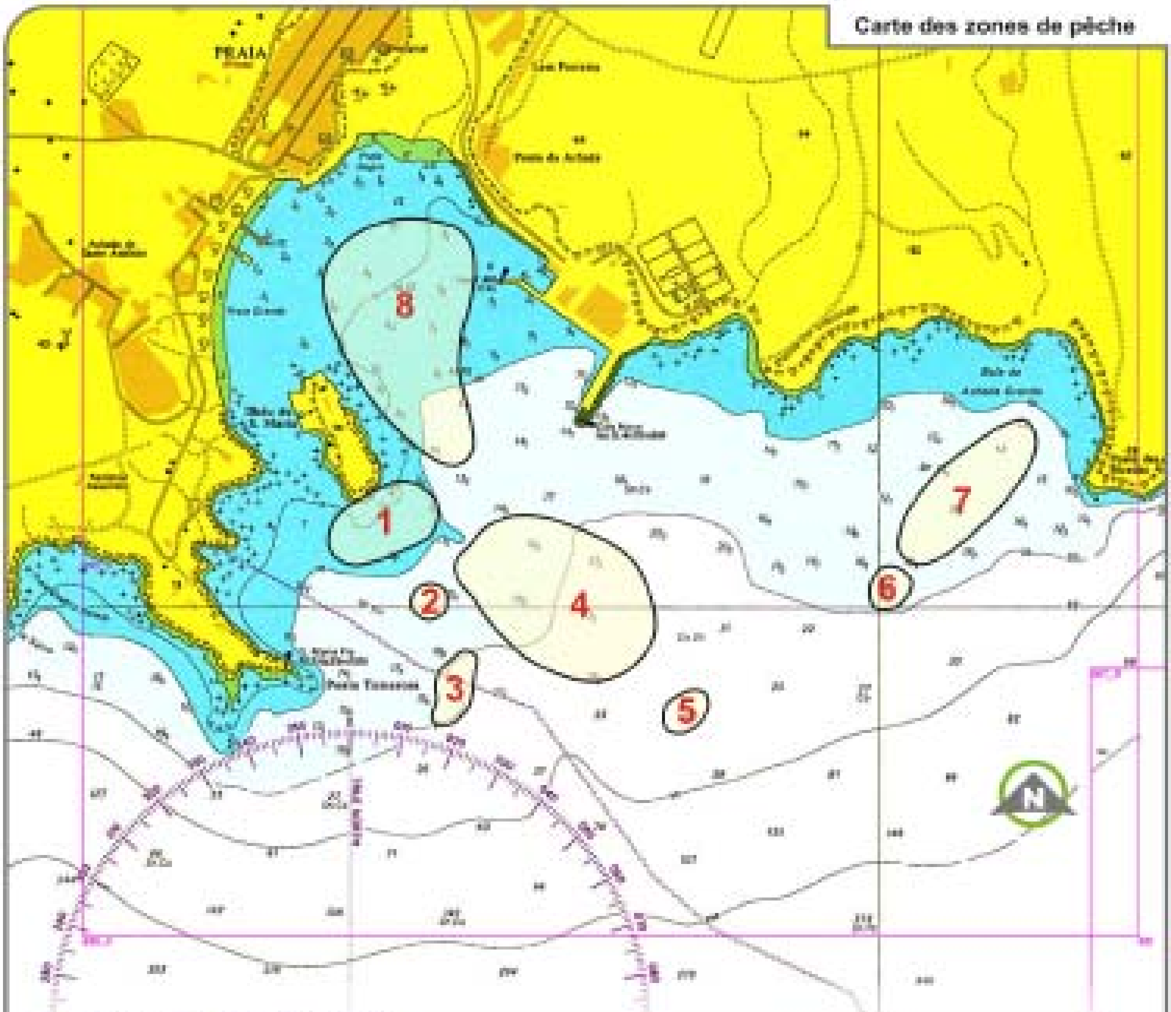
Several fishing sectors are exploited depending on the species sought after and the techniques employed:

- The rocky seabed south of Santa Maria island (Zone 1): lobster is fished for by divers holding their breath or equipped with scuba diving. These rocky depths are used for net fishing when fishing waters further out to sea are not practicable in bad weather. The surrounding net for the *oblades* is used on this site.
- The rocky depths further south to the isobath -10 m (Zones 2 & 3) were used for fishing sedentary fish (grouper, *garoupe* and mullet) and more generally, fish that live on the seabed.
- Zone 4, south of the port, in depths of between 15 and 30 m deep, is fished for the *lambi*. The same applies for Zone 7 situated south of Achada Grande Bay. Sea-cucumber is fished in depths of 30 m and more.
- The isolated rocky spot at a depth of - 20 m (Zone 5) is where pelagic fish are captured using surrounding nets.
- The isolated rocky spot in Zone 6 is a fishing spot for large-size species (red carp and *lutjan*). It should be noted that red carp come and lay their eggs south-east of Santa Maria island twice a year (in Autumn and Spring).
- The bay of Praia (zone 8), is used for fishing for live bait to be used for fishing at sea.

In Cape Verde women are very much involved in the selling of fish[19]. There is always at least one woman involved in sales per boat, except on Fogo. In most of the islands (except Fogo), when a fisherman returns from sea, he will have discussions with his wife or a with woman in whom he has confidence, either a member of or very close to his family, to set a price for the fish. The woman's task is then to sell the fish to other women who are either professional or occasional retailers, either on the beach or in the market. Women sell at least 80 % of the fish, either in municipal markets or in the distant neighborhoods of the city (selling door to door).

[19] M.-J. Surpris, 1994. Le rôle des femmes dans le secteur de la pêche artisanale en République du Cap-Vert. PROJET GCP/CVI/028/NET

Figure 11. Fishing grounds in the bay of Praia used by local costal fishermen




| Zone | Fishing grounds |
|---|---|
| 1 | Lobster is fished by divers holding their breath or equipped with scuba diving. These rocky depths are used for net fishing when fishing waters further out to sea are not practicable in bad weather. The surrounding net for the oblades is used on this site. Red carp come and lay their eggs south-east of Santa Maria island twice a year (in Autumn and Spring). |
| 2 and 3 | Used for fishing sedentary fish (grouper, garoupe and mullet) and more generally, fish that live on the seabed. |
| 4 and 7 | The lambi is fished in depths of between 15 and 30 m deep. Sea-cucumber is fished in depths of 30 m and more. |
| 5 | This isolated rocky spot at a depth of - 20 m is where pelagic fish are captured using surrounding nets. |
| 6 | This isolated rocky spot is a fishing spot for large-size species (red carp and lutjan). |
| 8 | The bay of Praia is used for fishing for live bait to be used for fishing at sea. |

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### 4.4.3. Traditional small traders

There are small service and food traders around the main entry to the port and opposite the commercial port (in shacks on the side of the road). These businesses are operated by women providing snacks for the staff and users of the commercial and fishing ports.

### 4.4.4. Artisanal activities

On Praia beach, a craftsman builds and repairs small coastal fishing boats using traditional materials (wood).

### 4.4.5. Recreational activities

The beaches of Praia, and in particular the beach furthest to the west, are used by the local inhabitants for bathing and seaside leisure activities. The Praia Grande breach is also used for bathing and beach games in spite of the unhealthy sanitary conditions (waste water outlet).

The end of the bay of Praia and the Praia Negra beach are considered a surfing spot (pure surf and body-board). The southern swells produce waves that are favorable to surfing. Most of those practicing the activity belong to the Skibosurf club in Praia.


# C. DESCRIPTION OF THE PROJECT

# 1. THE PROPOSED PROJECT

## 1.1. EXISTING SITUATION AND OBJECTIVES OF THE PROJECT

The Port of Praia is currently faced with the following issues:

1. Rising traffic levels within the port will cause more bottlenecks and delays.

2. Lack of container storage area will further squeeze the available quay aprons, slowing down ship unloading operations and adding to the traffic congestion.

3. Lack of container storage area will result in higher stacking of containers, resulting in an increasing amount of wasted moves, relocating containers while 'digging' to retrieve containers from lower down in the stack. As the number of available slots dwindles, the displaced containers must be taken further away, resulting in greater time lost in the digging process. This will result in over-utilization of the reach-stackers and hence a shortage of handling equipment, exacerbating the delays.

4. Shortages of space, equipment and increasing congestion will rapidly cause a significant increase in ship time at the quay, which will in turn cause rapidly increasing ship-waiting times. If unchecked, this will soon result in increased freight rates to Praia.

5. Overall, therefore, with regard to costs:

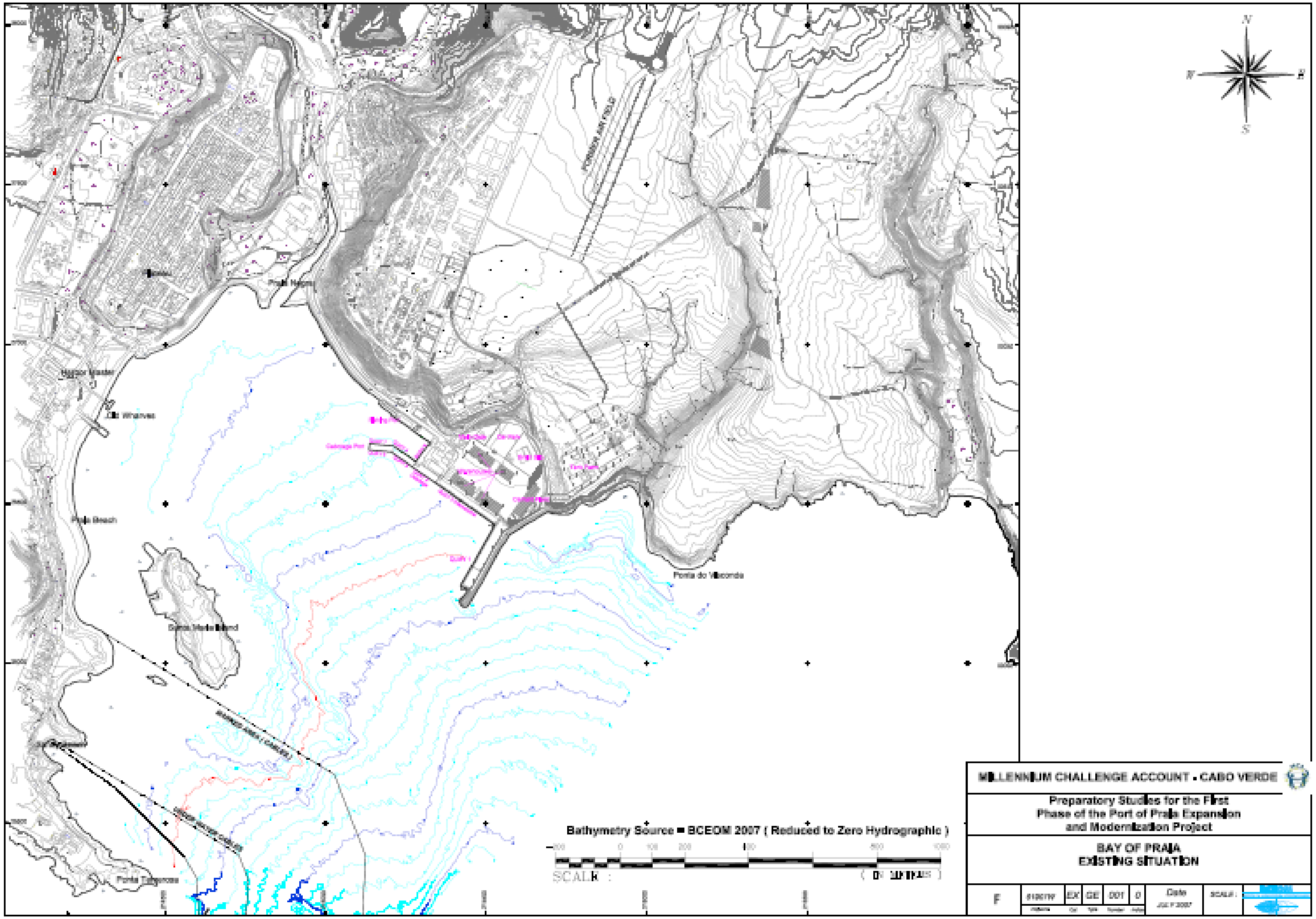
- Shipping costs will increase due to the longer time in port, both longer waiting times and longer times at the quay,
- Cargo handling costs will increase due to the higher utilization, and shortage, of equipment and general congestion,
- Transport costs will increase due to the increased congestion, slowed handling and increasing bottlenecks.

The Government of Cape Verde, acting through the Millennium Challenge Account – Cabo Verde (MCA-CV) and using the proceeds of a grant from the U.S. Government Millennium Challenge Corporation (MCC), intends to undertake a project to upgrade the facilities and operating systems at the Port of Praia to be able to handle forecast cargo growth efficiently and economically through the year 2020. The project aims at guaranteeing greater productivity in the terminal, bringing the Port into compliance with International Maritime Organization (IMO) environmental and security requirements and standards, and lowering overall cargo distribution costs in Cape Verde.

## 1.2. BOUNDARIES OF DEVELOPMENT AND LAND USE ISSUES

The project is located in the southeast corner of the island of Santiago, next to the city of Praia. The activities described in Section 1.1 will primarily concern the existing port territory, as well as the land to be occupied by the cargo village (near the old airport), the route of the road to be built to connect the existing port facility with the cargo village, and the proposed breakwater.

The area selected for installing the road to connect the existing port and the cargo village will pass through a break in the cliffs that border on the sea in this part of the island of Santiago.


MILLENNIUM CHALLENGE ACCOUNT - CABO VERDE
Preparatory Studies for the First Phase of the Port of Praia Expansion and Modernization Project
BAY OF PRAIA
EXISTING SITUATION
Bathymetry Source = BCEOM 2007 ( Reduced to Zero Hydrographic )
SCALE :
Harbor Master
Old Wharves
Praia Beach
Praia Negra
Ponta do Visconde
Santa Maria Island
Ponta Temerosa
N
S
E
W

All additional land to be occupied by this port project is owned by ENAPOR, the city of Praia or the GoCV (marine territory). Although further land use and zoning issues concerning the new areas to be annexed to the port may need to be further clarified, the main extended area, the site of the cargo village, is in an industrial zone.

## 1.3. RELATIONSHIP WITH OTHER EXISTING OR PLANNED PROJECTS

The Consultant is awaiting the imminent release of the urban development plan for Praia. Otherwise, few projects of this scale are foreseen in the general area of the two phases of the port project. The Consultant was told that the draft plan would be made available at the beginning of June 2007, although to date this plan has not been received by the Consultant.

## 1.4. OTHER ACTIVITIES WHICH MAY BE REQUIRED

As developed in Section 3.2., large amounts of materials from local quarries will be required. Furthermore, quarried materials will have to be brought to the construction site. The most viable method of transport is by truck. The three closest and most suitable quarries investigated by the Consultant are very close to the ring road that is currently under construction. The ring road is expected to open in June 2007.

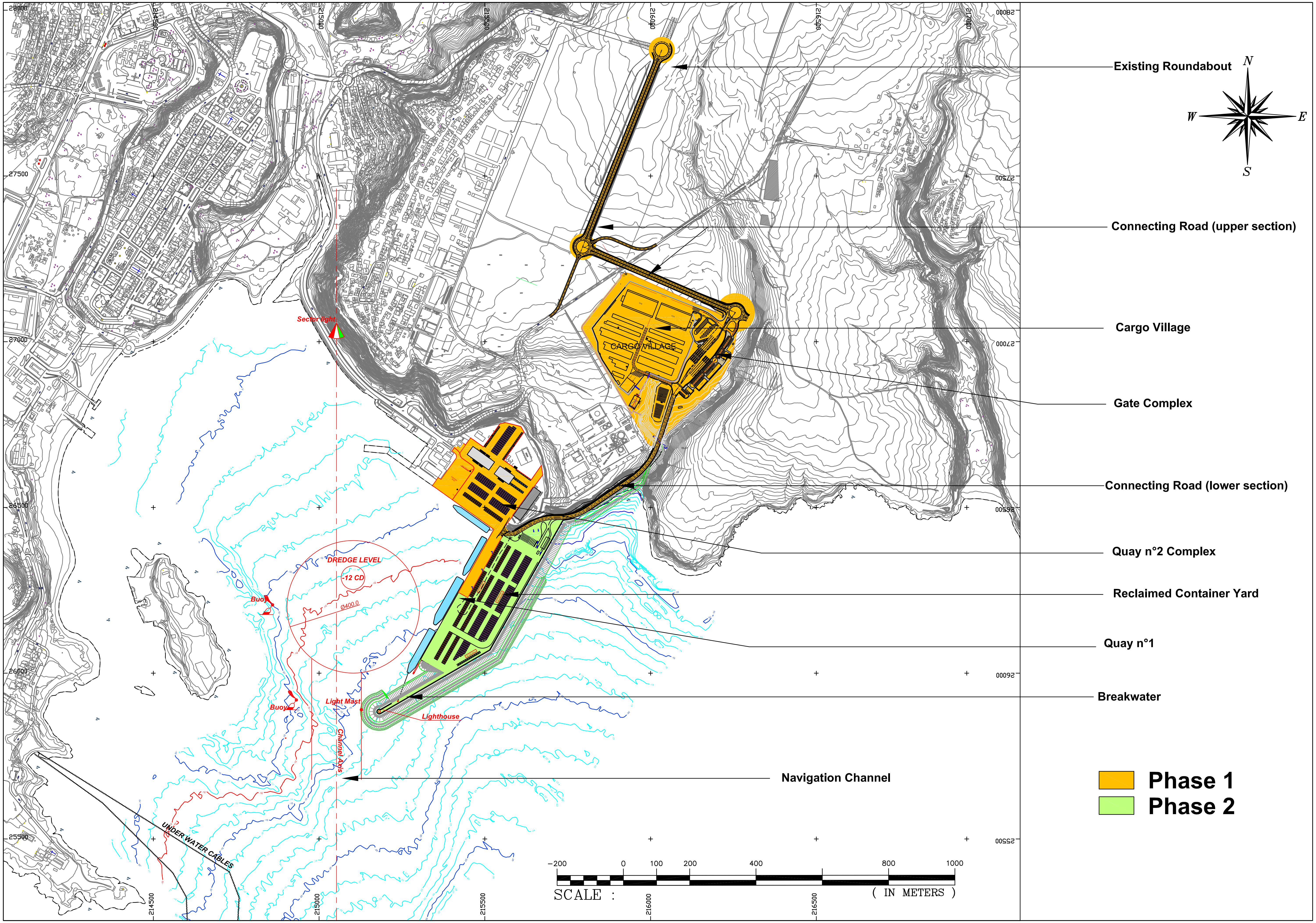
Water and electricity are currently supplied to the port by ELECTRA, the state-owned electricity generation and distribution company. This supply is expected to be sufficient during the period of construction and operation of the new facilities, although further evaluation is required to confirm this. However, the cargo village may have to secure an independent source of water and electricity. Similarly, provision must be made for sewage removal from the cargo village.

Water is a scarce resource on the island of Santiago. Nevertheless, the impacts of construction and operation of the new facilities on the regional water supply are expected to be minimal.

# 2. DESCRIPTION OF PHYSICAL DEVELOPMENT TO BE UNDERTAKEN

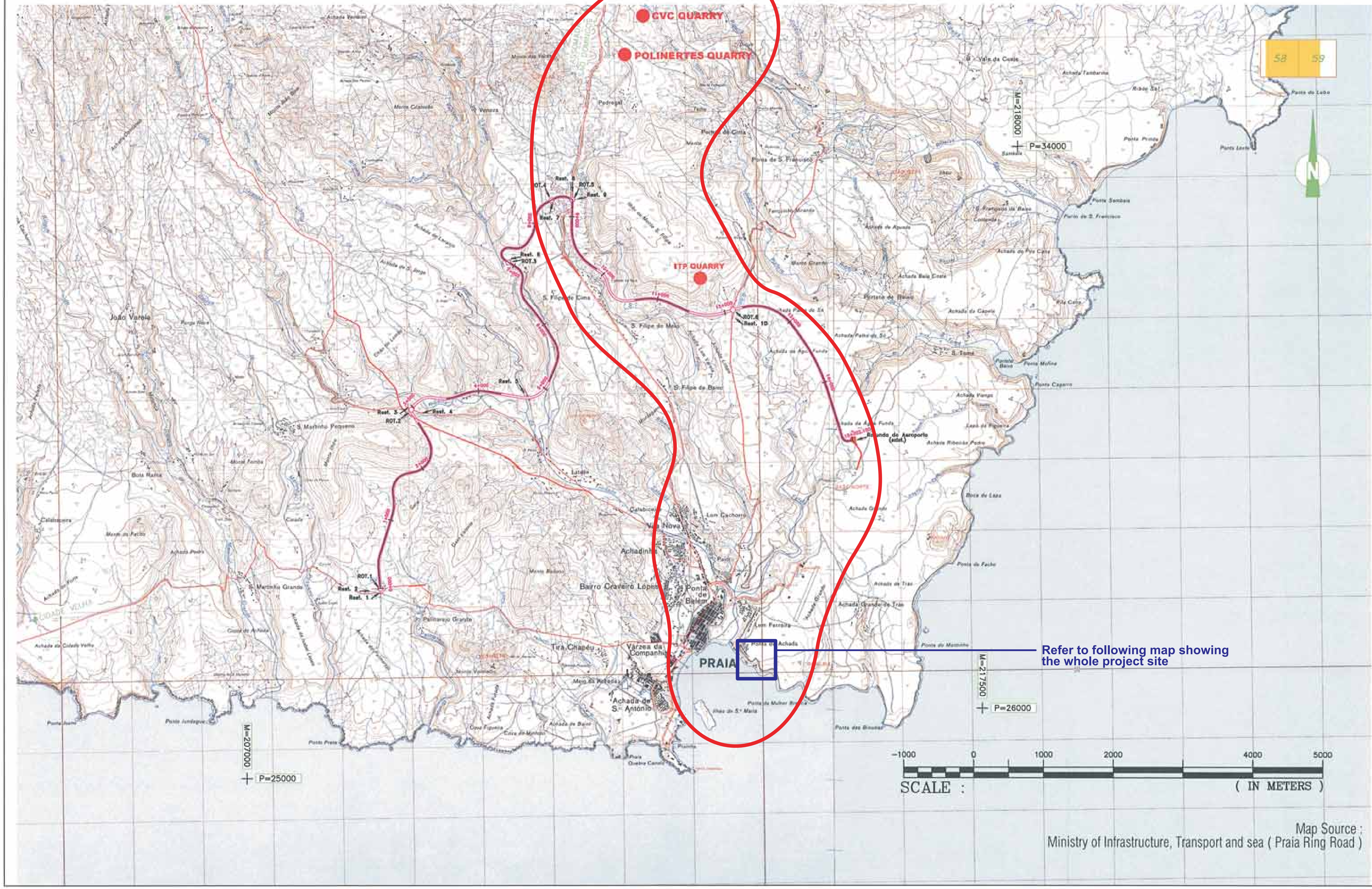
The map on next page shows the whole port project, with phase 1 components in yellow and phase 2 parts in green.

| | |
|---|---|
| **Phase I** | Phase I will consist of:<br>▪ Construction of a cargo village on the plateau above the port to house an inland container depot (ICD) for storing empty containers, stripping, stuffing and CFS (container & freight station) operations, a Customs Impoundment Area (CIA) and a business park for housing ENAPOR, Customs and agents' offices.<br>▪ Construction of a new port road from the cargo village to the port.<br>▪ At quay n°2, removal of old quayside warehouses, repairs to the quay apron and fenders, and re-pavement of the back-up yard. |
| **Phase II** | By amendment to the contract, the Consultant has been asked to evaluate the possible environmental impacts of Phase II as well. Phase II will consist of:<br>▪ Development of a breakwater to solve the wave problem in the harbor.<br>▪ Extension of quay n°1 to 450 m.<br>▪ Creation of a 6 to 8 ha container yard behind quay n° 1 using dredged material to reclaim the required land. |



Existing Roundabout
Connecting Road (upper section)
Cargo Village
Gate Complex
Connecting Road (lower section)
Quay n°2 Complex
Reclaimed Container Yard
Quay n°1
Breakwater
Navigation Channel
CARGO VILLAGE
Sector light
DREDGE LEVEL
-12 CD
Buoy
Light Mast
Lighthouse
Channel Axis
UNDER WATER CABLES
N
S
E
W
SCALE :
( IN METERS )
-200
0
100
200
400
800
1000
Phase 1
Phase 2

## PROJECT'S AREA OF INFLUENCE




Map Source :
Ministry of Infrastructure, Transport and sea ( Praia Ring Road )

# 3. WORK PROGRAM FOR CONSTRUCTION AND OPERATION

The Compact, or agreement between the two governments, requires the phase I of the port project to be completed within a period of four years starting from March 2008 by April 2011 (refer to time table / phase I).

## 3.1. CONSTRUCTION METHODS

Various physical activities will take place during development of this project: demolition, excavation, ground leveling, landfill, construction of buildings and dock facilities, road construction. Although it is too early to establish the specific methods to be used for each, general construction methods might involve the use and transport by truck of quarry materials to the construction site(s). As the active port area is quite congested, a temporary barge-loading facility may be required in the bay of Praia.

## 3.2. RESOURCES USED IN CONSTRUCTION

A great variety of materials will be used during construction of project facilities, including: landfill material, large rocks (for the breakwater), and concrete. A number of quarries currently under investigation by the Consultant should be able to provide suitable materials. However, two of the three most conveniently located quarries do not appear to have appropriate operating permits, which are granted with the consent of Ministry of Agriculture and Environment based primarily on a review of the quarry EIAs. One of the three quarries (São Francisco) has been granted a provisional operating permit for one year, which is unlikely to cover the full period anticipated for extraction and transport of required quarry materials.

During the construction phase, it will be up to the selected contractor to make his own quarry choice, that is, to make use of those quarries that are best suited to project requirements. The contractor will be responsible for assessing the possible environmental impacts of using materials from these quarries, and performing tests demonstrating the suitability of the properties of quarried materials and compliance of quarry operations with MCC guidelines and Cabo Verde and international environmental standards. Preliminary investigation by the Consultant indicated some deviation at the two operating quarries from international best environmental practice, some of which were highlighted in the respective provisional EIA reports.

It is essential that the quarried material remains sufficiently available throughout the construction period and that the quality remains the same. The second important factor when exploiting a quarry is the machinery and its condition, and the ways to get the machinery quickly repaired in case of a breakdown, in order to avoid delays at the construction site.

Concrete is one of the important materials to be used for port structures. It can only be made out of a mix of water, cement and crushed rock, following certain rules. The size of the crushed rock which is needed depends on the structure and the size of its structural members. Thus a quarry will break rock until it reaches the required sizes.

These sizes can be from 0 to 3 mm in diameter, from 3 to 6 mm, 4 to 8 mm, 5 to 15 mm, 5 to 30 mm or any other diameters as required.

Port structures to be built with concrete are typically foundations and slabs for buildings, frameworks for buildings and warehouses, slabs and paving stones for yards and for roads, artificial armor blocks for breakwaters[1], massive concrete units for quay walls and capping beams, single foundations for flood-lighting masts, concrete units for manholes and cable ducts, retaining walls, box culverts and bridges.

For typical marine structures, stone of various sizes can be used:

- For rubble mound structures, heavy quarry stones with a high specific weight and strong durability can be used as primary armor layers: the material is placed stone by stone and a single block of stone may weigh between 6 and 10 t.
- Riprap is being used for various purposes such as layers within a breakwater or as a revetment with minor wave action; it is generally dumped from barges or by trucks.
- To prevent undermining by scour, a toe protection must be provided. For breakwaters, for instance, selected material is used and can be dumped.
- A scour blanket or scour protection will generally be placed in front of quay walls or bridge foundations to prevent erosion induced by propeller action and thus prevent the collapse of the structure.
- Stone fill will be used for any kind of fill, such as the core of a breakwater, heavy duty traffic areas in ports, and this material is being dumped from barges or trucks.
- Filter layers are to be placed in or under structures to prevent loss of underlying soil or smaller stones with lower gradation.

Fill material, either selected (the range will be clearly defined by diameter or by weight) or non-selected (any material out of a quarry except fine material), must be used for various filling purposes such as behind quay walls, underneath roads and pavements, for storage areas and as core for breakwaters. All of this will normally come out of a quarry, if not provided by mass balancing of different diameter or weight materials at the spot or by using dredged material out of the harbor basin.

The use of other resources (for example from possible dredging operations in the Bay of Praia - see relevant chapter in the Source Material Study Report) is not currently confirmed, and will be detailed as necessary in the full EIA for this project.

Main Quantities of material are summarized on table 1.

[1] Such as Tetrapod®, Accropod® and Core-Loc® units.

**Table1. Phase I: Main Quantities of material used during construction of project facilities**

| | Rock material ($m^3$) | Main quantity ($m^3$ or m²) | Rate ($m^3$ or m²/day) |
|---|---|---|---|
| **Cargo village** | | | |
| Rock and soft rock excavation [2] | - 400 000 $m^3$ | - 400 000 $m^3$ | 750 $m^3$/day |
| Placing of paving blocks | | 48 100 m² | 430 m² / day |
| Building and warehouses | | 13 120 | |
| **Connecting road** | | | |
| Road port to CV | 111 100 $m^3$ | 700 m | 630 $m^3$/day |
| Shore protection for port- CV road | 18 900 $m^3$ (core and filter layers) | 18 900 $m^3$ | 750 $m^3$/day |
| Shore protection for port- CV road | 26 100 $m^3$ (3,9 $m^3$ CORE-LOC™)[3] | 6 526 pieces | 50 pieces / day |
| Road connecting CV | 20 000 $m^3$ | 1 500 m | |
| **Quay 2 complex** | | | |
| Production paving blocks | 10 110 $m^3$ | 101 100 | 1 000 m²/day |
| Remove asbestos cemetery roofs | | 5 000 m² | |
| Demolishing of sheds | | 5 000 m² | |
| Resurfacing quay 2 yard | | 53 000 m² | 430 m²/day |

[2] 50 000 $m^3$ clay to be dumped.

[3] The CORE-LOC™ armour unit was developed and patented in the mid-1990s by the U.S. Army Corps of Engineers' (USACE) Coastal and Hydraulics Laboratory.

# Time Table Phase I

ISSUE F one
28/09/2007

| | | | | | project month N° 1–38 (time: year 2008 month 3 – year 2011 month 4) FINAL END OF WORKS► | rock material (m3) | main quantity | rate | basis of calculation |
|---|---|---|---|---|---|---|---|---|---|
| Item | Con-tract | Main Work | Detail Work | Sub-detail | | | | | |
| 1 | I / II | Contractor | | | | | | | |
| 1.1 | I / II | | signing Contract I | | I | | | | |
| 1.2 | I / II | | site mobilization | | Ix Ix Ix | | | | |
| 1.3 | I / II | | site demobilization | | x x x x | | | | |
| 1.4 | I / II | | completion of the project | | | | | | |
| 2 | I | Cargo Village | | | | | | | |
| 2.1 | I | | rock & soft rock excavation | 90.000m3 clay to be dumped | x x x x x x x x x x x x x x | -290 000 | -290.000m3 | 750m3/d | 14 months |
| 2.2 | I | | placing of paving blocks | | x x x x x | | 48.100m2 | 430m2/d | 4,5 months |
| 2.3 | I | | buildings & warehouses | | x x x x x x x x x x x x x x x x x x | | 13.120m2 | | 18 months |
| 3 | I | Connecting | | | | | | | |
| 3.1 | I | road CV/port | divert 5 pipes at parapet wall | (*) | | | | | |
| 3.2 | I | & publ.roads | create opening in parapet | strengthen berm slope | (x) x | | | | 2 months |
| 3.3 | I | | creating rough access to CV | tempor.dirt/earth road track | x | | | | 1 month |
| 3.4 | I | | road: port to CV only | construct.from top and bottom! | (x) x x x x x x x | 111 100 | 700m | 630m3/d | 7 months |
| 3.5 | I | | shore protect.for port-CV road: | core and filter layers | x | 18 900 | 18.900m3 | 750m3/d | 1 month |
| 3.6 | I | | shore protect.for port-CV road: | placing 10,4t Tetrapods | x x x x x | 26 100 | 6.526 pcs. | 50pcs/d | 5 months |
| 3.7 | I | | road:connecting CV with the | remaining public road system | (x) (x) (x) (x) (x) (x) (x) x x x x x x x x | 20 000 | 1.500m | | 6 months |
| 3.8 | I | | regular maintenance of tempo- | rary road surface | I I I I I I I I I I I I I I I I I I I | | | | |
| 3.9 | I | | final surfacing of all roads after | completion of quarry haulage (**) | x x | | 2.200m | | 2 months |
| 4 | I | Quay 2 | | | | | | | |
| 4.1 | I | complex | prepa.productio.paving blocks | mixer, blockmachine, tests | x x x x | | | | 4 months |
| 4.2 | I | | production paving blocks | Quay2 & Cargo Village | x x x x | 10 110 | 101.100m2 | 1.000m2/d | 4 months |
| 4.2 | I | | remove asbestos-cem. roofs | sheds | x x | | 5.000m2 | | 2 months |
| 4.3 | I | | demolishing of sheds | sheds | x x | | 5.000m2 | | 2 months |
| 4.4 | I | | resurfacing Quay 2 yard | 4 crews | x x x x x | | 53.000m2 | 430m2/d | 5 months |
| 4.5 | I | | front works apron | fender, scour prot., fill cavities | x x x x | | | | 4 months |

truck capacity: averaged actual truck load
→ 18,5t or 8m3

working time: 303dyear
25,25d/month
5,83d/week

EFFECTIVE START OF WORKS FOR PHASE II

(*) will have been performed under ENAPOR's guidance ahead of the start of the works

(**) the final wearing course will be applied at the end of the works by contractor Phase II

rock balance (m3): 36 210 concrete
186 210 rock needed
-290 000 rock available

# D. COMPARISON OF DIFFERENT ALTERNATIVES WITH REGARD TO ENVIRONMENTAL IMPACTS

# 1. “NO PROJECT” ALTERNATIVE

## 1.1. EFFECTS ON PORT OPERATION[4]

At present the port of Praia is heavily congested and is operating near to capacity. This is demonstrated when the container operations are observed. For example, the area at the back of the quay is used as a container storage area rather than as a buffer zone because the stack areas behind Quay no 2 are already full. This delays and disrupts the ship-handling operations, slowing down the ship turn round and requiring additional container handling moves.

Warehouse use in the port is not, as might be expected, for break-bulk cargo. Instead the warehouses are used for the storage of goods stripped from LCL containers. FCL containers which are stripped in the port are emptied in the stacking areas, adjacent to the quay traffic, and the goods taken away directly. Break-bulk cargo is all handled by direct delivery, which slows the unloading process and contributes to the congestion at the quayside.

Parts of the port are occupied by long-stay cargo and containers and by impounded vessels and vehicles. These further contribute to the lack of usable space and consequent congestion.

**If neither phase of this modernization and expansion is undertaken, the following negative developments may be expected.**

1. Rising traffic levels within the port will cause more bottlenecks and delays.

2. Lack of container storage area will further squeeze the available quay aprons, slowing down ship unloading operations and adding to the traffic congestion.

3. Lack of container storage area will result in higher stacking of containers, resulting in an increasing amount of wasted moves, relocating containers while ‘digging’ to retrieve containers form lower down in the stack. As the number of available slots dwindles, the displaced containers must be taken further away, resulting in greater time lost in the digging process. This will result in over-utilization of the reach-stackers and hence a shortage of handling equipment, exacerbating the delays.

4. Shortages of space, equipment and increasing congestion will rapidly cause a significant increase in ship time at the quay, which will in turn cause rapidly increasing ship-waiting times. If unchecked, this will soon result in increased freight rates to Praia.

5. Overall, therefore, with regard to costs:

- Shipping costs will increase due the longer time in port, both longer waiting times and longer times at the quay
- Cargo handling costs will increase due to the higher utilization, and shortage, of equipment and general congestion
- Transport costs will increase due to the increased congestion, slowed handling and increasing bottlenecks.

[4] Source: BCEOM, May 2007. Port operation study

There may be variations in the above pattern. For example, to alleviate the shortage of container stacking spaces, the port could, through coordination with key importers, institute direct delivery of FCL containers, loading them directly onto the customers' trailers at the ship's side. This would further slow the ship unloading, so is not recommended, but could be used to alter the balance between the above effects if, for instance, some are more disruptive than others.

Without the implementation of the project, the occupancy rates of the quays would:

- Reach a plateau at Quay 2 international, Quay 2 cabotage and Quay 3 due to the reasons determined previously.
- Increase to unacceptable levels at Quay 1, 4, 5 and 7, causing related increases in waiting time of the ships.

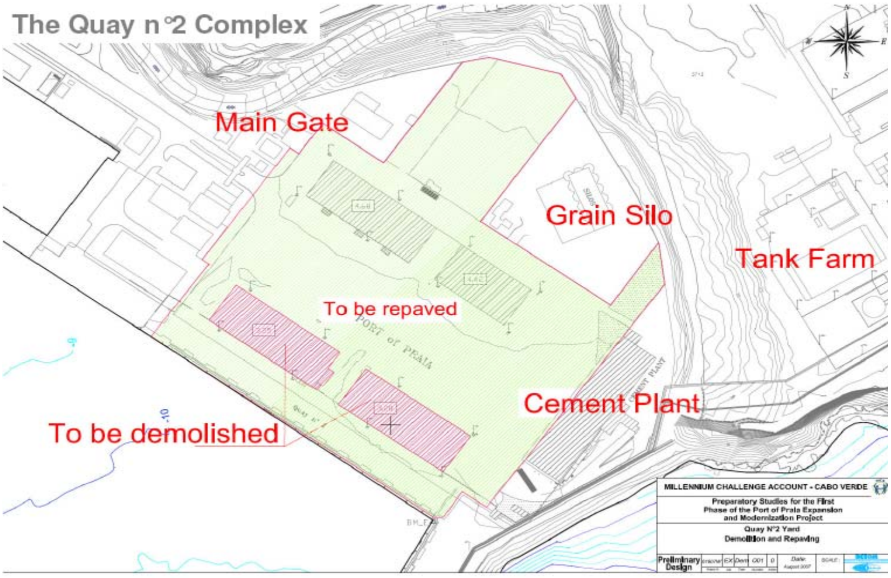
## 1.2. EFFECTS ON ENVIRONMENT

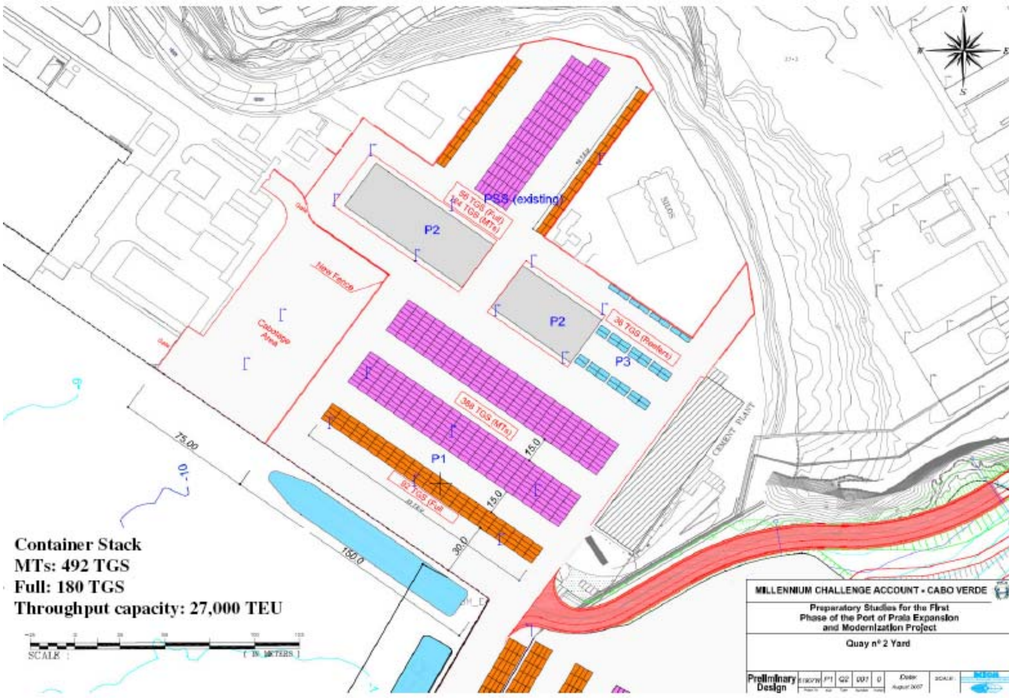
The "No Project" alternative should have the following impacts:

- The increased waiting time for ships in the harbor will increase the frequency of anchoring and therefore of degradation of the biodiverse rocky habitats, under the effects of the anchors and also as a result of discharges from the vessels (gray and foul waters and bilges).
- Increased traffic in a port with facilities of limited capacity will be detrimental to safety (maneuvering more difficult, higher turn rounds) increasing the risk of accidental pollution and accidents, especially involving port staff,
- In the port itself, lack of container storage space will lead to more storage handling operations, and therefore to more intense use of handling plant, resulting in increased emissions to the atmosphere (exhaust gases).
- Increased maritime traffic in the port will induce greater road traffic relating directly to the port, especially of heavy goods vehicles. Traffic will therefore increase on the single access road from the Ribera Trinidad roundabout resulting in traffic congestion and greater air pollution and noise in the urban areas crossed. The main entry to the port will become a 'black spot' (bottleneck, congestion, atmospheric pollution, risk of accident to other users).
- There is a strong urban planning dynamic to develop the city of Praia to the east, from Achada Grande to the south of the airport (The Plano Director Municipal [PDM − municipal master plan] includes mixed housing/commercial development). Pursuing this trajectory will eventually deprive the port of sufficient land reserves for its future expansion.
- The no project situation will not be favorable to joint consideration by the authorities and users of improvement to the environmental conditions of port operation (prevention of risk and pollution, environmental management of operations).

## 2. REMOVING OLD QUAYSIDE WAREHOUSES, REPAIRING QUAY N°2 AND REPAVING THE BACK-UP YARD

The components and objectives of this program are to remove old quayside warehouses on quay n° 2, make repairs to the quay apron and fenders and repave the back-up yard.



## 2.1. « NO PROJECT » ALTERNATIVE

The alternative of leaving the quay n° 2 yard in its present condition would, as a result of increased maritime traffic, lead to the problems described in Chapter 1, i.e.:

- Lack of container storage area further squeezing the available quay aprons and thereby slowing down ship unloading operations and adding to the traffic congestion.
- Lack of container storage area resulting in higher stacking of containers and causing an increasing amount of wasted moves. As the number of available slots dwindles, the displaced containers must be taken further away, resulting in greater time lost in the digging process. This will result in over-utilization of the reach-stackers and hence a shortage of handling equipment, exacerbating the delays.

Repair of the lower part of quay n° 2 is justified by the risk of collapse of the lower part of the quay as a result of wave action if no steps are taken.

## 2.2. DEVELOPMENT OF YARD ADJACENT TO QUAY N° 2 ALTERNATIVE

BCEOM proposed retaining an international gate close to quay n° 2 in May 2007. In June, ENAPOR decided, for reasons of port security, to have a single a gate for all international traffic, at the cargo village. Retaining a gate for international traffic close to quay n° 2 would have induced additional road traffic at the present gate, which already experiences jams under certain conditions.

## 2.3. ENVISAGED TREATMENT PROCESSES FOR DEMOLITION MATERIALS FROM THE OLD WAREHOUSES IN QUAY N°2

Several solutions are proposed for the disposal of the waste arising from demolition of the quay n° 2 buildings, depending on the nature of the materials. Details are given in Section E 4.2.

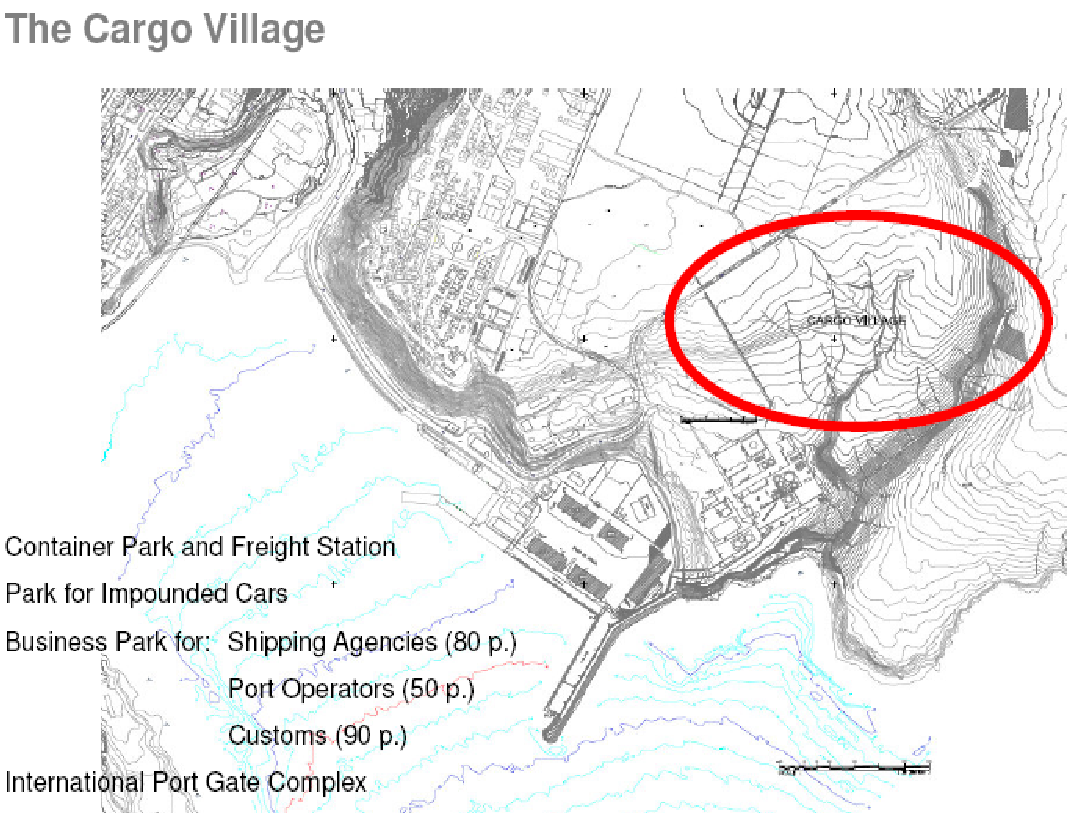
# 3. CONSTRUCTION OF THE CARGO VILLAGE

## 3.1. TECHNICAL AND ENVIRONMENTAL ISSUES

The next development required to create the necessary space for the port to be able to handle the forecast container traffic is to move the CFS (Container Freight Station), operations and empty container storage to an area outside the port.

An area has been selected and reserved, to be developed as a Cargo Village. This is located behind the tank farm which itself is behind the port area. It is at a level of some 50m, so is substantially above the level of the port.

The selected area is neither flat nor level, so significant leveling works are required before it can be used for container and CFS operations. A new road is to be built to the East of the port and tank farm, just outside the existing cliff, to provide access between the port and the Cargo Village.




The location and dimensioning of the cargo village have been studied taking several technical and environmental parameters into consideration.

**Table 2. Technical and environmental parameters taken into account in the choice of location of the cargo village**

| Technical parameters | |
|---|---|
| ▪ Control of land ownership without having to resort to expropriation,<br>▪ Proximity, if not contiguity of the cargo village with the port zone to optimize operations (short distances to save time in rotation and exchanges),<br>▪ Facilities of delivery with the hinterland, in relation with the networking of the roads planned for the Municipal Master Plan (PDM - Plano Director Municipal). | ▪ Installation outside the areas subject to the airport constraints associated with the height of constructions and electromagnetic radiation protection,<br>▪ Taking into account the nearby industrial constraints, such as the extension of the fuel storage area of Enacol and Shell,<br>▪ Connection facilities for the wet networks (water, sewerage) and dry networks ((telecommunications),<br>▪ Possibility of phasing the works and extending the cargo village in the long term |

| Environmental parameters |
| --- |
| ▪ Respect for hydraulic transparencies, the thalwegs being considered like natural areas to be respected in the PDM,<br>▪ Respect for natural areas (PDM),<br>▪ Distancing from existing and future areas of urbanization,<br>▪ Limitation of earthworks in order to reduce the associated costs and impacts (trucks transporting materials, noise, dust). |

## 3.2. DESCRIPTION OF ALTERNATIVES

**Option A. Basic solution.**

**Cargo Village as entirely port area**

Once substantially leveled, the Cargo Village area may be developed to provide the maximum amount of space for port operations. Leveling the entire area would be very difficult and costly due to the presence, in particular, of a deep ravine or canyon in the southern corner.

Under this option, provision would be made for 2 CFS buildings, each 100 m x 50 m, several office buildings, workshops and as much container stacking space as possible.

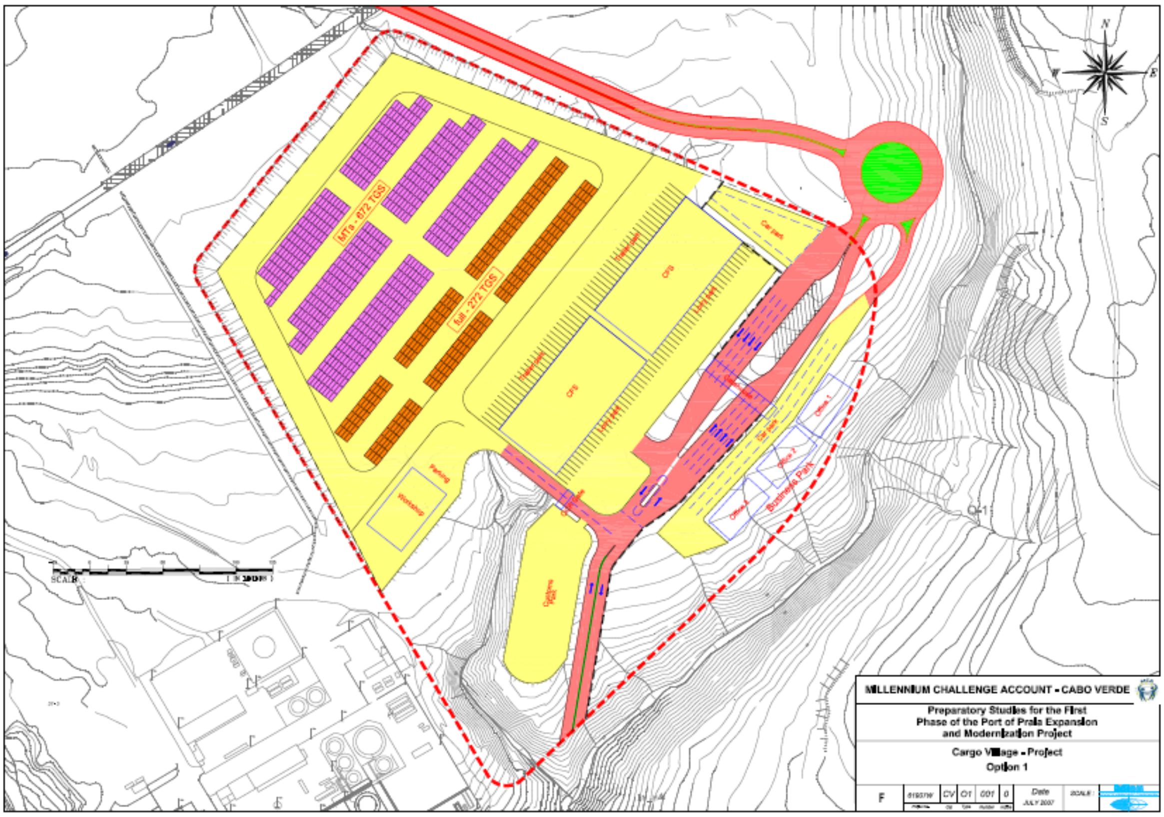
The area would then serve as the main container stacking area for the port, with all the full containers destined for the CFS being trucked up the hill. The containers would be stored until emptied in the CFS, whereupon the empty containers would be stored until required for export, at which point they would be trucked back down the hill.

A proposed layout for this option is shown on drawing no.6. It consists in leveling almost 2/3 of the 14 hectares to provide a horizontal area accommodating 920 ground slots as well as two container freight stations and a workshop. Office buildings would then be built on various separate terraces. This first option requires between 400,000 $m^3$ and 450,000 $m^3$ of earthworks, in rocky terrain.

This layout will provide a capacity of some 920 TGS[5], which is sufficient to provide for a throughput of 37,500 TEU[6] per year. In addition to the port capacity figure above, a total throughput capacity of almost 64,000 TEU per year may be achieved.

[5] TGS =TEU ground slots

[6] TEU = Twenty-foot-equivalent Unit



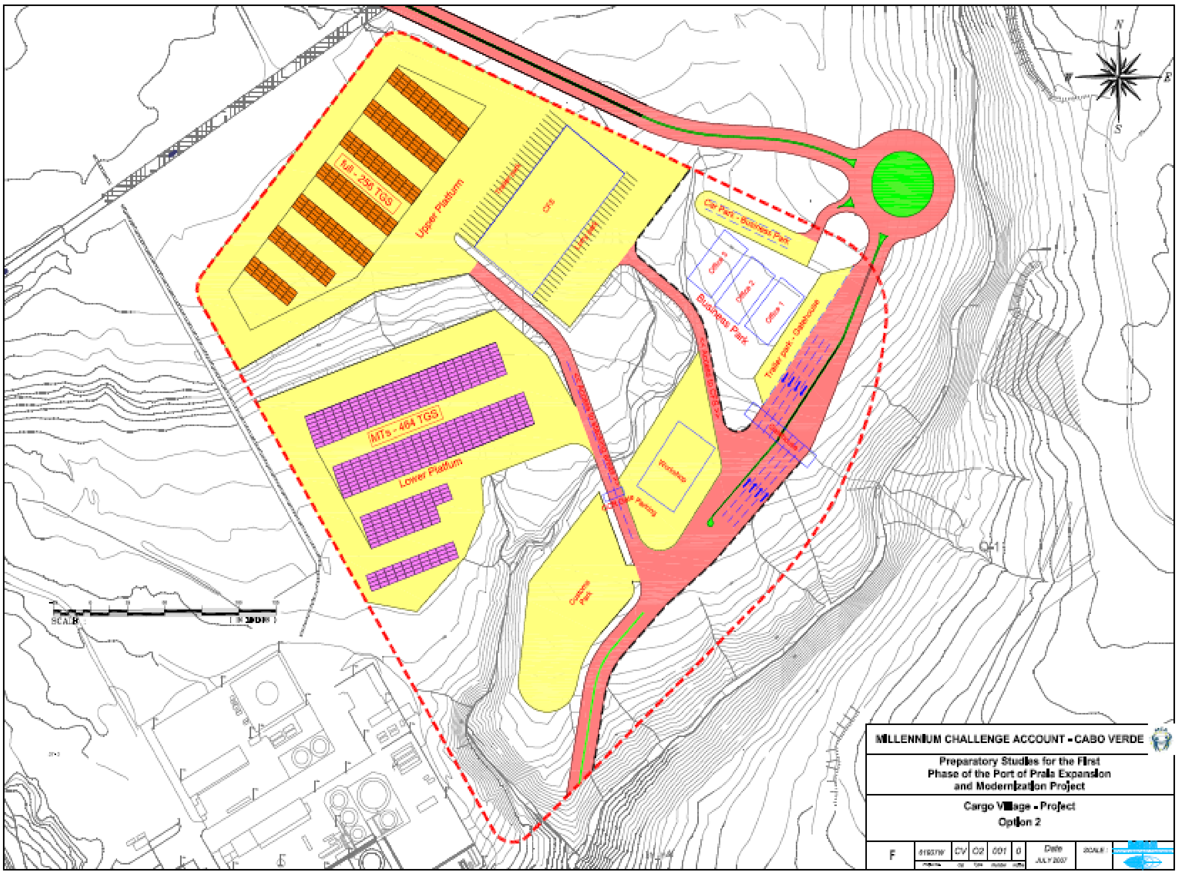

**Option B. Two level solution**

**Cargo Village as partly port area, partly Logistic Zone**

An alternative option is to use the area partly for port use, principally to provide space for the CFS operations and empty container storage, and partly as a Logistic Zone. With this option, a smaller amount of ground leveling works has been planned (140,000 $m^3$ of earthworks, in rocky terrain), to minimize the groundwork cost. The Logistic Zone would provide space for companies to set up logistic, warehousing, and similar functions to provide added-value services.

Under this option, a reduced area of container stacking would be available to the port, as shown on drawing no 5, comprising some 650 TGS which would provide an annual throughput capacity for the port of 26,400 TEU, giving a total throughput capacity, together with the port, of 52,900 TEU.

Under this option, the port makes use of a reduced area, which barely responds to the port's needs. It would not be long before the port again finds itself short of space, by which time the remaining area would probably have been taken up by logistics companies. In view of the expected continued rise in annual cargo traffic, particularly containers, this option is not recommended.


MILLENNIUM CHALLENGE ACCOUNT - CABO VERDE
Preparatory Studies for the First Phase of the Port of Praia Expansion and Modernization Project
Cargo Village - Project
Option 2
Date
JULY 2007
SCALE :
Upper Platform
Lower Platform
MTs - 484 TGS
Business Park
Workshop
Customs Park
CFS
Office 1
Office 2
Office 3
Trailer park - Gatehouse
Car Park - Business Park


Cargo Village: view of artist. Option A (middle) and option B (below).

**Option C. Flat solution**

This option consists in building the cargo village on a relatively flat area, around the southern end of the former airfield. This third option would require 100,000 $m^3$ of earthworks, in rocky terrain.

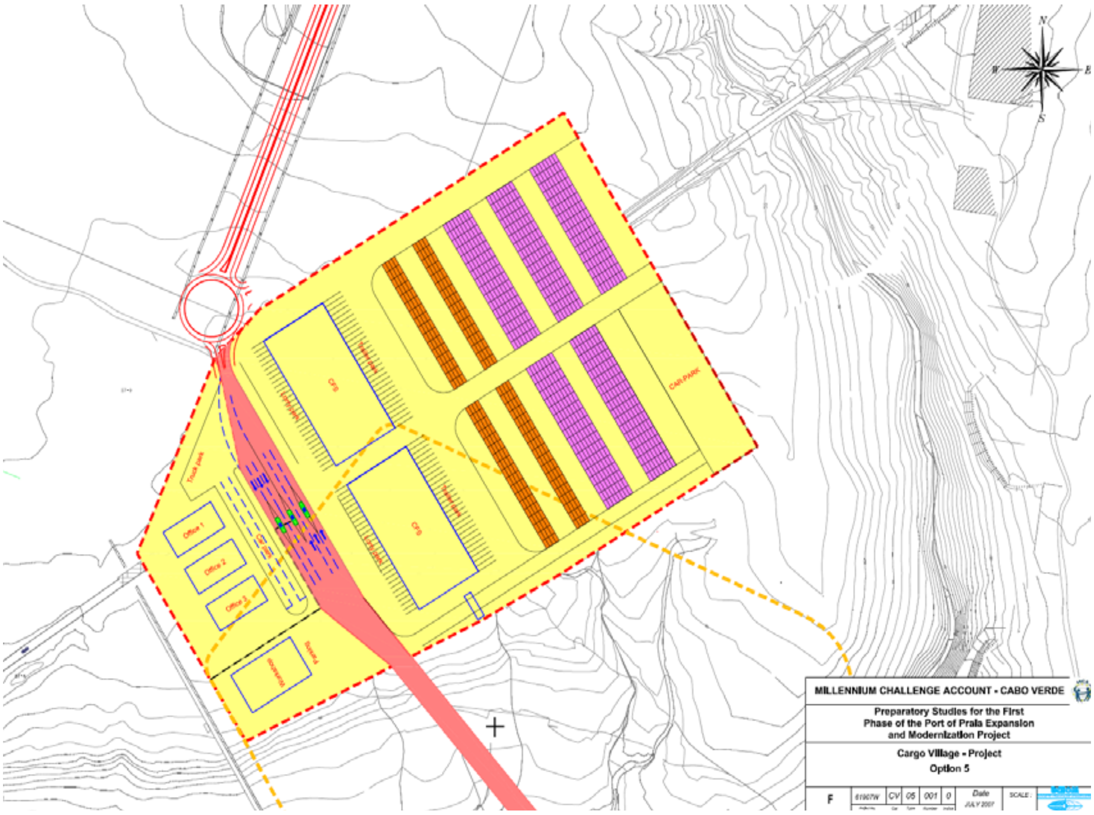



**Table 3.**

| Options | Territory (ha) | Earthworks ($m^3$) | Number of TGS | TEU / year |
|---|---|---|---|---|
| **A** | 14 | 350,000 | 672 TGS for MTs<br>272 TGS for full<br>944 TGS total | 38,960 |
| **B** | 14 | 110,000 | 464 TGS for full<br>256 TGS for MTs<br>720 TGS total | 29,700 |
| **C** | 10 | 90,000 | Same capacities as basic option:<br>672 TGS for MTs<br>272 TGS for full<br>944 total | 38,960 |

## 3.3. COMPARISON OF ALTERNATIVES

### 3.3.1. From the technical aspect

**Table 4. Comparison of alternatives from the technical aspect**

| | Option A | Option B | Option C |
|---|---|---|---|
| Control of land ownership without resorting to expropriation | Yes | Yes | To be verified |
| Proximity if not contiguity of the cargo village with the port zone | Yes | Yes | Greater distance |
| Facility of road links with the hinterland | Good | Good | Good |
| Installation outside the areas subject to airport constraints (1) | Yes | Yes | Yes |
| Taking into account of nearby industrial constraints | Yes | Yes | Yes |
| Facilities for connection to networks (sewerage, drinking water) | Normal | Normal | Normal |
| Possibility of phase the work on the site | Yes | Yes | Yes |
| Possibility of extending the cargo village in the long term | Low | Low | Good |

(1) The industrial zone is on the flight path of incoming and outgoing flights to and from the airport. Tentative confirmation has been received that the proposed buildings to be erected at the cargo village will not interfere with flight operations.

### 3.3.2. From the environmental aspect

**Table 5. Classification of options according to their impact on the environment**

| | | | |
|---|---|---|---|
| 1 = Level 1<br>Lowest negative impact. | 2 = Level 2 | 3 = Level 3<br>Highest negative impact. | E = equivalent impact |

| ↓ **Comments** | | Option A | Option B | Option C |
|---|---|---|---|---|
| **a** | ▪ Respect of hydraulic transparencies | Yes | Yes | Yes |
| | ▪ Hydraulic impact | **E** | **E** | **E** |
| | Respect of natural areas (PDM) | Yes | Yes | Yes |
| | Distance from existing and future areas of urbanization (PDM) | Yes | Yes | Yes |
| **b** | Impact on the quality of water | **E** | **E** | **E** |

| | | | | |
|---|---|---|---|---|
| **c** | Impact on vegetation coverage | **E** | **E** | **E** |
| **d** | Impact on the fauna | **2** | **2** | **1** |
| **e** | Impact on the landscape | **2** | **1** | **3** |
| **f** | Impact on the road infrastructures (induced heavy vehicle traffic) | **E** | **E** | **E** |
| **g** | Impact during construction | **3** | **2** | **1** |

**Comments**

**a**

**Respect of hydraulic transparencies and hydraulic impact**

The main thalwegs constituting the drainage system of the plateau are registered in the PDM as natural zones. The respect of hydraulic transparency is important so that these thalwegs conserve the possibility of correctly draining the natural and impermeabilized terrains and evacuating floodwater during rainy periods, which are very restricted in the year. In the project area of options A and B, there are two major water lines with deep troughs. These streams converge between Porto da Praia and Ponta Mulher Branca.

- In both options A and B, the distribution of the surface areas and the developments respect the routing of the main thalweg and its tributary. They do nevertheless require the construction of central and peripheral ditches to restore the drainage ensured by the surface drainage system.
- Option C respects the hydraulic transparency of the main thalweg. The existing road that crosses this area will be demolished in favor of a road section further north, which will require building a crossing structure. The surface drainage network will have to be directed to peripheral ditches to restore all the peripheral flow paths.

**b**

**Impact on water quality**

Whatever the chosen option, the management of activities must favor at-source prevention of chronic and accidental pollution. In view of the local climatology, the pollutants from the loading machines and trucks (hydrocarbons, heavy metals, dust) will accumulate on the impermeabilized surfaces and will be partially washed away during the rainy periods between July and October. Rainwater collection and treatment will have to be envisaged to reduce the impact on the receiving environment, i.e. the bay of Praia after transiting through the peripheral ditches and rias. The impermeabilized surfaces of Alternatives A, B and C are respectively: 59,600 m² (phase I) / 77,900 m² (phase II) and 66,300 m². As the surface areas are roughly identical for each alternative, the impact can be considered equivalent for each alternative.

**c**

**Impact on vegetation (flora)**

In all alternatives, the existing vegetation will be totally destroyed by the works. No endangered species of flora was found on these sites. Although the impact is negative, destruction of vegetation will not be significant since natural vegetation on the project area is scattered, creeping and composed of short lifecycle weed that only covers the soil partially in the wet season. It can be considered as equivalent for each alternative.

d **Impact on fauna**

The most affected fauna on the plateau will be birds. Birds from the plateau will certainly leave the area because they are used to living in dry areas away from intense human activity. The impact should be higher for options A and B which are in the vicinity of two critical and protected bird species.

e **Impact on the landscape**

The topography of the plateau will be completely changed. The resulting landscape will be of a huge human infrastructure, embracing the plateau and the cliff (impact of the road). That area will be a construction designed to accommodate warehouse goods, incoming and outgoing passengers and goods, offices and parking for vehicles and machinery.

The impact on the landscape will be related to the height of the storage hangars (15 m) as well as the mass formed by the containers, particularly when they are stacked on top of one another (empty containers stacked 4 high maximum, i.e. 10 m, and full containers stacked 3 high at the most, i.e. 7.5 m).

The cargo village platform in alternative B has the advantage of being built on two levels with elevations of + 45 m and + 52 m respectively. This difference in level of 7 m will partially mask the view of the rows of empty containers from the roads situated to the west. Given these conditions, and making abstraction of any considerations related to the architecture of the buildings, option B is the best integrated and option C would be the most visible in the landscape, in view of its location near the road infrastructures and the relatively flat ground on which the cargo village would be built.

f **Impact on the road infrastructures**

The road traffic induced on the access roads between the cargo village and Praia are identical, whatever the alternative. Consequently it is not a discriminating parameter.

g **Impact during the construction**

The general impacts during construction of the cargo village will be essentially proportional to the volume of the earthworks and the associated impacts (movements of trucks and site machines, noise, dust, bother to people living nearby, hindrance to traffic). Under these conditions, alternative A can be considered as having a greater impact than alternatives B and C.

## 3.4. PROPOSED SELECTED PROJECT

| | Option A: Basic Solution | Option B: Two-Level Solution | Option C: Flat Solution |
|---|---|---|---|
| **Container Capacity** | 944 TGS<br>39,000 TEU/year | 720 TGS<br>29,000 TEU/year | 944 TGS<br>39,000 TEU/year |
| **CFS Capacity** | 2 x 5,000 $m^2$ | 1 x 5,000 $m^2$ | 2 x 5,000 $m^2$ |
| **Fluency of Operations** | Adequate | Poor | Excellent |
| **Possibilities for Extension** | Very limited | Blocked | Better |
| **Safety** | Close to tank farm | Close to tank farm | Further from tank farm |
| **Investment Cost** | Cost base: 1 | Cost ratio: 0.7 | Cost ratio: 0.8 |
| **Cost difference from Option A** | Base | 3 million USD savings | 2 million USD savings |
| **Environmental Impact during construction** | Significant (but balance with quarries during the construction) | Lower | Best option in terms of earthworks |
| **Environmental Impact during operation** | Higher impact on fauna<br>Significant impact on landscape | Higher impact on fauna<br>Best integrated in landscape | Lower impact on fauna<br>Most visible in the landscape |

Although Option A represents an increased cost of 2 million USD compared to Option C, for the whole port project Option A generates savings of 1 million USD, as excavated material from the cargo village will be partly reused for the connecting road fill, and partly reused for the Phase 2 Project Components (option C would require more material from quarries).

On the basis of technical, cost and environmental parameters, MCA-CV has selected option A.

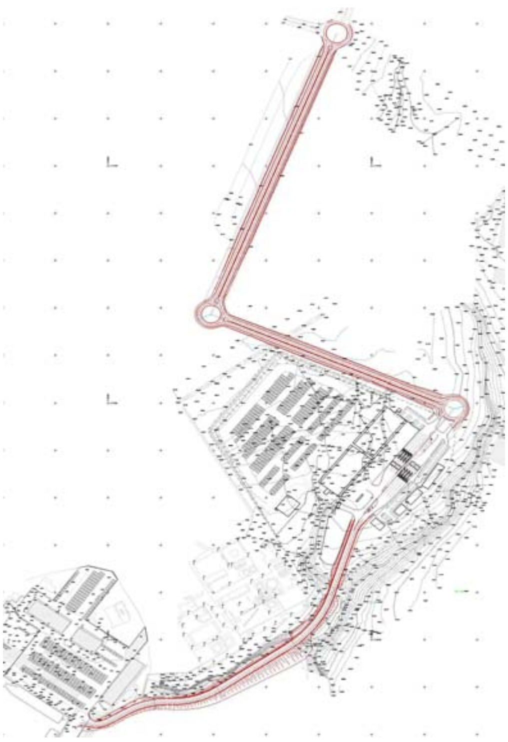
Even if the environmental impact during construction is absolutely significant due to the importance of earthwork, this latter criterion must be assessed and weighed up relatively from the technical, environmental and financial aspects, considering the project as a whole. The construction of the maritime structures planned for in phase II requires large quantities of filling material (up to 2 million $m^3$). The possibility of extracting rocky material from the cargo village site has been duly considered, giving the quality of the materials, the closeness of the source of materials to the construction sites, the environmental savings due to the fact that they would not be extracted from quarries (associated impacts avoided, improved carbon balance).

# 4. CONSTRUCTION OF THE PORT ACCESS ROAD

## 4.1. DESCRIPTION OF THE ROAD ALIGNMENT

The road access links the port to the airport roundabout via the cargo village on a distance of 2.17 km.

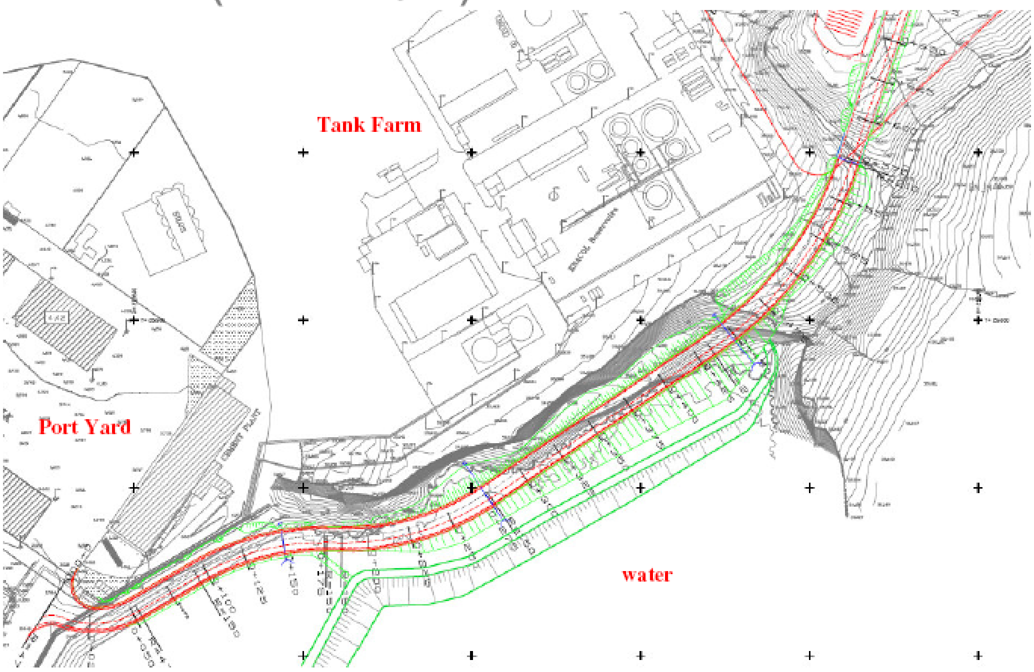
| Requirements | Constraints |
|---|---|
| ▪ Maximum grade of 7 % at any point along its course<br>▪ 2 lanes in each direction<br>▪ Moveable center<br>▪ Sidewalks where appropriate<br>▪ Full illumination over its length<br>▪ Fencing on both sides<br>▪ Protection against waves where needed | ▪ Natural characteristics of the implantation area: marine area under tides influence, cliff, steep valley and storm water river mouth<br>▪ Difference of level between the road start and the Cargo Village implantation area<br>▪ Wave action<br>▪ Construction time<br>▪ Existing structures and infrastructures<br>▪ Existing and foreseen road structures |



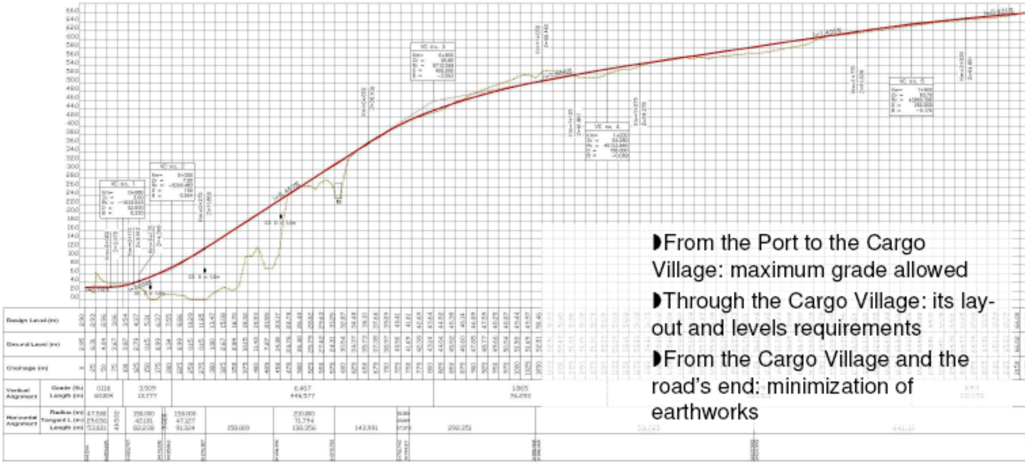
**Horizontal Alignment**

- Very constrained lay-out corridor
- Only two options were assessed for the section between the Port and the Cargo Village, with minimum differences between both
- Lay-out of the section outside the Cargo Village connecting to the urban network was defined by the municipal master plan

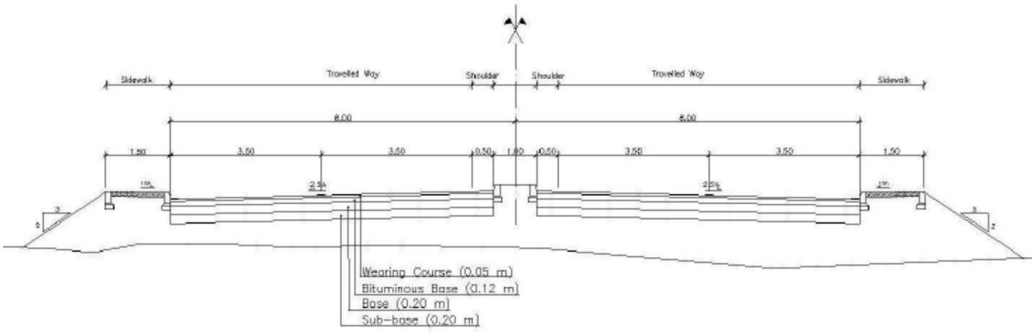
## The road (lower section)



## Vertical Alignment

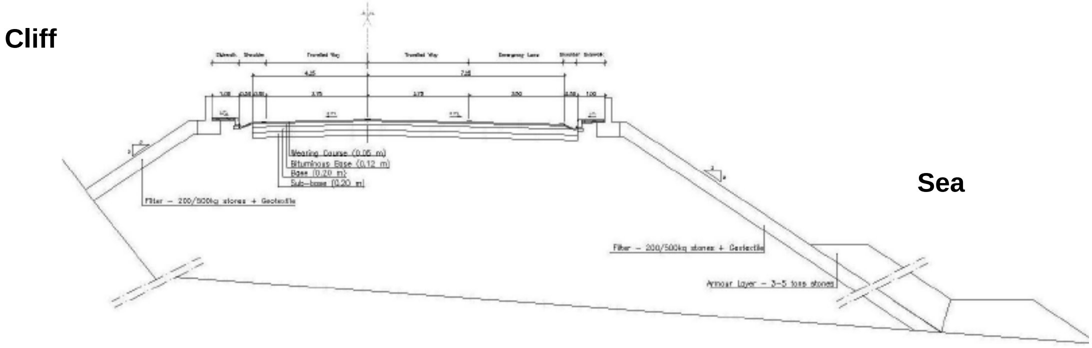



## Typical Cross Sections




- Typical Cross Section 2: 2 x 3.5 m lanes each direction + 1.0 m median island + 0.5 m inner shoulders and 1.5 paved sidewalk
- From the Cargo Village exit to the road's end

## Typical Cross Sections




- Typical Cross Section 1: 2 x 3.75 m lanes + 1 x 3.5 m emergency lane + 0.5 m shoulders + 1.0 paved sidewalk
- From the Port to the Cargo Village entrance

## 4.2. DESCRIPTION OF ALTERNATIVE ALIGNMENTS AND TECHNICAL SOLUTIONS

The section of the road situated on the plateau and linking the cargo village to the coast under the cliff is subject to constraints: it is the shortest route between the cargo village and the cliff foot, avoiding the main thalweg (crossing the affluent thalweg will require the construction of a box culvert).

It is impossible to route the road via the top of the cliff for technical reasons (joining up the gradients at the port) and security associated with natural risks (instability of the cliff) and industrial risks (proximity of the hydrocarbon storage tanks and the butane spheres).

The only possible alternatives therefore concern the construction of the road platform on the coastal fringe. Regarding the road infrastructure in the marine area, three options will be compared:

- **Option 1: a road built on fill simply protected from the sea by a slope revetment,**
- **Option 2: a road built on fill blocked by a retaining wall,**
- **Option 3: a road built on a pile-founded deck.**


**Access road to the port. Different options for the coastal lower section**: a road built on fill simply protected from the sea by a slope revetment (Option 1, up), a road built on fill blocked by a retaining wall (option 2, middle) and a road built on a pile-founded deck (Option 3: below).

## 4.3. ENVIRONMENTAL COMPARISON

Classification of the options according to their environmental impacts

| 1 = Level 1 | 2 = Level 2 | 3 = Level 3 | E = equivalent impact |
|---|---|---|---|
| Lowest negative impact | | Highest negative impact | |

| During construction of the road | | | | |
|---|---|---|---|---|
| ↓Comments | | Option 1 | Option 2 | Option 3 |
| **a** | Impact on the terrestrial environment | **E** | **E** | **E** |
| **b** | Impact on the marine environment | **2** | **2** | **1** |

| During operation of the road | | | | |
|---|---|---|---|---|
| ↓ Comments | | Option 1 | Option 2 | Option 3 |
| **c** | Impact on the terrestrial environment | **E** | **E** | **E** |
| **d** | Impact on the marine environment | **2** | **3** | **1** |
| **e** | Impact on water quality | **E** | **E** | **E** |
| **f** | Impact on the landscape | **2** | **3** | **1** |
| **g** | Impact on the geological legacy | **E** | **E** | **1** |
| **h** | Impact on human activities | **E** | **E** | **E** |

**Comments**

**a** **Impact on the terrestrial environment**

Whatever the alternative, the construction of the road platform will disturb the fauna of the plateau and above the whole cliff: frequentation by site machines and workmen, production of dust, noise and vibration, nocturnal illumination of the site. These stress factors will cause the most mobile species such as birds to desert the site. If work takes place during the nesting or reproduction periods, these activities will very likely be compromised.

**b** **Impact on the marine environment**

The main impact of alternatives 1 and 2 will be caused by the tipping of some 185,000 $m^3$ of fill of diverse materials (aggregates, riprap) to constitute the road platform. This will cause:

- Washing out of the tipped materials into the water, causing fine particles to be resuspended in the marine environment. They will be carried by the local currents and settle in the shallows;
- The disappearance of the coastal ecosystem situated under the cliff (supralittoral and strand) in the shallow water of between 0 and 4 m depth. The spillage of fill materials will destroy the fixed populations of marine flora and fauna.

Alternative 3 is built on piles. This allows a certain "transparency" and the maintaining of the coastal ecosystems beneath the road platform. Only the boring of the holes for the piles will cause fine materials into go into suspension, and will require the collection and treatment of the boring materials and sludge to avoid polluting the environment. This alternative has the least impact on the marine environment and is obviously the most recommendable from this aspect.

**c** **<u>Impact on the terrestrial environment</u>**

The movement of heavy vehicles on the road (105 vehicles/hour) will produce noise and vibrations, atmospheric pollutants (exhaust gases) by day and by night. The road lighting at night will constitute and additional nuisance factor. It is probable that the birds, particularly nesting birds, will leave the site to find equivalent coastal sites that are not disturbed by human activity. The alternatives are all equivalent from this point of view.

**d** **<u>Impact on the marine environment</u>**

Alternative 3 maintains the status of the coastal ecosystems (diversity of the sea bottom, large blocks fallen from the cliff favoring colonization by species of fish and crustaceans).

In the case of alternative 1, the platform is protected from the sea swell by large-sized riprap. This riprap covers the whole embankment, including the maritime part. In the shallow waters, the cavities and gaps among the rocks will provide shelter for the fauna, and notably for juvenile fish.

Lastly, alternative 2 provides no compensation for the loss of underwater habitats, as the retaining wall presents no interest for the marine fauna. The loss of biodiversity in this case is maximal and irreversible.

**e** **<u>Impact on the quality of the water</u>**

The heavy vehicle traffic will cause chronic pollution: accumulation of unburned hydrocarbon residues, oil, and tire and brake residues on the road surface. When it rains, these residues are washed out and run into the marine environment, thereby contributing to its pollution. A drainage system will reduce such pollution. It can be adapted to each of the studied alternatives.

The situation of accidental pollution by the overturning of a truck or container containing hazardous and polluting substances must also be envisaged.

**f** **<u>Impact on the landscape</u>**

The impact on the landscape is subjective. Alternative 3 however, built on piles, provides relative visual transparency. The entire height of the cliff is visible, and the appearance of the coastal fringe remains unchanged.

Alternative 2 has a strong impact on the landscape due to the spoiling the natural aspect of the cliff by the retaining wall (contrast between the dark basaltic rock and the retaining wall in smooth light concrete).

The impact of Alternative 1 is also strong due to the mass of the riprap. The impact will nevertheless be reduced by using basaltic rock of the same hue as the cliff face, thereby reducing the contrast between the natural and the man-made section.

In all three cases, the reinforcement of the cliff by various techniques (see paragraph 3.2.4.) will contribute to the denaturing of the cliff.

| | |
|---|---|
| **g** | **<u>Impact on the geological heritage</u>**<br>The cliff is characterized by a very striking geological feature: a carbonated sedimentary layer representing the ancient coast. This remarkable geological feature will be destroyed after construction of the road and consolidation of the cliff. |
| **h** | **<u>Impact on human activities</u>**<br>There are no human activities in this sector, which is isolated from housing and relatively difficult to access. The professional coastal fishermen do not use this site. The beach, made up of shingle and relatively large blocks of basaltic rock, is not used for leisure activities. |

## 4.4. PROPOSED SELECTED PROJECT

The embankment solution was selected on the basis of the following criteria, and mainly because it is the only option that enables to comply with the tight implementation timeline (all works must be completed by September 2010):

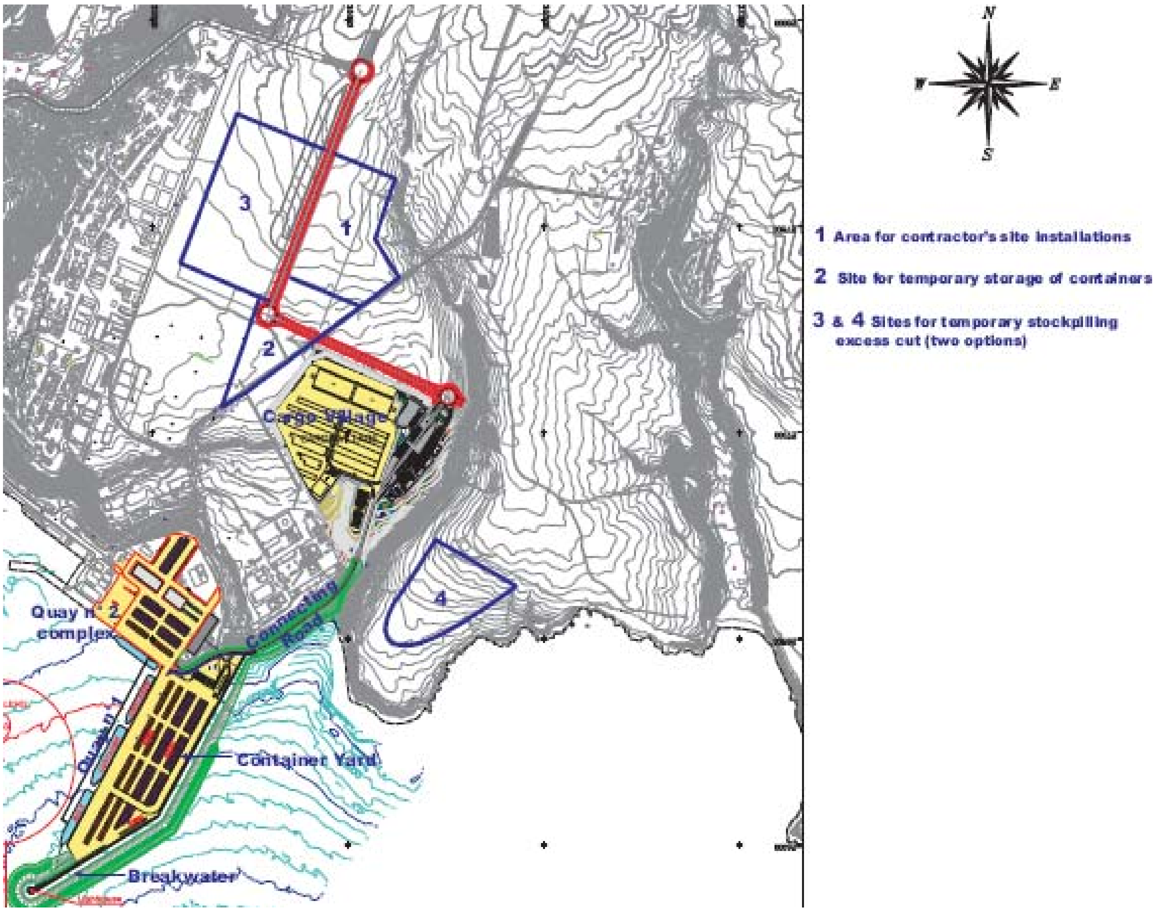
| | Option 1: Embankment | Option 2: Retaining wall | Option 3: Pile-founded |
|---|---|---|---|
| **Environmental Impact** | ++ | +++ | + |
| **Behaviour in breaking waves** | adequate | bad (reflection) | better |
| **Cost** | + | ++ | +++ |
| **Construction time** | shorter | longer | quite longer |

# 5. SITES FOR TEMPORARY WORKS AND RELATED ACTIVITES

The temporary works require sites relatively close to the main work sites. The temporary sites will be used for:

- Temporary installations for the main work site: plant storage, accommodation and offices, plant maintenance.
- Storage of containers during refurbishment of quay n° 2.
- Temporary storage of materials extracted from the cargo village site, to be used subsequently for construction of maritime structures (Phase II of the project).

Proposals have been made for certain sites, with an outline of their advantages and disadvantages. When the work sites are operational, contractors may propose alternative sites, for technical or land-use reasons, on condition that the impacts of the temporary activities carried out there are not such that they will have excessive consequences for the environment.



## 5.1. CONTRACTOR'S SITE INSTALLATION

The land made available for the Contractor's site installation is the territory marked "2" on this chart.

This site was chosen because of: its proximity to the various works sites; because it is served by the airport road, making it possible to avoid driving through Praia city; and because it is spacious enough to accommodate all of the activities and equipment needed for the project construction.

## 5.2. SITE FOR TEMPORARY STORAGE OF CONTAINERS

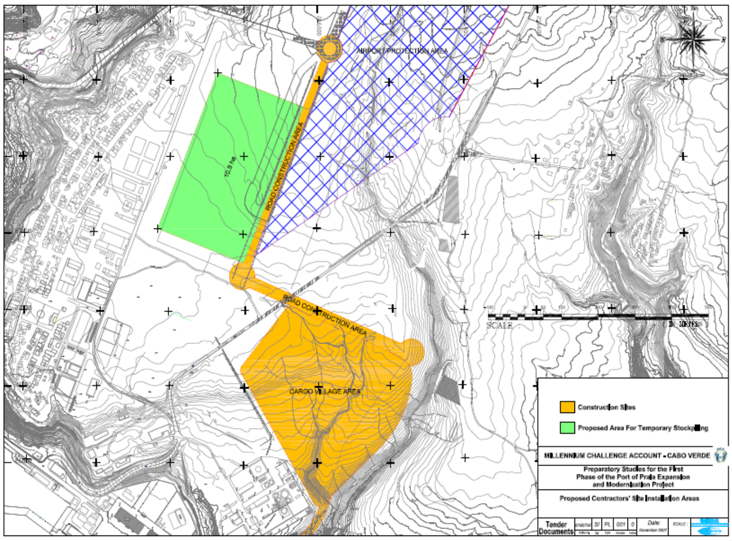
This site (Area 2 on map on previous page) was chosen because of its proximity to the quay n° 2 storage area and the fact that it is served directly by the road linking the main entry of the port to the western part of the plateau. The pavement of this sloping road has just been renewed. Its use avoids passing through the city center via the Ribeira Trindade roundabout.

## 5.3. SITES FOR TEMPORARY STOCKPILLING EXCESS CUT

A total amount of 400,000 m$^3$ shall be excavated to level the Cargo Village site, out of which 100,000 m$^3$ shall be reused as fill for the connecting road (lower part). Out of the remaining 300,000 m$^3$,

- 50,000 m$^3$ may not be reused at all for the works because the material may be too fine or too loose.
- Besides, the remaining 250,000 m$^3$ are supposed to be used for the marine structures in phase II of the project (extension of quay 1, breakwater and new marine yard) and have been to be temporarily stockpiled. It should not be far from the Cargo Village, to minimize transportation costs.

Two sites have been investigated for the temporary stockpiling (sites 3 and 4 on the previous map)




**Site 3** (green area on this map) is located along the future road, opposite the site dedicated to the contractor's installations.

**Site 4** (yellow-green area on the following chart), at Ponta da Visconda. The land has a considerable area (7 ha), a low inclination and for being located on the external side of the industrial area, it will cause less disturbance from the point of view of environmental components affected by the previous option. The inconvenience for the use of this land has to do with its access, as it is located 1.6 km from the cargo village (however, the Contractor should be allowed to build a temporary short-cut across the gully).

Location Map of the Temporary Stockpiling Area and Road Connection with the Cargo Village


**Table 6. Sites for temporary stockpiling excess cut. Comparison of impacts on environment.**

| Impact on | Site 3 | Site 4 |
|---|---|---|
| Water flow and drainage | Storage must not constitute an obstacle to the flow of water which, if heavy rainfall occurs, could lead to directing the flow towards the activity zone to the west and beyond to the residential district of Achada Grande. | Same hydrological condition can occur as for site 1. However there is no residential area downstream. |
| Fauna and flora | Disappearance of local vegetation. Impact of bird life | Disappearance of local vegetation Impact of birdlife, mainly those protected having their habitat on the sea cliffs. |
| Access | Direct from the cargo village area | Indirect via the existing road access (sea map). A temporary dam across the gully could be built |
| Landscape | Stockpile would be 2.3-m high and would be seen from the activity area and the neighbor dwellings of Achada | This coastal zone immediately to the east of the port facilities (Ponta da Visconda) is designed in the draft |

| | | |
|---|---|---|
| | Grande. | PDM of Praia City (Plano Director Municipal) as a natural area (Patrimonio Historico Natural). |
| Vicinity | The land is located within a mixed area (residential and industrial) therefore the possible disturbances can not be ignored. Disturbances will be felt by workers and local population, namely the dust transported by the wind, dust and noise resulting from heavy vehicles, air pollution by chemical compounds expelled by the exhaust pipes of these vehicles.<br><br>A warehouse has been built very recently on that area. | Same disturbances as for site 3 will be felt by workers and local population if trucks are running along the existing roads.<br><br>Dust will not affect the local population located upstream the dominating winds. |

| **Other destinations for a part or the totality of the excess cut material** |
|---|
| ▪ A possible destination could be Praia's dunghill, where the material could be used to cover the residues remaining at the surface.<br>▪ INIDA has expressed interest to use a portion of the excess material that will be removed off the Cargo Village implantation area to prepare, recover and treat several experimental agriculture plots that INIDA daily manages. However this destination may be compromised due to the transport costs linked to this option, since this material should be stored in São Jorge dos Órgãos.<br><br>Any of these additional options should be negotiated by the client or the contractor and entities involved. ENAPOR could lead the negotiation process. |

The final recommendation is to use Site n° 4, at the top of the Ponta do Visconda, which is located away from human settlements and is under the prevailing wind (as the prevailing winds are offshore, dust problems will be avoided). Storage of materials could be optimized by coordinating phases 1 and 2 (a large proportion of the material excavated for the cargo village could be used directly for construction of the maritime structures, without the need for temporary stockpiling).

In addition, when the works are completed, the contactors must clean up the areas so as to allow them to return rapidly to their initial state.

## 5.4. MATERIAL WHICH MAY NOT BE REUSED

As far as the 50,000 m3 of loose topsoil that cannot be reused in the project are concerned, three alternatives have been considered:

- Truck them to the quarries feeding the port project with rock and aggregates, taking profit of the empty trucks travelling back to the quarries. At quarries this material would be used to improve sites being closed.
- Use them at INIDA agricultural experimentation sites, on Santiago Island.
- Dump them at the Praia Municipal Dumping Site ("Lixeira Municipal"), located next to the connection of the new ring road with the Cidade Velha road).

The first option sounds satisfactory but it requires the agreement of the quarry operator(s), which could not be reached during the study phase.

The second option has the disadvantage of long trucking distances, as INIDA agricultural experimentation sites are all located far from the project site, at least 25 km from it.

At the present stage the third option, i.e. the Praia Municipal Dumping Site ("Lixeira Municipal"), looks therefore the most feasible one.

# E. IDENTIFICATION AND ASSESSMENT OF ENVIRONMENTAL IMPACTS

# 1. IMPACT OF SITE INSTALLATIONS FOR WORKS AND RELATED ACTIVITIES

## 1.1. CONTRACTOR'S SITE INSTALLATION

### 1.1.1. Impact on soils and vegetation

Setting up the site installations (living quarters, parking area for site machinery, maintenance zone, and temporary storage area for materials, asphalt-mixing plant, offices, and canteen) will require partially or even totally destroying the site vegetation.

Consequently, all vegetation in the project area will be destroyed. Although this impact is negative, destruction of vegetation will not be significant since natural vegetation on the project area is scattered, creeping and composed of short-lifecycle weed that only covers the soil partially during the wet season. In the dry season lasting most of the year, the soil does not have vegetation and is covered by loose rocks over the plateau.

### 1.1.2. Impact on fauna

The most affected fauna on plateau will be birds. Birds from the plateau, such as the Cream-colored courser (*Cursorius cursor*), Black-crowned sparrow-lark (*Eremopterix nigriceps*) and Bar-tailed lark (*Ammomanes cincturus*) will certainly leave the area because they are used to living in dry areas away from intense human activity. The laborers, heavy truck and machinery traffic (noise), will affect the birds' behavior.

## 1.2. IMPACT OF ACTIVITIES ON THE JOBSITE INSTALLATION AREA

### 1.2.1. Concrete-mixing plant

Using aggregate/gravel from quarries and cement from the port (cement terminal), this plant will mix concrete for:

- Surfacing, including replacement paving slabs for quay n°2 and buildings,
- Artificial rockfill (moulds filled with concrete to produce the CORE-LOC™).

Example of a concrete-mixing plant.

The plant is equipped with a mixer (pugmill) with a capacity of about 2 $m^3$ and one or more towers in which the concrete is produced. The plant comprises one storage silo for aggregate and one for storing cement.

The quantities to be produced are given in the following table.

| Designation | Quantities ($m^3$) |
|---|---|
| Concrete for buildings | 2 900 |
| Concrete for CORE-LOC™ and others | 2 000 |
| Total concrete | 4 900 |

To reduce temporary impacts on the environment, the following recommendations should be observed by the contractor:

- The concrete-mixing plant (and the asphalt-mixing plant, see section 1.2.2.) will be positioned in the south-east part of the terrain, nearer to the cargo village and the road and further away from the dwellings situated on the Achada Grande plateau.
- The concrete-mixing plant will only use moderate quantities of water (this water will be taken from the network or brought by water tanker, depending on the configuration of the network at the time of the works.
- Run-off will be collected, thanks to the concreted areas around the plant, and decanted, then treated in a settling chamber before being returned to the natural outlets.
- The system will function in a closed circuit with no waste. The process water will be collected then left to decant. Water used for washing the materials and mixing will then be reused for mixing concrete or for other washing operations. This system thus enables the only water necessary to be used for mixing concrete delivered to the site.
- Dust clouds, which can in some cases be a nuisance for local residents, are not a major problem here, although, under the prevailing winds (NE), the nearest dwellings of Achada Grande are situated 800 m away from the zone where it is proposed to install the concrete-mixing plant. This plant could be protected by metal paneling. The silos will be equipped with a dust filter and filling will be done automatically with a safety device to avoid overflow.

## 1.2.2. Asphalt-mixing plant

This plant will be necessary to produce asphalt for the access road and service road network for the cargo village. It will only function temporarily and for a limited period. The quantities to be produced will be of around 16,000 $m^3$.

The possible impacts of an asphalt-mixing plant are as follows:

- Pollution of underground and surface water on the plateau,
- Air pollution which is the main impact of an asphalt-mixing plant because of the nature of the installation involving heavy fuel combustion and the production of gases such as $SO_2$ and $NO_2$. The gas exhaust chimney, about 10 m high, should allow the gases to be well diluted given the frequency and speed of the prevailing winds.

The dust and combustion gases produced by the asphalt-mixing plant are evacuated by means of a chimney.

An asphalt-mixing plant serves to mix aggregate and bitumen together in a rotating drum, heating them to a very high temperature (around 160°C) and then evacuating the mix via a hopper into tipper trucks which then supply the road and access road network construction jobsites. The installations generally comprise:

- A coating plant using a burner;
- An asphalt depot comprising an insulated storage tank;
- A heavy fuel storage tank equipped with a heater and a tank of domestic fuel;
- Various material such as emergency electricity generators, filler silo, dust filter, heating circuits, conveyors, measuring hoppers, etc.

- Smells: laying the asphalt may cause these smells to propagate and especially so when the wind is strong as is often the case locally. Mixing road asphalt involves using bituminous matter and oil (hydrocarbons) and the main effect could be health risks.
- Dust pollution: some of the fine dust from the aggregate being fed into the mixing – drying drum will be thrown back into the natural environment. Other clouds of dust will be caused by truck traffic in connection with the plant.
- Noise pollution: a rise in the usual noise levels will be caused by machinery being put into motion and activity. Dwellings situated 800 m away are protected from noise by the buildings in the industrial zone.
- Accident risks: there is a risk of fire, explosion and dispersion of dangerous products around the oil storage tanks. The risk of explosion is due to the simultaneous presence of oil and electricity generators.

The following measures will be taken to reduce the effects of the project on the environment.

| | |
|---|---|
| **Air Pollution** | ▪ Aggregate will be stored behind embankments to keep dust clouds to a minimum<br>▪ The filler silo (very fine particles) will be equipped with an overflow prevention device situated high up to allow dust clouds to be treated in a reinjection system.<br>▪ The drying drum, which is the main potential source of dust, will be equipped with a reverse-air bag-filter to limit the dust content of the product and respect the standard applicable to this type of installation which is 50 mg/$Nm^3$<br>▪ The dust and combustion gases produced by the asphalt-mixing plant will be thrown back into the environment via a chimney at least 10 m high.<br>▪ The fuel used will be heavy fuel with a very low sulphur content (< 1 %) to respect the regulatory limit value for exhaust fumes of the sulphur oxide type set at 1,700 mg/$m^3$ particles). |
| **Water Pollution** | No water is used in this process. The only potential risk of water pollution concerns the use of domestic fuel, in case of a leak. The small quantity stored will be situated over a retention basin. The considerable viscosity of the bitumen and heavy fuel limits the risk of a leak to almost zero. The storage tanks, however, will be situated over retention basins.<br>Around the coating plant, flexible connections will be designed to enable coolants to circulate inside the bitumen pipeline, thus eliminating any risk of leakage into the natural environment.<br>Run-off will be collected via the jobsite stormwater drainage network and returned to the quarry stormwater basin after passing through the asphalt plant's water treatment system (oil separator). |
| **Noise pollution** | The main sources of noise are caused by the unloading of aggregate and by the burner on the mixing drum. This has been made soundproof as have the electricity generators equipping the plant. Embankments placed near the installations (around the edge of the platform) will limit noise pollution for local residents. |
| **Waste** | Operating the asphalt plant does not produce much waste. The dust collected by the dust filter is reincorporated into the final product which is the asphalt. The other waste produced by the installation will be eliminated via regularly authorized installations. |
| **Risks** | Operating this kind of installation does not involve much risk of fire or explosion under normal conditions. The liquids used are only very, very slightly inflammable. They are stored in tanks complying with road standards, equipped with temperature regulation captors and alarms.<br>The plant will be situated away from the other installations on a site reserved for storing aggregate.<br>The coating plant will be situated at least 10m away from the reservoirs where inflammable liquids are stored. It is equipped with temperature captors mainly to control the burner supply and air |

supply.

The installations will be equipped with a sufficient number of suitable extinguishers. Safety instructions will be drawn up along with prevention measures such as prohibiting smoking near inflammable liquid storage containers. A telephone link with the emergency services will be installed.

### 1.2.3. Impact of manufacturing artificial rockfill

The artificial rockfill of the CORE-LOC™ type will be manufactured in moulds on the site. The estimated number required is about 2,550. Production of this rockfill will need to be undertaken before building the road so as to have a stock which will be used as and when required to protect the road fill on the sea-side of the site.

Top left: view of the CORE-LOC™ artificial rockfill

Bottom left: mould used for making the rockfill.

Right: storage and preparation of the artificial rockfill before installation.

The rockfill will be molded next to the concrete plant. Concrete scraps will be collected and decanted in a mud filter which will also collect run-off from the concrete plant.

The units can be stored on one or more levels depending on the area available. This storage, apart from its temporary effect on the landscape, does not cause any particular environmental constraint.

### 1.2.4. Impact of the temporary storage of materials

The materials supplied from the quarries, mainly aggregate, will be temporarily stored on the works site before use (concrete production, asphalt production, etc.).

Storing these materials will mean respecting the site's hydraulic constraints. The materials must be placed parallel to the general direction of flow, in the form of discontinuous strips allowing for hydraulic transparency in case of a flood (which is a rare event, given the rainfall distribution for Cape Verde).

The temporary storage of these materials could cause dust to be produced due to the prevailing winds.

### 1.2.5. Impact of site frequentation by staff from the contracting companies

Example of site living quarters (unit model)

The contractors' personnel (supervisory staff, foremen, laborers) will require living quarters to be installed comprising:

- A drinking water supply, sanitation/drainage, electricity and telecommunications,
- Offices,
- changing rooms and sanitary installations (showers, toilet facilities),
- food service and rest installations,
- a dispensary for first aid.

Various types of personnel accommodation will need to be provided in Praia: building housing on a dedicated site, accommodation with local residents, bed and breakfast or hotels).

The site area will be equipped with a water supply (for site needs and drinking water for the personnel), sanitation, electricity and a waste collection system (see boxed text: Temporary and Permanent Utilities).

As regards sanitation, evacuating domestic waste water in septic tanks or soakaways should be avoided. The following should be considered:

- either a connection with the municipal sanitation network,
- or installing a small treatment plant (in this case, a treated waste water outfall should be installed in the nearest thalweg),
- or installing independent toilet facilities requiring periodically transferring the effluent to the municipal treatment plant.

| Temporary and Permanent Utilities |
|---|
| Temporary and permanent utilities used for construction shall be adequate for the intended uses and not to be overloaded or otherwise used or arranged in any manner endangering persons, premises or works. Connections shall be properly made, lines and wiring securely anchored in place and protected against accidents.<br>**Water**<br>The Contractor shall provide the necessary pumps, valves, motors, storage tanks or reservoirs and distribution lines to adequately supply water for the Project including:<br>▪ drinking water: providing and maintaining canisters, coolers or connected drinking fountains of sufficient number to reasonably serve the Project;<br>▪ construction water: providing and maintaining temporary water service and distribution of adequate capacity for construction, installation and testing including portable unit, line extensions, hoses, valves, etc.<br>**Electricity**<br>The Contractor shall provide and maintain generators including a stand-by generator of adequate capacity to meet the Project requirements. The Contractor shall also provide and maintain:<br>▪ temporary electric service and distribution of adequate capacity for power, lighting and other construction needs including wiring, transformers, safety devices, connections, etc., as necessary.<br>▪ temporary lighting as necessary to properly and safely perform work in enclosed spaces or under hazardous conditions. Likewise, provide lights for night protection as necessary.<br>**Waste and Rubbish**<br>The Contractor shall adopt waste disposal facilities and provide regular daily clean-up and removal of trash, waste, construction debris, etc. from site and temporary work yard and arrange for disposal of waste and rubbish to disposal areas. |

Traffic caused by site personnel – besides the flow of materials supplying the living quarters or various jobsites – must also be planned for:

- coaches/buses bringing workers to the site at peak morning and evening hours,
- traffic carrying supplies for base camp (food, various services, etc.).

## 1.3. IMPACT OF THE TEMPORARY STORAGE OF CONTAINERS

The site for storage of containers during refurbishment of quay n° 2 and its yard was chosen because of its proximity to the quay n° 2 storage area and the fact that it is served directly by the road linking the main entry of the port to the western part of the plateau (Achada Grande de Traz). The ground, once cleared of debris, will be leveled and compacted to allow the lifting equipment to handle the containers. The impacts of temporary use of this site will be as follows:

- Loss of existing (dry bush) vegetation in the north-eastern part and desertion by the fauna, mainly land birds (sparrows).
- Impacts resulting from traffic between the port and the temporary storage site. Trucks will use the sloping road between the port and the plateau road, of which the pavement has just been refurbished. Use of this route therefore avoids passing through the city. Conversely, it does mean driving along the fishing port, a very busy area (sales of fish on the quay, supplying of fishing vessels). An increase in

noise levels, inconvenience from exhaust gases and risk of accident is therefore to be expected in this sector.

- On the site itself, handling of containers will cause increased noise levels. The activity is, however, far from the first houses of Punta da Achada, separated from the site by a line of buildings and sheds on the industrial estate.
- The use of lifting and handling plant will result in an increased risk of chronic pollution (oil leaks, leaks when filling tanks).
- The landscape will be affected locally by the storage of containers in the site.

# 2. IMPACT OF QUARRY ACTIVITIES

## 2.1. INVESTIGATED QUARRIES

Three quarries were investigated by the Consultant in the vicinity of Praia: the ITP quarry in Sao Francisco, the Polinertes quarry and the CVC quarry, north of Praia, close to the Assomada road. Their locations are shown on the attached quarry location map.

### 2.1.1. Sao Francisco – ITP quarry

The Pedreira de São Francisco quarry is the former ITP quarry, taken over on 6 November 2006 by “Cimentos de Cabo Verde”, which belongs to the Portuguese “Cimpor” Group. The name “ITP quarry” was kept[7]. The concession has an operating permit valid for 30 years from 1997 and the quarry has a valid environmental permit.[8]

The quarry is allowed to sell any kind of rock and aggregate to any customer. The remaining capacity of the quarry is currently estimated at 4.2 million $m^3$, with significant possibility for further extensions. The whole surveyed area covers 31 hectares, lying between the contour lines of 150 m and 237 m.

The quarry is situated north of Praia (4.7 km as the crow flies, in the vicinity of the white wind turbines), beside the first roundabout (n°6) of the new ring road when approaching the new airport. The route from the quarry to the port via the new ring road (which is nearing completion) will be only 6km. The ring road in this area should be fully completed by 2007.

The material available is pure basalt standing in huge, sound columns. The normal production rate is about 9,000 tons/month and can be doubled. The quarry is able to furnish the whole range from small aggregate up to 6-ton blocks. Thus 0/4-mm, 4/14-mm, 4/30-mm and 5/12-mm concrete aggregate can easily be supplied. The quarry site has been checked by several exploratory borings to ensure the high quality and quantities of material everywhere on the site.

The quarry site is equipped with jaw-breakers and cone-type crushers made in Norway. The ITP quarry is ready to separate and sieve any kind of diameter in order to fit the required sieve curves and standards. The quarry is equipped with a hydraulic boring system. As the Cimpor Group (parent company) owns various quarries in Europe and South America, the quarry operator/owner can obtain spare parts or even complete sets of equipment quite rapidly.

The Cimpor Group adheres to very strict internal and local environmental standards. In December 2006 an environmental audit of their Sao Francisco quarry was performed (ref. 12) designed to bring quarry operations into line with the most recent Cape Verdean Environmental Regulations (Decrees/Laws of March 31, 2003[9] and March 6,

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[7] Industria de Transformaçao de Pedras, ITP Lda

[8] Cabo Verde requires a “licença de exploraçao” (exploration and operating license) and an environmental permit for quarries. The operating license cannot be obtained without the environmental permit. The “licença de exploraçao” for the ITP quarry was issued in 1997. A new operating license is now required to comply with the new Cape Verdean environmental regulations, dated respectively 2003 and 2006.

[9] Art 7: each year, the Environment Department (DGA) carries out an internal audit based on an operating report submitted by the operator. It then delivers a 1-year authorization or a permanent authorization, if quarry operation is in full compliance with DGA recommendations.

2006). This additional environmental study was approved by the General Environment Department (DGA, Ministry of the Environment and Agriculture) which delivered a one-year operating license to ITP in June 2007. The recommendations of the internal audit comply with those of the external audit.

### 2.1.2. Polinertes quarry

The quarry at Monte Parada is operated by the Polinertes Company which is owned by Mr. Ramiro Lopes. The quarry covers at least 34 ha of land and also includes the CVC quarry (see following chapter). This quarry is 13 km away from the port via the main Praia – Assomada road and the new ring road (roundabout n°5). According to the owner, the Company has an unlimited license to deliver material to any client. Its equipment is new. The material to be exploited at this quarry is smallish, and will be used to produce sand.

For the needs of the project, the Polinertes Company proposes to take samples of decimetric and/or metric blocks on one or more sites along a 3-km escarpment, oriented NW – SE, situated on the property of Mr. Lopes.

The Polinertes Company made an EIA in January 2005 which was approved in August 2006 by DGA (see attachments). The DGA granted a temporary authorization for operating this quarry which will take effect at the start of operation.

### 2.1.3. CVC quarry

The CVC quarry is owned by the Polinertes Company and operated by CVC. They have permission to operate the quarry for another 4 years (until 2011) without any limitation regarding quantities. The quarry lies east of the road to Assomada, about 2km north of the Polinertes quarry and 15 km away from the port of Praia. The company is allowed to sell any rock or processed rock material to any customer.

The rock looks very similar to the material found in the Polinertes quarry: quite fissured. It is therefore believed that no big stones for revetments can be delivered from the CVC quarry.

### 2.1.4. Sao Filipe quarry

Available documentation shows that the existing port of Praia was built in 1982 with material from the Sao Filipe quarry, which is situated at the eastern entrance of the Sao Francisco – ITP quarry. This quarry has been abandoned. No further information could be obtained.

## 2.2. ACTUAL ENVIRONMENTAL CONDITIONS

The environmental conditions of the three selected quarries are summarized in the table on the following page.

## Table 1. Selected quarries – Existing environmental conditions

| Items | ITP | Polinertes | CVC |
|---|---|---|---|
| **PHYSICAL ENVIRONMENT** | | | |
| **Altitude natural ground** | Concession area: about 155 to 237m | Installations zone: 210 to 230 m<br>Planned quarrying zone: about 200 to 250 m | About 200 to 240 m |
| **Surface** | 31 ha | Planned quarrying zone: 34 hectares | Undetermined – over 20 ha |
| **Geomorphology** | Rock: basalt<br>Operating the quarry face oriented west with an average slope of 12 to 13 % | Rock: basalt<br>Operation envisaged in the upper part of the northern slope of the Monte S.Filipe, generally oriented North–North-West, with an average slope of 25 to 35 % | Rock: basalt<br>Operating the quarry face oriented westwards with an average slope of 10 to 15 % |
| **Surface water** | Thalweg head situated north of the quarry draining the west part of the Monte San Filipe: very occasional flow. | Installations zone: thalweg bottom, over the head of the catchment basin of the San Filipe River (ribeira). Immediately upstream: 8-m-high dam reservoir.<br>No preferential flow identified in the planned quarrying zone. | Head of the (ribeira do) Portere River catchment basin. Installations and stocks in the thalweg bottom. Very occasional flow diverted to the edge of the installation zone. |
| **Groundwater** | No springs or groundwater discharge identified in the quarry or in the installation zone. | No springs or groundwater discharge identified in the planned quarrying zone. | No springs or groundwater discharge identified in the quarry or the installation zone. |
| **NATURAL ENVIRONMENT** | | | |
| **Vegetation** | Very sparse grassy covering.<br>Few bushes and trees (*Prosopis juliflora*) | At the foot of the slope: woods of acacia americana (*Prosopis juliflora).*<br>On the slope: sparse bushes. | Sparse bushes and trees (*Prosopis juliflora)*. |
| **Fauna** | Bird and animal wildlife common to arid sectors. | Bird and animal wildlife common to arid sectors. | Bird and animal wildlife common to arid sectors. |

| | | | |
|---|---|---|---|
| | The birdlife nesting in the study zone mainly comprises the Yellow-throated Sparrow (*Passer iagoensis*), the Helmeted Guineafowl (*Numida meleagris*) and the Common Quail (*Coturnix coturnix*).<br><br>Considerable perturbation of the local fauna by the activity of quarrying/processing materials. | The birdlife nesting in the study zone is mainly constituted by the Yellow-throated Sparrow (*Passer iagoensis*), the Helmeted Guineafowl (*Numida meleagris*) and the Common Quail (*Coturnix coturnix*) as well as species from wooded sectors and rocky escarpments. | The birdlife nesting in the study zone mainly comprises the Yellow-throated Sparrow (*Passer iagoensis*), the Helmeted Guineafowl (*Numida meleagris*) and the Common Quail (*Coturnix coturnix*).<br><br>Considerable perturbation of the local fauna by the activity of quarrying/processing materials. |
| **Protected areas** | None in the site environment | None in the site environment | None in the site environment. |
| **HUMAN ENVIRONMENT** | | | |
| **Habitat** | Urban district of San Felipe de Meio, 500m to the south-west; the quarry is not visible from this site. | A hamlet (Agostinho Abres) situated 500m north-west of the eastern end of the planned quarrying zone. | No housing within one km from the site. |
| **Agriculture** | Almost none. Possibly extensive grazing land around the site. | Almost none. Possibly extensive grazing land around the site. | Almost none. Possibly extensive grazing land around the site. |
| **Other activities** | Presence of 4 large wind turbines in service on the Monte S. Felipe, 300 to 500m north-west of the quarry. | Presence of 4 large wind turbines in service on the Monte S. Felipe, 300 to 500m north-west of the quarry. | None |
| **Road access and traffic** | Proximity (1km to the south) of the Ring Road (4-lane expressway by-pass) nearing completion. Access track to the quarry linked to it. The site is 6km away from the project via this road. | Installation zone: proximity (500 m east) of the Assomada road. Access road to the site developed in a trench from thereon. Site-project distance: about 13 km.<br><br>Current traffic on the Assomada road: 3,600 veh/day including 12 % heavy veh.<br><br>Planned quarrying site can be linked up to the Ring Road about 2km away. | Installation zone: proximity (700 m east) from the Assomada road. Access track to the site from the road. Distance between the site and the project: about 15km.<br><br>Current traffic on the Assomada road: 3,600 veh/day including 12 % heavy veh. |

## 2.3. LOGISTICS AND ENVIRONMENTAL ISSUES

This section provides our evaluation of the environmental issues and environmental management with respect to the quarries that are being evaluated for potentially supplying materials to the Praia port project. We first provide below some general environmental issues related to quarries. Then specific issues related to the selected quarries are highlighted, according to the documents approved by the DGA as part of the Cape Verde environmental regulations. We conclude with the proposed additional environmental measures and conditions to be complied with as part of the Praia port project.

### 2.3.1. Overall issues

Following are the issues related to rock quarrying operations that are generally considered critical with respect to environmental impacts.

- **Impacts on landscape.** Quarries like those visited near Praia often introduce features to the landscape that have a negative visual impact, including quarry faces and areas of exposed rock, soil and overburden stockpiles, product stockpiles, waste tips and artificial lighting. Furthermore, changes in vegetation, field patterns or topography through excavation, burial, stockpiling, or built structures (for example, offices, the processing plant, storage hoppers, and exhaust stacks) are likely to have a negative impact on landscape. Finally, landscape can be affected through airborne dust and dust deposits on surrounding land, mud on roads, light pollution and inappropriate restoration or use of vegetation around the site. Evaluation of the impacts (especially visual) on landscape can be subjective, and might change with the season, although seasonal changes are relatively small in the area of the quarries that are the subject of this analysis. Erosion can create negative impacts that may be considerably more significant than negative visual impacts. Cleared areas, for example, may result in increased, concentrated runoff.
- **Noise and vibration.** The exposure of aggregate by mechanical stripping of soil and rock, extraction by digging or blasting, transportation of aggregate around the site, and processing the aggregate are likely sources of noise. Impacts will be on site personnel, as well as on the surrounding areas. Blasting with explosives, which is essential at hard rock sites like those under investigation, is a significant source of vibration both within and outside the quarry site. Ground vibration from mobile or heavy fixed plant equipment is normally not felt outside the site. Loud or persistent noise or vibration, audible beyond the site boundary, is unlikely to cause physical damage, but could interfere with daily human habits (relaxation, sleep, and communication). Noise and vibration can also disturb wildlife. This may be especially important for endangered or rare species during the mating and nesting season.
- **Transport of aggregate offsite.** Road transport of the aggregate to the port area will be accomplished either entirely or in part using Heavy Goods Vehicles (HGVs). Potential impacts from transport by HGVs include: increased congestion, noise and vibration, reduced access and safety, increased pollutant emissions from truck exhausts, and inordinate road wear and tear (because of the large size and weight of the trucks), especially on minor roads that constitute the truck route. Poor driving habits by the truck drivers could result in considerable stress if not risk to pedestrians and other vehicles in communities through which the truck route will pass. Access by pedestrians and local vehicles may also be restricted due to the increased truck traffic. Dust, grit and mud may be spilled from the trucks or carried

by truck tires and chassis. Overall, HGVs are estimated to have a potential impact 2.3 times that of private vehicles.[10] Mitigating factors include the ongoing construction of the Praia ring road, which would be the principle part of the intended route for transporting the quarry materials to the port (see attached map).

- **Air quality.** Airborne dust is one of the principle negative consequences of quarry operation. Health risks due to airborne dust from hard rock quarries are not thought to be significant. Exhaust fumes from fixed and mobile plant equipment (which often run on diesel fuel) rarely cause impacts outside the site boundary, and are easier to control than dust, which can travel well beyond the site boundary. Dust is normally composed of solid inert particles of between 1 and 75 microns in size. The potential health impact is normally determined by the particle size. Particles greater than 30 microns make up the largest portion of quarry dust and normally deposit within 100 m of the source. These larger particles are usually what cause public "nuisance", through deposit on surfaces. Intermediate-sized particles (10 to 30 microns) can travel 200 to 500 m from the source. Small dust particles of less than 10 microns (also known as 'PM10') make up a relatively small proportion of quarry dust, but can remain airborne for longer, dispersing more widely and depositing more slowly over a wider area than larger particles. Local communities can potentially be affected by dust up to 1 km from the source. Possible health risks from PM10 particles should be evaluated if communities are located within 1km of the quarry. Soil and overburden stripping, drilling and blasting, stockpiling, disposal of waste, processing operations, loading (for example of the primary crusher) and unloading of materials, transport of materials and site restoration can all potentially release dust into the atmosphere. The impact of each of these depends on the duration and location of the operation, site topography, meteorological conditions, exposure of workers, and the distance to communities. We note that concerning air emissions, other sources of air emissions (especially dust) in the area must be taken into account, because the **cumulative** emissions (other sources plus emissions from the quarry) must be evaluated.

- **Water resources.** Quarries may have an impact on surface water and groundwater resources in terms of water use and contamination. These impacts can typically result from boreholes acting as points of entry for runoff (which might facilitate groundwater contamination), changes in groundwater recharge due to removal of soil and overburden, depression of the water table due to excessive pumping, and restoration of the site during site closure. Potential groundwater and surface water contaminants include suspended solids, petroleum products (such as fuel and lubricating or hydraulic oil, nitrates derived from the use of explosives, and other chemicals used on site, including acids and alkalis). Domestic sewage from these sites is often discharged to on-site septic tanks. Without appropriate measures to protect and manage water resources, contaminants can be widely dispersed, with negative impacts on the quality of surface and groundwater, and consequently on habitats and the wildlife that they support.

- **Mineral waste.** Mineral wastes are an unavoidable by-product of extraction and processing of aggregates for which no market currently exists. Mineral wastes generated at hard rock quarries are generally inert and non-hazardous, and vary from small to large depending on the nature of the site, the depth of the commercially valuable material and the quality of rock extracted. These wastes include overburden and inter-burden (material of limited value that occurs above or between layers of economically valuable aggregates), and processing wastes (non-marketable fine-grained material from screening, crushing and other

[10] See NECESI/The Environmental Practice (2004).

processing activities). These wastes are normally disposed of in ‘tips’[11] within the site boundary.

- **Biodiversity.** Permission for operating quarries must normally consider whether sites are host to endangered or sensitive plants, animals and habitats, or likely to have an impact on the same outside of the site boundary. If so, the Environmental Management Plan for the site must include measures for ensuring biodiversity conservation and protection of sensitive flora and fauna and their habitats.

### 2.3.2. Mitigation measures

Typical mitigating measures during a quarry operating phase are as follows:

- *Destruction of fauna and vegetation cover:* care should be taken to leave vegetation and animal habitats around the quarry as untouched as possible. Workers should be trained regarding the presence of and need to preserve sensitive habitats within and outside of the site boundary.
- *Chemical pollution:* the impacts of pollutants such as dust, silt, oil, fuel and other chemicals should be reduced or eliminated through proper storage, offsite recycling, watering down waste piles, and other common measures.
- *Blasting:* Damage to fauna and sensitive habitats should be limited by carefully selecting blasting zones and the time of blasting activities.
- *Erosion:* Erosion resulting from road construction and other construction activities should be minimized, for example by ensuring that rainwater can soak into the ground slowly. Uncontrolled drainage of muddy runoff should be avoided.
- *Groundwater:* Underground water resources close to a conservation area should be left intact, that is, undisturbed by quarry operations.

Habitat disturbance and the effects of mitigating measures should be monitored regularly, for example at three-year intervals (depending very much on the nature of the site and of the quarry activities).

Subsequent to depletion of the site, a closure and rehabilitation plan must be developed for reconstructing the landscape, in compliance with Cape Verdean law and international practice. Financing of the closure plan (normally by the company responsible for exploitation of the site) must be ensured well in advance of site closure. Closure and rehabilitation could include the following measures:

- Removal of wreckage, buildings, equipment.
- Remodeling perpendicular slopes.
- Loosening the quarry floor and access roads (normally compressed and hardened by the use of heavy machinery).
- Ensuring sufficient drainage of the quarry floor.
- Filling in crevices and holes in reconstructed gentle slopes with sterile soil.
- Replanting.
- Monitoring the results.

[11] Any accumulation of mineral wastes, including waste and soil heaps, stockpiled materials, backfill, screening embankments, and lagoons and settling ponds.

### 2.3.3. Evaluating impacts and measures under environmental authorization applications

Under the authorization procedures for operating the three quarries, the impacts and mitigation measures are identified in the documents approved by – or produced by – the DGA. They are presented in the tables on the following pages.

The environmental situations relative to the operation of each of the three quarries are illustrated by the photographic reportages attached.

## Sao Francisco ITP Quarry - Impacts and Mitigation Measures[12]

| Activity | Environment Media Affected | Impacts | Mitigation Measures |
|---|---|---|---|
| Exploration of materials and construction of access routes | Geology and geomorphology | Increased instability of quarry walls | Designing the access roads to the active quarry face, ecological restoration after the area is no longer being exploited, treatment of terraces |
| Tearing down and excavating quarry walls during exploration activities, and depositing earth | Hydrology (surface and groundwater) and soil erosion | Fall in water quality, risk of flooding, alteration of surface water, hydraulic load fluxes | Minimizing the interference of groundwater flows, maintaining infiltration rates in recharge zones, use of conservation measures for soil and water at the site, gravel layout areas at appropriate locations |
| Lubricating machines and other equipment | Soil, surface water and groundwater | Pollution of soil, surface water and groundwater | Collecting used oils in drums, to be sent to Shell facility. Adequate collection, storage and transport of used oils, training workers in the proper management of used oils |
| Generating residual solids | Landscape, surface water and groundwater quality, soil | Visual impacts, impacts on water quality, impacts on soil | Collecting and transporting materials to municipal landfill |
| Quarrying materials | Atmosphere | Particulate matter (dust) | Use of dust-suppressing measures (through vacuum suction or humidification) |
| Production of sand, movement of heavy machines and other equipment | Atmosphere | Increased level of atmospheric emissions (particulate matter, $NO_x$, CO, $SO_2$, COVs and hydrocarbons) | Use of a system of particulate (dust) collection through humidification (water spray), periodic maintenance of machines and other equipment, flattening and sprinkling working areas with water as necessary |
| Operating primary and secondary gravel processing systems | Atmosphere | Increased levels of noise (continuous or discrete) | Use of ear plugs, sound insulated cabins, protection of caterpillar treads with special rubber |
| Use of explosives and operation of equipment | Human environment | Noise and vibrations | Use of equipment with low noise levels |

[12] Source: Auditoria ambiental – Praïa, dezembro 2006

| | | | |
|---|---|---|---|
| Exploration for quarry materials | Landscape | Visual impacts | Recovery (restoration) of explored areas if further production is not warranted |
| Construction of terraces | Fauna and flora | Direct destruction of vegetation cover and related fauna | Maintain the possibility of the return of animal and plant species adapted to the conditions at the site |
| Removal of basalt rock | Human health | Worker health and safety | Use of face masks and other personal protection equipment, implementation of periodic medical check-ups |

## Polinertes Quarry - Impacts and Mitigation Measures[13]

| Activity | Environment Media Affected | Impacts | Mitigating Measures |
|---|---|---|---|
| **Treatment of materials** | Noise environment | Increased noise levels | Least noisy equipment.<br>Workers wearing noise protection equipment. |
| **Extraction and transport of materials to the treatment unit** | Air | Dust | Dust captors during extraction<br>Sheltered exposure of the quarry<br>Suction and spraying the treatment installation<br>Wearing of protective equipment (masks and goggles) by workers. |
| **Storage of fuel and lubricants** | River and water table pollution | Pollution risk | Collecting up waste (used oil) by the supplier. |
| **Transporting the materials produced** | Existing roads | Road deterioration | Checking axle loads. |

[13] Source: Análise da problemática ambiental do Projecto – Janeira de 2005

| | | | |
|---|---|---|---|
| **(Quarry activity)** | Social-economics | | Creating temporary and permanent jobs.<br><br>Increasing the municipal revenue.<br><br>Boosting the construction, industrial and commercial sectors.<br><br>Creating new internal and external investment opportunities.<br><br>Improving the living conditions of the populations. |

## CVC Monte Parada- S. Domingos Quarry – Impacts and Mitigation Measures[14]

| Activity | Environment Media Affected | Impacts | Mitigating Measures |
|---|---|---|---|
| Removing topsoil and moving earth during the setting up and extraction phases | Geomorphology, soil, landscape and noise | Modifying the morphology and natural areas in the quarries<br><br>Disturbing existing visual structures and spoiling the landscape | Defining a management plan for excess materials from the works for using them later for rehabilitating the quarry face to restore the environment. Defining a plan to prevent and control noise and impacts on the landscape. |
| Quarry activity | Social-economics | Creating temporary and permanent jobs<br><br>Increasing municipal revenue<br><br>Boosting the construction, industrial and commercial sectors.<br><br>Creating new internal and external investment opportunities. | |

[14] Source: Avaliaçao de impac ambiental do projecto intitulado « exploraçao de uma pedreira e de uma industria de producao de inertes », pela direcçao do ambiente, do ministério do ambiente, agricultura et pescas –Outubro de 2004.

| | | | |
|---|---|---|---|
| | | Improving the living conditions of populations. | |
| Extraction and quarry areas | Rivers and water tables | Modifying natural drainage routes<br>Pollution of rivers by used oil | Channeling flow around the quarry, adapted for maximum flows. Carrying out this work before setting up the quarry.<br>Removing used oil by the supplier and dumping in an appropriate place. |
| Extraction and quarry areas | Vegetation and fauna | Destroying the existing *Prosopis juliflora* cover<br>Disturbance of local fauna | Landscape rehabilitation works after operation. |
| Production of solid and liquid waste | Landscape, water and soil quality | Producing domestic and construction waste | Collection, proper conditioning and transport of materials to municipal landfill |
| Quarry activity | Noise and vibrations | Noise source of a level of 115 dB(A)<br>Increase in noise levels during setting up and extraction phases<br>Seismic wave peaks during explosions (dynamite) | Use of silent equipment guaranteeing noise levels of between 75 and 80 dB(A), not in excess of 70 dB(A) around industrial and commercial zones.<br>Use of ear plugs by operators<br>Checking vibrations based on maximum peaks |
| (Quarry activity) | Atmosphere | Increased concentrations of suspended matter (dust).<br>Emission of pollutants. | Use of dust captors in the extraction zone.<br>Use of suitable equipment for reducing dust pollution<br>Spraying all areas likely to generate dust<br>Adopting protection measures for operators and technical personnel involved in production. |

## 2.3.4. Evaluation of quarry sites

**ITP São Francisco quarry**

The ITP São Francisco quarry is located within pretty reasonable distance from the new ring road. The quarry, which is located within a basalt escarpment, appears to be relatively isolated, and is relatively hidden from the surrounding area.

Although water is intended to be used to keep dust down at the site, there appears to be relatively little use of water for that purpose. The existing reservoir built for that purpose (cf. photo 1) is inadequate (capacity 10 to 20 $m^3$). A ditch designed to collect rainfall run-off from the quarry is currently being dug in the centre of the stockpile area (cf. photo 2). Although it will have a large capacity in the long term (several hundred cubic meters), its natural supply seems somewhat hypothetical.

Domestic water is used at the site and small amounts of domestic waste water are generated. The inadequate toilet facilities for the quarry personnel (about 20 people) are currently being extended (cf. photo 6). In conjunction with improving the water supply for these facilities, the evacuation of sewerage should be planned for by means of a soakaway for example.

The most recent environmental document for the São Francisco quarry[15], the basis of the current annual license, provides details on site operations, equipment, types of explosives used, etc. Following are the main environmental impacts described therein:

- **Noise.** Estimated noise levels at 1m from various types of heavy processing equipment are given. This allowed noise levels to be estimated at a distance of up to 100m from the various sources. The report states that because of topography and vegetation, noise levels fall quite rapidly. Therefore, there would be virtually no impacts offsite and staff would only need earplugs when very close to operating machinery.
- **Dust.** The report states that dust generation is limited to the areas around the main processing equipment, and that dispersion of dust is limited. Dust collection equipment is used at the site. Nevertheless, no detailed study seems to have been made concerning the impacts of dust.
- **Visual impact.** The report confirms the Consultant's observations that the quarry is rather isolated and hidden, thus visual impacts are limited.
- The authorized concession crosses a ridge to the south west isolating the extraction site from the valley containing the ring road, overlooked by the urban centre of S. Felipe de Meio. Materials extraction is progressing in the direction of this ridge. Confining all pollution (visual, noise, dust) which the quarry generates, with regard to these vulnerable sectors, requires preserving this ridge.
- **Flora and fauna.** The report states that impacts on flora and fauna are limited. Nevertheless, the report does not appear to include a review of flora and fauna existing in the quarry area.
- **Occupational health and safety.** The report lists various aspects of quarry operation that pose health and safety risks for quarry workers: manipulation of explosives, equipment with high noise levels, insufficient warnings around the quarry operation zone, movement of heavy equipment in and around the area(s) of operation, production of dust and other atmospheric emissions, failure by operators to use protective equipment. Training by the ITP person responsible for worker health and safety is recommended for ITP employees.

[15] ITP, *Auditoria Ambiental*, Praia, December 2006.

The document includes an Environment Management Plan (EMP) listing mitigation measures for dust dispersion, noise generated by the use of explosives and operation of heavy machinery, impacts caused by the generation and storage of solid waste, visual impacts of exploration activities, impacts on fauna and flora, impacts on surface water and groundwater of the improper management of used lubricating and hydraulic oils, and various impacts on worker health and safety.

It is up to the company ITP to implement all the measures to which it has committed itself, in order to fulfill all the conditions, by the end of the current temporary authorization (June 2008), for obtaining a permanent authorization delivered by the DGA.

Between 1,200,000 and 2,000,000 $m^3$ of material may be required for the port construction project over a period of 2½ years. The amount of material extracted from the quarry will therefore be slightly higher (about 20 % of the reserves at the quarry are estimated to be low-quality unmarketable material). This is a significant proportion of the estimated reserves of 4,200,000 $m^3$ at the São Francisco quarry. The port project will therefore accelerate depletion of this quarry, thus creating the need for additional quarry development in a shorter timescale than originally anticipated. Any negative environmental or social impacts of this accelerated depletion in the region must be evaluated by the Competent Authority.

**Polinertes quarry at Monte Parada**

The quarry at Monte Parada operated by Polinertes is scheduled to begin production in 2007. An earth dam was built to allow water to infiltrate the groundwater reserve. Water to be used at the site will be brought to the reservoir, which will have a capacity for 18 tons and will be refilled approximately every three days to one week. Site personnel were able to provide little or no information regarding environmental management or the site closure/reclamation plan. This quarry is located near the ring road, which will be opened to traffic in June or July 2007. The quarry appears otherwise to be isolated, with little or no evidence of cultivation or habitation in the area around the site. The site is relatively hidden from the surrounding area by a series of small hills.

The operating permit for the Pedregal quarry at Monte Parada is pending. The review of environmental issues for this quarry, summarized in a table,[16] mentions noise, dust, contamination of surface water and groundwater and increase of heavy vehicle traffic as the main potential impacts. Very little basis is provided for these conclusions, and an EMP (mitigation plan) is not provided.

Current operation demand does not seem to exactly cover the materials extraction activity which Polinertes is planning to implement to satisfy the needs of the project as regards 100 to 300-kg blocks on the one hand and 3 to 5-ton rockfill on the other. If such is the case, Polinertes should provide the DGA with an additional impact study for this operation. This study should comprise, in particular:

- The location and characteristics (depth, volume, access,…) of the material quarried,
- The impacts and environmental measures not forgetting the effects on flow, fauna and flora,
- The site rehabilitation plan once quarrying is finished.

[16] Ramiro Lopes for Polinertes, *Installation of an industry for production of sand – Pedregal*, January 2005.

Finally, the quarrying planned by Polinertes is not far from the access to the ring road. As such, it is geographically at a similar distance to the port project as the ITP quarry. However, a practicable access will need to be built to link the quarry to the ring road. The impacts of this access shall be taken into account in the complementary environmental study which will certainly be necessary.

In all, the quarrying proposed by Polinertes to supply the port project with rockfill, on condition that it is effectively feasible and in proportion with the project requirements, has environmental advantages as compared to operating the quarry using explosives. A complementary environmental study which includes service developments is however vital and should demonstrate the advantages of this kind of operation.

**CVC quarry**

The undeniable advantages of this quarry lie in its isolation from any vulnerable environment (housing, activities, etc.).

However, there are two reservations:

- Certain conditions must be improved: installation and maintenance zones, compulsory protective equipment to be worn by personnel (goggles, masks, ear plugs, etc.), water supply, road signs indicating the quarry and protecting the road (cf. photo 17);
- Production only concerns small caliber aggregate, a tiny fraction of the materials requirements for the port project.

Within the limits of these two constraints, the CVC quarry is perfectly suitable for the needs of the project from an environmental point of view.

## 2.4. ENVIRONMENTAL RECOMMENDATIONS FOR QUARRIES AROUND THE PROJECT

The MCC Environmental Guidelines require that proposed projects must be developed such that they “are not likely to cause significant environmental, health or safety hazard.” There must be some assurance that the production of quarry material to be used for port construction does not result in any significant negative environmental impacts.

We suggest that possession by the selected quarries of a valid operating license, based on an EIA approved by the Competent Authority (DGA) must be a condition of the contract with the future beneficiary construction Company. Furthermore, given the considerable volume of materials required (up to 2 million $m^3$) and the period during which this supply must be guaranteed (over 2 years), two special conditions could be added to the materials supply contracts:

1. the quarries must have, from the start of the project, a permanent quarrying authorization delivered by DGA. The non renewal of a temporary authorization valid for one year could compromise the continuity of supply of the project site:
2. the operator(s) must present a landscape and ecological rehabilitation plan, along with financial guarantees for its accomplishment, validated by the DGA. Such a plan alone provides the assurance that the indirect impacts of the project on the environment due to the supply of quarry materials, will be under control. Although it cannot be formally requested, the partial rehabilitation, depending on the cases, of quarry sites at the end of the project would be desirable.

## 2.5. RESULTS AND CONCLUSIONS

Up to 2 million cubic meters of quarry material may have to be transported from quarries to the port site.

The Consultant investigated three quarries located in the vicinity of Praia:

- **The Pedreira de São Francisco – ITP quarry**, located at a distance of 6km by road from the port, which is able to supply by itself all the required amounts of materials with satisfying rock properties. This quarry has an operation license valid until 2027. Environmental management at this site can be improved. This quarry will soon be connected to the port by a new four-lane road.
- **The Polinertes quarry**, located 13 km by road away from the port, which is scheduled to start operating in 2007, with brand new equipment. The rock quarrying conditions for the needs of the project proposed by the operator, have the environmental advantage of not requiring the use of blasting operations as is usually the case for rock quarries. Nevertheless, this requires providing a complement to the impact study, initially oriented around sand production. The advantage of the proximity and accessibility of the deposit with regard to the project, near to that of the ITP quarry, should not be neglected.
- **The CVC quarry**, located 15 km from the port by road. The CVC quarry has a valid operation license till 2011, without limitation regarding quantities likely to be extracted. The environmentally-friendly production conditions are due to the isolation of the site. However, production oriented around small-size aggregate can only satisfy a very small part of the site requirements.

None of the three sites under consideration can be definitely eliminated from an environmental standpoint. Each has its own specific advantages. If the ITP site is the most suitable for quarrying rocks (proximity and accessibility, materials and capacities likely to cover the whole range of needs, favorable environmental conditions), the Polinertes site has impact reduction potential, on condition that it is shown in an additional operation impact study. Finally, operating the CVC site could contribute as regards aggregate in supplying the project in satisfactory environmental conditions.

# ITP quarry

Sao Francisco ITP quarry 1/2

**1. On-site water storage project**

Pit being dug, to be 10 m deep when finished. Situated in a central position in the quarry stockpile area, the pit will collect all the stormwater runoff from the quarry. Its leakproofness must be tested. Furthermore, the water report on the reservoir (supply / evaporation) should show the advantages of this measure.

**2. General view of the quarry stockpile area**

The west part of the quarry face (left) needs purging of the large quantity of overburden. This soft material should be preserved for re-use when redeveloping the quarry. In the centre, the pit reserved for storing water is being dug.

**3. Neighboring district to the south-west of the quarry**

View from the ridge of the south-eastern slope in the direction of the quarrying. In the forefront: the ring road under construction (materials centre) about 200m below. In the background: the S. Felipe da Meio district, about 500m away, leeward of the prevailing wind in relation to the site.

The ridge, from where the photo was taken, should be preserved around the quarry to avoid a landscape impact and the spread of quarrying pollution (dust, noise, etc.), spreading towards the ring road and the urban zone.

Sao Francisco ITP Quarry 2/2

**4. Fine dust deposit resulting from the first screening**

Considerable production of dust: protecting this dust from settling with regard to the prevailing winds would seem to be advisable.

Plan to re-use this material for site rehabilitation at the end of quarrying.

**5. Current water reservoir**

Designed for watering, it only has a limited capacity 10 to 20m$^3$. It is insufficient to guarantee watering to reduce dust production.

**6. Workshop – Toilet facilities zone**


The workshop zone (on the left), made of containers, is to be redeveloped: the ground is to be concreted, (equipped if possible with a maintenance pit) and a roof.

The toilet facilities are currently being extended (extreme right). Their water supply, currently provided by two reservoirs (top and bottom left of the photo) is to be improved.

# Polinertes quarry

Polinertes quarry 1/2

**7. Processing / Storage Installations**

View of the processing installations for the materials in the course of completion downstream of the dam.

**8. Scree and rocks on the slope**

The slope, over about 3km, has outcrops of broken scree and metric blocks which the operator proposes to collect for the project.

**9. Detail of a metric rock**

Huge rocks weighing several metric tons are scattered over the slope. Their hardness and angular nature make them suitable for use as rock armor for the planned breakwater.

Polinertes quarry 2/2

**10. View of the slope and the wooded cover below**

Acacia americana (*Prosopis juliflora*) woods and grassy vegetation in the valley.

The alignment of the access road(s) to quarried sector(s) will involve clearing operations.

**11. Nearest dwellings in the north-east.**

Housing is situated at least 1km away, windward, from the planned quarrying zone.

**12. Ridges north east of the quarrying slope**

As an alternative to removing metric blocks from the slope: quarrying blocks in the cliff using traditional quarrying methods.

# CVC quarry

## CVC Quarry 2/2

**13. Materials processing installations**

Production of aggregate only. Installing screening / crushing facilities with a capacity of between, 900 and 1300 t/day, raises large clouds of dust.

The site is isolated and relatively sheltered by the mountains from the prevailing NE winds as is the quarry face from the SW winds.

**14. Stockpiling aggregate**

The current stockpile of material is close on 35,000 t. The stockpile, situated next to the treatment zone, is relatively sheltered from the wind by the surrounding hills.

**15. Close-up of screening/crushing installations**

The equipment is correctly hooded. The conveyors are not equipped with water sprinklers.

The workers do not have sufficient protective equipment: ear plugs and dust masks.

CVC quarry 2/2

**16. View of the maintenance and oil storage zone**

Mechanical maintenance zone neither paved nor covered. No collector tank under the gas oil tank (5 $m^3$).

**17. Road access to the quarry – Assomada road**

Access to the quarry is insufficiently indicated (« truck exit” signs).

Measures to prevent mud/earth soiling the new pavement should be implemented, such as installing a cattle grid at the site exit.

**18. Linking the Assomada road to the Ring Road**

The wide roundabout facilitates the free circulation of material transport trucks.

# 3. IMPACTS OF TRANSPORTATION AND STORAGE OF EARTH MATERIALS

This chapter deals globally with the movements, storage and reuse of natural materials concerning the two main project components: the cargo village and the road linking the port and the cargo village.

## 3.1. RAW MATERIALS: TYPE AND ESTIMATED QUANTITIES REQUIRED

The project will require large amounts of materials to be moved as follows:

- Digging up and leveling the area of ground planned for the cargo village,
- Temporary storage of excess cut,
- Using part of the rocky materials dug up for the cargo village to build the access road between the cargo village and the port,
- Supplying the site with rockfill from neighboring quarries,
- Manufacturing artificial rockfill to protect the road against waves and installing this rockfill.

**Table 7. Phase I: Main Quantities of raw material used during construction of project facilities (cargo village + access road)**

| | **Rock material ($m^3$)** | **Main quantity ($m^3$ or m²)** | **Rate ($m^3$ or m²/day)** |
|---|---|---|---|
| **Cargo village** | | | |
| Rock and soft rock excavation (*) | - 400 000 $m^3$ | - 400 000 $m^3$ | 750 $m^3$/day |
| Placing of paving blocks | | 48 100 m² | 430 m² / day |
| Building and warehouses | | 13 120 | |
| **Connecting road** | | | |
| Road port to CV | 111 100 $m^3$ | 700 m | 630 $m^3$/day |
| Shore protection for port- CV road | 18 900 $m^3$ (core and filter layers) | 18 900 $m^3$ | 750 $m^3$/day |
| Shore protection for port- CV road | 26 100 $m^3$ (3,9 t Core Loc ®) | 6 700 pieces | 50 pieces / day |
| Road connecting CV | 20 000 $m^3$ | 1 500 m | |

(*) 50 000 $m^3$ clay to be dumped.

**Table 8. Phase I: Quantities of materials brought from quarries ($m^3$)**

| | |
|---|---|
| **Cargo village** | |
| Crushed stones for base and sub base for asphaltic pavement | 13 538 |
| Crushed stones for asphalt concrete | 1 388 |
| Crushed stones for bitumen macadam | 3 330 |
| Base course for cobble stone pavers | 1 000 |
| Crushed stones for lean concrete for base course | 11 300 |
| Crushed stones for concrete pavers | 4 518 |
| Sand layer | 1 130 |
| **Connecting roads** | |
| Crushed stones for base and sub base for asphaltic pavement | 11 609 |
| Crushed stones for asphalt concrete | 1 290 |
| Crushed stones for bitumen macadam | 3 103 |
| **Shore protection connecting road** | |
| Filter layer | 23 313 |
| Core (quarry run) | 17 471 |
| **Quay 2 area** | |
| Crushed stones for sub base | 10 874 |
| Crushed stones for lean concrete for base course | 21 747 |
| Crushed stones for concrete pavers | 4 349 |
| Sand layer | 1 087 |
| **TOTAL** | **131 047 $m^3$** |

## 3.2. MOVEMENTS OF NATURAL MATERIALS AND SUBSEQUENT ROAD TRAFFIC

Materials' movements causing extra traffic:

- On the public roads, mainly supplies of materials from quarries (aggregate for construction materials + fill materials + natural rockfill),
- Near the site: storing excess cut, building the road, transporting artificial rockfill, rebuilding quay n°2, building the cargo village.

We consider that the materials will be transported using 6-axle trucks with a useful load of 13 t.

**Table 9. Movements of natural materials on the site**

| Designation of works | Volumes (m) | Weights (t) d = 2 | Daily rates (t/day) | Number of trucks movements /day | Duration of works (months) |
|---|---|---|---|---|---|
| **Excavation from cargo village, deposit of exceeding materials** | | | | | |
| | 300 000 | 600 000 | 1 500 t/day | 115 | 18 |
| **Construction of connecting roads** | | | | | |
| | 100 000 | 200 000 | 1 500 t/day | 115 | 6 |
| **Transportation of Core Loc TM** | | | | | |
| | - | 6 700 | 50 pieces/day | 25 | 6 |
| **Transportation of materials from quarries to the site of storage or to the site of the connecting road using public roads** | | | | | |
| | 131 000 | 262 000 | 2 600 t/day (*) | 200 | 4,5 |

(*) Base: 20 x 13-t trucks; one rotation per hour per truck, given the average distance between the quarries and the site; 10-hour working day (07:00-17:00)

### 3.2.1. Traffic on public roads

The main route taken by transportation will be the Praia-Assomada road which serves the three potential quarries, followed by the ring road via the airport to the last roundabout situated on the Achada Plateau. Due to construction constraints, works on the future port access road will be fast-tracked from the base of the quay n°1 breakwater. That supposes transporting the materials by the main port service road along the seafront.

**Table 10. Transportation and potential routes for natural materials**

| Transportation of raw materials | Potential routes |
|---|---|
| From quarries to the contractor's site installations | 1. The highway Praia Assomada providing access to the three main investigated quarries,<br>2. then the Praia ring road under construction, which would be the principle part of the intended route for transporting the quarry materials to the work sites (see attached map),<br>3. then the road linking the airport in direction of Praia City to the last existing roundabout on Achada Plateau. |
| Materials for the construction of the access road | 1. Natural rockfill: ditto the above then four-lane road to Praia until the Ribeira da Trindade roundabout, then the port access road.<br>2. Fill materials and CORE-LOC$^{TM}$: from the contractor's site installations to the port via the four-lane road to Praia until the Ribeira da Trindade roundabout, then |

| | |
|---|---|
| | the port access road. |
| Materials for repairing quay n°2 and repaving the yard | Ditto route 2 above. |

Road transport will be accomplished either entirely or in part using Heavy Goods Vehicles (HGVs). However potential impacts from transport will include increased congestion, noise and vibration, reduced access and safety, increased pollutant emissions from truck, exhausts, and inordinate road wear and tear (because of the large size and weight of the trucks), especially on minor roads that constitute the truck route. Poor driving habits by the truck drivers could result in considerable stress if not risk to pedestrians and other vehicles in communities through which the truck route will pass. Access by pedestrians and local vehicles may also be restricted due to the increased truck traffic. Dust, grit and mud may be spilled from the trucks or carried by truck tires and chassis.

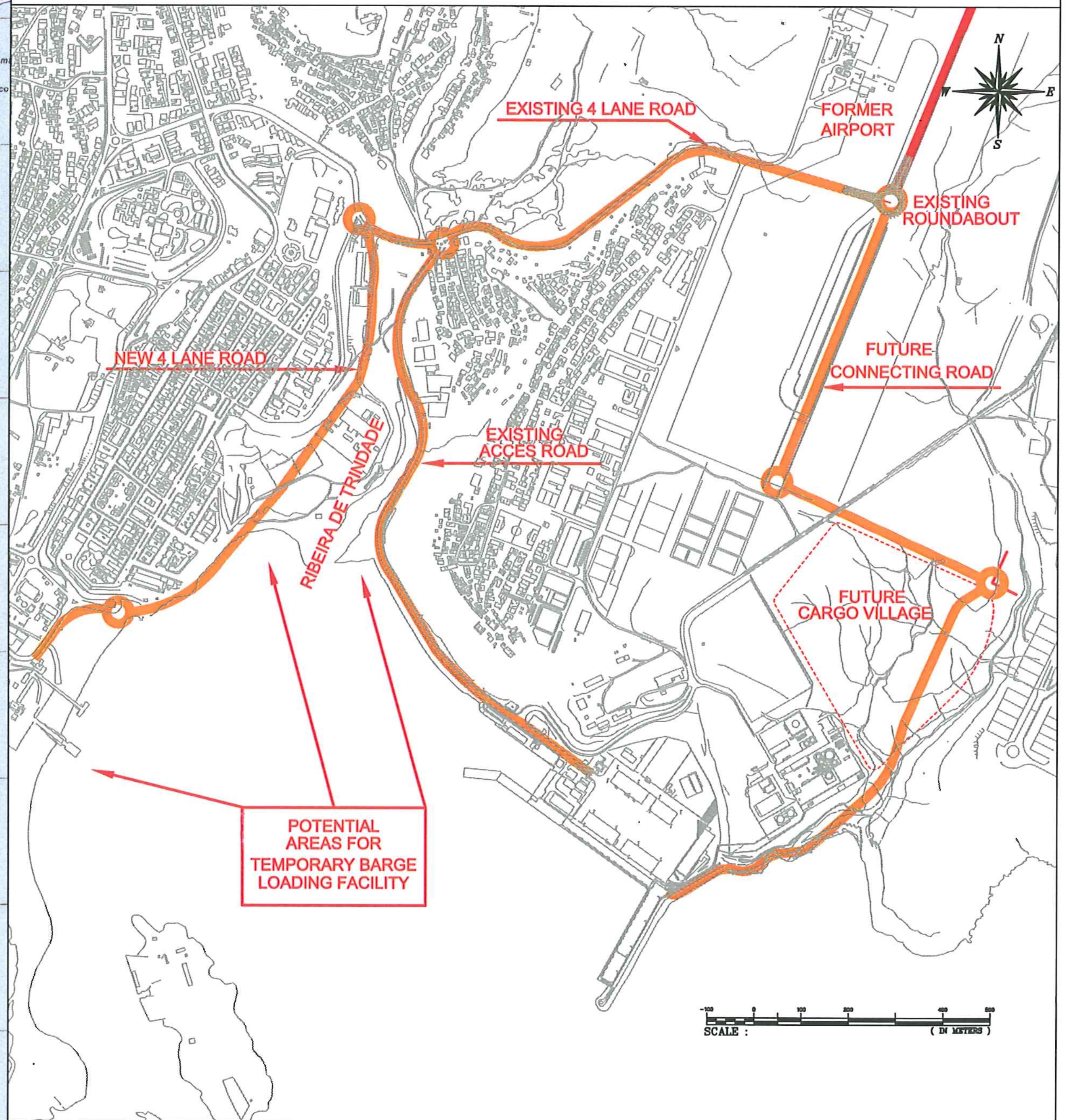
Based on the assumptions in Table 7, expected traffic will involve around 400 HGV movements per hour. Traffic on the Praia Assomada road being of around 3,600 veh/per day, the traffic increase would be around 11 %. The rate of HGV would increase during construction from 7 % (current situation) to 21 %. Traffic on the future Ring Road is not known as no forecast study has been made. It might be that traffic will be at least equal to that arriving at the Ribeira Trindade junction, i.e. 5,800 veh/day. The traffic increase caused by the jobsite would therefore be of around 7%. The rate of HGV traffic would increase during construction from 12 % (current situation) to 13 %.






From the quarries to the constructor's site installations, impacts of the transportation of raw materials will nevertheless be limited due to the fact that the road serving the quarries does not run through any villages and there are no isolated dwellings or clusters of housing nearby, except for one or two activity and shopping zones.

# Routes from Quarries to Works Sites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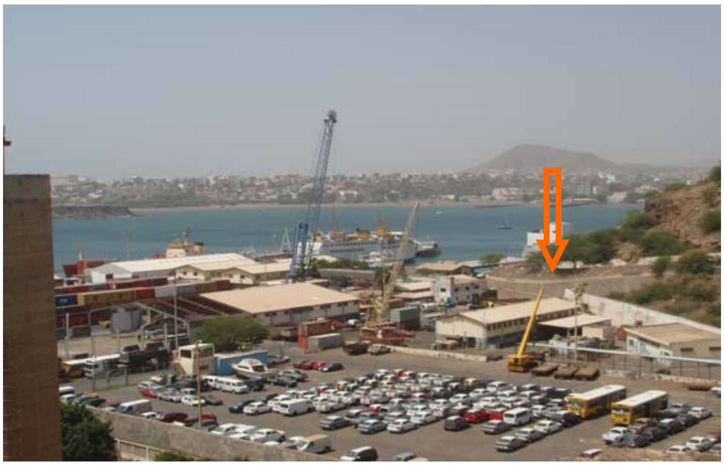
During transportation of fill materials and rockfill for the future access road, the worst pollution is expected in the south-west built-up area of Praia (along the road between the plateau and the Ribeira de Trindade) and then along the coastal road to the port. The following may be expected:

- Considerable noise levels for nearby housing which may even affect the first houses situated on the edge of the Achada Grande Plateau,
- Considerable amounts of dust if cargoes are not perfectly covered,
- Congestion, especially during peak morning and evening hours on the Ribeira de Trindade roundabout,
- Risks of accident due to the increase in heavy vehicle traffic,
- Conflicts and congestion in the port entrance zone (near Enapor's offices, fishing port activities, small-scale commercial activity),
- Inside the port area, congestion with regard to handling and container transport activities and movements of handling machinery.

The existing port service road will be used to transport construction materials for the future access road between the port and the cargo village.



Instead of using the main port road, an alternative would be to use the port access road running west of the Plateau (*orange arrow*). This road is linked to the airport road. It is rather steep and winding.

This road could be used depending on the traffic conditions: road exclusively reserved for heavy vehicles transporting materials, lorries less than 5 years old with an up-to-date technical check (brakes, tires, etc.), organization of port traffic (traffic lights at entrances and exits), emergency escape lane in case of truck failure.

Using this route that has been recently asphalted, would avoid traffic and safety disturbance as well as air and ambient noise in the most used roads that connect the square of airport with the square in Lém Ferreira and the port. The option for the Achada Grande Frente road would entail less transport disturbance since it would be within an essentially industrial area.

### 3.2.2. Traffic in the works sites and area (site installation, village, excess cut storage site, cargo village construction site and access road)

Materials transport within the site area will produce:

- dust, thrown up by the trucks, especially as the service roads are not paved and materials may fall out of the trucks. This nuisance could be prevented by compacting and watering the service roads and covering the trucks (for materials comprising fine particles). This dust pollution could be a nuisance for activity zones on either side of the construction site and for users of the airport road.
- exhaust gas emissions,
- more or less noise depending on the combinations of machinery and/or materials working simultaneously on the site. The nearest housing is more or less distant. Only staff or people using the activity zones may be bothered by the increased noise in this sector.

## 3.3. STORING EXCESS CUT

A total amount of 400,000 $m^3$ shall be excavated, out of which 100,000 $m^3$ shall be reused as fill for the connecting road (lower part). Out of the remaining 300,000 $m^3$,

- 50,000 $m^3$ may not be reused at all for the works because the material may be too fine or too loose.
- Besides, the remaining 250,000 $m^3$ are supposed to be used for the marine structures (extension of quay 1, breakwater and new marine yard) and may need to be temporarily stockpiled. It should not be far from the Cargo Village, to minimize transportation costs. The proposed site is located at the Ponta Visconda, as it has been discussed earlier (if the phase 1 and phase 2 works are properly co-coordinated, then the temporary stockpiling may be avoided or, at least, significantly reduced).

### 3.3.1. Material that may be not reused

As far as the 50,000 m3 of loose topsoil that cannot be reused in the project are concerned, three alternatives have been considered:

- Truck them to the quarries feeding the port project with rock and aggregates, taking profit of the empty trucks traveling back to the quarries. At quarries this material would be used to improve sites being closed.
- Use them at INIDA agricultural experimentation sites, on Santiago Island.
- Dump them at the Praia Municipal Dumping Site ("Lixeira Municipal"), located next to the connection of the new ring road with the Cidade Velha road).

The first option sounds satisfactory but it requires the agreement of the quarry operator(s), which could not be reached during the study phase.

The second option has the disadvantage of long trucking distances, as INIDA agricultural experimentation sites are all located far from the project site, at least 25 km away.

At the present stage the third option, i.e. the Praia Municipal Dumping Site ("Lixeira Municipal"), looks therefore the most feasible one. Contractors shall be forced to truck this material via the ring road, not through the town.

### 3.3.2. Temporarily stockpiling of material supposed to be used for the marine structures

The potential impacts of this storage on site 4 will be as follows:

- Impact on water flow: storage must not constitute an obstacle to the flow of rain water. To do this, materials should not be stored in a single stockpile, but rather in several piles separated from each other by drainage ditches running parallel to the general direction of water flow in the area.
- Disappearance of local vegetation and the disappearance of fauna, especially birds.
- A minimal impact on the landscape due to a fairly low storage height, but the site will lose its natural beauty and character.

Upon completion of the use of this site the Contractor shall be urged to leave it in a decent condition, likely to facilitate return to the original conditions.

# 4. REMOVING OLD QUAYSIDE WAREHOUSES, REPAIRING QUAY N°2 AND REPAVING THE BACK-UP YARD

The components and objectives of this program are to remove old quayside warehouses on quay n° 2, make repairs to the quay apron and fenders and repave the back-up yard.

## 4.1. REMOVING OLD QUAYSIDE WAREHOUSES

The project plans to demolish two old hangars situated in front of and running parallel with quay No.2. Each hangar is about 80 m long x 25 m wide x 8 m high.

The hangars have stone walls, concrete and steel beams and roofs covered with asbestos-cement panels that could contain asbestos. Tests on these materials will say whether such toxic substances are present or not.

### 4.1.1. Demolition techniques

The following demolition techniques could be used:

- The hangars will be demolished using mechanical diggers equipped with hydraulic rock breakers (HRB) and grabs and hydraulic shears for metal and concrete.

Mechanical diggers equipped with hydraulic rock breakers (HRB) and grabs and hydraulic shears for metal and concrete will be used to demolish the hangars.

- The large metal parts, beams, spacers, steel reinforcing bars will be cut up on the spot and stacked under tarpaulins and stored for collection and/or recycling.
- The other elements (wires and electrical cabinets, ducts, doors and door frames, glass panes etc. will undergo selective sorting.
- Any polluting and hazardous objects that might still be stored in these hangars will be collected and sorted.

### 4.1.2. Removal of asbestos-cement roofs panels of the hangars

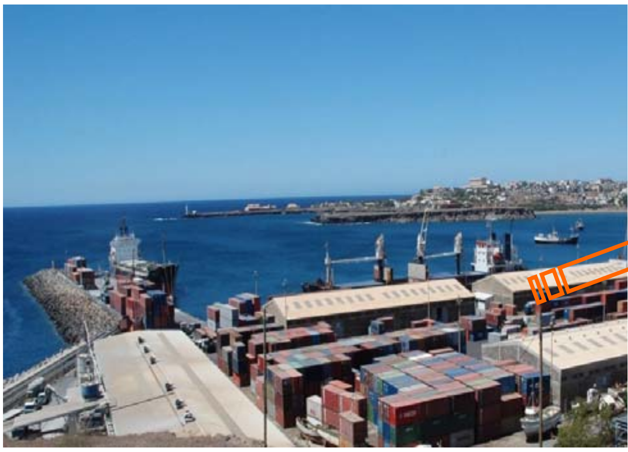
The roofs of the hangars are made of asbestos-cement. The roof panels will be removed manually, stored on the quay, and then taken away for specific processing. The panels are to be removed manually without any drilling, sawing or grinding, to avoid releasing asbestos fibers into the atmosphere. Workers will wear adequate protective clothing (suits, gloves, masks).

After their removal, the panels will be handled as follows:

- The materials may be stored temporarily on the engineered storage site, under surveillance.
- The demolition contractor will be required to palletize and package asbestos-cement panels and to then enclose them in double walled big bags or container

bags made from polypropylene and polyethylene. The material is to be marked 'asbestos'.

- The carrier will ensure the integrity of the packaging units, in particular by using smooth containers free of any internal hooks.
- Transport of these wastes is covered by a consignment note for asbestos waste (see possible destination in para. 4.2.3).



Conditioning of asbestos cement roofs panels in container bags

### 4.1.3. Environmental impacts

The environmental impacts will be limited if the following precautions are taken:

- Selective deconstruction to separate the essential of the non-inert materials before the building is demolished. The prime contractor will audit the building to be demolished in order to identify the potentially recyclable materials and help develop recycling.
- Sorting, or rather non-mixing, implies organizing the worksite, informing and training the personnel. It requires having several skips on the site at the same time: skips reserved for given types of inert waste that can be recycled, and a skip for inert waste that cannot be recycled.

The main impacts of the demolition site will be:

| | |
|---|---|
| **Hindrance to the port activities during work owing to:** | ▪ The need to clear away the two rows of containers stocked between the hangars and quay No.2,<br>▪ Indirect impacts (dust blown towards the ships berthed at quay No.2 and onto the goods),<br>▪ The movement of the site machines and the space occupied by the demolition materials storage and sorting areas,<br>The possibility of having nocturnal demolition work can be envisaged to reduce the daytime functional hindrances. |
| **Dust** | This is the main nuisance expected, considering the frequency of winds on the site.<br>▪ It is nevertheless a fact that the concentration of dust in the air in the port is generally noticeable (dust created when unloading bulk products),<br>▪ Flying dust can be bothersome for port personnel present near the work area,<br>▪ There are no people living near the port, the first houses being situated 400 m to the north-west of the port on the summit plateau, and in a direction that is not downwind of the prevailing winds.<br>▪ The prevailing wind direction is north-easterly, whatever the season, which implies that the dust will be carried to the port outer harbor, given its orientation. From July to November the winds sometimes blow from the south-east, south or south-west, but not often. In such situations the dust can be blown towards the interior of the port.<br>▪ To limit the raising of dust it is recommended to spray the hangars with water as the demolition work progresses. |
| **Noise of the machines** | The site machines will make noise when working. The mean sound power levels ($L_{WA}$) may be of the following order:<br>Digger on tracks < 100 kW = 107 dB(A)<br>Digger on tracks > 100 kW = 109 dB(A)<br>Digger with rock breaker = 118 dB(A)<br>Saw on tractor = 114 dB(A)<br>The noise may at times be bothersome for the port personnel and people frequenting the port on professional grounds. The noise levels heard at the first houses can be estimated at between 50 and 60 dB(A) depending on the number of machines working. This estimation does not take into account the barrier effect of the other buildings near the hangars. |

## 4.2. ENVISAGED TREATMENT PROCESSES FOR DEMOLITION MATERIALS

### 4.2.1. Inert wastes

The inert waste is generally non-soiled mineral waste with very low pollution characteristics. In this case it will comprise construction materials including concrete, cement, natural mineral materials (stone) and glass.

The inert waste can be given to:

- inert waste crushing platforms: they enable the crushed materials (concrete, rubble, stone, bricks, tiles, etc.) to be reused in the production of recycled aggregates.
- site waste collectors: they hire the skips and collect the waste. The waste is transported to a disposal center which must be duly authorized.
- site waste sorting centers: they perform manual and mechanical sorting of site waste.
- grouping centers: these centers enable companies to transfer their waste, which is then routed to sorting centers or an appropriate landfill (class 3 equivalent).

Given the Cape Verde context, where recycling and valorization of inert waste from building sites and demolition work are not organized and are no specialized landfills, two means of disposal or valorization can be recommended:

- Reuse as filling material (new road),
- Recycling to produce aggregate from crushed and screened rubble: these aggregates will be used for road bases, earthworks and concrete. It should nevertheless be noted that the recycled rubble must be of good quality: it must be free of wood, polystyrene, plastic and scrap metal.

### 4.2.2. Ferrous metals

The demolition shall be preceded by a removal phase during which the main metallic elements are extracted from the building. It must be checked that the metallic waste is depolluted before mechanical pretreatment when necessary. The metals will be sold to a scrap metal dealer at the market value of the metals (instead of paying the cost of removal and processing).

### 4.2.3. Conditionning and destination of cement-asbestos materials

The roof panels from the demolished hangars are corrugated sheets containing asbestos with a cement binder. The quantity is estimated at 57 tons. After removal, of the panels and their packaging[1], there are three possible solutions.

| | |
|---|---|
| **1st solution:**<br><br>**Creation of a special Cape Verde storage site** | Wastes containing asbestos bound to inert materials can be admitted to storage facilities for rubble and inert demolition wastes (building and public works). There is no such facility on Cape Verde. The Praia Municipality did not respond to the query regarding possibilities of dumping or disposal of contaminated material such as asbestos cement from warehouse roofs. Such a facility could be set up on condition that it be open to reception of the island's demolition wastes. The project could be commissioned by the city of Praia and an agreement made between the city and MCA for deposition of the wastes in question.<br><br>If a storage facility were to be set up, the operator would have to implement measures to limit the risks arising from management of such wastes, such as:<br><br>- engineering of an area suited to reception of the waste;<br>- checking that each load is accompanied by a consignment note for asbestos waste and visual inspection at entry;<br>- organization of off-loading, temporary storage and storage in such a way as to limit release of dust. The waste placed on pallets, in racks or in large flexible containers, must be unloaded carefully and using appropriate means such as forklifts, and taking care to avoid any release of fibers;<br>- for the same reason, compacting operations required to ensure the stability of the site, must not be carried out directly on the waste tipped into the cells. A layer of earth, sand or equivalent material is to be placed on top of each layer of waste prior to compacting or settling operations to act as intermediary and confining layer; it must have a sufficient thickness or, if relevant, sufficient strength;<br>- the capping layer must be laid so as to limit the long term release of asbestos fibers or dust arising from the inert materials stored in the dedicated cells. This can be achieved by covering the cell with a 1 m thickness of rubble and inert site waste then a sufficient layer of topsoil to allow planting, unless there are specific conditions on future use of the site;<br>- marking of these special cells on the site and keeping the site plan up to date, allowing the cells to be located in the future. |

[1] These panels must be previously confined in big bags or deposited in wooden platforms totally covered with plastic film.

| | |
|---|---|
| **2nd solution:**<br><br>**Confinement of the panels in the fill material for the new access road** | The panels, contained in a double-walled big bag, could be confined in the fill material of the new access road, in specially engineered cells. As on disposal site, their positions should be logged accurately. |
| **3rd solution:**<br><br>**Export to Europe to an accredited facility** | In Europe, wastes containing bound asbestos have to be disposed of to a landfill that is specifically accredited for asbestos waste and having specific asbestos waste cells. Classification of the landfill (in class 1, 2 or 3) is determined by the nature of the substance to which the asbestos is bound. There are three categories: hazardous substances (category 1), inert substances (category 2) and other substances (category 3).<br><br>The panels are considered to be inert and can therefore go to a Class 3 type facility. Cape Verde does not have such a facility and exporting of the wastes to a suitable facility in Europe, in Portugal for example, is considered. Two landfills with cells for this type of waste have been identified in Portugal: ResiLei and Citri (Setubal, near to Lisbon).<br><br>The wastes can be sent from Santiago to Lisbon Port by ship. From there an authorized company can proceed by truck with the waste transfer to Setúbal (CITRI). This company is able to manage all the process as well. |

| Nature of operations | Costs (euros) |
|---|---|
| Shipping from Santiago to Lisbon Port (3-20' containers)<br>Freight surcharge<br>Bunker adjustment factor | 750 x 3<br>150 x 3<br>120 x 3 |
| Transfer by truck to Setúbal (3 x 20' containers x 370 €) | 370 x 3 |
| Deposit in an approved industrial waste reception site located in Setúbal: 95,00 €/ ton plus the environmental tax of 5,00 € / ton | 100 x 57 tonnes |
| Preliminary evaluation of the process | 400 |
| Total | 10 270 |

| **Legal requirements** |
|---|
| The legal requirements to export the asbestos wastes to Portugal must attend the requirements of the European Council (CE) 1013/2006, 14 de June de 2006 and the Portuguese law 259/93, February 1st. A preliminary authorization of the Portuguese Environmental Agency and Cape Verde legal authorities is required.<br><br><u>Waste shipments by sea</u><br><br>Competent Authority: Portuguese Environment Agency (APA)<br><br>For shipments of waste that are carried out by sea is required: |

- generic favourable opinion of the Directorate General of Ports, Shipping and Navigation (DGPNTM), which led into account the safety standards specific to the transport concerned to ensure the safety of navigation, the safety of life at sea and the protection of the environment;
- Mention in the ship's daily nautical transport of waste, the inputs and outputs in national waters of member states or third countries and the date of delivery to the respective recipients;
- Record at the loading of the vessel's location, type, packaging and quantity of waste transported;
- Maintenance on board the ship samples of the waste transported, for a minimum period of three months, properly identified, sealed and authenticated by the charger and notifier, in the case of bulk transportation of waste;
- Collection of samples, as defined in the preceding paragraph, when breakdowns occur in charge, involving spills of waste packaged.

Financial guarantee

- Shipment of waste covered by the provisions of Regulation is subject to establishment of a financial guarantee or equivalent to cover the costs of shipment and its disposal or recovery.

Insurance

- Shipments of waste which applies this diploma are conditional on the existence of civil liability insurance for damage to the environment or public health.
- The obligation to insure lies with the carrier.
- The contract of insurance for the guarantee of the payment of claims that are legally due to the insured, because of its responsibility subjective or objective, for damage caused to third parties and that resulting from the exercise of the professional activity of transporting waste.

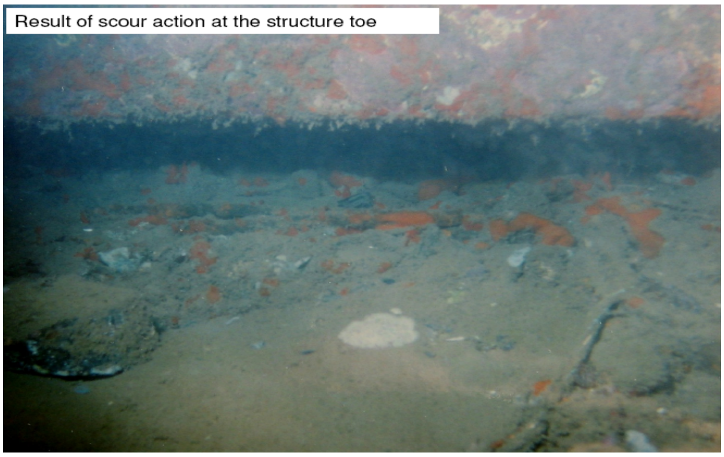
For these issues, it is thus proposed to consider that asbestos cement elements will be shipped to Lisbon and disposed in an appropriate Portuguese dumping site.

## 4.3. REPAIRS TO THE QUAY

### 4.3.1. Nature of the works

Diving inspections revealed that additional works will be needed along the lower part of the quay n°2 bulkhead such as filling gaps underneath the quay toe, filling joints between the quay blocks[2] and rehabilitating the scour protection.

[2] The Consultant noticed that wave action sometimes induces air blows through pavement cracks.




## 4.3.2. Environmental impacts

The work could cause limited impacts on the marine environment. This work takes place within the confines of the port, the waters of which are already disturbed by the various port operations (propellers resuspending sediment, waste from the ships, pollution when unloading goods, and loose bulk products in particular).

- The laying of riprap at the base of the quay will temporarily cause fine sediment to be resuspended, but this will be limited to the vicinity of the quay. Firstly the quantity of materials will be small, and secondly the riprap will comprise medium and large sized blocks that are not loaded with fine particles,
- The repair of the quay could necessitate the demolition of certain sections of the quay facing in order to prepare their repair. The large pieces of concrete from such demolition work will be stocked on the yard near the quay. The company will position a barge under the beam in order to collect the demolition debris.
- The repair of the quay beam edge will require the pouring of concrete. Spatters of concrete could fall into the harbor.
- If underwater work is carried out to repair certain submerged parts of the quay, precautions shall be taken to prevent pollution by the concrete or materials used.

## 4.4. REPAVING THE BACK-UP YARD

### 4.4.1. Nature of works and machines used

- Removal of the present covering that consists of dressed basalt paving stones using a caterpillar track digger. The paving stones will be stocked temporarily, then used to repair the paving of local roads.
- Removal of the underlying capping layer over a depth of about 1 m, i.e. about 48,000 $m^3$. The excavation of these materials shall take two constraints into account:
    - The presence of dry and wet networks in the sub-soil (water supply, power supply, reefer-container plugs, drainage[3], CCTV and optic fiber networks, fire-fighting and flood-lighting).
    - The possibility that these soils could be polluted by the various activities (transshipment of goods, heavy vehicles and service vehicles, accidental pollution).
- Filling with raw quarry aggregates and a capping layer in a gravel-sand mixture (48,000 $m^3$).
- Leveling and laying of a covering of rectangular concrete paving stones.

The future pavement system proposed will most probably be the one recommended by PIANC / IAPH, currently applied on major modern container terminals (see model on following picture). Although such pavement blocks are normally made of concrete, they can also be made of strong quarry stone, provided that the pavement surface is perfectly even, with no sharp edges.

PIANC recommended pavement structure/pattern

**Table 1 - Repaving the back-up yard: nature of works and machinery**

| Nature of works | Machinery used |
|---|---|
| Removal of paving stone surface covering | Mechanical digger, lorries to carry away the paving stones (about 20,880 t, i.e. equivalent to 1,740 lorries with a capacity of 12 t) |
| Removal of the capping layer | Mechanical digger, loader, lorries |
| Filling with sandy gravel | Lorries, mechanical digger, tire-mounted compacter, about 48,000 $m^3$ or 76,800 t, i.e. 6,400 equivalent lorries of 12 t capacity |
| Laying of the surface covering | Manual paving (the quantity of concrete paving stones is |

[3] At the moment there is no embedded rainwater system.

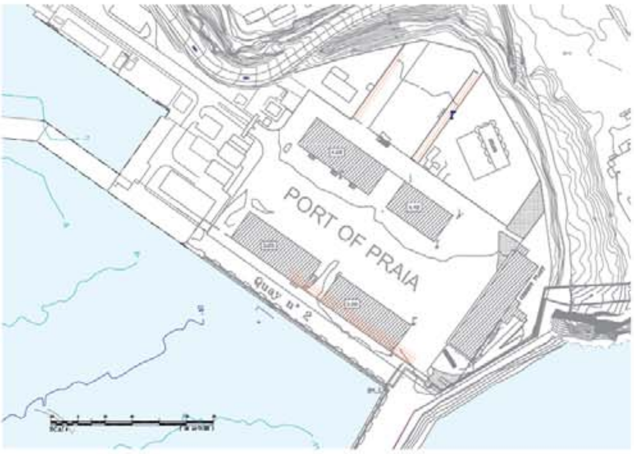
| | |
|---|---|
| | roughly the same as that of the basalt paving stones that will be removed) |

### 4.4.2. Environmental impacts

| | |
|---|---|
| **General impacts of the worksite** | The impacts will be associated with the transport of materials brought to the port (aggregates and gravel-sand mixtures, new paving stones) or taken away from it (old basalt paving stones, material from old underlying capping layer): noise and dust on the transport route, hindrance to traffic and port operations during work. |
| **Removal of the capping layer** | Considering its age, this course is likely to be contaminated by infiltrations loaded with pollutants from the various port operations (essentially the unburned hydrocarbons from vehicle exhausts and heavy metals from the wear of tires and brakes). Any physical-chemical analysis of these materials will therefore be carried out on several samples before the work to determine the level of contamination, if any.<br>▪ If these materials are not polluted, they will be reused as embankment material or possibly for making aggregates after screening. Reuse on other sites (access roads, maritime structures) has the advantage of avoiding the need to transport the materials away from the site and therefore reduces nuisance from transportation and energy consumption.<br>▪ If these materials are polluted, their reuse as embankment material must be examined, for example by isolating them in a dyke body or in the roadbed embankment (confinement in a sealed geotextile). |
| **Reuse of the old paving stones** | These hand-dressed paving stones shall be reused to repair traditional roads on Santiago Island. Some of these paving stones will be used to repave the cargo village parking areas. |

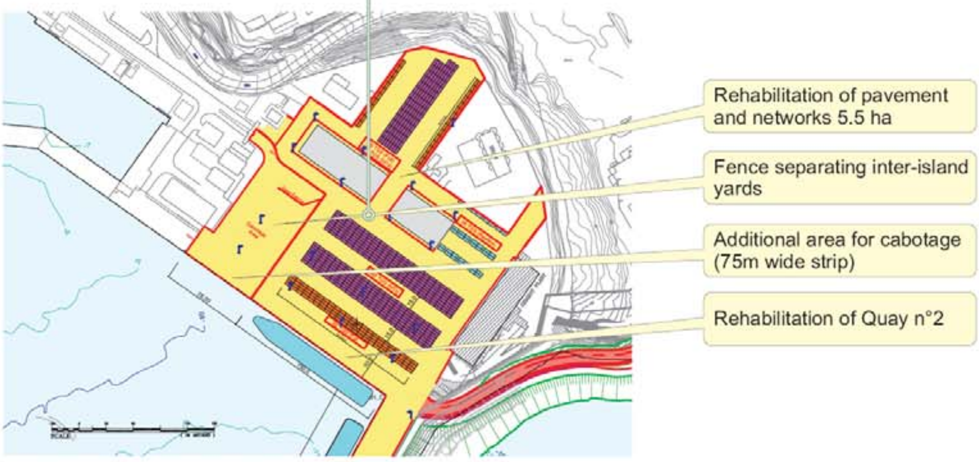
# QUAY N°2 AND YARD

## Environnemental issues/ Scope of impacts/ Reducing measures




Quay n°2 and yard - Existing situation


-Selective demolition (buildings, pavement)
-Reuse of neutral material (fill, cobble stones)
-Wrap and containerize asbestos cement roof tiles
-Dispose asbestos cement in Europe (dedicated site)




Quay n°2 and yard - Project

BCEOM
SOCIETE FRANÇAISE D'INGENIERIE

# 5. IMPACTS OF THE CARGO VILLAGE

## 5.1. IMPACTS OF THE CARGO VILLAGE PROJECT UNDER CONSTRUCTION

### 5.1.1. Levelling and earthmoving

The cargo village is part of an industrial zone that includes an industrial park, the airport and the Shell and Enacol petroleum depots. It is planned for an area to be leveled mainly through earthmoving. The current cargo village site is close to a depression that descends to the sea between the cliffs (the connecting road will go through this area), with potential natural habitat near the cliff area. Furthermore, at the current proposed site, a great deal of imported material will be extracted and removed to level the site (400,000 $m^3$).

The possibility of extracting rocky material from the cargo village site was a key factor in the choice of the site. The reason for this is that the construction of the maritime structures planned for in phase I and phase 2 requires large quantities of embankment material (2 millions $m^3$). The site offers this possibility thanks to the quality of the materials and their proximity to the construction sites, not to mention the environmental benefits since they will not have to be extracted from quarries (avoiding associated impacts, improved carbon balance).

Leveling and earthmoving will be the main sources of environmental impacts. They may temporally or permanently affect soils, drainage, vegetation, fauna and flora, the quality of life and health of the inhabitants (truck traffic, dust, noise, disturbance during the works). To a lesser extent, the construction of roads and pavements, warehouses and other facilities should have only a temporary impact.

The ground leveling and earthmoving operations will require several types of site machinery:

- caterpillar track diggers with hydraulic rock breakers,
- caterpillar track loaders,
- self-propelled leveler,
- dumpers and lorries.

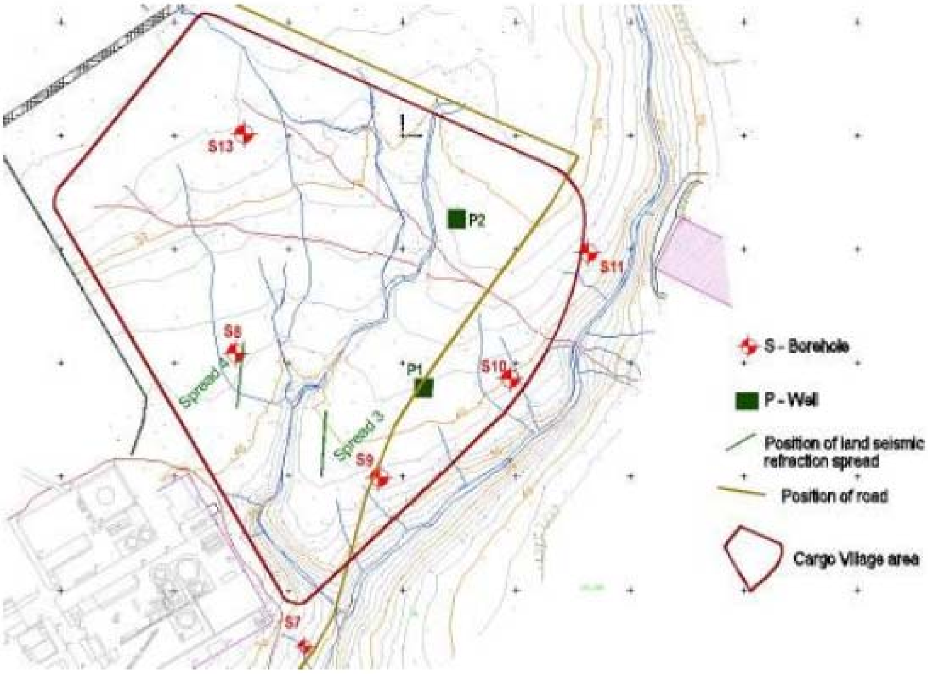
### 5.1.2. Impact on soils

Seven pits or wells were excavated using a retro tractor in the port yard, the cargo village area (P1 and P2) and along the upper part of the future road. They were used to investigate local geological and geotechnical conditions, topsoil thickness and to collect samples for laboratory tests[4].

Although the volcanic rocks show some lithological variety, depending on the volcanic episode which they are related to, they have similar geomechanical characteristics,

[4] Geotechnical Survey Report. GEOSOLVE, June 2007.

namely regarding compaction, porosity, weathering and fracturing. All materials found below a depth of 1.5m are suitable for foundations, able to withstand loads higher than 350 kPa (3.5 bars).




Localization of Seismic Refraction Profiles on Cargo Village Area

| Pit | Photograph | Max. Depth | Major Features |
|---|---|---|---|
| P1 |  | 1,80m | 0,00 m a 0,30 m – Altered surface of volcanic soils<br>0,30 m a 1,00 m – Volcanic soils with small fragments of basalt<br>1,00 m a 1,80 m - Volcanic soils with small fragments of vesicular basalt |
| P2 |  | 1,30m | 0,00 m a 0,30 m – Altered surface of volcanic soils<br>0,30 m a 1,30 m – Volcanic soils with small fragments of basalt |

**Figure 1. Location of pits P1 and P2 on the cargo village area and characteristics of superficial soils**

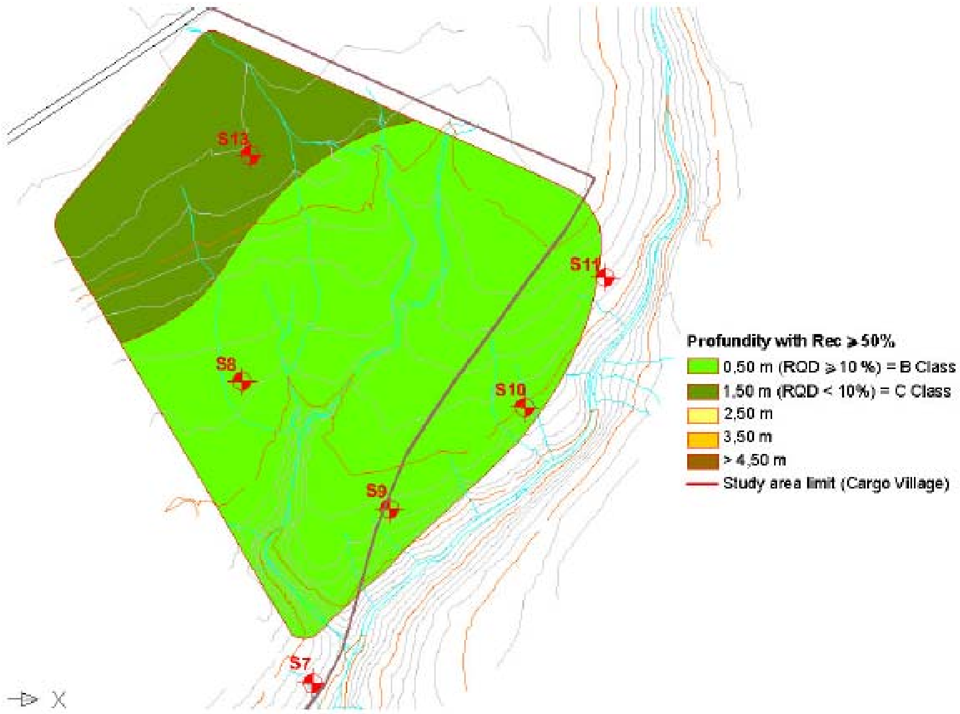



**Figure 2. Suitability of soils for foundations in the cargo village area.**

| | |
|---|---|
| A | Very good for foundation |
| B and C | Good for foundation |
| D e E | Not appropriate for foundation |

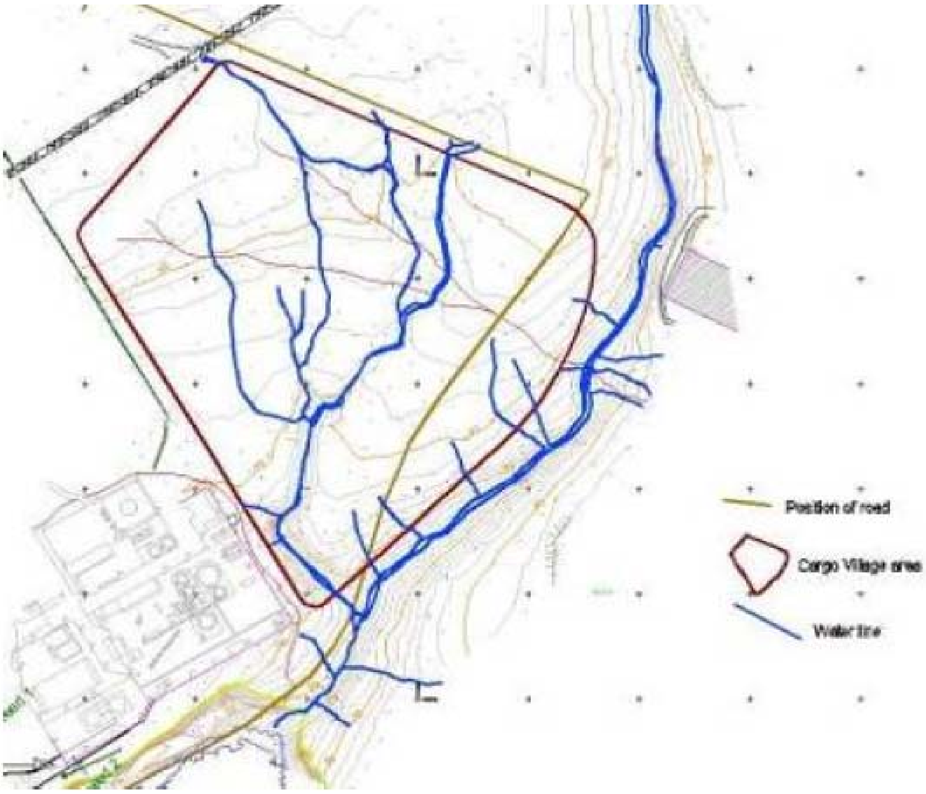
Prior to the leveling work, the ground shall be thoroughly cleaned of the various waste present (unauthorized wasted dumped, inert waste).

The surface soils are characterized by the low levels of organic matter and life. Nonetheless, the superficial horizon constituting the "topsoil" must be carefully stripped and stocked in an approved place to that it can be reused later for the stabilization and planting of the fills and embankments.

## 5.1.3. Impact on hydraulics

In the project area, two major streams run in deep troughs, both shown on the figure below. These streams converge between Porto da Praia and Ponta Mulher Branca. The loose materials and the poor vegetation on the stream slopes mean that considerable erosion takes place due to storm water. These small streams have sub vertical slopes and U-shaped cross sections as a result of the relative freshness of the lava of surface mantles.

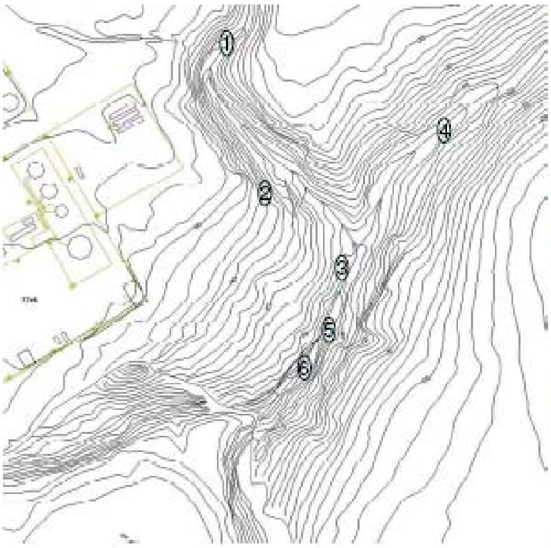
Rainfall is concentrated in a short wet season between the months of August and October, with a few days of torrential rainfall.




Water Flow Net in the Project Area

The risks of erosion can be high in arid areas. In spite of the very moderate annual rainfall, the risks of erosion can be very high because the showers are sometimes very intense, causing severe runoff from certain poorly permeable surfaces and because of the sparseness of the vegetation cover. Although the length of the dry season facilitates works, they arrival of the rainy season (August to October), especially if early, can have a very serious impact if the works have not been completed or made secure by that date.

It is therefore recommended to carry out the stormwater drainage work as the construction work progresses: maintain hydraulic transparency regarding the natural outlets (thalwegs) and build collector ditches as soon as the leveling levels so permit (see paragraph 2.5.1. on the restoring of hydraulic flows).










Localization of small streams in the study area and details of observed characteristics: (1) north of the water line with direction NW-SE, (2) north of the water line with direction SE-NW, (3) zone of confluence that will demand a hydraulic passage, (5) & (6) hard bedrock.

View of flow in the thalweg collecting stormwater from the ground area planned for the cargo village. Storm of 29 August 2007.

The thalweg outfall carrying water towards the sea East of the port during the same storm.

### 5.1.4. Impact on topsoils

The ground leveling, excavations, and earthmoving will require soil and vegetation to be removed. Consequently, all vegetation in the project area will be destroyed. Although this impact is negative, destruction of vegetation will not be significant since natural vegetation on the project area is scattered, creeping and composed of short-lifecycle weed that only covers the soil partially during the wet season. In the dry season lasting most of the year, the soil does not have vegetation and is covered by loose rocks over the plateau.

The most common phanerophytes are dry region bushes such as

- the rooster tree (*Calatropis procera*), abundant in dry regions of the island but scarce in the project area,
- the honey mesquite (*Prosopis juliflora*), abundant on the island and in the project area, specially at the cliff base.
- the Ana tree (*Acacia albida*), typical of dry regions. Only one very small shrubby specimen was found in the area.
- On the cliff cornice was found a specimen of *Sarcostemma daltonii*, an endemic plant growing on cliffs, cornices and precipices. This plant abounds on other sites of the island and on cliffs near the project area. The construction of the cargo village does not concern this species.

The existing vegetation will be totally destroyed by the works planned in the project area. However no endangered species were found on the site.

### 5.1.5. Impact on fauna

The most affected fauna on plateau will be birds. Birds from the plateau, such as the Cream-colored courser (*Cursorius cursor*), Black-crowned sparrow-lark (*Eremopterix nigriceps*) and Bar-tailed lark (*Ammomanes cincturus*) will certainly leave the area because they are used to living in dry areas away from intense human activity. The laborers, heavy truck and machinery traffic (noise) and use of explosives if necessary, will affect the birds' behavior.

## 5.2. IMPACTS OF THE CARGO VILLAGE PROJECT WHEN IN OPERATION

### 5.2.1. Operations to be carried out

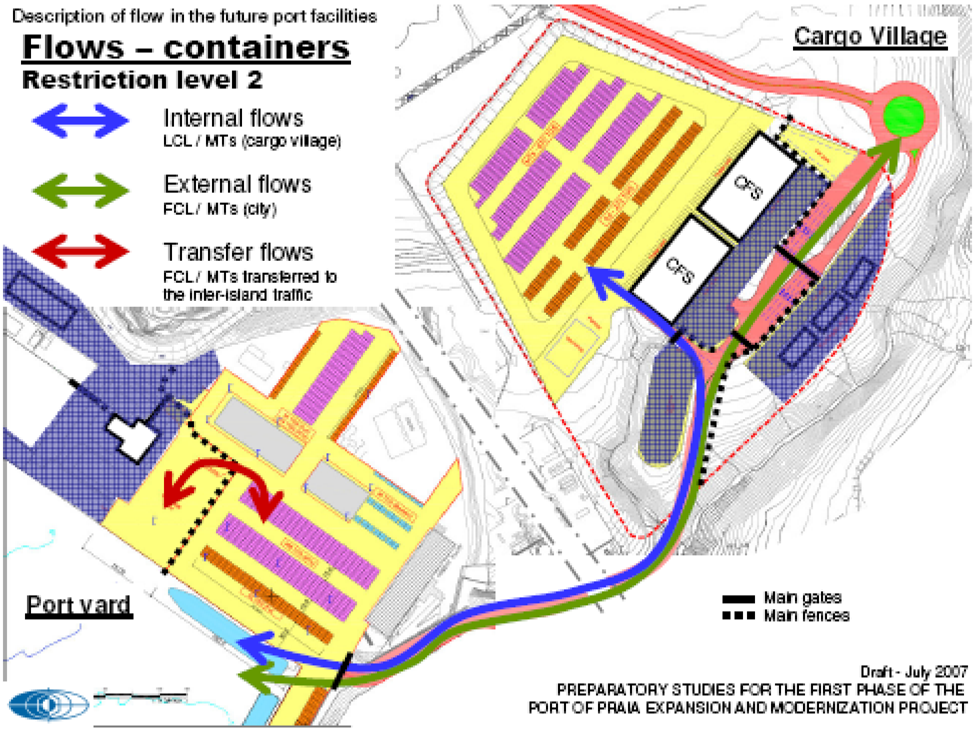
The operations to be carried out in the cargo village comprise:

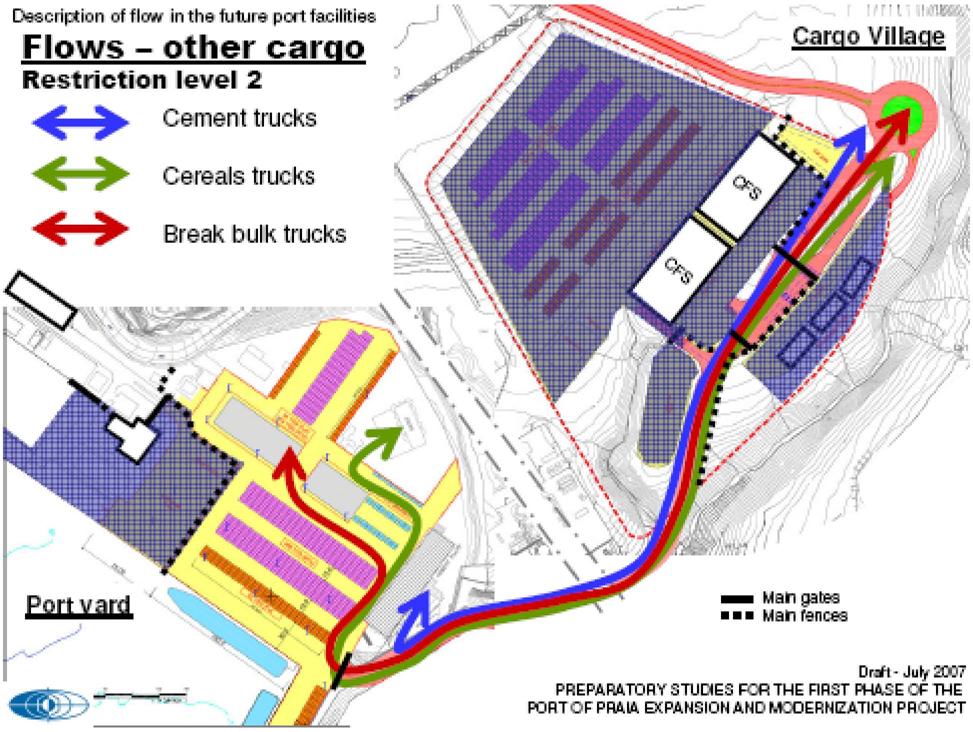
- Trucking containers up and down the hill between the port and the cargo village,
- Stacking and retrieving full and empty containers in the cargo village,
- Taking containers between the stack and the CFS,
- CFS operations, stripping containers,
- Workshops.

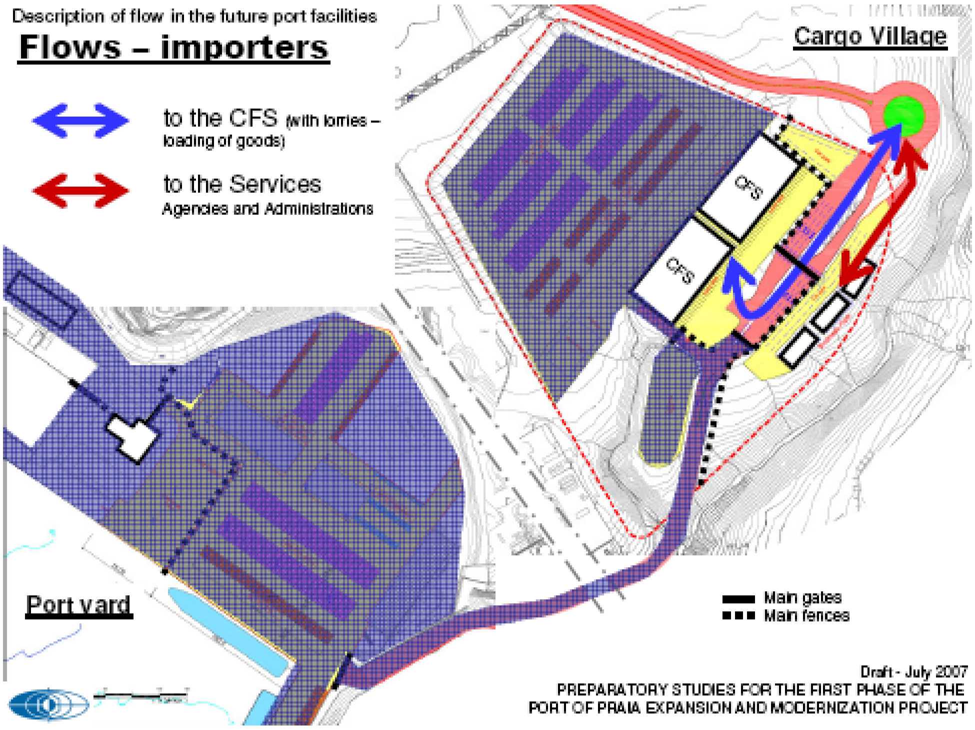
**Table 2. Quantities of the principal mobile equipment:**

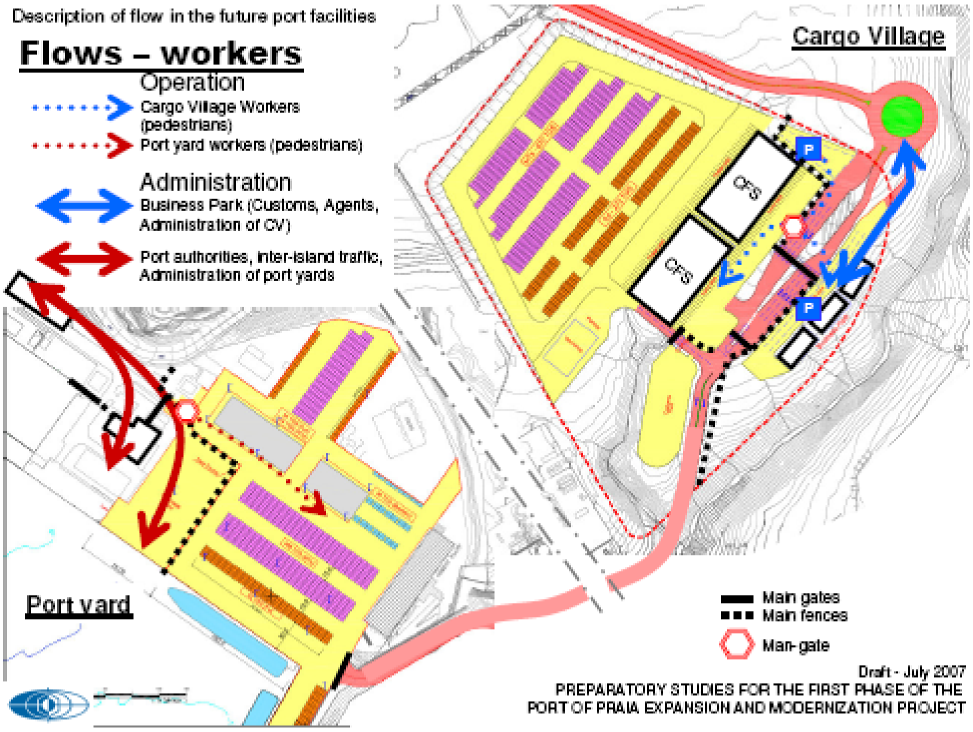
| Equipment | Number Required |
|---|---|
| Road tractors/trailers | 6 |
| Reach-stackers | 2 |
| Yard tractors | 7 |
| Yard trailers | 18 |
| CFS forklift trucks (3t) | 9 |

### 5.2.2. Description of flows




Description of flow in the future port facilities
Flows – other cargo
Restriction level 2
Cement trucks
Cereals trucks
Break bulk trucks
Cargo Village
CFS
CFS
Port yard
Main gates
Main fences
Draft - July 2007
PREPARATORY STUDIES FOR THE FIRST PHASE OF THE
PORT OF PRAIA EXPANSION AND MODERNIZATION PROJECT


Description of flow in the future port facilities
Flows – importers
to the CFS (with lorries – loading of goods)
to the Services
Agencies and Administrations
Cargo Village
CFS
CFS
Port yard
Main gates
Main fences
Draft - July 2007
PREPARATORY STUDIES FOR THE FIRST PHASE OF THE
PORT OF PRAIA EXPANSION AND MODERNIZATION PROJECT




### 5.2.3. Estimate of road traffic

The road traffic by the year 2020 has been estimated according to the different flows generated by the port operations summarized in the above diagrams.

**Table 3. Container Traffic 2020**

| | UP | | | | DOWN | | | |
|---|---|---|---|---|---|---|---|---|
| | P>CV | P>city | CV> city | CSF>city | City>CFS | City>CV | City>P | CV>P |
| Move/year | 47 665 | 15 335 | 15 335 | 0 | 0 | 15 335 | 15 335 | 46 252 |
| Move/day | 159 | 51 | 51 | 0 | 0 | 51 | 51 | 154 |
| Peak move/day | 207 | 66 | 66 | 0 | 0 | 66 | 66 | 200 |
| Peak move/hr | 24 | 16 | 16 | 0 | 0 | 16 | 16 | 24 |

P = Port; CV = Cargo Village; city = city of Praia; CSF = Container Freight Station

**Table 4. General Cargo Traffic in 2020**

| | UP | | | | DOWN | | | |
|---|---|---|---|---|---|---|---|---|
| | P>CV | P>city | CV> city | CSF>city | City>CFS | City>CV | City>P | CV>P |
| Move/year | 0 | 42352 | 0 | 25229 | 25229 | 0 | 42352 | 0 |
| Move/day | 0 | 141 | 0 | 84 | 84 | 0 | 141 | 0 |
| Peak move/day | 0 | 184 | 0 | 84 | 109 | 0 | 184 | 0 |
| Peak move/hr | 0 | 44 | 0 | 26 | 26 | 0 | 44 | 0 |

P = Port; CV = Cargo Village; City = City of Praia; CSF = Container Freight Station

**Table 5. Yearly traffic on the new port access road and external road to the City**

| | **Internal road** | | **External road** | |
|---|---|---|---|---|
| | Upwards | Downwards | Upwards | Downwards |
| Import container (full) | 45 000 | 68 732 | 15 335 | 15 335 |
| Export container (MTs) | 39 067 | 39 067 | 15 335 | 15 335 |
| General cargo / Break bulk | 16 962 | 45 000 | 42 191 | 42 191 |
| General cargo / Dry Bulk | 25 391 | 19662 | 25 391 | 25 391 |
| **Annual total by direction** | **126 419** | **126 419** | **98 252** | **98 252** |
| **Annual total** | **252 838** | | **196 504** | |

## 5.2.4. Impact on drainage

### 5.2.4.1. Principles adopted

The effects of impermeabilization will result in the complete prevention of infiltration of water into the soil, causing virtually immediate surface runoff after the start of rainfall:

- reduction in the response time of the catchment area by eliminating the time delay due to infiltration of the first rain to fall (that is to say when the soil has its maximum retention capacity); the rise of water levels is faster, which represents an aggravating factor in terms of risk,
- obvious increase in peak flow rate when the rainfall is of short duration, in comparison with a natural soil that would have allowed infiltration of the rain water,
- obvious increase in surface runoff volumes during the rainfall event.

The hydraulic flows shall therefore be re-established in accordance with good working practices, by ditches and hydraulic structures that will carry the storm water towards the downstream thalwegs (canyon principal), then to the sea in the cove between the port and Ponta do Visconde.

- The solutions adopted for stormwater collection and treatment shall be as simple as possible in order to minimize network and outfall maintenance requirements.

- Given this aim, it has been decided not to adopt rectangular-section gutters running alongside the roads and covered by grids or removable slabs (risk of blocking if the gutters are not cleaned regularly).
- The project plans for a platform drainage system using the main roads serving the lots, which implies giving the roads a "V" profile and a transverse gradient.

The general scheme plans orienting:

- the main road system broadly perpendicular to the contours, to facilitate water flow. This will enable these roads to be put back into service rapidly after exceptional rainfall events,
- the secondary road system broadly parallel with the contours to favor the temporary holding of storm water.

#### 5.2.4.2. Hydrology[5]

The rainfall data of Dakar has been chosen for the Praia Cargo village project, for geographical reasons as Dakar is situated on the same latitude as the Cape Verde Islands, and is the nearest African city to Praia.

**Table 6. Rainfall intensity in Senegal [mm/h]**

| | ***Concentration time [min]*** | |
|---|---|---|
| ***Return period [year]*** | *10* | *20* |
| *2* | 120 | 88 |
| *5* | 140 | 100 |
| *10* | 150 | 110 |
| *20* | 170 | 120 |

According to the characteristics of the cargo village catchment basin area, the flow values are calculated using a rational method (Table 11).

**Table 7: Assumption for the catchment basin for the platform**

| | | |
|---|---|---|
| Catchment basin area | 0,28 | [km²] |
| Hydraulic path | 1 047 | [m] |
| Runoff coefficient | 0,3 | [-] |
| Slope | 1,15 % | [-] |

[5] Rainwater Drainage system hydraulic calculations. EGIS EAU-Hydraulic Department, September 2007.

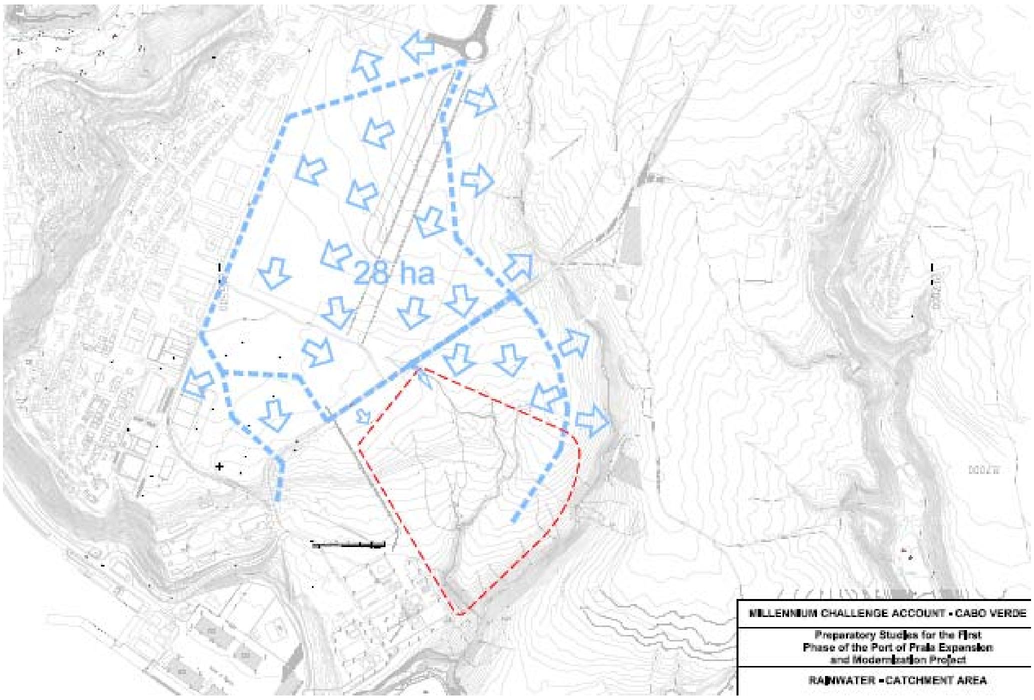



**Table 8. Flow value for the cargo village [m$^3$/s]**

| | ***Concentration time [min]*** | |
|---|---|---|
| ***Return period [year]*** | *10* | *20* |
| *2* | 2,80 | 2,05 |
| *5* | 3,27 | 2,33 |
| *10* | 3,50 | 2,57 |
| *20* | 3,97 | 2,80 |

### 5.2.4.3. Flow value

**Flow value at the entrance of the platform**

A culvert under the access road, over the platform, is situated at the catchment basin outfall. This culvert reduces water in the platform. The culvert's water capacity is 3m$^3$/s. The experiment shows that this culvert has not yet been under pressure. So far, the flow value at the entrance of the platform is 3.5 m$^3$/s. This flow value represents a 10-year return period.

**Flow value at the entrance of the water treatment basin *(refer also to section 2.2.5.)***

The flow value has been used to size up the water treatment basin. This flow value has been taken from the rational method. The rational method depends on the concentration time, which relates to the catchment basin area, slope and runoff. The concentration time of the platform is lower than that of the catchment area above the platform. The hydrological data of Dakar, and that of Senegal, does not explain the IDF curves for this low concentration time. The water treatment basin is consequently set up using the rainfall data of Lisbon, increased by 40 %.

At the entrance of the water treatment basin, the peak flow is 6 $m^3/s$. This is the most critical case, because it means that all the rainfall arrives at the same time at the entrance of the basin. This is not true, even if the concentration time is relatively short (only 6 minutes).

### 5.2.4.4. Design of the drainage system

**Outer ditches**

The ditches have been designed by a backwater calculation. The aim is to adjust the geometry, minimize the covered area and minimize the velocity so that steps and fall can be avoided. All the ditches are in concrete.

According to the topography, the water surface has subcritical behavior over 200 m, and then a supercritical profile till it reaches the outfall in the natural environment. This profile change can not produce a hydraulic jump. Consequently the only erosive factor is the water velocity.

**Figure 3. Water profile of the ditch around the platform – right bank**

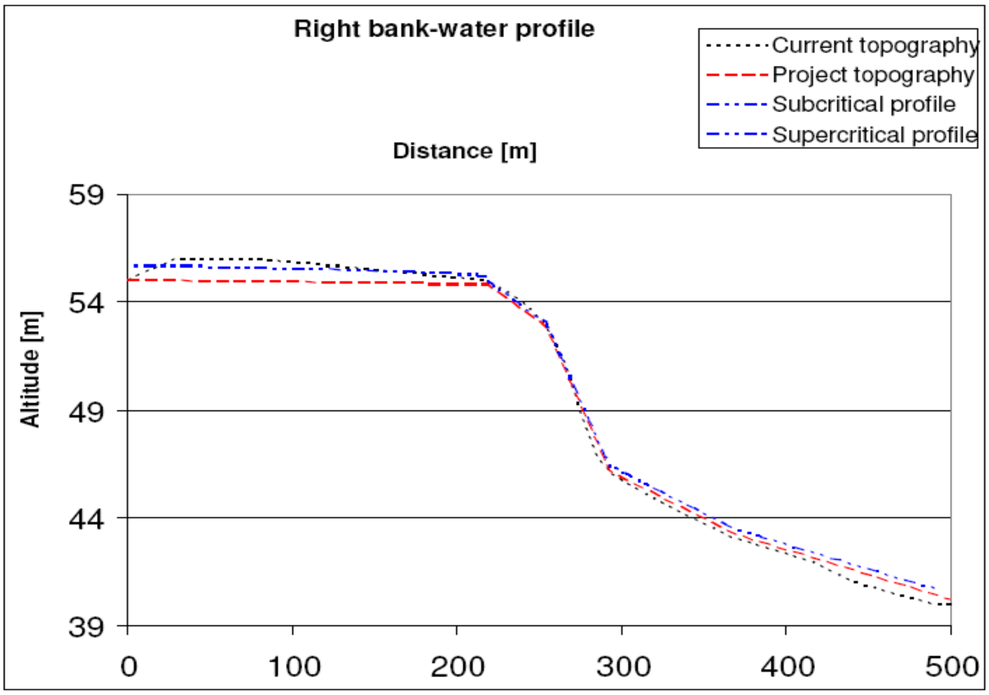
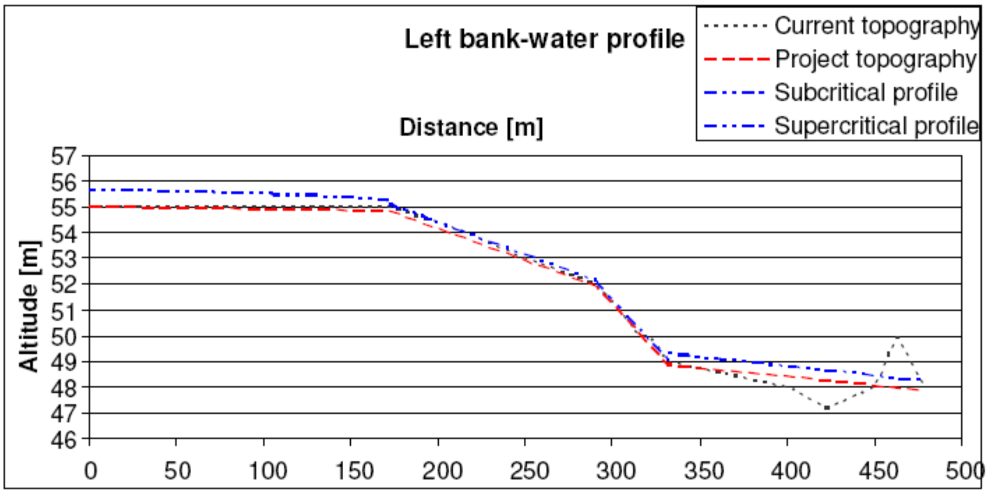


**Figure 4: Water profile of the ditch around the platform – left bank**




The ditch cross sections are rectangular, 2 m wide and 1 m high. The velocity is quite high in that section, but is sufficiently low to avoid erosion of the concrete ditches. Rip-rap material shall be placed on the floor of the ditches, in order to reduce the velocity of water and protect the ditch concrete.

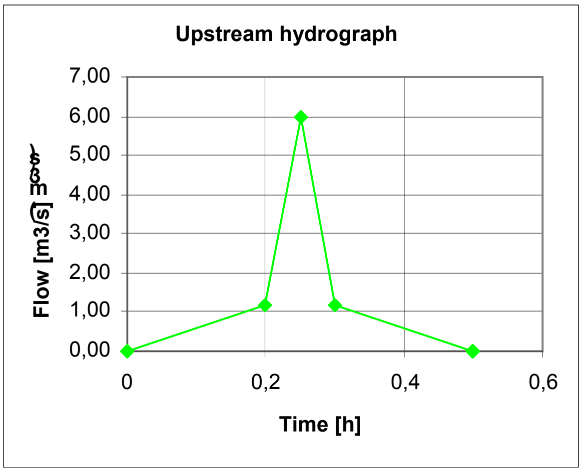
### 5.2.4.5. Design of the water treatment works

**Design of the equalizing tank**

The water treatment basin has been designed with a peak flow of 6 $m^3/s$ as stated in the hydrological part of this report. This equalizing tank has been designed to collect all the runoff water caused by a 10-year return period rainfall event. Its second purpose is to control the flow at the entrance of the oil separator.

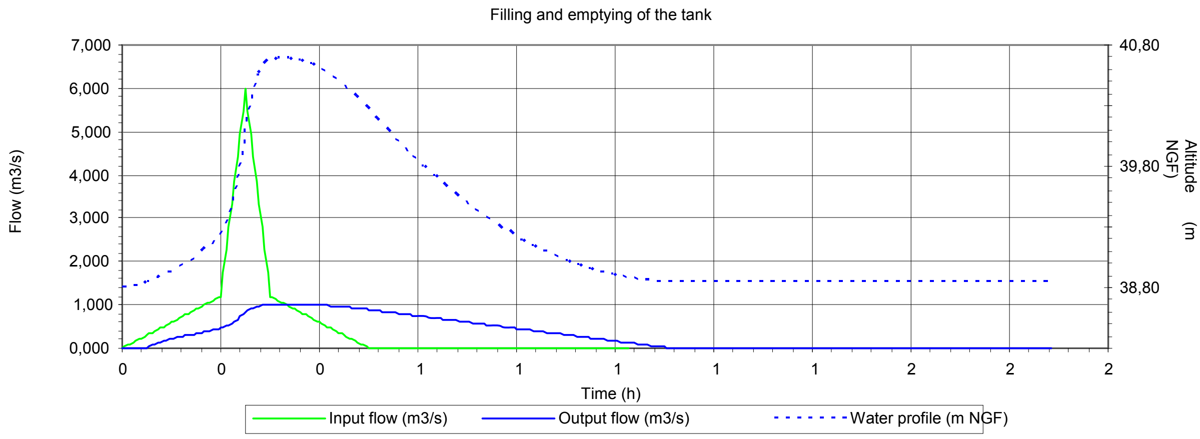
The hydrograph has a double triangular shape. This construction is the optimum for the flow calculation. It has been used to design the equalizing tank.

**Figure 5: Hydrograph used for designing the equalizing tank**



The dimensions of the equalizing tank are 20 m x 35 m for the surface, which means an area of 700 m². The results for the flow and water profile are described in Figure 6.

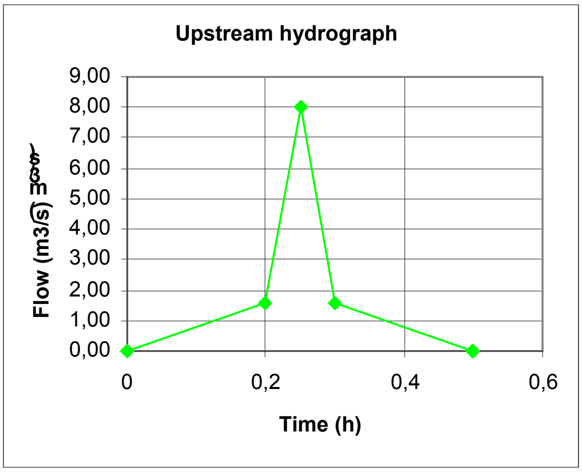
**Figure 6: Filling and emptying the equalizing tank**




## Design of the overflow

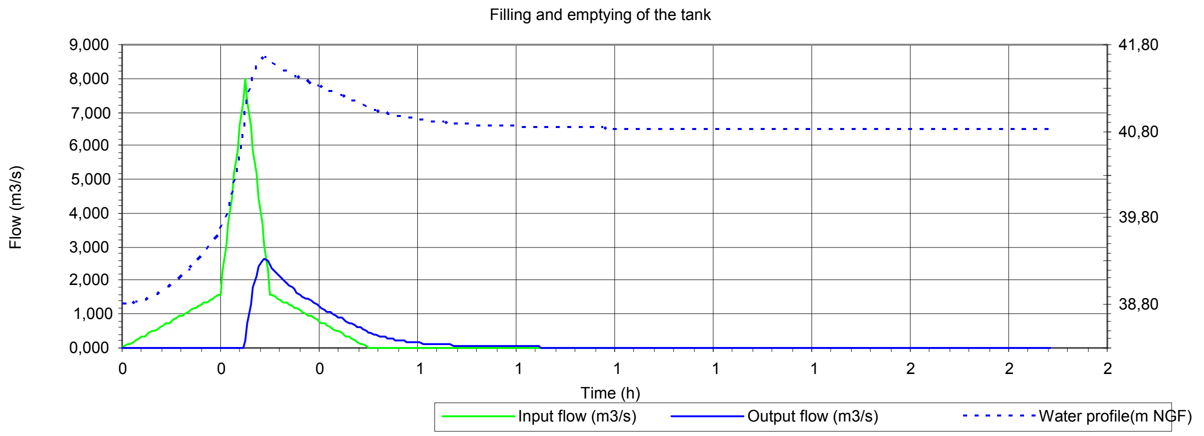
The overflow is designed for a 100-year return flow. It corresponds to a peak flow of 8m$^3$/s. At the same time, it has been assumed that all the control pipes are closed.

**Figure 7: Hydrograph used for the design of the overflow**



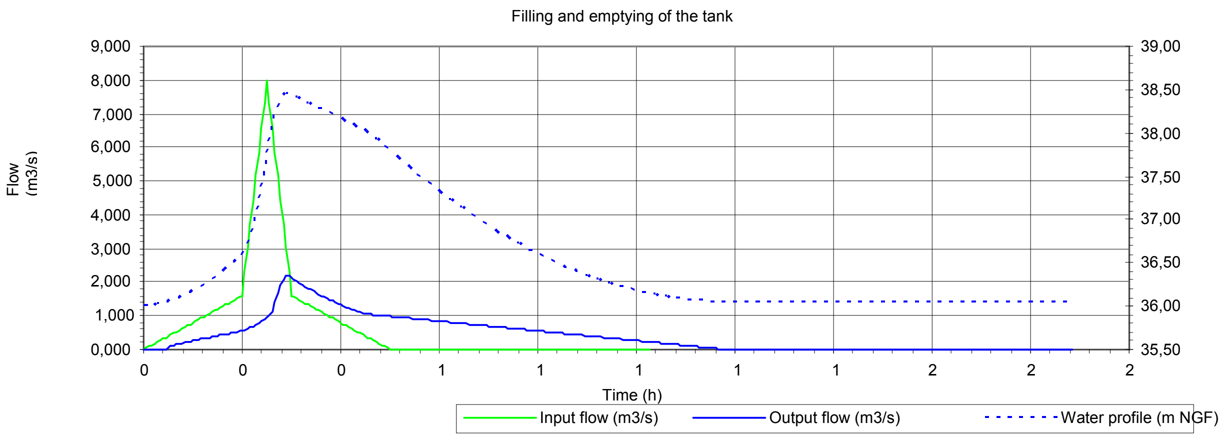

The top of the overflow reaches 40.85 m, which corresponds to the maximum level in the equalizing basin for a 10-year return flow. The width of the overflow is 2 m.

**Figure 8: Filling and emptying of the equalizing 100-year return period – closed outfall pipes**




The maximum flow on the overflow is 2.65 $m^3/s$, with a water depth of 0,85 m. This depth determines the impact point of the water after the overflow. This point is used to design the protection at the base of the overflow. The impact point is 1.19 m from the overflow. The protection at the base of the overflow will have a length of 1.5 m. This protection is a plunge basin. The energy of the water will be dissipated in the plunge basin, and the soil erosion due to the water energy will disappear. The water goes naturally to the ravine.

**Figure 9: Filling and emptying equalizing tank – 100-year return period – open outfall pipes**




It must now be ensured that the oil can be separated from the water even in a 100-year return period rainfall. For an output flow of 1.16 $m^3/s$, the velocity is:

$$v = Q / S = 1.16 / 20.01 = 0.58 \text{ m/s.}$$

The velocity is slow enough to allow for good oil separation.

**Settling check**

**Table 9: Stokes velocity**

| Diameter [mm] | Name | Gravity speed (Stokes velocity) [mm/s] | Time to cover 1 m (sec) |
|---|---|---|---|
| **10** | Gravel | 1 000 | 1 |
| **1** | Coarse sand | 100 | 10 |
| **0,1** | Fine sand | 8 | 120 |

The efficiency of settlement depends only on the bottom surface of the equalizing tank.

$$V_0 = Q / A,$$

with $V_0$ Stokes velocity [mm/s], Q flow [$mm^3$/s] and A Surface of the settling tank [mm²].

In a normal situation (10-year return period), the flow is 1.02 $m^3$/s. The gravity speed is consequently 1.5 mm/s. Fine sand is completely settled.

In an exceptional situation (100-year return period), the flow is 1.16 $m^3$/s. The gravity speed is consequently 1.7 mm/s. Fine sand is in this case also completely settled.

The equalizing tank satisfies its settling function.

**Design of the oil separator**

The output flow of the oil separator is 1.02$m^3$/s. The lower the velocity, the better the oil separator works. To ensure that the side wall correctly separates the oil from the water, the velocity shall be less than 1m/s. Considering an 0.1-m opening, the corresponding velocity is v = Q /l.h = 1.02 / 20.01 = 0.51 m/s.

## 5.2.5. Impact on water quality

### 5.2.5.1. Sources of pollution

**Transport activities and operations on the cargo village**

The main activity likely to cause pollution is the transport activity itself due to the large number of lorries (containers, general cargo) that will transit on the site. The annual number of heavy vehicle movements frequenting the cargo village is estimated at 93,900, i.e., about 300 movements per day. To this must be added the movements of the lifting trucks and machines dedicated to container handling and stocking, as well the cars and vans (employees, government bodies, forwarding agents, etc.).

Most of these vehicles are old. Their utilization will cause losses of hydrocarbons and oil, heavy metal emissions (wear of tires and brakes), and dust that will be deposited on the impermeabilized surfaces during the dry season. The first rains will cause widespread washing-off from the roads and storage area surfaces, carrying these different pollutants into the drainage ditches, the outfall, and finally into the sea.

Table 10 gives the mean values of the specific loads deposited on the impermeabilized surface according to the type of soil use.

**Table 10. Examples of specific loads (in kg/ha/year) deposited on the impermeabilized surfaces according to the type of land use (nm = non-measured parameter)**

| *Parameters* | Urban site 1 | Urban site 2 | Commercial zone 1 | Commercial zone 2 | Residential zone | Load variation range |
|---|---|---|---|---|---|---|
| ***TMIS*** | 665 | 552 | 50 - 800 | 50 - 840 | 600 – 2 300 | 50 – 2 300 |
| ***COD*** | 630 | Nm | 1 000 – 1 029 | 456 | nm | 456 – 1 029 |
| ***BOD5*** | 90 | Nm | 74 | nm | nm | 74 - 90 |
| ***Lead*** | 1 | 0.83 | 0.17 – 1.1 | 0.17 – 1.1 | 0.06 | 0.06 – 1.1 |
| ***Hydrocarbons*** | 15 | Nm | nm | nm | nm | 15 |

The pollutant flows can be estimated annually as follows according to the impermeabilized surface areas.

**Table 11. Estimation of pollutant flows due to vehicle traffic on impermeabilized surfaces**

| *Parameters* | Annual flows (kg) Phase I (59,614 m²) | Annual flows (kg) Phase II (66,287 m²) |
|---|---|---|
| ***TMIS*** | 298 to 13 711 | 331 to 15 246 |
| ***COD*** | 2 718 to 6 134 | 3 022 to 6 820 |
| ***BOD5*** | 441 to 536 | 490 to 596 |
| ***Lead*** | 0.35 to 6.6 | 0.40 to 7.3 |
| ***Hydrocarbons*** | 89 | 99 |

**Other sources of chronic pollution**

The vehicle and handling equipment repair shop, the service station that will supply fuel, lubricants and vehicle washing services.

**Accidental pollution**

Accidental pollution can result from a lorry turning over (fuel or oil leaks), an oil tank leaking, fire (extinguishing water), spillage of hazardous products from a container.

#### 5.2.5.2. Specific equipment and arrangements to limit pollution caused by stormwater

The project plans for the construction of a **retention basin downstream** of the cargo village. It will have a dual function:

- Collect the first stormwater, i.e. the water that washes out the impermeabilized areas and carries a concentrated polluting load at the start of the rainfall event. To avoid overloading the basin, an overflow will divert the slightly polluted or unpolluted stormwater that follows on from the first storm run-off water.
- In dry weather, be able to contain accidental pollution (overturning of a tanker containing polluting substances, containment of fire-extinguishing water). In this respect the settling basin will include a fixed, sealed retention area with a minimum volume of 30 $m^3$ for collecting accidental pollution in dry weather.

It will be built downstream of the cargo village at the head of the main thalweg serving the outfall. The basin construction could comprise several successive basins in a terraced arrangement, the first serving to contain accidental pollution (30$m^3$ lined with a plastic geomembrane), the second (and the first) containing the first storm runoff water. Downstream of the basin, small weirs could be built to slow the flow and allow the sedimentation of materials entrained by the runoff water.

The vehicles and handling machine repair shop and the service station will be independently equipped with a **sedimentation-separation tank that treats hydrocarbons and the vehicle washing water**, given the specific risks of chronic and accidental pollution of water through hydrocarbon spillage from these activities.

### 5.2.6. Wastewater

The Cargo Village area shall be equipped with a separate sewer system, collecting sewage waters from the sanitary equipment of the Cargo Village buildings. All sanitary sewage waters shall be drained from the buildings towards a compact Wastewater Treatment Plant (WWTP) located south of the Cargo Village.

| | |
|---|---|
| **Treatment capacity** | In accordance with the expected water consumption, site users correspond to a population of 300 Inhabitant-Equivalent (IEq);<br>▪ Daily flow of raw sewerage $Q_j$ = 25,25 $m^3$/j,<br>▪ Average hourly flow (considering 8 to 10 operating hours per day)<br>▪ $Q_m$ = 2,906 $m^3$/h and Peak flow $Q_p$ = 8,303 $m^3$/h. |
| **Quality of effluents** | Pollution flow is calculated in accordance with the quantity of pollutants produced per Inhabitant-Equivalent (IEq), based on following production case: 90 g MES / day / IEq 60 g $DBO_5$ / day / IEq ;125 g DCO / day / IEq.<br>Thus the daily flow to be treated is:<br>▪ 27 kg MES / day ;<br>▪ 18 kg $DBO_5$ / day ;<br>▪ 37.5 kg DCO / day. |

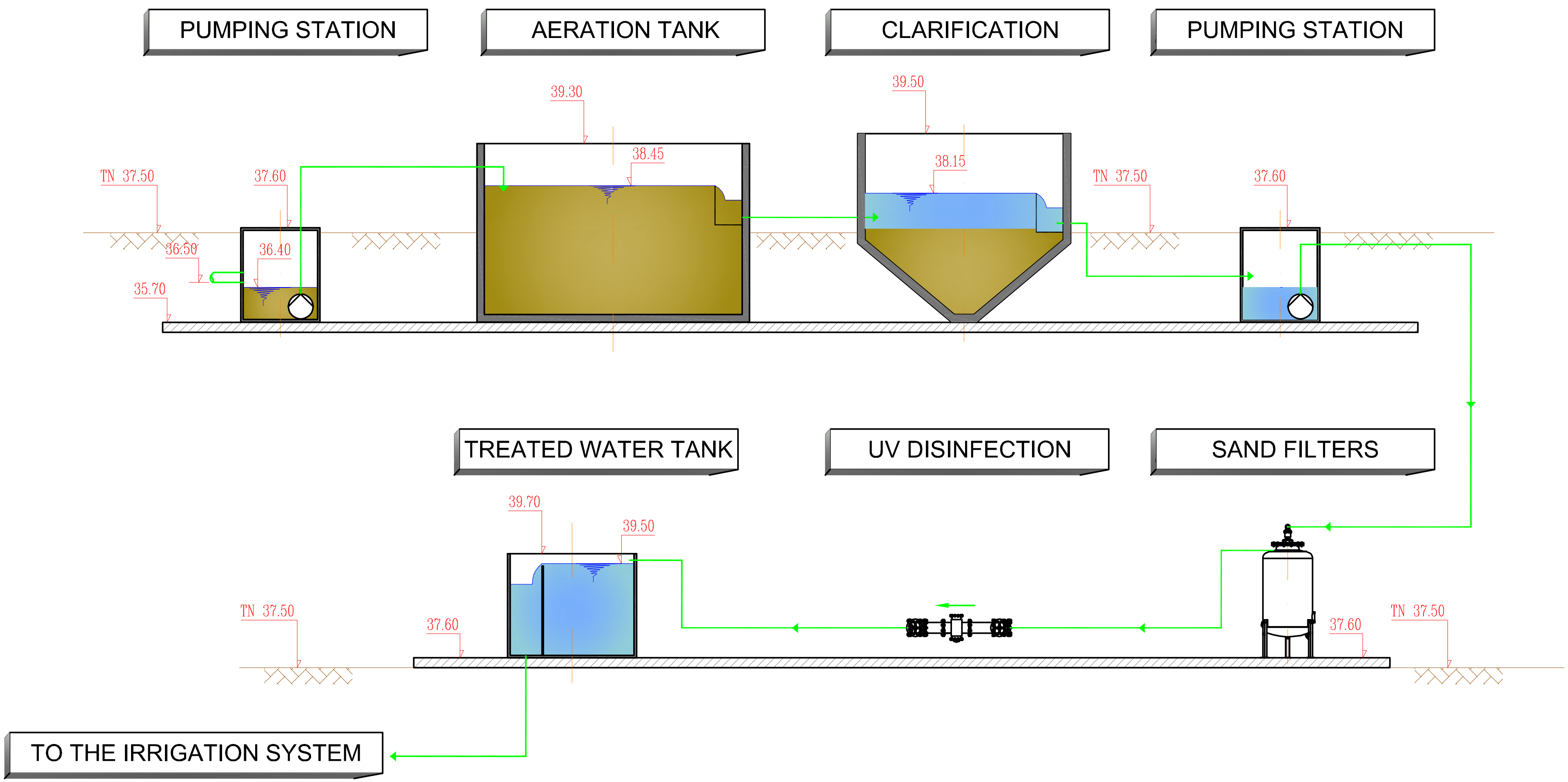
| | |
|---|---|
| **Process of wastewater treatment** | "Activated sludge with extended aeration". The compact WWTP shall comprise, in a single block, all compartments required for appropriate treatment, namely screening, aeration and settling.<br>▪ At the start of the treatment, the screening compartment shall enable screened materials, evaluated at 16l/day, to be retained. The grid spacing shall be 6 mm[6].<br>▪ The activated sludge compartment shall be designed for extended aeration and low load. It shall be equipped with an air blowing system and receive re-circulated sludge from the settling compartment.<br>▪ Required aeration volume $V_{aer}$ = 58 $m^3$ and required air flow $Q_{air}$ = 170 $Nm^3/h$<br>▪ The settling surface and volume required for separation of treated water from sludge are respectively S = 10.75 m² and V = 20.75 $m^3$. |
| **Discharge and outfall of treated waters** | Three solutions can be considered for the treated effluent outfall:<br>▪ A direct outfall into the thalweg: the impact of outfall into the dry thalweg results, at some distance from the outfall point, by infiltration, evaporation due to the heat of the sun but also by stagnating water (ponds) depending on the topography of the thalweg bed. This could result in pollution (smells).<br>▪ A sea outfall (on the coast) by an underground pipe running along the thalweg. Given the low volume of effluent and the strong hydrodynamic nature of the area, this solution would allow treated effluent to be diluted with no sanitary risk (the beach is not used as it is difficult to access). An undersea outfall is not envisaged due to its prohibitive cost and the small amount of outfall which does not require much dilution.<br>▪ Using treated water to irrigate green spaces and vegetation in the cargo village through drip irrigation system. This solution is advantageous as it means that outfall piping becomes unnecessary and will allow savings to be made on irrigation water. It obviously requires a specific distribution network.<br>Considering the scarcity of the water this third solution has been selected. It should however be accompanied by sanitary precautions given the composition of treated effluent (no sprinkling, green spaces closed to the public). For that purpose, the treatment plant will ensure water quality complying with the following standards:<br>▪ COD less than125 mg / liter<br>▪ Matters in suspension less than 35 mg / liter<br>▪ Helminthe eggs less than 1 / ml<br>▪ *E. Coli*. Less than 1 000 / ml<br>Each month water samples will be taken at the plant outlet, and |

[6] At the Canteen building, downstream the connection to all sanitary equipment, a Grease Trap with sufficient capacity shall be installed before the connection to the general sewage networks (Emptying and cleaning of this grease trap shall be done regularly).

the 4 above parameters will be checked.

Sludge material from the plant will be grouped with other sludge generated by the Praia waste water treatment plant.

The scheme on next page shows the principles of the proposed water treatment plant.


PUMPING STATION
AERATION TANK
CLARIFICATION
PUMPING STATION
39.30
39.50
38.45
38.15
TN 37.50
37.60
36.50
36.40
35.70
TN 37.50
37.60
TREATED WATER TANK
UV DISINFECTION
SAND FILTERS
39.70
39.50
TN 37.50
37.60
37.60
TN 37.50
TO THE IRRIGATION SYSTEM

### 5.2.7. Production and management of solid waste

The cargo village will produce different types of waste:

- **waste from port operations and the logistics zone**: debris from wood and pallets, various packaging materials, non-reusable bags, scrap metal, worn out spare parts and cables, cargo residues from losses during storage or loading of lorries, etc.
- **waste from vehicle servicing and repairs**: oil from oil changes, hydraulic fluids, grease, used tires and batteries, toxic waste in dispersed quantities (paints and solvents, acids, industrial detergents and cleaners, recipients, soiled brushes and rags, etc.).
- **waste from the maintenance of the sewerage networks and the settling basin** (after the rainy period): solid macro-waste, gravel and sands, cleansing sludge.
- **household waste** from catering (restaurant service for the cargo village employees and traditional "take-away" food stalls in the street).

It is impossible to quantify this waste at this stage. A system for collecting and treating the solid waste from the cargo village will be put in place.

The operator shall take all necessary measures in the design and operation of the facilities to ensure good management of the waste produced. The waste and residues produced will be stored before they are recycled or disposed of, under conditions that prevent any risks of pollution (prevention of washing out by stormwater, pollution of surface or ground water, airborne particles or odors). Temporary storage before waste recycling or disposal shall be ensured in the sealed retention tanks, with protection from stormwater if possible. The measures to be taken on the site for collection and the recommended disposal processes are indicated in table 21.

**Table 12. Proposals for the management of the waste produced on the platform (collection and treatment processes)**

| ***Waste*** | ***Measures to take*** | ***Recommended disposal processes*** |
|---|---|---|
| Cargo residues | Sweeping up and storing in a closed skip | S3 |
| Washing water | Sealed area with deoiler desludger | S2 |
| Oils and hydraulic fluids | Storage tank | R, I |
| Worn out batteries | Sealed storage tank | R, I |
| Cloths, filtering materials | Storage tank | S1, I |
| Solvents and paints | Storage tank | S1/S2, I |
| Tires | Storage in a closed place with the tires chained up to prevent any risk of fire or theft | Retreading, export or second-hand sale; |
| Cables and worn out spare parts | Storage area | S2, R |
| Cleaning products | Shoveling and direct clearing away in watertight skip | S2/S3 |

R = recycling

I = incineration

S 1/2/3 = waste storage centers

- Storage center type I: special industrial waste (dangerous for nature or living organisms),
- Storage center type II: domestic urban waste and/or standard industrial waste (non dangerous),
- Storage center type III: waste issued from public works.

At the moment Cape Verde does not have the capacity for recycling this type of wastes.

- One solution would be to ship all operational wastes, especially dunnage from the Cargo Village Container Freight Stations, towards a foreign port equipped for waste recycling (considering that almost all outbound containers are shipped empty from Praia).
- The other solution would be to collect the waste and dump it at the existing dunghill of Praia Municipality (Enapor has a convention for that with he Municipality). A new discharge site for wastes is projected to enhance the exiting conditions of waste treatment. That will be a global facility for the whole island.

### 5.2.8. Impact on fauna

The fauna will have deserted the site during the earth movement and leveling work. The frequentation by man and the general increase in traffic over the entire industrial zone will have the effect of reducing the local fauna and biodiversity.

The fauna may suffer indirect effects, for example due to the illumination of the cargo village, as the technical zones and maneuvering areas are lit up for reasons of security and to allow night-time work operations.

To limit these effects, sodium vapor lamps shall be used for the lighting masts. They attract insects to a lesser extent than mercury vapor lamps, whose ultra-violet radiation has a strong attraction effect on insects.

### 5.2.9. Impact on landscape

The works to extend the existing Port of Praia will result in considerable change due to human presence. The topography of the plateau will be completely transformed. The resulting landscape will be a huge infrastructure facility, embracing the plateau, the cliff and the sea where the existing quay has been extended. This area will be designed to accommodate ships, warehouse goods, incoming and outgoing passengers and goods, offices and parking facilities for vehicles and machinery.

This extensive landscape is deeply marked by desertification and dominated by creeping brushwood and rocky outcrops, creating a rough, inhospitable, uninteresting landscape with average scenic and environmental quality and absorption capacity.

The impacts on the landscape during the operation phase will be significant:

- The impact on the landscape will depend on the height of the storage hangars (15m) as well as the mass formed by the containers, particularly when they are stacked one on top of the other (empty containers stacked 4 high maximum, i.e. 10 m, and full containers stacked 3 high at the most, i.e. 7.5m). The cargo village will be visible from the industrial zone situated to the West and East, and from the road linking the airport to Praia.

- The impact on the landscape will be minimized by adopting a number of measures: architectural quality of the hangars (high environmental quality), planting vegetation on embankments and free spaces with local plant species adapted to the arid climate and reusing the local basalt paving stones for the vehicle parking areas.

The Cargo Village landscape project is designed to:

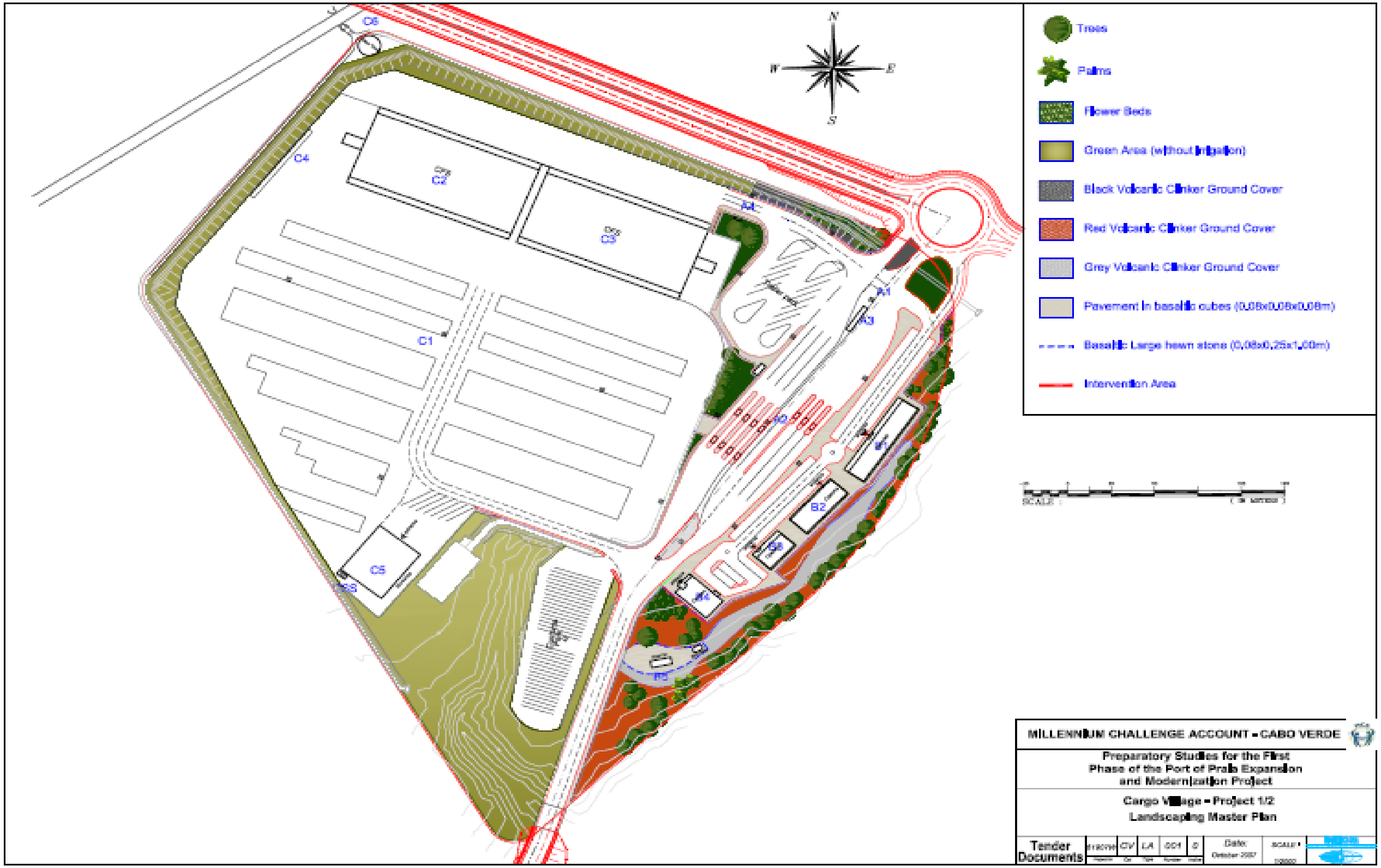
- Create surrounding areas which are attractive, functional and ecological,
- Minimize construction and maintenance costs by using endemic plants, and local materials, where possible,
- Use endemic trees to create tree-lined areas,
- Create pleasant, practical walkways,
- Provide color and texture variations, following the seasons, by using bushes, trees, and herbaceous plants.

The landscaping component of the Cargo Village includes the following:

| | |
|---|---|
| **Framing area** | This area is a transition between the project and the surrounding area. It shall be covered with a mix of herbaceous, bushes and trees, well adapted to the island of Santiago, protecting the soil. |
| **Entering and services area** | This is a more frequented area where the canteen, agencies, administration and customs are located. Therefore the proposal includes the creation of an attractive area that invites people to stay a while.<br>Many trees, bushes and herbaceous species shall be used, to supply shadow, color and texture diversity. These species are completely adapted to the environment where they will be installed.<br>The service areas and walkways shall be paved with basaltic cubes, which provide a comfortable pedestrian surface. The entire zone is marked with *Jacaranda ovalifolia, Agave sialana* and with dark grey volcanic clinker cover. The boundary is emphasized with a volcanic clinker cover red and gray, which not only protects the soil and vegetation, but also reinforces the identity and connection with the place in which this project is inserted. |
| **Revetment** | Unpaved areas shall receive a cover of volcanic clinker: ("jorra vulcânica") cover shall be in 0.005 to 0.01 m red, gray and dark gray particles. This cover shall be placed under the trees, bushes and herbaceous plants. |

The trees, bushes and herbaceous plants located in the entrance and services area shall be irrigated with a drip irrigation system.


Millenium challenge account - Cabo Verde
Port of Praia expansion and modernization project
Aménagement de la plate-forme
Etat actuel
Variante plate-forme à 41m



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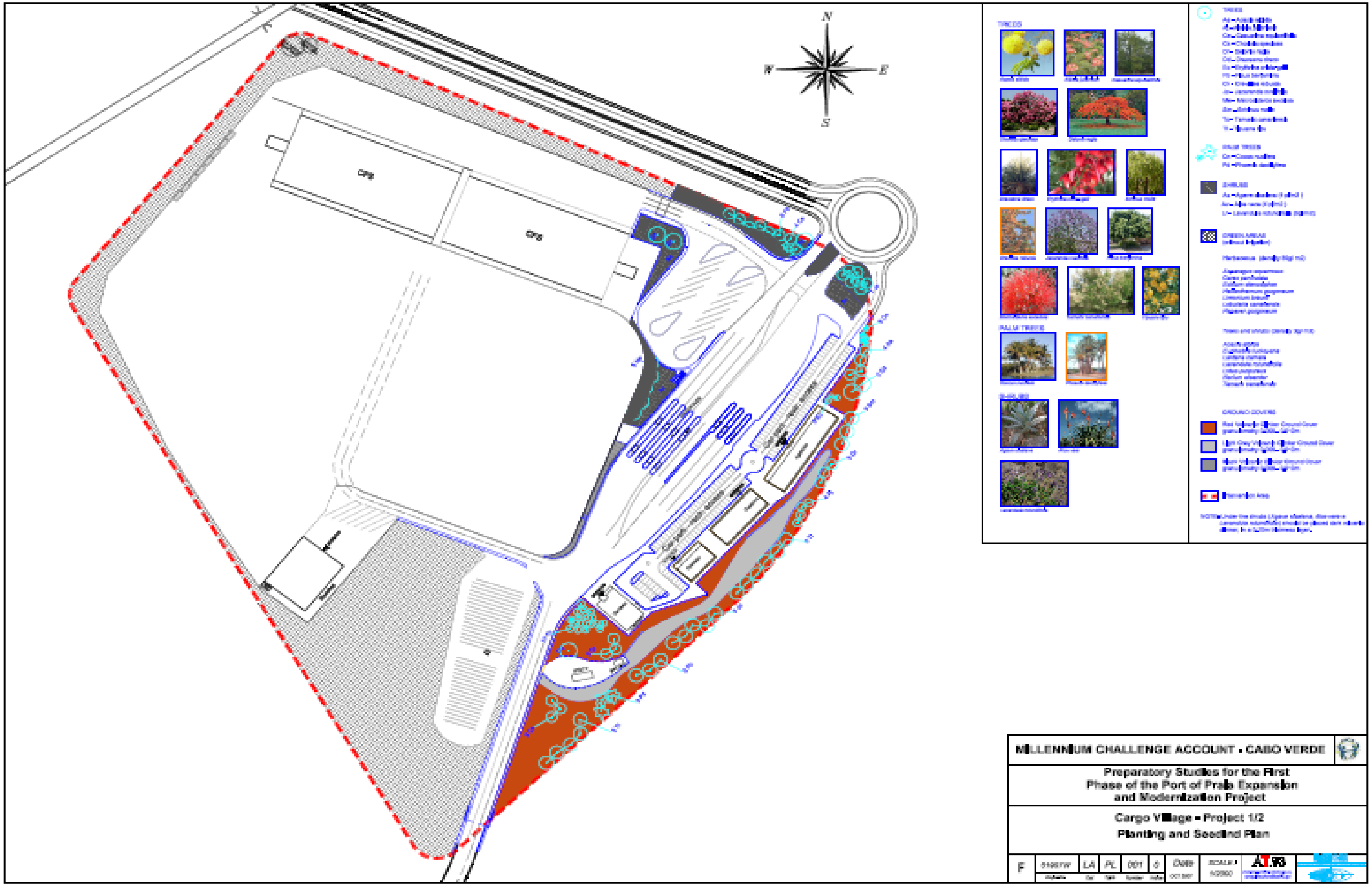
E
S
C1
C2
C3
C4
C5
C6
A1
A3
A4
B1
B2
B3
B4
B5
Trees
Palms
Flower Beds
Green Area (without irrigation)
Black Volcanic Clinker Ground Cover
Red Volcanic Clinker Ground Cover
Grey Volcanic Clinker Ground Cover
Pavement in basaltic cubes (0,08x0,08x0,08m)
Basaltic Large hewn stone (0,08x0,25x1,00m)
Intervention Area
SCALE
MILLENNIUM CHALLENGE ACCOUNT - CABO VERDE
Preparatory Studies for the First Phase of the Port of Praia Expansion and Modernization Project
Cargo Village - Project 1/2
Landscaping Master Plan
Tender Documents
CV
LA
001
Date:
October 2007
SCALE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MILLENNIUM CHALLENGE ACCOUNT - CABO VERDE
Preparatory Studies for the First Phase of the Port of Praia Expansion and Modernization Project
Cargo Village - Project 1/2
Planting and Seedind Plan

### 5.2.10. Impact on road traffic

The expected heavy vehicle traffic flows have been assessed[7], linking the three different zones:

- The Port to the Cargo Village,
- Cargo Village to the city road network,
- The Port to the city.

**Table 13. Traffic Forecast for the year 2020 on the new port access road and external road to the City (cf. table 8).**

| | Internal road | External city road network |
|---|---|---|
| Annual total traffic (Q) | **252 838** | **196 504** |
| Veh/day (Q/300) | **840** | **655** |
| Veh/day (8 hrs) | **105** | **82** |

[7] Car traffic has not been calculated as it is low enough not to influence the outcome in terms of numbers of traffic lanes required.

# CARGO VILLAGE

## Environnemental issues/ Scope of impacts/ Reducing measures

Birds as affected fauna

Destruction of vegetal covering

Earthmoving during the works (dust, noise, traffic)

Environmental management plan during the works

Hight environmental quality for warehouses and office buildings

Water pollution due to the cargo operations and heavy vehicule traffic

Ditches and retention tank downstream

Waterproofing of a natural area

Water drainage: basic solutions as "V shaped" areas and ditches

Impact of road traffic (noise, accident risk)

Waste pollution and health risk

Waste management

Familia : Agavaceae
Sisal / piteira (Agave sisalana)

Familia : Leguminosae / Fabaceae caesalpinioideae
Acacia-martins (Parkinsonia aculeata L.)

Familia : Liliaceae
Babosa (Aloe vera (L.) Burm. f)

Familia : Agavaceae
carrapato (Furcraea gigantea Vent.)

Landscape changes,

Landscaping with local plant species

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# 6. IMPACT OF THE ROAD ACCESS

## 6.1. IMPACTS OF THE ROAD PROJECT UNDER CONSTRUCTION

### 6.1.1. Section between the cargo village and the cost line

The road is built on the plateau and requires only a small amount of fill representing about 10,000 $m^3$. The road works will be integrated in the construction of the cargo village. The expected disturbances (movement of vehicles and machines, noise, vibration and dust) will therefore be global.

The earthmoving machines will have to avoid dropping materials on the thalweg slopes in order to preserve their hydraulic transparency. The embankments will have to be stabilized as rapidly as possible with local vegetation.

### 6.1.2. Maritime section to the point where the road joins the port

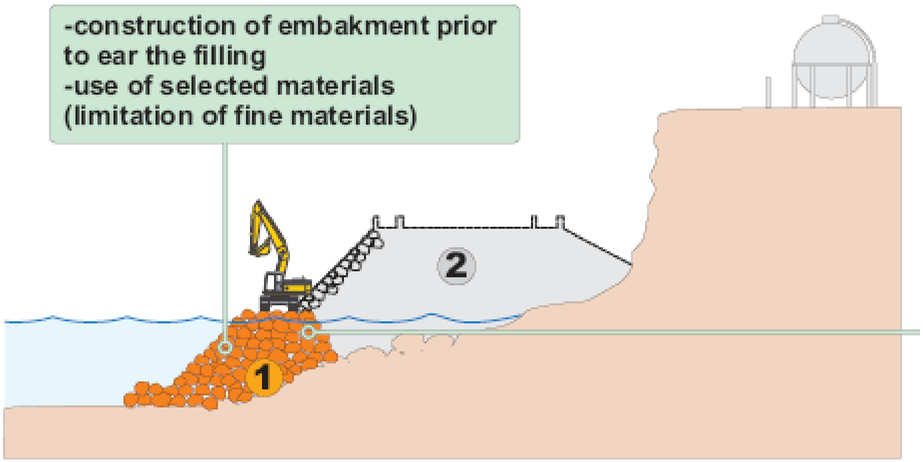
The environmental impacts on this maritime section will depend on the construction techniques used. The road platform will be built using the progressive construction technique. From the port and the cargo village, the quarry materials and/or those from the leveling of the cargo village will be brought by lorry then dumped at the foot of the cliff to constitute the body of the road platform. The quantity of material required is estimated at 180,000 $m^3$.

**Impact of material filling on the marine environment**

The aggregate materials are loaded to varying extents with fine particles that will be washed out as soon as they come into contact with the seawater. These particles will create a cloud of turbidity at the foot of the cliff, which will diffuse through the water as dictated by the local agitation of the sea and the currents. The expected effects are:

- The creation of a plume of turbidity that will be visible on the surface of the water and will reduce the penetration of light into the water column. Depending on the oceano-meteorological conditions, this plume will tend to spread to a greater or lesser extent towards the exterior of the small bay limited by the breakwater of quay 1 and the Pointe da Visconde. With a north-easterly wind, as the site is relatively sheltered, the plume of turbidity will tend to stagnate, with a portion of the elements settling on the sea bottom (see following indent). With southerly winds (photo below), the site is more exposed and the long swell will tend to create bottom currents that will disperse the turbid plume.

- Rapid sedimentation of the largest particles on the sea bottom. These particles will settle on the sandy bottom with no notable impact on the basalt blocks that constitute the supporting medium for the marine life, and notably the fixed organisms (photophile algae, sponges, bryozoa, ascidians). With no bottom current, the populations could suffer damage (organisms covered with fine particles, clogging of branchial filters). Natural turbidity of water (suspended particulate matter) in this area (station 5) can reach 20 mg/l at both the top and the bottom of the column of water. We could expect major influence of cleaner oceanic waters. However, bottom currents can contribute to the observed turbidity, only detected in the bottom water layer. The underwater film made at this station illustrates this hypothesis. The impact of suspended particulate matter due to the work site should therefore not create a threat for the marine flora and fauna in this sector, given the frequent reworking of the loose seabed material by the bottom currents.
- The proposed way of reducing this risk is to first build the breakwater to provide protection against the swell, then to fill the volume between the breakwater and the foot of the cliff with aggregate materials. This solution will limit to a large extent the washing out of fine particulate materials and production of suspended particulate matter that temporarily increases the turbidity of the seawater. The large blocks used for the construction of the external breakwater will induce very little or even no suspended particulate matter.




The following measures shall also be adopted:

- Either, prior washing of the quarry materials the most heavily loaded with fine particles,
- Or, establishing precise specifications for these materials in order to limit losses of materials and the generation of turbid plumes. It is thus recommended that in the 0/50-mm fraction of the materials, elements of dimensions exceeding 2mm should represent 40 to 60% of the 0/50-mm fraction and the particles smaller than 80 µm should represent less than 12% of the 0/50-mm fraction. The mean grading range of the selected materials shall be submitted to the prime contractor for approval.

Moreover, the real-time tracking of water turbidity during the works shall be made contractual.

**Destruction of littoral marine populations in the area covered by the road**

The area of the marine floor covered by the road foundation represents some 23,650 m². Over this surface area the hard substratum populations will be irreversibly destroyed. This concerns the population characteristic of the supralittoral and strand stages: seaweed, mollusks (with predominance of gastropods), crustaceans including the amphipods and fixed polychetes. A variable portion of the large blocks will be covered by the fill embankment material, depriving the marine fauna of the shelter these blocks would have provided.

The immersed part of the riprap of the external shell of the breakwater would partly, but only partly, compensate for the loss of these habitats:

- The hard substratum populations will be reconstituted following the natural staging (supralittoral and strand stages), but on a lesser scale in view of the linearity of the road,
- The lower part of the blocks in the shallow waters will provide shelter for certain species of fish and crustaceans.

| | |
|---|---|
| **Impacts of consolidation of the cliff on the avian fauna.** | The geological appraisal of the cliff below which the road passes evidences the risk of rockfalls from the cliff (para. 3.2.4.) and recommends protective measures such as fitting a net to protect against falling rocks, a drainage system at the top of the cliff, consolidation of the limestone layer, filling in the cavities in the cliff.<br><br>If such work is necessary to ensure the safety of traffic below the cliff, it also leads to an irreversible change of the biotope for the birds that frequent it, and notably the species that nest and reproduce there. The impact of the work itself, but above all the structural modifications made to the cliff, will result in the desertion of the recorded species.<br><br>To reduce this impact it is recommended:<br><br>▪ To leave the cliff in its natural state, possibly removing any boulders that risk falling before commencing the road construction work,<br><br>▪ To move the road away from the foot of the cliff with a sufficient margin to prevent boulders from falling onto the road platform.<br><br>▪ To create a drainage system on the cliff top to limit the risks of infiltration,<br><br>▪ To perform periodic appraisals of the cliff (before, during and after the road construction work). |

## 6.2. IMPACTS OF THE ROAD PROJECT DURING OPERATION

### 6.2.1. Impact on the hydraulics and water quality

Concerning road drainage, it is planned to collect stormwater in a lateral ditch situated at the foot of the cliff, and then evacuate it to the sea via two transverse pipes situated at low points. Due to the shortage of space at the low point in the road, no settling basin is planned for pretreating stormwater in the event of heavy rainfall.

However, the project plans:

- To use this ditch to contain accidental pollution in dry weather (spillage from a truck, large leak from a gasoil reservoir). The two outlets would then be closed with a valve and the polluted effluent would be pumped up and evacuated to a treatment site.
- Periodic cleaning of the road to avoid the pavement being washed in heavy rain and carrying away concentrated pollution which would then find its way into the sea. The heavy vehicle traffic will cause chronic pollution: accumulation on the road surface of residues of unburned hydrocarbons, oil, particles from the wear of tires and brakes. To prevent these residues from being washed out and running into and polluting the sea, the principle will be to periodically clean the pavement (2 to 3 times a year during the dry period) using a motorized brush. Cleaning water would be drained into the ditch (with the outfall valves closed). The ditch would serve as a settling area. The sludge would be cleaned and evacuated before the rainy season.

### 6.2.2. Impact on the terrestrial environment

The movement of heavy vehicles on the road (105 vehicles/hour) will produce noise, vibration and exhaust gas discharges into the atmosphere by day and night.

The road lighting will constitute and additional nuisance factor at night-time (see box).

| **The impacts of artificial light on the living environment**[8] |
|---|
| The direct and indirect effects of artificial light on the living environment are very poorly known, but all the groups of fauna are concerned, and especially the birds, chiropters (bats) and insects. Very few scientific studies have studied or evaluated them in detail, but there is nevertheless a consensus on the following points:<br>Some light sources, including radiation invisible to Man, constitute for certain species (sometimes only at certain periods of their development or during migrations) a strong attracting or repelling force.<br>Birds are particularly affected by direct mortality further to dazzling, disturbance of their biological clock or disorientation for migratory species. Some birds seem to desert the areas artificially lit at night. Other species seem to become readily accustomed to the presence of urban artificial lighting. Sometimes birds nest in brightly lit – but calm – industrial zones, but nevertheless often in a less brightly illuminated part of the zone. |

[8] Source: Association Nationale pour la Protection du Ciel Nocturne (National Association for the Protection of Night Skies)

Insect species seem to have been the most affected by the development of urban and countryside lighting. It is unanimously acknowledged that the large quantity of UV radiation emitted by mercury vapor lamps has played a role in reducing or even eliminating the presence some species of urban and peri-urban fauna.

A few species give the impression of having adapted by turning nocturnal lighting to their advantage, such as certain bats that feed on insects attracted by the street lamps or domestic lighting. But one must remain prudent regarding species that adapt to or exploit the lighting: ecosystems are complex, and a behavioral adaptation that initially seems positive can ultimately turn out to be catastrophic for a species and/or the biocenosis in which it is integrated.

It is probable that the birds, and the nesting birds in particular, will desert the cliff for equivalent coastal sites that are not disturbed by human activities. The most seriously threatened species in this respect are *Phaeton aethereus* (Red-billed tropicbird) classified as an endangered species, and *Pandion haliaetus* (Osprey*)* considered as a rare species. These two birds are on the red list.

Measures can be taken to limit the effects of lighting on the avian fauna, namely by using suitably adapted lamps.

- Sodium vapor lamps shall be used to reduce the attracting effect on insects, and therefore on potential predators (nocturnal birds and bats).
- When the bulb is well concealed by the reflector and the diffuser (transparent part) is not prominent, all the light is directed downwards below the horizontal. For a distance, the light source is invisible from all directions.

Bird population monitoring must be included in the project effects monitoring plan.

### 6.2.3. Impact on the marine environment

As was emphasized earlier, the main impact is the loss of biodiversity due to the irreversible disappearance of some 23,650 m² of marine habitat characteristic of the supralittoral and strand stages.

### 6.2.4. Impact on the landscape

The access road will not be visible from the high town of Praia (Plateau), nor from Santa Maria Island, due to the orientation of the cliff which masks the views from the back of Praia bay.

The maritime part of the road will not be visible from the roundabout at the end of the Punta da Visconde access road.

The only point of visibility will be from the seaside plateau situated to the east of the port (Punta da Visconde), which gives a downward view.

The visual impact will be strong due to the mass of the riprap. It will be slightly attenuated by the use of basaltic rocks of the same color as the cliff face, which will reduce the contrast between the natural and artificial parts.

### 6.2.5. Impact on the geological heritage

The cliff is characterized by a very striking geological feature: a carbonated sedimentary layer representing the ancient coast. This remarkable geological feature will be destroyed during the construction of the road.

### 6.2.6. Impact on human activities

There is no human activity in this sector, which is isolated from habitations and of relatively difficult access. The professional coastal fishermen do not use this site, but there is little activity on rocky grounds south of Ponta do Visconde. The beach, made up of shingle and relatively large blocks of basaltic rock, is not used for leisure activities.


REPUBLIC OF CAPE VERDE
MILLENNIUM CHALLENGE ACCOUNT – CABO VERDE
PREPARATORY STUDIES FOR THE FIRST PHASE OF THE PORT OF PRAIA
EXPANSION AND MODERNIZATION PROJECT
ACCESS ROAD
Environnemental issues/
Scope of impacts/
Reducing measures
Existing situation
Destruction of an outstanding geological feature
Impact on birds during the earthworks
-the road shall be located as far as possible from the cliff toe
-drainage system at the top of the cliff
Projected road
Impact on marine life : destruction of a coastal ecosystem due to the embankment of the road
Risk of water pollution (spills, dangerous goods)
-ditches along the road
-emergency tank
Impact on wildlife (nesting birds, 2 endangered bird species) due to road traffic and lights
2
1
When earthfilling, impact on marine life by suspended matters
-construction of embankment prior to the fill
-use of selected materials (limitation of fine materials)
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# 7. IMPACT ON SOCIO-ECONOMICS

## 7.1. IMPACT DURING THE CONSTRUCTION

### 7.1.1. Impact on the local population

The inhabited areas of the Achada Grande plateau, on the western and eastern sides, are relatively far away from the works. Conversely, the temporary sites (temporary container storage, contractors' facilities) are closer, but are separated from the housing areas by a line of hangars and industrial buildings. The houses will therefore be protected from the noise but they may be temporarily inconvenienced by dust, exhaust gases and fumes (asphalt-mixing plant).

Transport of large quantities of materials, mainly from the quarries to the northwest of the airport, has been organized so as not to pass through densely inhabited or even sparsely inhabited areas. The trucks will not use the port road passing through the city center (Ribeira da Trindade roundabout) but the sloping road between the Achada Grande plateau and the port. Furthermore, the road from the quarries, which follows a large part of the route for the ring-road, is not in an urbanized area.

On the other hand, transport will entail a road safety risk on the ring-road/airport/port route (significant increase in traffic, disruption of communications with the industrial estates). A 'black spot' that will require particular attention is at the main gate of the port. This area already concentrates human activities (entry and exit of staff, users and fishermen, nearby small traders), and a part of the materials required for construction of the access road (in its lower part) will also pass through this point. Road safety is an issue that must be addressed, since road accidents result in deaths, injuries and damage to property. If the main access road will be in service for other users, special measures must be adopted to prevent the increased mobility of motorists from undermining the safety and health of other users. Improved safety conditions can be achieved through signs and markings, safety barriers and provisions for pedestrians.

### 7.1.2. Generation jobs for the construction and sanitary risks

During the works period, between September 2008 and mid-2011, the work site will involve around 200 to 300 people (for both project phases). The contractors' personnel (supervisory staff, foremen, laborers) will require living quarters to be installed comprising drinking water supply, sanitation/drainage, electricity and telecommunications, offices, changing rooms and sanitary installations (showers, toilet facilities), restauration and rest installations, a dispensary for first aid. Various types of personnel accommodation will need to be provided in Praia: building housing on a dedicated site, accommodation with local residents, bed and breakfast or hotels.

An important social impact is the potential for sexually transmitted infections (STI), which already represents one of the major causes of death in Cape Verde (Source: Small Islands Development States Organization).

Recent HIV-AIDS studies indicate that given activities– such as road and port construction, development of the tourism sector– may accelerate the pandemic expansion. Potentially, some projects funded by MCC are likely to contribute to HIV-

AIDS expansion; therefore MCA-Cabo Verde is undertaking to participate in the HIV-AIDS prevention campaign, in partnership with CCS-SIDA.

| AIDS in Cape verde |
|---|
| Currently the HIV-AIDS prevalence rate in Cape Verde is relatively low compared to other African countries. The HIV-AIDS prevalence survey conducted in Cape Verde in 2005 by the Ministry of Health and National Institute of Statistics indicates a 0,5 %, HIV prevalence rate (preliminary data). HIV-AIDS transmission happens in more than 90 % by heterosexual contact. Mother to child transmission has been oscillating between 4.6 % and 13.3 % from 2000 to 2005.<br>The main concerns arise from the high levels of risky behavior in the general population, relating either to sexual precociousness (30 % of girls become pregnant between the ages of 15 and 19 years) or to the high level of irregular partners, as well as to the low level of use of condoms. Knowledge of HIV-AIDS continues to increase, with around 65 % of young people being aware of at least two of the principal forms of protection (use of the condom and fidelity). The perception of the risk of infection is continuing to increase amongst the young and adults (73 % consider themselves to be at risk of HIV-AIDS).<br>To respond to this increasing threat, the Government established the National Coordination Committee to Fight Aids and Sexually Transmitted Diseases (CCS-SIDA) on July 4, by the Decree-law 50/2001 published in the Official Gazette n° 23 of July 30, 2001. |

MCA-CV intends to use to conduct an HIV-AIDS prevention campaign, simultaneously included in the Port Project lifetime and CCS-SIDA´s works (for details, refer to the Environmental management Plan).

## 7.2. IMPACT AFTER IMPLEMENTATION OF THE PROJECT AND DURING PORT OPERATION

### 7.2.1. Generation jobs for port operation

The Port of Praia’s operational personnel, mainly ship-handling personnel, include about 300 persons. According to management’s estimate, there is a large redundancy of labor. This became particularly clear after the recent labor reform in which gang size was reduced by about 1/3. For example, a container gang (ship-side only) was reduced from 15 to 10.

#### Container Operations in the Port

In the port, the anticipated container operations in 2020 will be an extension of the current practice. It is expected that 2 ships will be able to be handled simultaneously using two ship’s cranes on each ship – and hence 4 gangs of stevedores. Equipment numbers are estimated as follows:

| Equipment | Number Required |
|---|---|
| Reach-stackers | 6 |
| Yard tractors | 12 |
| Yard trailers | 18 |

One reach-stacker is required at each ship, with one in the yard receiving containers from the ship, while the other reach-stacker in the yard will be occupied with land-side deliveries, principally loading/unloading trailers taking the containers to/from the Cargo Village. The likely staffing levels required are given in the table below.

| Shipside Gangs | | Reach-stacker drivers | |
|---|---|---|---|
| No of gangs | 4 | Quay side | 2 |
| Crane driver | 1 x 4 | Yard: shipside | 2 |
| Tractor driver | 3 x 4 | Yard: landside | 2 |
| Stevedore | 4 x 4 | | |
| Banksman | 1 x 4 | | |
| Checker | 1 x 4 | | |
| Total shipside gang staffs | 40 | Total RS drivers | 6 |
| **Total staff = 46** | | | |

### Cargo Village

For the Cargo Village, the operations to be carried out comprise:

- Trucking containers up and down the hill between the port and the Cargo Village
- Stacking and retrieving full and empty containers in The Cargo Village
- Taking containers between the stack and the CFS
- CFS operations, stripping containers
- Workshop

For these operations, the following numbers of the principal mobile equipment have been calculated:

| Equipment | Number Required |
|---|---|
| Road tractors/trailers | 6 |
| Reach-stackers | 2 |
| Yard tractors | 7 |
| Yard trailers | 18 |
| CFS forklift trucks (3t) | 9 |

The staffing levels required for these operations are given in the table below.

| Trucking Operations | Yard Operations | CFS | Workshop |
|---|---|---|---|
| 6 Road tractor drivers | 2 Reach-stacker drivers | 1 Manager | 1 Foreman |

| | | | |
|---|---|---|---|
| | 6 Yard tractor drivers | 1 Secretary | 1 Secretary |
| | | 4 Foreman | 1 Stores |
| | | 8 Fork-lift (3t) driver | 2 Fitters/fuelers |
| | | 16 CFS operative | 1 Electrician/Electronics |
| | | 4 Checkers | |
| | | 2 Accounts clerks | |
| | | 2 Sweepers | |
| | | 2 Tea-boys | |
| Total 6 | Total 8 | Total 40 | Total 6 |
| **Total cargo village 60** | | | |

## 7.3. SOCIO-ECONOMIC IMPACTS

Direct and indirect socio-economic impacts include:

- Generation of jobs through the development of industrial, commercial, logistic and other activities on the port ,
- Contracting of new operators sue to the improvement of transport and types of business and the improvement of the receptions conditions, ships clearing, goods and interisland and international passengers movement,
- Increase of service capacity provides to the inhabitants and economic activities by the construction of new quays and container areas, namely at the level of food safety, employment, and the interisland transportation of passengers and goods,
- The achievement of better competitive conditions for economic agents through the creation of conditions for the installation of maritime and port operators, offices as well as enterprises with industrial functions,
- The attainment of better competitive advantages for importers and exporters through the creation of infrastructure and service conditions to warrant the frequent and regular flow of goods regardless of their origin/destination,
- The reinforcement of the appeal for the establishment of economic activities (industrial, commercial and logistic activities directly or indirectly related to the port of Praia),
- The realization of foreign investment ant technology, especially in the Zone of logistic Activities (ZAL) of the port of Praia (this factor can be reinforced if the ZAL has the statute of industrial free zone) and increasing the port's fulfillment ant the function of its related areas.
- The improvement of public wealth generation by creating conditions for national or foreign investment in new enterprises and related services mainly through the creation of ZAL, diminishing in this way the recourse to Public Funds for investments in industrial and logistical activities, therefore originating an increase in the generation of public wealth.
- The improved attraction of the city, island and country for higher income tourism and the encouragement of trade expansion.

## 7.4. IMPACT ON LAND USE

Cabo Verde is characterized by the youthfulness of its young population (68.7% of the population is under 30 years of age), by a relatively high average annual growth rate (2.4% during the 1990-2000 period) and by the increasingly imbalanced geographic distribution among the nine inhabited islands.

This imbalance is the result of the strong internal migrant flow directed to the urban centres, namely to the cities of Praia (an average flow of about 3.500 people/year between 1990 and 2000) and Mindelo (1.700 people/year) and to the island of Sal (whose population doubled in ten years).

This migration, under the form of rural exodus, results in an accentuated urbanization process in almost all islands, with all its implications in terms of housing, sanitation, access to drinking water and other basic social services. Thus, according to the 2000 Census, more than half (58 %) of the urban population disposes of its wastewater in their surroundings or out in the nature, while only 38 % have access to running water.

Increased port activities will entrain development of related activities (logistics, SMEs) implying a greater demand for land. In terms of induced employment, a population increase is probable, with a resulting increase in demand for housing in the city of Praia and its surrounding area. Development of port activities will contribute, in particular, to an acceleration in the urbanization in the sector in the direction of the airport and to the East.

The Plano Director Municipal (PDM − municipal master plan) establishes land use for the coming decade (housing areas, activities areas, public amenity areas, undeveloped areas). After several years of preparation, the municipality of Praia should now see to the drafting of a final version of the PDM in the near future, to its approval via the appropriate channels and to its application in accordance with the rules, to control the various forms of settlement and uses of the territory.

# F. IDENTIFICATION OF MITIGATION & COMPENSATION MEASURES AND MONITORING PROGRAMME

# 1. GENERAL MITIGATION MEASURES DURING THE CONSTRUCTION PERIOD

This chapter 1 details all the measures intended to eliminate or reduce the environmentally damaging effects of the project during the general works and the various construction works.

The measures indicated in italics and signaled by an arrow ➔ are measures already recommended in the environmental impact assessment.

Particular measures relative to the three main construction works (quay n° 2 complex, cargo village and connecting road) are detailed in chapters 3, 4 and 5 of this section.

## 1.1. SITE MANAGEMENT

The areas concerned are:

- The various work sites (quay n° 2, cargo village and access road).
- Temporary or permanent access roads, parking areas, material storage areas, dumps, quarries, etc.
- Contractors' facilities site, other temporary living areas.

### 1.1.1. Site selection

**Objectives**

- Avoid destroying or damaging an environmentally sensitive site.
- Minimize the social impacts (expropriation).
- Minimize the visual and landscape impacts.

**Actions**

- The construction of temporary or permanent access roads must be minimized and existing roads used insofar as possible.

  ➔ *It is planned to use as the main service road the airport access road and, once it is in service, the ring road (direct serving of the quarries to the North of Praia). On the work site area, existing unpaved tracks shall be used in priority.*

- When new access ways are necessary, their layout must be defined taking into account their direct environmental impact and the fact that these new roads may potentially facilitate access to hitherto preserved natural areas;

➔ *If provisional accesses are provided, they shall be created in the locations planned for the roads serving the activities zone in conformity with the master plan (town planning and roads) of the PDM (Plano Director Municipal).*

### 1.1.2. Site preparation

**Objectives**

- Minimize the surface area concerned and hence the impacts on the local flora and fauna.
- Minimize erosion and respect the hydraulic transparency.

**Actions**

- Before beginning any construction activity, detailed plans of the different sites (construction sites, contractor facility sites, access roads, temporary or permanent storage areas, etc.) must have been drawn up.

***Protection***

- Do not uproot any vegetation unless strictly necessary; the areas to be left intact must be clearly delimited.
- Before starting clearing and excavation activities, any rare or endangered plant species identified at the impact study stage must be transplanted to a protected area. If necessary, a wild species displacement programme will be implemented before starting excavations.

  ➔ *The impact study did not evidence any protected plant species on the cargo village site (only one protected species was found at the top of the cliff which will be unaffected by the works). An inventory of the flora on the sites on either side of the airport road used for the contractors' facilities and temporary stocking of excavated material must be drawn up to determine the situation there.*
- It is good practice to leave unbroken vegetation corridors that interlink the remaining natural spaces to enable animal species to leave the area during the preparation phase.

  ➔ *Given the biogeographical conditions, there are no vegetation corridors. The most sensitive areas are the thalwegs (ribeiras) and their banks, which must be left intact (no filling in or using the river beds for traffic movements during dry periods).*
- If the construction site is close to ecologically sensitive areas, it is recommended to create buffer zones to minimize the impact on the areas to preserve; these zones must be clearly identified on the drawings and access to them prohibited (fencing or other means).

  ➔ *Access to the top of the cliffs between the port and the Ponta da Visconde shall be prohibited.*

***Site excavation***

➔ *Prior to the leveling work, the ground shall be thoroughly cleaned of the waste present (unauthorized wasted dumped, inert waste).*

### *Management of the topsoil*

- Remove the topsoil and store it for reuse on slopes before planting operations.
- The storage site must ensure suitable conservation and in particular minimize the risks of retaining moisture, erosion, or exposure to dust.

### *Erosion management*

- Erosion-prone areas[1] must be identified and, if possible, no work shall be carried out on them.
- It is recommended, depending on local characteristics, to limit works in erosion-prone areas to the dry season.
- Gradients that are modified during the construction must be stabilized to prevent rill erosion.
- Vehicle traffic and other activities on the stabilized zones must be controlled.

➔ *The erosion-prone areas are essentially the banks of the thalwegs. The works will lead to the construction of slopes (cargo village, road section on the plateau). The slopes must be stabilized (berm systems, planting, for instance with* Aloe Vera*). The movement of site machines and vehicles shall be prohibited in the thalweg beds and on the banks.*

### *Demolition work*

- For the demolition of the quay 2 hangars and the laying of the foundation course, the responsibilities regarding decontamination must be explained in the contract documents.
- The demolition waste must be sorted and eliminated so as to minimize the overall volume (potential reuse) and any contamination by hazardous waste.

  ➔ *See chapter 3 of this section F for more details.*

[1] Erosion-sensitive areas: areas less than 30 m from the banks of natural thalwegs, embankment slopes, gradients > 20%.

### 1.1.3. Site clean-up / landscaping

**Objectives**

- Clean up the areas affected by the construction and replant with species adapted to the local ecosystem.
- Minimize the visual impact.

**Actions**

- Maximize the reuse of inert construction waste in the works, notably as fill for the lower part of the connecting road, in order to reduce disposal volumes.

***Revegetation***

- The topsoil and vegetation removed during the construction phase must be used in the landscaping of the site whenever possible.

➔ *The topsoils of the Cargo Village are characterized by the low levels of organic matter and life. Nonetheless, the superficial horizon constituting the "vegetable soil" must be carefully stripped and stocked in an approved place to that it can be reused later for the stabilization and planting of the fills and embankments.*

- The spaces not directly occupied by the infrastructures must be replanted as quickly as possible.
- Local and hardy species must be used for the revegetation.

➔ *Chapter 4 of this section provides a list of plant species recommended for the stabilization of areas susceptible to erosion and for the landscaping.*

- The revegetated areas must be monitored regularly during and after the construction period, and if the ground cover is considered insufficient, a new revegetation programme must be implemented until a satisfactory level of ground cover is obtained.
- The revegetated and erosion-prone areas must be monitored and looked after during the period of commercial operation.

***Landscaping***

- It is recommended that the revegetation and landscaping be carried out with a view to ensuring the harmonious integration of the site and infrastructures in the landscape.
- In a dry climate, the landscaping work must minimize irrigation needs and maximize the absorption of runoff water.

➔ *A landscape architect is involved in the design of the cargo village. It is planned to keep natural plots within the cargo village that will be planted with local plants that require very little watering, given that saving water is of prime importance in the construction and operation of the project.*

### 1.1.4. Safety

**Objectives**

- Ensure the safety of the site, minimize nuisance factors.

**Actions**

***Safety***

- Delimit the construction areas; put up temporary and/or permanent fences, limit site access to authorized persons only.
- Put in place a procedure for temporary site closure if necessary (security, storage of hazardous materials, etc.).
- Control access of construction personnel to the natural areas near the site.

➔ *Sensitive areas, particularly for the avifauna, such as the cliff-tops and surrounding area between the port and Ponta da Visconde, and the thalwegs, must be prohibited to human access.*

### 1.1.5. Cultural heritage and landscape

**Objectives**

- Protect the cultural heritage that might exist on the site.
- Minimize the visual impact.

**Actions**

***Cultural heritage***

➔ *The impact study on the land sector only identified one site of historical interest. The Arriba da Mulher Branca, overlooking the present port, was the site of a defense battery that operated until the end of the 18$^{th}$ century. This feature was not preserved and so there are no remains to be found.*

*In the event of a potential discovery of archaeological or historical remains on the sites on which excavations will be carried out, essentially the cargo village, survey or salvage excavation should be carried out in order to protect the underwater cultural heritage potentially affected. The following shall be specified: the methods of notifying the discovery, the intervention of experts, the criteria for temporary work stoppage, the respective roles and responsibilities of the project owner, the contractors and the national authorities in charge of the cultural heritage (Ministry of Culture, Institute of Research on the Cultural Heritage.*

***Visual impact***

It is recommended that the contractor's site organization and infrastructure positioning should minimize the visual impact. The implementation of attenuation measures such as choosing construction materials or infrastructure colors that allow better integration into the local environment is considered to be a good practice.

## 1.2. MANAGEMENT OF CONSTRUCTION MATERIALS

### 1.2.1. Quarries and borrow areas

**Objectives**

- Identify and manage the environmental impacts associated with the location of the quarries and borrow areas.
- Ensure that the borrow areas are closed and rehabilitated after exploitation.

**Actions**

- The various quarries and borrow areas used by the project must be clearly identified upon commencement of the works.
- The sites are selected taking into account the land usage in the neighboring areas, and the natural and cultural resources potentially affected by the working of the quarry.

  ➔ *A specific study inventoried the quarries potentially usable for the project, compared their advantages and drawbacks, and examined their conformity with environmental regulations. Three quarries were investigated in the vicinity of Praia: the ITP quarry in Sao Francisco, the Polinertes quarry and the CVC quarry, north of Praia, close to the Assomada road.*
- Minimizing of the impacts associated with quarrying on the air quality (dust in particular), the water resources (water runoff), noise levels and the sensitive natural environments.

  ➔ *Mitigating measures have been defined for each of the 3 selected quarries, all of which are in operation: upgrading of the environmental measures with respect to the current situation and with respect to the situation of quarrying in connection with the project*.

***Rehabilitation measures***

A rehabilitation plan after closure of the quarries must be prepared and cover the following aspects

- Restoring to initial condition in order to recreate insofar as possible the development conditions of the pre-existing ecosystem.
- Management of the runoff water and prevention of negative impacts on the quality of neighboring water courses.
- Revegetation with local species with the aim of limiting erosion and encouraging the development of an autonomous ecosystem.

➔ *Recommendations are made for the selected quarries rehabilitation plan.*

### 1.2.2. Management of materials

**Objectives**

- Ensure that the materials are used such that the risk for the health of the workers and the environmental impacts are minimized.
- Limit the risks of leaks or spillage leading to potential contamination of the soils, groundwater and surface water.

**Actions**

***Hazardous substances***

- All hazardous substances must be clearly labeled as such.
- Any chemical product or waste considered to be hazardous must be registered so that the quantities stocked, used and/or generated can be tracked.
- It is recommended that the materials used contain neither lead nor asbestos.
- Transformers or other equipment containing PCBs (polychlorobiphenyls) must not be used on the site.

***Handling***

- The workers concerned must be trained in the handling of hazardous materials.
- Explosives must be stocked under lock and key in a place of restricted access.
- The schedules of large convoys of hazardous substances must be indicated in advance. It is recommended for such transport to be carried out during low-traffic periods.
- Concrete must not be prepared directly on the ground or in the immediate vicinity of a water course.

➔ *Recommendations concerning concrete production (concrete mixing plant) are made in the impact study*:

- It is recommended that the loading and unloading of materials be carried out in specific areas equipped with a retention system capable of confining any accidental spillage.
- Refueling areas must be protected to prevent contamination of the ground.
- Materials must be satisfactorily contained during transport. The transported loads, particularly when they consist of sand, gravel, waste, and notably demolition waste, bags of cement, etc., must be covered.

***Storage of materials***

- Any area for the storage of construction materials must be located and designed so as to minimize the risks of leaks, spillage and contamination of soils and of groundwater and surface water.
- Insofar as possible, the materials must not be stored near environmentally sensitive or potentially floodable areas.

- Tanks and other material storage facilities that could be subject to leakage must be placed on retention lagoons. Fuel tanks must also be provided with retention systems capable of collecting at least 110% of the volume of the largest tank. Tanks containing fuel must have a lid and remain closed. Used oils must be stocked in a dedicated place on the site, before being sent to a predetermined place for disposal.
- Containers and tanks must be tested regularly to prevent any risk of leakage.

## 1.3. MANAGEMENT OF LEAKS AND SPILLAGES

**Objective**

If accidental leakage or spillage should occur in spite of the prevention efforts, minimize the environmental impact through actions aiming first at confining and then cleaning up the pollution.

For information, the order of the actions to perform in the event of an accident of this type is as follows:

- give first aid to any injured person(s);

- prevent any further risk to persons by evacuating the zone if necessary;

- prevent any environmental impact by using confining, absorbent or other materials;

- give notification of the accident – to be defined in the framework of an environmental management system;

- clean up the spilled/leaked product;

- restore the affected area to initial condition;

- give notification of restoring to initial condition.

**Actions**

- All the site machine repair shops must have an impermeable floor with a hydrocarbon retention system.
- Pumps, compressors and other static equipment must be placed on retention lagoons, which must be emptied and cleaned regularly.
- All vehicles and equipment must be regularly overhauled.
- Apart from emergency repair situations, oil and other lubricant changes and refueling must only be carried out in the areas provided for that purpose.
- The absorbent materials designed to limit the environmental impact in case of leakage must be available on the site and in sufficient quantities at all times.
- The spilled fuel, the soiled sand or earth used to soak up the spillage, and any other contaminated material must follow the hazardous waste disposal channel.
- The use of vegetable shuttering oil shall be favored and the quantities used limited to the strict necessary.

## 1.4. WATER MANAGEMENT

### 1.4.1. Water consumption

**Objective**

- Minimize the water volumes consumed.

**Actions**

- Implement water conservation measures (including wastewater recycling).
- In situations where water is scarce, ensure that the consumption of the site will not lead to significant cuts for other potential users or, if it does, that any notable impact directly related to the work site will be compensated.

➔ *Given the situation of Cape Verde, where economizing water is a major issue, the contractor will have to justify the processes used in the construction activities that consume the most water (concrete mixing plant, washing of machines), evaluate the volumes consumed and indicate the specific reduction measures to be used.*

➔ *It is recommended to choose taps with diffused jet to save water to be installed in all the buildings of the Cargo Village.*

### 1.4.2. Management of wastewater and runoff water

The wastewater discharged by the site could include:

- domestic wastewater;

- water pumped from the groundwater sheet or used in the construction processes (which can be very heavily loaded with materials in suspension);

- runoff water coming from storage areas, workshops, vehicle servicing and washing, concrete mixing plants,

- rainwater.

**Objectives**

- Minimize the contamination of runoff water and ultimately of the surface water and groundwater.
- Ensure that the site wastewater discharged into the thalwegs meets the standards in effect.
- Limit erosion.

**Actions**

- Toilets equipped with a water treatment system adapted to the local situation must be present in sufficient numbers on the works site and on the site reserved contractors' facilities.

- The domestic wastewater must be treated on site or emptied periodically with a view to future treatment, or be discharged into the municipal sewer system.
- The site activities that produce wastewater (depots, shops, equipment washing areas, concrete mixing plants) must be positioned on the site so as to minimize the risks of groundwater pollution; water runoff from these areas must be channeled and treated in an appropriate manner (oil separator, settling basins, etc.).

  ➔ *It is required to create provisional settling basins for the water loaded with suspended matter, such as the water from the concrete mixing plant or from the washing of the site machines. After a night of settling the clear water is recycled for reuse in the concrete mixing process and the concrete is disposed in a skip for inert rubble.*

- The natural water runoff must be diverted from the work site as much as possible, and channeled if necessary.

  ➔ *For the cargo village it is planned to have a stormwater drainage system to channel the rainwater, particularly during flood episodes. Settling basins and hydrocarbon treatment basins are also to be provided to treat the chronic pollution during the subsequent operation of the structures. This drainage system will be partly developed during the period of site work to collect and pre-treat the site runoff water.*

### 1.4.3. Protection of groundwater

**Objective**

- Minimize the impact on the quality of the groundwater.

**Actions**

- The levels of the groundwater must be monitored during the excavation of the terrains (cargo village), and during and after the work in order to make a full evaluation of the impacts on the groundwater regime.
- It is recommended to monitor the evolution of the groundwater quality (in a few selected boreholes), with respect to the impact of the wastewater from work site or specifically the nitrate concentrations if explosives have been used.

### 1.4.4. Thalweg crossings

**Objective**

- Minimize the erosion and sedimentation, obstruction of the river beds and pollution by hydrocarbons.

**Actions**

- The flood levels must be determined before the start of construction in order to ensure that the risks are managed appropriately.

- If the water course is natural, it is recommended to restore its initial geomorphology after completion of the works.
- Particular attention must be paid to the prevention of any contamination of the river by runoff water loaded with sediments.

➔ *The situation of the surface drainage network of Cape Verde is particular because of the dry tropical climate and the strong rainfall deficit. (The rainy season is from August to November in the south). A detailed hydraulic study enabled the project flows to be defined and the rainwater drainage and crossing structures of existing thalwegs (ribeiras) to be dimensioned accordingly.*

*Furthermore, the impact study highlights the need to not erode the banks of these thalwegs, to only discharge treated effluent into them (during rainy periods) and to put in place a waste collection system to prevent these water courses from becoming waste dumps as is common practice in Cape Verde.*

## 1.5. MANAGEMENT OF ATMOSPHERIC EMISSIONS

**Objectives**

- Minimize the impacts of the dust produced by the site on the neighboring populations.
- Ensure by regular maintenance that the atmospheric emissions produced by the site equipment (macadam mixing plant, exhaust gases from site machines and trucks transporting materials) comply with local and international standards.

**Actions**

- Each vehicle must undergo regular inspection to adjust the engines with respect to the atmospheric pollutants they emit.
- The volumes of dust raised by the vehicles on the dirt tracks must be minimized by implementing traffic control measures (limiting the speed of vehicles, traffic volumes, etc.).
- The materials liable to produce dust during their transportation or storage must be covered.
- If necessary, and if appropriate with respect to water availability in the area, the dirt tracks must be sprayed with water and the vehicles regularly cleaned.
- If the site is characterized by strong winds, the activities most likely to raise dust must be scheduled in the light of the weather forecasts.
- It is good practice to implement an atmospheric emissions monitoring programme during the activities most likely to produce dust.

  ➔ *Cape Verde is characterized by regular North-East trade winds. In view of the nature of the top soils, these winds naturally raise dust virtually permanently when their speed is moderate to strong. This must be taken into account by the site, which adds further sources of dust (bother to the local population and the workmen). Trucks carrying loads of fine-particle substances shall always be covered with a tarpaulin or closed. With regard to water savings, the dirt tracks shall not be sprayed but shall be compacted regularly. In certain conditions, the settled water and the vehicle washing water, if it does not contain hydrocarbons, could be recovered and used to spray the tracks.*

## 1.6. MANAGEMENT OF SOLID WASTE

### Objectives

- Minimize waste production.
- Maximize the development of internal and external recycling of materials.
- Minimize the volume of solid waste disposed of to landfill.

### Actions

- The work site, the contractors' facilities and the other sites (access roads, storage sites, etc.) must be kept clean at all times.
- Waste incineration, burial or dumping on the site is prohibited.
- Uncontrolled dumping must be discouraged by providing suitable containers that are emptied regularly.
- Opportunities for reuse and recycling must be sought as a matter of course.
- At-source separation must be implemented, for example by assigning a particular area for that purpose, where the different types of waste can be brought in and sorted (site waste sorting area).
- The site waste sorting areas shall include: a skip for wood and green waste, a skip for paper and cardboard, a skip for non-ferrous metals and storage of iron, a skip for harmless industrial waste, a skip for plaster, and a skip for concrete, cement, masonry and bricks.
- The site waste sorting areas must be protected from the elements and rodents, and be inspected frequently.
- The final destinations of the waste (dumps, landfill) if they already exist, must comply with local and international standards. Treatment and reuse/recycling processes shall be sought locally for each type of waste.

| Type of waste | Treatment and reuse/recycling processes |
|---|---|
| Concretes and inert rubble | Crushing, sorting, sizing |
| Metallic waste | Scrap metal dealer |
| Green waste | Composting |
| Paints and varnish | Sorting and incineration or disposal in class I waste disposal site |

*Class I waste disposal site*: for special industrial waste (that is dangerous for the natural environment or living beings).

*Class II waste disposal site*: for urban waste and/or harmless industrial waste.

*Class III waste disposal site*: for inert waste from the building industry or public works for example.

➔ *It is noted that Cape Verde does not have at present the capacity for recycling this type of wastes. A part of inert wastes should be dumped in the Praia dumping area. However it is proposed that the to ship construction waste, towards a foreign port equipped for waste recycling (almost all containers are shipped back empty from Praia). This solution could be adopted for the operation waste, especially dunnage from the future Cargo Village Container Freight Stations*

➔ *The demolition of the Quay No. 2 hangars requires selective deconstruction and sorting of the various materials before valorization, treatment or confinement.*

***Management of excavated material***

- The excavated material must be eliminated in a manner that minimizes their environmental impact in terms of erosion, production of dust and visual impact.
- The reuse of excavated material must be maximized in the landscaping of the site.

➔ *Some 200,000 to 300,000 $m^3$ of excavated material coming from the cargo village site have to be temporarily stockpiled on a ground near the Cargo Village. The stockpiling must be organized without obstructing the flow of runoff water. To achieve this, stockpiling must not be done in a single depot but in several depots separated from each other by drainage ditches running parallel to the general direction of flow of the area.*

## 1.7. MANAGEMENT OF NUISANCE FACTORS

### 1.7.1. Management of transport and its impacts on local traffic

**Objective**

- Minimize the congestion and risks for the other road users.
- Minimize the damage to the road infrastructures and existing buildings resulting from the passage of heavy vehicles.

**Actions**

*To be implemented on all the roads specific to the site and to the public roads:*

- The speed limits must be strictly enforced and checked.
- The transportation of large loads and hazardous materials must be avoided during peak traffic hours.
- Vehicles must not be overloaded.
- The use of horns must be limited to emergency situations.
- The roads must be cleaned regularly to remove the dust and mud deposited by the site vehicles.

➔ *All transport trucks shall be subject to a technical inspection (braking system, condition of tires, signaling equipment, pollution emissions). Heavy vehicle drivers shall receive prior training in the specific risks. Special signs shall be erected at dangerous* *points on the itinerary (quarry exits, site entrances). An inventory of the condition of the roads shall be drawn up in the presence of all the parties concerned at the start of the works for all the public roads used. The Contractor will be responsible for repairing and rehabilitating any road damage.*

### 1.7.2. Management of noise and vibrations

**Objectives**

- Minimize the nuisance and site noise in particular.
- It is recommended that the noise levels measured by the closest receivers beyond the limits of the site should comply with the following standards.

Noise levels (Portuguese Decreto-Lei n°9/2007)

| **Noise indicator** | **Noise Limit levels dB(A)** | | |
|---|---|---|---|
| | Mixing areas | Sensitive areas | Without classification |
| **Lden** | 65 | 55 | 63 |
| **Ln** | 55 | 45 | 53 |

**Lden** is the day-evening-night noise indicator, in decibels (dB)A

**Ln = Lnight** is the A-weighted long-term average sound level as defined in ISO 1996-2: 1987, determined over all the night periods of a year ;

**Day** covers the period 07:00 – 20:00 hours in any 24 hour period;

**Evening** covers the period 20:00 – 23:00 hours in any 24 hour period;

**Night** covers the period 23:00 – 07:00 hours in any 24 hour period;

**Actions**

- The equipment must be properly maintained (lubrication, etc.) to limit noise emissions.
- Appropriate equipment designed to limit noise must be put in place if necessary (silencers, coatings, barriers, etc.).
- If possible, static noise-generating equipment such as pumps, generators, compressors, etc. must be positioned as far as possible from the inhabited zones or sensitive ecosystems and/or in a sheltered area (buildings in the course of construction for example).
- Noisy activities must, insofar as possible, only be carried out during the periods that cause the least disturbance to the neighboring environment (for example, during working hours in a residential area).
- A schedule must be drawn up for the noisy activities (pneumatic drills, boring machines, use of explosives, etc.) if the construction work is near a residential area.

- The inhabitants of the neighboring buildings must be informed at least 24 hours before any activity involving the use of explosives is carried out.
- A monitoring programme must be implemented to measure the noise levels at a few key points around the site (before and during construction).

➔ *The various construction sites are far from particularly sensitive environments (schools, hospitals, residential areas, etc.). The nearest buildings are those of the commercial and trade activities zones on either side of the site of the facility and the various work sites. The noisiest equipment could be placed at the centre or the west of the terrain (installation zone).*

*Any static noisy equipment shall be prohibited near the natural cliff areas between the port and Ponta da Visconde. It is recommended that the access road construction work be limited to daytime hours to avoid disturbing the avifauna during the night, in the vicinity of the marine cliffs (negative effects caused by the frequentation, the noise and the lighting).*

- If necessary, the buildings situated near the sites where explosives are used must be examined, and any existing cracks recorded; monitoring actions must be implemented if necessary.

➔ *If explosives are used for rock excavation in certain parts of the Cargo Village terrain, an expert appraisal of the risks associated with the existence of the liquid and gas fuel storage tanks (SHELL and ENACOL) shall be carried out beforehand. This appraisal must give a verdict on the feasibility of using explosives, on the technical nature of the explosives (micro-charges, minimum permissible particle velocity) and on the safety and environmental conditions in which they can be used.*

### 1.7.3. Management of night lighting

**Objective**

- Minimize the impact while maintaining an adequate level of safety.

**Actions**

- Ensure that the lighting put in place does not risk interfering with the existing signaling lights, and that it is not a source of reasonably avoidable nuisance for the communities and the environment.

➔ *The lighting of the installation site and of the various work sites will take account of the recommendations of the airport authorities (site in the axis of the international airport runway) and of the municipal amenities department as regards road safety (risk of dazzling). The installation of systems along the length of the airport to reduce the dazzling of car drivers may be envisaged (for example if a road internal to the site used by trucks at night-time runs parallel with the public highway.*

*Furthermore, for the port access road construction site, illumination of the cliffs will be prohibited to avoid disturbing the avifauna that frequents and/or nests on the cliffs.*

### 1.7.4. Other nuisance factors

**Objective**

Minimize nuisance for the neighboring communities.

**Actions**

- Permanent access to the neighboring properties must be provided.
- Cuts in the supply of essential services such as water or electricity must be minimized.
- In the residential and commercial areas, detailed schedules of the construction activities must be communicated to the residents and retailers, particularly if severe disturbance is anticipated.

➔ *In coordination with the representatives of the two areas of commercial and artisan activities situated on either side of the site, the project owner shall study the measures to allow permanent access to these areas during work on the site. These accesses must be independent of the roads and tracks for the site's own traffic. A provisional traffic plan shall be drawn up and submitted to the retailers' representatives for their opinion. This plan may change depending on the progress of the different work sites (e.g. change in directions of movement, extension of itinerary). If particular service roads or interchanges, even temporary, are developed, they must insofar as possible be located on the definitive rights of way reserved for the municipal road system in the PDM (Plano Director Municipal).*

## 1.8. CONTROLLING THE FIRE RISK AND EMERGENCY PROCEDURES

**Objective**

- Minimize the risk of fire or another major accident.
- Ensure that the consequences of any accidents remain minor and do not affect the environment.

**Actions**

- Standard fire prevention actions must be implemented, such as clear signaling of the prohibiting of smoking or other activities in risk areas (fuel and hazardous or polluting substance stores); the signaling texts shall be indicated in Portuguese, French and English at least.
- On-site incineration of used materials, vegetation, household or other waste is prohibited. Under exceptional circumstances which must be justified, fires may be authorized but must be strictly controlled.
- The use of open fires for cooking workmen's meals is prohibited.
- Fire-fighting equipment (fire extinguishers in particular) must be available at all times.

- A description of the emergency procedures including the names of the persons responsible for safety, emergency telephone numbers and reporting procedures must be available at several appropriate places on the site.

➔ *The project owner shall draw up a Fire-Fighting Plan and the emergency procedures in accordance with Cape Verde and international regulations, including more specifically casualties, fires and explosions.*

## 1.9. MANAGEMENT OF SOCIAL ISSUES

**Objective**

- Incorporate timely participatory and meaningful public consultation in the development of Compact-related Environmental Impact Assessment and Environmental Management Plans.
- Making these documents available ad easily accessible.

**Actions**

- The population consultation process must have started before the construction work commences. MCC's Environmental Guidelines requires that public participation is initiated at earlier stages during the development, of Compact-related EIA's and EMP's.
- During the construction period, the population of Praia and particularly the quarters nearest the site must be kept informed of the risks and nuisance associated with the ongoing activities. Dialogue must be maintained with the local population and the people neighboring the site during the construction period, with the aim of creating good relations with the project owner and the contractors.
- A system for handling complaints and conflicts shall be put in place and be operational during the construction period. Its aim is to receive the complaints from the local population and site neighbors concerning the risks and nuisance caused by the project and to facilitate the finding of solutions. The efforts made shall be adapted to the potential impacts of the project, from the designation of a person responsible for contacts with the local populations to the implementing of a formal complaints register.
- Land acquisitions must insofar as possible have been settled before the start of the construction work.

➔ *The consultation phase was initiated through discussions with key stakeholders last spring. In August 2007 a stakeholders conference, during which the main elements of the proposed investment and expected environmental impacts, was held in Praia that included the participation of representatives from national government, the municipality of Praia, NGO's and others. Comments were duly recorded in the minutes of this meeting. Further consultations were held with NGO's and other stakeholders subsequent to this meeting. The conference of 18 January 2008 in Praia also included various key stakeholders.*

➔ *The project is subject to a public inquiry on account of the Cape Verde regulations (Decree-Law n°29-2006, 6 March 2006). The impact study file shall be consultable by the public who will be able to make observations and comments on the inquiry register. On completion of the inquiry, the inquiry commission will give an opinion on the project,* *subject to the implementation of measures aiming at eliminating, reducing or compensating for the damaging effects of the project on the environment. The commission will be able to request complementary studies or add any pertinent and justified measure in the light of the public's remarks.*

*The project Employer / Beneficiary will appoint an environment / health / safety coordinator who will be responsible in particular for the verification of good conducting of the site work by the designated contractor. This coordinator will ensure :*

- *compliance with the instructions relative to the environment and the life space that the companies must respect.*
- *verification of the implementation of mitigating measures during the site works in collaboration with the public works contractors.*
- *The contacts between the project owner and the associations, the public, and the socioprofessional groups to resolve complaints and conflicts induced by the nuisance and bother caused by the different work sites. An operational cell will be functional throughout the construction works.*
- *The organization and implementation of monitoring during the site works and the subsequent operation of the structures.*

## 1.10. HEALTH MANAGEMENT / FIGHT AGAINST HIV-AIDS

### Objective

- Investing in the fight against HIV-AIDS in Africa for a successful poverty reduction through economic growth.
- Activities such as road and port construction, development of the tourism sector, may accelerate the pandemic expansion of AIDS. Potentially, some projects funded by MCC are likely to contribute to HIV-AIDS expansion; therefore MCA-Cabo Verde is undertaking to participate in the HIV-AIDS prevention campaign, in partnership with CCS-SIDA.
- Sensitization to workers through information, education and communication strategies will provide them the needed social skills to keep away the AIDS spectrum in their life style.

### Actions

MCA-CV intends to use a strategy to conduct an HIV-AIDS prevention campaign, simultaneously included in the Port Project lifetime and CCS-AIDS's works[2].

**➔ *Integration of MCA-CV in HIV-AIDS awareness campaign***

*The Contractor will comply with aiming at ensuring the completion of an HIV-AIDS sensitization campaign in the different work sites of the Port of Praia Modernization and Expansion Project.*

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[2] The cooperation agreement between MCA-CV and CCS/SIDA was materialized by a Protocol signed on July 3[r], 2006.

➔ ***Operationalization / Fine tuning with CCS/SIDA***

- *The Contractor will recruit an Expert in IEC (Information, Education, Communication) acceptable to CCS/SIDA.*
- *This Consultant, will primarily assist the Contractor to design and implement an HIV-AIDS Sensitization Plan, including :*
  - *Develop an Action Plan based on IEC, aiming at sensitizing the workers and local populations on HIV-AIDS.*
  - *Provide the access to prevention methods, in particular condoms, to workers and local communities.*
  - *Provide voluntary counseling and testing to workers and local communities.*
- *Funding of these activities is supported by the Contractor under the works contract funded by MCA-CV.*
- *CCS-SIDA Executive Secretariat will cooperate with MCA-CV to approve, monitor and evaluate the IEC plans presented by the contracted firms.*
- *The first information/sensitization activity will take place at the beginning of each of the works with a summary public presentation of the whole project.*
- *The Environmental Manager will be responsible for conducting the process and will articulate with the Infrastructure Project Manager, the Implementing Team, IEC Expert, CCS/SIDA focal person for MCA-CV, ENAPOR Environmental Specialist and Supervision. He/she will maintain monthly contact with the Focal person at CCS-SIDA level and visit at on a quarterly basis each of the work sites as to contact the entities responsible for execution, supervision and target-public.*
- *In the absence of the Environmental Manager, he/she will be replaced by the Port Project Manager or by any other person the Managing Director shall appoint at his discretion.*

# 2. MEASURES RELATIVE TO THE QUARRIES

Under the authorization procedures for operating the three quarries - the ITP quarry in Sao Francisco, the Polinertes quarry and the CVC quarry, north of Praia -, the **mitigation measures** are identified in the documents approved by – or produced by – the DGA. The mitigation measures are presented in section E.

Following are the main environmental impacts developed for the main quarries that are candidates for supplying materials for the Port of Praia project:[3]

- **Noise estimates** Noise levels at 1 meter from various types of heavy processing equipment has been measured. This allowed estimation of noise levels at a distance of up to 100 meters from the various sources. The report states that because of topography and vegetation, noise levels reduce rather rapidly. There would be, therefore, virtually no impacts offsite, and staff would only need earplugs when very close to operating machinery.
- **Dust** Dust generation is generally limited to the areas around the main processing equipment, and that dispersion of dust is limited. Dust collection equipment is used at the quarry sites. Nevertheless, no detailed study seems to have been done concerning the impacts of dust.
- **Visual impact** The reports confirm that the quarries are rather isolated and hidden, thus visual impacts are limited. As the extraction zone proceeds in the direction of this border, various impacts (visual, noise and dust) underline the importance of maintaining the permitted extent of quarry operations.
- **Flora and fauna** Impacts on flora and fauna are limited. Nevertheless, the EIAs do not appear to include a review of flora and fauna existing in the area of the quarries.
- **Occupational health and safety** The EIA reports list various aspects of quarry operations that pose health and safety risk for quarry workers: manipulation of explosives, equipment with high noise levels, insufficient warnings around the zone of exploitation, movement of heavy equipment in and around the area(s) of exploitation, production of dust and other atmospheric emissions, failure by operators to use protective equipment. Training by the quarry staff responsible for worker health and safety is recommended for quarry employees.

**Mitigation measures** are identified in various documents (Environmental Impact Assessments and others) approved or produced by the DGA under the authorization procedures for operating the three quarries - the ITP quarry in Sao Francisco, the Polinertes quarry and the CVC quarry, all north of Praia.

Mitigation measures for the expected principle impacts might include training of HGV drivers to induce reductions in driver delay, limit of hours of transport of quarry materials to reduce noise and impacts on traffic, and, as necessary, improved traffic management. Details are provided in the EAP.

[3] The EIAs are prerequisites for the DGA's environmental approval process with respect to the quarry operating permits.

# 3. MEASURES RELATIVE TO REMOVING OLD QUAYSIDE WAREHOUSES, REPAIRING QUAY N°2 AND REPAVING THE BACK-UP YARD

## 3.1. REMOVING OLD QUAYSIDE WAREHOUSES

The environmental impacts will be limited according to the following precautions :

- **Selective deconstruction** to separate the essential of the non-inert materials before the building is demolished. The prime contractor will audit the building to be demolished in order to identify the potentially recyclable materials and help develop recycling.
- **Sorting,** or rather non-mixing, implies organizing the worksite, informing and training the personnel. It requires having several skips on the site at the same time: skips reserved for given types of inert waste that can be recycled, and a skip for inert waste that cannot be recycled.
- To limit the raising of dust, the hangars will be sprayed with water as the demolition work progresses.
- Destination of demolition materials will be the following :

| | |
|---|---|
| **Inert waste** | Given the Cape Verde context, where recycling and valorization of inert waste from building sites and demolition work are not organized and are no specialized landfills, two means of disposal or valorization can be recommended:<br>▪ Reuse as filling material for the connecting road (lower section).<br>▪ Recycling to produce aggregate from crushed and screened rubble: these aggregates will be used for road bases, earthworks and concrete. It should nevertheless be noted that the recycled rubble must be of good quality: it must be free of wood, polystyrene, plastic and scrap metal. |
| **Ferrous metals** | The demolition shall be preceded by a removal phase during which the main metallic elements are extracted from the buildings. The metals will be sold to a scrap metal dealer. |
| **Asbestos-cement waste** | The full asbestos removal and conditioning processes will be handled by a certified environmental firm.<br>It is thus proposed to consider that asbestos cement elements will be shipped to Lisbon and disposed in an appropriate Portuguese dumping site (for details, refer to section E 4.2.3.) |

## 3.2. REPAIRING QUAY N°2

The repair of the quay will require demolition of certain sections of the quay facing. The pieces of concrete from such demolition work will be broken into small pieces and incorporated in the fill of the connecting road (lower section).

## 3.3. REPAVING THE BACK-UP YARD

### Removal of the capping layer

- The Contractor will carry out appropriate physical and chemical analysis of these materials on several samples before the work to determine the level of contamination.
- If these materials are not polluted, they will be reused as embankment material or possibly for making aggregates after screening. Reuse on other sites (access roads, maritime structures) has the advantage of avoiding the need to transport the materials away from the site and therefore reduces nuisance from transportation and energy consumption.
- If these materials are polluted, their reuse as embankment shall be made by wrapping them into impermeable sheets.

### Reuse of the old paving stones

These hand-dressed paving stones shall be reused to repair traditional roads on Santiago Island.

### Construction of an impervious retention area in case of accidental pollution

In the event that a container containing hazardous and polluting substances should leak, after an accidental fall for example, it is planned to equip the container reception area with an impervious reception area.

# 4. MEASURES RELATIVE TO THE CONSTRUCTION OF THE CARGO VILLAGE

**A number of developments or measures form an integral part of the project design. They have been integrated from the outset to eliminate or reduce the potential impacts.**

| | |
|---|---|
| **To prevent chronic and accidental pollution of water** | The project plans for the construction of a retention basin downstream of the cargo village. It will have a dual function :<br>▪ Collect the first stormwater, i.e. the water that washes out the impermeabilized areas and carries a concentrated polluting load at the start of the rainfall event. To avoid overloading the basin, an overflow will divert the little or unpolluted stormwater that follows on from the first storm run-off water.<br>▪ In dry weather, be able to contain accidental pollution (overturning of a tanker containing polluting substances, containment of fire extinguishing water). In this respect the settling basin will include a fixed and sealed retention area with a minimum volume of 30 $m^3$ for collecting an accidental pollution in dry weather. |
| **System for collecting and treating the solid waste** | The operator shall take all necessary measures in the design and operation of the facilities to ensure good management of the waste produced. The waste and residues produced will be stored before they are recycled or disposed of, under conditions that prevent any risks of pollution (prevention of washing out by stormwater, pollution of surface or ground water, airborne particles or odors). Temporary storage before waste recycling or disposal shall be ensured in the sealed retention tanks, with protection from stormwater if possible. |
| **Reducing the effects of illumination on fauna** | To limit the effects due to the illumination of the cargo village, sodium vapor lamps shall be used for the lighting masts. They attract insects to a lesser extent than mercury vapor lamps, whose ultra-violet radiation has a strong attracting effect on insects. |
| **High environmental quality for landscaping** | The impact on the landscape will be minimized by adopting a number of measures: architectural quality of the hangars (high environmental quality), creation on embankments and free spaces of plantations with local plant species adapted to the arid climate (*see below*), reuse of the local basalt paving stones for the vehicle parking areas. |

Família : Liliaceae

Babosa (*Aloe vera*)

Família : Agavaceae

Sisal/piteira (*Agave sisalana*)

Família: Leguminosae/Fabaceae/ Caesalpinioideae

Acacia-martins (*Parkinsonia aculeata*)

*From : Eng. Samuel GOMES, Centro de Estudos Geograficos, Loa*

Família: Agavaceae

Carrapato (*Furcraea gigantea*)

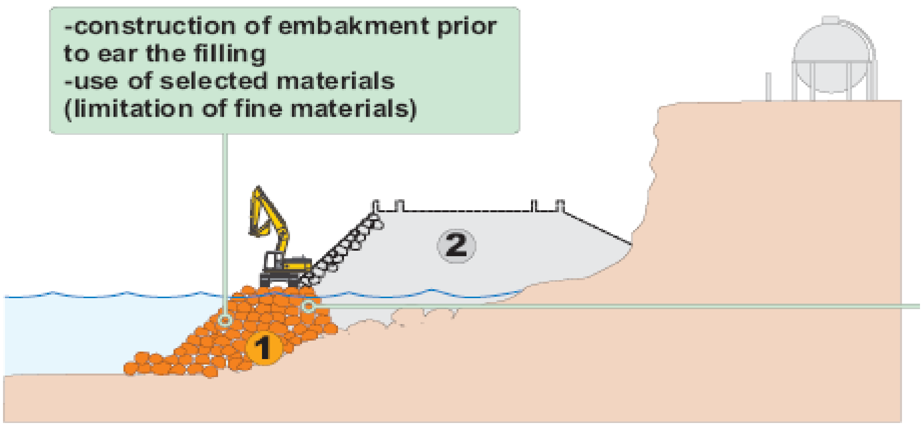
# 5. MEASURES RELATIVE TO THE CONSTRUCTION OF THE ACCESS ROAD

A number of developments or measures form an integral part of the project design. They have been integrated from the outset to eliminate or reduce the potential impacts.

## 5.1. REDUCTION OF IMPACT OF MATERIAL FILLING ON THE MARINE ENVIRONMENT AND LIFE (REDUCTION OF WATER TURBIDITY)

To avoid that aggregate materials will be washed out as soon as they come into contact with the seawater, the following measures shall also be adopted :

- The proposed way of reducing this risk is to first build the breakwater to provide protection against the swell, then to fill the volume between the breakwater and the foot of the cliff with aggregate materials. This solution will limit to a large extent the washing out of fine particulate materials and production of suspended particulate matter that temporarily increases the turbidity of the seawater. The large blocks used for the construction of the external breakwater will induce very little or even no suspended particulate matter.
- Either prior washing of the quarry materials the most heavily loaded with fine particles.
- And /or establish precise specifications for these materials in order to limit losses of materials and the generation of turbid plumes. It is thus recommended that in the 0/50 mm fraction of the materials, elements of dimensions exceeding 2 mm should represent 40 to 60 % of the 0/50 mm fraction and the particles smaller than 80 µm should represent less than 12 % of the 0/50 mm fraction. The mean grading range of the selected materials shall be submitted to the prime contractor for approval.
- Moreover, the real-time tracking of water turbidity during the works shall be made contractual (*refer to chapter on Monitoring*).



## 5.2. MEASURES TO REDUCE THE IMPACTS OF CONSOLIDATION OF THE CLIFF ON THE AVIAN FAUNA.

The geological appraisal of the cliff below which the road passes evidences the risk of rockfalls from the cliff and recommends protective measures : fitting a net to protect against falling rocks, a drainage system at the top of the cliff, consolidation of the limestone layer, filling of the cavities in the cliff. If such work is necessary to ensure the safety of traffic below the cliff, it also leads to an irreversible change of the biotope for the birds that frequent it, and notably the species that nest and reproduce there. The impact of the work itself, but above all the structural modifications brought to the cliff will result in the desertion of the recorded species.

To reduce this impact, the following measures have been adopted :

- To move the road away from the foot of the cliff with a sufficient margin to prevent boulders from falling onto the road platform.
- To leave the cliff in its natural state.

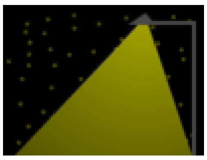
## 5.3. MEASURES TO REDUCE THE IMPACT OF ROAD TRAFFIC ON THE HYDRAULICS AND WATER QUALITY

The project plans:

- To use this ditch to contain accidental pollution in dry weather (spillage from a truck, large leak from a gas oil reservoir). The underground pipes would then be closed and the polluted effluent would be pumped.
- Periodic cleaning of the road to avoid the pavement being washed in heavy rain and carrying away concentrated pollution which would then find its way into the sea. The heavy vehicle traffic will cause chronic pollution: accumulation on the road surface of residues of unburned hydrocarbons, oil, particles from the wear of tires and brakes. To prevent these residues from being washed out and running into and polluting the sea, the principle will be to periodically clean the pavement (2 to 3 times a year during the dry period) using a motorized brush. Cleaning water would be drained into the ditch (with the outfall valves closed). The ditch would serve as a settling area. The sludge would be cleaned and evacuated before the rainy season.

## 5.4. MEASURES TAKEN TO LIMIT THE EFFECTS OF LIGHTING ON THE AVIAN FAUNA

Namely adapted lamps will be used suitably Sodium vapor lamps shall be used to reduce the attracting effect on insects, and therefore on potential predators (nocturnal birds and bats).



When the bulb is well concealed by the reflector and the diffuser (transparent part) is not prominent, all the light is directed downwards below the horizontal. For a distance, the light source is invisible from all directions.

# 6. COMPENSATORY MEASURES FOR AVIFAUNA

## 6.1. IMPACT ON AVIFAUNA

The construction and operation of the access road should induce direct and indirect effects on avifauna, especially the section of the road under the cliff.

The section of the road situated on the plateau and linking the cargo village to the coast under the cliff is subject to constraints: it is the shortest route between the cargo village and the cliff foot. As explained in section E, it is impossible to route the road via the top of the cliff for technical reasons (joining up the gradients at the port) and security associated with natural risks (instability of the cliff) and industrial risks (proximity of the hydrocarbon storage tanks and the butane spheres).

The construction, then the movement of heavy vehicles on the road (up to 100 vehicles/hour) will produce noise, vibration and exhaust gas discharges into the atmosphere by day and night. The road lighting will constitute an additional nuisance factor at night-time.

It is probable that the birds, and the nesting birds in particular, will desert the cliff for equivalent coastal sites that are not disturbed by human activities. The most seriously threatened species in this respect are *Phaeton aethereus* (Red-billed tropicbird, in Portuguese "Rabo de Junco") classified as an endangered species, and *Pandion haliaetus* (Osprey) considered as a rare species. These two birds are quite vulnerable and are on the Cabo Verde red list for species on the verge of extinction.

The Guincho doesn't really use the area for nesting, but does use it only for feeding. Once the connecting road is built, this species will probably have no problem finding sources of food in similar habitat nearby.

This situation is not the same for the Rabo de Junco. The Rabo de Junco is a migratory species, but is also on international red lists. It is protected under UICN (International Union for the Conservation of Nature and Natural Resources), CMS (Convention on Migratory Species) and CITIES (Convention on International Trade in Endangered Species of Wild Fauna and Flora).

In the project area the Rabo de Junco is currently threatened by local fishermen who like to catch young birds on the cliffs and to eat them (in the same area lots of cats do the same).

Three colonies of Rabo de Junco are known on Santiago island: that of Praia, between the port and the Punta Bicuda (where a large coastal tourism project is being developed), the Porto Mosquito colony and that of Tarrafal, in the north.

The Rabo de Junco is a sensitive species, and is likely to be negatively affected by the port project. The INIDA (*Instituto Nacional de Investigaçao E Desenvolvimento Agrario*), which participated in the field study[4] appended to the impact study, estimates that the project area harbors about 5 nests, that is to say 5 couples out of the 160 inventoried on the archipelago (3.1% of the population).

[4] Aline Rendall, José Maria Semedo, Samuel Fernandes Gomes. Biophysical Characterization of the Praia port expansion area. June 2007.

## 6.2. REDUCING MEASURES

- The road is proposed to be designed and built slightly away from the cliff to ensure the integrity of the cliff and protection of the nesting sites (5 to 10 m away from the cliff).
- The question of maximizing road construction activities outside of the period of reproduction of this species has been considered. The reproduction of this species takes place from September to June, with peak activity from January to May. Incubation (there is usually one egg per couple) lasts about 40 to 46 days, and is implemented by both parents. The fledgling stage normally occurs 12 or 13 weeks after hatching. This unfortunately leaves a very narrow window (July and August) for road construction activities. According to the planning of the works, the probability is weak to begin works in July and to complete high impact construction activities prior to the end of August (road construction will most likely start around September-October 2007 and end 6 to 7 months later).

## 6.3. COMPENSATING MEASURES

The above measures will not guarantee that individuals of the species will not be affected. Compensatory measures are therefore proposed.

- The possibility to ensure the protection of the habitat of Rabo de Junco, i.e. the area comprised between the port and the Ponta Bicuda. For the time being this cliff section is still more or less protected (except from "hunters"), but risks are increasing, notably due to the Punta Bicuda tourism project.

  The Municipality of Praia, through its PDM, considers that this cliff area should be protected but the PDM is not yet completed. Therefore the protection is not yet in force.

  Besides, according to the decree-law n°3-2003, the site does not meet all requirements for being classified as a "National Protected Zone" (Rede Nacional de Areas Protegidas).

  DGA is currently considering a possible action aiming at protected such zones.

  Considering the above, the official protection of that coastal section cannot be done immediately, and requires national-wide actions.

  However, it must be highlighted that, for port security reasons, the future connecting road will be fenced and equipped with video cameras (of Pan-Tilt-Zoom type). These devices will automatically discourage fishermen from hunting birds on the cliff front between the port and the cargo village.
- INIDA, together with DGA, is currently developing a national plan aimed at protected marine birds in Cape Verde. The plan will include wide information/incentive actions to minimize bird hunting. MCA-CV and/or ENAPOR should participate to that plan:
  - MCA-CV and/or ENAPOR should commit in information/incentive measures towards local fishermen likely to kill the Rabo de Junco. Incentive measures could include distribution of decorated T-shirts and caps.
  - MCA-CV and/or ENAPOR should also commit in information/incentive actions towards young people, inside schools, with videos, brochures and site visits to observe the beautiful birds.

## 6.4. MONITORING

It is recommended to arrange a monitoring of the Rabo de Junco population in the vicinity of the port of Praia.

In co-operation with INIDA, this monitoring would consist of periodic countings of the birds, say once a week. The ideal observation time is 15:00, when the Rabo de Junco comes back to the nest, after its daily fishing campaign (Rabo de Junco feeds with exocet flying fish). Once the construction works are over observations spacing could be only once per month, over a few years at the beginning of the new port operation period. But, again, INIDA must be associated, as their experts are the most qualified ones for such counting actions.

The road PTZ vide-cameras, under the control of ENAPOR, will help. They will allow watching the cliff from the port to the Ponta Visconda.

## 6.5. COST ESTIMATE

| Actions | Budget (USD) |
|---|---|
| Information/ Incentive campaigns for the attention of the local fishermen | 10,000 |
| Information/Incentive campaigns for the attention of local teenagers | 20,000 |
| Monitoring of the Rabo de Junco local colony during construction works and during the 5 following years | 25,000 |
| **Total Estimate** | **55,000** |

# 7. COMPENSATORY MEASURES FOR MARINE LIFE

## 7.1. IMPACTS

As was emphasized earlier, the area of the marine floor covered by the road foundation represents some 25,000 m². Over this surface area the hard substrate populations will be irreversibly destroyed. This concerns the populations characteristic of the supralittoral and strand stages: seaweed, molluscs - with predominance of gastropods -, crustaceans including the amphipods and fixed polychaetes. A variable portion of the large blocks will be covered by the embankment material, depriving the marine fauna of the shelter these blocks would have provided.

The immersed part of the external shell of the road protection will partly, but only partly, compensate for the loss of these habitats:

- The hard substrate populations will be reconstituted following the natural staging (supralittoral and strand stages), but on a lesser scale in view of the linearity of the road.
- The lower part of the blocks in the shallow waters will provide shelter for certain species of fish and crustaceans.

Marine structures of the Phase 2 (reclaimed container yard and breakwater) will have large footprints on the seabed and will therefore severely impact the bay biodiversity, much more than the Phase 1 road embankment.

From a social point of view the impacted population will be that of the local fishermen. In and around the bay of Praia, there is a small informal fishing activity comprising several communities of fishermen, many of whom are not registered as maritime professionals. Three fishing communities, Achada, Brazil and Tirachapeu, operate in the bay, involving about 100 fishermen who deserve a decent consideration.

A global compensatory measure must therefore be sought to compensate for this loss of biodiversity and halieutic production. The proposal consists in setting up artificial reefs for the benefit of these coastal fishermen.

## 7.2. ARTIFICIAL REEFS AS A COMPENSATION

The artificial reef project needs to be developed under the common action of the following parties:

- The 3 coastal fishermen communities.
- The INDP.
- The Praia Municipality.
- ENAPOR and MCA-CV.

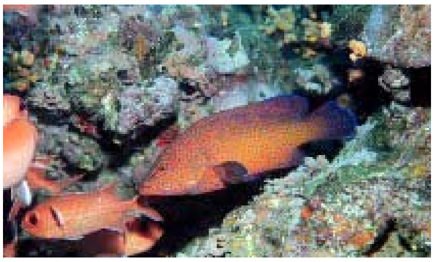
As far as possible the construction of the reefs should make use of easily-available elements such as broken or useless old Tetrapod units, pieces of concrete slabs etc.

An accurate and detailed knowledge of target species as well as of fishing techniques and means will be compulsory while designing the artificial reefs.

### 7.2.1. Target Species

These species include highly-valuable demersal species (living on the seabed) and all associated species, such as seaweed and specific fish, as follows:

1. Groupers *« garoupa »* & badèche « badejo » (Serranidae),



2. Lobsters

3. Sparidae

4. Red Carp (snapper)

5. Moray (Muraenidae)

### 7.2.2. Site Selection for the Reefs

Natural marine habitats for the above species are rocky seabeds such as those of the Santa Maria island and of shoals. Ideally they should have vertical fronts of a few meters high and be located in water depths of 10 to 30 m. Cavities are needed.

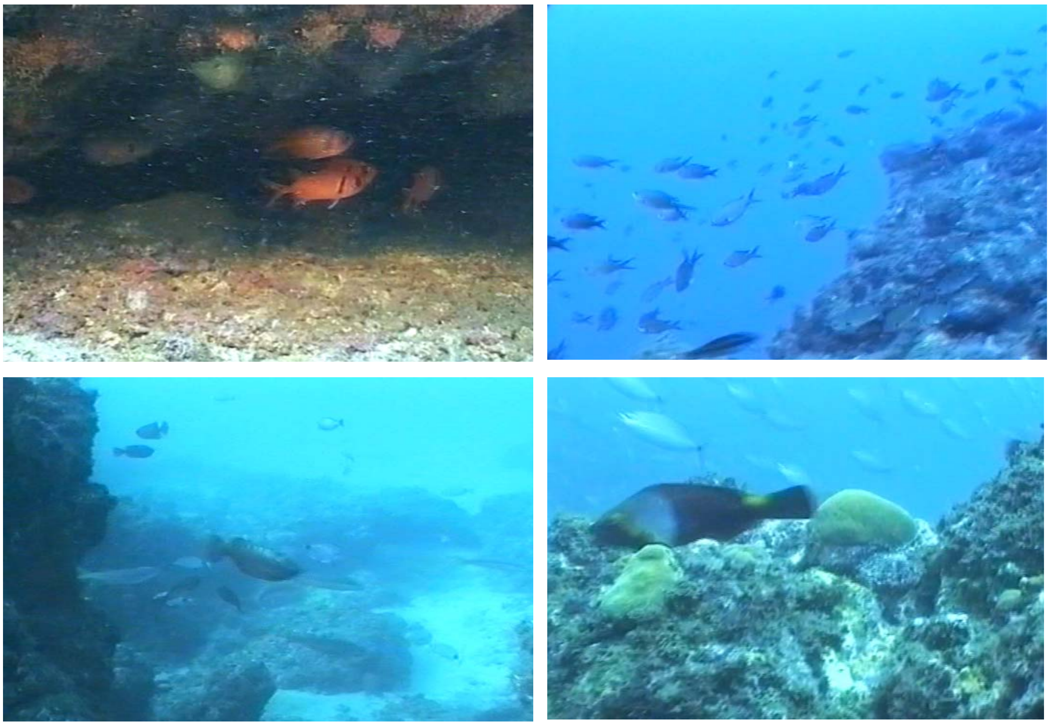


Figure 1. Examples of suitable seabeds around Santa Maria Island (IMAR, 2007)

Selection of sites for the reefs should take into account the following:

- The existing seabed types.
- The navigation channels and the ship anchorage areas.
- The distance from the port (coastal fishing boats cannot go far from the port).

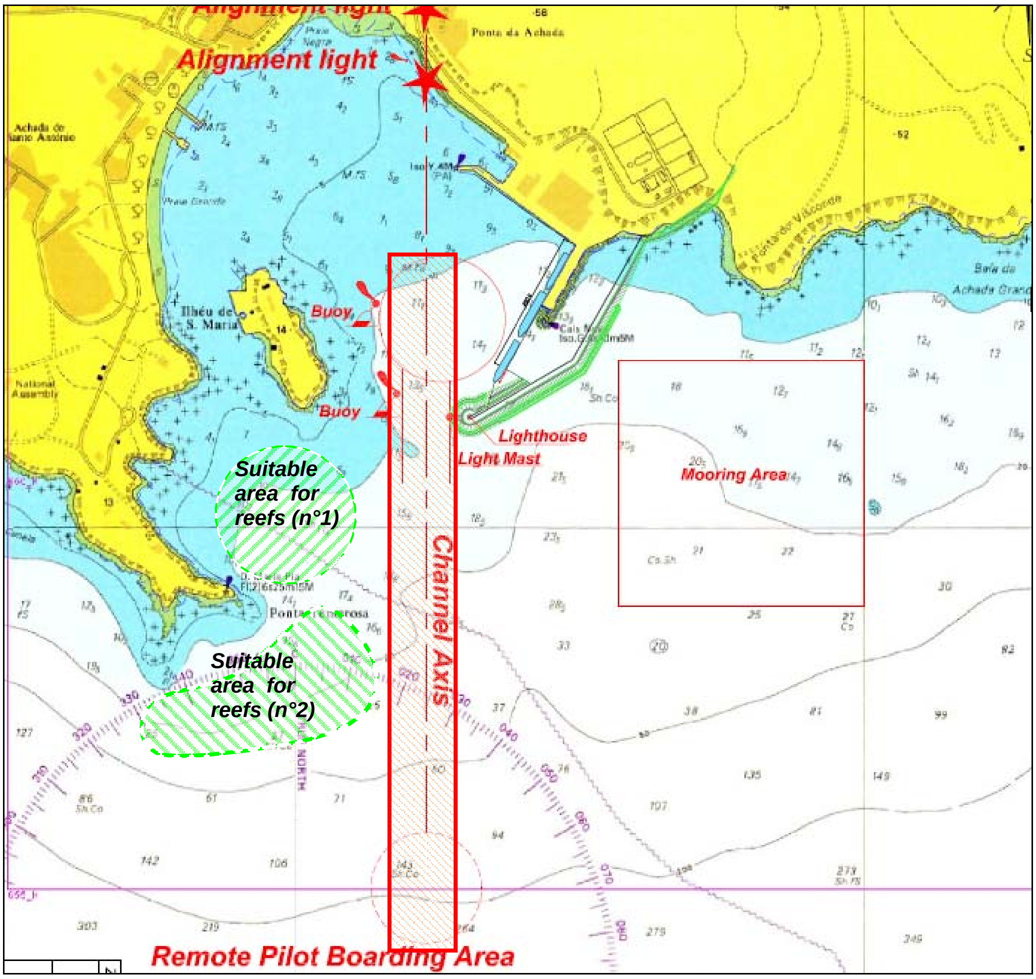



Figure 2. Locations of two potentially suitable sites for artificial reefs

Both proposed sites consider navigation conditions and are complementary in terms of environment. Site n°1 would better suit shallow water benthic species (reefs should be made of rather small elements, not higher than 3 m), whereas site n°2 would better suit deep water species (reefs should be made of bigger elements).

### 7.2.3. General proposals for reef structures

It is recommended to place the reefs on sandy sea-beds, next to rocky areas, to facilitate the approach of marine life.

**Table 1. Reef Details**

| | Details | Targets |
|---|---|---|
| **Chaotic shapes** | Protecting shadows / Hiding niches | Specific species |
| **Cavities** | Cavities dimensions between 0.1 and 1 m | Shelter, feeding and reproduction |
| **Suitable sites** | Sandy sea bottoms | Stability of reefs |
| **Site arrangements** | "Villages" made of piled blocks, minimum 3 m high, spacing about 100 m, connected by corridors of single blocks | Increase fishing areas and avoid conflicts<br>Ensure connection with natural sites |
| **Orientation** | Perpendicular to the prevailing currents (NE-SW) | Provide shelter from current |
| **Specific constraints** | As far as possible from shipping fairways and anchorage zones | Avoid interferences |

### 7.2.4. Recommended Structures

The following structures are recommended:

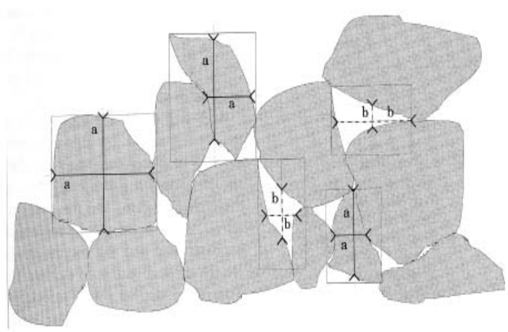
- **Quarry blocks and concrete armoring units (Core-Locs, Tetrapods – even broken units)**

Blocks may be zipped by meshes to make their handling easier.

Such habitats will especially attract red-fish, lobsters, morays and seabrems.

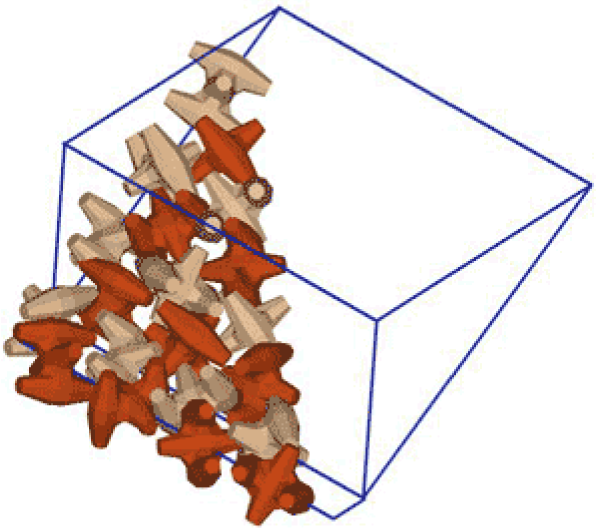
Their costs should be marginal, as they will be made of elements already foreseen for the needs of the port project.

**Figure 3. Chaotic arrangement of quarry blocks inside a steel net**



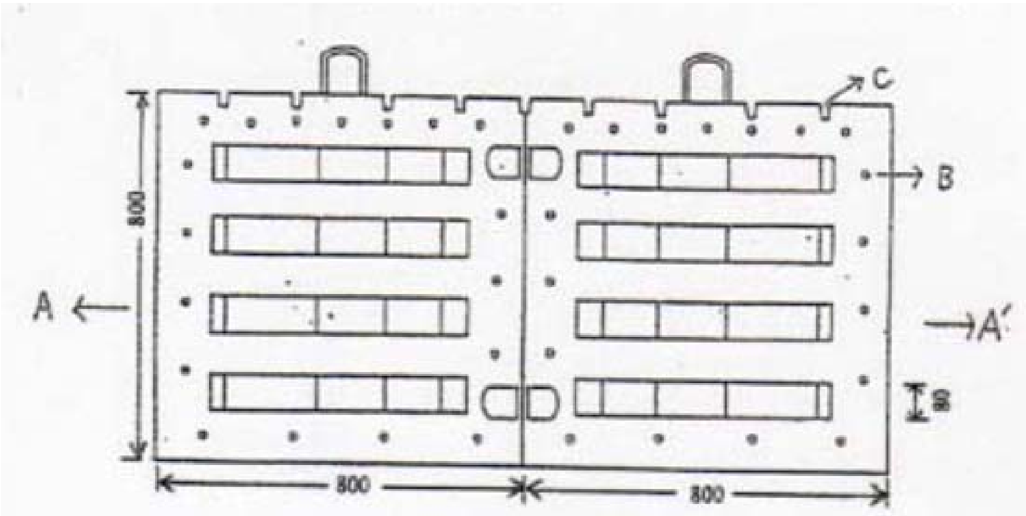

Amas constitué de 3 tailles principales de blocs : 0 ;5 t (0,70 m), 1-2 t (0,90-1,20 m)

**Figure 4. Chaotic arrangement of Core-Loc units**



- **Pre-cast elements for lobsters**

This type of reef should only be installed at a second stage, after some monitoring on the first experiments, notably a follow-up of fishing results on artificial reefs.




### 7.2.5. Fishing Activities on Reefs

Fishing activities on reefs should focus on lobsters, redfish, seabrems and morays, in agreement with the fishermen's opinion. Fishing techniques should consist of long lines, turning nets and traps.

### 7.2.6. Action Plan and Budget

The following action plan is proposed for the whole of the project, covering both phase 1 and phase 2. The phase 2 EIA will deepen the plan and its estimate.

| Action Steps | Budget (USD) |
|---|---|
| **1. Promoter Selection** | - |
| **2. Implementation Studies**<br>▪ Detailed site selection (this notably requires meetings with fishermen and diving surveys)<br>▪ Elaboration of structure positioning plans<br>▪ Elaboration of a reef management plan (species to be caught, fishing times etc.)<br>▪ Elaboration of a monitoring plan (to be implemented by INDP) | **50,000** |
| **3. Structural Designs and Preparation**<br>▪ Definition of materials to be used and related quantities<br>▪ Design of structures<br>▪ Assessment of required nautical and handling equipment<br>▪ On-land preparation | **40,000** |
| **4. Placement of Artificial Reefs at Sea (prel. est. 1,000 $m^3$)** | **70,000** |
| **5. Operational Phase**<br>▪ Fishermen training<br>▪ Procurement of fishing equipment<br>▪ Scientific follow up on a 5-year period (bio-diversity, fishing action and fishing results) | **40,000** |
| **Total** | **200,000.00** |

# 8. MONITORING PROGRAMME

ENAPOR, being the direct Project Beneficiary and the Port Operator, shall be the primary entity in terms of environmental management. In 2007 ENAPOR has appointed his own Environmental Officer. ENAPOR's Environmental Officer should be responsible for monitoring actions.

## 8.1. MONITORING PROGRAMME DURING THE WORKS IN PROGRESS

Environmental monitoring of the site will have the objective of monitoring application of the Environmental Management Plan during the works.

### 8.1.1. Monitoring of land environment

**Table D.1 Monitoring programme during works in progress : land environment**

| Type of monitoring and measurements | Stations / sampling | Frequency |
|---|---|---|
| **Water** | | |
| Measurement of the quality of wastewater: physico-chemical parameters (TSS, $O_2$, pH, $BOD_5$) | All the site effluents: wastewater (after purification treatment), washing water, stormwater | Every two weeks during the site works and according to particular events |
| Measurement of the quality of wastewater: heavy metals, PAH | Same as above plus effluent from the concrete and macadam mixing plants | Monthly and according to particular events |
| Measurement of the quality of the groundwater by piezometry (TSS, pH, PAH, bacteriology) | Preliminary measurement campaign before the works on the contractor's installation site (1 station), the cargo village (2 stations), and the excess excavated material stocking site (2 stations). | 6 months before the works, 1 measurement per month<br>Monthly measurements during the site works |
| **Noise** | | |
| Measurement of the ambient noise level over a 24-hour period | 5 measurement points: see map of measurement points drawn up for the analysis of the initial condition of the site. | 1 measurement per month and point measurements according to particular events |
| **Vibration** | | |
| Vibration measurement (particle velocities) during certain specific work, such as rock excavation using explosives | Concerns the excavation of the' cargo village site in relation with the proximity of the hydrocarbon storage sites | According to the need to excavate rocks. |

| | | |
|---|---|---|
| **Air quality / dust** | | |
| Measurement of air quality parameters over 24 h: $NO_x$, $SO_2$, CO, $CO_2$, Unburned hydrocarbons (HC) and $PM_{10}$ [5] | 1 station centered on the site<br>1 control station situated in the inhabited quarter of Achada Grande | Measurements on the control station for 6 months before starting the work (1 monthly measurement)<br>Monthly measures during the site works |
| Measurement of dust contents<br>(placing of filters for 24 h) | 1 station on the contractor facilities site, the cargo village site and the excess excavation material depot.<br>2 stations on the main road | Measures on a control station for 6 months before starting the work (1 monthly measurement)<br>Monthly measurement during the site works |
| **Landscape** | | |
| Photographic record showing the development of the landscape in relation to the execution of the different work sites | Photographs at 10 points characteristic of the local landscape | A series of monthly photographs |
| **Flora** | | |
| Prior inventory of the plant species identifying the rare, endemic and protected species | All the sites concerned by the project: contractor facilities site, Cargo village site, site for provisional stocking of excess excavation material | Pre-works inventory |
| Monitoring of the station of the rare and endemic species *Sarcostemma daltonii (Gestiba)*. | | Periodic monitoring to ensure the long-term continuity of the station concerned (top of the cliffs) |
| **Avifauna** | | |
| Prior inventory of the avifauna | All the sites concerned by the works and the sites: contractor facilities site, Cargo village site, site for provisional stocking of excess excavation material, maritime cliff areas. | Pre-works inventory |
| Monitoring of the two species *Phaeton aethereus* (Rabo de Junco) and *Pandion haliaetus (*Guincho) | Coastal cliffs, particularly those concerned by the layout of the road | Periodic observations during the works (monitoring of frequentation and nesting) |

[5] $PM_{10}$ = particles of aerodynamic diameter less than 10 µm.

## 8.1.2. Monitoring of marine environment

**Table D.2 Monitoring programme during works in progress : marine environment**

| Type of monitoring and measurements | Stations / sampling | Frequency |
|---|---|---|
| **Benthic communities** | | |
| Inventory of the benthic populations of the hard and soft substrates | Area of the road affecting the marine environment.<br>Sampling of stations 5 and 3 (see location in the analysis of the initial condition of the site) | Pre-works inventory (1st campaign) |
| **Geochemicals in marine sediments** | | |
| Measurement of the quality of the sediments (physico-chemical parameters, heavy metals, PCB, HAP, TBT) | Sampling of stations 5 and 3 (for the access road ) and station 1 (for the quay n°2 renovation work) | Pre-works measurements (1st campaign) |

| **Marine water quality** | | |
|---|---|---|
| Measurement of water quality during the period of construction of the access road: physico-chemical parameters (suspended matter, $O_2$, pH) | The essential objective will be to check the contents of matter in suspension to avoid reaching excessively high levels that would affect the marine environment. Two stations will be sampled (stations 5 and 3), at a depth of –3 m. | 1 time per week during the marine environment reclamation work and according to particular events. |
| Note: the construction of the road is accompanied by measures to reduce the suspended matter contents at source. The proposed way of reducing this risk is to first build the breakwater to provide protection against the swell, then to fill the volume between the breakwater and the foot of the cliff with aggregate materials. This solution will limit to a large extent the washing out of fine particulate materials and production of suspended particulate matter that temporarily increases the turbidity of the seawater.<br>Monitoring the suspended matter content will provide a check on the effectiveness of the technical measure taken. Suspended matter contents are commonly between 17 mg/l and 30 mg/l according to the monthly measurements taken between June and October 2007. The average at station 5 is 21 mg/l with a maximum of 26 mg/l. It is recommended that:<br>▪ the works should not lead to the exceeding of a suspended matter level of 50 mg/l at the entrance to Praia bay (station 3).<br>▪ the turbidity plume should not reach the sensitive points of the bay (beaches).<br>If either of these conditions is reached, the filling work could be temporarily stopped until a normal situation is restored. | | |

## 8.2. MONITORING PROGRAMME AFTER COMPLETION OF THE WORKS

The **monitoring during the operational phase** consists in performing measurements and analyses in accordance with a predetermined programme to monitor the environmental impacts of the extensions to the Port of Praia facilities and structures.

### 8.2.1. Monitoring of land environment

| Type of monitoring and measurements | Stations / sampling | Frequency |
|---|---|---|
| **Water** | | |
| Measurement of the quality of wastewater: physico-chemical parameters (TSS, $O_2$, pH, $BOD_5$), heavy metals, PAH) | Discharges from the retention basin of the settling tank and from the road. Verification of treatment effectiveness | During a significant rainy episode |
| Measurement of the quality of the groundwater by piezometry (TSS, pH, PAH, bacteriology) | One station situated hydrologically downstream of the cargo village. | 4 measurements per year |
| **Noise** | | |
| Measurement of the ambient noise level over a 24-hour period | 1 measurement point situated near the cargo village to measure its contribution to the ambient noise level. | 2 measurements per year |
| **Air quality** | | |
| Measurement of air quality parameters over 24 h: $NO_x$, $SO_2$, CO, $CO_2$, Unburned hydrocarbons (HC) and $PM_{10}$ [6] | 1 measurement point situated near the cargo village to measure its contribution to the deterioration of the air quality. | 4 measurements per year |
| **Avifauna** | | |
| Monitoring of the species *Phaeton aethereus* (Rabo de Junco) | Coastal cliffs, particularly those concerned by the layout of the road | Observations in the framework of the management and protection programme for this species on account of the compensatory measures. |

[6] $PM_{10}$ = particles of aerodynamic diameter less than 10 µm.

### 8.2.2. Monitoring of marine environment

| Type of monitoring and measurements | Stations / sampling | Frequency |
|---|---|---|
| **Geochemicals in marine sediments** | | |
| Measurement of the quality of the sediments (physico-chemical parameters, heavy metals, PCB, HAP, TBT) | Sampling from stations 5 and 1. | 1 campaign one year after the works, then once every two years. |
| **Benthic communities** | | |
| Monitoring of the benthic populations of the soft and hard substrates | Sampling from station 5. | 1 campaign one year after the works, then once every three years. |
| Monitoring of the recolonization of the natural and artificial riprap by the fish | Three stations distributed along the line of riprap protecting the road | 1 campaign one year after the works, then once every three years. |

# G. ENVIRONMENTAL MANAGEMENT PLAN (EMP)

The measures required for ensuring mitigation or compensation of environmental impacts for the port of Praia expansion project are summarized in this Environmental Management Plan (EMP). The EMP indicates performance indicators for each proposed action, as well as the organization(s) responsible for following and implementing the actions.

# 1. INTRODUCTION

This Environmental Management Plan (EMP) for Phase I of the Port of Praia Expansion and Modernization Project has been prepared for use by the MCA-CV, ENAPOR, the Contractor in charge of construction works and the Engineer in charge of the supervision of works. It provides the management framework needed for planning and implementation of activities during both the construction and operational phases in accordance with environmental commitments identified within the first phase of the Port of Praia Expansion and Modernization Project Environmental Impact Assessment (EIA), in compliance with legal and regulatory requirements of the Republic of Cape Verde, and the MCC Environmental Guidelines. Issues addressed in the EIA include:

- Air emissions.
- Impacts on surface water and groundwater.
- Impacts on terrestrial and marine flora and fauna and their habitat.
- Land use.
- Socioeconomic impacts, including possible occurrence of AIDS/HIV.

The objective of the EMP is to describe the measures and actions to be implemented during the construction and operation of the project to eliminate or reduce key identified biophysical, socioeconomic and health issues and impacts to acceptable levels. Adherence to the EMP will reduce the risk of adverse impact of construction on sensitive environmental receptors and minimize social impacts, especially with respect to disturbance of local residents. Project participants must commit to implementing this plan and to devoting to the implementation of the plan whatever resources may be required to achieve this objective.

The EMP addresses the need for environmental safeguards during the construction and operational phases of the project, and facilitates the adoption of environmentally sensitive workplace practices with respect to the above issues. The EMP further addresses:

- Management of hazardous materials during the construction and operational phases of the project.
- Waste management requirements for both hazardous and non-hazardous wastes that will be generated during the construction and operational phases of the project.
- Occupational health and safety (OHS).

The Environmental Management Plan (EMP) includes measures that must be implemented during both the construction and operational phases of this project. They include:

- Investments in equipment and other infrastructure.
- Development of required procedures.
- Capacity strengthening.
- Additional research or evaluation.

Any required changes in the legal and regulatory framework shall be addressed by the respective Competent Authority.

The EMP forms part of the overall Project Management for this investment, and as such activities described are required to be integrated with other Quality, Sustainability and Health & Safety (H&S) management processes.

This document, together with the EIA report, will serve as the basis for a specific **Construction Environmental Management Plan (CEMP)** that is to be developed by the Contractor after contract signature. The CEMP should be agreed with the relevant Authorities prior to commencement of construction activities. The CEMP shall include:

- Summary of environmental aspects.
- Specific Environmental Risk relating to each construction activity.
- A management structure, including roles and responsibilities of all staff undertaking environmental work.
- Procedures setting out internal communication and coordination.
- Procedures for handling external communications, liaison and complaints.
- Procedures for environmental training and awareness.
- Procedures fro monitoring, recording and disseminating environmental information and performance.
- Procedures for addressing non-compliance and corrective action.
- Procedures for dealing with major incidences, unexpected occurrences or finds (for example, national heritage artifacts) during construction.
- Procedures relating to operational control.
- Environmental control measures

The CEMP must be subject to review at regular time intervals, or at other times when it is considered necessary (for example following an accident or an emergency case). Reviews of the CEMP must take into account the following:

- Changes in environmental conditions.
- Results of monitoring activities.
- Records of emergencies and accidents.
- Results of internal and external audits.

The CEMP review must be carried out by the Project Management Team or members thereof, in collaboration with the wider project team. The specific responsibilities for undertaking a review of the CEMP must be clearly defined in the CEMP. The results of the review must be documented, and will provide the basis for revision of the CEMP. The CEMP must define responsibility, Authority and procedures for implementing and recording any changes in documented procedures resulting from its review.

# 2. COMPLIANCE REQUIREMENTS

The Employer, the Beneficiary, the Engineer and the Contractor are required to comply with all relevant legislation for the project. The table below shows the various responsibilities according to phases:

| | The Employer (MCA-CV) | The Beneficiary (ENAPOR) | The Engineer | The Contractor |
|---|---|---|---|---|
| **Construction Phase** | X | X | X | X |
| **Operational Phase** | | X | | |

This shall include but is not limited to the following:

- Law n° 86/IV/93, the Basic Law of Environmental Policy.
- Decree-Law n°29-2006 of March 2006 concerning sets the framework for the environmental evaluation of the development projects.
- Laws and regulations concerning water resources, air emissions and solid and hazardous waste.

In addition to complying with relevant legislation, all activities must comply with the provisions set out in the following:

- Environmental Assessment for this project.
- This Outline Construction Environmental Management Plans (and further revisions).
- Contractual documents issued to the contractor including, but not limited to, “Low Nuisance” site instructions.

The state agencies that oversee studies on the environment in Cape Verde are:

- The National Assembly through a special Commission of the Ministry of Agriculture, Food, Environment, Energy and Water.
- The Government through the Ministry of Agriculture, Food and Environment (especially the Environmental General Directorate, so-called "DGA"), together with the National Commission for the Environment, the National Commission for Water and several Non-Governmental Organizations.

Emphasis is placed on the central role played by the DGA, with its prerogatives and ability to contribute to the definition of the National Environment Policy; to participate in the elaboration of plans, programs and projects related to activities associated with the environment and natural resources; and to define measures of evaluation of the quality of water and air, and noise. The DGA is the Competent Authority responsible for reviewing EIAs, and granting environmental permits for investment projects. The DGA is responsible for overseeing compliance of this project with this EMP.

Besides, all construction activities must be in compliance with the **Port of Praia Safety Plan** (last revised in May 2004). The report outlines:

- Port of Praia safety policy.
- General means of prevention and safety at the port, including the organizational structure, functions of involved parties and specific responsibilities for such activities.
- Emergency response framework.
- Lines of communication.
- Safety procedures and measures.
- Inspection and maintenance of equipment and systems for safety.
- Training.

The Plan includes various detailed appendices, and invokes the following national and international codes and guidelines:

- National Fire Protection Association Codes - NFPA 307 - Construction and fire protection of marine terminals, piers and wharves (1990);
- National Fire Protection Association Codes -NFPA 30 - " Flammable and Combustible Liquids";
- National Fire Protection Association Codes -NFPA 395 - "Standard for the storage of Flammable and Combustible Liquids";
- National Fire Protection Association Codes -NFPA 14 - “Standard for Installation of Standpipe and Hose System”;
- National Fire Protection Association Codes -NFPA 101 - “Life Safety Code”;
- National Fire Protection Association Codes -NFPA 325M - “Fire Hazard Properties of flammable liquids, gases and volatile solids"
- IMDG Code - International Maritime Dangerous Goods Code;
- Decree nº 55/99 of the 6th September –Establishes the health and safety measures to ensure adequate conditions in working stations;
- Provincial decree nº 13/74 of the 8th August - Regulamento de Tarifas da Junta Autónoma dos Portos de Cabo Verde;
- Porto da Praia Safety Diagnosis, Certitecna, 2001;
- Law nº 100/V/99 of the 19th April - Estabelece as bases gerais de protecção civil;
- Porto Grande Safety Manual, Certitecna, 2002;
- NP 3064: Portable fire extinguishers operation;
- NP 3992: Fire fighting equipment signalization;
- NP EN 3: Portable fire extinguishers;
- NP 4303: Fire fighting safety equipment;
- Service Order nº 07/CA/2001 –Empresa Nacional de Administração dos Portos S.A.; organisation functional contents;
- Decree nº 1456-A/95, of the 11th December – Rules the minimum demands of health and safety signalization display;

- IMO Recommendations - Recommendations on the safe transport, handling and storage of dangerous substances in Port Areas. IMO publication;
- International illumination table (indoor illumination) published by Philips.

Safety standards contained in the Plan concern work station cleaning and maintenance, personal protection equipment, fire protection, first aid, noise, electricity, storage, manual tools, mechanical tools, welding operations, cutting operations, painting operations, manual cargo movement and mechanical load moving.

Workers Safety Sheets from the Plan are provided in the 2 following pages:

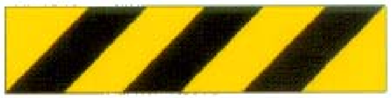
# Safety Signalization

**Prohibition**

**Obligation**

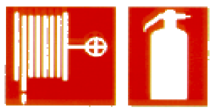
**Warning / Danger**

**Obstacles**



**Emergency**

**Fire**



# Praia Port

**Empresa Nacional de Administração dos Portos, S.A.**
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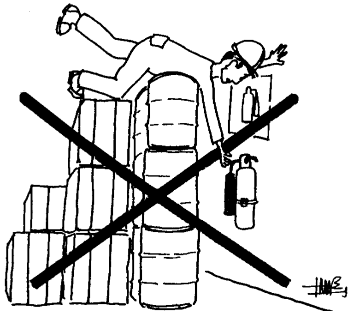
# Health and Safety

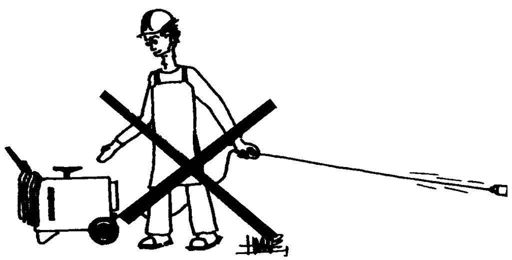
# Cleaning and Arrangement



Do not obstruct ways, staircases, doors, emergency exits, portable extinguishers and hydrants.

# Electrical Risks

To unplug do not pull by the electric cable.



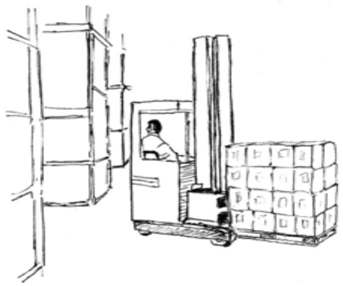
# Cargo Moving

Obligatory feet protection

Always use adequate individual safetu equipment (helmet, gloves and protective foot ware).

Never stay under hanging loads.

Danger: Suspended loads



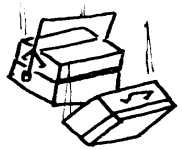
Do not drive a stacking truck with elevated cargo. Make sure that the cargo is pertfectly balanced, tied and supported, so that any slipping or fall will be avoided.

# Personal Protection Equipment

Ear noise protection obligatory

The ear´s protectors, auriculars or plugs shall be used by the workers when the working places have dangerous noise levels.

**PROTECT YOURSELF FROM THE NOISE!**

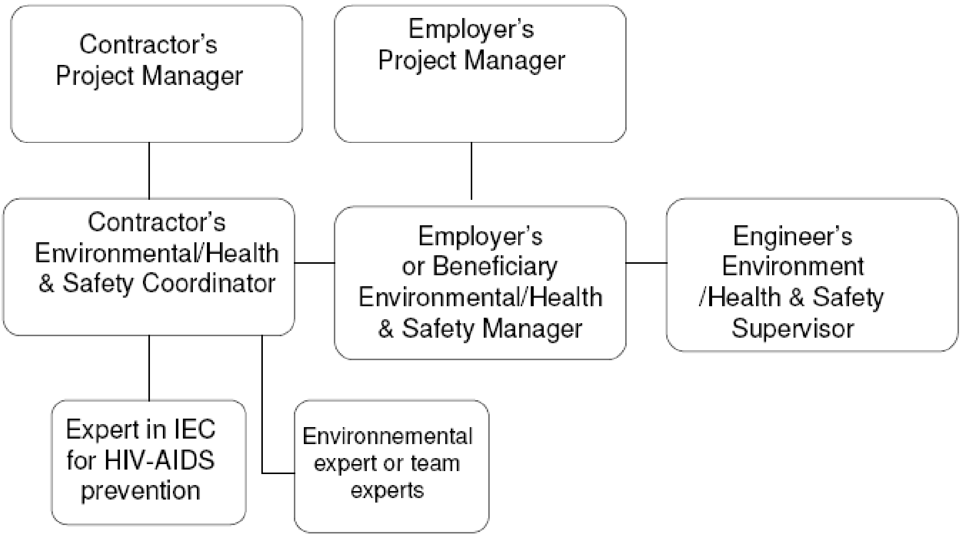


The safety helmet must be used in all the works where falling objects risks may occur, namely in crane operating zones.

# 3. ROLES AND RESPONSIBILITIES

## 3.1. GENERAL

Members of the Project Team will be assigned specific roles and will be responsible for the correct application of the EMP:




## 3.2. EMPLOYER'S PROJECT MANAGER

The Project Manager (MCA-CV) will have the responsibility for managing the project throughout the construction period and will ensure that appropriate resources are made available for application of the EMP, and environmental control and any agreed appropriate protection measures are implemented.

## 3.3. EMPLOYER'S OR BENEFICIARY'S ENVIRONMENTAL MANAGER

This Environmental Manager will be appointed by and act on behalf of the employer (MCA-CV) or the Beneficiary (ENAPOR) for coordinating and managing all the environmental activities during the construction phase and then, in the operation phase. The Environmental/Health & Safety Manager's responsibilities include:

- Ensure that the Contractor develops, and then reviews, the CEMP and specialist procedures and method statements.
- Ensure delivery of environmental training to personnel within the project team.
- Review method statements for environmental aspects and advise of any suggested improvements prior to work starting.

- Monitor construction activities and performance to ensure that appropriate environmental control measures are being implemented and are effective and ensure compliance with the CEMP.
- Liaison with Contractor's environment coordinator to ensure coordination of environmental mitigation and monitoring procedures.
- Dissemination of "Low Nuisance" site instructions to all relevant personnel on site.
- Compliance with the instructions relative to the environment and the life space that the companies must respect.
- Verification of the implementation of mitigating measures during the work site in collaboration with the public works contractors.
- The contacts between the owner and the associations, the public and the socio/professional groups, to resolve complaints and conflicts induced by the nuisance and bother caused by the different site works. An operational cell will be functional throughout the construction works.
- The organization and implementation of monitoring during the site works and the subsequent operation of the structures.

## 3.4. ENGINEER'S ENVIRONMENTAL SUPERVISOR

The **Engineer's Environmental / Health & Safety Supervisor** has the following responsibilities:

- Intervene on the ground to ensure that the rules described in the Environmental Management Plan are applied by the Contractor's. He can carry out specific inspection measures (taking water samples, making point measurements of the noise level, prepare a photographic record, etc.).
- Issue and follow up on Corrective Action Requests (CARs) or Non Conformance Requests (NCRs), ensuring that a corrective action plan is submitted to the Employer's or Beneficiary Environmental Manager, indicating the action that will be carried out and a deadline for the action.
- Provision of advice and liaison with the construction teams to ensure that environmental risks are identified and appropriate controls are developed and included within Method Statements and risk assessments.
- Organize periodic meetings with the Contractor to make a detailed assessment of the problems posed in the preceding period and find solutions in anticipation of new impacts.
- At the end of the mission, assess the actions conducted in the field and judge the effectiveness of the measures and methods used on the site to prevent the temporary impacts of the site. He can propose a methodological framework applicable to similar sites (experience feedback).

## 3.5. CONTRACTOR'S ENVIRONMENTAL MANAGER

The **Contractor's Environmental / Health & Safety Manager** is responsible for coordinating and managing all the environmental activities during the construction phase, reporting to the Employer's Environmental Manager. The Contractor's

Environmental Manager will provide a full time presence on site throughout the construction period. His responsibilities should minimally include:

- Liaison with the Employer's / Beneficiary's Environmental Manager.
- Follow the development of the CEMP.
- Monitor construction activities and performance to ensure that appropriate environmental control measures are being implemented and are effective and ensure compliance with the CEMP.
- Assistance in the development and delivery of environmental training for personnel of the Contractor and Sub-contractors.
- Management of the environmental monitoring programme, including noise, vibration and dust and review the routine reports.
- Dissemination of "Low Nuisance" site instructions to all relevant personnel on site.
- Implementation, operation and monitoring of the project Site Waste Management Plan
- Environmental audit of Sub-contractors and suppliers.

## 3.6. EXPERT IN IEC FOR HIV-AIDS PREVENTION

The Contractor will recruit an **Expert in IEC** (Information, Education, Communication) who will primarily assist the Contractor to design and implement an HIV-AIDS Sensitization Plan[7], including:

- Developing an Action Plan based on IEC, aiming at sensitizing the workers and local populations on HIV-AIDS.
- Providing the access to prevention methods, in particular condoms, to workers and local communities.
- Providing voluntary counseling and testing to workers and local communities.

## 3.7. ENVIRONMENTAL SPECIALISTS

The Contractor will be required to employ environmental specialists to support the Project as required to provide the mitigation measures described both in the CEMP and in response to particular construction activities that may otherwise present an environmental risk. The environmental specialists' roles will be to undertake the detailed mitigation design within their own fields, oversee its implementation, maintenance and monitoring throughout the construction period up to the end of the maintenance period.

[7] For more details, refer to section F2/1.10.

# 4. MANAGEMENT PLAN

## A. Construction Phase

| Project Component | Action N° | Activity | Expected Impact(s) | Mitigation and Control Measure(s), Monitoring and Corrective/Preventive Actions | Performance Indicators | Entity responsible for the action |
|---|---|---|---|---|---|---|
| **1. Cultural Resources Mitigation Plan** | | | | | | |
| Site preparation | 1.1 | Excavation and filling (Cargo village, access road, temporary stockpiling area) | • Destruction of, or damage to cultural heritage | • Proper Authorities must be notified, and survey or salvage excavation should be carried out in the event of discovery of archeological or historical remains<br>• Systematic report of archeological features<br>• Periodic visit of an archeologist during site preparation | • Notification reports<br>• Contractor daily logs<br>• Archeologist site reports | **Contractor** under supervision of the Engineer<br>In association with the Ministry of Culture, Institute of Research on Cultural Heritage |
| **2. Habitat, Fauna and Flora Conservation Plan** | | | | | | |
| Site management | 2.1 | Site selection | • Destruction of, or damage to environmentally sensitive sites | • Maximize existing road network use<br>• Minimize construction of temporary or permanent access roads or tracks | • Contractor plan for arrangement of access roads | **Contractor** under supervision of the Engineer |

| Project Component | Action N° | Activity | Expected Impact(s) | Mitigation and Control Measure(s), Monitoring and Corrective/Preventive Actions | Performance Indicators | Entity responsible for the action |
|---|---|---|---|---|---|---|
| | | | | • Layout of new access accounting for direct environmental impact, but also indirect, as providing an easier access to preserved areas | | |
| Site management | 2.2 | Site preparation | • Damage to habitat of local flora and fauna | • Avoid uprooting vegetation, and clearly mark areas to be left intact<br>• Identify and, if necessary, transplant any rare or endangered plant or animal species<br>• Leave unbroken vegetation corridors that link remaining natural habitats<br>• Create buffer zones to minimize impact on ecologically sensitive areas (which must be clearly marked on construction drawings)<br>• Possibly, restrict construction personnel and population access to selected areas to be preserved | • Contractor maps of vegetation prior to construction<br>• Contractor plans for placement of infrastructure and management of vegetation and habitats<br>• Contractor maps of vegetation corridors during construction | **Contractor** under supervision of the Engineer |
| Site | 2.3 | Management of | • Disturbance of local | • Ensure that lighting does not unduly disturb nesting or other | • Reports from NGOs | **Contractor** under the supervision of the |

| Project Component | Action N° | Activity | Expected Impact(s) | Mitigation and Control Measure(s), Monitoring and Corrective/Preventive Actions | Performance Indicators | Entity responsible for the action |
|---|---|---|---|---|---|---|
| management | | night lighting | fauna<br>• Negative impacts of lighting on attraction of insect vectors | activities of local fauna<br>• Use sodium vapor lamps for lighting masts in order to reduce attraction of insects | | Engineer<br>In association with DGA |
| Construction of the connecting road | 2.4 | Various | • Likely desertion of cliff habitat by *Phaeton aethereus*, an endangered species, and *Pandion haliaetus*, a rare species | • Develop an Action Plan to finance actions of sensibilization (fishermen, school pupils) to the vulnerability of this species in relation with the Action Plan for the Conservation of Marine Birds.<br>• Monitoring of *Phaeton aethereus* during the construction period and after completion of the works (video-Cameras installed along the connecting road will make this action easier)<br>• Ref. EIA Section F, Chapter 6 | • Number of fishermen and school pupils sensibilized<br>• DGA inspection reports<br>• Monitoring reports<br>• Ref. EIA Section F, Chapter 6 | **DGA** (entity responsible for National Protection Policy implementation)<br>In association with MCA-CV / ENAPOR (funding), INIDA, NGOs<br>Ref. EIA Section F, Chapter 6 |
| Construction of the lower part of the connecting road | 2.5 | Various | • Contamination of marine environment and life by aggregate materials<br>• Increased turbidity | • Prior washing of quarry materials with high fine particle content and/or establishing specifications for these materials to limit losses of materials and generation of | • Contractor and ENAPOR reports<br>• Visual inspection<br>• Monitoring reports<br>• DGA inspection reports | **Contractor** under the supervision of the Engineer |

| Project Component | Action N° | Activity | Expected Impact(s) | Mitigation and Control Measure(s), Monitoring and Corrective/Preventive Actions | Performance Indicators | Entity responsible for the action |
|---|---|---|---|---|---|---|
| | | | due to diffusion of aggregate materials | turbid plumes in the marine environment (this only concerns material to be used to build up the marine containment dam and its shore protection) | | |
| **3. Water and Groundwater Mitigation Plan** | | | | | | |
| Management of Construction Materials | 3.1 | Extraction of Quarry Materials | • Contamination of groundwater and plugging of groundwater recharge zones<br>• Alteration of surface water flow patterns | • Minimize interference with groundwater by allowing infiltration in recharge zones<br>• Application of conservation measures for soil and water at the site<br>• Development of adequate water storage on the site(s)<br>• Study and develop alternate routes for natural surface water flows at the site<br>• See other details in Appendice n°1 | • Plan for site surface water and groundwater management<br>• Confirmation of water storage capacity | **Quarry Owner/Operator** under supervision of the Engineer<br>In association with the DGA |
| Work sites management | 3.2 | Various | • Contamination of surface and groundwater through release of | • Equip construction site toilets with water treatment system<br>• Place site activities that generate waste water (such as | • Contractor and Engineer reports<br>• ENAPOR reports | **Contractor** under supervision of the Engineer |

| Project Component | Action N° | Activity | Expected Impact(s) | Mitigation and Control Measure(s), Monitoring and Corrective/Preventive Actions | Performance Indicators | Entity responsible for the action |
|---|---|---|---|---|---|---|
| | | | contaminated runoff | depots, mechanical workshops; equipment washing areas, concrete mixing plants) in such a way that the risks of groundwater pollution are minimized<br>• Rainwater must be diverted from the work site to the extent possible to avoid contamination<br>• Groundwater reserves must be monitored and protected (e.g. through boreholes) during excavation (for example of the cargo village)<br>• Minimize obstruction of river beds and pollution of the same by hydrocarbons and other potential pollutants<br>• If a water course is altered by construction activities, make every effort to restore its original geomorphology after completion of civil works | | |

| Project Component | Action N° | Activity | Expected Impact(s) | Mitigation and Control Measure(s), Monitoring and Corrective/Preventive Actions | Performance Indicators | Entity responsible for the action |
|---|---|---|---|---|---|---|
| **4. Construction Spoils Management Mitigation Plan** | | | | | | |
| Removing Old Quayside Warehouses | 4.1 | Various | • Burdening limited local landfill capacity<br>• Excessive use of natural and other resources<br>• Inappropriate disposal of hazardous wastes in local sanitary landfill, with possible contamination of soil, groundwater and surface water, and negative effects on human health. | • Thorough audit of buildings to be demolished, to identify potentially recyclable materials; investigate local market for the same, and prepare procedures for recycling<br>• Selective removal of building components to ensure separation of non-inert materials prior to final demolition<br>• Separation of recyclable materials, where required, to ensure maximum value of the same, to allow recycling of wood, polystyrene, plastics and metal scrap<br>• Reuse of appropriate demolition rubble as fill material<br>• Develop safe temporary packaging and storage (with appropriate labels) at the construction site for hazardous materials (excluding asbestos | • Contractor and Engineer reports ENAPOR reports<br>• DGA inspection reports<br>• Plans for storage facilities | **Contractor** under the supervision of the Engineer |

| Project Component | Action N° | Activity | Expected Impact(s) | Mitigation and Control Measure(s), Monitoring and Corrective/Preventive Actions | Performance Indicators | Entity responsible for the action |
|---|---|---|---|---|---|---|
| | | | | cement) until they can be properly managed offsite | | |
| Removing Roofs of Quayside Warehouses | 4.2 | Asbestos-cement roof panels | Inappropriate disposal of asbestos cement panels or materials in local sanitary landfill, with possible resulting contamination of soil, groundwater and negative impacts on human health | • Conditioning of asbestos cement roof panels in container bags with appropriate labels<br>• The full asbestos-removal process will be handled by a certified environmental firm, which will be required to produce a detailed program<br>• The asbestos cement elements will be shipped to Lisbon and disposed in an appropriate Portuguese dumping site (see Appendice 2), or in another appropriate dump proposed by the Contractor and approved by the Engineer | • Contractor and Engineer reports | **Contractor** under the supervision of the Engineer |
| **5. Natural Resources Use Mitigation Plan** | | | | | | |
| Earth movements on the plateau (Cargo Village, contractor's site, temporary | 5.1 | Site preparation | • Excessive use of natural and other resources | • Reuse turfsoil on project slopes before planting operations | • Report of contractor landscape architect or other specialist(s) | **Contractor** under supervision of the Engineer |

| Project Component | Action N° | Activity | Expected Impact(s) | Mitigation and Control Measure(s), Monitoring and Corrective/Preventive Actions | Performance Indicators | Entity responsible for the action |
|---|---|---|---|---|---|---|
| storage of containers, temporary material stockpiling site) | | | | | | |
| Water use | 5.2 | Water consumption | • Drain on water resources of Santiago Island | • Implement water conservation measures (waste water recycling)<br>• Justify processes used in the construction activities that consume the most water (*e.g.* concrete mixing plant, vehicles and other equipments washing) | • Contractor and Engineer reports<br>• ENAPOR reports | **Contractor** under supervision of the Engineer |
| Repaving the Quay n°2 Backup Yard | 5.3 | Various | • Excessive use of natural and other resources | • Uncontaminated materials should be reused as fill material for the lower part of the connecting road (when appropriate) or for making aggregates, after screening. If polluted, the reuse of these materials for embankment material must be evaluated (possibility of isolating them, possibly through use of a sealed geo-membrane). Paving stones can be used to repair traditional roads on | • Physical and chemical analyses<br>• Contractor reports | **Contractor** under the supervision of the Engineer |

| Project Component | Action N° | Activity | Expected Impact(s) | Mitigation and Control Measure(s), Monitoring and Corrective/Preventive Actions | Performance Indicators | Entity responsible for the action |
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| | | | | Santiago Island. | | |
| **6. Erosion and Sediment Control Plan** | | | | | | |
| Existing vegetation conservation on the plateau (Cargo Village, Contractor's site, temporary storage of containers, temporary material stockpiling site) | 6.1 | Site preparation | • Damage to local flora that helps controlling erosion | • Avoid uprooting vegetation outside the project footprint, and clearly mark areas to be left intact<br>• Collect uprooted vegetation inside the project footprint, and reuse it for landscaping works, in order to minimize purchase of plants | • Contractor maps of vegetation prior to construction<br>• Report of contractor landscape architect or other specialist(s)<br>• Contractor plans for placement of infrastructure and management of vegetation | **Contractor** under supervision of the Engineer |
| Earth movements on the plateau (Cargo Village, contractor's site, temporary storage of containers, temporary material stockpiling site) | 6.2 | Site preparation | • Stockpile instability<br>• Excessive earth movements<br>• Traffic in instable areas | • Remove and store topsoil, as necessary, with dispositions against moisture, erosion, and exposure to dust<br>• Identify and avoid working in erosion-prone areas, especially during dry season<br>• Stabilize any gradients that are modified during construction<br>• Promote vehicle traffic in stabilized zones | • Report of contractor landscape architect or other specialist(s) | **Contractor** under supervision of the Engineer |

| Project Component | Action N° | Activity | Expected Impact(s) | Mitigation and Control Measure(s), Monitoring and Corrective/Preventive Actions | Performance Indicators | Entity responsible for the action |
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| Runoff control on the plateau (Cargo Village, contractor's site, temporary storage of containers, temporary material stockpiling site) | 6.3 | Various | • Soil runoff due to rain | • Conduct site work during the low water period insofar as possible<br>• Rainwater runoff coming to the work sites must be diverted (gutters, dikes) to decrease volumes to be managed<br>• Avoid risks from flooding by determining potential flood levels and making consequent plans to avoid risks from construction activities<br>• Water runoff must be channeled in work sites to ensure a better control<br>• Water runoff must be treated an appropriate manner (for example oil-water separator, settling basins, etc.)<br>• Install retention basin downstream of the cargo village in order to collect stormwater and vehicle washing water that flows through uncovered areas of the cargo village, as well as to | • Reports of contractor landscape architect or other specialist(s)<br>• Retention basin plans | **Contractor** with supervision of the Engineer |

| Project Component | Action N° | Activity | Expected Impact(s) | Mitigation and Control Measure(s), Monitoring and Corrective/Preventive Actions | Performance Indicators | Entity responsible for the action |
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| | | | | support containment of accidental pollution (the basin must include a fixed and sealed retention with a 30 $m^3$ minimum capacity)<br>• Regular and after rainy event inspection of diversion and retention devices | | |
| Restore vegetation coverage after construction | 6.4 | Site cleanup and landscaping | • Bared topsoil<br>• Use of vegetation not appropriate to Cape Verde climate | • See Operation Phase Programme | | **Contractor** with supervision of the Engineer |
| Management of construction materials | 6.5 | Quarry exploitation | • Erosion of terraces | • See Operation Phase Programme | | **Contractor** with supervision of the Engineer |
| **7. Fugitive Dust Control and Air Quality Monitoring Plan** | | | | | | |
| Management of construction materials | 7.1 | Construction of terraces at quarries | • Release of particulate material (dust) | • Periodic monitoring of dust emissions at the quarry sites, at selected locations<br>• Use of dust suppression measures (through aspiration or spraying surfaces with water, especially in the area around the screening/crushing | • Monitoring reports on dust emissions<br>• Visual inspections | **Quarry Owner/Operator** with supervision of the Engineer<br>In association with the DGA |

| Project Component | Action N° | Activity | Expected Impact(s) | Mitigation and Control Measure(s), Monitoring and Corrective/Preventive Actions | Performance Indicators | Entity responsible for the action |
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| | | | | units) | | |
| Management of construction materials | 7.2 | Extraction of Quarry Materials | • Release of dust; excessive soil movement | • Use of dust prevention measures | • Dust emissions analysis<br>• Visual inspections | **Quarry Owner/Operator** with supervision of the Engineer<br>In association with the DGA |
| Management of construction materials | 7.3 | Transport of quarry materials to the construction site(s) by heavy goods vehicles (HGVs) | Dust release with impacts on construction workers and nearby residents | • Use of dust prevention measures<br>• Implementation of a hotline to receive complaints from local residents<br>• Minimize dust raised by vehicles on dirt track by implementing traffic control measures (limit vehicle speed, traffic volumes, etc.)<br>• Cover (that is, with tarpaulins) materials liable to produce dust during transportation or storage<br>• Spray and/or regularly compact dirty tracks with water, and clean vehicles regularly (if necessary and appropriate, | • Visual inspections<br>• Monitoring reports on dust emissions<br>• Confirmation that hotline works<br>• Daily maintenance logs<br>• Contractor and Engineer reports<br>• DGA inspections | **Contractor** with supervision of the Engineer<br>In association with the Municipality of Praia |

| Project Component | Action N° | Activity | Expected Impact(s) | Mitigation and Control Measure(s), Monitoring and Corrective/Preventive Actions | Performance Indicators | Entity responsible for the action |
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| | | | | within the availability of water in this area)<br>• To the extent possible, schedule dust-raising activities during periods when low or no wind velocity is forecasted<br>• Clean roads regularly to remove dust and mud deposited by vehicles associated with construction activities | | |
| Removing Old Quayside Warehouses | 7.4 | | • Dust emissions | • Spray sheds with water as necessary during demolition process to keep dust down | • Monitoring reports<br>• ENAPOR reports<br>• DGA inspection reports | **Contractor** under the supervision of the Engineer |
| Air emission control | 7.5 | Various | • Health impacts from pollutants derived from exhaust from site mechanical equipment (macadam mixing plant, trucks, etc.)<br>• Health impacts from airborne pollutants coming from solid | • Each vehicle must undergo regular inspection in terms of emissions<br>• Prohibit emission control device removal<br>• Minimize vehicle usage<br>• Prohibit incineration of solid wastes | • Daily maintenance logs<br>• Contractor and Engineer reports<br>• DGA inspection reports<br>• ENAPOR reports | **Contractor** under supervision of the Engineer |

| Project Component | Action N° | Activity | Expected Impact(s) | Mitigation and Control Measure(s), Monitoring and Corrective/Preventive Actions | Performance Indicators | Entity responsible for the action |
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| | | | waste burning | | | |
| **8. Noise Control Mitigation Plan** | | | | | | |
| Management of Construction Materials | 8.1 | Use of explosives and operation of related equipment at quarries | High noise levels at the site, possibly exceeding 115 dB(A) | • Use of equipment with low noise levels, not exceeding 80 dB(A)<br>• Conduct operations such that noise is limited; use of earplugs and other safety equipment by workers<br>• Periodic monitoring of noise and vibrations over several working days | • Equipment specification<br>• Visual inspections<br>• Monitoring reports on noise and vibration | **Quarry Owner/Operator**<br>Contractor<br>DGA |
| Management of Construction Materials | 8.2 | Transport of quarry materials to the construction site(s) by heavy goods vehicles (HGVs) | • Noise and vibration coming from construction trucks | • Training for drivers on safe driving methods, including testing; implementation of a traffic study concerning main expected routes trucks will take from the quarry(ies)<br>• Restricted access for quarry trucks (for example during daytime non-congested hours)<br>• Identification of any sensitive ecological zones or other sensitive zones (schools, shopping areas, etc.) along the | • Training participants list and test scores<br>• Traffic study report (with recommendations, and including indication of sensitive ecological or social zones);<br>• Visual inspections<br>• Confirmation that hotline works | **Contractor** with supervision of the Engineer<br>In association with the City of Praia and/or other concerned municipality, National and/or local highway and public works department(s), Quarry operators |

| Project Component | Action N° | Activity | Expected Impact(s) | Mitigation and Control Measure(s), Monitoring and Corrective/Preventive Actions | Performance Indicators | Entity responsible for the action |
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| | | | | route(s)<br>• Placement of signs placing limits on truck velocities and routes (and adequate enforcement of these rules)<br>• Implementation of a hotline to receive complaints from local residents | • Penalties regarding excessive speed in the category of HGVs carrying quarry materials for the new port project. | |
| Other construction activities | 8.3 | Construction traffic | • Impact of noise and vibrations on local residents | • Strict enforcement of speed limits<br>• Avoid the use of horns except during emergency situations<br>• Properly maintain vehicles to limit noise emissions<br>• As appropriate, use noise-limiting equipment (*e.g.* silencers, coatings, barriers)<br>• Position non-mobile noise-generating equipment (*e.g.* pumps, generators, compressors, pneumatic drills, boring machines) or explosives, as far as possible, remotely from inhabited zones or sensitive eco-systems | • Local authority reports<br>• Contractor vehicle maintenance logs<br>• DGA inspection reports<br>• Equipment specifications<br>• Noise and vibration monitoring results | **Contractor** with supervision of the Engineer<br>In association with the Municipality of Praia |

| Project Component | Action N° | Activity | Expected Impact(s) | Mitigation and Control Measure(s), Monitoring and Corrective/Preventive Actions | Performance Indicators | Entity responsible for the action |
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| | | | | • Implement high-noise activities during periods that cause the least disturbance to local residents and sensitive eco-systems<br>• Inform residents at least 24 hours in advance of any activity involving the use of explosives<br>• Develop and implement a noise and vibration monitoring programme at key points around the site (before and during construction activities) | | |
| **9. Light and Visual Impact Mitigation Plan** | | | | | | |
| Construction of the Cargo Village, the Contractor's Site | 9.1 | Management of night lighting | • Disturbance of incoming flights in the area of the airport<br>• Disturbance of local traffic<br>• Disturbance of local residents | • Ensure that lighting installed for construction activities, at Cargo Village and along connecting road does not interfere with existing signaling lights (air and vehicular traffic) | • Aviation authority reports<br>• Record of complaints from local residents | **Contractor** under supervision of the Engineer |

| Project Component | Action N° | Activity | Expected Impact(s) | Mitigation and Control Measure(s), Monitoring and Corrective/Preventive Actions | Performance Indicators | Entity responsible for the action |
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| Infrastructure design | 9.2 | Other site-related aspects | • Threats to visual impact | • Construction materials and color of installed infrastructure should be selected to promote maximum integration with the local environment | • Report on selection of construction materials | **Contractor** with supervision of the Engineer |
| Construction of the Cargo Village, Contractor's site, temporary storage of containers, temporary material stockpiling site | 9.3 | Various | • Negative landscape impacts | • Design sheds to minimize visual impacts and impacts on landscape (including embankments and plantations with local plant species | • Contractor and ENAPOR reports | **Contractor** with the supervision of the Engineer |
| Construction of the access road | 9.4 | Various | • Negative landscape impacts | • Use basaltic rocks for riprap of the same color as the cliff face to reduce the contrast between natural and artificial structures | • Contractor and ENAPOR reports | **Contractor** with the supervision of the Engineer |
| **10. Solid Waste and Wastewater Mitigation Plan (see also Appendice 2)** | | | | | | |
| Management of Construction Materials | 10.1 | Generation of residual solids at quarries | Visual impacts, impacts on water and soil quality through leaching | Testing of materials, and, as necessary, collection and transport of materials to suitable disposal sites | • Periodic reports on soil and water quality<br>• Visual inspections | **Quarry Owner/Operator** with supervision of the Engineer<br>In association with the DGA and the |

| Project Component | Action N° | Activity | Expected Impact(s) | Mitigation and Control Measure(s), Monitoring and Corrective/Preventive Actions | Performance Indicators | Entity responsible for the action |
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| | | | | | | concerned municipalities |
| Management of Solid Waste | 10.2 | Various | • Contamination of soil, groundwater and surface water, with consequent impacts on human health and environment<br>• Vectors for disease and other negative human health and environmental impacts of uncontrolled waste deposits<br>• Impacts on human health and environment (e.g. fauna and flora) of airborne waste components<br>• Excessive use of natural and other resources | • Maintain cleanliness of contractors' facilities and other sites<br>• Avoid uncontrolled burial or unsanctioned dumping of solid wastes (*e.g.* by providing suitable containers that are emptied regularly)<br>• Maximize reuse and recycling of waste materials (including excavated materials, which must be managed in a way that minimizes erosion, production of dust and visual impact)<br>• Implement separation of wastes at the source (e.g. through a site waste deposition and sorting area, which should include a skip for concrete, cement, masonry and brick wastes)<br>• Protect waste deposits and waste sorting areas (whether temporary or permanent) from | • DGA inspection reports<br>• Contractor and Engineer reports ; ENAPOR reports | **Contractor** with supervision of the Engineer |

| Project Component | Action N° | Activity | Expected Impact(s) | Mitigation and Control Measure(s), Monitoring and Corrective/Preventive Actions | Performance Indicators | Entity responsible for the action |
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| | | | | the elements and animal (e.g. rodent) and disease vectors<br>• Ensure that the management and final destination of waste are in keeping with local regulations and international standards | | |
| Cargo Village, Contractor's site, temporary storage of containers, temporary material stockpiling site | 10.3 | Site preparation | • Lack of management of pre-existing waste | • Remove and properly manage all waste prior to leveling | • Contractor and Engineer reports | **Contractor** with the supervision of the Engineer |
| Cargo Village, Contractor's site, temporary storage of containers, temporary material stockpiling site | 10.4 | Various | • Accumulation and negative impacts of solid waste | • Install retention basin downstream of the cargo village in order to collect stormwater and vehicle washing water that flows through uncovered areas of the cargo village, as well as to support containment of accidental pollution (the basin must include a fixed and sealed retention area with a 30 $m^3$ minimum capacity) | • Contractor reports<br>• Waste management plan<br>• Monitoring reports | **Contractor** with the supervision of the Engineer |

| Project Component | Action N° | Activity | Expected Impact(s) | Mitigation and Control Measure(s), Monitoring and Corrective/Preventive Actions | Performance Indicators | Entity responsible for the action |
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| | | | | • As per above, good management of any non-hazardous or hazardous waste generated must be ensured, and safe temporary storage prior to recycling or final disposal must be provided (through the use of labeled bins that are regularly checked). Proper management must be ensured (including regular collection of non-hazardous by the City of Praia waste collection services, and appropriate management of hazardous wastes). | | |
| **11. Reforestation / Regeneration Mitigation Plan** | | | | | | |
| Not Applicable to this Project<br>(however, the project includes planting of ground slopes and landscaping at the cargo village) | | | | | | |
| **12. Traffic Control Mitigation Plan** | | | | | | |
| Traffic related to construction | 12.1 | Transport of quarry materials to the construction site(s) by heavy | • Additional traffic for local residents<br>• Increase in accidents | • Minimize vehicle use to extent feasible (shuttle buses for personnel, on-site lunch trucks for workers remaining on site)<br>• Training for drivers on safe | • Shuttle buses attendance<br>• Training participants list and test scores | **Contractor** with supervision of the Engineer<br>In association with the City of Praia and/or |

| Project Component | Action N° | Activity | Expected Impact(s) | Mitigation and Control Measure(s), Monitoring and Corrective/Preventive Actions | Performance Indicators | Entity responsible for the action |
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| | | goods vehicles (HGVs) and other construction traffic | • Deterioration of road networks | driving methods, including testing; implementation of a traffic study concerning main expected routes trucks will take from the quarry(ies)<br>• Restricted access for quarry trucks (for example during daytime non-congested hours)<br>• Identification of any sensitive ecological zones or other sensitive zones (schools, shopping areas, etc.) along the route(s)<br>• Placement of signs placing limits on truck velocities and routes (and adequate enforcement of these rules)<br>• Implementation of a hotline to receive complaints from local residents<br>• Transport of large loads and hazardous materials must be carefully planned in advance, during low-traffic periods and avoiding residential areas as possible (local authorities must | • Traffic study report (with recommendations, and including indication of sensitive ecological or social zones);<br>• Confirmation that hotline works<br>• Penalties regarding excessive speed in the category of HGVs carrying quarry materials for the new port project. | other concerned municipality, National and/or local highway and public works department(s), Quarry operators |

| Project Component | Action N° | Activity | Expected Impact(s) | Mitigation and Control Measure(s), Monitoring and Corrective/Preventive Actions | Performance Indicators | Entity responsible for the action |
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| | | | | be advised)<br>• Coordination with the public works department with respect to the need for road maintenance<br>• Avoid overloading vehicles | | |
| **13. Public Communications Strategy and Plan** | | | | | | |
| Public Communication | 13.1 | Various construction aspects | • Disturbance to local residents<br>• Disturbance of local traffic | • Implementation of a hotline to receive complaints from local residents | • Confirmation that hotline works<br>• List of complaints analysis and treatment | **Engineer**<br>in co-operation with MCA-CV and ENAPOR |
| Site management | 13.2 | Various | • Presence of public in work sites | • Site fencing<br>• Adequate signing | • Contractor and Engineer reports | **Contractor** |
| Environmental Communication | 13.3 | Various | • n/a | • Environmental reporting (monthly, in case of uncommon events, final): see **Appendice 3** | • Contractor and Engineer reports | **Engineer**<br>in co-operation with MCA-CV and ENAPOR |
| **14. Occupational Health and Safety Plan** | | | | | | |
| Exposure of personnel to hazardous materials, | 14.1 | Various | Various | • Provision of protective equipment for personnel (including hearing protection devices) appropriate to specific | • Employee health records<br>• Inspections by Competent | **Contractor** |

| Project Component | Action N° | Activity | Expected Impact(s) | Mitigation and Control Measure(s), Monitoring and Corrective/Preventive Actions | Performance Indicators | Entity responsible for the action |
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| excessive levels of noise, vibrations, air pollution, chemicals and dangerous products, etc. | | | | job requirements, including training regarding proper use and maintenance<br>• Periodic reviews and assessments regarding project safety and industrial hygiene practices and programs<br>• Assessment and inspection of chemical control practices, use of protective equipment, noise control measures<br>• Development of a Project Occupational Health & Safety Plan, including worker health education and awareness program<br>• Development of insect control program<br>• Development of a workers medical surveillance program | Authority | |
| Fire and Other Emergency Situations | 14.2 | Various | Damage to human health, sensitive eco-systems and human infrastructure from fire or other emergencies | • Implement standard fire prevention actions, including clear signs prohibiting smoking or other activities in high-risk areas (e.g. fuel and hazardous or polluting substance storage | • Contractor and Engineer reports; ENAPOR reports<br>• DGA inspection reports<br>• Procedures | **Contractor** with supervision of the Engineer<br>In association with ENAPOR |

| Project Component | Action N° | Activity | Expected Impact(s) | Mitigation and Control Measure(s), Monitoring and Corrective/Preventive Actions | Performance Indicators | Entity responsible for the action |
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| | | | | areas)<br>• Prohibit onsite incineration of used materials, vegetation, household or other waste, and ensure that offsite management complies with national and local legal and regulatory framework and international guidelines<br>• Prohibit the use of open fires for cooking<br>• Ensure that fire extinguishers and other fire fighting equipment are available and easily accessible<br>• Ensure that emergency procedures (including the names of persons responsible for safety, emergency telephone numbers and reporting procedures) at appropriate locations at the site, and that workers are properly instructed regarding the same | | |

| Project Component | Action N° | Activity | Expected Impact(s) | Mitigation and Control Measure(s), Monitoring and Corrective/Preventive Actions | Performance Indicators | Entity responsible for the action |
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| **15. Health and HIV/AIDS Management Plan** | | | | | | |
| Health management, Fight against HIV-AIDS | 15.1. | Sexual activities of the workers | Contribution to HIV-AIDS expansion | • Develop an Action Plan based on IEC, aiming at sensitizing the workers and local populations on HIV-AIDS<br>• Provide the access to prevention methods, in particular condoms, to workers and local communities<br>• Provide voluntary counseling and testing to workers and local communities | Number of campaigns conducted per works<br>Number of campaigns conducted outside the work sites, targeted to local populations<br>Number of workers sensitized<br>Number of workers directed to voluntary and anonymous testing<br>Number of local population directed to voluntary and anonymous testing<br>Number of male condoms distributed<br>Number of condoms distributed outside the work sites to the local population | **Contractor** with the supervision of the Engineer and Expert in IEC (Information, Education, Communication)<br><br>In association with the MCA-CV, ENAPOR and CCS/SIDA |

| Project Component | Action N° | Activity | Expected Impact(s) | Mitigation and Control Measure(s), Monitoring and Corrective/Preventive Actions | Performance Indicators | Entity responsible for the action |
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| **16. Construction Phase Monitoring Plan (see also Environmental Program in Appendice 4)** | | | | | | |
| Monitoring Programme During Works in Progress | 16.1 | Various | n/a | • Appoint environmental/H&S coordinator and environmental inspection supervisor<br>• Monitoring of land environment (water, noise, vibration, air quality/dust, landscape, flora, avifauna)<br>• Monitoring of marine environment (benthic communities, geo-chemicals in marine sediments, marine water quality) | • Monitoring reports | **Contractor** with the supervision of the Engineer<br>In association with ENAPOR |
| **17. Construction Security Plan** | | | | | | |
| Site Management | 17.1 | Various | • Uncontrolled access to work sites<br>• Unknown evacuation procedures | • Delimit the construction areas<br>• Put temporary and/or permanent fences<br>• Control the access (check-in procedure or tag system for workers and visitors)<br>• If necessary, create site areas with restricted access even to construction workers (*e.g.* | • Contractor and Engineer reports<br>• Security guards reports<br>• Security procedure training reports | **Contractor** with the supervision of the Engineer |

| Project Component | Action N° | Activity | Expected Impact(s) | Mitigation and Control Measure(s), Monitoring and Corrective/Preventive Actions | Performance Indicators | Entity responsible for the action |
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| | | | | hazardous materials storage)<br>• Use of security guards<br>• Evacuation procedures and exercises | | |
| **18. Spill and Hazardous Materials Control Plan** | | | | | | |
| Management of Construction Materials and Wastes | 18.1 | Lubrication of machines and other equipment at quarries | Accumulation and possible spills of used oils | • Collection of used oils in drums, to be sent to the Shell used oil collection facility<br>• Training of workers regarding proper management of used oils<br>• Installation of a retention basin where used oils and other hazardous materials are stored | • Inspection of drum storage facility<br>• Log of vehicle and equipment maintenance<br>• Training materials, programme and participant list<br>• Waybill confirming shipment of used oils to Shell or other receiving facility | **Quarry Owner/Operator** with supervision of the Engineer |
| | 18.2 | Management of materials at the construction site | • Some materials used or recovered at the site might be hazardous in nature<br>• There are non-insignificant risks of leaks or spills, with possible | • All hazardous materials must be clearly labeled following international labeling standards<br>• Chemical products or waste considered to be hazardous must be registered and their use and movement tracked | • DGA inspection reports<br>• Contractor and ENAPOR hazardous waste storage and transport reports<br>• Training | **Contractor** with supervision of the Engineer |

| Project Component | Action N° | Activity | Expected Impact(s) | Mitigation and Control Measure(s), Monitoring and Corrective/Preventive Actions | Performance Indicators | Entity responsible for the action |
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| | | | consequent contamination of soil, groundwater or surface water in the area of the construction site | • Workers must be trained in the handling of hazardous materials<br>• Explosives must be stored under lock and key, in restricted areas that are isolated<br>• Transport of hazardous material must be carefully planned in advance, during low-traffic periods and avoiding residential areas as possible (local authorities must be advised)<br>• Loading and unloading of hazardous materials must be carefully supervised, and a retention system must be provided for confining any accidental spills<br>• Refueling areas must be protected to avoid ground contamination<br>• Hazardous products and wastes must be packaged following international | participant lists | |

| Project Component | Action N° | Activity | Expected Impact(s) | Mitigation and Control Measure(s), Monitoring and Corrective/Preventive Actions | Performance Indicators | Entity responsible for the action |
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| | | | | standards during storage and transport<br>• Hazardous materials must be stored away from ecologically sensitive zones<br>• Retention zones must be provided in hazardous waste storage areas (fuel tanks must surrounded by a retention area capable of holding 110 of the volume of the tank)<br>• Used oils must be stored in a dedicated site, and not mixed if possible<br>• Containers and tanks for hazardous products or wastes must be tested regularly to reduce the risk of leakage | | |
| | 18.3 | Management of Leaks and Spills | Contamination of soil, groundwater or surface water | • Ensure that site machine repair shops have impermeable floors to confine pollutants<br>• Pumps, compressors and other non-mobile equipment must be placed in retention basins<br>• Vehicles and equipment must | • Daily maintenance logs<br>• Reports to DGA<br>• DGA site inspection reports<br>• Engineering design specifications and | **Contractor** with supervision of the Engineer |

| Project Component | Action N° | Activity | Expected Impact(s) | Mitigation and Control Measure(s), Monitoring and Corrective/Preventive Actions | Performance Indicators | Entity responsible for the action |
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| | | | | be subject to regular maintenance<br>• Spilled fuel, soiled sand or earth used to soak up spills and any other contaminated material must be managed in a safe manner corresponding to the properties of the material | P&IDs | |
| Removing Old Quayside Warehouses | 18.4 | Asbestos-cement roof panels | Inappropriate disposal of asbestos cement panels or materials in local sanitary landfill, with possible resulting contamination of soil, groundwater and negative impacts on human health | • Conditioning of asbestos cement roofs panels in container bags<br>• The full asbestos-removal process will be handled by a certified environmental firm, which will be required to produce a detailed program in the proposal.<br>• The asbestos cement elements will be shipped to Lisbon and disposed in an appropriate Portuguese dumping site (see Appendice 2). | • Contractor and Engineer reports | **Contractor** with the supervision of the Engineer |
| Hazardous Material Management at Port site | 18.5 | Various | • Improper handling and storage resulting in OHS/E impacts | • **See Appendice 6** | • Contractor and Engineer reports | **Contractor** with the supervision of the Engineer<br>In association with |

| Project Component | Action N° | Activity | Expected Impact(s) | Mitigation and Control Measure(s), Monitoring and Corrective/Preventive Actions | Performance Indicators | Entity responsible for the action |
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| | | | | | | ENAPOR |
| **19. Auditing Plan to Ensure Implementation of Mitigation Measures** | | | | | | |
| Environment Auditing Plan for Construction Phase | 19.1 | Various | n/a | • Exhaustive list of implemented mitigation measures<br>• Comparison between initial state and monitoring results<br>• Evaluation of mitigation efficiency, through comparison between predicted and measured data<br>• Implementation of additional corrective actions if required | • Contractor and Engineer reports<br>• DGA reports<br>• NGO's reports | **MCA-CV & ENAPOR** |

# B. Operational Phase

| Project Component | Action N° | Activity | Expected Impact(s) | Mitigation and Control Measure(s), Monitoring and Corrective/Preventive Actions | Performance Indicators | Entity responsible for the action |
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| **1. Environmental Monitoring Plan (see also Environmental Program in Appendice 5)** | | | | | | |
| Land Environment, Marine Environment | 1.1 | Various | n/a | • Appoint environmental/H&S coordinator and environmental inspection supervisor | • Monitoring reports | **ENAPOR** |

| Project Component | Action N° | Activity | Expected Impact(s) | Mitigation and Control Measure(s), Monitoring and Corrective/Preventive Actions | Performance Indicators | Entity responsible for the action |
|---|---|---|---|---|---|---|
| and Coastal Zone | | | | • Monitoring of land environment (water, noise, vibration, air quality, flora, avifauna)<br>• Monitoring of marine environment (benthic communities, geo-chemicals in marine sediments) | | |
| **2. Vegetation Planting and Restoration of Natural Habitat Mitigation Plan** | | | | | | |
| Restore vegetation coverage after construction (Cargo Village, Contractor's site) | 2.1 | Site cleanup and landscaping | • Bared topsoil<br>• Use of vegetation not appropriate to Cape Verde climate | • Use removed vegetation to landscape during site cleanup wherever possible<br>• Replant spaces not directly occupied by project infrastructure<br>• Use local species for re-vegetation<br>• Monitor replanted areas during and after the construction period<br>• Ensure that re-vegetation and landscaping is implemented in such a way as to ensure harmonious integration of the site and infrastructure in the | • Inspection reports of contractor and DGA | **Contractor**<br>then the Port Operator |

| Project Component | Action N° | Activity | Expected Impact(s) | Mitigation and Control Measure(s), Monitoring and Corrective/Preventive Actions | Performance Indicators | Entity responsible for the action |
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| | | | | landscape<br>• Given the Cape Verdean dry climate, minimize irrigation needs and maximize absorption of runoff water | | |
| Management of construction materials | 2.2 | Quarry exploitation | • Erosion of terraces | • Design terraces such that they can be recovered for use by plant species | • Report of contractor landscape architect or other specialist(s) | **Quarry Owner/Operator** |
| **3. Dredge Material Management Plan** | | | | | | |
| Not Applicable to Phase 1 Port Project | | | | | | |
| **4. Ballast Water Management Plan** | | | | | | |
| Not Applicable in Praia (ships don't release ballast waters in Praia) | | | | | | |
| **5. Public Consultation and Community Communications Plan for Operations Activities** | | | | | | |
| Information of stakeholders | 5.1 | Various | n/a | • Create a background information (*e.g.* newsletters, press releases)<br>• Organize, promote and facilitate consultation of all stakeholders (meetings, logbooks) | • Number of articles<br>• Number of meetings and attendance<br>• Logbooks<br>• Number of website connections<br>• Complaints follow | **ENAPOR** |

| Project Component | Action N° | Activity | Expected Impact(s) | Mitigation and Control Measure(s), Monitoring and Corrective/Preventive Actions | Performance Indicators | Entity responsible for the action |
|---|---|---|---|---|---|---|
| | | | | • Create a website for the project, informing on project and monitoring results, and collecting complaints | up | |
| **6. Occupational Health and Safety Plan** | | | | | | |
| Exposure of personnel to hazardous materials, excessive levels of noise, vibrations, air pollution, chemicals and dangerous products, etc. | 6.1 | Various | Various | • Provision of protective equipment for personnel (including hearing protection devices) appropriate to specific job requirements, including training regarding proper use and maintenance<br>• Periodic reviews and assessments regarding project safety and industrial hygiene practices and programs<br>• Assessment and inspection of chemical control practices, use of protective equipment, noise control measures | • Employee health records<br>• Inspections by Competent Authority | **ENAPOR** |
| Fire and Other Emergency Situations | 6.2 | Various | Damage to human health, sensitive eco-systems and human infrastructure from fire or other emergencies | • Implement standard fire prevention actions, including clear signs prohibiting smoking or other activities in high-risk areas (e.g. fuel and hazardous or polluting substance storage | • ENAPOR reports<br>• DGA inspection reports<br>• Procedures | **ENAPOR** |

| Project Component | Action N° | Activity | Expected Impact(s) | Mitigation and Control Measure(s), Monitoring and Corrective/Preventive Actions | Performance Indicators | Entity responsible for the action |
|---|---|---|---|---|---|---|
| | | | | areas)<br>• Prohibit onsite incineration of used materials, vegetation, household or other waste, and ensure that offsite management complies with national and local legal and regulatory framework and international guidelines<br>• Prohibit the use of open fires for cooking<br>• Ensure that fire extinguishers and other fire fighting equipment are available and easily accessible<br>• Ensure that emergency procedures (including the names of persons responsible for safety, emergency telephone numbers and reporting procedures) at appropriate locations at the site, and that workers are properly instructed regarding the same | | |

| Project Component | Action N° | Activity | Expected Impact(s) | Mitigation and Control Measure(s), Monitoring and Corrective/Preventive Actions | Performance Indicators | Entity responsible for the action |
|---|---|---|---|---|---|---|
| **7. Management of Materials Requiring Special Treatment** | | | | | | |
| Management of Materials Requiring Special Treatment | 7.1 | Various | • Unsafe behaviors<br>• Damage to health and environment | • Clearly identify materials requiring special treatment<br>• Working procedures (*e.g*. for handling, preparation, stabilization, transportation) | • ENAPOR reports<br>• Procedures | **ENAPOR** |
| **8. Spill and Hazardous Materials Control Plan** | | | | | | |
| Management of Machines and Vehicles | 8.1 | Lubrication of machines and other equipments | • Accumulation and possible spills of used oils | • Collection of used oils in drums, to be sent to the Shell used oil collection facility<br>• Vehicles and equipment must be subject to regular maintenance<br>• Training of operators regarding proper management of used oils<br>• Installation of a retention basin where used oils and other hazardous materials are stored<br>• Ensure that site machine repair shops have impermeable floors to confine pollutants<br>• Spilled fuel, soiled sand or | • Inspection of drum storage facility<br>• Log of vehicle and equipment maintenance<br>• Training materials, programme and participant list<br>• Waybill confirming shipment of used oils to Shell or other receiving facility | **ENAPOR** |

| Project Component | Action N° | Activity | Expected Impact(s) | Mitigation and Control Measure(s), Monitoring and Corrective/Preventive Actions | Performance Indicators | Entity responsible for the action |
|---|---|---|---|---|---|---|
| | | | | earth used to soak up spills and any other contaminated material must be managed in a safe manner corresponding to the properties of the material | | |
| Hazardous Material Management | 8.2 | Various | • There are non-insignificant risks of leaks or spills, with possible consequent contamination of soil, groundwater or surface water in the area of the construction site | • All hazardous materials must be clearly labeled following international labeling standards<br>• Chemical products or waste considered to be hazardous must be registered and their use and movement tracked<br>• Workers must be trained in the handling of hazardous materials<br>• Transport of hazardous material must be carefully planned in advance, during low-traffic periods and avoiding residential areas as possible (local authorities must be advised)<br>• Loading and unloading of hazardous materials must be carefully supervised, and a retention system must be | • Daily maintenance logs<br>• ENAPOR hazardous waste storage and transport reports<br>• Training participant lists<br>• DGA site inspection reports | **ENAPOR** |

| Project Component | Action N° | Activity | Expected Impact(s) | Mitigation and Control Measure(s), Monitoring and Corrective/Preventive Actions | Performance Indicators | Entity responsible for the action |
|---|---|---|---|---|---|---|
| | | | | provided for confining any accidental spills<br>• Refueling areas must be protected to avoid ground contamination<br>• Hazardous products and wastes must be packaged following international standards during storage and transport<br>• Hazardous materials must be stored away from ecologically sensitive zones<br>• Retention zones must be provided in hazardous waste storage areas (fuel tanks must surrounded by a retention area capable of holding 110 of the volume of the tank)<br>• Used oils must be stored in a dedicated site, and not mixed if possible<br>• Containers and tanks for hazardous products or wastes must be tested regularly to | | |

| Project Component | Action N° | Activity | Expected Impact(s) | Mitigation and Control Measure(s), Monitoring and Corrective/Preventive Actions | Performance Indicators | Entity responsible for the action |
|---|---|---|---|---|---|---|
| | | | | reduce the risk of leakage | | |
| Hazardous Material Management at Port site | 8.3 | Various | • Improper handling and storage resulting in OHS/E impacts | • See Appendice 6 | • ENAPOR reports | **ENAPOR** |
| **9. Management of Solid Waste (see also Appendice 2)** | | | | | | |
| Management of Solid Waste | 9.1 | Various | • Contamination of soil, groundwater and surface water, with consequent impacts on human health and environment<br>• Vectors for disease and other negative human health and environmental impacts of uncontrolled waste deposits<br>• Impacts on human health and environment (e.g. fauna and flora) of airborne waste | • Avoid incineration, uncontrolled burial or unsanctioned dumping of solid wastes (e.g. by providing suitable containers that are emptied regularly)<br>• Maximize reuse and recycling of waste materials (including excavated materials, which must be managed in a way that minimizes erosion, production of dust and visual impact)<br>• Implement separation of wastes at the source (e.g. through a site waste deposition and sorting area), especially at the Cargo Village (dedicated area for bins West of Container Freight Stations)<br>• Protect waste deposits and | • DGA inspection reports<br>• ENAPOR reports<br>• Waste management plan | **ENAPOR** |

| Project Component | Action N° | Activity | Expected Impact(s) | Mitigation and Control Measure(s), Monitoring and Corrective/Preventive Actions | Performance Indicators | Entity responsible for the action |
|---|---|---|---|---|---|---|
| | | | components<br>• Excessive use of natural and other resources | waste sorting areas from the elements and animal (e.g. rodent) and disease vectors<br>• Ensure that the management and final destination of waste are in keeping with local regulations and international standards<br>• Promote shipment of waste towards ports equipped with recycling facilities (such as Lisbon or Setubal, Portugal) | | |
| **10. Management of Wastewater** | | | | | | |
| Cargo Village Wastewater Management | 10.1 | Various | • Chronic and accidental pollution of soil, groundwater and surface water | • Install retention basin downstream of the cargo village in order to collect stormwater and vehicle washing water that flows through uncovered areas of the cargo village, as well as to support containment of accidental pollution (included in the project)<br>• Install separate sewer system, collecting sewage waters from the sanitary equipment of the | • Retention basin plans<br>• ENAPOR reports<br>• Waste management plan<br>• Monitoring reports | **ENAPOR**, in association with the tenants |

| Project Component | Action N° | Activity | Expected Impact(s) | Mitigation and Control Measure(s), Monitoring and Corrective/Preventive Actions | Performance Indicators | Entity responsible for the action |
|---|---|---|---|---|---|---|
| | | | | Cargo Village buildings. All sanitary sewage waters shall be drained from the buildings towards a compact Wastewater Treatment Plant (WWTP) located south of the Cargo Village. Water flows will be measured at the WWTP inlet. Once a month water samples shall be taken at the WWTP outlet and analyses shall be made to make sure that:<br>▪ COD is always below 125 mg/liter<br>▪ Matters in suspension are below 35 mg/liter<br>▪ Helminthe eggs are always less than 1/ml<br>▪ *E. Coli*. are always less than 1,000/ml | | |
| **11. Management of Air Emissions** | | | | | | |
| Management of Atmospheric Emissions | 11.1 | Various | • Health impacts from pollutants derived from exhaust from site mechanical equipment (cranes, | • Each vehicle must undergo regular inspection in terms of emissions | • Daily maintenance logs<br>• DGA inspections | **ENAPOR** |

| Project Component | Action N° | Activity | Expected Impact(s) | Mitigation and Control Measure(s), Monitoring and Corrective/Preventive Actions | Performance Indicators | Entity responsible for the action |
|---|---|---|---|---|---|---|
| | | | trucks, etc.) | | | |
| **12. Operation Security and Emergency Plan** | | | | | | |
| Site Management | 12.1 | Various | • Uncontrolled access to work sites<br>• Unknown evacuation procedures | • Permanent fencing and security gates<br>• Control the access (check-in procedure or tag system for workers and visitors)<br>• Use of security guards<br>• Evacuation procedures and exercises<br>• Alarm systems and security systems<br>• If necessary, create site areas with restricted access even to workers (*e.g.* hazardous materials storage) | • ENAPOR reports<br>• Security guards reports<br>• Security procedure training reports | **ENAPOR** |
| **13. Economic Impact Monitoring Plan** | | | | | | |
| Project Impact on Santiago Economy | 13.1 | Various | n/a | • Establish a baseline on economic sectors and demography of Praia and Santiago Island<br>• Assessment of short-term and medium-term impact (*e.g.* on | • Baseline and annual Reports | **ENAPOR** |

| Project Component | Action N° | Activity | Expected Impact(s) | Mitigation and Control Measure(s), Monitoring and Corrective/Preventive Actions | Performance Indicators | Entity responsible for the action |
|---|---|---|---|---|---|---|
| | | | | an annual basis) | | |
| **14. Auditing Plan to Ensure Implementation of Mitigation Measures** | | | | | | |
| Environment Auditing Plan for Operation Phase | 14.1 | Various | n/a | • Exhaustive list of implemented mitigation measures<br>• Comparison between initial state and monitoring results<br>• Evaluation of mitigation efficiency, through comparison between predicted and measured data<br>• Implementation of additional corrective actions if required | • ENAPOR reports<br>• DGA reports<br>• NGO's reports | **ENAPOR** |

## Appendice 1

## Quarry Environmental Management

Typical mitigating measures during a quarry operating phase are as follows:

- *Destruction of fauna and vegetation cover:* care should be taken to leave vegetation and animal habitats around the quarry as untouched as possible. Workers should be trained regarding the presence of and need to preserve sensitive habitats within and outside of the site boundary.
- *Chemical pollution:* the impacts of pollutants such as dust, silt, oil, fuel and other chemicals should be reduced or eliminated through proper storage, offsite recycling, watering down waste piles, and other common measures.
- *Blasting:* Damage to fauna and sensitive habitats should be limited by carefully selecting blasting zones and the time of blasting activities.
- *Erosion:* Erosion resulting from road construction and other construction activities should be minimized, for example by ensuring that rainwater can soak into the ground slowly. Uncontrolled drainage of muddy runoff should be avoided.
- *Groundwater:* Underground water resources close to a conservation area should be left intact, that is, undisturbed by quarry operations.

Habitat disturbance and the effects of mitigating measures should be monitored regularly, for example at three-year intervals (depending very much on the nature of the site and of the quarry activities).

Subsequent to depletion of the site, a closure and rehabilitation plan must be developed for reconstructing the landscape, in compliance with Cape Verdean law and international practice. Financing of the closure plan (normally by the company responsible for exploitation of the site) must be ensured well in advance of site closure. Closure and rehabilitation could include the following measures:

- Removal of wreckage, buildings, equipment.
- Remodeling perpendicular slopes.
- Loosening the quarry floor and access roads (normally compressed and hardened by the use of heavy machinery).
- Ensuring sufficient drainage of the quarry floor.
- Filling in crevices and holes in reconstructed gentle slopes with sterile soil.
- Replanting.
- Monitoring the results.

The precise mitigation measures would be dependent of the chosen quarry/quarries.

Nevertheless, the MCC Environmental Guidelines require that proposed projects must be developed such that they “are not likely to cause significant environmental, health or safety hazard.” There must be some assurance that the production of quarry material to be used for port construction does not result in any significant negative environmental impacts.

Two special conditions could be added to the materials supply contracts:

1. The quarries must have, from the start of the project, a permanent quarrying authorization delivered by DGA. The non renewal of a temporary authorization valid for one year could compromise the continuity of supply of the project site:
2. The operator(s) must present a landscape and ecological rehabilitation plan, along with financial guarantees for its accomplishment, validated by the DGA. Such a plan alone provides the assurance that the indirect impacts of the project on the environment due to the supply of quarry materials, will be under control. Although it cannot be formally requested, the partial rehabilitation, depending on the cases, of quarry sites at the end of the project would be desirable.

# Appendice 2

## Waste Management

Non-hazardous waste management in Cape Verde is governed by Decreto-Lei n°31/2003 of September 1, 2003. This law requires proper management of municipal wastes with a view to protecting the environment and public health. Emphasis is placed on waste prevention and waste recovery. Responsibility for proper waste management is placed on the municipalities, companies, and health units (with respect to medical wastes).

Management of hazardous and non-hazardous wastes at the Port of Praia is not implemented within an overall framework for waste management. Furthermore, although municipal waste collection services are provided in the city of Praia, there is at present no national or city integrated waste management plan, and waste management infrastructure in the city of Praia is considered inadequate. Waste management is therefore addressed here as a global issue that is of concern for implementation of the EMP. The project will involve management of non-hazardous domestic wastes (including plastic and paper), construction wastes (some of which may be hazardous), and hazardous wastes.

There are currently four kinds of waste that are managed by the Port of Praia:

- Food waste (largely from the cabotage area).
- Plastic.
- Paper (especially empty boxes).
- Used hydraulic and lubricating oils.

Empty containers present a significant problem at the port, for which a solution has not so far been found.

Currently the first three types of waste are collected by the city of Praia waste collection services and delivered to the city landfill (Lixeira do Praia), which is located close to the new ring road, at the connection with the Cidade Velha road. The city landfill does not meet international standards for sanitary landfill design, construction and operation, although such a landfill is being planned for the future, for the whole island. Approximately two to three trucks (each with a capacity of 20 $m^3$) remove waste every week. Used oils are collected in steel drums and delivered to Shell, who ships the oils to Senegal for recycling. Otherwise there appear to be no opportunities for recycling waste materials on the island of Santiago at present.

The port **Safety Manual** specifically addresses a limited number of hazardous wastes:[8]

- Various petroleum products (especially jet fuel, gas oil, heavy fuel oil, gasoline and liquefied petroleum gas, or LPG).
- Ammonia.

By IMO requirements, incoming vessels must report to the port the presence of any hazardous wastes in containers.

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[8] Hazardous materials are generally defined as those materials that possess one or more of the following qualities: flammable, corrosive, explosive or toxic characteristics.

The project will result in various types of construction and demolition wastes (including asbestos-cement roof tiles that will be removed from existing during demolition of existing Quay 2 warehouses, and shipped to Portugal). Furthermore, the expected significant increase in the volume of containers during the operational phase of this project will result in increased quantities of non-hazardous packing wastes, dunnage, and possibly additional types and quantities of hazardous materials.

Following are the issues that should be addressed specifically during the construction and operational phases of this project:

- Identification and classification of waste types/waste streams.
- Evidence of the use specific materials and substances in order to reduce or eliminate hazardous characteristics of certain wastes.
- Source reduction/recycling/reuse guidelines for selected wastes.
- Disposal requirements for non-recyclable non-reusable waste types.
- Handling, transport and storage requirements for each major waste type/waste stream.
- Waste tracking procedures.
- Locations of site waste management facilities, design features, operational procedures and monitoring programs for project waste management facilities' during both the construction and operational phases of this project.

These waste management issues should be specifically reflected in the CEMP, and should be incorporated in a Port-wide Waste Management Plan including also the fishing part of the port, which largely contributes to the pollution of the basin waters (notably by oil and paint residues).

Specific measures regarding the use of hazardous materials and management of hazardous and non-hazardous wastes during the construction and operational periods of this project are provided in this EMP.

## ASBESTOS CEMENT

The roofs of the hangars close to Quay 2 are made of asbestos-cement. The roof panels will be removed manually, stored on the quay, and then taken away for specific processing. The panels are to be removed manually without any drilling, sawing or grinding, to avoid releasing asbestos fibers into the atmosphere. Workers will wear adequate protective clothing (suits, gloves, masks).

After their removal, the panels will be handled as follows:

- The materials may be stored temporarily on the engineered storage site, under surveillance.
- The demolition contractor will be required to palletize and package asbestos-cement panels and to then enclose them in double walled big bags or container bags made from polypropylene and polyethylene. The material is to be marked ‘asbestos’.
- The carrier will ensure the integrity of the packaging units, in particular by using smooth containers free of any internal hooks.
- Transport of these wastes is covered by a consignment note for asbestos waste

These corrugated sheets containing asbestos with a cement binder represent a quantity estimated at 57 tons. After removal, of the panels and their packaging[9], could be either dumped in an appropriate (and not yet existing) storage site in Cape Verde, or included in road fill materials, or exported to an abroad accredited facility.

A possible final destination is the CITRI dump Setúbal, Portugal (easily reached by ship from Praia), or the ResiLei dump site, located in Leiria. These two Portuguese landfills have been contacted, and are equipped with cells dedicated to this type of waste. However, the Contractor shall be allowed to propose to the Engineer any other suitable treatment site.

[9] These panels must be previously confined in big bags or deposited in wooden platforms totally covered with plastic film.

| Legal requirements |
|---|
| The legal requirements to export the asbestos wastes to Portugal must attend the requirements of the European Council (CE) 1013/2006, 14 de June de 2006 and the Portuguese law 259/93, February 1st. A preliminary authorization of the Portuguese Environmental Agency and Cape Verde legal authorities is required.<br><br><u>Waste shipments by sea</u><br><br>Competent Authority: Portuguese Environment Agency (APA)<br><br>For shipments of waste that are carried out by sea is required:<br><br>▪ generic favorable opinion of the Directorate General of Ports, Shipping and Navigation (DGPNTM), which led into account the safety standards specific to the transport concerned to ensure the safety of navigation, the safety of life at sea and the protection of the environment;<br><br>▪ Mention in the ship's daily nautical transport of waste, the inputs and outputs in national waters of member states or third countries and the date of delivery to the respective recipients;<br><br>▪ Record at the loading of the vessel's location, type, packaging and quantity of waste transported;<br><br>▪ Maintenance on board the ship samples of the waste transported, for a minimum period of three months, properly identified, sealed and authenticated by the charger and notifier, in the case of bulk transportation of waste;<br><br>▪ Collection of samples, as defined in the preceding paragraph, when breakdowns occur in charge, involving spills of waste packaged.<br><br><u>Financial guarantee</u><br><br>▪ Shipment of waste covered by the provisions of Regulation is subject to establishment of a financial guarantee or equivalent to cover the costs of shipment and its disposal or recovery.<br><br><u>Insurance</u><br><br>▪ Shipments of waste which applies this diploma are conditional on the existence of civil liability insurance for damage to the environment or public health.<br><br>▪ The obligation to insure lies with the carrier.<br><br>▪ The contract of insurance for the guarantee of the payment of claims that are legally due to the insured, because of its responsibility subjective or objective, for damage caused to third parties and that resulting from the exercise of the professional activity of transporting waste. |

## Appendice 3
## Environmental Communication Program

# Construction Phase Reporting Requirements

The Contractor shall be required to prepare a number of periodic reports including:

- Monthly Reports during the construction phase
- Special Reports / Incident Response Reports
- Final Report on the construction phase

### Monthly Reports

The monthly reports shall be prepared during the whole construction phase of the project. This report may include all information collected at the different work sites; emphasizing the environment control measures used, the achievements accomplished, and difficulties encountered. Copies of the environmental site forms may be incorporated as an appendix.

### Special Reports / Incident Response Reports

Extraordinary events, such as incidents that cause or have the potential to cause pollution, or extraordinary repairs or maintenance, requires special reports to document magnitude of the impacts and the effectiveness of the corrective actions and remedial work.

### Final Report

Within one month after conclusion of the project, a draft of the Summary of Environmental Monitoring during Construction report will be required. This report will describe the work done on each of the environmental issues and the resolution of any complaints received. This draft may be reviewed and commented before being presented to the regulatory entities. The final version of this report will include all comments made and may be required to be submitted within one month following receipt of comments from the regulatory entities.

### Field Logbooks

Field logbooks shall be used to document where, when, how, and from whom any vital project information was obtained. Logbook entries should be complete and accurate enough to permit reconstruction of field activities. Bound with consecutive numbered pages, they may be illustrated by photographs.

## Operational Phase Reporting Requirements

ENAPOR will prepare annual reports that document the relevant environmental issues occurring during that period, including results of operational monitoring.

## Appendice 4

## Construction Phase Monitoring Program

Environmental monitoring of the site will have the objective of monitoring application of the Environmental Management Plan during the works.

# Monitoring of land environment

**Table D.1 Monitoring programme during works in progress : land environment**

| Type of monitoring and measurements | Stations / sampling | Frequency |
|---|---|---|
| **Water** | | |
| Measurement of the quality of wastewater: physicochemical parameters (TSS, $O_2$, pH, $BOD_5$) | All the site effluents: wastewater (after purification treatment), washing water, stormwater | Every two weeks during the site works and according to particular events |
| Measurement of the quality of wastewater: heavy metals, PAH | Same as above plus effluent from the concrete and macadam mixing plants | Monthly and according to particular events |
| Measurement of the quality of the groundwater by piezometry (TSS, pH, PAH, bacteriology) | Preliminary measurement campaign before the works on the contractor's installation site (1 station), the cargo village (2 stations), and the excess excavated material stocking site (2 stations). | 6 months before the works, 1 measurement per month<br>Monthly measurements during the site works |
| **Noise** | | |
| Measurement of the ambient noise level over a 24-hour period | 5 measurement points: see map of measurement points drawn up for the analysis of the initial condition of the site. | 1 measurement per month and point measurements according to particular events |
| **Vibration** | | |
| Vibration measurement (particle velocities) during certain specific work, such as rock excavation using explosives | Concerns the excavation of the' cargo village site in relation with the proximity of the hydrocarbon storage sites | According to the need to excavate rocks. |

| | | |
|---|---|---|
| **Air quality / dust** | | |
| Measurement of air quality parameters over 24 h: $NO_x$, $SO_2$, CO, $CO_2$, Unburned hydrocarbons (HC) and $PM_{10}$ [10] | 1 station centered on the site<br>1 control station situated in the inhabited quarter of Achada Grande | Measurements on the control station for 6 months before starting the work (1 monthly measurement)<br>Monthly measures during the site works |
| Measurement of dust contents<br>(placing of filters for 24 h) | 1 station on the contractor facilities site, the cargo village site and the excess excavation material depot.<br>2 stations on the main road | Measures on a control station for 6 months before starting the work (1 monthly measurement)<br>Monthly measurement during the site works |
| **Landscape** | | |
| Photographic record showing the development of the landscape in relation to the execution of the different work sites | Photographs at 10 points characteristic of the local landscape | A series of monthly photographs |
| **Flora** | | |
| Prior inventory of the plant species identifying the rare, endemic and protected species | All the sites concerned by the project: contractor facilities site, Cargo village site, site for provisional stocking of excess excavation material | Pre-works inventory |
| Monitoring of the station of the rare and endemic species *Sarcostemma daltonii (Gestiba)*. | | Periodic monitoring to ensure the long-term continuity of the station concerned (top of the cliffs) |
| **Avifauna** | | |
| Prior inventory of the avifauna | All the sites concerned by the works and the sites: contractor facilities site, Cargo village site, site for provisional stocking of excess excavation material, maritime cliff areas. | Pre-works inventory |
| Monitoring of the two species *Phaeton aethereus* (Rabo de Junco) and *Pandion haliaetus (*Guincho) | Coastal cliffs, particularly those concerned by the layout of the road | Periodic observations during the works (monitoring of frequentation and nesting) |

[10] $PM_{10}$ = particles of aerodynamic diameter less than 10 µm.

## Monitoring of marine environment

**Table D.2 Monitoring programme during works in progress: marine environment**

| Type of monitoring and measurements | Stations / sampling | Frequency |
|---|---|---|
| **Benthic communities** | | |
| Inventory of the benthic populations of the hard and soft substrates | Area of the road affecting the marine environment.<br>Sampling of stations 5 and 3 (see location in the analysis of the initial condition of the site) | Pre-works inventory (1st campaign) |
| **Geochemicals in marine sediments** | | |
| Measurement of the quality of the sediments (physico-chemical parameters, heavy metals, PCB, HAP, TBT) | Sampling of stations 5 and 3 (for the access road ) and station 1 (for the quay n°2 renovation work) | Pre-works measurements (1st campaign) |

| **Marine water quality** | | |
|---|---|---|
| Measurement of water quality during the period of construction of the access road: physico-chemical parameters (suspended matter, $O_2$, pH) | The essential objective will be to check the contents of matter in suspension to avoid reaching excessively high levels that would affect the marine environment. Two stations will be sampled (stations 5 and 3), at a depth of –3 m. | 1 time per week during the marine environment reclamation work and according to particular events. |
| Note: the construction of the road is accompanied by measures to reduce the suspended matter contents at source. The proposed way of reducing this risk is to first build the breakwater to provide protection against the swell, then to fill the volume between the breakwater and the foot of the cliff with aggregate materials. This solution will limit to a large extent the washing out of fine particulate materials and production of suspended particulate matter that temporarily increases the turbidity of the seawater.<br>Monitoring the suspended matter content will provide a check on the effectiveness of the technical measure taken. Suspended matter contents are commonly between 17 mg/l and 30 mg/l according to the monthly measurements taken between June and October 2007. The average at station 5 is 21 mg/l with a maximum of 26 mg/l. It is recommended that:<br>▪ the works should not lead to the exceeding of a suspended matter level of 50 mg/l at the entrance to Praia bay (station 3).<br>▪ the turbidity plume should not reach the sensitive points of the bay (beaches).<br>If either of these conditions is reached, the filling work could be temporarily stopped until a normal situation is restored. | | |

## Appendice 5

## Operation Phase Monitoring Program

The **monitoring during the operational phase** consists in performing measurements and analyses in accordance with a predetermined programme to monitor the environmental impacts of the extensions to the Port of Praia facilities and structures.

# Monitoring of land environment

| Type of monitoring and measurements | Stations / sampling | Frequency |
|---|---|---|
| **Water** | | |
| Measurement of the quality of wastewater: physico-chemical parameters (TSS, $O_2$, pH, $BOD_5$), heavy metals, PAH) | Discharges from the retention basin of the settling tank and from the road. Verification of treatment effectiveness | During a significant rainy episode |
| Measurement of the quality of the groundwater by piezometry (TSS, pH, PAH, bacteriology) | One station situated hydrologically downstream of the cargo village. | 4 measurements per year |
| **Noise** | | |
| Measurement of the ambient noise level over a 24-hour period | 1 measurement point situated near the cargo village to measure its contribution to the ambient noise level. | 2 measurements per year |
| **Air quality** | | |
| Measurement of air quality parameters over 24 h: $NO_x$, $SO_2$, CO, $CO_2$, Unburned hydrocarbons (HC) and $PM_{10}$ [11] | 1 measurement point situated near the cargo village to measure its contribution to the deterioration of the air quality. | 4 measurements per year |
| **Avifauna** | | |
| Monitoring of the species *Phaeton aethereus* (Rabo de Junco) | Coastal cliffs, particularly those concerned by the layout of the road.<br>Video-Cameras installed along the connecting road will make this action easier. | Observations in the framework of the management and protection programme for this species on account of the compensatory measures. |

[11] $PM_{10}$ = particles of aerodynamic diameter less than 10 µm.

## Monitoring of marine environment

| Type of monitoring and measurements | Stations / sampling | Frequency |
|---|---|---|
| **Geochemicals in marine sediments** | | |
| Measurement of the quality of the sediments (physico-chemical parameters, heavy metals, PCB, HAP, TBT) | Sampling from stations 5 and 1. | 1 campaign one year after the works, then once every two years. |
| **Benthic communities** | | |
| Monitoring of the benthic populations of the soft and hard substrates | Sampling from station 5. | 1 campaign one year after the works, then once every three years. |
| Monitoring of the recolonization of the natural and artificial riprap by the fish | Three stations distributed along the line of riprap protecting the road | 1 campaign one year after the works, then once every three years. |

# Appendice 6

## Management of Hazardous Materials at the Port of Praia

> *The entry and presence of dangerous cargoes in port areas and any consequential handling should be controlled to ensure the general safety of the area, the containment of the cargoes, the safety of all persons in or near the port area, and the protection of the environment.* – International Maritime Organization

The Port of Praia *Safety Manual* and *Internal Emergency Plan* address in great detail the scenarios, risks and response required for leaks or catastrophic events related to the reception and transfer of petroleum products to the ENACOL and Shell tank farms above the port, near the proposed site of the Cargo Village. Issues related to reception of ammonia at the port and to transfer to the port refrigeration facility are also addressed.

However, issues related to other hazardous materials received at the port, for example in containers, are not addressed. Given the planned port expansion, provision must be made for properly managing hazardous materials that are not currently covered by the Safety Manual and IEP, and to ensure that emergency response to any spill, leak or other abnormal disposition of these materials is developed, in order to protect workers, residents in surrounding areas, and the marine and terrestrial environment.

Hazardous materials are normally defined as having one or more of the following properties: *flammable, corrosive, explosive or toxic* (for example, harmful or fatal if ingested, and known to leach into groundwater).

## New facilities

The main areas of concern are the existing storage areas for containers at the port, the future expansion of container storage next to Quay N° 1, the connecting road (used for transferring containers from the port to the Cargo Village), and the Cargo Village. In handling these materials the port must ensure 1) compliance with legal and regulatory requirements of the Republic of Cape Verde, and 2) compliance with international requirements.

The IMO has identified the following factors as critical for planning new facilities or upgrading existing facilities in a port area:

- Protection of health, property and environment
- Nature and characteristics of dangerous cargoes to be transported or handled
- Other hazardous installations in the vicinity
- Population density in the area under consideration and the vulnerability of the population
- Ease of evacuation or other measures which may need to be taken in the event of an accident

- Emergency services and procedures available

During the basic design of the new investments, the following have been assured:

- Location of facilities on areas which are safe from flooding or are adequately protected from it by means such as dykes or walls
- Unrestricted access/egress of emergency services
- Limitation of size of areas where dangerous cargoes are kept
- Use of non-flammable construction materials
- Provision of lightning protection equipment
- Installation of smoke and heat-extraction equipment
- Ensuring adequate supply of fire-extinguishing water and, if necessary, other fire control agents
- Provision of automatic fire-detection equipment
- Provision of sealed areas and absorption equipment facilities for retaining spilled substances harmful to the aquatic environment

## Operations

International regulation of transport and handling of dangerous cargoes in port areas is governed by a number of key documents, including:

- **MARPOL 73/78**, as amended
- **International Maritime Dangerous Goods (IMDG) Code and Supplement**

SOLAS[12] regulation VII/5 and MARPOL 73/78 Annex III, regulation 4 provide for the requirement that ships must make available to the port State authority a detailed list of all goods stowed onboard prior to leaving port.

The national legal and regulatory framework of the Republic of Cape Verde is assumed to be harmonised with these and other international legal agreements. **Decree N° 31/2003** establishes the requirements for management of municipal solid wastes, industrial wastes, hospital wastes and other wastes, within the overall objective of protecting the environment and public health. The generator of these wastes is legally responsible for these wastes from cradle to grave. The decree places evidence on pollution prevention and resource recovery, for example through clean technology, and recycling and reuse of materials. The application of proper 'housekeeping' measures is implied (for example, separate storage of containers containing hazardous materials in an area where response to accidents can be quickly brought to bear, and separate storage of incompatible hazardous materials). This would require the Port of Praia to carefully handle and track all hazardous materials that pass through the port area. Any hazardous wastes generated at the port through improper handling must be disposed by authorised entities.

As per IMO guidelines, an essential requirement for safe transport and handling of dangerous cargoes is their proper identification, containment, packaging, packing, securing, storage, marking, labelling, and documentation. Based on this requirement, the port authority must "exercise control over the movement of shipping through the

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[12] *International Convention for the Safety of Life at Sea* (1974).

port area and should establish systems for the receipt of prior notification and the conditions under which dangerous cargoes may enter the port area." Although the Port of Praia appears to be following this requirement with respect to bulk shipment of petroleum products and ammonia, smaller volumes of hazardous materials that arrive in containers may not be as rigorously tracked. Furthermore, it is not clear whether there are limitations on the classes or quantities of dangerous cargoes that may be handled in the port area (for example, explosives).

The Port of Praia *Safety Manual* and *Internal Emergency Plan* (IEP) must include provision for any equipment, procedures and assignment of personnel that reflect all hazardous wastes that normally pass through the port. The plan should also address the possible presence of hazardous wastes that normally would not be expected at the port (for example with respect to a ship in distress containing hazardous materials that enters the report).

The current documentation only addresses the following:

- Ammonia;
- Butane;
- Gasoline;
- Petrol;
- Diesel.

*Safety information sheets* are contained in the Safety Manual and IEP for these substances. Safety information sheets must be similarly available for all other hazardous materials that are present in the port, whether on a short- or long-term basis.

The Safety Manual and IER define high-risk (Level III) accidents as "those that occur due to a leakage of dangerous substances (flammable or toxic), which will lead to the creation of a flammable and/or toxic cloud." The accident scenarios addressed for Level III accidents at the port involve:

- Butane
- Ammonia
- Dust explosion during granulated goods discharge

These scenarios are based on possible accidents caused by leaks from cracks in valves, loading hoses or other equipment, or from road accidents within port area.

Accidents involving other hazardous materials that may be present in the port area are not specifically defined. All accident scenarios not included under Levels II or III are defined as Level I accident scenarios, which reduced levels of risk.

In principle there are no restrictions on quantity of hazardous materials brought into the port area. If such restrictions are applied, official notice must be distributed to all involved port personnel and other potentially concerned persons. The Port of Praia authority should have the right to refuse dangerous cargoes intended for use or storage within the port area, or transit through the port area, if their presence would "endanger life or property because of their condition, the condition of their containment, the condition of their mode of conveyance, or the conditions in the port area."[13] The Port of Praia authority should be able to remove any dangerous cargo within the port area that presents an unacceptable risk of hazard. Unstable substances should not be accepted unless all conditions necessary to ensure its safe transport and handling have been specified and met.

## Inspection

The port authority should regularly inspect areas and facilities used for transport, storage or other handling of dangerous cargoes. This should include:

- Inspection of documents and certificates concerning safe transport, handling, packing and storage of dangerous cargoes in the port area.
- Inspection of packages, unit loads and cargo transport units containing or relating to handling of dangerous cargoes to verify that they are packed, marked, labelled or stored in accordance with the IMDG Code, or other applicable international, national or local requirements. Unnecessary labels or marks should be removed. Cargo transport units must have been loaded, packed and secured in accordance with *IMO/ILO Guidelines for Packing Cargo in Freight Containers or Vehicles*.
- Inspection of freight containers, tank containers, portable tanks and vehicles containing dangerous cargoes to ensure they have a current safety approval plate in accordance with the *International Convention for Safe Containers* (CSC) of 1972, as amended, or otherwise that they have been approved in accordance with relevant provisions of the IMDG Code;
- Inspection, by external examination, of the physical condition of each freight containers, tank containers, portable tank or vehicle containing dangerous cargoes for any damage that might affect strength or packaging integrity, or for the presence of any sign of leakage.

An example of a checklist for inspection of containers/trailers containing dangerous cargoes is provided in the Annex.

## Precautions and emergency procedures

Fire precautions have been taken in the present port area and have been planned for the new Quay 1, Quay 2 (including container storage area), connecting road and Cargo Village. This includes a fire detection system, a pump for pumping seawater to the firewater system, and a firewater distribution network. However, provision for separate areas for storage, unpacking or repacking of containers with hazardous materials, and for subsequent special precautions in those areas, has not been made. Damaged packages containing dangerous cargoes must not leave these designated areas unless they have been repackaged and are confirmed to be fit and safe for further transport and handling.

[13] Source: IMO

Other possible precautions, according to need, are as follows:

- Fire resistant walls
- Ventilation
- Fire extinguishers
- Extinguishing sand
- For enclosures designated for storage of liquid hazardous materials, appropriate floor construction and drainage[14]
- Electrical equipment and wiring specified for storage of flammable gases and liquids of a flashpoint below 23 °C
- Gas detection and warning system for storage of hazardous substances demonstrating a toxic inhalation hazard
- Segregation according to the IMDG Code

Special requirements apply to explosives of Class 1 (except for Class 1.4), if allowed to enter the port area. Separation distances are specified/

Hot work and any use of equipment or implementation of activities that may lead to a fire or explosion hazardous should be prohibited in areas where certain dangerous cargoes are handled, unless authorised by the port authority. Hot work should only be carried out by personnel approved by the port authority for these activities. In areas where a flammable atmosphere may exist or develop, electrical equipment should be specified for use in a flammable atmosphere.

The following are the minimum requirements for emergency response:[15]

- Provision of appropriate emergency alarm operating points
- Procedures for notification of an incident or emergency to the appropriate emergency response services within and external to the port area
- Procedures for notification of an incident or emergency to the port area users, both on land and water
- Provision of emergency equipment appropriate to the hazards of the dangerous cargoes to be handled.
- Formation of a local emergency response team to coordinate action in the case of a major emergency and to deal with any day-to-day incidents such as minor leaks or spillage or other contact of dangerous cargoes with persons, soil, water or air.
- Coordination of arrangements for the release of a ship in case of an emergency
- Arrangements to ensure adequate access/egress at all times.

These requirements have been addressed in the Port of Praia Safety Manual and IEP.

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[14] Drained to a sump of capacity 3,000 l, the maximum permitted capacity of one intermediate bulk container).

[15] Ibid.

## Bibliography

1. *Recommendations on the Safe Transport of Dangerous Cargoes and Related Activities in Port Areas*, IMO (1995)
2. *Dangerous cargoes in ports, Report of Working Group 35*, International Navigation Association (2000)

## Example of checklist for container/trailer inspection on dangerous cargoes

<table>
<tr><td rowspan="2">Type of container:</td><td colspan="3">o Container<br><br>o Trailer</td><td rowspan="2">Place of first origin:</td><td rowspan="2">Place of last destination:</td><td rowspan="2">By company:</td></tr>
<tr><td>20°</td><td>40°</td><td></td></tr>
<tr><td>Checking place:</td><td colspan="3" rowspan="2">Authorized party (name/company)</td><td colspan="3">Opened/closed by:<br><br>o Authorized party o Waterways police o Customs</td></tr>
<tr><td>Date:</td><td>Container n°:</td><td colspan="2">Seal n° …………………..<br><br>Old: ……………………...<br><br>New: ……………………...</td></tr>
<tr><th>Mode of Inspection</th><th colspan="4">Defects</th><th colspan="2">Remarks</th></tr>
<tr><td>Documentation</td><td colspan="4" rowspan="2"></td><td colspan="2" rowspan="2"></td></tr>
<tr><td>1. Particulars on packing certificate/shipping note</td></tr>
<tr><td>Outside Inspection</td><td colspan="3" rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td></tr>
<tr><td>2. Identification, marking of container/trailer according to contents shown on dangerous good declaration</td></tr>
<tr><td>3. CSC Convention</td><td colspan="3"></td><td></td><td></td><td></td></tr>
<tr><td>Inside Inspection</td><td colspan="3" rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td></tr>
<tr><td>4. Packaging marking and labelling of packages inside container/trailer</td></tr>
<tr><td>5. Segregation</td><td colspan="3"></td><td></td><td></td><td></td></tr>
<tr><td>6. Stowage</td><td colspan="3"></td><td></td><td></td><td></td></tr>
<tr><td>7. Packages damaged</td><td colspan="3"></td><td></td><td></td><td></td></tr>
<tr><td>8. Measures taken</td><td colspan="3"></td><td></td><td></td><td></td></tr>
</table>

# Annex 1

## Environmental Marine Survey Report

# ENVIRONMENTAL STUDIES OF THE PORT OF PRAIA EXPANSION AND MODERNIZATION PLAN (SANTIAGO ISLAND, CAPE VERDE)

## Marine Survey

*By Subcontractor*

**IMAR – Instituto do Mar**
Guia Marine Laboratory
Faculty of Sciences of University of Lisbon
**Coordinator**: José Paula (Associate Professor)
**Researchers**: Abel Sousa Dias, David Gonçalves

**May 2007**

## PRELIMINARY NOTE

This report presents the results obtained by subcontractor IMAR during the campaign carried out at Praia Bay, Santiago Island, Cabo Verde. The structure of this reports follows strictly the Annex II of the relevant subcontract, concerning the technical specifications of those Terms of Reference specifically assign to IMAR by Geosolve.

# INDEX

***Note***: The capitulation refers to the Technical Annex.

## 1.2.1 – Underwater video

The exact methodology for this component was not precise in the technical protocol. A number of options were assumed, in function of the characteristics of the area, the logistical constraints and issues such as diving security:

1) The method for producing the video used Video Hi8 Sony TR2000 camcorder fitted into Ikelite sealed equipment.
2) The photographs were produced by 2 Sea&Sea MM II –EX cameras using 35 mm conventional film, later digitized using a Nikon 5000 slide scanner.
3) The length of transects and especially a number of critical insecure parts for divers have obliged to use a point approach along the defined transects. Please see Fig. 1 for stations used. Note that 2 of the stations presented risky or adverse conditions for performing the footage. Station1, inside the inner harbour presented high risks, as traffic of heavy ships at low depths was permanent. Station 10 is in the surf zone near the beach, with very restricted visibility and high water movement, thus preventing any adequate filming. Filming was thus restricted to the stations 2-9.
4) Filming stations were geo-referenced, and depth registered.
5) A continuous filming was performed, between 8 and 45 minutes according to the bottom level of heterogeneity.
6) Hi8 video was converted to DV (Digital Video), and illustrative parts were edited using a Macintosh based system and inserted in DVD.
7) Complete filming and photographic records were kept for eventual future reference.
8) In addition, the referenced wrecks existing in the bay were surveyed and filmed. These images are included in the annexed DVD. The image taken for the wrecks is basically non-edited.

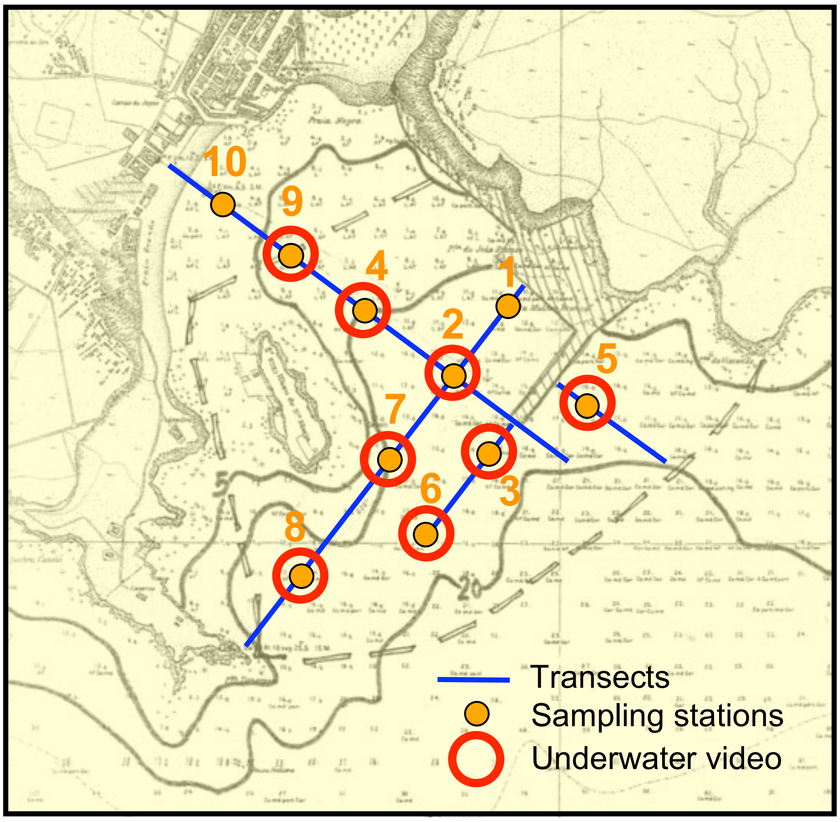



**Figure 1** – Map of Praia Bay showing position of stations used for video.

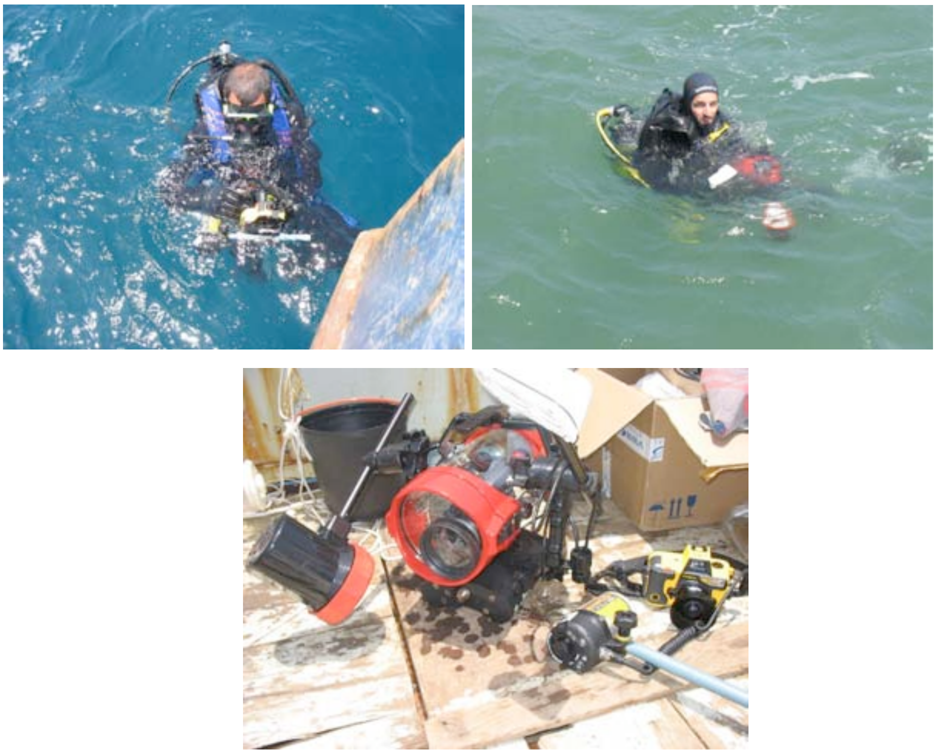


**Figure 2** – Divers and equipment used.

A brief description of the diving data is presented in table I.

**Table I** – Dive description.

| Date | Local time | Location | GPS | Objective | Max. depth (meters) | Average depth (meters) | Duration | Temperature (ºC) | Bottom description |
|---|---|---|---|---|---|---|---|---|---|
| 29.04.2007 | 11:24 | station #5 | 14º 90854 N 23º 49815 W | fish count and bottom video | 13,4 | 10,9 | 61 | 23 | sand with scattered rocks |
| 30.04.2007 | 10:11 | station #6 | 14º 90319 N 23º 50257 W | fish count and bottom video | 15,8 | 12,3 | 64 | 23 | rocky bottom with sandy intervals |
| 01.05,2007 | 11:00 | wreck # 1 | 14º 54' 41"N 23º 30' 26"W | wreck video | 5,9 | | 8 | 23 | muddy |
| 01.05.2007 | 15:38 | wreck #4 "Fátima" | 14º 54876 N 23º 30201 W | Wreck video | 6,5 | 4,7 | 23 | 23 | muddy |
| 01.05.2007 | 17:09 | wreck # 1 "Federico" | 14º 54' 41"N 23º 30' 26"W | wreck video | 6,5 | 4,2 | 19 | 23 | muddy |
| 02.05.2007 | 8:49 | station #3 | 14º 90663 N 23º50036 W | fish count and bottom video | 17,9 | 14,8 | 36 | 23 | sandy bottom with scattered small boulders |
| 02.05.2007 | 14:26 | station #4 | 14º 91056 N 23º 50570 W | bottom video | 9,2 | 7,2 | 13 | 23 | sand with a fine mud layer |
| 02.05.2007 | 15:02 | station #9 | 14º 91132 N 23º 50671 W | bottom video | 6,8 | 4,7 | 16 | 23 | fine sand/muddy |
| 02.05.2007 | 14:38 | wreck #2 | | wreck video | 5,5 | 3,9 | 25 | 23 | muddy |
| 03.05.2007 | 8:56 | station #8 | 14º 90227 N 23º 50610 W | bottom video | 16,3 | 12,1 | 16 | 23 | rocky bottom with sandy intervals |
| 03.05.2007 | 9:32 | station #7 | 14º 90474 N 23º 50368 W | bottom video | 15,2 | 10,2 | 25 | 23 | rocky bottom with sandy intervals |
| 03.05.2007 | 10:26 | station #2 | 14º 90908 N 23º 50230 W | bottom video | 13,8 | 10,7 | 8 | 23 | very muddy |
| 03.05.2007 | 11:00 | wreck #3 | 14º 91151 N 23º 50788 W | Wreck video | 6,1 | | 12 | 23 | muddy |

## 1.2.4. – Sediment biological sampling

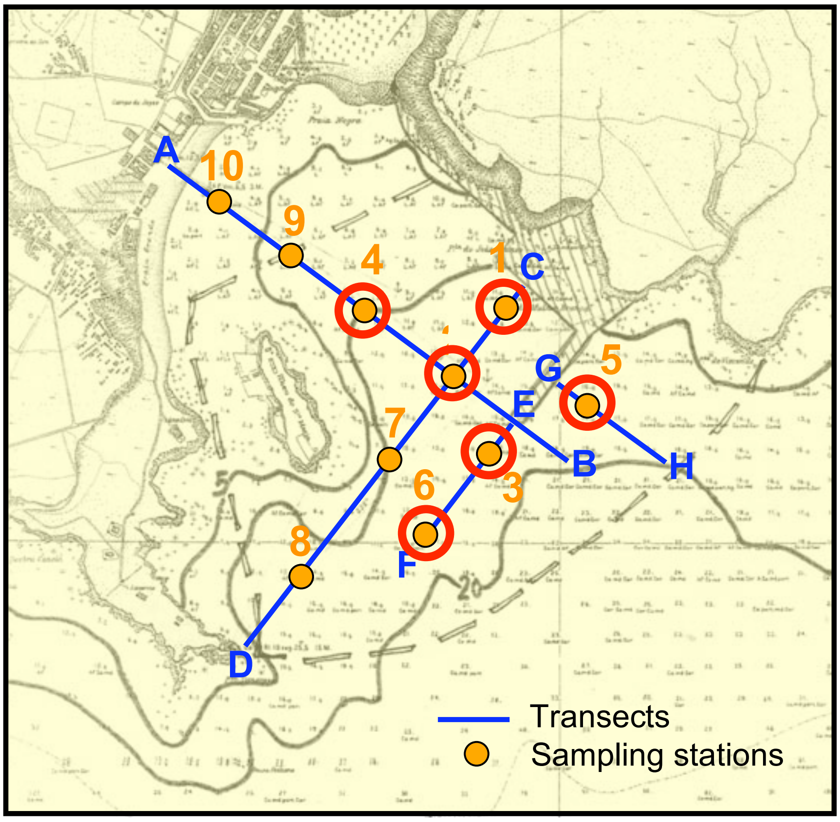



**Figure 3** – Stations used for sediment sampling.

The methods followed strictly the technical annex and 5 replicate samples were made at stations 1 to 6, using a 15x15 cm (base) Van Veen dredge. Fauna were separated using a 1mm sieve and then fixed with buffered (sodium borate) formaldehyde at 4%, with Bengal rose for a more precise sorting. Organisms were identified and counted in the lab with the help of binocular microscope and taxonomic guides.

The fact that part of the collecting stations had a mixture of sediment and rocky bottoms was overcome by repeating replication and modifying position of the ship. However, at station 5 the 'sediment' was a mixture of sand with larger boulders, and, irrespective of a long trial period, it was not possible to perform the planned replication with the optimal operational conditions. In this case we assume a higher error in the abundance of the organisms, as a degree of loss from the dredge was evident.

**Figure 4** – Sediment sampling.

The list of macro faunal *taxa* and respective abundance (number per m$^2$) is presented on table II. Polychaets were the only *taxa* present at all stations (and all replicates), with minima of 64 individual per m$^2$, found at station 3, and maxima of 2656 individuals per m$^2$ at station 4. Station 3 presents higher diversity followed by stations 5 and 6. Stations 1, 2 and 4 are less diverse being dominated by polychaets. These correspond to the muddier sediments. Diversity seemed to be higher in areas dominated by rocky bottoms (Fig. 5).

**Table II**– Macrofaunal abundance (number per m$^2$) in sediment sampling replicates (stations 1 to 6).

| | Crustacea | | | | | | Molusca | Anelida | | | Others | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Decapoda | | | | | | | | | | | | |
| | Amphipoda | Brachyura | Natantia | Cumacea | Isopoda | Tanaidacea | Bivalvia | Polychaeta | Oligochaeta | Hirudinea | Actinaria | Ophiuridea | Nemertinea | Sipunculidea |
| #1 | 0 | 0 | 0 | 0 | 0 | 0 | 32 | 96 | 0 | 0 | 0 | 0 | 0 | 0 |
| #1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 128 | 0 | 0 | 0 | 0 | 0 | 0 |
| #1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 128 | 0 | 0 | 0 | 0 | 0 | 0 |
| #1 | 0 | 0 | 32 | 0 | 0 | 0 | 0 | 480 | 0 | 0 | 0 | 0 | 0 | 0 |
| #1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 96 | 0 | 0 | 0 | 0 | 0 | 0 |
| #2 | 0 | 0 | 0 | 0 | 0 | 0 | 32 | 704 | 0 | 32 | 0 | 0 | 0 | 0 |
| #2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 736 | 0 | 0 | 0 | 0 | 0 | 0 |
| #2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1184 | 0 | 0 | 0 | 0 | 0 | 0 |
| #2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1568 | 0 | 0 | 0 | 0 | 0 | 0 |
| #2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 864 | 0 | 0 | 32 | 0 | 0 | 0 |
| #3 | 32 | 32 | 0 | 0 | 96 | 0 | 0 | 160 | 0 | 0 | 0 | 0 | 0 | 0 |
| #3 | 0 | 0 | 0 | 0 | 0 | 32 | 0 | 64 | 0 | 0 | 0 | 0 | 0 | 0 |
| #3 | 32 | 0 | 0 | 0 | 0 | 0 | 0 | 128 | 0 | 0 | 0 | 0 | 0 | 0 |
| #3 | 384 | 96 | 0 | 0 | 96 | 64 | 0 | 192 | 0 | 0 | 0 | 32 | 96 | 64 |
| #3 | 32 | 0 | 0 | 0 | 0 | 32 | 0 | 96 | 0 | 0 | 0 | 0 | 0 | 32 |
| #4 | 0 | 0 | 0 | 0 | 0 | 0 | 32 | 224 | 0 | 0 | 0 | 0 | 0 | 0 |
| #4 | 0 | 0 | 0 | 0 | 32 | 0 | 32 | 224 | 0 | 0 | 0 | 0 | 0 | 0 |
| #4 | 0 | 0 | 0 | 64 | 0 | 0 | 0 | 128 | 0 | 0 | 0 | 0 | 0 | 0 |
| #4 | 0 | 0 | 0 | 0 | 0 | 0 | 32 | 2656 | 0 | 0 | 0 | 0 | 0 | 0 |
| #4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 992 | 0 | 0 | 0 | 0 | 0 | 0 |
| #5 | 160 | 0 | 32 | 0 | 64 | 704 | 0 | 160 | 0 | 0 | 0 | 0 | 0 | 64 |
| #5 | 32 | 32 | 0 | 0 | 0 | 160 | 0 | 544 | 0 | 0 | 0 | 0 | 0 | 32 |
| #5 | 0 | 32 | 0 | 0 | 0 | 96 | 0 | 160 | 0 | 0 | 0 | 0 | 0 | 0 |
| #5 | 64 | 32 | 32 | 0 | 0 | 448 | 0 | 224 | 0 | 0 | 0 | 0 | 0 | 0 |
| #6 | 2912 | 32 | 0 | 0 | 96 | 0 | 0 | 96 | 0 | 0 | 0 | 0 | 0 | 32 |
| #6 | 320 | 0 | 0 | 0 | 32 | 0 | 0 | 352 | 32 | 0 | 0 | 0 | 0 | 0 |
| #6 | 1024 | 64 | 96 | 0 | 0 | 0 | 0 | 128 | 32 | 0 | 0 | 0 | 0 | 0 |
| #6 | 384 | 32 | 128 | 0 | 64 | 0 | 0 | 416 | 0 | 0 | 0 | 0 | 0 | 32 |
| #6 | 256 | 64 | 0 | 0 | 128 | 0 | 0 | 192 | 0 | 0 | 0 | 0 | 0 | 32 |

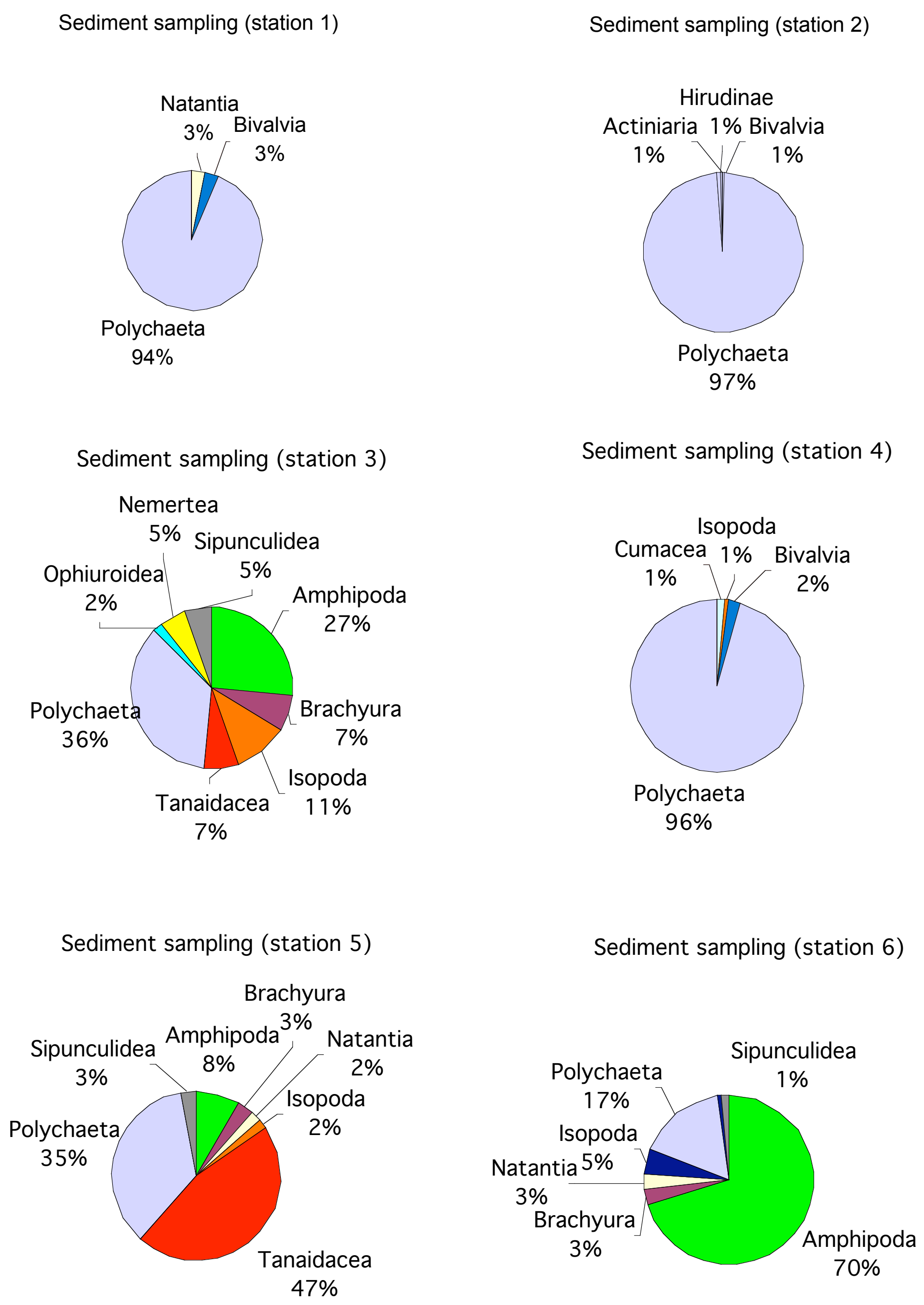



**Figure 5** – Relative percentage of *taxa* present in sediment at the six sampling stations.

Stations 1, 2 and 4 were composed by muddy sediments and comprise a macrofauna composed almost exclusively by polichaets (Fig. 5). Bivalves, although showing very low densities, were only present at these stations, probably due to higher food availability in the water mass, as they are suspension feeders. Actinaria and Hirudinea were found only at station 2, and Cumacea only at station 4. Station 3, composed by sandy bottom, was the more diverse in what refers to its macrofauna, composed by 8 higher taxonomic groups, from which polichaets and amphipods were the most important, with 36% and 27%, respectively. Nemertineans and ophiuroids were found only at this station. The crustaceans Tanaidacea dominated station 5, composed by sand and gravels, reaching almost half of the overall abundance. Seven higher taxonomic groups were observed in this station. Station 6 was a sandy bottom clearly dominated by crustacean of the group Amphipoda (70%). Although this dominance, 6 taxonomic groups were observed at this station.

Overall, the macrofaunal assemblages of the Praia bay are as roughly expected, namely in view of the present sediment types. Sandy (and gravel) bottoms are usually more diverse than muddy bottoms, being the former dominated by crustaceans and the latter by polichaets.

A Multidimensional scaling (MDS) of sediment samples of stations 1 to 6 was performed (see Fig. 6). There is a clear separate trend when the inner stations (1, 2 and 4) are compared with the outer stations (3, 5 and 6). Stations 1, 2 and 4 replicates are along a gradient axis, with a degree of overlapping, and denoting a relative homogeneity. All these three stations correspond to muddy areas with little bottom variation. Station 2 replicates were the more consistent along all stations surveyed. The outer stations separate clearly from the former group, and show an evident dispersal and overlapping. This is obviously explained by the much higher bottom heterogeneity and sediment diversity in the outer part of the bay.

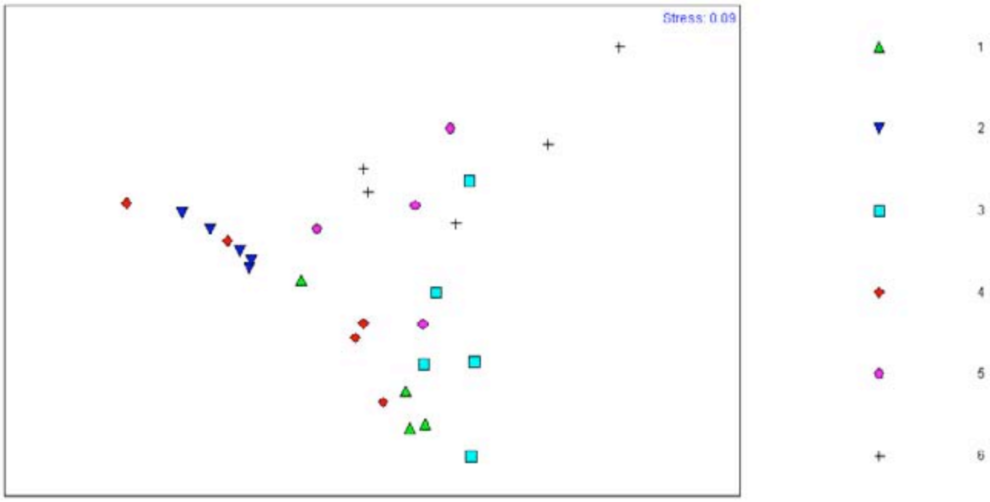



**Figure 6** – Multidimensional scaling (MDS) of biological community of sediment samples of stations 1 to 6.

Richness, evenness and diversity indexes were used (Tables III and IV). The results are concordant with the graphic analysis (Fig. 5), showing that muddy bottoms are less diverse than sandy ones. Stations 1 and 2 were the least diverse, although, only relating these stations, Shannon-Wiener and Simpson index of diversity rank them differently (Table III). Station 6 had the highest diversity followed by stations 3 and 5, respectively. The fact that these stations are composed of a more heterogeneous bottom type could have influenced the results, especially at station 6, which showed a high value of species richness.

**Table III - Average richness and diversity for each station (ranked from lowest to high diversity)**

| Station | Species richness | Shannon-Wiener | Simpson index of diversity |
|---|---|---|---|
| 1 | 0,180325 | 0,11246 | 0,125 |
| 2 | 0,30104 | 0,155424 | 0,072442 |
| 4 | 1,50018 | 1,17596 | 0,65356 |
| 5 | 2,56175 | 1,61725 | 0,748575 |
| 3 | 2,6812 | 1,6954 | 0,93264 |
| 6 | 7,1384 | 3,093 | 0,9731 |

**Table IV - Richness, evenness and diversity in each sample.**

| Station | S | d | J' | H'($log_e$) | 1-Lambda' |
|---|---|---|---|---|---|
| 1 | 2 | 0,7213 | 0,8113 | 0,5623 | 0,5 |
| 1 | 1 | 0 | **** | 0 | 0 |
| 1 | 1 | 0 | **** | 0 | 0 |
| 1 | 1 | 0 | **** | 0 | 0 |
| 1 | 1 | **** | **** | 0 | **** |
| 2 | 3 | 0,6293 | 0,3137 | 0,3446 | 0,163 |
| 2 | 2 | 0,3189 | 0,258 | 0,1788 | 8,70E-02 |
| 2 | 1 | 0 | **** | 0 | 0 |
| 2 | 2 | 0,2569 | 0,1437 | 9,96E-02 | 4,08E-02 |
| 2 | 2 | 0,3001 | 0,2223 | 0,1541 | 7,14E-02 |
| 3 | 7 | 2,731 | 0,941 | 1,831 | 0,9167 |
| 3 | 3 | 1,82 | 1 | 1,099 | 1 |
| 3 | 3 | 1,243 | 0,9602 | 1,055 | 0,8 |
| 3 | 18 | 4,821 | 0,9342 | 2,7 | 0,9465 |
| 3 | 6 | 2,791 | 1 | 1,792 | 1 |
| 4 | 2 | 0,4809 | 0,5436 | 0,3768 | 0,25 |
| 4 | 5 | 1,924 | 0,9284 | 1,494 | 0,8571 |
| 4 | 4 | 1,674 | 0,9591 | 1,33 | 0,8667 |
| 4 | 8 | 1,58 | 0,5477 | 1,139 | 0,5402 |
| 4 | 7 | 1,842 | 0,7912 | 1,54 | 0,7538 |
| 5 | 10 | 2,492 | 0,65 | 1,497 | 0,6381 |
| 5 | 10 | 2,796 | 0,8487 | 1,954 | 0,85 |
| 5 | 4 | 1,542 | 0,9212 | 1,277 | 0,8095 |
| 5 | 12 | 3,417 | 0,7006 | 1,741 | 0,6967 |
| 6 | 33 | 7,222 | 0,8535 | 2,984 | 0,9266 |
| 6 | 20 | 6,147 | 0,9897 | 2,965 | 0,9913 |
| 6 | 37 | 9,632 | 0,9894 | 3,573 | 0,9942 |
| 6 | 27 | 7,436 | 0,9796 | 3,229 | 0,9867 |
| 6 | 17 | 5,255 | 0,9581 | 2,714 | 0,9667 |

S: Total species

d: Species richness (Margalef)

J’: Pielou evenness

H’: Shannon-Wienner index

1-lambda’: Simpson index of diversity (range: 0-1)

**** calculation not possible due to single species

## 1.2.5. – Hard bottom sampling

The technical annex defined 2 zones to be sampled intertidally: station E, on the harbour peer, and station I, on the outer bay of the harbour. However, practical constraints have precluded the use of station I. During the whole period of the field campaign, exposure (wave action) at station I low shore made impracticable its use for adequate sampling, despite a focused effort (please see Fig. 7). Station I used then substituted by Prainha, which after careful observation showed to bear the same type of biological communities. The basic criteria used for the substituting station were 1) substrate characteristics, 2) orientation, 3) proximity, 4) accessibility, and 5) similar biological communities. Figure 8 shows the position of the sampling areas.

**Figure 7** – Station I during low tide.

In the hard bottom intertidal zone, a stratified sampling was used. Two strata: mid-eulittoral and upper sub-littoral. In each stratum 2 sites were chosen and 10 replicate quadrates (25x25 cm) randomly sampled at each site. The 50x50cm quadrates initially planed were not used due to topographic constraints. Sampling consisted on photographic recording and percent cover and abundance of organisms were calculated in the lab using ImageJ software.

In addition, at station Prainha, 2 sites were chosen and 5 replicate 25x25 cm quadrates were scrapped in the algal belt for faunal identification and quantification (Fig. 9). Due to reasons of topography, algal abundance and security, on the station Porto (station E) only qualitative sampling was made (Fig. 10).

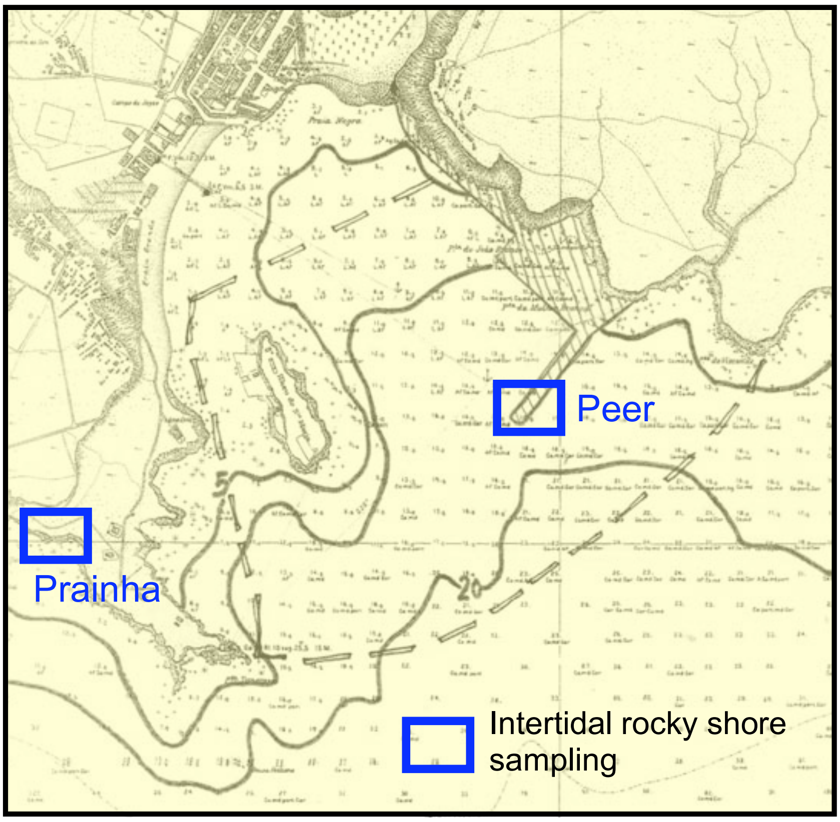



**Figure 8** – Position of hard bottom sampling areas.

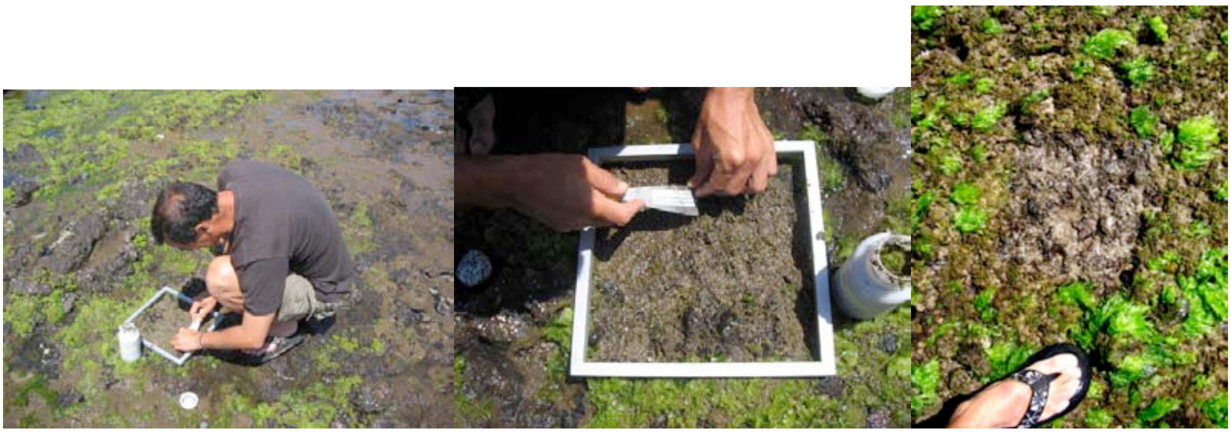


**Figure 9** – Scrapping sampling at Prainha shore.

**Figure 10** – Scrapping sampling in Porto (station E) shore.

The list of macro faunal *taxa* and respective abundance (number per $m^2$) for Prainha shore is presented in Table V. The highest abundance was found at site 1 of Prainha with 9216 amphipods per $m^2$, and 16128 gastropods per $m^2$ at site 2, with an average of 6080 and 10522 individuals per $m^2$, respectively.

**Table V**– Macrofaunal abundance (number per $m^2$) at Prainha shore.

| Replicates | | | 1.1 | 1.2 | 1.3 | 1.4 | 1.5 | 2.1 | 2.2 | 2.3 | 2.4 | 2.5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Crustacea** | | Amphipoda | 5632 | 8000 | 5760 | 9216 | 1792 | 0 | 256 | 0 | 384 | 0 |
| | Decapoda | Anomura | 128 | 0 | 0 | 0 | 0 | 384 | 128 | 0 | 128 | 0 |
| | | Brachyura | 128 | 480 | 0 | 512 | 128 | 0 | 128 (*) | 0 | 0 | 0 |
| | | Natantia | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | Copepoda | 512 | 0 | 5376 | 3072 | 1056 | 0 | 0 | 0 | 128 | 0 |
| | | Isopoda | 0 | 0 | 128 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | Picnogonidae | 0 | 0 | 0 | 0 | 160 | 0 | 0 | 0 | 0 | 0 |
| | | Tanaidacea | 4480 | 5760 | 6272 | 5888 | 2432 | 0 | 0 | 0 | 1152 | 0 |
| **Mollusca** | | Bivalvia | 0 | 0 | 0 | 0 | 96 | 320 | 1408 | 512 | 1664 | 1536 |
| | | Gastropoda | 2688 | 320 | 8064 | 7424 | 2144 | 13696 | 10496 | 5248 | 7040 | 16128 |
| | | Mollusca n.d. | 640 | 480 | 896 | 0 | 192 | 0 | 0 | 0 | 0 | 0 |
| **Annelida** | | Polychaeta | 3072 | 4960 | 4352 | 4864 | 2496 | 192 | 768 | 0 | 384 | 256 |
| **Others** | | Anthozoa | 384 | 0 | 128 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | Echinoidea | 128 | 320 | 128 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | Insect larvae | 0 | 0 | 128 | 0 | 128 | 0 | 0 | 0 | 0 | 0 |
| | | Sypuncula | 0 | 480 | 256 | 0 | 64 | 0 | 0 | 0 | 0 | 0 |
| | | Polyplacophora | 0 | 0 | 128 | 0 | 32 | 0 | 0 | 0 | 0 | 0 |

(*) - Megalopa

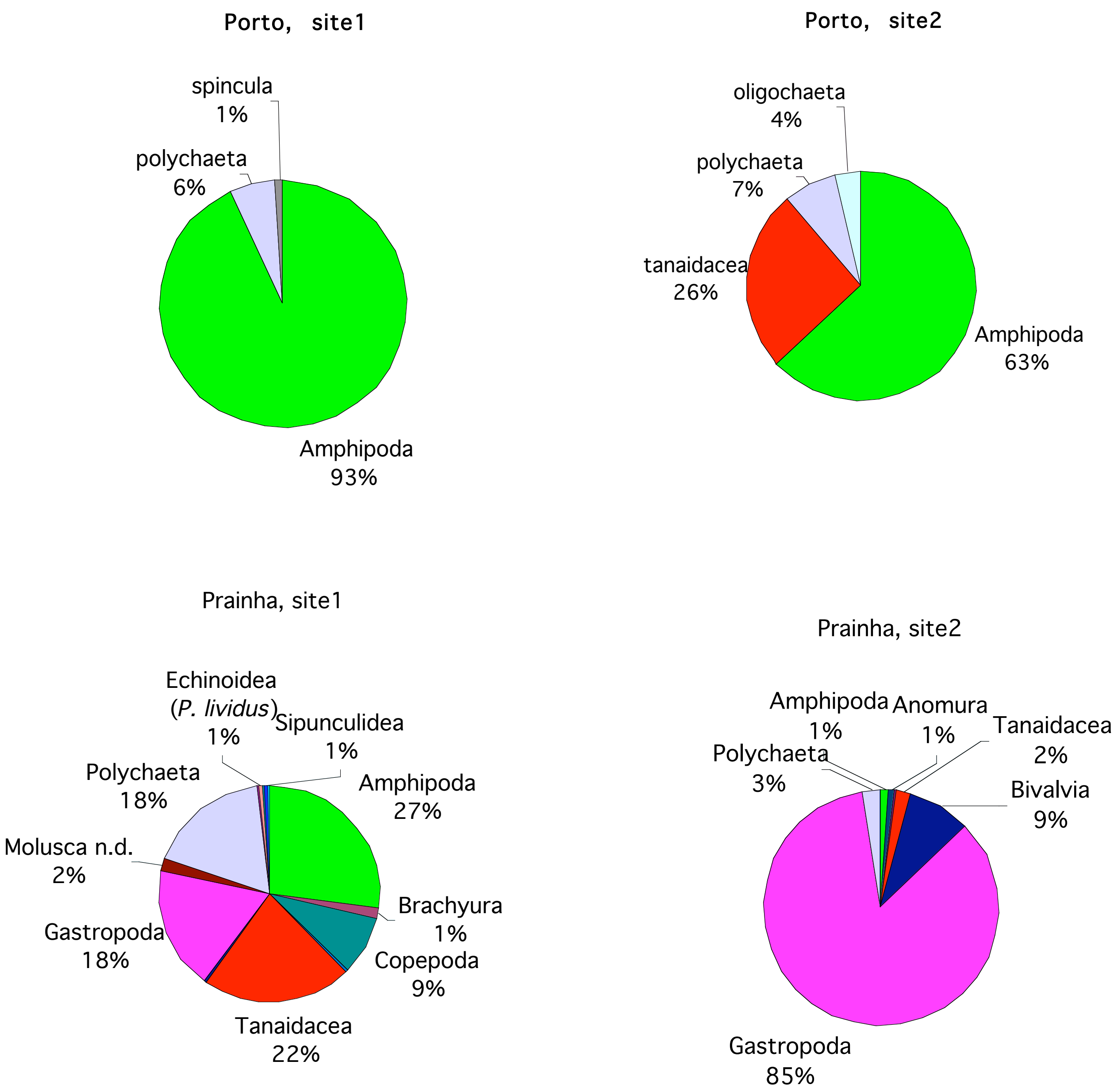



**Figure 11** – Relative percentage of *taxa* at the two sites of each station (Porto and Prainha).

Figure 11 shows the relative percentage of faunal groups on the rocky shores of Porto and Prainha. Amphipods dominated station E (Porto) and gastropods dominated site 2 of station Prainha, with 85%, although at site 1 they represented only 18% of the faunal community. The highest diversity was found on site 1 of Prainha, where no *taxa* clearly dominated, although crustaceans were more abundant.

Results of faunal abundance on mid- and upper sub-littoral rocky shore are presented on Figure 12. Results of faunal and algae percent cover on mid- and upper sub-littoral rocky shore are presented on Tables VI to IX and figure 13.

Percentage cover of mid-littoral rocky communities was calculated based on a 36 multi-layer intersection points. One hit corresponds to roughly 2.77%. Multi-layer means that, for instance, a limpet covered by algae below an intersection point, counts 1 hit for limpet and 1 hit for algae. Moreover, species that are present in the quadrate but never below an intersection point, counts as 0.5%. These procedures are standard in benthic ecology. Thus, often percentage cover is over 100%. In table VI percentages are given in "full" numbers, so they are round up or down.

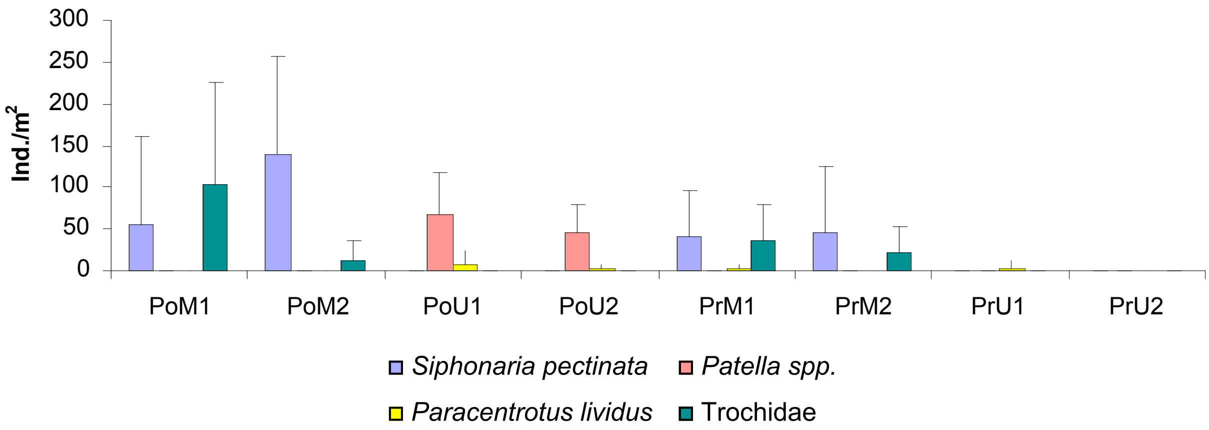



**Figure 12** – Density of rocky shore fauna. PoM1= station Porto, mid-littoral, site1; PoM2= station Porto, mid-littoral, site2; PoU1(2)= station Porto, upper sub-littoral, site 1(2); PrM1(2)= station Prainha, mid-littoral site1(2); PrU1(2) = station Prainha, upper sub-littoral, site 1 (2). Standard errors are shown.

The mid-littoral zone had higher density of false limpets (*Siphonaria pectinata*) and secondly gastropods of family Trochidae (Fig.12). In the upper sub-littoral, limpets (*Patella* spp.) substitute false limpets and are the more abundant animals amongst the target community (*Litorina* spp. were more abundant, but were not quantified due to focused method requirements). The high standard errors obtained corroborate the spatial heterogeneity observed in the field.

**Table VI** – Percentage cover of Porto's mid-littoral rocky shore community.

| | Station Porto, mid-littoral | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | site 1 | | | | | | | | | | site 2 | | | | | | | | | |
| Bare substratum | 58 | 94 | 86 | 86 | 80 | 91 | 89 | 94 | 91 | 83 | 83 | 72 | 86 | 80 | 91 | 86 | 86 | 69 | 86 | 89 |
| *Chthamalus* spp. | 11 | 3 | 14 | 8 | 17 | 8 | 8 | 3 | 8 | 17 | 17 | 25 | 11 | 19 | 8 | 14 | 11 | 30 | 11 | 11 |
| *Siphonaria pectinata* | 3 | 1 | 0 | 6 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 3 | 3 | 0 | 1 | 1 | 3 | 1 | 3 | 1 |
| Trochidae | 0 | 3 | 1 | 1 | 3 | 1 | 3 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 |
| *Littorina* spp. | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 |

**Table VII** – Percentage cover of Porto's upper sub-littoral rocky shore community.

| | Station Porto upper sub-littoral | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | site 1 | | | | | | | | | | site2 | | | | | | | | | |
| *Codium decorticatum* | 36 | 0 | 0 | 0 | 17 | 0 | 0 | 0 | 0 | 39 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Ulva* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Enteromorpha* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Caulacanthus ustulatus* | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 25 | 8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Ceramium* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 25 | 0 | 0 | 8 | 0 | 6 | 0 | 28 |
| *Chondrus crispus* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 11 | 0 | 0 | 0 |
| *Dasya* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 14 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Gelidium* sp. | 14 | 0 | 0 | 0 | 19 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Jania* sp. | 3 | 0 | 0 | 0 | 6 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Laurencia* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 14 | 39 | 0 | 28 | 8 | 0 |
| *Lithophylum incrustans* | 28 | 64 | 58 | 94 | 58 | 64 | 61 | 33 | 22 | 28 | 28 | 39 | 28 | 28 | 80 | 11 | 69 | 42 | 47 | 42 |
| Brown incrusting algae n.d. | 14 | 0 | 0 | 0 | 0 | 17 | 1 | 25 | 36 | 8 | 61 | 33 | 39 | 42 | 0 | 33 | 0 | 25 | 8 | 14 |
| Folious algae n.d. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 11 | 0 |
| Bare substratum | 6 | 36 | 42 | 6 | 0 | 17 | 19 | 0 | 28 | 22 | 11 | 25 | 8 | 28 | 6 | 8 | 19 | 0 | 19 | 17 |
| *Patella* spp. | 0 | 0 | 0 | 0 | 0 | 3 | 3 | 3 | 3 | 3 | 0 | 3 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 |

**Table VIII** – Percentage cover of Prainha's mid-littoral rocky shore community.

| | Station Prainha, mid-littoral | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | site1 | | | | | | | | | | site2 | | | | | | | | | |
| *Ulva* sp. | 0 | 3 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 6 | 47 | 0 | 0 | 0 | 3 | 11 | 0 |
| *Lithophylum incrustans* | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Bare substratum | 69 | 66 | 61 | 72 | 78 | 69 | 50 | 33 | 83 | 69 | 44 | 50 | 55 | 19 | 72 | 58 | 30 | 69 | 39 | 39 |
| *Chthamalus* spp. | 30 | 25 | 39 | 25 | 22 | 30 | 47 | 66 | 17 | 30 | 53 | 28 | 6 | 19 | 22 | 42 | 66 | 28 | 50 | 39 |
| *Siphonaria pectinata* | 0 | 3 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 | 1 | 0 | 1 | 0 | 3 |
| *Patella* spp. | 0 | 0 | 0 | 0 | 0 | 1 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Paracentrotus lividus* | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Trochidae | 0 | 3 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| *Littorina* spp. | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 3 | 0 | 1 | 0 | 0 | 1 | 3 | 1 | 1 | 0 |
| *Mytilus edulis* | 0 | 0 | 1 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 22 | 28 | 14 | 0 | 0 | 0 | 1 | 0 | 19 |

**Table IX** – Percentage cover of Prainha's upper sub-littoral rocky shore community.

| | Station Prainha, upper sub-littoral | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | site1 | | | | | | | | | | site2 | | | | | | | | | |
| *Ulva* sp. | 42 | 61 | 72 | 30 | 47 | 36 | 42 | 36 | 28 | 42 | 69 | 44 | 22 | 25 | 72 | 39 | 58 | 75 | 80 | 25 |
| *Enteromorpha* sp. | 0 | 3 | 0 | 0 | 6 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Caulacanthus ustulatus* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 11 | 30 | 33 | 22 | 30 | 28 | 8 | 8 | 58 |
| *Jania* sp. | 11 | 8 | 14 | 17 | 19 | 19 | 17 | 33 | 39 | 17 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Laurencia* sp. | 47 | 25 | 11 | 53 | 25 | 42 | 36 | 30 | 30 | 42 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Lithophylum incrustans* | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Bare substratum | 0 | 3 | 0 | 0 | 0 | 0 | 6 | 0 | 0 | 0 | 25 | 39 | 47 | 42 | 6 | 28 | 11 | 14 | 11 | 14 |
| *Paracentrotus lividus* | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Littorina* spp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 | 1 | 1 | 1 | 1 | 1 | 3 | 1 | 1 | 3 |
| *Mytilus edulis* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 | 0 | 0 | 0 | 3 | 0 | 3 | 0 | 0 |

**Figure 13** – Examples of photos used for percent cover determination and faunal density.

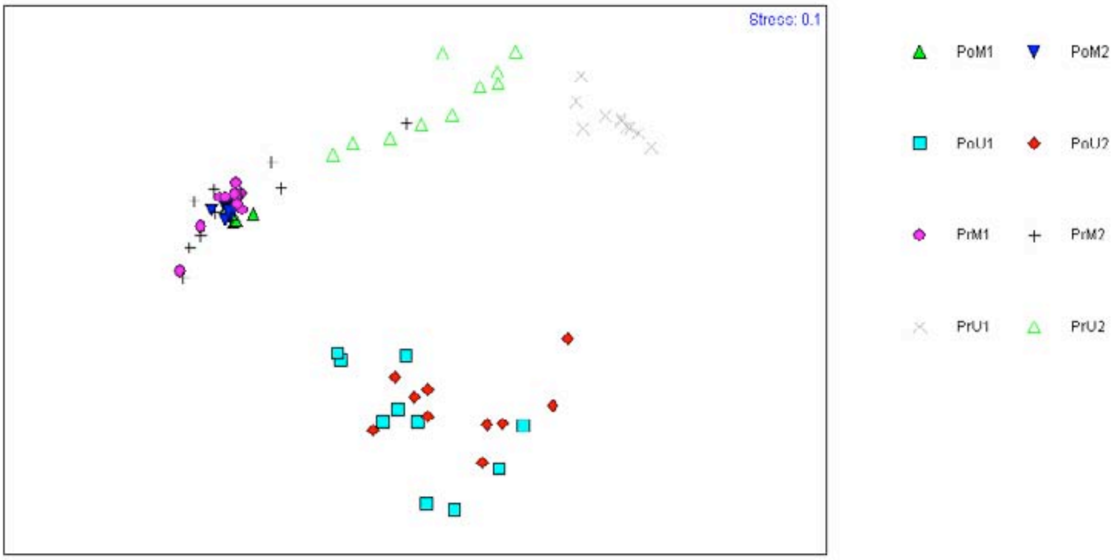



**Figure 14** – Multi Dimensional Scaling (MDS) of rocky shore organisms' percentage cover. PoM1= station Porto, mid-littoral, site1; PoM2= station Porto, mid-littoral, site2; PoU1(2)= station Porto, upper sub-littoral, site 1(2); PrM1(2)= station Prainha, mid-littoral site1(2); PrU1(2) = station Prainha, upper sub-littoral, site 1 (2).

Multidimensional scaling (Fig. 14) shows that mid littoral communities were basically similar between station and sites, as they cluster together. The upper sub-littoral communities were similar at both sites of Porto, but different from Prainha station, which presents a more diverse algal community. Although with some similarity, the two sites of Prainha shore form two separate clusters, especially because site 1 presents a more diverse and homogeneously distributed algal community. The low stress value (0.1) indicates a very good association between 3D and 2D representations.

## 1.2.6. – Fish qualitative census

The ichthyofauna was identified at a species level and the species abundance was classified on an ordinal scale from 0 (absent) to 3 (abundant). Three stations close to the harbour were sampled by underwater video recording, as defined in the technical annex. The species abundance at each station was classified from video images. Figure 15 presents the position of the sampling stations used for the ichthyofaunal surveys. For comparison with the study area, a species survey on a well-preserved coastal section at Tarrafal (north Santiago island), using exactly the same methodology, was also included in the report.

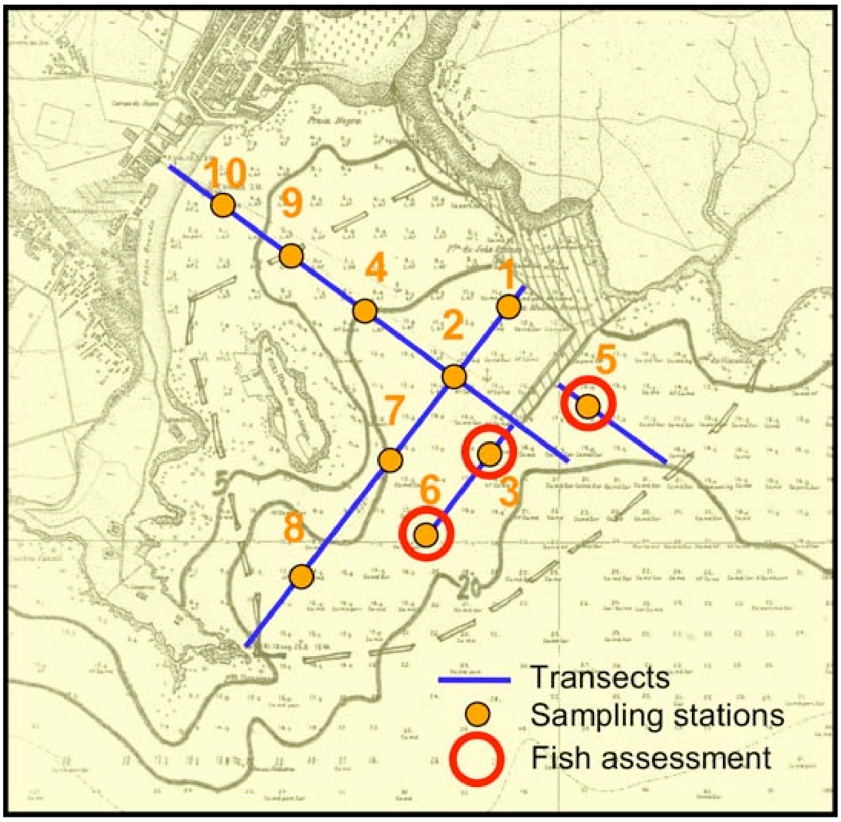



**Figure 15** – Stations used for fish census.

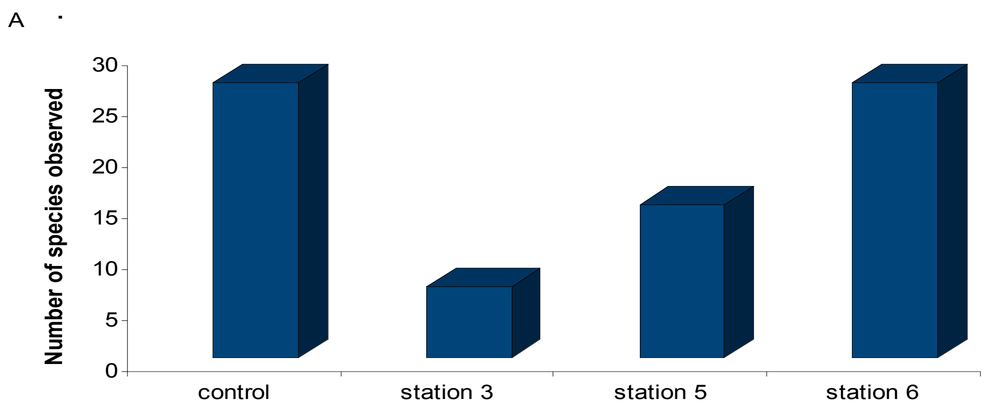
**Figure 16** – Divers on fish survey.

The three stations differed in terms of habitat and, consequently, in the associated fish assemblage. Mainly large boulders separated by small sandy patches constituted station 6. The boulders were superimposed on top of each other increasing the complexity of the rocky habitat. Accordingly, the highest number of species was observed at this station (Fig. 17) and the mean species abundance was also highest at station 6 (Fig. 19). The dominant species were the canary damsel, *Abudefduf luridus*, the brown chromis, *Chromis multilineata* and the saddled seabream, *Oblada melanura* (Table X). A sandy bottom covered by a thin sediment layer with small boulders interspersed characterized station 3. The scarceness of rocky substrate and the low complexity of the habitat accounted for the small number of fish observed (Fig. 17). The dominant species were two gobies *Bathygobius soporator* and *B. casamancus* (Table X). Station 5 presented intermediate characteristics from the two previous ones. Medium-sized rocks dispersed in a sandy bottom characterized it. In accordance, species diversity and abundance at this site was higher than at station 3 but lower than at station 6 (Fig. 17). The dominant species were the canary damsel, *Abudefduf luridus*, the brown chromis, *Chromis multilineata* and the yellow goatfish, *Mulloidichthys martinicus* (Table X).

The station used for comparison at Tarrafal was dominated by large rocks with interspersed small sandy patches. The dominant species were the brown chromis,

Chromis multilineata*, the Atlantic cornet fish, *Aulostomus strigosus* and the blackbar soldierfish, *Myripristis jacobus* (Table X). The habitat structure and complexity was similar to station 6 and both the total number of species and the mean species abundance were similar between these two stations (Figs. 17 and 19).

These results suggest that areas in close vicinity to the harbour are still well-preserved regarding species diversity and abundance. The lower species richness at Stations 3 and 5 is probably the result of the habitats there present being less complex, and not a consequence of their closer proximity to the harbour.



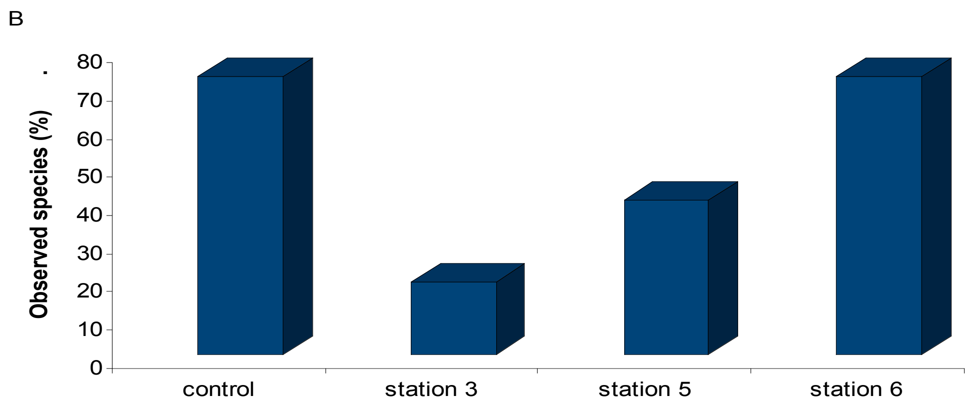




**Figure 17** – A) total number and B) percentage of species from the total observed recorded at stations 3, 5, 6 and control.

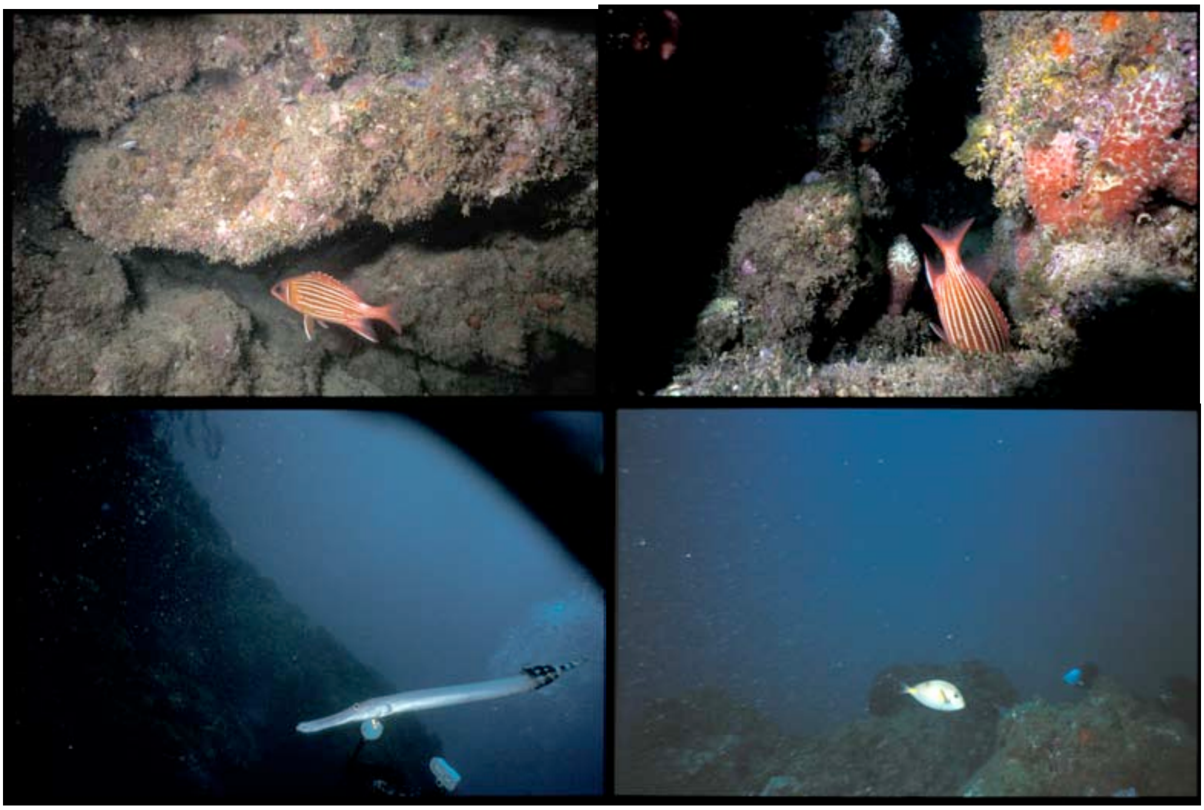


**Figure 18** – Examples of fishes observed during fish survey.

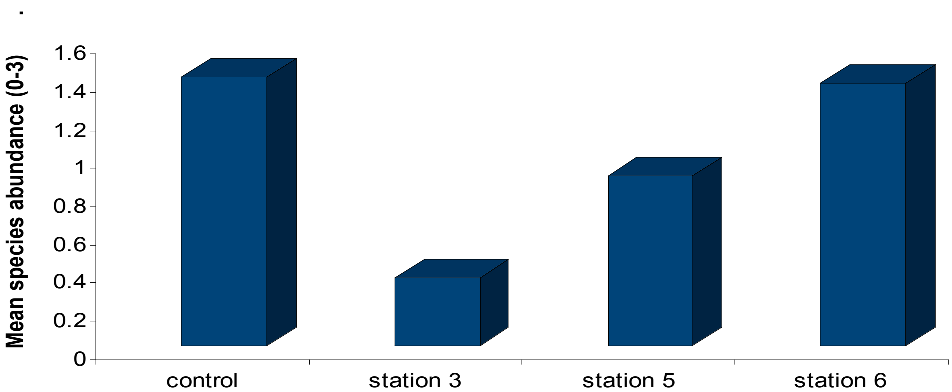
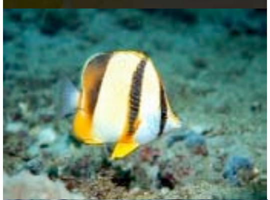
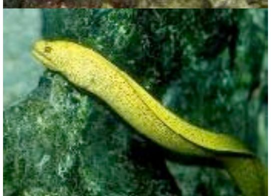
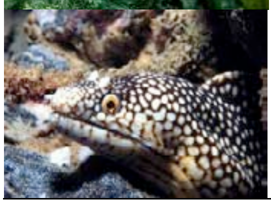



**Figure 19** – Mean species abundance at each station. Species abundance was classified on a four point ordinal scale from 0 (absent) to 3 (abundant).

**Table X**. Fish species abundance at stations 3, 5 and 6, and control site.

| Photo | Family | Scientific name | Common name | Local name | Abundance 0.absent; 1.rare; 2.common; 3.abundant | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | Control Tarrafal | # 3 | # 5 | # 6 |
|  | Acanthuridae | Acanthurus monroviae | Monrovia doctorfish | cirurgião; barbeiro | 2 | 0 | 2 | 2 |
|  | Aulostomidae | Aulostomus strigosus | Atlantic cornetfish | peixe-trombeta; agulha; buzina | 3 | 0 | 3 | 3 |
|  | Chaetodontidae | Chaetodon robustus | Three-banded butterflyfish | feiticeira; peixe-pava | 1 | 0 | 0 | 1 |
|  | Chaetodontidae | Prognathodes marcellae | Butterflyfish | peixe-borboleta; lebre | 1 | 0 | 0 | 0 |
|  | Diodontidae | Chilomycterus reticulatus | Spotfin burrfish | Crum; porkspin | 1 | 0 | 0 | 0 |
|  | Gobiidae | Bathygobius casamancus | Goby | góbio | 0 | 3 | 0 | 0 |
|  | Gobiidae | Bathygobius soporator | Frillfin goby | góbio | 1 | 1 | 0 | 0 |
|  | Haemulidae | Pomadasys incisus | Bastard grunt | roncador; besugo | 0 | 0 | 0 | 1 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
|  | Holocentridae | Myripristis jacobus | Blackbar soldierfish | olheto | 3 | 0 | 2 | 2 |
|  | Holocentridae | Sargocentron hastatum | Squirrel fish | rainha; rei; esquilo | 3 | 0 | 2 | 2 |
|  | Labridae | Coris julis | Mediterranean rainbow wrasse | bodião-meredia | 2 | 2 | 2 | 2 |
|  | Labridae | Thalassoma pavo | Ornate wrasse | rei; mordedor; bodião merédia | 0 | 0 | 0 | 2 |
|  | Monacanthidae | Aluterus scriptus | Scrawled filefish | cabra; cabrinha | 2 | 0 | 0 | 1 |
|  | Mullidae | Mulloidichthys martinicus | Yellow goatfish | salmonete | 3 | 0 | 3 | 3 |
|  | Mullidae | Mullus surmuletus | Striped red mullet | salmonete | 0 | 0 | 2 | 2 |
|  | Muraenidae | Gymnothorax miliaris | Goldentail moray | xita | 1 | 0 | 0 | 1 |
|  | Muraenidae | Muraena melanotis | Honeycomb moray | moreia-pintada | 0 | 0 | 0 | 1 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
|  | Phycidae | Phycis phycis | Forkbeard | abrota | 1 | 0 | 0 | 0 |
|  | Pomacentridae | Abudefduf luridus | Canary damsel | castanheta-ferreira | 3 | 0 | 3 | 3 |
|  | Pomacentridae | Abudefduf saxatilis | Sergeant major | burrinho | 1 | 0 | 0 | 3 |
|  | Pomacentridae | Abudefduf taurus | Night sergeant | burrinho | 2 | 0 | 0 | 0 |
|  | Pomacentridae | Chromis multilineata | Brown chromis | castanheta | 3 | 0 | 3 | 3 |
|  | Pomacentridae | Stegastes imbricatus | Cape Verde gregory | castanheta | 0 | 0 | 1 | 0 |
|  | Pomacentridae | Stegastes leucostictus | Beaugregory | loriana-preta; burrinho | 1 | 0 | 0 | 1 |
|  | Priacanthidae | Heteropriacanthus cruentatus | Glasseye | façola | 1 | 0 | 1 | 2 |
|  | Priacanthidae | Priacanthus arenatus | Atlantic bigeye | façola | 2 | 0 | 2 | 1 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
|  | Scaridae | Sparisoma cretense | Parrotfish | bidião | 3 | 0 | 0 | 2 |
|  | Sciaenidae | Umbrina ronchus | Fusca drum | corvina | 0 | 0 | 0 | 1 |
|  | Scorpaenidae | Scorpaena scrofa | Largescaled scorpionfish | charroco; garoupa-da-Madeira | 0 | 1 | 0 | 1 |
|  | Serranidae | Cephalopholis taeniops | African hind | garoupa preta | 2 | 1 | 3 | 2 |
|  | Serranidae | Epinephelus aeneus | White grouper | mero; cherne; merato | 0 | 1 | 0 | 0 |
|  | Serranidae | Rypticus saponaceus | Greater soapfish | Badejo-sabão | 2 | 2 | 2 | 2 |
|  | Sparidae | Diplodus prayensis | Two-banded seabream | sargo-salema | 0 | 0 | 0 | 2 |
|  | Sparidae | Diplodus sargus lineatus | Seabream | sargo; sargo-branco | 2 | 0 | 0 | 0 |
|  | Sparidae | Oblada melanura | Saddled seabream | Dobrada | 3 | 0 | 0 | 3 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
|  | Synodontidae | Synodus saurus | Atlantic lizardfish | pescada | 1 | 0 | 0 | 0 |
|  | Tetraodontidae | Canthigaster rostrata | Caribbean sharpnose-puffer | peixe-sapo; sapinho; baíacu | 2 | 2 | 2 | 2 |

## 1.2.7. – Water analyses

Sampling was made at stations 1 to 6 (see Fig. 3) using a VanDorn type bottle (see Fig. 20). At each station, water was collected near the bottom and at the surface. Temperature, salinity and pH were registered using a multi-parameter WTW341i probe. Dissolved oxygen could not be measured due to probe malfunction. Turbidity was measured by light attenuation using a HACH DR/2010 spectrophotometer. Water microbiological analyses were collected on the last sampling day (surface and bottom) and stored in sterilized vials, kept cool and analysed within the next 24h. Triplicate samples for inorganic nutrient concentrations were collected at the same depths and filtered through GF/C Whatman filters and immediately frozen for later colourimetrically analysis with a Tecator FIAstar$^{TM}$ 5000 Analyser. Nitrate was determined according to Grasshoff (1976), Nitrite according to Bendschneider and Robison (1952), phosphates according to Murphy and Riley (1962).

**Figure 20** – Equipment used for water sampling.

Locations of the sampling stations are presented on table XI. Results of water temperature, salinity, pH, turbidity and total suspended matter are presented on Figures 21 to 25. Total coliforms, *E. coli* and intestinal *Enterococcus* are presented on table XII, and nitrites, nitrates and orto-phosphates results are presented on table XIII.

Temperature values were quite homogeneous (Fig. 21), as expected; all falling between 23.9 and 24.5ºC. Temperature is also highly dependent of time of day and wind conditions when sampling was performed at each station. Regarding salinity (Fig. 22), values are within the expected oceanic range. Minor anomalies were detected at some stations, such as 2, 3, 4 and 5, with lower values at surface. These may correspond to limited freshwater discharges from port activities. PH also falls within the expected range for these types of marine waters (Fig. 23).

Turbidity values were negligible at most stations (Fig. 24). We could detect a degree of turbidity at stations 1 (inner harbour), 4 (mid bay) and 5 (outer harbour). Stations 1 and 4 correspond to areas with finer sediments and higher port activities. It is thus logical that fine sediment re-suspension contributes to the observed turbidity at these stations. At station 5 we could expect major influence of oceanic cleaner waters. However, bottom currents can contribute for the observed turbidity, only detected at the bottom water layer. The underwater film made at this station is illustrative of this hypothesis.

Suspended particulate matter (Fig. 25) was relatively uniform throughout the sampling stations, especially at the bottom layer, roughly between 18 and 22 mg $L^{-1}$. At the surface layer there was higher variability, mainly in the port waters (stations 1 and 2). Station 1 presented the higher value (over 30 mg $L^{-1}$), which can be due to port activities. Parametric correlation between water suspended matter and turbidity was not significant, both for surface ($R^2$ = 0.102; p = 0.54) and bottom layers ($R^2$ = 0.046, p = 0.682). Suspended particulate matter is an important component of water quality and can be measured as turbidity (inorganic plus organic suspended matter). In this work, turbidity was measured using by spectrophotometric method; several samples had concentrations below the detection of the spectrophotometer, giving several zero values. Moreover, the number of sampling points was small (6 values for each correlation). These constraints precluded a strong correlation between the two sets of data, and may explain the absence of significance.

In terms of bacteriological water quality, considering that the sampling area in in the vicinity of a port in a semi-closed bay bordering a mid size city, we found a relatively good situation (Table XII). At most stations bacterial abundance was negligible or very low. At the bottom layer near the port (stations 2 and 4) values were slightly higher, above maximum recommended but well below maximum admissible. These values are most probably related to fish and other products discards from the fishing terminal and larger ships in the port. It would be interesting to observe the situation when events of land drainage due to rains occur, bringing accumulated materials in the riverine lines.

The set of data obtained for nutrients (Table XIII) does not correspond to what should be expected in these waters. The nitrate plus nitrite values were very low, the majority below detection limit of our system, i.e. < 0.4 µmol $L^{-1}$. However, phosphate values ($PO_4$) were extremely high. Normally, the molar ratio of Nitrate to Phosphate (N/P) in ocean waters is near 15. According to Kennish (2001), the low values for nitrates obtained are in the range of those reported for Tropical Aquatic Ecosystems, from 0.0 to 2.0 µmol $L^{-1}$, but phosphates should be in the order of 0.0 to 0.4 µmol $L^{-1}$. The results obtained presently for $PO_4$ in Bay of Praia, Cabo Verde, were above 3 µmol $L^{-1}$, a value higher than values obtained for instance for the Portuguese neritic coast, with the exception of Lisbon Bay (which is influenced by Tagus estuary strong plume), where $PO_4$ maximum in summer is 0.8 and in winter 9.0 µmol $L^{-1}$ (Cabeçadas et al, 2000). We cannot explain these results with the available information. A possible hypothesis that should be studied is if there is any anthropogenic source of phosphate in the bay, or if it was due to any unusually event.

### Nutrient method and results references

Bendschneider, K., Robison, N.J., 1952. A new spectrophotometric determination of nitrite in seawater. *Journal of Marine Research,* 11: 87-96.

Cabeçadas, G., Brogueira, M.J., Cabeçadas, L., 2000. Southern Portugal: the Tagus and Sado estuaries. In: Sheppard C.R.C. (Ed.), *Seas at the Millennium: An Environmental evaluation*. Elsevier Science Ltd., Oxford, UK, pp. 151-165.

Grasshoff, K., 1976. Methods of seawater analysis. *Verlag Chimie*, New York, 520 pp.

Kennish, M. J., 2001. *Pratical Handbook of Marine Science*, 3rd ed. CRC Press, 875 pp.

Murphy, J., Riley, J.P., 1962. A modified single solution method for the determination of phosphate in natural waters. *Analytica Chimica Acta*, 27: 31-36.

**Table XI** – Location of sampling stations.

| Station | Lat | Long |
|---|---|---|
| 1 | 14.91126º N | 23.50146º W |
| 2 | 14.90908º N | 23.50302º W |
| 3 | 14.90663º N | 23.50036º W |
| 4 | 14.91056º N | 23.50570º W |
| 5 | 14.90854º N | 23.49815º W |
| 6 | 14.90319º N | 23.50257º W |

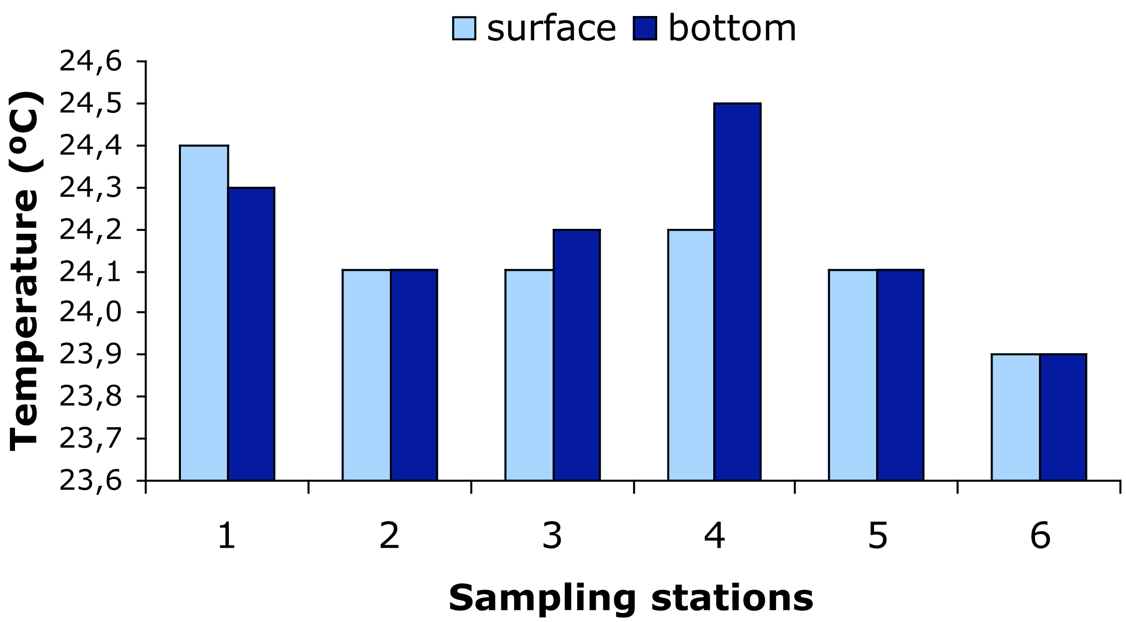



**Figure 21** – Water temperature recorded at surface and bottom at the six sampling stations.

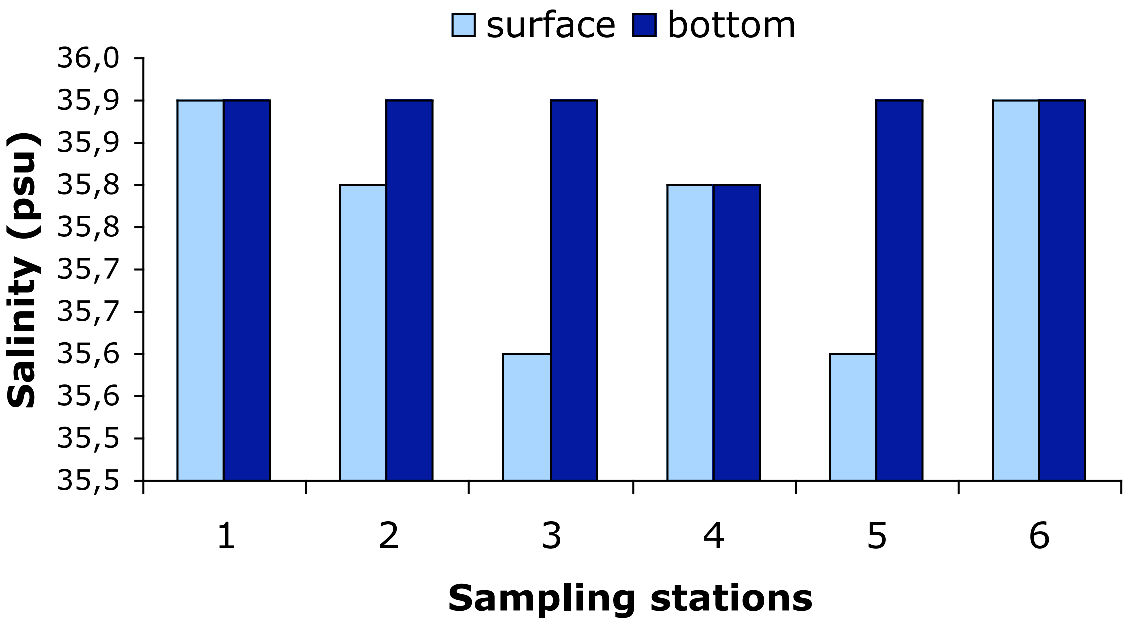



**Figure 22** – Water salinity recorded at surface and bottom at the six sampling stations.

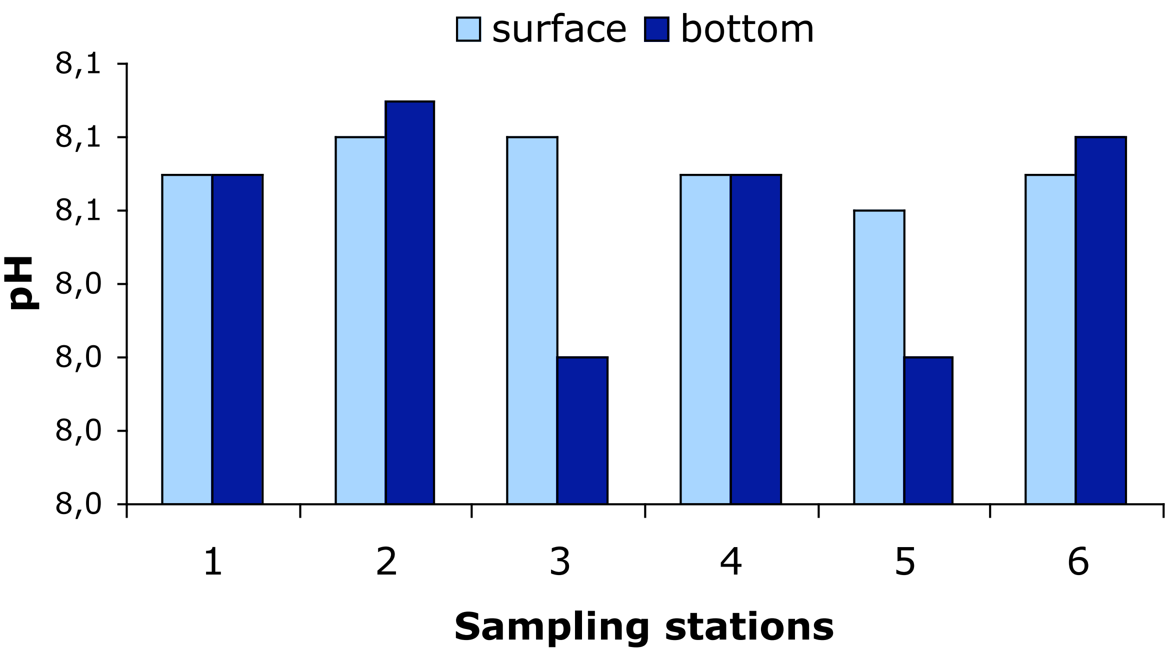



**Figure 23** – Water pH recorded at surface and bottom at the six sampling stations.

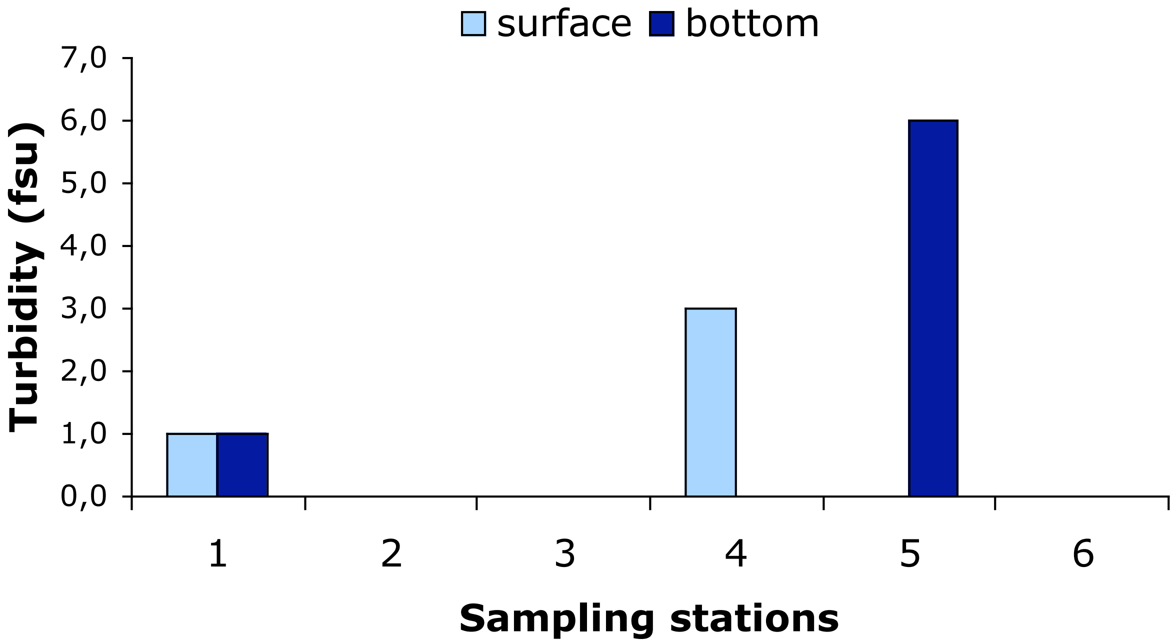



**Figure 24** – Water turbidity recorded at surface and bottom at the six sampling stations.

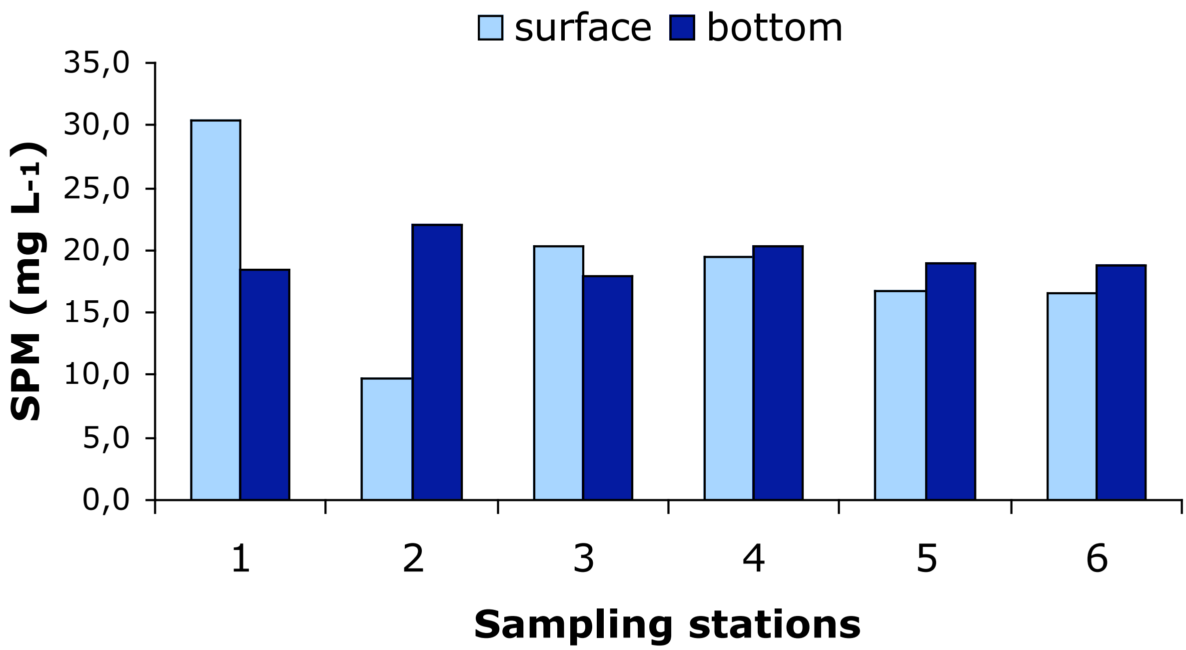



**Figure 25** – Suspended particulate matter (SPM) recorded at surface and bottom at the six sampling stations.

**Table XII** – Water microbiology at stations 1 to 6 (surface and bottom).

| | | **Total Coliforms (Colilert - N.M.P.)** | ***E. coli* (Colilert - N.M.P.)** | **Intestinal *Enterococcus* (Enterolert - N.M.P.)** | **Water quality** |
|---|---|---|---|---|---|
| **#1** | **Surface** | < 10 cfu/100ml | < 10 cfu/100ml | < 10 cfu/100ml | Good |
| | **Bottom** | 10 cfu/100ml | < 10 cfu/100ml | < 10 cfu/100ml | Good |
| **#2** | **Surface** | 10 cfu/100ml | 10 cfu/100ml | 10 cfu/100ml | Good |
| | **Bottom** | 178 cfu/100ml | 150 cfu/100ml | < 10 cfu/100ml | Aceptable |
| **#3** | **Surface** | < 10 cfu/100ml | < 10 cfu/100ml | < 10 cfu/100ml | Good |
| | **Bottom** | < 10 cfu/100ml | < 10 cfu/100ml | < 10 cfu/100ml | Good |
| **#4** | **Surface** | 10 cfu/100ml | 10 cfu/100ml | < 10 cfu/100ml | Good |
| | **Bottom** | 192 cfu/100ml | 178 cfu/100ml | 20 cfu/100ml | Aceptable |
| **#5** | **Surface** | < 10 cfu/100ml | < 10 cfu/100ml | < 10 cfu/100ml | Good |
| | **Bottom** | 64 cfu/100ml | 64 cfu/100ml | < 10 cfu/100ml | Good |
| **#6** | **Surface** | < 10 cfu/100ml | < 10 cfu/100ml | < 10 cfu/100ml | Good |
| | **Bottom** | 53 cfu/100ml | 31 cfu/100ml | < 10 cfu/100ml | Good |

Maximum recommended:

| | | | |
|---|---|---|---|
| | 500/100ml | 100/100ml | 100/100ml |

Maximum admissible:

| | | | |
|---|---|---|---|
| | 10000/100ml | 2000/100ml | … |

N.M.P. – Number More Probable

cfu – colonies forming units

**Table XIII** – Water nutrients - Nitrates ($NO_3^-$), Nitrites ($NO_2^-$), and Orto-phososphates ($PO_4^{3-}$) - at stations 1 to 6 (surface and bottom).

| Sample | $NO_3^-$ + $NO_2^-$ (mmol $L^{-1}$) | $NO_2^-$ (mmol $L^{-1}$) | $PO_4^{3-}$ (mmol $L^{-1}$) | SPM (mg $L^{-1}$) |
|---|---|---|---|---|
| **#1_surface** | < 0.4 | < 0.4 | 3.61 | 30.4 |
| **#1_bottom** | < 0.4 | < 0.4 | 3.65 | 18.5 |
| **#2_surface** | < 0.4 | < 0.4 | 3.60 | 9.7 |
| **#2_bottom** | < 0.4 | < 0.4 | 3.68 | 22.1 |
| **#3_surface** | < 0.4 | < 0.4 | 3.63 | 20.4 |
| **#3_bottom** | 0.50 | < 0.4 | 3.62 | 17.9 |
| **#4_surface** | < 0.4 | < 0.4 | 3.56 | 19.4 |
| **#4_bottom** | < 0.4 | < 0.4 | 4.52 | 20.4 |
| **#5_surface** | < 0.4 | < 0.4 | 3.58 | 16.8 |
| **#5_bottom** | 2.96 | < 0.4 | 3.66 | 18.9 |
| **#6_surface** | < 0.4 | < 0.4 | 4.05 | 16.5 |
| **#6_bottom** | < 0.4 | < 0.4 | 3.63 | 18.7 |

**Note**: Detection limit of the equipment for is $NO_3^-$ + $NO_2$ 0.4 mmol $L^{-1}$ (all values below this concentration were designated as < 0.4 mmol $L^{-1}$).

# Annex 2

## Environmental Land Survey Report

# BIOPHYSICAL CHARACTERIZATION OF THE PRAIA PORT EXPANSION AREA

**Aline Rendall**
**José Maria Semedo**
**Samuel Fernandes Gomes**

**Praia June 2007**

# BIOPHYSICAL CHARACTERIZATION OF THE PRAIA PORT EXPANSION AREA

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# INDEX

# BIOPHYSICAL CHARACTERIZATION FROM ACHADA GRANDE CLIFF BETWEEN THE DOCK AND PONTA DA MULHER BRANCA

## 1. Goals

This report aims to present the biophysical characterization of the cliff and the plateau between the Praia dock and Ponta da Mulher Branca. This is the area for future expansion of the Praia Port which foresees interventions on the cliff, namely demolitions, backward movement, filling of the marine platform adjacent to the cliff, leveling of the plateau through ground handling, excavations, soil compaction and masonry for building a stock of containers.

Considering the changes introduced in this area, the purpose of this report is to diagnose the present condition of the environment concerning flora, fauna and terrestrial ecosystem that will go through changes due to the constructions mentioned above.

## 2. General background

Since the Praia Port is the main port of the country when it comes to cargo handling, it's expansion is considered a construction of national priority. This Port represents over 60% of the archipelago's port handling. The present port has many constraints such as the stock of containers' small dimension, lack of security for ships during rainy season due to south quadrant wind, impossibility to keep up with the fast growth of Praia city and the increase of consumption at Santiago Island. This port is also responsible for the entry of international merchandize intended to the neighboring Maio, Fogo and Brava islands.

The construction of the new port aims to solve the present constraints and to ensure the better access to the biggest island of the country, in a fast growing scenario, having strong participation in the country's economy, concerning tourism and the triangular commerce between Europe, Western Africa, North and South America.

Among other improvements, the expansion of the Praia Port aims to increase the breakwater length, build a parking on the cliff base in an area conquered to the sea, build a second link road to Achada Grande and a stock of containers also in Achada Grande over the cliff that borders the port.

These interventions will have great environmental impact since changes are expected concerning land topography, geomorphology (relief forms and morphogenetic processes), destruction of soil and vegetation, destruction of wild fauna shelters at the cliff and the plateau, general landscape change concerning the visual profile.

This construction involves great strategic national interest since it will have great social impact: constriction decrease of Praia City and Santiago Island, increase on incoming and outgoing of goods and passengers, improvements on passenger maritime transport between the islands and improvements on tourism related services. The political decision concerning these interventions might overcome interests related to the environment, such as the preservation of the flora, fauna, the ecosystems and property assets. Nevertheless, it is possible to minimize the negative impact and adjust both political and environmental interests. Considering these interests, we will analyze the works' incidence on the biological diversity of the project's area of intervention.

## 3. Geomorphology and geological structure

The main land form around Santa Maria Beach bay, as well as the southeast and south areas of Santiago Island, has extensive structural tablelands of columnar lava, locally named as plateau. Achada Grande is a tableland that on the top has sub aerial lava placed on submarine lava that overlaps with Miocenic marine sedimentation and the anti Miocenic Ancient Complex (AC). On the surface area of the "plateau" there are traces of quaternary marine sedimentation that witness a marine transgression over 40 meters high than the present level. This might be counterbalanced by the general rise of the island in recent geological seasons.

Within the project's intervention area Achada Grande ends on a 30 to 40 meter cliff. This cliff drops straight down to the sea and has been shrinking fast due to the existence of whitish material on its base, namely extremely changed basalts from the Ancient Complex and calcarenites. On the base of the cliff, however, big blocs pile up and fall off the cornice. Occasionally these blocks protect the cliff against the ocean's erosive force.

The cliff's layer of submarine basalts presents a considerable amount of caves between the lavas. These caves serve as shelter for the avifauna, both marine, being close to their feeding source, as well as terrestrial that, due to the steep of the cliff, are protected from their enemies.

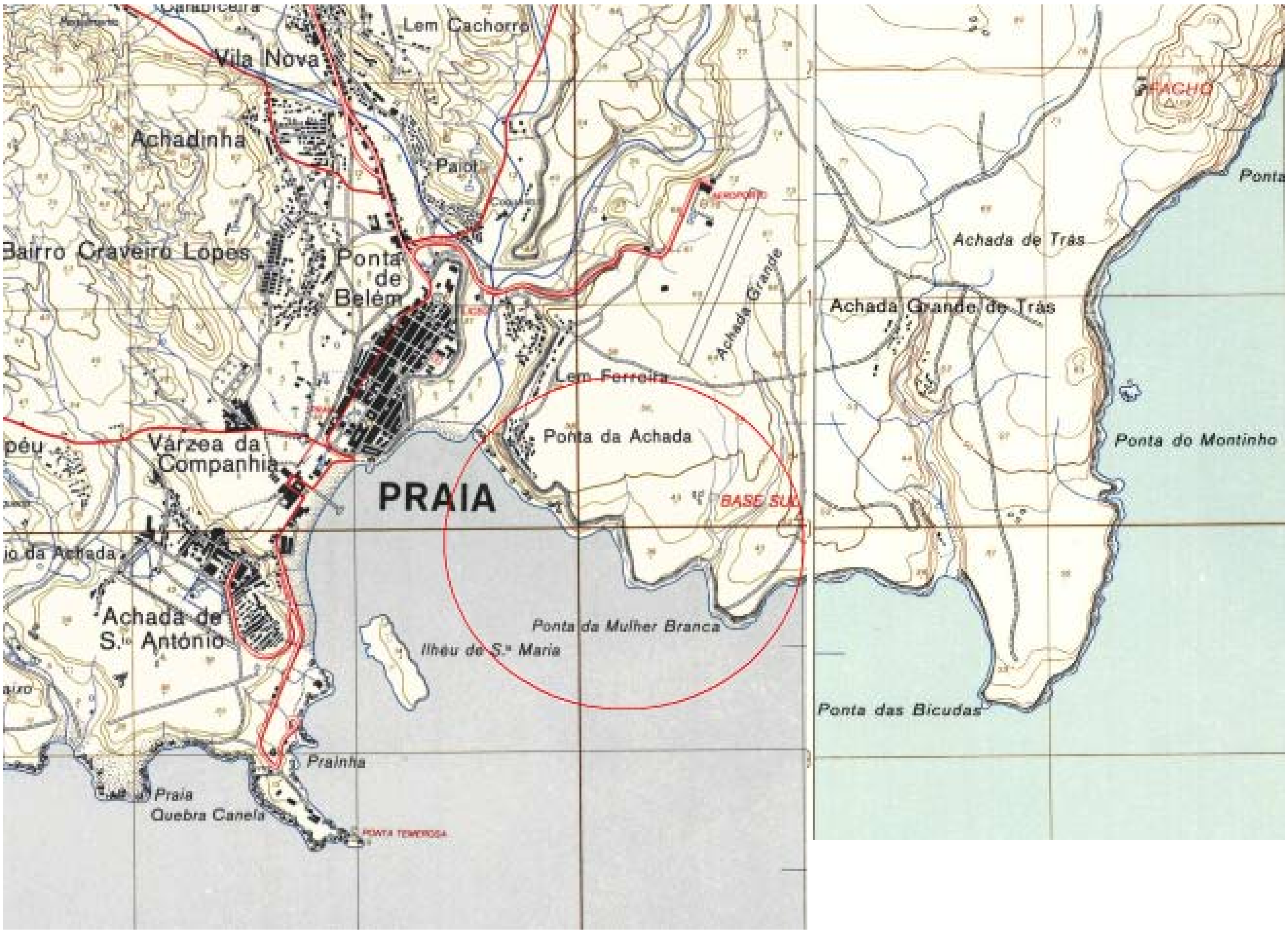
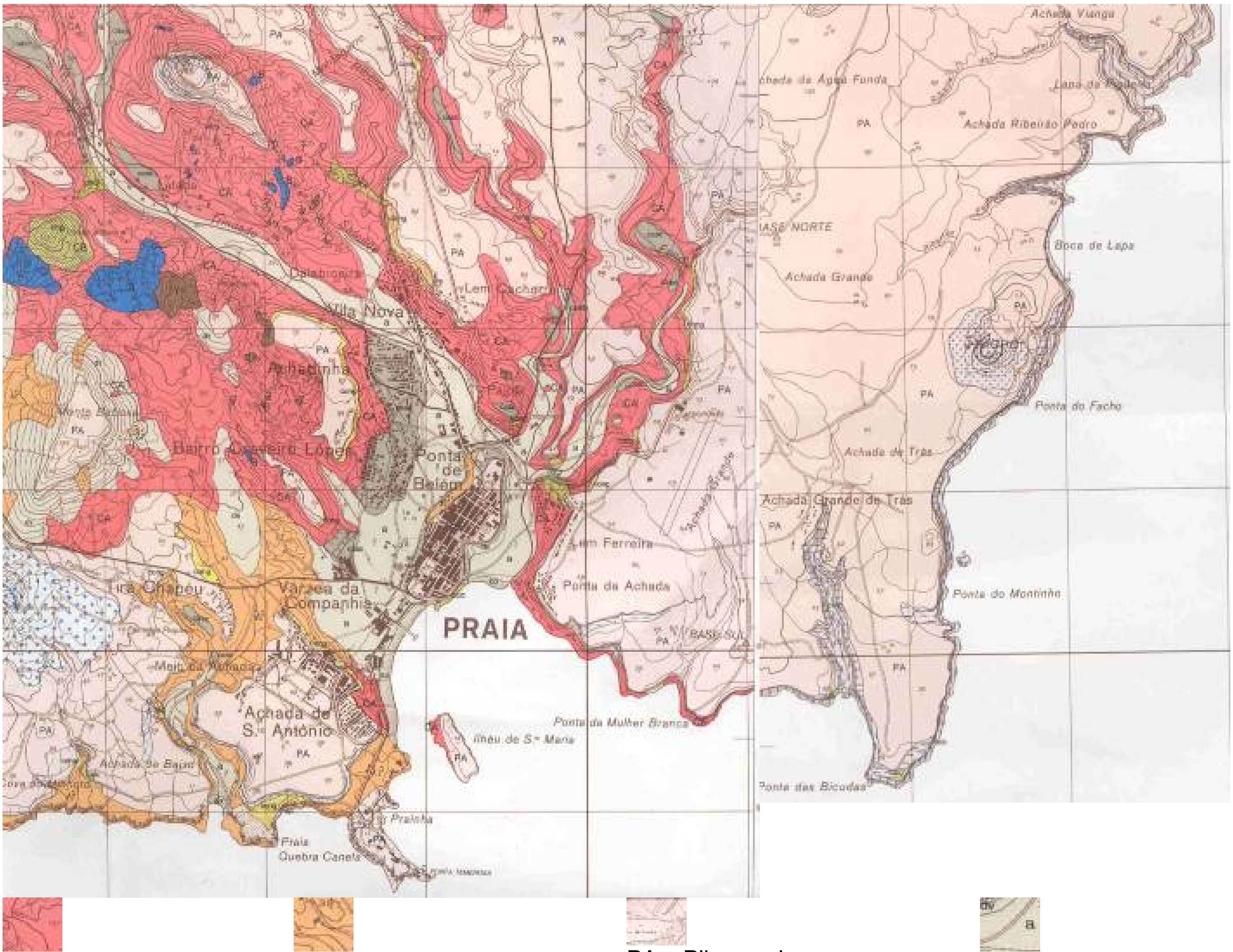



*Fig. 1 – Localization of the intervention area at Praia city*

***Fig. 2 – Present occupation of the Project area***


*Fig. 3 – Localization of the intervention area at Santiago Island*




CA – Anti Miocenic lavas

Λρ -Miocenic submarine lavas

PA – Pliocene lavas

Quaternary alluvium

***Fig.4 – Geological map of Praia***

*Fig.5 – Sequence of the cliff's geological layers – project area*

*Fig.6 – The cliff's profile and geological layers on the project area*

*Fig.7 – Appearance of sub aerial lava at the cornice on the project site*

***Fig. 8 – Appearance of PA's Submarine lava – the caves serve as shelter to wild pigeons***

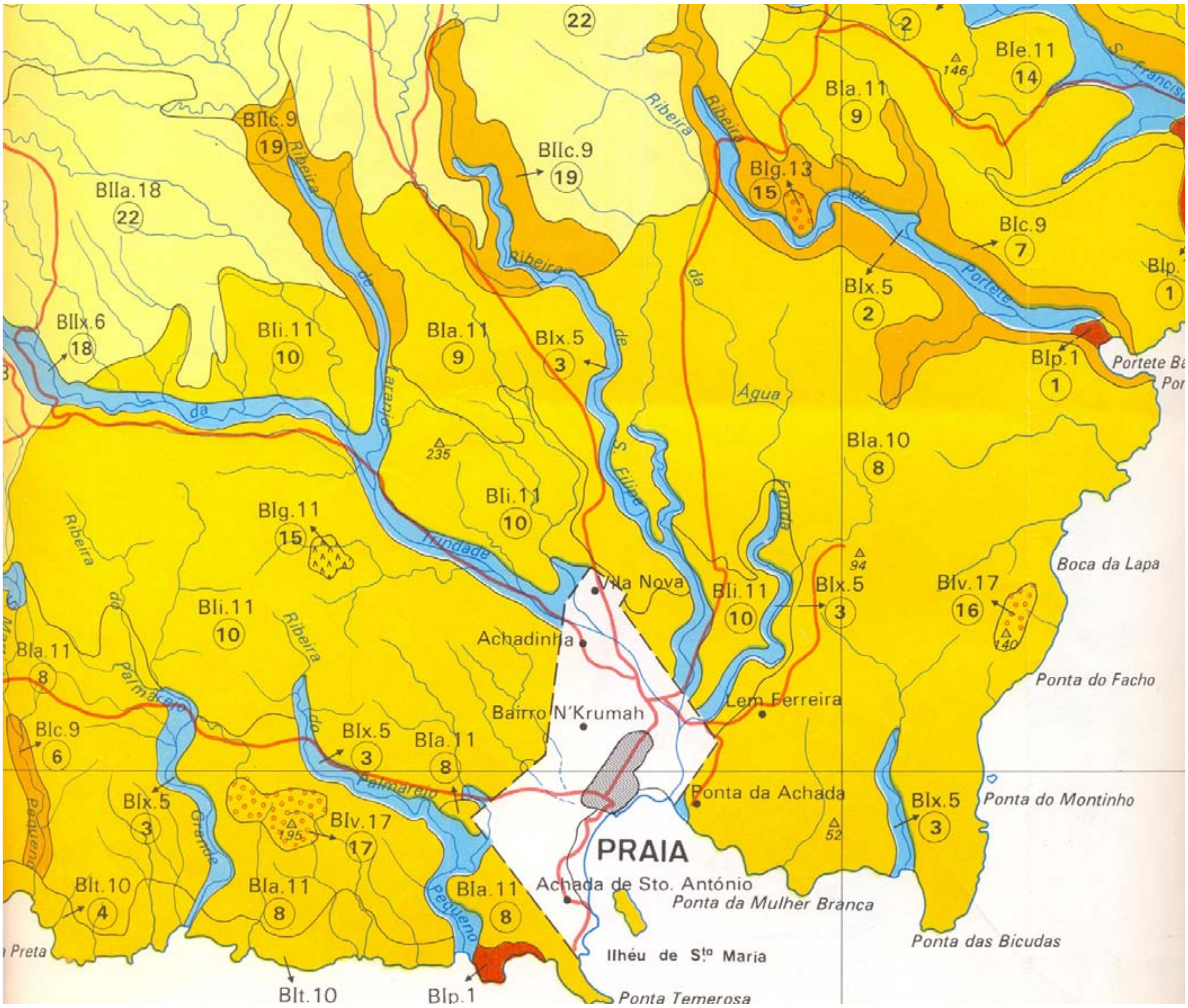
## 4. Vegetal covering

Achada Grande, like all the "plateaus" south of the island, is on the dry level of altitude on the classification of agro ecological chart and Santiago Island's vegetation. With a rainfall level of less than 300 mm per year on humid years, ground herbs of annual cycle, bushes and trees with great adaptation to dryness are the dominant vegetation.

Concerning Achada Grande above the cliff, the untamed cattle breeding since the beginning of the occupation towards the end of the 1960's caused a violent diminishing on the vegetal covering due to overgrazing. Wind erosion combined with rain concentrated on the wet season transformed it into a field of stones. For the past few years Achada Grande has been pushed by the urban subsidence, especially warehouses and other equipment related to harbor activity.

Untamed goat breeding is limited due to urban subsidence; however, the presence of goats wandering on the "plateaus" is still common.

Achada Grande's faunal community is formed by birds from dry and desert like regions such as Sahel and the Sahara, reptiles from Santiago Island's dry areas and insects. Although there are endemic birds from dry areas and reptiles on the archipelago, none of these animal categories are exclusive or endemic from the project intervention area.




 Dry area community  Semi-Dry community 

Open river banks community

***Fig. 9 – Vegetation communities around Praia***

***Fig. 10 – General appearance of the vegetation at the stock of container's installation site at Achada Grande – 9 of June – Year's dry season***

***Fig. 11 – General appearance of the cliff's vegetation – on the project site – 9 of June***

# 5. Flora & Fauna

## 5.1. Flora's description

After analyzing this area it can be determined that, considering both biological and ecological elements, this area is characterized by a degraded vegetation cover with dominance of herbaceous tufts, adding up to 21 (twenty one) species, including those with specific localization such as small shrubs and trees, honey mesquite (*Prosopis juliflora*) and rooster tree (*Calatropis procera*).

In general, the impact on flora/vegetation resulting from the project's implementation will have an extremely local effect, limited to the new exploitation area. These will be related to ground clearing, road construction and vehicle circulation activities.

Given the site's characteristics, this impact is not considered to be significant.

The main minimization measures of the impact on fauna and habitats are the definition of rules to take into account during the enlargement phase, aiming to limit disturbance to the necessary sites and during the shortest possible period of time.

| Scientific name | Common name | Description | Environmental value | Abundance |
|---|---|---|---|---|
| Aerva javanica (Burm. f.) Juss. | Kapoc bush | Small herbaceous. 40 to 60 cm tall. Yellowish to whitish leaves. Whitish to grayish flowering. | Herb with no pastoral value. However, in the past its fruit was commonly used for stuffing mattresses and pillows. | Small abounding on the intervention area of the project. Common on all islands. |

| Scientific name | Common name | Description | Environmental value | Abundance |
|---|---|---|---|---|
| *Acacia albida* Del.  | Ana tree | A 6-8 m tall tree, which sometimes can go up to 12 m, light brownish-grayish rhytidome, wrinkled, large tree top and new grayish, whitish branchlets. Glaucous leaves; petiole of 0,5-1 cm long; 6-20 leaflet pairs, 3,5-8 mm long; linear-oblong. Sessile or shortly pedicellated flowers. Corolla c. 3 mm long, white. Shell 7-20 X 2-3 cm, thick, falciform or circular winding orange or brownish-reddish while maturing, hairless, indehiscent. Bright seeds 5-9 X 3,5-6 mm; big, oblong. | The fruits are good dried food. | On the intervention area of the project was found only one specimen of this species. However, it can be seen at Santo Antão, São Vicente, Sal, Boavista, Maio, Fogo. Widely dispersed in tropical and subtropical Africa from west Senegal and Gambia to northeastern Egipt and, towards the south, to Natal; also in the Middle East. |

| Scientific name | Common name | Description | Environmental value | Abundance |
|---|---|---|---|---|
| *Cleoma brachycarpa* DC. | Cleome | Annual herb, 20 to 40 cm tall with yellow flowers. Unpleasant smell. | No medical or pastoral value. | Small abounding on the project area. Spread on other archipelago islands and on other areas of Santiago Island. Great abundance on the "plateaus" dry areas, mainly during wet season. |

| Scientific name | Common name | Description | Environmental value | Abundance |
|---|---|---|---|---|
| *Cleoma viscosa* L. | Cleome | Annual herb, 20 to 60 cm tall, yellow flowers. It's sticky and has an unpleasant smell. | This specimen is used on traditional medicine. | Abounding on the plateau area where the implementation works will take place. It is spread on other archipelago islands. There is great abundance on the "plateaus" dry areas. |

| Scientific name | Common name | Description | Environmental value | Abundance |
|---|---|---|---|---|

| | | | | |
|---|---|---|---|---|
| *Ipomoea asarifolia* (Desr.) Roem. & Schult. | Morning-glory | Climbing herbaceous with triangular leaves; purplish flowers, invading. | Protects the degraded soil against erosive effects, namely Aeolian erosion. | Small abounding on the cliff. Only a few specimens can be dispersedly seen. Abounding on other sites of Santiago Island and on other islands. |

| **Scientific name** | **Common name** | **Description** | **Environmental value** | **Abundance** |
|---|---|---|---|---|
| *Bidens bipinnata* L. | Spanish needles | Herbaceous plant, invading, grows up to 60 cm tall; leaves have up to 3 rows of lateral leaflets; yellow flowers on solitary heads; the fruit is a black achene, thorny extremity. | It has medical value. | Small abounding on the project area. It is spread on other archipelago islands. |

| **Scientific name** | **Common name** | **Description** | **Environmental value** | **Abundance** |
|---|---|---|---|---|
| *Leucas martinicensis* (Jacq.) Ait. f. | Whitewort; tumbleweed | Woody herbaceous, annual or perennial, it can grow from 40 to 60 cm tall. Rounded leaves. | It is not used on traditional medicine and is of little use for animal feeding. | Common on the project area, spread around the cliff. Abounding on other Santiago Island sites and on other archipelago islands, especially during the wet season when it forms great herbaceous tufts. |

| Scientific name | Common name | Description | Environmental value | Abundance |
|---|---|---|---|---|
| *Borreria verticillata* (L.) G.F. Meyer | Buttonweed | Woody herbaceous, annual or perennial, sometimes with several branches. It can go up to 60 cm tall. Linear rounded leaves, white flowers on the top or along the stems. | Widely used on traditional medicine. It is not used for animal feeding. | Little abounding on the cliff where the project will take place. Abounding on other archipelago islands. |

| Scientific name | Common name | Description | Environmental value | Abundance |
|---|---|---|---|---|
| *Calotropis procera* (Ait.) Ait. f.  | Rooster tree | Shrub or small tree. Large grayish buff leaves with white nervure; white and purple flowers arranged in groups. Big green fruits. | Medicinal herb. | Abounding on the project area of intervention. Common on other sites of Santiago Island as well as on other islands on compact soil on the coastal region. |

| Scientific name | Common name | Description | Environmental value | Abundance |
|---|---|---|---|---|
| *Prosopis juliflora* (Sw.) DC.  | Honey mesquite | Small tree 4-8 m tall, perennial; bark thick; stipular spines, straight, divergent, grouped as pairs on the same branch, 0,5-2,5 cm long, many times nonexistent. Alternate leaves with a pedicle c. 1 mm long. Pod, 8-29 X 1,0 – 1,7 cm, suberecta, thick, hairless. Egg-shaped to ellipsoidal light brown seeds transversely positioned on the pod. | Widely introduced and planted on tropical and subtropical areas. In Cape Verde it's planted as reforestation element. It is also used to shade the villages' streets and roads. The cattle feed off it. Specially appreciated in various tropical regions for its economical interest, since it produces good wood, supplies fuel, is also a shade tree and it becomes dry food when the pods get dry. | On the project intervention area this tree is widely spread and can be considered one of the dominant species of the area, when compared to others, concerning its presence and abundance. This species can be found on other archipelago islands (São Vicente, Sal, Maio, Fogo and Brava). It is not a specimen protected by law and it doesn't belong to the list of those in peril of extinction. |

| Scientific name | Common name | Description | Environmental value | Abundance |
|---|---|---|---|---|
| *Salvia aegyptiaca* L.  | Lavender | Annual or perennial herbaceous, with several ramifications, it can grow 20 to 40 cm tall. Strongly scented. Simple leaves. | Widely used in perfumery. | Abounding and widely spread along the cliff. It can also be found on other areas of Santiago island as well as on other archipelago islands. |

| Scientific name | Common name | Description | Environmental value | Abundance |
|---|---|---|---|---|
| *Alternanthera caracasana* H. B. & k. | Washerwoman | Perennial herbaceous, creeping, small yellowish flowers. Oblong leaves. | It doesn’t have medicinal or animal feeding value. | Little abounding on the project intervention area. However it is abounding on Santiago Island as well as on other archipelago islands on very dry and desert like regions. |

| Scientific name | Common name | Description | Environmental value | Abundance |
|---|---|---|---|---|
| *Boerhavia repens* L. | Anena | Semi erectile herbaceous that can grow 60-80 cm tall. Narrow leaves, half-roundish, small white flowers with a mixture of red. | Widely used on animal feeding. | Abounding on the project area of intervention. Widely abounding on other regions of Santiago Island and on other archipelago islands. |

| Scientific name | Common name | Description | Environmental value | Abundance |
|---|---|---|---|---|
| *Chloris virgata* Swartz | Showy chloris; feather fingergrass | Annual herbaceous, it can grow 40-50 cm tall. Narrow, long leaves. | Widely used on animal feeding. It has great pastoral value. | Very little abounding on the project area. Sporadic specimens here and there. It can be found on other areas of Santiago island and on other islands of the archipelago. |

| Scientific name | Common name | Description | Environmental value | Abundance |
|---|---|---|---|---|
| *Nicandra physalodes* (L.) Gaertn. | Shoofly plant | Perennial herbaceous that can reach 60-80 cm tall. Large leaves and fruits. Erect and resistent stem. | It has no medical or pastoral value. | Little abounding on the project area of intervention. However, it can be found on other regions of Santiago Island and on other archipelago islands. |

| Scientific name | Common name | Description | Environmental value | Abundance |
|---|---|---|---|---|
| *Corchorus trilocularis* L. | Wild jute | Erect herbaceous, widely branched, 40-60 cm tall. Single leaves; fruit with small loculus. | It has no medical nor pastoral value. | Abounding on the project area. It is also abounding on other regions of Santiago island as well as on other islands of the archipelago, specially after the wet season. |

| Scientific name | Common name | Description | Environmental value | Abundance |
|---|---|---|---|---|
| *Cucumis anguria* L. | Burr cucumber; cohombro | Climbing and creeping herbaceous. Semi-round leaves; thorny and yellowish fruits. | It has medical value. | Little abounding on the intervention area. Abounding on dry and coastal regions of Santiago island and other regions of the archipelago islands. |

| Scientific name | Common name | Description | Environmental value | Abundance |
| --- | --- | --- | --- | --- |
| *Jatropha gossypiifolia* L.<br> | Black physicnut; cotton leaf | 2 m tall shrub. Petiole 4-10 cm long, pubescent, with glandulous ramified hair, more dense on the top; clear 1-9 X 6-11 cm, 3-5 palmatipartite. Male flower with calyx-leaves c. 2 mm long, lance-shaped, pointed, pubescent, engrailed glandular. Petals c. 3 mm long. Seeds c. 7 X 5 mm, ellipsoid, grayish, softly brown colored, smooth, bright. | Widely used on the improvement of degraded soil, specially on stony ground. | On the project area of intervention were registered several specimens of this species. This specimen is common on stony grounds, mountain clefts and dry riverbanks bedsteads, across paths and on cropped land.<br>It is widely abounding on Santiago island. |

| Scientific name | Common name | Description | Environmental value | Abundance |
| --- | --- | --- | --- | --- |
| *Sarcostemma daltonii* Dcne.<br> | gestiba<br>(no english common name) | Creeping herb of juicy sap, roll-shaped succulent branches, with no leaves. Yellow-greenish flowers. | The juicy sap is usually used to treat carious teeth. We damp a piece of cotton with the juicy sap and put it in the carious tooth hole. The pain stops and the tooth comes out in pieces. | Among all the species mentioned this is the only one present that it is considered rare and endemic on the project area; it stands out on the cliff and belongs to the endangered species list. It can be seen in Santo Antão, São Vicente, São Nicolau, Boavista, Santiago, Fogo and Brava, on the stony and dry areas close to the sea. |

| Scientific name | Common name | Description | Environmental value | Abundance |
|---|---|---|---|---|
| *Sonchus oleraceus* L. | Sowthistle | Herb with yellow flowers, juicy sap, 40-50 cm tall. Toothed leaves. | It has medical value. | This species is not abounding on the cliff area. The number of specimens found is very limited. |

| Scientific name | Common name | Description | Environmental value | Abundance |
|---|---|---|---|---|
| *Chamaesyce prostrata* (Aiton) Small | Prostrate sandmat; creeping spurge | Annual herb, 20 cm long branches, prostrated or decumbent. Short petiolate leaves, 5-7 X 3-5 mm, oblong-elliptic to oblong-obovate, with asymmetric base, slightly thick, puberulent dorsally. 1 mm long seeds, narrowly ovoid, quadrangular, strongly wrinkled. | It has no pasture value but it is widely used in traditional medicine. | Little abounding on the project area of intervention. It can be seen at Santo Antão, São Vicente, Santiago, Fogo and Brava. Abounding on dry riverbank's bedstead, in alluviums and as cropped land infesting. |

## 5.2. Fauna's description

Concerning avifauna, it was confirmed the existence of 14 native bird species in Cape Verde, corresponding to 34,1% of the archipelago's native bird species. Two of them are on the red list, *Phaeton aethereus* (Red-billed tropicbird) classified as an endangered species and *Pandion haliaetus* considered a rare species (Hazevoet, 1996).

Among the analyzed species it was also verified the presence of three endemic species on the archipelago *Falco tinnunculus alexandri, Passer iagoensis, Apus alexandri.* Nontheless, these are considered to be abounding species present on all the islands.

The rocky shore is confirmed to be a reproduction region for *Phaeton aethereus* and *Columba livia*. Most likely, the surrounding grounds are used by the species: *Cursorius cursor, Ammomanes cincturus* and *Eremopterix nigriceps* for nesting. The *Apus alexandri* specimen, present in the area, probably uses the rock fissures for reproduction.

There are also references of migratory species: *Bubulcus íbis, Ardea cinérea, Numenius phaeopus, Arenaria interpres*, on the port surroundings (Hazevoet,, 1995; Colin & Geiregat, 2003 Krabbe *et al* 2003).

There must exist, on the Plateau, at least two terrestrial reptile specimens, a wall-lizard *Mabuya spp*, and *Hemidactylus bouvieri.* During the reconnaissance visit to the area on June 9, towards the end of the dry season, no specimens were seen. Although these are endemic species on the archipelago, they are not exclusive from the project area where, if they do exist there, their population is small.

In order to be more expressive, we will describe the birds found on the project area.

## List of the avifauna identified on the project area – Plateau and Cliff

| Scientific name | Common name | Description | Environmental value | Abundance |
|---|---|---|---|---|
| *Cursorius cursor*<br><br>*Fonte: Aline Rendall* | Cream colored courser | Typical dry region species; It has red brownish coloring, a double black and white stripe on the head that goes from the eyes to the nape; black wing tips and under the wings. Light yellow paws. 21 to 24 cm long. | Typical specimen of dry regions, **It reproduces on the surroundings.** | It can be found on most of the islands, except on Brava, Fogo and Santo Antão. It builds the nest on the ground. |

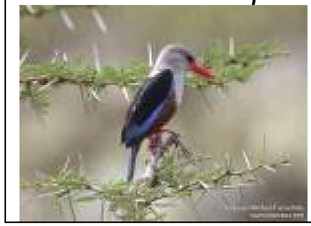
| Scientific name | Common name | Description | Environmental value | Abundance |
|---|---|---|---|---|
| *Ammomanes cincturus*<br><br>*Fonte: Aline Rendall* | Bar tailed lark | Similar sexes; brown reddish colored plumage, uniform. Wings and tail with big black circles on the feather tips (wing-quill and rectrices respectively); a few brownish imprecise strias on the craw. Nest cup shaped, dug on the floor sheltered by a stone. | **It reproduces on the surroundings.** | Abounding on Sal, Boavista, Maio and Santiago islands. |

| Scientific name | Common name | Description | Environmental value | Abundance |
|---|---|---|---|---|
| *Columba livia*  | The rock dove; pigeon | 20 to 22 cm long, dark bluish-gray colored; whitish light grey tail end; two dark bands across the wings and one black band at the end of the tail; metallic, gold, reddish-brown, lilac and green reflexes on the side of the neck. Small head and feet, seroma beak or with upper base and the tip has a hook shape. The beak is red, short and thin. The nest is usually on a ledge in a cave or on trees, where they lay two white eggs. The eggs are incubated by both parents for 14 to 19 days. | **It reproduces on the site.** | Widely abounding. |

| Scientific name | Common name | Description | Environmental value | Abundance |
|---|---|---|---|---|
| *Falco tinnunculus alexandri*<br><br>*Fonte: Aline Rendall* | Common krestel | Bluish-grey head and tail with a large back stripe; bright chestnut feathers with black spots. The female is black striped rather than spotted. A black moustache goes from the lower eyelid to the end of the neck almost arrow like directed (compared to the bird's body axis) through its white cheeks. Light fulvous lower parts. | Archipelago endemic subspecies. | Widely abounding, present on all islands and, in smaller number, also present on islets such as Raso or, more sporadic, on Branco islet. |

| Scientific name | Common name | Description | Environmental value | Abundance |
|---|---|---|---|---|
| *Phaeton aethereus*<br><br>*Fonte: Aline Rendall* | Red billed tropicbird | One of the endangered species according to the red list (Hazevoet, 1996). Hazevoet (1995) estimated this species'population on 160 pairs. They are 1 m tall (40 cm correspond to the central tail feathers): 30 to 31,5 cm Weight: 650 to 700 g. White with black stripes on the back, the tip of the wing is also black and the beak is red. Young birds have yellow beaks and short tail.<br>**Distribution**: there are colonies in Santo Antão, Santiago, Brava, Sal and Boavista and on Raso and Rombo islets (Naurois, 1994; Hazevoet, 1995). | **Preservation:** Catalogued as **endangered** according to Cape Verde's First Red List. Is among the extinction endangered falcon species worldwide with the IUCN.<br>**It reproduces on the site.** | It is estimated that there are 160 pairs in the whole archipelago Hazevoet (2). |

| Scientific name | Common name | Description | Environmental value | Abundance |
|---|---|---|---|---|
| *Apus alexandri* | Cape Verde swift | Dark grey colored; a large, almost white mark on the throat; grayish head; grayish-brown back with metallic reflexes; dark grey rectrices on the upper side. Grey lower parts with ocher; bright grey under the tail and rectrices' lower side.<br>Aerial plankton on all altitudes, especially at sea level. | Endemic species of Cape Verde.<br>(Naurois, 1994) | Abounding species distributed through all the islands. |

| Scientific name | Common name | Description | Environmental value | Abundance |
|---|---|---|---|---|
| *Halicion leucocephala*<br> | Grey headed kingfisher | Red beak and paws, light grey head; blue back, bright brown abdomen. | Insect predator. Maintains ecological balance on the food chain. | Abounding, distributed on Santiago, Fogo and Brava islands. |

| Scientific name | Common name | Description | Environmental value | Abundance |
|---|---|---|---|---|
| *Passer hispaniolensis*  | Spanish sparrow | The adult Spanish sparrow has a brown calotte, brown back and rectrices' upper side, black throat and chest; white cheeks; on the centre, between the craw and abdomen, as on the sides, it has oblong black stripes over its white dorsum; dark white abdomen; strong beak; the female has grey feathers with indistinct dark stripes on the sides. In general, the dark upper parts contrast with the light under parts. | It's a granivorous bird and attacks crops to eat the seeds. | Abounding on all islands, except on Santa Luzía. |

| Scientific name | Common name | Description | Environmental value | Abundance |
|---|---|---|---|---|
| *Passer iagoensis*  | Cape Verde Sparrow | It's about 13 cm long, both sexes present a pale yellow eyebrow; the male has a black crown on the top of the head with brownish color surrounding it, brown dorsum, with wide black stripes, brown feathers with a wide white stripe, wide black line on the throat that, on males, goes down just near the craw; strong dark white lower parts; the female, just like *Passer hispaniolensis* is of a grayish color. | Endemic species of Cape Verde. | Abounding on all islands. |

| Scientific name | Common name | Description | Environmental value | Abundance |
|---|---|---|---|---|
| *Charandrius alexandrinus*  | Kentish plover; snowy plover | Migrate or sedentary coastal species. White forehead, stria above the eyes with a black stripe between the white cheeks and the grey head (nonexistent on females), a black line from the beak to the nape but it doesn't go around the neck. It has a white collar around the neck and black spots on both sides of the chest, brownish-gray dorsum, white under parts; black paws and beak. 15 to 17 cm tall, 42 to 45 cm wingspan and 40 to 60 g weight. | Limicoline bird, usually with migratory habits. | Little abounding. |

| Scientific name | Common name | Description | Environmental value | Abundance |
|---|---|---|---|---|
| *Pandion haliaetus*  *Fonte: Natura 2000* | Osprey | White face jutted out by dark stripes that cross the eye. Dark dorsum that contrasts with the white lower parts. The chest, specially on females, has several dark lines. Juveniles (less than a year old) resemble adults, but the dark feathers from the upper parts have a thin white and yellow outline. While flying the wings become slightly arched and slightly bent on the extremities.<br>43-56 cm wide, 167 cm wingspan, weight: 1.1-2.0 kg. Females are usually 10% larger than males and weight about 200 g more.<br>**Habitat:** since ospreys eat mainly fish, this fishing eagle lives near fresh or salty water. | Uncommon species, according to Cape Verde's First Red List. Extremely sensitive to human presence on nesting sites during reproduction season. Guincho is a reliable indicator of the environmental quality on the coastal region; it's an attractive and public species, therefore, it's an important element for quality tourism supply. **This species was seen feeding on the site.** | 76-86 pairs are estimated to live on the archipelago and no more than 3 at Santiago (Palma *et al,* 2004) |

| Scientific name | Common name | Description | Environmental value | Abundance |
|---|---|---|---|---|
| *Corvus ruficollis*  *Fonte: Aline Rendall* | Brown-necked raven | It's about 37 cm long, black with flight-guides on the dorsum and brownish lower parts. It's omnivorous, including small invertebrate animals, seeds (especially corn) and fruit; it can also be necrophagous. | Predatory and necrophagous, this species plays an important role on ecological balance. | It can be seen on all islands, but has a tendency to diminish. |

| Scientific name | Common name | Description | Environmental value | Abundance |
|---|---|---|---|---|
| *Falco (perigrinus) madens*  *Foto: cursorius .net* | Peregrine falcon | **Description:** endemic species on the archipelago, ocher on the abdomen and on the sides; the upper parts (top of the head, nape, mantle, tail, rectrices and wing covering) are black slate-colored; white on the cheeks. 38 to 48 cm long. **Habitat**: mountains and slopes on island and islet shores. | It's an endemic extinction endangered species according to the red list. They feed off alive preys that they hunt on flight, this is why they are excellent predators. **This species was seen flying on the site.** | Total species population is estimated to be of a few tens of pairs on the whole archipelago (Hazevoet, 1995). |

| Scientific name | Common name | Description | Environmental value | Abundance |
|---|---|---|---|---|
| *Eremopterix nigriceps*<br><br>*Fonte: Aline Rendall* | Black-crowned sparrow-lark | Male: white forehead until the crown top; light brownish-grey upper parts (sandy colored); white cheeks; black lower parts; whitish lower abdomen; black under the tail; sandy colored central rectrices, white external rectrices (on the top and sides); black middle rectrices (different compared to *Ammomanes c. cincturus).* Female: fulvous (sandy colors) head and upper parts, including the cheeks, fulvous craw, whitish abdomen. | They eat insects, contributing to maintaining ecological balance. | Relatively abounding population; it can be seen on Boavista, Maio, Santiago, Fogo, Brava and São Nicolau islands. |

# 6. Change prediction

## 6.1. On vegetal covering

The dock and stock of container' works will demand rock movement, excavations, ground leveling, causing ground and vegetation covering removal. Being so, all the vegetation on the project area will be destroyed. Although the impact is negative the vegetation cover destruction will not be significant, since natural vegetation on the project area is scattered, creeping and composed of short lifecycle weed that only covers the soil partially on wet season. On dry season, that lasts most of the year, the soil does not have vegetation and is covered by lose rocks over the plateau. The most common **phanerophytes** are dry region bushes such as the rooster tree (*Calatropis procera*), abounding on dry regions of the island but little abounding on the project area, the honey mesquite (*Prosopis juliflora*), abounding on the island and on the project area, specially on the cliff base. The Ana tree (*Acacia albida*), typical of dry regions, it was only found one shrubby and very small specimen on the area. On the cliff cornice was found a *Sarcostema daltonii* specimen, endemic plant from cliffs, cornices and precipices. This specimen is abounding on other sites of the island and on cliffs near the project area of intervention.

The present vegetal covering will be totally destroyed by the works predicted on the project. No endangered species was found on the site. As compensation measure works on the port should consider a greenbelt on vehicle parks and on the surroundings.

It's extremely important to do a study that will look into the man – nature relation, and will analyze how it is developed, proposing measures to attenuate and mitigate the adverse environmental impacts through a sustainable development local plan.

The group of cliffs is 30 to 40 m high and its side face has intervals of rectilinear walls, re-entrances and accentuated extremities.

On the implementation point of view, regardless of the kind of intervention, some kind of disturbance will occur, causing negative impact on the project site. Elements such as the existence of population or animal and vegetal species are crucial for the occurrence, or not, of the impact. On the operational point of view, the project will probably have a positive impact on society.

The extension project of the Praia port will have an impact on an already degraded cliff and its existence tends to improve the environmental conditions of the region. The 20 (twenty) vegetal species that exist there are not included in Cape Verde's preservation norms. It's important to point out that only 1 (one) species, (*Sarcostemma daltinii*), on the top of the cliff, is on the endangered species list, going up to 21 (twenty one) species on the project area of intervention. The negative impacts, though minimized by the use of less impatient technologies, will only occur during the implementation phase and after that period highly positive impacts are likely to arise: impact on road traffic, on stock of containers and on the new port dynamic, motivated by de access relieving of congestion and capacity to receive more cargo-boats. During installation the noise caused by the machines may disturb the neighboring population as well as the existent fauna on the surroundings. On the other hand, it's an essential terminal for the entire archipelago since it will allow a large daily number of passengers and cargo realization/movement.

Specifically concerning the negative impacts during the works, it's important to stand out a common activity that attacks the environment in various ways: the leveling of the ground activities. Even if we exclude animal population and human or vegetal occupation, the leveling of the ground causes visual impact, atmospheric emissions caused by equipment, noise and vibrations. Also, if it is not correctly done it causes erosive processes on the soil. Generally speaking, all positive impacts of the operation vary depending on the enterprise's function.

Some will benefit directly, those with bigger and smaller revenue, but all tend to indiscreetly improve the entire society through economic and social development.

### 6.2. On fauna

The most affected fauna on the cliff and plateaus will be birds and, within this group, those that nest on the cliffs. The pigeons' nests are most abounding and will be destroyed. Depending on when the works will take place, eggs and young pigeons or just nests will be destroyed. This species also nests on other regions of the island and on other cliff sites, off the project area. Adult birds will most probably seek shelter on other numerous cliff caves nearby. Explosions might disturb birds' behavior. The species is not abounding on the island but it's not considered to be endangered.

The most critical species that nest near the project area are: the Red-billed tropicbird (*Phaeton aetereus*) and the Osprey (*Pandeon haliaetus*) that are on the red list. These are sea birds that nest on the cliff's caves. With the intervention on the cliff it is expected that the birds will find shelter elsewhere but, depending on the nest season, young birds and eggs might be affected. The presence of machines and explosives will affect birds' behavior.

Birds from the plateau, such as Cream colored courser (*Cursorius cursor*), Black-crowned sparrow-lark (*Eremopterix nigriceps*) and Bar tailed lark *(ammomanes cincturus)* will certainly leave the area because they are used to living in dry areas away from villages and regions of intense human activity.

### 6.3. On landscape

The extension works will be done on the continuity of the existing Praia port, a deeply changed region due to human presence. The cliff is on its' natural condition with no man-induced changes and still liable to morphogenetic processes related to its geological structure, to the island's climatic scene and the marine's dynamic. The extension works will have to stabilize the cliff to prevent the fall of big blocks on the bottom. These works will affect both the marine and terrestrial fauna.

The topography on the plateau will be completely changed. The consequent landscape will be of a huge human infrastructure, embracing the plateau, the cliff and the sea on the extension of the present quay. That area will be a construction designed to receive ships, to warehouse goods, passenger and goods' incoming and outgoing, offices, vehicle and machinery parking.

The extension on the Praia port will introduce into a 30 to 40 m tall cliff. This is an extensive landscape deeply marked by desertification and dominated by creeping brushwood and rock outcrop, creating an inhospitable, rough and uninteresting landscape. It has medium scenic and environmental quality, absorption capacity and landscape sensibility.

The impacts on landscape during the exploitation phase are significant, but with the implementation of a landscape recovery and integration plan of all the surroundings and seafront, amortizing this interface, visual impacts will be minimized, contributing to a significant positive impact.

The presence of endemic species on this area is scarce. Among all the species mentioned, only one, (*Sarcostemma daltinii*), is present that is considered to be rare. It's on the steep side of the slope.

## 7. Final reflections

The extension works of the Praia port will have negative impact mainly on the avifauna that lives and nests on the cliffs' caves and on the plateaus of the project area. Among the species identified on the site, two are on the red list. The works might destroy shelters, nests and young birds, depending if the intensive work phase coincides with birds' reproduction.

The species are not exclusive from the project area. After the beginning of the works it's expected that birds' habits and nesting will change.

Due to the extension and social importance of the project, it should go forward and compensation measures shall be applied by creating a greenbelt that will promote the accommodation of other bird species. The impact will be more negative during the construction phase. On the exploitation phase it's arranged that new birds will be accommodated on the region and many of those identified on the region will be able to raise its population, which is the case with birdlike species.

## 8. Bibliography

**ASSUNÇÃO, C.T. (**1968) – Geologia da Província de Cabo Verde – in Curso de Geologia do Ultramar, JIU Lisboa. Pag. 3-52.

**BAKKER, T. 8 DIJK, K. VAN,** (1996). Cabo Verde. March 1996. *Banco de Dados de Biodiversidade Cabo Verde*

**BEBIANO, B. A.** (1932) – Geologia do Arquipélago de Cabo Verde – Comunicação ao Serviço Geológico de Portugal, Lisboa.

**CASTANHEIRA DINIZ, A. CARDOSO DE MATOS G.** (1993) – Carta de Zonagem Agro-Ecológica e da Vegetação de Cabo Verde. I – Ilha do Santiago. Lisboa.

**CLERKE, T. & HANSBRO P.** (1999) Trip report CapeVerde island, 5- 20 March1999. *Banco de Dados de Biodiversidade Cabo Verde*

**COLIN, D; GEIREGAT, N.** Trip report Cape Verde islands. 5-21 April 2003. *Banco de Dados de Biodiversidade Cabo Verde*

**HAZEVOET, C. J**. The Birds of the Cape Verde Islands. An annotated check-list, 13ed; *editorial: British Ornithologists' Union, c/o The Natural History Museum, Tring, Herts* HP23 6AP, UK, 192p, 1995**.**

**HAZEVOET, C.J. (2003)** Fifth report on birds from the Cape Verde islands, induding records of 15 taxa new to the Archipelago. Arquivos do Museo Bocage. Vol 3 nº 19 Pg 503-528.
**INSTITUTO DE INVESTIGAÇÃO CIENTÍFICA TROPICAL** (1976) – Carta Geológica da Ilha de Santiago 1: 25 000. Lisboa.

**KRABBE, E. ELIAS, G. RILLEY,** A. Bird observations in the Cape Verde islands, 18-26 October 2003. *Banco de Dados de Biodiversidade Cabo Verde*

**NAUROIS, R, de.** Aves do arquipélago de Cabo Verde. Instituto de Investigação Científica Tropical. Lisboa 1994.

**PALMA, L., J. FERREIRA, R. CANGARATO y P. V. PINTO** *(2000): A Situação actual do Guincho na República de Cabo Verde. INDP (Instituto Nacional de Desenvolvimento das Pescas), Departamento de Investigaqao Halieutica. Mindelo, S. Vicente. 34 pp.*

# Annex 3

## Environmental Report on Noise

# Environmental Noise Report

**REPORT N :** G_002_CV_BCEOM_PortoPraia_R1
**DATE :** 09-07-2007

## INDEX

## 1.1 INTRODUTION

Noise constitutes one of most important factors of life quality degradation. Environmental noise control meant to protect the population of the noises intruders who cause disturbance in its daily activities, as well as preventing the increase of noise levels.

In this chapter we identify the main sources of noise emission as well as the exposed population, noise levels are characterize in a qualitative and quantitative form, to evaluate environmental noise in the area of Praia Port.

To characterize noise levels we carry through measurements near the exposed population and in the project area.

## 1.2 NOISE SOURCES

A visit allowed verifying that the main noise sources in the area are Praia Port, access roads, Praia Airport and an industrial area.

## 1.3 EXPOSED POPULATION

The most exposed populations in study area are houses locate throughout access roads, houses next to Airport, houses and offices near the industrial area and houses next to temporary stockage of heavy rocks.

We select 5 areas with exposed population and 1 area without noise interferences, selection criteria had been the necessity to characterize environmental noise in the intervention area, as well as characterizing the noise without interference noise sources (Annex I).

## 1.4 PORTUGUESE LEGAL FRAME

Board 1 – Noise Levels according Decreto – Lei nº 9/2007

| Noise indicator | Limit levels | | |
|---|---|---|---|
| | Mixing areas | Sensitive areas | Without classification |
| Lden | 65 dB(A) | 55 dB(A) | 63 dB(A) |
| Ln | 55 dB(A) | 45 dB(A) | 53 dB(A) |

### 1.4.1 DEFINITIONS

**Noise indicator** shall mean a physical scale for the description of environmental noise, which has a relationship with a harmful effect;

**Lden** (day-evening-night noise indicator) in decibels (dB) is defined by the following formula:

$$L_{den} = 10 \times log \frac{1}{24}\left[13 \times 10^{\frac{L_d}{10}} + 3 \times 10^{\frac{L_e+5}{10}} + 8 \times 10^{\frac{L_n+10}{10}}\right]$$

**Lday** is the A-weighted long-term average sound level as defined in ISO 1996-2: 1987, determined over all the day periods of a year,

**Levening** is the A-weighted long-term average sound level as defined in ISO 1996-2: 1987, determined over all the evening periods of a year,

**Lnight** is the A-weighted long-term average sound level as defined in ISO 1996-2: 1987, determined over all the night periods of a year;

**Day** covers the period 07:00 – 20:00 hours in any 24 hour period;

**Evening** covers the period 20:00 – 23:00 hours in any 24 hour period;

**Night** covers the period 23:00 – 07:00 hours in any 24 hour period;

**Environmental noise** shall mean unwanted or harmful outdoor sound created by human activities, including noise emitted by means of transport, road traffic, rail traffic, air traffic, and from sites of industrial activity.

**Mixing area** it is an area defined in municipal plan of territory order, whose occupation is affected to other uses, existing or foreseen, stops beyond the cited ones in the definition of sensible zone.

**Sensitive area** it is an area defined in municipal plan of territory order vacationed for habitation use, or schools, hospitals or similar, or spaces of leisure, existing or foreseen, being able to contain small units of commerce and services destined to serve the local population, such as coffees and other establishments of restoration, stationery stores and other establishments of traditional commerce, without functioning in the night period.

## 1.5 Noise Levels Measurement

### 1.5.1 Technical Crew

Board 2 – Technical crew

| Function | |
|---|---|
| Coordination | Miguel Barra |
| Measurements | Pedro Carmo |
| Report | Marta Henriques |

### 1.5.2 Methodology

Board 3 – Methodology

| References | Methodology |
|---|---|
| NP 1730: 2 | LAeq, LT |
| Notes for environmental noise evaluation – IA | |
| DL 9/2007 | |

### 1.5.3 Equipment

Board 4 – Equipment

| Equipment | Resolution |
|---|---|
| Sonometer QUEST | 0,1 dB(A) |
| Calibrator QUEST QC-10 | 0,1 dB(A) |
| Precision Class | II |
| Model | 2900 E |
| Homologation | IPQ |
| Thermo Hygrometer | -20 a 80ºC |

### 1.5.4 MEASUREMENTS LOCATIONS

Board 5 – Measurements location

| Reference | Description | Photos |
|---|---|---|
| P1 | Houses along Praia Port access roads **Sensitive area** |  |
| P2 | Houses near Praia Airport **Sensitive area** |  |

| Reference | Description | Photos |
|---|---|---|
| P3 | Area without noise interference **Without classification** |  |
| P4 | Industrial Area (offices) **Mixing area** |  |

| Reference | Description | Photos |
|---|---|---|
| P5 | Houses near Industrial Area **Mixing area** |  |
| P6 | Houses next to temporary stockage of heavy rocks **Sensitive area** |  |

### 1.5.5 WEATHER CONDITION

Board 6 – Weather condition

| Date | Nebulosity | Temperature | Moister | Wind |
|---|---|---|---|---|
| 07-06-2007 | Clouded sky | 22ºC | 76% | 4,5 m/s |
| 08-06-2007 | Clean sky | 26ºC | 65% | 4 m/s |
| 11-06-2007 | Clean sky | 22ºC | 60% | 4,8 m/s |
| 12-06-2007 | Clean sky | 23ºC | 68% | 4,2 m/s |

### 1.5.6 RESULTS

Board 7 – Day Values (Lday dB(A))

| Day | Lday dB(A) | | |
|---|---|---|---|
| | 07-06-2007 | 08-06-2007 | Average |
| P1 | 52,8 | 54,8 | 54 |
| P2 | 55,8 | 58,5 | 57 |
| P3 | 55,6 | 59,1 | 58 |
| P4 | 62,9 | 60,7 | 62 |
| P5 | 60,4 | 62,8 | 62 |
| **Day** | **11-06-2007** | **12-06-2007** | **Average** |
| P6 | 61,0 | 61,9 | 61 |

Board 8 – Evening Values (Levening dB(A))

| Evening | Levening dB(A) | | |
|---|---|---|---|
| | 07-06-2007 | 08-06-2007 | Average |
| P1 | 47,7 | 47,9 | 48 |
| P2 | 54,1 | 53,0 | 54 |
| P3 | 50,0 | 51,6 | 51 |
| P4 | 54,5 | 56,9 | 56 |
| P5 | 55,7 | 56,6 | 56 |
| **Evening** | **11-06-2007** | **12-06-2007** | **Average** |
| P6 | 57,1 | 55,7 | 56 |

Board 9 – Night Values (Lnight dB(A))

| Night | Lnight dB(A) | | |
|---|---|---|---|
| | 07-06-2007 | 08-06-2007 | Average |
| P1 | 42,0 | 44,8 | 44 |
| P2 | 46,5 | 49,8 | 48 |
| P3 | 41,7 | 44,6 | 43 |

| Night | Lnight dB(A) | | |
| --- | --- | --- | --- |
| | 07-06-2007 | 08-06-2007 | Average |
| P4 | 49,1 | 51,6 | 51 |
| P5 | 49,5 | 52,1 | 51 |
| **Night** | **11-06-2007** | **12-06-2007** | **Average** |
| P6 | 54,3 | 54,9 | 55 |

Board 10 – Noise Indicator

| Location | Noise Indicator in dB(A) | | Limit Levels in dB(A) | |
| --- | --- | --- | --- | --- |
| | Lden | Ln | Lden | Ln |
| P1 | 52 | 44 | 55 | 45 |
| P2 | 55 | **48** | 55 | 45 |
| P3 | 55 | 43 | 63 | 53 |
| P4 | 60 | 51 | 65 | 55 |
| P5 | 60 | 51 | 65 | 55 |
| P6 | **60** | **55** | 55 | 45 |

## 1.6 ENVIRONMENTAL NOISE SITUATION

The obtain results allow to conclude that in the area in study the noise levels do not exceed the limits foreseen in the law for the occupation and use of the ground, except for P2 and P6 where respectively the night level (Ln) and the two limits (Lden and Ln) are overpassed. P2 and P6 are mainly concerned by noise distyrbance due to urban traffic (traffic along the seafront in P2 and port traffic in P6).

It is considered that the analysis of the case in study allows pointing out a situation of conformity with the requirements of DL 9/2007, except for P2 (Ln) and P6 (Lden and Ln).

In accordance with the General Noise Regulation (DL 9/2007), the classification of sensible or mixing areas is the responsibility of the city councils, having such zones to be delimited and to be disciplined in the respective of Municipal Plan of Territory Order (n.º 2 of art. 6º).

## Annex I – Measurements Locations


Picture 1 – Measurements locations

## Annex II – Measurement Data and Noise Levels

### 1. Noise Levels Measurements

| | | Measured Noise Levels | | |
|---|---|---|---|---|
| **Day** | **Location** | **Day** | **Evening** | **Night** |
| 1 | P1 | 52,2 | 48,9 | 40,6 |
| | | 52,7 | 44,4 | 43,8 |
| | | 53,3 | 48,5 | 40,9 |
| | P2 | 56,2 | 54,4 | 46,6 |
| | | 56,3 | 54,9 | 46,1 |
| | | 54,9 | 53,5 | 46,8 |
| | P3 | 57,0 | 51,8 | 41,8 |
| | | 54,4 | 49,4 | 43,8 |
| | | 54,8 | 47,9 | 37,3 |
| | P4 | 63,4 | 49,5 | 46,1 |
| | | 59,2 | 51,6 | 50,2 |
| | | 64,6 | 57,9 | 49,9 |
| | P5 | 58,7 | 55,6 | 48,3 |
| | | 62,1 | 52,1 | 52,6 |
| | | 59,5 | 55,0 | 52,5 |
| | P6 | 60,7 | 57,4 | 54,6 |
| | | 61,3 | 56,7 | 55,7 |
| | | 61,0 | 57,2 | 54,3 |
| 2 | P1 | 55,9 | 50,3 | 43,4 |
| | | 54,3 | 45,4 | 46,7 |
| | | 53,8 | 46,3 | 43,3 |
| | P2 | 58,9 | 56,1 | 49,9 |
| | | 58,8 | 49,5 | 49,6 |
| | | 57,7 | 50,0 | 49,8 |
| | P3 | 58,1 | 53,0 | 47,3 |
| | | 59,1 | 47,5 | 41,0 |
| | | 59,8 | 52,6 | 43,0 |
| | P4 | 62,5 | 55,5 | 46,9 |
| | | 59,3 | 55,2 | 53,1 |
| | | 59,5 | 58,9 | 52,6 |
| | P5 | 60,8 | 54,3 | 50,1 |
| | | 64,3 | 55,5 | 52,3 |
| | | 62,7 | 54,6 | 53,4 |
| | P6 | 61,9 | 56,2 | 53,8 |
| | | 62,0 | 55,7 | 54,9 |
| | | 61,8 | 55,0 | 54,1 |

### 3. Noise Indicator Ld, Le, Ln

| | | Noise Levels | | |
|---|---|---|---|---|
| Day | Location | Ld | Le | Ln |
| 1 | P1 | 52,8 | 47,7 | 42,0 |
| | P2 | 55,8 | 54,1 | 46,5 |
| | P3 | 55,6 | 50,0 | 41,7 |
| | P4 | 62,9 | 54,5 | 49,1 |
| | P5 | 60,4 | 55,7 | 49,5 |
| | P6 | 61,0 | 57,1 | 54,9 |
| 2 | P1 | 54,8 | 47,9 | 44,8 |
| | P2 | 58,5 | 53,0 | 49,8 |
| | P3 | 59,1 | 51,6 | 44,6 |
| | P4 | 60,7 | 56,9 | 51,6 |
| | P5 | 62,8 | 56,6 | 52,1 |
| | P6 | 61,9 | 55,7 | 54,3 |

| | Noise Levels Average | | |
|---|---|---|---|
| Location | Ld | Le | Ln |
| P1 | 54 | 48 | 44 |
| P2 | 57 | 54 | 48 |
| P3 | 58 | 51 | 43 |
| P4 | 62 | 56 | 51 |
| P5 | 62 | 56 | 51 |
| P6 | 61 | 56 | 55 |

### 4. Noise indicators Lden and Ln

| Location | Lden | Ln |
|---|---|---|
| P1 | 52 | 44 |
| P2 | 55 | 48 |
| P3 | 55 | 43 |
| P4 | 60 | 51 |
| P5 | 60 | 51 |
| P6 | 60 | 55 |

# Annex 4

## MCC Environmental Guidelines

**January 20, 2006**

# MILLENNIUM CHALLENGE CORPORATION

# ENVIRONMENTAL GUIDELINES

## TABLE OF CONTENTS

## Statement of Principles

The Millennium Challenge Corporation ("MCC") recognizes that the pursuit of sustainable economic growth and a healthy environment are necessarily related. The purpose of these guidelines is to establish a process for the review of environmental and social impacts[1] to ensure that the projects undertaken as part of programs funded under Millennium Challenge Compacts with eligible countries ("Compacts") are environmentally sound, are designed to operate in compliance with applicable regulatory requirements, and, as required by the legislation establishing MCC, are not likely to cause a significant environmental, health, or safety hazard.[2]

MCC is committed to program design that reflects the results of public participation in host countries during all phases of the program, integrating governmental interests with those of private business and civil society. In this spirit, MCC will work to ensure that the preparation of Environmental Impact Assessments will include consultation with affected parties and public disclosure of the associated documents.

Finally, MCC is committed to the principle of host-country ownership of a Compact, including host-country responsibility for measures to mitigate adverse environmental and social impacts. A Compact project is expected to comply with host-country laws, regulations and standards, as well as requirements by which the host country is bound under international agreements.

## Sources of Policy; Applicability of Guidelines

The policies reflected in these guidelines are based, broadly speaking, on sound sustainable development project design principles and international best practices in this field, including, but not limited to, the “Principles of Environmental Impact Assessment Best Practices” of the International Association for Impact Assessment, the environmental policies and guidelines of other United States government development assistance and financing entities, the environmental policies and guidelines of the multilateral development banks, the *Common Approaches* developed by export credit agencies through the Organization for Economic Cooperation and Development (OECD), and the *Equator Principles* in use by international commercial banks. In addition, these guidelines reflect the following:

- Section 605(e)(3) of the Millennium Challenge Act of 2003 prohibits MCC from providing assistance for any project that is "likely to cause a significant environmental, health, or safety hazard." Consequently, the presence of such a project in a host country's proposal will preclude MCC funding (or continued funding) of that project. (See the discussion of "environmental, health or safety hazard" in Appendix A.)

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[1] “Environmental and social impacts” include the effects of a project on the surrounding natural environment and on the humans reliant on that environment, to include effects on cultural property, indigenous peoples, and involuntary resettlement, as well as the impacts on human health and safety. They may also include significant induced, indirect, and cumulative impacts and reasonably foreseeable effects that may be associated with, or ancillary to the project.

[2] Appendix A sets forth definitions of words and phrases used in these guidelines.

- Executive Order 12114, January 4, 1979, 44 Fed. Reg. 1957 (January 9, 1979) requires every federal agency taking actions encompassed by that Executive Order to establish procedures to implement it with respect to certain major federal actions having significant effects on the environment outside the geographical borders of the United States and its territories and possessions. It is expected that the Executive Order will have limited applicability to MCC programs, but where the terms of the Executive Order apply, the procedures described in Appendix B will be used.

- In those instances where MCC's actions or a project undertaken or funded under a Compact may significantly affect the quality of the environment of the United States, including its territories or possessions, MCC will require adherence to the environmental review procedures established by the Council on Environmental Quality under the National Environmental Policy Act (NEPA), 40 CFR Part 1500, in lieu of these guidelines.

These guidelines are primarily intended to describe the principles of environmental impact assessment that Compact-eligible countries will be expected to apply in the context of a Compact. These guidelines are not intended to describe MCC’s internal implementation procedures, which MCC will develop to reflect experience with these guidelines.

MCC will review and revise these guidelines from time to time to reflect lessons learned in their application as well as relevant changes in international standards and norms of practice. In addition, MCC may provide such additional guidance to a host country during the implementation of a program as may be advisable in light of host-country norms and international standards, such as the Pollution Prevention and Abatement Handbook of the World Bank Group (1998, or as amended from time to time) or World Health Organization guidelines and standards.

## Environmental Review

These guidelines will apply to the review of each project described in a Compact or proposed Compact (generally referred to herein as a “project” or, collectively, as "projects"). The application of these guidelines to specific projects and the breadth, depth, and type of environmental and social impact review to be completed will depend on the nature, scale, and potential environmental and social impact of proposed projects.

MCC’s process of environmental review should take into account specific host-country conditions, the findings of host-country environmental studies, National Environmental Action Plans (NEAPs), the host country's overall policy framework and national legislation, the capabilities of the entities implementing the project and managing its environmental and social impacts, and obligations of the host country under relevant international agreements.

## Environmental Screening

As early as possible in the Compact proposal review process, MCC will screen each project as described in these guidelines. As part of its review of Compact proposals, MCC funding decisions will be informed by the results of screening and, where needed, an Environmental Impact Assessment or other environmental and social impact analysis. To that end, MCC will not fund a project unless there is provision for appropriate screening and appropriate environmental and social impact analysis.

While the completion of the requisite environmental and social impact analysis is the responsibility, either directly or indirectly, of the host country, MCC will advise and consult on the requirements of an Environmental Impact Assessment. MCC will review the findings and recommendations of the Environmental Impact Assessment to ensure their consistency with these guidelines, and where appropriate, may require additional assessment work, including public consultation and information disclosure (see below).

**Categorical Prohibition**: As stated above, MCC may not provide assistance for any project that is "likely to cause a significant environmental, health, or safety hazard." Accordingly, as part of its environmental screening, MCC will identify and exclude such a project from MCC funding, using the definition contained in Appendix A. Such a project will be classified as a Categorical Prohibition.

**Determination of Project Category**: MCC will screen all Compact proposals to identify projects that require further review due to their potential adverse environmental and social impacts, and projects that are in sensitive sectors or in or near sensitive locations. The result of this screening process will be an environmental classification following the recommendations contained in the OECD *Common Approaches* and the practices of the World Bank, classifying in accordance with the potential environmental and social impact, and the extent of the environmental review required.

**Category A**: A project is classified as Category A if it has the potential to have significant adverse environmental and social impacts that are sensitive, diverse, or unprecedented. These impacts may affect an area broader than the sites or facilities subject to physical works. Category A, in principle, includes projects in sensitive sectors or located in or near sensitive areas. An illustrative list of sensitive sectors and sensitive locations is set out in Appendix C.

> For **Category A** projects, MCC will require an Environmental Impact Assessment in accordance with these guidelines. An Environmental Impact Assessment evaluates the potential environmental and social risks and impacts of a specific project in its area of influence; examines alternatives to the project, including ways of improving project selection, siting, planning, design, and implementation in order to prevent, minimize, mitigate, or compensate for adverse environmental and social impacts and enhance positive impacts; and includes an Environmental Management Plan, which describes the process of mitigating and managing adverse environmental and social impacts during the implementation of a project. The recommended

contents of an Environmental Impact Assessment report are included in Appendix D.

An Environmental Impact Assessment should be initiated as early as possible in project development and be integrated closely with the economic, financial, institutional, social, and technical analyses of a proposed project.

An Environmental Impact Assessment should take into account the natural environment (air, water, and land); human health and safety; social aspects (involuntary resettlement, indigenous peoples and cultural property); natural disaster risk and vulnerability assessment; and transboundary and global environmental aspects.

For a Category A project, disbursement of some or all of the MCC funding for that project will be contingent upon completion of an Environmental Impact Assessment. In deciding whether to provide some MCC funding for the project in advance of completion of the Environmental Impact Assessment, MCC may consider funding costs of the assessment itself as well as costs of some other project elements (*e.g.*, initial project administration) that can be prudently undertaken before the Environmental Impact Assessment is completed. In the event that it is not possible to complete the Environmental Impact Assessment, MCC will define procedures for addressing such a case on a Compact-specific basis. In any event, the project will be subject to the other requirements of these guidelines.

**Category B**: A project is classified as Category B if its potential environmental and social impacts are less adverse than those of Category A projects. Typically, these impacts are site-specific, few if any of them are irreversible, and mitigation measures are more readily available.

For a **Category B** project, MCC will require specific environmental and social impact analyses, including Environmental Management Plans, as appropriate. Such analyses may be a condition for disbursement of some or all of the MCC funding for the project. The scope and format of the analyses will depend on the project and its potential environmental and social impacts. Like an Environmental Impact Assessment for a Category A project, the analysis for a Category B project must examine the potential negative and positive environmental and social impacts of the project and recommend any measures needed to prevent, minimize, mitigate, or compensate for adverse impacts and enhance positive impacts. Generally, the scope of such work will be narrower than for Category A projects.

**Category C**: A project is classified as Category C if it is unlikely to have adverse environmental and social impacts.

While MCC generally will not require environmental and social impact analysis for a **Category C** project, MCC reserves the right to require specific

> environmental and social impact studies, reporting, or training where relevant or where positive environmental and social impacts may be enhanced.

**Category D:** A proposed project is classified as Category D, if it will involve an intermediate facility (such as a municipal public grant fund) that will use MCC funding to finance subprojects that may potentially result in adverse environmental and social impacts.

> The host country must require that subprojects under a **Category D** project comply, at a minimum, with the environmental and social impact analysis standards, as well as relevant laws and regulations, of the host country. MCC reserves the right to set additional environmental performance standards and monitoring requirements for subprojects on a case-by-case basis, depending on the nature of the intermediate facility. For all subprojects, the intermediate facility will ensure that environmental and social impact analyses and associated documents are developed with public consultation and made available in a public place accessible to potentially affected parties.
>
> The host country must require the intermediate facility to monitor the environmental performance of its subprojects and submit to MCC periodic (usually annual) reports on the implementation of its environmental procedures and the environmental performance of its portfolio.

In addition to or in lieu of the determinations described above, MCC will determine during the environmental screening whether Appendix B of these guidelines, the National Environmental Policy Act, or other requirements or procedures must apply to the proposed project.

**Public Consultation and Disclosure**

Consistent with MCC's principle of host-country ownership of the projects implemented under a Compact, implementing entities will be expected to incorporate timely, participatory, and meaningful public consultation in the development of Compact-related Environmental Impact Assessments, analyses, and Environmental Management Plans. They will also be expected to make these documents publicly available and easily accessible.

**Monitoring**

In order to ensure compliance with measures to mitigate any adverse environmental and social impacts of projects undertaken pursuant to a Compact, as part of the Compact and related documents, MCC may condition disbursement of some or all of the MCC funding for the project on satisfactory implementation of those mitigation measures. The means of ensuring compliance with measures to mitigate any adverse environmental and social impacts of a given project, including any conditions for disbursement, will be specified in the Compact and related documents.

The host country will be responsible for appropriate monitoring of project mitigation plans (*e.g.*, Environmental Management Plan) during the term of the Compact. Recognizing that not all

Compact-eligible countries may have this capacity, MCC can, where appropriate, provide funds within the Compact to help ensure proper oversight and implementation of mitigation measures. MCC will monitor compliance through the review of information provided by the implementing entity and through site visits.

In addition, MCC may require, where appropriate, an environmental audit in order to assess the impact of prior or existing activities not funded with MCC funds or of an MCC-funded project to determine the status of regulatory compliance and environmental performance, as well as potential environmental and health and safety risks, liabilities, and opportunities associated with the activities or project.

These guidelines will be referenced and reflected in the Compact. The Compact will include a prohibition, for the full term of the Compact, on the use of MCC funding for projects deemed likely to cause a significant environmental, health, or safety hazard.

### Reporting

The host country must report regularly to MCC, describing how the activities funded under the Compact are being carried out in compliance with these guidelines and the environmental and social safeguards described in the Compact and related documents. The reports should provide detailed information on realized environmental and social impacts and the status of the implementation of mitigation plans (*e.g.*, Environmental Management Plan), including associated costs. MCC may modify its guidance regarding project implementation following the review of such reports.

## *Appendix A: Definitions*

**Environmental, Health or Safety Hazard** -- A project is deemed "likely to cause a significant environmental, health, or safety hazard" and, therefore, prohibited from receiving MCC funding, if:

(a) as a result of the project, even with mitigation efforts and proper use, there exists or will exist a substance, condition, or circumstance that represents a significant risk of harm to the environment or to human health because of the physical, chemical or biological effects of such substance, condition or circumstance;

(b) the project involves or will involve the production, procurement or intentional release of:

-- Persistent Organic Pollutants (POPs) that the United States Environmental Protection Agency (USEPA) has identified as of greatest concern to the global community[3];

-- any pesticide or industrial or consumer chemical that is listed by the United States Environmental Protection Agency as "banned" or "severely restricted" under the Prior Informed Consent (PIC) Program[4]; or

-- a product (including an emission or effluent) that is prohibited or strictly regulated in the United States because its toxic effects on the environment create a serious public health risk; or

(c) the project is a physical project that is prohibited or strictly regulated by Federal law in the United States to protect the environment from radioactive substances,

unless MCC has made a final determination, taking into account a thorough Environmental Impact Assessment, that the project is not likely to cause a significant environmental, health, or safety hazard.

**Environmental Impact Assessment** – Analysis that identifies the potential environmental and social impacts of a specific project in its area of influence; examines alternatives to the project; identifies ways of improving project selection, siting, planning, design, and implementation in order to prevent, minimize, mitigate, or compensate for adverse environmental and social impacts and enhance positive impacts; and includes the process of mitigating and managing adverse environmental and social impacts during the implementation of a project. The scope and level of detail in an Environmental Impact Assessment should be commensurate with a project's potential impact. At a minimum, an Environmental Impact Assessment should include the information outlined in Appendix D: Environmental Impact Assessment Reports.

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3 http://www.epa.gov/oppfead1/international/pops.htm
4 http://www.epa.gov/oppfead1/international/piclist.htm

**Environmental Management Plan (EMP) –** An Environmental Management Plan describes mitigation, monitoring and institutional measures to be taken during project implementation to eliminate adverse impacts, offset them, or reduce them to acceptable levels.

## *Appendix B: Procedures Implementing Executive Order 12114*

This Appendix sets forth the procedures that MCC will use to implement Executive Order 12114, January 4, 1979, 44 Fed. Reg. 1957 (January 9, 1979) (the "Executive Order").

### 1. Actions Covered

The MCC officer having the ultimate responsibility for authorizing and approving actions will take into consideration an appropriate environmental impact analysis before authorizing and approving any:

a. MCC action that significantly affects the environment of the global commons outside the jurisdiction of any nation (*e.g.*, the oceans or Antarctica);

b. MCC action that significantly affects the environment of a foreign nation not involved or participating with the United States in the action; or

c. MCC action outside the United States that significantly affects natural or ecological resources of global importance which have been designated for protection by the President or, in the case of resources protected under a binding international agreement, by the Secretary of State.

### 2. Type of Environmental Review

Subject to section 4,

a. For actions specified in section 1.a above, MCC will take into consideration an Environmental Impact Assessment.

b. For actions specified in sections 1.b or 1.c above, MCC will take into consideration an appropriate environmental review in accordance with the criteria in the "Environmental Review" section of these guidelines.

### 3. State Department Coordination

MCC will contact the State Department for coordination of all communications with foreign governments concerning environmental agreements and other arrangements to implement sections 1 and 2 above.

### 4. Meaning of Certain Terms

This section 4 applies to this Appendix B and to no other part of these guidelines. For purposes of applying the Executive Order and this Appendix B, "environment," as specified in the Executive Order, means the natural and physical environment and excludes social, economic and other environments; and an action significantly affects the environment if it does significant harm to the environment even though on balance the action is believed to be beneficial to the environment.

## *Appendix C: Illustrative List of Sensitive Sectors and Sensitive Locations*[5]

**The following list provides examples of projects with the potential to cause significant negative environmental impacts due to their type, location, sensitivity and scale. This list is indicative and the types of projects it contains are examples only. This list is not intended to be exhaustive.**

- Crude oil refineries (excluding undertakings manufacturing only lubricants from crude oil) and installations for the gasification and liquefaction of 500 tons or more of coal or bituminous shale per day.

- Thermal power stations and other combustion installations with a heat output of 300 megawatts or more and nuclear power stations and other nuclear reactors, including the dismantling or decommissioning of such power stations or reactors (except research installations for the production and conversion of fissionable and fertile materials, whose maximum power does not exceed 1 kilowatt continuous thermal load).

- Installations designed for the production or enrichment of nuclear fuels, the reprocessing, storage or final disposal of irradiated nuclear fuels, or for the storage, disposal or processing of radioactive waste.

- Integrated works for the initial smelting of cast-iron and steel; installations for the production of nonferrous crude metals from ore, concentrates or secondary raw materials by metallurgical, chemical or electrolytic processes.

- Installations for the extraction of asbestos and for the processing and transformation of asbestos and products containing asbestos: for asbestos-cement products, with an annual production of more than 20,000 tons finished product; for friction material, with an annual production of more than 50 tons finished product; and for other asbestos utilization of more than 200 tons per year.

- Integrated chemical installations, *i.e.*, those installations for the manufacture on an industrial scale of substances using chemical conversion processes, in which several units are juxtaposed and are functionally linked to one another and which are for the production of any of the following: basic organic chemicals; basic inorganic chemicals; phosphorous-, nitrogen- or potassium-based fertilizers (simple or compound fertilizers); basic plant health products and biocides; basic pharmaceutical products using a chemical or biological process; explosives.

- Construction of motorways, express roads and lines for long-distance railway traffic and of airports with a basic runway length of 2,100 meters or more; construction of a new road of four or more lanes, or realignment and/or widening of an existing road so as to provide four or more lanes, where such new road, or realigned and/or widened section of road would be 10 kilometers or more in a continuous length.

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[5] Source: EBRD Environmental Policy (http://www.ebrd.org/about/policies/enviro/policy/policy.pdf), also in use under the Organization for Economic Co-operation and Development (OECD ) “Common Approaches.”

__ Pipelines, terminals, and associated facilities for the large-scale transport of gas, oil, and chemicals.

__ Sea ports and inland waterways and ports for inland-waterway traffic which permit the passage of vessels of over 1,350 tons; trading ports, piers for loading and unloading connected to land and outside ports (excluding ferry piers) which can take vessels of over 1,350 tons.

__ Waste-processing and disposal installations for the incineration, chemical treatment or landfill of hazardous, toxic or dangerous wastes.

__ Large[6] dams and other impoundments designed for the holding back or permanent storage of water.

__ Groundwater abstraction projects or artificial groundwater recharge schemes in cases where the annual volume of water to be abstracted or recharged amounts to 10 million cubic meters or more.

__ Industrial plants for the (a) production of pulp from timber or similar fibrous materials; (b) production of paper and board with a production capacity exceeding 200 air-dried metric tons per day.

__ Peat extraction, quarries and open-cast mining, and processing of metal ores or coal.

__ Extraction of petroleum and natural gas for commercial purposes.

__ Installations for storage of petroleum, petrochemical, or chemical products with a capacity of 200,000 tons or more.

__ Large-scale logging.

__ Municipal wastewater treatment plants with a capacity exceeding 150,000 population equivalent.

__ Municipal solid waste-processing and disposal facilities.

__ Large-scale tourism and retail development.

__ Construction of overhead electrical power lines.

__ Large-scale land reclamation.

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[6] A large dam is a dam with a height of 15 meters or more from the foundation or a dam that is between 5 and 15 meters high with a reservoir volume of more than three million cubic meters (the definition used by the International Commission on Large Dams (ICOLD)).

__ Large-scale primary agriculture/silviculture involving intensification or conversion of natural habitats.

__ Plants for the tanning of hides and skins where the treatment capacity exceeds 12 tons of finished products per day.

__ Installations for the intensive rearing of poultry or pigs with more than: 40,000 places for poultry; 2,000 places for production pigs (over 30 kilograms); or 750 places for sows.

__ Projects that are planned to be carried out in sensitive locations or are likely to have a perceptible impact on such locations, even if the project category does not appear in the above list. Such sensitive locations include national parks and other protected areas identified by national or international law, and other sensitive locations of international, national or regional importance, such as wetlands, forests with high biodiversity value, areas of archaeological or cultural significance, and areas of importance for indigenous peoples or other vulnerable groups.

## *Appendix D : Environmental Impact Assessment Reports*[7]

The scope and level of detail of an Environmental Impact Assessment should be commensurate with the potential impacts of the project. The Environmental Impact Assessment report should include the following items (not necessarily in the order shown):

- **Executive summary**: concisely discusses significant findings and recommended actions.

- **Scoping**: identifies the issues and impacts that are likely to be important and establishes the terms of reference for the Environmental Impact Assessment.

- **Policy, legal and administrative framework**: discusses the policy, legal, and administrative framework within which the Environmental Impact Assessment is carried out.

- **Project description**: describes the proposed project and its geographic, ecological, social, and temporal context, including any offsite investments that may be required (*e.g.*, dedicated pipelines, access roads, power plants, water supply, housing, and raw material and product storage facilities); indicates the need for any resettlement or social development plan; and normally includes a map showing the project site and the project's area of influence.

- **Baseline data**: assesses the dimensions of the study area and describes relevant physical, biological, and socio-economic conditions, including any changes anticipated before the project commences. Also, it takes into account current and proposed development projects within the project area but not directly connected to the project. Data should be relevant to decisions about project location, design, operation, or mitigatory measures; the section indicates accuracy, reliability and sources of the data.

- **Environmental and social impacts**: predicts and assesses the project's likely positive and negative impacts on the surrounding natural environment and on the humans reliant on that environment, to include effects on cultural property, indigenous peoples, and involuntary resettlement, as well as the impacts on human health and safety, in quantitative terms to the extent possible. This may also include significant induced, indirect, and cumulative impacts and reasonably foreseeable effects that may be associated with or ancillary to the project. It identifies mitigation measures and any residual negative impacts that cannot be mitigated. It explores opportunities for environmental enhancement. It identifies and estimates the extent and quality of available data, key data gaps, and uncertainties associated with predictions, and specifies topics that do not require further attention.

- **Analysis of alternatives**: systematically compares feasible alternatives to the proposed project site, technology, design and operation -- including the "without project" situation -- in terms of their potential environmental and social impacts; the feasibility of mitigating these impacts; their capital and recurrent costs; their suitability under local conditions; and their institutional, training and monitoring requirements. For each of the alternatives, it quantifies the environmental and social impacts to the extent possible and attaches economic values where feasible. It states the

[7] This Appendix is based on the World Bank Operational Manual, OP 4.01

basis for selecting the particular project design proposed and justifies recommended emission levels and approaches to pollution prevention and abatement.

- **Environmental Management Plan**:  describes mitigation, monitoring and institutional measures to be taken during project implementation to eliminate adverse impacts, offset them, or reduce them to acceptable levels.

- **Consultation**:  lists and describes consultation meetings, including consultations for obtaining the informed views of the affected people, local nongovernmental organizations and regulatory agencies.  Project-level consultation should begin at scoping and continue through implementation.

# Annex 5

## Minutes of the Public Workshop held in Praia in August 2007

# Praia Workshop, 27 August 2007

## Questions / Answers

<u>**MCC:**</u> **The circulation inside the port of trucks carrying materials will impact seriously its functioning and raises security problems. Did the Consultant study other options for bringing construction materials from the quarries to the site?**

<u>Consultant:</u> We did. Moving materials by barges from Santa Cruz quarry, which is between 45 and 50 km far from the site, is time-consuming (whereas the road needs to be quickly built), expensive and an important source of pollution. The easier solution is to carry rocks by roads and avoid small streets as well as residential areas. Moreover, as soon as the future connecting road is completed, that is to say 7 to 8 months after the start of the works, the trucks will not go through the port anymore. At last, the Consultant still studies the possibility to use dredging materials as much as possible, even if the quality does not seem to be good.

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<u>**Surfers & Body Boarders Association:**</u> **There is no doubt that this project will harm the practice of water sports in the bay and impact the city coastline. As the City of Praia is getting highly saturated in terms of urbanization and regarding the decentralization process illustrated by the project of the Express Way between Praia and Tarrafal, wouldn't it have been better to consider a different location for building a port and to implement a global project for the management of the whole coast line ? What about the rehabilitation of the beach of Gamboa?**

<u>Consultant:</u> It is true that waves will decrease in the bay (more with a detached breakwater than with an attached one). We are aware that inhabitants of Praia are using the beach and this has been taken into account in the environmental studies.

<u>MCA:</u> This question is not an issue for the Consultant. The port is located where it is and building a port elsewhere is out of the scope. This is not the right place to answer this question. Anyway, there is no contradiction between this project and the protection of the bay.

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<u>**MITM:**</u>

- **It appears that water depth is decreasing along the quays because of a sedimentation phenomenon. Why don't you plan to dredge along the quays?**
- **What about offshore facilities for oil in the bay?**
- **You can see that congestion is the biggest problem of the port (5 ships are waiting in the bay). Won't it be worse during the works?**

<u>**Captain Cruz, ENAPOR:**</u>

- **Because of the breakwater and the extensions of Quay 1, don't you think that the issue of the renewal of water in the Bay will worsen, especially in the fishing pier area, which is the most polluted place?**
- **I am very concerned by the security problems raised by the transit of 50 trucks per day in the port which is already congested. I ask the Consultant to reconsider others options that will bring safer working conditions for the port staff.**

**<u>Surfers & body boarders Association:</u>**

- **We also ask the question of the renewal of water in the Bay, as it is poor today and will be worse with the project.**
- **Am I right if I understand that the best marine ecosystem of the Bay will be destroyed by the new yard?**

<u>Consultant:</u>

- Concerning the issue of sedimentation along the berths. We have carried out a detailed comparison of several bathymetric charts that showed that the only evolution of water depths occurs along the shore where the beach is becoming wider and water shallower. We could not find any sedimentation along the berths nor water depth reduction.
- Concerning the offshore facilities for oil. We are aware that the current situation is not sustainable as it only allows too small vessels to berth. Offshore facilities such as buoy systems are very interesting but very expensive and need costly maintenance. What we propose, as an alternative, is a deep water oil berth along the breakwater at -15m deep. It is a limited but suitable area and a cheaper solution.
- Concerning the congestion during works. During the construction of the connecting road (7 to 8 months), we estimate that 48 trucks per day will go through the port, which will have a limited impact. As soon as the connecting road is completed, the whole material will be brought by this road, at a rate of 50 trucks per hour, permitting normal operations in the port. The extension of Quay 1 and the construction of the breakwater will not impact the quays 1 and 2.
- Concerning the water quality in the Bay. It is correct that the future breakwater will reduce the waves in the Bay and the wave induced currents. But the Environment Management Plan aims to reduce the pollution at its source by designing facilities to collect and treat water in the Cargo Village and on the Yards. Moreover, the implementation of a Waste Management Program would have a significant impact on the quality of water. Ultimately, as there are many sources of pollution, a global integrated management of the Coast should be implemented. This is difficult because of conflicts of interest but it could significantly enhance the marine environment.
  We also noticed that the beach of Praia Negra is more polluted than the Bay.
- Concerning the destruction of a marine biodiversity site. Compensation measures as artificial reefs aim at balancing destruction of marine areas.

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**<u>Captain Cruz, ENAPOR:</u>**

- **Concerning the construction of the road, we have to count the empty trucks going out of the site to the quarries: near 100 trucks per day will thus transit through the port. Stronger congestion will create very difficult and dangerous working conditions for the port staff.**
- **I am surprised to see no mention or recommendations concerning the fishing pier whose pollution will be increased by the reduction of waves in the port.**

<u>ENAPOR:</u>

- Concerning port operations during the works. We understand Captain Cruz' point of view but we believe that the solution chosen by the Consultant is the best and that we will manage the constraints. ENAPOR is developing a set of actions to easy port operations during the works: area currently covered by empty containers will be cleaned before the works and prepared to receive the containers and cargo.
- Concerning the fishing pier pollution. Pollution is not due to the lack of water movements but to the fishing pear activities. The solution is a management plan to reduce this pollution, and a proactive behavior of people working there.
- ENAPOR Master Plan includes the Gamboa area and its whole rehabilitation.
- Praia Negra beach is a private land and we only work on public land.

Bceom, September 1st, 2007

# Annex 6

## Minutes of the Public Workshop held in Praia in January 2008

# Port of Praia Expansion and Modernization Project

# Praia Workshop of 18 January 2008

## Summary of Questions and Answers

**<u>MITM (Mr. Jorge Costa Pina):</u> The MITM recommends to pay significant attention to Port security and pollution prevention. It is for instance necessary to have the proper facilities to receive waste produced at the port.**

- **The breakwater is one of the major components of the project, as swell is currently the main handicap of the Port. The detached solution provides protection for a larger area but is expensive and dangerous for ship maneuvering. The attached one is cheaper and safer. But the overall cost of the project increases: why?**
- **The works will bring an intense traffic in the port. ENAPOR was asked to implement a team to free some space in the Port to allow this traffic without disturbance for port operations. How is it going?**
- **There is the project to create a logistics center in Cape Verde to manage oil products. Does the project take into account this logistics center? What was the coordination with Shell and ENACOL?**

<u>MCA: (Mr. Luis Silva):</u>

- There is confusion about the breakwater issue: the Consultant showed that both solutions (attached and detached) provide equivalent protection inside the port. The attached solution only has advantages.
- There is actually an increase in the project cost, but in regard to what? To the Pre-Feasibility Study, which did not forecast all the components of the present project:
  - It forecasted a reclaimed container yard of 5 ha against 8 ha now.
  - There was no real breakwater.
  - The cargo village was a much simpler facility.
  - Besides, since 2005 the project suffered from the devaluation of the US dollar against the euro.
- Concerning the oil terminal, we had meetings with the different actors of the issue. The expansion of quay 1 and the attached breakwater will allow to receive higher traffic and larger oil carriers.

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**<u>Shell:</u>**

- **With dolphins at the end of Quay 1, what kind of tankers will be able to berth?**
- **What kind of unloading system for oil products is forecast in the project?**

<u>MCA:</u> We are still discussing the system for unloading. Anyway, this workshop does not to have to go too much into details.

<u>Consultant:</u> The draft at the end of Quay 1 will be 12 meters. In the navigation simulation, we use a tanker with 10.3 m draft, LOA of 170 m and DWT around 25,000 tons.

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**<u>Ministry of Economy, General Director for Industry:</u>**

- **We are concerned with the timeline. There is a process of expansion of energy production capacities in Santiago. When will the Port be ready to receive this new fuel traffic?**
- **Are we sure that we can use explosives in the Cargo Village, at the proximity of the tank farm and industrial facilities?**

MCA: The new oil unloading facilities will be ready when the works are completed, in 3 years and a half. In the meantime an intermediate solution must be found.

Consultant: The soil of the Cargo Village is very hard rock which can not be removed by excavation machines, except the upper part. The Contractor will have to do a blasting plan taking into consideration the risks. It is perfectly feasible to use low charges and to avoid vibrations and fall of small rock pieces on tank farm with appropriate blasting plan and adequate procedure.

**Ministry of Economy, General Director for Industry: I am very concerned with this intermediate solution as demand for fuel will double in March 2008 for electrical production.**

MCA: The solution has to be found in co-operation with the port operator.

ENAPOR (Mr. Franklim Spencer):

- It is not ENAPOR responsibility but that of oil companies which are importing and selling fuel. We are studying the question. Let's remember that at the beginning of the project, there was no oil terminal in it (the plan was to have an offshore system on buoys). Now there is the solution at the end of Quay 1!
- In answer to MITM question: to solve the issue of truck traffic during the works, ENAPOR found 3 solutions, 3 areas to store abandoned cargo outside the port. I precise that abandoned cargo is not the responsibility of ENAPOR, but we will free the Quay 2 yard for the beginning of the works. ENAPOR is paying great attention to this matter.

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**DGA: DGA has several matters of concern:**

- **The presentation included a contingency/emergency plan in case of spills: this issue is no more a concern for us.**
- **This will be the first port of this size in Cape Verde, with a complex management. Responsibilities should be very well shared between institutions and actors. Training and drills (rehearsals) are very adequate: it allows monitoring work of each employee during emergencies.**
- **The Consultant presented mitigation measures for the impact on birds, especially on the species on the red list. We think that this issue could be treated further, with more solutions to propose.**
- **The Consultant presented reduction and mitigation measures for the impact of the berm construction. There should be more consultation with fishermen and their representatives; they must be involved in the process.**

MCA: The project is complex and does involve several institutions and actors. Compensatory measures will be developed regarding bird species affected by the project.

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**ENAPOR (Mr. Franklim Spencer): The Consultant raised the issue of the estimation of dredging works, which look difficult to estimate. There is a dredging company based in the Canaries Islands that already worked in Cape Verde. We also know that several dredging companies are operating in the Guinea Gulf, which is not that far from Praia.**

Consultant: We will manage to improve our estimates thanks to the above information.

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