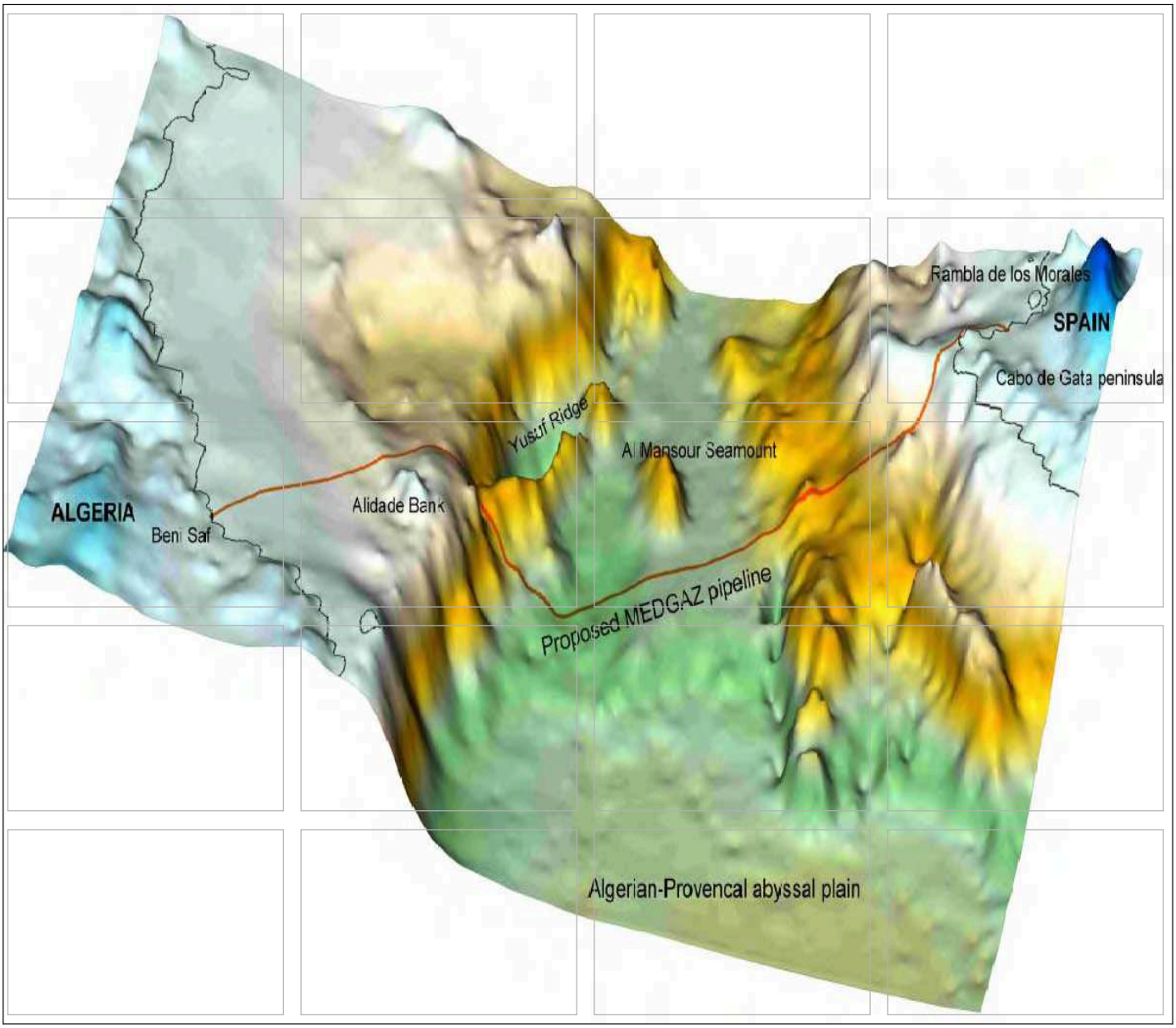
Final Report



MEDGAZ NATURAL GAS TRANSPORTATION SYSTEM

ENVIRONMENTAL IMPACT ASSESSMENT

MEDGAZ

Prepared for
MEDGAZ

ERM Iberia, S.A.

ERM

Delivering sustainable solutions in a more competitive world

FINAL REPORT

MEDGAZ

MEDGAZ Natural Gas Transportation System

ENVIRONMENTAL IMPACT ASSESSMENT

August 2004

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Signature: _____

Date: 6th August of 2004

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SECTION 1

INTRODUCTION

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1 INTRODUCTION

1.1 PREAMBLE

This Environmental Statement (ES) presents the findings of an Environmental Impact Assessment (EIA) for the proposed Algeria to Spain gas pipeline crossing the Mediterranean Sea. It has been prepared as an integral part of the "Front End Engineering Design" (FEED) stage of the project and covers the entire length of the marine pipeline, between the Compressor Station in Algeria (BSCS) and the Reception Terminal (OPRT) in Spain, as well as the terminals.

An EIA "Memoria Resumen" [Summary Memorandum] for the part of the pipeline that would be in Spanish territory has already been issued, in July 2003, in accordance with Royal Decree 1131/1988, 30 September, which requires:

> *"Any natural person or legal entity, public or private, that proposes to carry out a project of the types included in the Annex to Legislative Royal Decree 1302/1986, of 28 June, shall notify the competent environmental body of its intentions, accompanied by a "Memoria Resumen" that sets out the most significant characteristics of the project to be undertaken, a copy of which it shall also send to the body with substantive competency".*

Comments on the "Memoria Resumen" have already been received and taken into account in preparing this Environmental Statement, because one of the main purposes of this document is to take the Spanish approval process to the next stage. For this reason, it has also been prepared in accordance with the same pieces of Spanish legislation mentioned above and the European Union Directives from which they were derived.

Attention has been given to the equivalent legislation covering the upstream section of the pipeline, because it will also be submitted for the equivalent approval process operated by the Algerian authorities.

Finally, with a view to the Statement being used in support of funding applications, reference has been made to the World Bank policies and guidelines, in the understanding that compliance with these requirements is normally recognised by most major international banks as a reasonable indication of project acceptability on environmental grounds.

1.2 BACKGROUND AND PROJECT JUSTIFICATION

The object of this gas pipeline is to connect Algeria with Europe, via Spain. There are several general socio-economic reasons which justify the interest of this project:

a) Growth of Gas Market in Spain/Europe

As mentioned in the document titled "Planning of Electrical Power and Gas Sectors. Development of Transportation Networks 2002-2011" issued by Spain's Ministry of Economy in September 2002, gas demand in Spain will go from a current level of 20 BCM to 44 BCM in 2011, assuming a yearly average growth of 9.5%, with the European increase being around 4%.

b) Substantiated Demand within the Gas Market Deregulation Process

The liberalised market share, now standing at 63%, is gradually increasing at the same time as the demand covered by the regulated tariff market is decreasing. Taking into account the present positioning of MEDGAZ shareholders in the Spanish and European markets and commitments already undertaken by the shareholders in terms of their letters of intent for long-term gas purchases, the gas supply forecasts through the MEDGAZ pipeline, as shown in *Table 1.1*, are substantiated by the market:

Table 1.1 ***Gas Supply Forecasts through the MEDGAZ Pipeline (BCM/year)***

Destination	2007	2008	2010	2012	2015	2020
Spain	6.5	8.0	8.0	8.0	9.0	9.0
Portugal	0.5	0.5	0.5	0.5	1.0	1.0
Rest of Europe	-	-	2.0	2.0	4.0	6.0
Total	**7.0**	**8.5**	**10.5**	**10.5**	**14.0**	**16.0**

c) Natural Gas-Liquefied Natural Gas Balance

In Spain, there is a sharp imbalance between entry capacities in the form of natural gas (NG) and liquefied natural gas (LNG), with the current ratio being 65:35. This proportion will tend to increase in favour of LNG since most of the infrastructures approved for the next few years are to expand existing re-gasification plants and to build three new plants, with the first (BBG) coming on stream in 2003. This situation could lead to a lack of security in gas supplies in Spain due to their seasonal dependence on account of adverse weather conditions as well as exposure to increases in global demand that could lead to the re-routing of LNG vessels, as was the case in January and February 2003. On the other hand, there are increasingly greater maritime transportation restrictions, which will bring about a reduction in the number of LNG vessels that are able to operate within the European Union.

d) Gasification in Spain

The new gas pipeline will cross south-eastern Spain, mainly in the provinces of Almería, Murcia and Albacete, before its link-up to the Spanish gas grid. This is one of the areas awaiting gasification and the fact that the new pipeline will go through it will facilitate and optimise the development of future transportation and distribution networks.

e) Security of Supply and Competitiveness

The gas pipeline promoted by MEDGAZ means a direct link (without involving transit through third countries) between the Spanish gas grid and gas fields in Algeria, a country whose reserves are estimated to come to 4,500 BCM, and which is the fourth largest natural gas producer in the world. It is important to mention the major changes that will take place in Algeria with a view to the deregulation of the oil and gas market both in the upstream and downstream segments. This will allow for the future supply of equity gas from the shareholders through the MEDGAZ pipeline. Furthermore, this direct connection to fields operated by shareholders in MEDGAZ will alleviate the lack of storage facilities in Spain. On the other hand, the cost of transportation of LNG by ship is practically twice as high as the cost for transportation by pipeline (NG).

f) Energy Reliance

Europe's energy reliance on hydrocarbon and natural gas imports is undeniable and will likely increase in the future in line with greater demand and the decline in European reserves, mainly in Great Britain and Norway. A breakdown of NG imports into Europe shows that 40% come from Russia, 30% from North Africa and 25% from Norway. In the future, the quantity of Russian gas will increase as most of the new members of the European Union are in Eastern Europe and are dependent on Russian energy sources. In the case of Spain, it relies more on North Africa for reasons of geographical proximity with its resulting lower cost. The MEDGAZ pipeline will not increase the country's energy reliance on Algeria (which is necessary to maintain the Spanish economy's competitiveness) but rather its way of entry into Spain will be redistributed. According to the Algerian national oil company Sonatrach, MEDGAZ represents an alternative to doubling the Gazoduc Maghreb-Europe (GME).

g) Interconnections/Gas Hub

From the very beginning, the MEDGAZ project was presented at several international forums and bilateral meetings between Spain's government and Algeria, which is strongly endorsing the project, as well as France, a country with which plans are to increase energy interconnections.

The European Union, as in other markets, is seeking to achieve greater integration, transparency and coordination of the European gas market. Accordingly, the EC Gas Directive EC/30/98 was adopted on June 22, 1998 (to be replaced this summer by a second directive aimed at accelerating the market deregulation and unification process) and subsequently, the Madrid Forum was created to standardize energy legislation in each member country. The more integrated the European gas market, the less reliant each country will be on its own infrastructures, supply sources and storage facilities. The MEDGAZ project will encourage this integration due to its pan-European nature and its direct connection to one of the key gas supply sources for Europe. This was what the European Commission had in mind when it included the project in the list of projects of priority interest in the Major Energy Infrastructures Plan by the European Commission, as one of maximum interest in the TEN (Trans European Network) and when it more recently included it in the "Quick Start" initiative for promoting economic growth in the European Union.

The development of spot markets for natural gas plays a key role in making gas more competitive as an energy source. The first hub developed in Europe began to operate in Zeebrugge (Belgium) in 1998 as a result of the construction of the gas Inter-connector between Great Britain and the rest of Europe. In order for a gas hub to exist, it is necessary to have major gas flows, storage facilities and sufficient connections to absorb these flows in the area. The construction of the gas pipeline promoted by MEDGAZ could be a decisive factor in the creation of a gas hub in south-western Europe involving significant gas flows at competitive prices.

h) Environmental Considerations

There are also other purely environmental reasons to justify this project. It is European Union policy to gradually reduce usage of fossil fuels, because they are the main man-made source of carbon dioxide, the gas believed to be, overwhelmingly, the largest contributor to the much-reported global warming effect. Nevertheless, such fuels must clearly remain the major source of energy for the foreseeable future. Of the three forms of fossil fuel; natural gas, oil and coal, it is natural gas that produces the least amount of carbon dioxide per unit of energy generated. The quantitative comparison is shown in *Table 1.2.*

Table 1.2 Carbon Dioxide Emissions from the Different Fossil Fuels

Fuel type	Carbon dioxide per kilowatt of energy generated (kg)
Coal	0.34
Oil	0.29
Gas	0.21

Therefore, on the global warming case alone natural gas should be the fossil fuel of choice. However, natural gas also has benefits in terms of the other common pollutants associated with fossil fuel combustion. In contrast to the other two forms, it produces virtually no sulphur dioxide or particulate matter and allows more use of the modern burners that are designed to produce only very low emissions of nitrogen dioxide.

At the more local level, completion of the pipeline will have the significant benefit of reducing shipping through and across the very congested Straits of Gibraltar, by replacing the present means of transporting the fuel, to Spain and the rest of Europe, by sea-going tankers, in the form of LNG, a highly hazardous substance. Buried onshore or sub-sea pipelines are now internationally recognised as the environmentally preferred means of transferring large quantities of hydrocarbons over long distances.

1.3 DEVELOPMENT CONCEPT AND PROJECT DESCRIPTION

According to the strategic planning of the Ministry of the Economy, the project is referred to as MEDGAZ. The project owner is *Sociedad para el Estudio y la Promoción del Gasoducto Argelia Europa, vía España, S.A.*, a company formed by CEPSA (Spain), SONATRACH (Algeria), BP, Total, Gaz de France, Iberdrola (Spain) and Endesa (Spain). The project is looking to transport natural gas from Algeria to Europe via Spain across the Mediterranean Sea. The MEDGAZ transportation system is being designed to carry a total volume of 10 billion cubic metres per year of gas through ultimately two submarine pipelines, with an estimated start-up rate of 6 billion cubic metres per year (BCM/yr) targeted for the third quarter of 2008. The system will reach full capacity in year 2020 and will be able to carry a total volume of 16 BCM/yr.

The pipeline will run from a Compressor Station that will be constructed about 1.2 km inland from Djelloul Beach, some 10 km to the south-east of Beni Saf on the Algerian coast, see *Map 1.1*. It will then cross the Mediterranean Sea by way of an optimised sub-sea route, down to depths of around 2000 m, making it one of the world's deepest pipelines. Two onshore routing alternatives have been studied in Spain: Rambla Morales and Rambla del Agua. This EIA develops the Rambla Morales Alternative (Rambla del Agua Alternative has been developed in the Spanish EIA). In the Rambla Morales Alternative the landfall will be close to the mouth of the Rambla Morales, on El Charco Beach, about 1 km north-west of Cabo de Gata village. From here, it will continue 4.5 km inland to cross the ALP-202 (E340) main road and connect with the proposed Albacete-Eje Trunk Main, where the Reception Terminal will be constructed about 2 km west of Ruescas village. The proposed pipeline will cover a total offshore distance of 200 kilometres from Beni Saf in Algeria to a landfall at Rambla Morales, near Almería in Spain.

Map 1.1 General project location

The transportation system will therefore include the following:

- An Offshore Pipeline from Beni Saf in Algeria to Rambla Morales , near Almería in Spain, approximately 200 km long. The offshore route reaches a maximum water depth of approximately 2,200 m across the Mediterranean Sea.
- Onshore pipeline sections in Algeria from Hassi R'Mel to Beni Saf (approximately 550 km long), in Spain from the receiving terminal at Rambla Morales to Albacete (approximately 270 km long).
- Onshore facilities, including a compressor station at Beni Saf in Algeria and a receiving terminal in Spain.

The MEDGAZ transportation system is designed for a lifetime of 50 years.

The intention is to initially lay only a single 24-inch diameter pipeline across the entire route. It will have sufficient capacity to transport natural gas, in a condition ready for use, with an estimated start-up rate of 6 BCM/yr. However, another, parallel, pipeline will be required in the future to accommodate flow rates up to 16 BCM/year. In the land and shore approaches sectors, therefore, a twin pipeline system will be laid during this present project, in order to minimise the overall environmental impact in the longer term.

MEDGAZ will construct and operate the compressor station, the offshore pipeline and the receiving terminal, including the short pipeline sections from the coasts to the plants. SONATRACH will construct, own and operate the onshore Algerian pipeline, whereas ENAGAS will have similar responsibilities for the Spanish onshore pipeline.

The studies carried out so far include a Phase I Engineering Study and the Front End Engineering Design (FEED), which have focused on the Onshore Facilities and Offshore Pipeline.

MEDGAZ considers that an Environmental Impact Assessment (EIA) is to be a required part of the ongoing process of environmental management that will continue throughout all phases of the development. In meeting the requirements of the MEDGAZ environmental policy, an EIA of the proposed transportation system has been undertaken. Careful consideration has been given to the applicable legislation and to the requirements of any statutory orders presently in force governing the construction and operation of oil and gas installations in Algeria and Spain.

The assessment examines those features of the development, which are likely to interact with the environment. This covers input, discharges, emissions and

disturbances to the environment and potential conflicts with other users of the land and sea. Priority issues are analysed, and the scale of interaction that is likely to occur is predicted. Mitigating measures are then recommended in order to influence development planning so that the lowest reasonable level of environmental impact can be achieved using best available techniques (BAT) with due consideration of cost.

This Environmental Impact Assessment concerns the entire pipeline route, the receiving terminal at Rambla Morales in Spain, and the compressor station at Beni Saf. It gives a general description of the receiving station and the influence this may have on the environment, as well as possible safety hazards to human occupancy of the area (from the time that the plant is constructed, set in operation and at the end of its service lifetime decommissioned).

Specific EIAs have been submitted to both the Spanish and Algerian authorities to provide documentation for administrative, planning and environmental permits and particularly environmental authorisation of the project subject to the relevant legislation including:

- the Spanish Legislative Royal Decree 1302/1986 of 28 June on environmental impact assessment as approved by Royal Decree 1131/1988 of 30 September and with later amendment in Law 6/2001 of 8 May; and
- the Algerian law on protection of the environment, *Loi n° 83-03 du5 février 1983 relative a la protection de l'environnement*, and order on environmental impact studies, *Décret exécutif n° 90-78 de 27 février 1990 relatif aux études d'impact sur l'environnement.*

Use has been made of available data directly relevant to the affected locations for the offshore pipeline as well as the landfalls at both Beni Saf and at the receiving terminal in Rambla Morales in Spain. Proven analytical techniques have been used where necessary to ensure that the occurrence and consequence of potential accidental events are realistically assessed. Furthermore, specific studies have been commissioned and conducted by various universities and private companies to ensure that the there is sufficiently detailed environmental information for the EIAs.

From an environmental perspective, a significant feature is the proposed routing through the Cabo de Gata -Níjar Natural Park (UNESCO MAB Biosphere Reserve, December 1987) and the associated Marine Reserve. This area cannot be avoided because of constraints imposed, primarily by the narrow seabed corridor that provides the only suitable means for crossing the Mediterranean between Algeria and Spain.

The present intention is to start construction of the pipeline in the second quarter of 2005, with a view to completion in the final quarter of 2008. The expected service life-time of the pipeline is around 50 years.

SECTION 2

LEGISLATIVE AND POLICY FRAMEWORK

CONTENTS

2 LEGISLATIVE AND POLICY FRAMEWORK

2.1 INTRODUCTION

This section provides a review of relevant national and international laws, conventions, policies and guidelines. It is structured in the following manner:

- European Union Legislation;
- Spanish Legislation (national and local);
- Algerian Legislation;
- International Guidelines; and
- MEDGAZ Policy.

2.2 EUROPEAN UNION

The most relevant European regulations on environmental and nature conservation that are considered in the project include:

- The EEC EIA Directive, Council Directive 97/11/EC on the assessment of the effects of certain public and private projects on the environment.

- The IPPC Directive, Council Directive 96/61/EC on Integrated Pollution Prevention and Control, introducing the concept of Best Available Technology (BAT).

- The EEC air emission directives, Council Directive 2001/80/EC on the limitation of emission of certain pollutants into the air from large combustion plants, and Council Directive 2001/81/EC on national emission ceiling for certain air pollutants.

- The EEC Air Quality Framework Directive and the first Daughter Directive 1999/30/EC relating to limit values for nitrogen dioxide, sulphur dioxide, lead and particulate matter in ambient air.

- The EEC Birds and Habitat Directives. Council Directive 79/409/EEC on the conservation of wild birds, and Council Directive 92/43/EEC on the conservation of natural habitats and of wild flora and fauna.

- The Ramsar Convention on wetlands of international importance, especially waterfowl habitat.

- The UNECE ESPOO Convention on environmental impact assessment in a transboundary context, which Spain has signed in 1991 and ratified in 1992.

- The Barcelona Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean.

The European Union requirements for carrying out an Environmental Impact Assessment (EIA) are laid down in Council Directive 85/337/EEC, 27 June 1985 and its major amendment, Directive 97/11/EC, 3 March 1997. The developer is required to prepare an Environmental Statement using the information gathered from the EIA and, in support of the development application, submit it for approval to the 'Competent Authority', designated by the Member State in question. The following paragraphs present a summary of the main points of relevance to the MEDGAZ Project.

The Directive, as amended, requires the resultant Environmental Statement to contain the following:

- A description of the project;
  - physical characteristics of the whole project and the land-use requirements during the construction and operational phases,
  - an explanation of the main characteristics of the production processes, for instance, the nature and quantity of materials used,
  - an estimate, by type and quantity, of expected residues and emissions (water, air and soil pollution, noise, vibration, light, heat radiation etc).
- An outline of the main alternatives studied by the developer and an indication of the main reasons for this choice, taking into account the environmental effects.
- A description of the aspects of the environment likely to be significantly affected by the proposed project, including; population, fauna, flora, soil, water, air, climatic factors, material assets, including the architectural and archaeological heritage, landscape and inter-relationships between the above factors.
- A description of the likely significant effects of the proposed project on the environment, resulting from; the existence of the project, the use of natural resources, the emissions of pollutants, the creation of nuisances and elimination of waste, including explanations of the forecasting methods used to assess these effects. This description should cover all effects; that is, direct, indirect, secondary, cumulative, short-, medium- and long-term, permanent and temporary, positive and negative.
- A description of the measures envisaged to prevent, reduce and where possible, offset any significant adverse effects.
- An indication of any difficulties (technical or data deficiencies) encountered in compiling the required information.
- A non-technical summary of the information provided under the above headings.

The Member States must have in place administrative procedures for all

authorities likely to be concerned by the project to express their opinion on the information given by the developer. The Member States must also establish and implement formal disclosure and consultation arrangements with regard to the concerned public and for providing the necessary information in an appropriate and timely fashion.

By way of the 1997 amendment Directive, and in keeping with the ESPOO Convention on EIA in a Cross-boundary Context, this same requirement for open consultation and free exchange of information is extended to other Member States that might be affected by the project.

The amendment Directive also makes more explicit the role of the appointed Competent Authority in the period before the application is submitted. If required by the developer, the Competent Authority must provide an opinion on the scope of the information that must be supplied in the Environmental Statement, based on consultations with the developer and the other concerned authorities.

Both Directives specify the types of project that must be considered for EIA, by way of two categories:

- Annex I lists those projects for which an EIA is always obligatory.
- Annex II lists projects that must be considered on a case by case basis.

In the original Directive of 1985 (85/337/EEC), all "Industrial installations for carrying gas" were placed in Annex II but, following the 1997 amendment (97/11/EC), those with a length of more than 40 km and diameter greater than 800mm were regarded as Annex I projects.

Therefore, when considering the land sections of the MEDGAZ pipeline alone, the proposal does not fall strictly into the Annex II category. However, the amendment Directive provides guidance on Annex II projects that will probably require EIA, which states that particular attention should be given to the absorption capacity of the natural environment in coastal zones and nature reserves and parks, both of which are relevant to the MEDGAZ project.

In view of the project location, and especially the crossing of the Cabo de Gata-Níjar Natural Park and Marine Reserve, consideration must also be given to the Wild Birds Directive (79/409/EEC) and the Habitats Directive (92/43/EEC). This latter Directive has the fundamental objective of establishing a network of protected areas throughout the Community, both terrestrial and marine. This network of Special Areas of Conservation (SAC) is referred to as Natura 2000 sites. Article 6 of this Directive is especially relevant because it states that any plan or project that is likely to have a significant effect on a Natura 2000 site must be subjected to an appropriate assessment of its likely implications for the site's conservation objectives. If it is deemed that a project must be implemented for reasons of overriding public interest, despite a negative assessment of its environmental implications, the Member State must take all compensatory measures necessary to ensure that

the overall coherence of the Natura 2000 sites are protected.

Where the site contains a designated priority natural habitat and/or a priority species the only considerations that may be raised in favour of the development are those relating to human health, public safety or beneficial consequences of primary importance to the environment. For any other reasons the opinion of the European Commission must be sought.

2.3 SPAIN

2.3.1 National Legislation

The original 1985 European Council Directive on EIA (85/337/EEC) was transposed into Spanish legislation by means of Legislative Royal Decrees 1302/1986, 28 June, and 1131/1988, 30 September, which similarly define the scope of the EIA and, hence, the contents of the Environmental Statement as well as the administrative process and matters related to monitoring and responsibilities.

The 1997 amendment Directive (97/11/EC) was transposed into Spanish legislation by Law 6/2001, 8 May (BOE 111, 9.5.01), which amongst other things, deals with the autonomous regions such as Andalusia, in the context of cross-boundary EIA as described above.

The environmental assessment process is to provide environmental information during the planning process and to provide documentation for the authorities who will approve the project. This is particularly relevant for the environmental authorisation of the project which is subject to the law on environmental impact assessment and other environment related regulations.

For this project, the Competent (Substantive) Authority is the Directorate General for Energy and Mines, which is part of the Ministry for the Economy. The Competent (Environmental) Authority is the Ministry of the Environment. If any discrepancy arises between the Directorate General for Energy and Mines and the Ministry for the Environment, the matter is resolved by intervention of the Council of Ministers. The final outcome of the administrative process is the Environmental Impact Declaration (DIA), which must be published in the appropriate Official State Gazette (BOE). This document determines whether the project is acceptable or not, exclusively on environmental grounds and, if so, it must establish the control conditions and the means by which compliance will be monitored.

Other miscellaneous laws of possible relevance are as follows:

- Law 25/1988, 29 July on highways (BOE 182, 30.7.88) and its approval by Royal Decree 1818/1994, 2 September (BOE 228, 23.09.94);
- Law 4/1989, 27 March on the conservation of natural sites and wild flora and fauna (BOE 74, 28.3.89);

- Law 27/1992, 4 November on state ports and merchant shipping, article 21.2 (BOE 283, 25.11.92); and
- The State Fisheries Act, Law 3/2001, 28 March; the basic law regulating the scope and measures for conservation, protection and regeneration of fish resources.

The European Council's Habitats Directive (92/43/EEC) was transposed into Spanish legislation by Royal Decree 1997/1995, 7 December, in order to incorporate those aspects that were not already covered by the existing Law 4/1989 mentioned above.

The related Spanish national catalogue of endangered species is regulated by Royal Decree 439/1990, 30 March (BOE 82, 5.4.90).

Protection of beaches and the coast is covered by Law 22/1998, 28 July and Royal Decrees 1471/1989, 1 December and 112/1992, 18 September. Under this legislation, the seashore is defined as belonging to the state maritime-terrestrial public domain. This definition includes the beaches, territorial waters and tidal inland waters with their seabed and subsoil, as well as the natural resources of the economic zone and the continental platform. Utilisation of the maritime-terrestrial public domain requires the formulation of a basic project, which establishes the characteristics of the installations and work. For projects that involve intervention at sea, it is imperative to make a basic study of littoral dynamics, referring to a coastal physiographic unit, and of the effects of the foreseen actions.

A recent piece of legislation, Law No. 02/2002, 5 February, concerning the protection and valuation of the coast (Article 26 institutes a Development Management Plan for the Coastal Zone) has come into force. One of its objectives is to demarcate sensitive, pertinent and priority areas for which the management plans will be reviewed. Among the marine sites that are explicitly protected, are coral reefs, sea grass beds and submarine coastal forms and formations.

Applications to use the protected areas and to make discharges from the land into the maritime-terrestrial public domain are considered with reference to the state legislation in force, including that which is set out regarding the protection of the sections of the coastline covered by the Coasts Act (02/2003), as well as the regional regulations, which are discussed in the section below.

2.3.2 Andalusian Legislation

Autonomous regions such as Andalusia are permitted to develop and extend the national laws on environmental protection. Under this arrangement the following legislation is of particular relevance to the proposed MEDGAZ project:

- Decree 292/1995, 12 December, which approves the regulation on EIA.

This decree also develops Law 7/1994 of 18 May on environmental protection;

- Decree 4/1986, 22 January, which extends the list of protected species and sets out rules for their protection in Andalusia;
- Decree 104/1994, 10 May which establishes the Andalusian catalogue of threatened wild flora species;
- Law 1/199, 3 July, on the historic heritage of Andalusia, with regard to archaeological sites and other elements of socio-cultural heritage, including the possible existence of shipwrecks and other remains of interest on the seabed;
- Decree 32/1993, 16 March, which regulates archaeological activities;
- Decree 19/1995, 7 February, which regulates protection and promotion of the historic heritage of Andalusia; and
- Law 3/2001, 4 April, which complements the State Fisheries Act, with regard to the management, promotion and control of sea fishing, shell fishing and marine aquaculture.
- Decree 326/2003 which cover protection against noise pollution in Andalusia and which establishes acceptable limits for noise in the surrounding environment.

A further significant instrument of local control is the Urban Planning General Plan for Almería, especially Article 13.11, entitled, "Uses Related to Public Works". It is this article that makes provision for the installation, maintenance and service of basic infra-structures, including oil and gas, water supply, and sewage pipelines. In principle, the activities in question are regarded as provisional land uses. Therefore, the permit normally places time limits for temporary constructions to remain in place and for re-establishing the land to its original farming use and/or natural condition after the installation is completed.

2.3.3 Cabo de Gata-Níjar Natural Park Regulations

The proposed pipeline will make its landfall on the Spanish side in the Cabo de Gata-Níjar Natural Park and, in doing so, it will also cross the Marine Reserve associated with this Park. The framework for the protection of this area is found in the Natural Resources Regulatory Plan and the Master Plan for the use and Management of the Gata-Níjar Natural Park, which is given legal status by Decree 418/1994, 25 October. The marine part of the Park is also controlled by Ministry of Agriculture, Fisheries and Food, Order of 3 July 1995, in response to objectives laid down by European Council Directive 1626/1994/EC for the conservation of Mediterranean fisheries, in particular the conservation of sea grass meadows. However, the Master Plan does not impose requirements beyond those that are already covered by the wider National and Andalusian legislation.

The Park is divided into zones of decreasing importance with regard to protection of the natural environment. These are designated as follows:

LAND

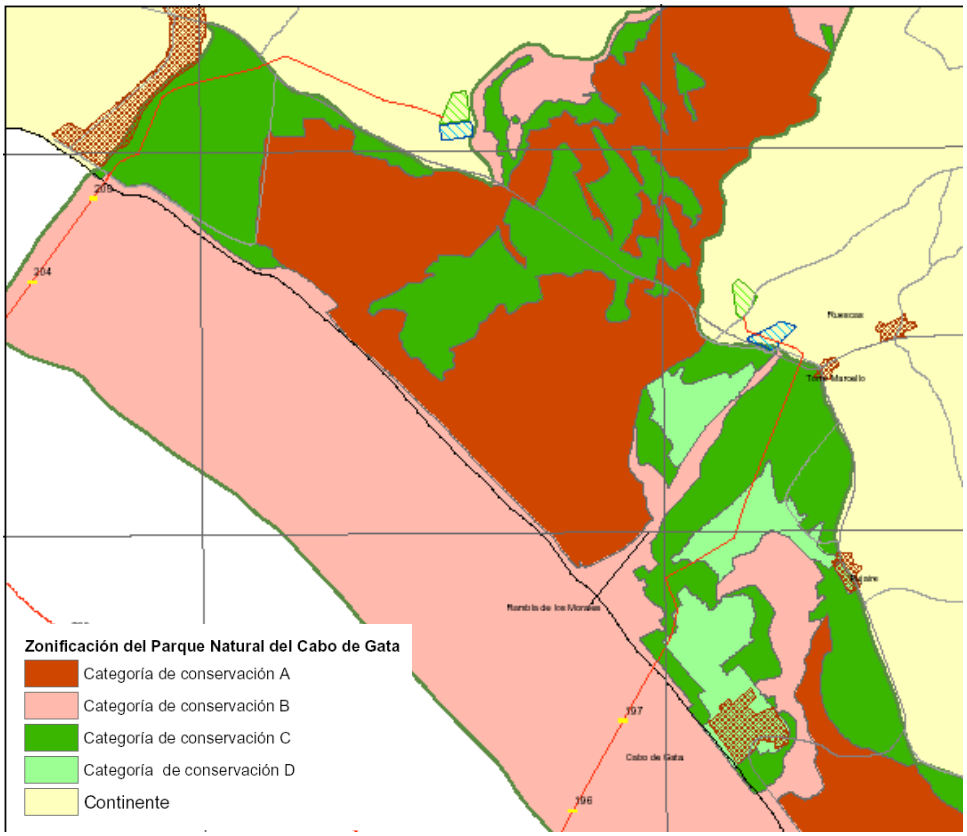
- Zone-A1: Exceptional natural ecosystem;
- Zone-A2: Antropic humid zones;
- Zone-B: Exceptional natural ecosystems with antropic transformations;
- Zone-C1: Natural areas of general interest;
- Zone-C2: Areas of traditional crops;
- Zone-D: Spaces of no specific environmental interest due to significant alterations by human activities;
- Zone D1: Urban areas;
- Zone D2: Areas of urban potential;
- Zone-D3: Areas of intensive agriculture;
- Zone-D4: Areas of mining exploitation; and
- Zone-D5: Pre-existing human habitat.

MARINE

- Zone-A: Spaces requiring a high level of conservation, both with respect to their seabed structures as well as their ecological conditions. Fishing, nautical developments and even vessel transit and anchorage are forbidden in these zones; and
- Zone-B: Buffer zones to protect the more sensitive A-grade zones against potentially damaging uses. Activities in these zones are restricted, but uses related to environmental education, tourism, recreation and fish farm regeneration are permitted.

The zones in the vicinity of the proposed pipeline route are shown in *Figure 2.1*

Figure 2.1 Zones of the Cabo de Gata - Níjar Natural Park



2.4 ALGERIA

2.4.1 *Environmental Impact Assessment Legislation*

Environmental impact assessment in Algeria is regulated through the Law 83-03, 5 February 1983, on the protection of the environment, which establishes the initial framework, with the objective of assessing and making people aware of the direct and indirect impacts of development projects on ecological balances, the environment and quality of life. Section 5, in particular, describes impact studies as basic instruments for implementation of environmental protection and states that prior studies should be carried out on all works that may adversely affect the environment.

Actual implementation of the legislation is by way of Decree 90-78, 27 February 1990, which requires an EIA for any activity that may directly or indirectly affect the environment, public health, agriculture, natural areas, fauna, flora or historic monuments and sites. As in Spain, the environmental assessment process is to provide documentation to the authorities who will approve the project based on the project's compliance with the relevant environmental regulations.

Decree 90-78 also specifies the methodology for carrying out an acceptable EIA, as follows:

- The conditions under which the environmental issues must be accounted for within the existing regulatory procedures for development projects;
- The scope of the assessment must include;
    - (i) An analysis of the original state of the site and its environment, including ecological value and agricultural, forest, maritime, hydraulic or leisure areas, affected by works, developments and undertakings.
    - (ii) An analysis of the effects on the environment and, in particular, on sites, landscapes, fauna, flora, environment and biological balances, site neighbourhood (noise, vibrations, odours, smoke and light) and on hygiene and public health.
    - (iii) The reasons why the project is acceptable.
    - (iv) The measures contemplated by the project owner or the petitioner to suppress, mitigate and compensate the damaging consequences of the project on the environment, as well as an estimation of the corresponding costs.
- The conditions in which environmental impact studies have been publicised; and
- The arrangements by which the Environment Minister can act or can be asked to act for an opinion on any impact study.

To support this legislation, the Ministry for the Environment and Regional

Development have published a document entitled Guidelines for Production of an Environmental Assessment Report, which is intended to:

- Standardise the implementation of EIA studies;
- Provide information to the people taking part;
- Explain the general methodology; and
- Facilitate the examinations of EIA reports that must be carried out by the various authorities.

The Guidelines explain the legal basis of EIA, administrative process and the roles of the different organisations and personnel involved. It also provides some advice on the identification and assessment of impacts and the expected scope of the Environmental Statement. Although this guidance is generalised, it is essentially compatible with current international practice, so an Environmental Statement prepared to European Union standards should also be generally adequate to satisfy the Algerian requirements.

2.4.2 Other Legislation

The current primary piece of legislation specifically intended for the hydrocarbons industry is Law 86-14, as amended, on the "Production, Operation and Pipeline Transport of Hydrocarbons", which covers the associated works as well as the actual production and transport processes. This Law defines the rights and responsibilities of companies involved in such activities, but environmental matters are not addressed beyond Article 14, which only requires licence holders to comply with the regulations on conservation of the hydrocarbon resources.

The regulations, which are laid down in Decree 94-43 require licence holders, associated companies and operators to take appropriate measures to protect the environment, particularly with regard to surface waters.

The draft of a proposed new law places far more emphasis on environmental protection in the hydrocarbon industry. It devotes a whole paragraph to articles dealing with environment, hygiene and safety. In Article 13, for example, it states that all activities covered by the law must comply with specified obligations for the protection of:

- Public health, hygiene and safety;
- The characteristics and features essential to the terrestrial and maritime environment; and
- Archaeological interests.

It also requires developers to prepare and submit an Environmental Impact Statement and Environmental Management Plan, which must include a description of prevention and environmental risk management measures, for the approval of the hydrocarbons industry regulatory authorities.
Other applicable regulations include the law on the protection of the coastal

zone and its fauna which includes the Decree 83-509, 20 August 1983 which covers protected non domestic animal species, birds, mammals and reptiles.

2.4.3 *Algerian Regulatory Authorities*

Preamble

This section gives an overview of the key regulatory authorities responsible for environmental protection in Algeria. All these departments are consulted during the process for approval of Environmental Statements in support of development applications.

The Ministry of Environment and Regional Development

The Ministry of the Environment secures compliance with the legislation and regulations in force concerning environmental impact assessments for development, capital and infrastructure projects. It also secures compliance with the enforcement of the technical regulation and standards linked to development planning and the environment.

Under the aegis of the Ministry of Environment and Regional Development, it is the National Committee for the Environment that is responsible for:

- Supervision and control of the environment;
- Approving Environmental Impact Assessments;
- Granting environmental permits and consents; and
- Encouraging awareness, education and communication actions in the environmental field.

Ministry of Health and Population

The Ministry of Health and Population is responsible for enforcement of the regulations and recommendations described in Law 85-05, on health protection and promotion, and in Law 88-07, on hygiene, safety and occupational medicine. Enforcement of the provisions of Law 88-07 is assigned to the Labour Inspectorate in recognition of its expertise in this area

Ministry of Culture

The Ministry of Culture is responsible for the management of protected cultural and archaeological sites. The operational aspect of this responsibility is carried out by the National Agency for Archaeology and Protection of Historical Monuments and Sites.

Local Authorities

The local authority (Wilaya) is responsible for water resources, development planning, agricultural service, forestry, health and population, urban

development and habitat construction.

2.5 *WORLD BANK*

The World Bank Group, including its private investment organisation, the International Finance Corporation (IFC), has developed a set of environmental, health, safety and social policies, and guidelines primarily for the use of its own staff in making decisions on applications for project funding.

The basic requirements for an Environmental Impact Assessment are laid down in Operational Policy OP 4.01, which previously could have been regarded as considerably more stringent than the EC Directive, because it specifically includes a systematic Analysis of Alternatives and a final Environmental Management and Monitoring Plan to integrate the commitments of the EIA into the subsequent construction and operational phases of the project. The amendment Directive of 1997 has done much to harmonise the two sets of requirements, so preparation of an Environmental Statement to European Union standard would also meet most of the World Bank requirements. However, the World Bank is still far more prescriptive on the need for auditable post-EIA control, because it also includes a, so called, Environmental Action Plan (EAP) in the scope of work. This additional document must be prepared according to Note-C: "Guidelines for the Contents of an EAP", which essentially amounts to a comprehensive site management manual, covering:

- The organisational structure, management procedures and responsibilities;
- Measures to mitigate adverse effects to a minimum and at least to the agreed acceptable levels;
- Measures for promotion of development benefits;
- Monitoring procedures; explaining the relevant control standards, measurement methods, location, parameters, frequency, reporting and corrective action requirements;
- Procedures for on-going disclosure of information and consultation with the various project stakeholders; and
- Implementation schedule and costs.

Other World Bank Group documents of relevance are:

- The World Bank "Pollution Prevention and Abatement Handbook", July 1998, especially the section on "Oil and Gas Developments Onshore" and the supplementary IFC Guidelines for "Oil and Gas Developments Offshore" and "Hazardous Materials Management".
- IFC Guidance Note-F: "Preparation of a Public Consultation and Disclosure Plan".
- Operational Policy OP 4.04: "Natural Habitats".

2.6 *MEDGAZ HEALTH, SAFETY, SECURITY AND GENERAL ENVIRONMENTAL POLICY*

MEDGAZ has a Health, Safety, Security and General Environmental Policy that will be applied to the proposed project. The fundamental principles are embodied in the following Corporate Statement:

- The Directors and Management of MEDGAZ, consider the Health, Safety and Security of its employees and operations and the protection of the Environment, of paramount importance. Business decisions will be made considering HSSE issues with the same level of importance as economic or technical considerations.
- MEDGAZ is committed to taking all necessary action to protect the health safety and security of its employees and to ensure that the health and safety of the public are not adversely affected by our activities.
- MEDGAZ requires its employees to work safely and with due consideration to the safety of others and provides whatever training and supervision are necessary.
- It is the Company's policy to take full account of the environmental implications of its operations and to protect the environment. Complying with local regulations is only a starting point, not necessarily the objective in environmental protection. The Company applies the basic hierarchy of impact prevention prior to correction in the planning and decision assessment stages. Deploying good industrial practices that allow sustainable development and continuous improvement is the philosophy in maintaining a high standard of environmental protection.
- Health, safety, security and environment are an important responsibility for every one of our personnel. In addition, every manager should ensure that this Policy is implemented and improved in their areas of responsibility.
- This responsibility includes contractors. Contractors who are selected to undertake work for the Company are required to apply the same standards of care for health, safety, security and environment as we do ourselves, and HSSE performance is included in the selection criteria.
- MEDGAZ provides support and all the resources to implement this Policy effectively and efficiently and, in order to assure the proper implementation of this Policy, MEDGAZ management will make inspections and audits on a regular basis.

Before start of the construction phase, the above Statement will be expanded into a Project-specific Environmental Management and Monitoring Manual based on the elements of International Standard ISO 14001, to ensure that all the commitments of this Environmental Statement and requirements of the relevant environmental control authorities are properly implemented throughout the course of the project.

SECTION 3

PROJECT DESCRIPTION

CONTENTS

3 PROJECT DESCRIPTION

3.1 DESCRIPTION OF THE OFFSHORE PIPELINE RECEIVING TERMINAL

3.1.1 Overall objectives and concept basis

The Offshore Pipeline Receiving Terminal (OPRT) is established to meter and regulate the gas before sending it to the Spanish Grid. The terminal is provided with filters, heaters, metering station and pressure regulation facilities to ensure operational pressure at discharge to the Spanish grid.

Gas volumes and system build-up rate

The transported natural gas is predominantly a methane/ethane gas, being the expected co-mingled gas coming from various producing fields in Algeria.

The build-up rate in terms of capacity for the transportation system indicated in *Table 3.1.* is expected.

Table 3.1 Transportation system build-up rate.

Year	Year 1	Year 2	Year 3	Year 4	Year 9	Year 14
Flow in BCM/yr	6.0	7.5	9.5	9.5	14.0	16.0

The gas is targeted to flow during the third quarter of 2008 through one 24" pipeline. The capacity of this single line is reached during 2010 to 2012, at which time a second 24" pipeline shall be in place. The system will reach full capacity of 16 BCM/yr in the next decade.

The flow rates are considered to vary over the year, such that the flow rates during shorter periods may reach up to approximately 17 % higher (1/0.85) than the figures in above *Table 3.1*. The percentage increase of flow over short periods of time versus yearly average flow is often referred to as the 'swing factor', which in this case equals 0.85.

Operating and design pressures

The maximum operating discharge pressure from the Beni Saf Compressor Station (BSCS) in Algeria into the offshore pipeline is approximately 233 barg, which will ensure an arrival pressure at the OPRT of approximately 77 to 80 barg at times when the pipelines are operating at their full capacity.
The common design pressure for the offshore pipeline and for parts of the OPRT (until downstream of the pressure control valves) is 250 barg, whereas the design pressure for the Spanish onshore pipeline is 80 barg.

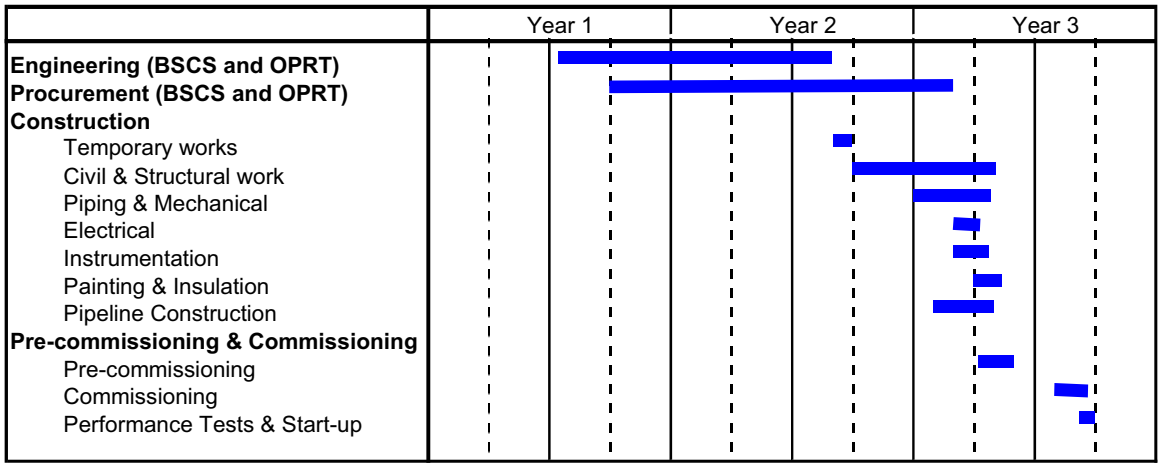
Overall time schedule

The envisaged start-up of the transportation system is targeted for around 2008. Construction activities on site will last for a period of approximately 9 months, with a probable commencement of engineering and procurement activities from the middle of 2004 and commencement of construction works from the third quarter of 2006.

The construction works will be completed within a time frame of approximately 8 to 9 months. The pre-commissioning activities will commence one to two months before end of construction, after which the plant will await the completion of the BSCS before commissioning (the actual gas filling operation) can take place. The start-up of the transportation system will be approximately 13 months after commencement of the construction works.

The outline time schedule is visualised in *Figure 3.1.*

Figure 3.1 ***Project Schedule***



3.1.2 Project location

The site identified for the Offshore Pipeline Receiving Terminal (OPRT) is located in the Province of Almería, approximately 30 km east of Almería, to the west of Rambla Morales, at Cortija de Garrotera, at the foot of the Morales Hill. It is around 4 km north of Cabo de Gata village and 2.5 km west of Ruescas village. It is located on the pipeline route running from the Playa del Charco towards Albacete via Ruescas.

The plot is identified in the next page in *Figure 3.2.*and in *Photo 3.1.*

Figure 3.2. ***OPRT site location***

Photo 3.1 ***View on the identified OPRT site from the Morales Hill towards southeast. The site is located in front of the greenhouses in the middle. The main road ALP-202 is to the right. Behind the greenhouses is a green belt at the course of Rambla Morales and further in the background to the left is Ruescas.***

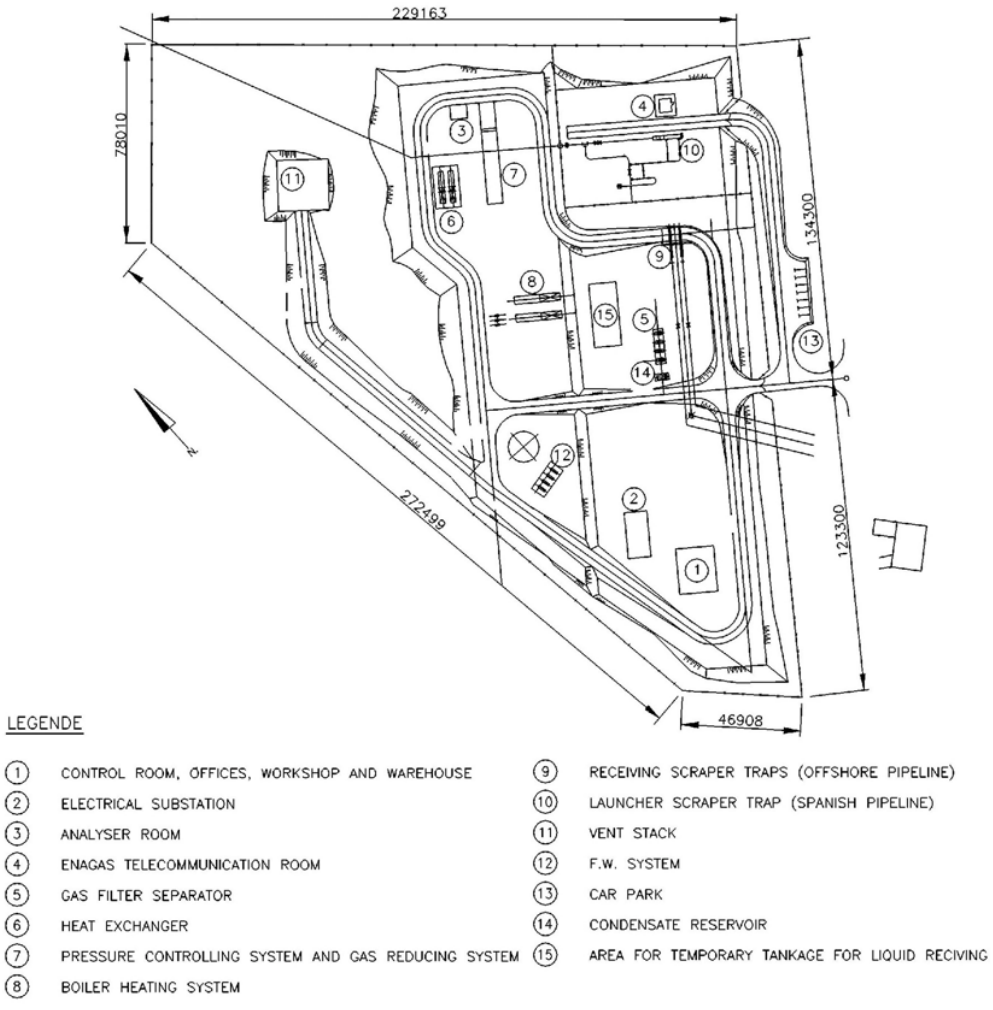
3.1.3 Layout, system and facilities

The main components at the receiving station are filters, heaters, metering and regulation facilities, pig receivers and launchers, venting system for station depressurisation, and a station process control system. In addition to these facilities the station is provided with auxiliary facilities comprising backup

diesel generator, electrical substation, oily water and wastewater treatment system, and fire fighting and gas detection system.

The layout of the receiving station is shown in *Figure 3.3.*

Figure 3.3. OPRT layout



Main process facilities description

Gas filters
Filter/separator unit with initially 3 cartridge filters (2 plus 1 stand-by) and a 4th unit to be installed for the second phase extension to 16 BCM/yr capacity. The filters shall remove particles and droplets from the gas before metering and regulation.

Gas heaters
A set of 2 heaters for heating the gas prior to discharge to the Spanish grid at times of large flows through one offshore pipeline, and at times of transportation system start-up.

Metering facilities

Metering station with initially 3 turbine meters in parallel (2 operating and 1 stand-by) and a 4th unit to be installed for the second phase extension to 16 BCM/yr capacity. The meters are equipped with flow, pressure and temperature transmitters connected to a dedicated multilane flow computer. Within the station is also found two natural gas chromatographs and two water content analysers, in redundant configuration.

Scraper traps
Receiving scraper trap in which cleaning and measuring pigs are received from the offshore pipeline. Launching scraper trap in which cleaning and measuring pigs are launched to the onshore pipeline. The scraper traps are fitted with motorised block valves.

Vent system
Venting system for station piping and equipment. The system is designed as a combined vent/flare, with a 33 m high vent stack, for flaring in cases of planned shutdown of the plant and venting in cases of emergency shutdown. The vent system will enable depressurisation to 7 barg within 15 minutes.

Local control room
Control room for local operation of the station, with local Automation and Process Control System (PCS) for safe and efficient operation of the OPRT, including Distributed Control System (DCS) and Emergency Shutdown (ESD) system. The system is linked with the Central Control Room (CCR) located on a site far from the OPRT, on a site yet to be confirmed, probably in Madrid. Supervisory Control and Data Acquisition system (SCADA) will be installed in the CCR.

Auxiliary facilities

Fire & gas system
Fire fighting and gas detection system with water pumps with hydrants and associated instrumentation, flame detection and extinguishing system in venting silencers, and flame detection and extinguishing system in control building and electrical substation.

Condensate tank
Underground horizontal cylinder-tank for collection of liquids drained from the gas filter.

Electrical sub-station
Electrical sub-station equipped with High and Low Voltage Distribution Boards, Power Centre, Motor Control Centre (MCC), 220 Vac UPS and 24 Vdc boards.

Diesel generator
Diesel generator for emergency power supply.

Anti intrusion system

Intrusion detection system with Closed-Circuit Television (CCTV) and presence detection.

Wastewater treatment system
Treatment system for domestic wastewater, with septic tank and biological treatment for domestic water.

Water supply system
Domestic and industrial use water supply and distribution system with above ground concrete storage tank and circulation pumps.

Buildings

The following buildings will be part of the OPRT plant:

- Control building with control room, offices, rest room for occasional use by maintenance personnel, workshop and warehouse
- Electrical sub-station
- Guard house

Generally, all buildings are in one level with a height of 4-5 m except for the workshop with a height of 6-7 m. Walls are concrete frames with brick fill, and roofs are concrete slabs with asphalt and gravel layer.

Adjacent to the entrance but outside the fence of the OPRT will be established a car park of limited capacity.

All units will be placed in the open, but sound proofed to acceptable levels in accordance with governing laws and regulations.

The station vent will basically consist of a large-diameter tube extending 24 metres above ground level. The vent stack for the onshore pipeline receiving facilities has a height of 15 m. Mass concrete foundations cast below ground level support the vent.

Utilities

Electricity
Electrical power for the terminal is supplied at voltage 20 kV from an external grid. The power requirement is 400 kVA. An emergency diesel generator is installed for backup in case of power failure.

Water
Water is required for domestic consumption on occasional basis by operation and maintenance staff (shower, bathroom etc), for workshop purposes and cleaning, and for the fire fighting system. Quantity of water consumption anticipated is corresponding to 3 persons. Supply is either from the public

network, from a well, or delivered to the station by tank trucks, whichever is possible and most feasible.

Two water depositories will be installed: one for fire fighting and one for domestic consumption, Chlorination will be applied for domestic water unless a connection to the public network is made. It is not anticipated that the water shall be potable. Water will be distributed by pumping, in a network for domestic use and a network for industrial use.

Wastewater
A small treatment plant for sewage water will be installed with a capacity for 6 persons. Discharge of water from the sewage treatment plant is anticipated to the Rambla Morales watercourse nearby.

Oily water collection is not anticipated at the terminal.

Liquids produced in the gas filters will be drained manually to a condensate tank with a capacity around 10 m^3 for offsite disposal by tank truck.

Waste
Waste from the station will include household from station staff, used lubricants and filters. Arrangements for disposal of the waste will be sought with the local waste authorities.

3.1.4 Implementation

The actual construction works on site will last approximately 8 to 9 months. The activities and the plant used for the works are what are normally required for the erection of any industrial plant.

The site works at the OPRT will consist of the following:

- Preparatory works – preparing access to the work site, site clearing, site levelling including cut to fill and soil compaction, erection of sheds, workshop, store and utilities, temporary fences
- Civil & Structural work paving of roads and paths, casting of concrete foundations, columns and slabs for buildings, foundations for equipment, vent/flare, slabs and pits, brickwork, erection of steel structures in the form of pipe bearings, supporting structures etc and the permanent fence around the site
- Piping & Mechanical – welding of all pipes and fittings, setting-up of heaters, filters etc and making tie-ins to pipe work
- Electrical – arrange and connect all power cables and wiring to package units and equipment

- Instrumentation – arrange and connect all instrumentation wiring to package units, equipment, PLCs, local as well as central control room, and fit and connect all communication equipment
- Painting & Insulation – pipe coating and thermal insulation

The main quantities of resources for civil works are approximately as indicated in *Table 3.2.*

Table 3.2. Main resources for civil work

Resource	Quantity
Excavation, cut to fill	62,500 m^3
Excavation, foundations	11,500 m^3
Paved surfaces	12,500 m^2
Concrete	2,500 m^3
Reinforcement steel	100 tonnes
Structural steel	1 tonne
Area of buildings	600 m^2

3.1.5 Commissioning

The scope of the pre-commissioning and commissioning activities is to render the OPRT as safe and trouble-free as possible and to have a smooth production start-up.

The pre-commissioning and commissioning activities include conformity checks and static tests of equipment and systems and preparations for start-up of the terminal.

Pre-commissioning includes:

- Systematic conformity checks on equipment or component of compliance with specifications, safety rules, and codes and standards.
- De-energised tests to ensure the quality and correct installation of each item, equipment, component as well as the static test of vessels, piping etc. Cold testing of equipment and components comprising calibration of instruments, machinery alignment, setting of safety valves, pressure testing of mechanical components.
- Pipes and vessels. Flushing and cleaning to be performed.

Commissioning includes the dynamic verifications and dynamic test phase and the work to render the installation ready for the start-up and the start-up itself:

- Ready for start-up:

    - Dynamic verifications that each electrical and instrumental function performs properly.
    - Mechanical preparation, running-in and on line tests for the utilities such as fuel gas, lube oil, water fire fighting etc and wherever applicable for the process equipment.
    - The activities related with the gas-in preparation such as drying-out, leak tests, loading of chemical etc.

Pressure tests are made with water without any additives.

- Start-up: This work begins with the introduction of the natural gas into the plant.

    The start-up activities are:

    - Gas-in
    - Bringing the plant in operation
    - Performance tests to prove the installation design capacity

MEDGAZ has prepared various detailed specifications dealing with pre-commissioning and commissioning. These specifications give in detail the contents of each key activity as well as examples of forms and dossiers to be prepared.

The overall planning of the project will be optimised if the pre-commissioning and commissioning activities are organised, not as whole plant activities, but by sections of the plant.

In the case of OPRT, these would be:

- Gas filtering
- Gas heating
- Custody transfer metering and gas control
- Blow down and venting
- Arrival and departure terminal of the pipeline
- Power generation, HV, LV, distribution, etc
- Telecommunication

The utility systems would be:

- ESD and DCS system
- Water fire fighting system
- Gas conditioning units and gas distribution network to control valves and boiler units
- Lube oil system

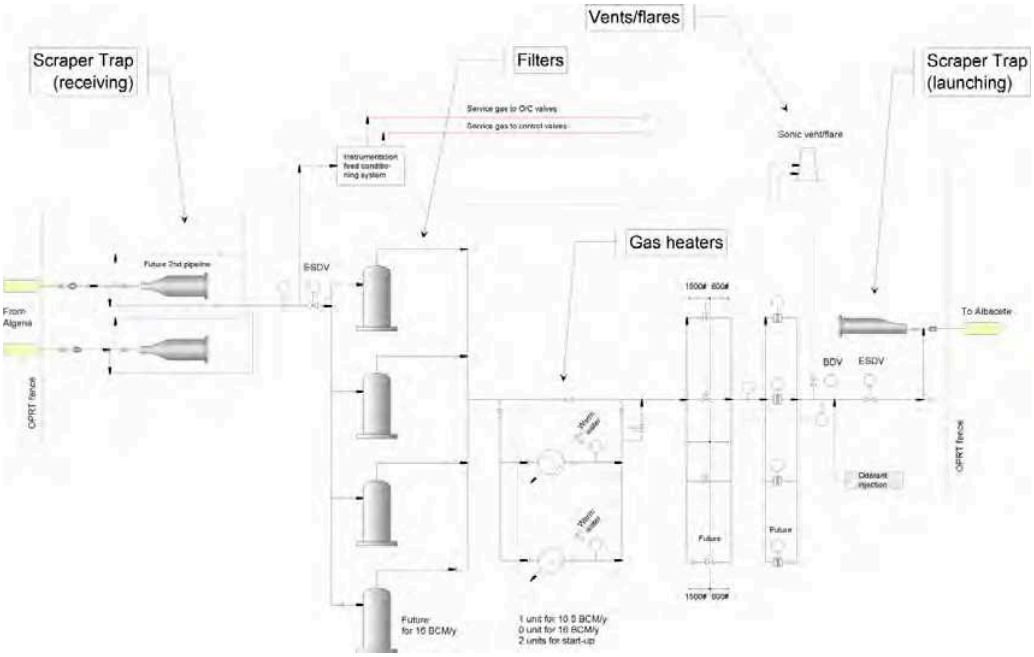
3.1.6 Operation

The main purpose of the Offshore Pipeline Receiving Terminal (OPRT) is to meter and regulate the gas before sending it to the Spanish Grid.

Natural gas enters the receiving station after passing the inlet shutdown valve. The gas is filtered and flow measured in the metering units. At start-up and at certain gas throughput quantities, heating of the gas is required to achieve an operational outlet temperature, minus 5ºC, before it is sent to the Spanish Grid. Odorant injection is also made at the station. The gas is sent into the Spanish Grid at a pressure of 75 barg, through the terminal outlet shutdown valve.

The process layout is visualised in *Figure 3.4.*

Figure 3.4 OPRT Process Diagram



Gas filtering
Solids and liquids, which may be present in the gas, shall be separated by in order to protect the station equipment. Contamination can be expected as a result of the following factors:

- Start-up conditions, dirt/foreign matter from the construction phase and residual water from hydrostatic testing.
- Pipeline scraping, dirt and rust/scale flakes.
- Process conditions at high flow rates, dirt and rust/scale flakes.

Filtering is made in a filter/separator unit consisting of four identical filter units, with 1 stand-by and the fourth unit to be installed for the second phase extension to 16 BCM/yr capacity.

Separated liquids are collected in an underground condensate tank, with level control by a level switch with level alarm. The liquids are discharged manually from the filter, through a restriction orifice plate, into an atmospheric underground tank. The underground tank is emptied to a tank truck.

The filters are cleaned when the pressure drop through the filters increases. Stand-by filters are manually switched to operating condition to allow the dirty filters to be cleaned.

Gas heating

A gas heating system is installed to ensure a minimum gas temperature at discharge to the Spanish Grid. The heating system comprises boilers, warm water pumps and closed circuit piping, and shell & tubes gas/water heat exchangers.

At a previous design of maximum flow of 10.5 BCM/year for a single pipeline and a prescribed temperature at the entrance of the Spanish system of minus 5°C minimum, the heat energy required would be 6.3 MW for steady state conditions, implying the installation of two boilers.

These conditions have been re-assessed in the sense of lowering the maximum capacity of the single pipeline to 9.5 BCM/year and increasing the temperature of entry to between 0º and 1º C. This new situation implies that heating will not be necessary for steady state operations, neither for the single pipeline nor for the 2 x 24" pipelines in operation, with a flow up to 16 BCM/year. Heating will still be required,
but only for OPRT start-up conditions. For this situation a single boiler or warm water heater has been designed.

Although the air emissions and noise arising from a single boiler/temporary operation is much lower than the ones generated by two steady state operating boilers, the latter worst case situation has been maintained in the EIA for the sake of assessing the worst case scenario.

Pressure regulation and metering
Pressure regulation and custody transfer gas flow metering is installed downstream of the heating system. The metering element is of the turbine type.

Three pressure regulation and metering runs, each with a 50% design capacity, based on the design flow rate (9.5 BCM/yr) will be installed. Connections will be planned to install one additional identical run, with regards to the future second phase extension (16 BCM/yr).

Flow metering calculations are performed by a flow computer.

Two gas chromatographs will be installed in the common discharge pipe to determine gas composition, and to determine gross heating value.

Odorant injection
An odorant is injected into the natural gas to facilitate easy detection of leaks in the onshore transportation system and at the final user's installations. The system consists of a 40 m^3 storage vessel, a daily injection tank with a volume of 1200 l and two injection pumps. The odorant is tetrahydrotiophene, THT (S CH_2 $3CH_2$), delivered to the storage vessel, and injected via the daily injection tank while metered via the injection pumps. The injection rate is regulated via information received from the metering station.

The odorisation system is covered under a roof to protect it from sun radiation and to avoid diffusion loss through the equipment vent as a consequence of heating and pressure increase. An active carbon filter is installed to absorb any THT vapours.

Venting
The vent system is provided for venting in cases of planned depressurisation and emergency shutdown of the terminal. The vent system is divided into sections:

- Venting of terminal lines and equipment to the station vent stack
- Venting of launching pig traps through the vent stack in the area controlled by ENAGAS
- Individual venting to the atmosphere of the condensate tank and valve actuator gas.

The system is designed to facilitate depressurisation of each section down to 8 bar(a) in 15 minutes. Venting of the offshore pipeline, which is an unlikely event, will only take place in case of a planned situation and can be made through the station vent stack at the capacity of this vent stack.

The vent stacks are designed to comply with safety distance requirements, plume dispersion and heat radiation requirements. The station vent stack has a height of 33 m and a safety distance to the vent stack of 50 m, dictated by the flow in case of station venting. The vent stack is fitted with silencer, in order to reduce noise to an acceptance level.

Control philosophy
Overall control of the MEDGAZ transportation system is based on a remotely operated Supervisory Control and Data Acquisition (SCADA) system, placed at the Central Control Room (CCR). The location of the CCR remains yet to be confirmed, but it will be situated on a site far from the OPRT (probably in Madrid).

The local automation and Process Control System (PCS) at the compressor station in Algeria (BSCS) and OPRT will be connected to the SCADA system via satellite communication using data channels provided by VSAT.

In the LCRs, a local automation and a PCS will be installed in order to ensure the safe and efficient operation of the station. This will include: Station DCS, Station ESD, Station Fire and Gas (F&G), and a control system for equipment units (heaters, gas metering units etc).

Station Emergency Shutdown Conditions
An emergency shutdown of the OPRT may be triggered by the CCR operator or by local intervention in the form of actuation of an emergency shutdown push button in the LCR of the OPRT.

All ESD routines will be implemented and executed by the ESD control system integrated in the PCS.

The emergency shutdown command will shut down and lock out all units and close the station inlet and outlet valves, interrupting gas flow through the pipeline. If necessary, the station may be depressurised through the station venting system by appropriate action from CCR or LCR. The station can be started again only if the 'locked' condition no longer exists and the 'locked' condition has been acknowledged manually.

OPRT shutdowns are classified in levels from ESD level 1 to level 4, according to seriousness of the situation and risks to plant integrity.

Pipeline blow-down using OPRT vent system
A blow-down of the offshore pipeline is considered extremely rare, but is feasible by using the OPRT station vent system. The following procedure could be adopted:

- The turbo-compressors at the compressor station in Algeria (BSCS) are stopped and the situation is assessed both at the CCR and the LCRs at BSCS and OPRT. If deemed feasible, delivering gas into the Spanish onshore pipeline system will be continued until the pipeline pressure will have reached a pressure of 45-50 barg
- If still required, further pressure reduction would be possible by venting the remaining gas from the OPRT, and the BSCS, by opening the blow-down/outlet valves to the station vent system.

It is emphasised that the need for depressurisation of the offshore pipeline is considered improbable for the life of the project.

Risk and safety measures
Risks at the receiving terminal are associated with fire and explosion. All systems of the terminal are designed for safe operation, meaning the system shall be brought to a safe operating condition.

Measures to ensure a high level of safety consider:

- Access to the station premises is restricted by fencing and video monitoring, and in an emergency gates are provided for rapid exit from the station.
- Machine enclosures are made with safe distance to other buildings, use of low-flammable materials, design in compliance with safety regulations, venting by natural and forced ventilation, gas detection system, flame detection system, fire alarm system, and fire extinguishing system for the machine housing.
- Electrical facilities contemplate definition of hazardous areas subject to explosion risk, standby power supply with automatic switch-over, emergency illumination, and emergency cut off at the main entrance, in the control room and at the emergency exits.
- Safety and protection systems on process equipment are with pressure limitation systems, gas detection system with automatic switch off of machine units and shut off and depressurisation of gas pipes in the machine room, fire alarm system with switch off of forced ventilation system and closure of automatic fire dampers, emergency switches which, further to the gas detection actions, also automatically closes station inlet and outlet valves.

Before commissioning the terminal is inspected with regard to leakage, pressure shut-off fixtures, pressure regulators, pressure vessels, functionality, documentation and start-up procedure.

Operation of the terminal is subject to instructed and trained personnel, standby service for faults, preparation of alarm and fire protection plans, regular inspection of the gas-containing components, maintenance and repair work in compliance with the manufacturer's specifications.

Fire protection and gas detection systems are installed:

- Fire detection and extinguishing system in the main control building and electrical substation
- Fire protection on the plant site and outside the terminal by fixed water system with hydrants and portable powder and foam extinguishers
- Gas detection in boiler rooms connected to the boiler control system

Auxiliary processes

Service gas
Service gas is supplied via a conditioning unit, to heating boilers, valve actuators and pressure control valves.

Actuation of station valves is with pneumo-hydraulic actuators, incorporating a "fail-safe" mechanism to those valves, which should adopt a safety position in case of power fail or blockage. The rest of the valves are manually operated with an adequate device (wrench or hand-bar).

Wastewater treatment
Domestic water from toilets, showers, kitchen etc will be sent to a treatment package, comprising a septic pit and a biological treatment unit, both installed underground. Discharge from the treatment plant is to the Rambla Morales watercourse is assumed.

Oily water is not expected to be collected at OPRT.

Domestic and industrial use water supply and distribution
Domestic and industrial water is provided from a system comprising an above ground reinforced concrete storage tank, a water distribution pump, a hypochlorite injection system with a storage vessel and an injection pump for the domestic water conditioning, an elastic membrane type accumulation vessel to maintain the piping networks under pressure, a domestic use water supply network, and an industrial use water supply network.

The water for domestic use is not drinkable water, but for supply to toilets, showers and workshop.

Utilities and auxiliary consumables
Consumption comprises gas, electric power, lubricants, and water for domestic purposes and fire fighting. Gas is used for heating boilers and for valve actuation. Gas is released occasionally for station depressurisation in planned cases (flaring) and emergency cases (cold venting). Electric power is supplied to the terminal at a capacity of 400 KVA.

Quantities of gas, electric power and water consumption are indicated in *Table 3.3.*

Table 3.3. Utility consumptions

Consumable	Consumption
Gas for heating boiler, continuous operation 1) Gas for heating boiler, start-up scenarios 1) Gas for valve actuation Flaring of gas Cold venting of gas	6 Mm^3/yr 75,000 m^3/yr 30,000 m^3/yr 38,000 m^3/yr 7,500 m^3/yr
Electric power	400 KVA
Water	400 m^3/yr
1) In the flow range 8.5 BCM/yr to 10.5 BCM/yr only, years 2008-2012, based on 1 boiler in continuous operation. At other flow rates heating is only needed in start-up scenarios, estimated to 100 hours annually.	

Lubricants are used for process equipment, pumps, valves etc.

Diesel is used occasionally for a backup power diesel generator.

An odorant is injected in the gas before launching to the Spanish Grid. The chemical applied is tetrahydrotiophene, THT (S CH_2 $3CH_2$). The injection rate

at normal operation conditions is around 5 kg/h corresponding to 44 tonnes/yr.

Occasionally chemical substances, glycol or methanol, may be applied for injection in case of hydrate formation in the pipeline, but this is considered an unlikely emergency situation and storage of chemicals at the terminal is not anticipated.

Noise

Noise from the station machinery and equipment will primarily be from the boilers. All machinery and equipment will be specified with a sound level intended to guarantee acceptable levels in accordance with applicable standards, at the station premises, at the station fence and at neighbouring areas or habitation.

The acceptance levels applied to machinery and equipment are specified to comply with ISO noise curves at a distance of 100 m, NR 45 (equiv. 54 dB-A-). The vent system shall comply wit the ISO NR 80 (equiv. 86 dB-A-) at 100 m distance, or 115 dB-A- at the restricted area fence (at 50 m distance).

Air

Sources of emission to the air are combustion flue gas for heating boilers, and for backup power diesel generator and from flaring of gas, gas from cold venting for station depressurisation and for valve actuation.

Table 3.4 Flue gas and Ngas emissions

Source	Flue gas	N gas
Heating boilers	72 Mkg/yr	
Gas flaring	450,000 kg/yr	
Gas cold venting		7,500 m^3/yr
Gas for valve actuation		30,000 m^3/yr

Table 3.5. Gas composition

Component	Molar Percentage (%) Average gas composition
Methane (C1)	84.00
Ethane (C2)	9.21
Propane (C3)	2.24
I-Butane (i-C4)	0.26
N-Butane (n-C4)	0.35
I-Pentane (i-C5)	0.06
N-Pentane(n-C5)	0.05
Hexane +	0.04
Helium	0.10
Hydrogen	0.00
Nitrogen	2.57
Carbon dioxide	1.13

Component	Molar Percentage (%) Average gas composition
Molecular weight (kg/kg-mol)	18.92
Density (kg/Sm3)	0.800
Gross calorific value (Kcal/Sm^3)	9950
Water content (ppm)	40

Waste

Waste generated at the terminal includes dust and condensate from filters and domestic waste generated by personnel at the terminal. The filters are cleaned or exchanged regularly. Minor quantities of used lubrication oil will be generated.

3.1.7 Decommissioning

The MEDGAZ transportation system is designed for a lifetime of 50 years. The plant may over the years be modified and upgraded and various measures may be taken to increase the life expectancy of the plant – if found economically advantageous. However, at some time in the future the plant will be obsolete and shall be demobilised.

The plant and equipment will be dismantled or cut in manageable sections, wiring and electronic boxes are removed and handled in accordance with the above, and finally the items – predominantly steel sections – are carted away for reuse or reprocessing.

Building structures, including pits and culverts, and paved surfaces on the site are demolished and the used building materials are transported to an approved waste disposal site.

Finally, the area is reinstated by contouring the site to its original slope and undulation, and any scrubs and vegetation are planted. The reinstatement will be planned and drafted in co-operation with the relevant authorities, whose approval shall be in hand prior to commencement of any fieldwork.

A few years thereafter, the site should appear to be mingling in with the general landscape, and any traces from past operations by MEDGAZ would be hard to detect.

3.2 DESCRIPTION OF THE BENI SAF COMPRESSOR STATION

3.2.1 Overall objectives and concept basis

The Beni Saf Compressor Station (BSCS) is established to lift the gas pressure to the level required to drive the gas through the offshore pipeline and deliver it at the required pressure at the Offshore Pipeline Receiving Terminal (OPRT) near Almería on the Spanish coast. The station is provided with turbo-compressors, gas air-coolers, gas filters and metering facilities.

Gas volumes and system build-up rate
The transported natural gas is predominantly a methane/ethane gas, being the expected co-mingled gas coming from various producing fields in Algeria.

In terms of capacity for the transportation system, the expected following build-up rate is shown in *Table 3.1.*

The gas is targeted to flow during the third quarter of 2008 through one 24" pipeline. The capacity of this single line is reached during 2010 to 2012, at which time a second 24" pipeline shall be in place. The system will reach full capacity of 16 BCM/yr in the next decade.

The flow rates are considered to vary over the year, such that the flow rates during shorter periods may reach up to approximately 17 % higher (1/0.85) than the figures in above. The percentage increase of flow over short periods of time vs yearly average flow is often referred to as the 'swing factor', which in this case equals 0.85.

Operating and design pressures
The operating pressure for the Algerian onshore pipeline upstream of the Beni Saf Compressor Station is 44 barg, whereas the maximum operating discharge pressure from the BSCS (ie downstream of the compressor installation) is approximately 233 barg. The discharge pressure of 233 barg will ensure an arrival pressure at the BSCS of approximately of 77 to 80 barg at times when the pipelines are operating at their full capacity. The common design pressure for the compressor station and the offshore pipeline is 250 barg, whereas the design pressure for the Algerian onshore pipeline is 80 barg.

Overall time schedule
The envisaged start-up of the transportation system is targeted for 2008. Construction activities on site will last for a period of approximately 18 months, with a probable commencement of engineering and procurement activities from the middle of 2004.

The construction works will be completed within a time frame of approximately 15 months. The pre-commissioning activities will commence a couple of months before the end of construction, and will lead to commissioning (the actual gas filling operation) and start-up of the transportation system — altogether a period of time of approximately 18 months.

The outline time schedule is visualised in *Figure 3.1.*

3.2.2 *Project location*

The site identified for the Beni Saf Compressor Station (BSCS) is on the hills near Sidi Djelloul, approximately 10 km east of Beni Saf. The area is an agricultural field, reasonably flat with very gentle slopes. It is located right on the planned pipeline route.

Access to the station will be via an access road, connecting to the D.20, approximately 3 km southeast of the station. The road will be made with a width of 6 m and will follow existing rural tracks.

The plot is identified in *Figure 3.5*.and in *Photo 3.2*

Figure 3.5 BSCS site location.

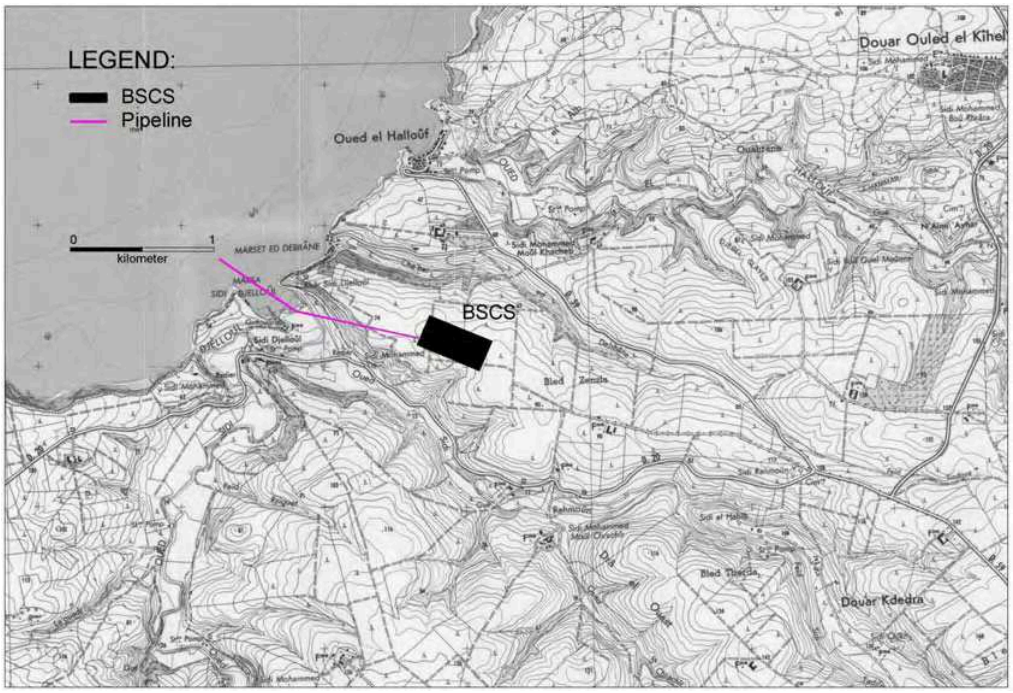


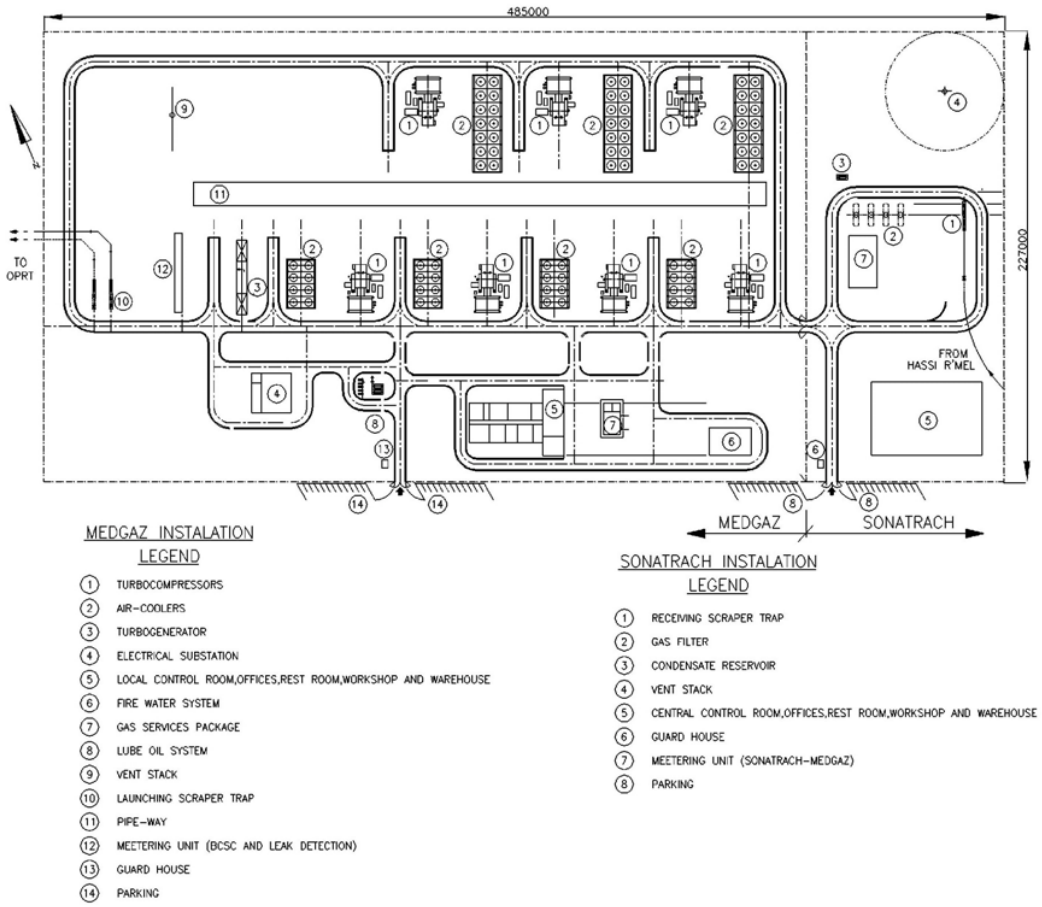
Photo 3.2 ***View of the identified compressor station plot from southwest towards northeast across the valley***

3.2.3 Layout, system and facilities

The main components at the compressor station are compressors, gas filters, gas coolers, metering facilities, pig receivers and launchers, venting system for station and compressor depressurisation, and station process control system. In addition to these facilities the station is provided with auxiliary facilities comprising backup power generator, starting and fuel gas systems for compressors and backup power generator, electrical substation, lube oil system, oily water and wastewater treatment system, and fire fighting and gas detection system.

The layout of the compressor station is shown on *Figure 3.6.*

Figure 3.6. BSCS layout



Main process facilities description

Gas filters

Cartridge type filters to remove particles and droplets from the gas before reaching compressor inlets.

Metering facilities

Metering station with 3 turbine meters (2 operating and 1 stand-by) arranged in three parallel lines for custody transfer measurements. The meters are equipped with flow, pressure and temperature transmitters connected to a dedicated multilane flow computer. Within the station are also found two natural gas chromatographs and two water content analysers, in redundant configuration.

Turbo-compressors

4 turbo-compressors (1 stand-by) operating in parallel will ensure first stage (low level) compression and 3 turbo-compressors (1 stand-by) operating in parallel will ensure second stage (high level) compression. The compression system is fitted with instrumentation, yard valves and unit control systems.

Gas air-coolers
3 gas coolers (1 future) lowering the gas temperature after the discharge of the first stage compression and 3 gas coolers (1 future) lowering the gas temperature after the discharge of the second stage compression. Once the natural gas leaves BSCS, the gas temperature shall not exceed 50°C.

Scraper traps
Receiving scraper trap where cleaning and measuring pigs are received from the onshore Algerian pipeline (located within an area controlled by Sonatrach). Launching scraper trap where pigs are launched to the offshore pipeline. The scraper traps are fitted with motorised block valves.

Vent system
Venting system for station piping and turbo-compressors depressurisation. The system is designed as a combined vent/flare with flaring in cases of planned shutdown of the plant and venting in cases of emergency shutdown. The vent system will enable depressurisation to 7 barg within 15 minutes. A separate venting system is provided for the associated onshore pipeline receiving facilities (within the area controlled by Sonatrach).

Local Control Room (LCR)
Control room for local operation of the station, with local Automation and Process Control System (PCS) for safe and efficient operation of BSCS, including Distributed Control System (DCS) and Emergency Shutdown (ESD) system. The system is linked with the Central Control Room (CCR) located on a site far from the BSCS, a site yet to be confirmed, probably in Madrid. Supervisory Control and Data Acquisition system (SCADA) will be installed in the CCR.

Auxiliary facilities

Fuel and starting gas unit
Gas service unit with starting and fuel gas system for turbo-compressors and for turbo-generator, with associated instrumentation and control panel.

Lube oil system
System with underground tanks for lube oil to compressors and gas turbines.

Turbo-generator
Turbo-generator for station power supply backup.

Electrical sub station
Electrical sub-station equipped with high and low voltage distribution boards, power centre, Motor Control Centre (MCC), 220 Vac UPS, 24 VDC and 110 VDC boards, cathodic protection board.

Fire & gas system

Fire fighting and gas detection system with water pumps with hydrants and associated instrumentation, flame detection and extinguishing system in venting silencers, and flame detection and extinguishing system in control building and electrical sub-station.

Anti intrusion system
Intrusion detection system with Closed-Circuit Television (CCTV) and presence detection.

Water treatment system
Oily and domestic water treatment system with pit for collection of oily waters and oil separation, and a treatment plant with septic tank and biological treatment for domestic water.

Buildings

The following buildings will be part of the BSCS plant:

- Main control building with control room, offices, rest room for plant personnel, workshop and warehouse
- Electrical sub-station
- Guard house

Generally, all buildings are in one level with a height of 4-5 m except workshop with a height of 6-7 m. Walls are with concrete frames with brick fill, and roofs are concrete slabs with asphalt and gravel layer.

Adjacent to the entrance but outside the fence of the BSCS will be established a car park of limited capacity.

The compressors will be placed in the open, but sound proofed to acceptable levels in accordance with governing laws and regulations.

The station and compressor vents/flares will be combined in a common stack, basically consisting of a laterally wire-supported large-diameter tube to a height of 75 metres. The vent for the onshore pipeline receiving facilities will extend approximately 15 metres above ground level. Mass concrete foundations cast below ground level support the vent.

Utilities

Electricity
Electrical power need for the compressor station is 2,500 kVA, which is supplied at a voltage of 30 kV from an external grid. A backup turbo-generator is installed for backup in case of power failure.

Water
Water is required for domestic consumption by operation staff (shower, bathroom etc), for workshop purposes and cleaning, and for the fire fighting

system. Quantity of water consumption anticipated is corresponding to 6 persons. Supply is either from the public network, from a well, or delivered to the station by tank trucks, whichever is possible and most feasible.

Two water depositories will be installed: one for fire fighting and one for domestic consumption. Chlorination will be applied for domestic water unless connection to the public network is made. It is not anticipated that the water shall be potable. Water will be distributed by pumping, in a network for domestic use and a network for industrial use.

Wastewater
A small treatment plant for domestic wastewater will be installed with a capacity for 6 persons. Discharge of water from the sewage treatment plant is anticipated to the watercourse, Oued Side Rahmoun, in the valley.

Oily wastewater from workshop and areas with machinery will be collected on concrete pavements, channelling oil spillages and washing waters to pits and further to an oil separator. The maximum admissible content of oil in the treated water is specified to 10 ppm. If the water meets quality criteria after the oil separator, it is discharged to the rainwater system.

Liquids produced in the gas filters will be drained manually to a $10m^3$ condensate tank for removal by tank truck.

Waste
Waste from the station will include household waste from the station staff, oil waste from the oil separator and used oil from the compressors.
Arrangements for disposal of the waste will be sought with the authorities.

3.2.4 Implementation

The actual construction works on site will last approximately 15 months. The activities and the plant used for the works are what is normally required for the erection of any industrial plant.

The site works at Beni Saf will consist of the following:

- Preparatory works – preparing access to the work site, site clearing, site levelling including cut to fill and soil compaction, erection of sheds, workshop, store and utilities, temporary fences.
- Civil & Structural work – paving of roads and paths, casting of concrete foundations, columns and slabs for buildings, foundations for compressors, equipment, vent/flare, slabs and pits, brickwork, erection of steel structures in the form of pipe bearings, supporting structures etc and the permanent fence around the site.
- Piping & Mechanical – welding of all pipes and fittings, setting up of turbo-compressors, coolers, filters etc and making tie-ins to pipe work.

- Electrical– arrange and connect all power cables and wiring to package units and equipment.
- Instrumentation – arrange and connect all instrumentation wiring to package units, equipment, PLCs, local as well as central control room, and fit and connect all communication equipment.
- Painting & Insulation – pipe coating and thermal insulation.
- Pipeline construction – installation of the pipeline from the compressor station to the beach landfall.

The main quantities of resources for civil works are approximately as indicated in *Table 3.6.*

Table 3.6 Main resources for civil work

Resource	Quantity
Excavation, cut to fill	141,000 m^3
Excavation, foundations	31,500 m^3
Paved surfaces	53,500 m^2
Concrete	8,500 m^3
Reinforcement steel	450 tonnes
Structural steel	50 tonnes
Area of buildings	1,650 m^2

3.2.5 Commissioning

The scope of the pre-commissioning and commissioning activities is to render the BSCS as safe and trouble-free as possible and to have a smooth production start-up.

The pre-commissioning and commissioning activities include conformity checks and static tests of equipment and systems and preparations for start-up of the station.

Pre-commissioning includes:

- Systematic conformity checks on equipment or component of compliance with specifications, safety rules, and codes and standards.
- De-energised tests to ensure the quality and correct installation of each item, equipment, component as well as the static test of vessels, piping etc. Cold testing of equipment and components comprising calibration of instruments, machinery alignment, setting of safety valves, pressure testing of mechanical components.
- Pipes and vessels. Flushing and cleaning to be performed.

Commissioning includes the dynamic verifications and dynamic test phase and the work to render the installation ready for the start-up and the start-up itself:

- Ready for start-up:
  - Dynamic verifications that each electrical and instrumental function performs properly.
  - Mechanical preparation and running-in and on line tests for the utilities such as fuel gas, lube oil, water fire fighting, etc, and wherever applicable for the process equipment.
  - The activities related with the gas-in preparation such as drying-out, leak tests, loading of chemical etc.

Pressure tests are made with water without any additives.

- Start-up: This work begins with the introduction of the natural gas into the plant.
  The start-up activities are:
  - Gas-in.
  - Bringing the plant in operation.
  - Performance tests to prove the installation design capacity.

MEDGAZ has prepared various detailed specifications dealing with pre-commissioning and commissioning. These specifications give in detail the contents of each key activity as well as examples of forms and dossiers to be prepared.

The overall planning of the project will be optimised if the pre-commissioning and commissioning activities are organised, not as whole plant activities, but by sections of the plant. In the case of BSCS, these would be:

Process systems:
- Gas filtering
- Custody transfer metering
- Low compression stage
- High compression stage
- Gas cooling
- Blow down and venting
- Arrival and departure terminal of the pipeline
- Power generation, HV, LV, distribution etc.
- Telecommunication

Utility systems:
- ESD and DCS system
- Water fire fighting system
- Gas conditioning unit and gas distribution network to turbo generator and turbo compressor
- Lube oil system

3.2.6 Operation

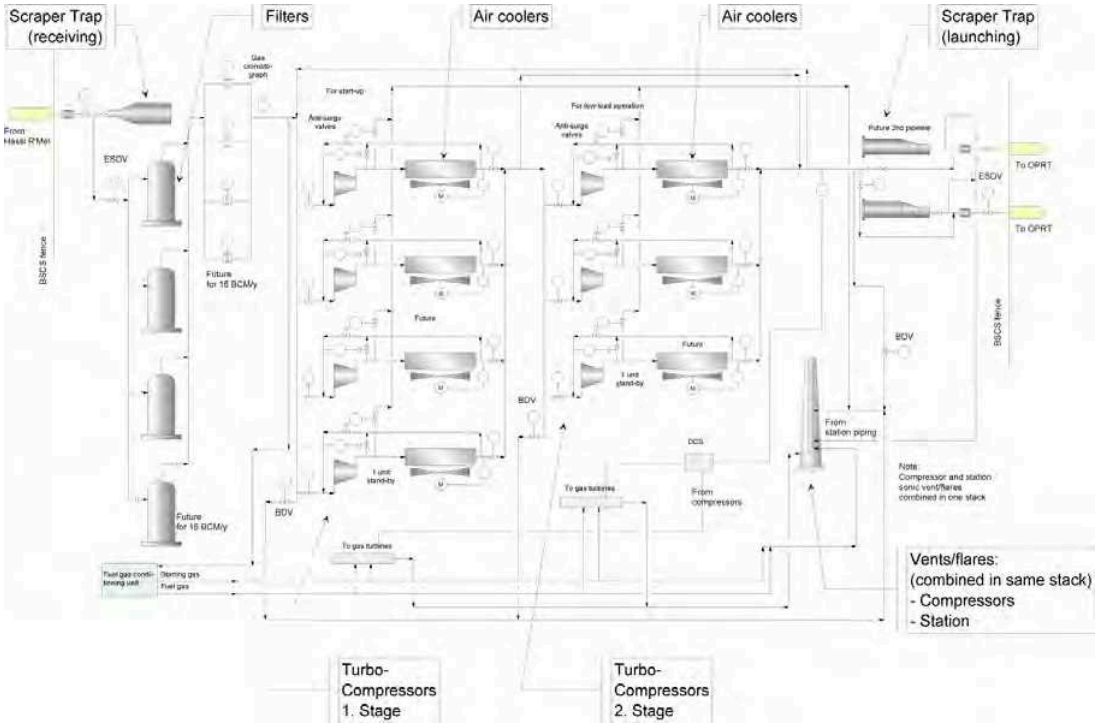
The main purpose of the Beni Saf Compressor Station (BSCS) is to lift the gas pressure to the level required to drive the gas through the offshore pipeline

and deliver at the required pressure at the Offshore Pipeline Receiving Terminal (OPRT) near Almería on the Spanish coast.

Natural gas enters the compressor station after passing the inlet shutdown valve. Before reaching the compression section the gas is filtered and flow measured in the turbine metering units in the area controlled by SONATRACH. In the compression section, the pressure is lifted through a 2-stage compression cycle with intermediate cooling before sending the gas to the offshore transmission line at a pressure of 233 barg, via the station outlet shutdown valve.

The process layout is visualised in *Figure 3.7.*

Figure 3.7. BSCS process diagram



Gas filtering

Solids and liquids, which may be present in the gas, shall be separated by means of filter/separators in order to protect the compressors and other sensitive station equipment. Contamination can be expected as a result of the following factors:

- Start-up conditions, dirt/foreign matter from the construction phase and residual water from hydrostatic testing.
- Pipeline scraping, dirt and rust/scale flakes.
- Process conditions at high flow rates, dirt and rust/scale flakes.

Filtering is made in a filter/separator unit consisting of four identical units, with 1 stand-by and the fourth unit to be installed for the second phase extension to 16 BCM/yr capacity.

Separated liquids are collected in an underground condensate tank, with level control by a level switch with level alarm. The liquids are discharged manually from the filter, through a restriction orifice plate, into an atmospheric underground tank. The underground tank is emptied to a tank truck.

Filters are cleaned when pressure drop through the filters increases. Stand-by filters are manually switched to operating condition and the dirty filters are replaced for cleaning.

Compression

Compression of gas to the required level to drive the gas through the offshore pipeline to Spain is made by turbo-compressors in two stages: first stage from the suction pressures to an intermediate pressure level and second stage from intermediate level achieved at first stage to the required discharge pressure, 233 barg, from the station. Three turbo-compressors are operating at first stage (low level) and two are operating at second stage (high level), with one additional turbo-compressor at each level for backup.

Gas cooling

Cooling is required under operating conditions of the compressors because the gas discharge temperature exceeds the maximum allowable temperature for the transmission pipeline, 50°C. Fin-fan coolers are installed downstream of each compression stage (LP and HP) to cool the gas down to 50°C. The gas coolers are air-cooled forced draft heat exchanger, with fan blades operated by electrical motors.

The air-coolers are fans driven by electrical fixed speed motors, which are automatically started and stopped depending on outlet temperature levels, in order to have a precise control of the outgoing gas temperature.

Venting

The vent system is provided for venting in cases of planned depressurisation and emergency shutdown of the station. The vent system is divided into sections:

- Venting of the station receiving pig-trap lines.
- Venting of the station lines and equipment to a dedicated vent stack.
- Venting of compressor lines to a dedicated vent stack.
- Individual venting to the atmosphere of condensate tank, relief valve filter/separator, and fuel gas conditioning unit trains.

The system is designed to facilitate depressurisation of each section down to 8 bar(a) in 15 minutes.

Venting of the offshore pipeline, which is an unlikely event, will only take place in case of a planned situation, and can be made through the station lines vent stack at the capacity of this vent stack.

The vent stacks are designed to comply with safety distance requirements and plume dispersion and heat radiation requirements. The station vent stack has a height of 75 m and a safety distance to the vent stack of 60 m, dictated by the flow in case of station lines venting. The vent stacks are fitted with silencers, in order to reduce the noise to an acceptance level.

Control philosophy

Overall control of the MEDGAZ transportation system is based on a remotely operated Supervisory Control and Data Acquisition (SCADA) system, placed at the Central Control Room (CCR). The location of the CCR remains yet to be confirmed, but it will be situated on a site far from the BSCS (probably in Madrid).

The local automation and Process Control System (PCS) at the BSCS and OPRT will be connected to the SCADA system via satellite communication using data channels provided by VSAT.

In the LCRs, a local automation and a PCS will be installed in order to ensure the safe and efficient operation of the stations. This will include: Station DCS, Station ESD, Station Fire and Gas (F&G), and control system for Package Units (turbo compressors, gas metering units etc).

Station Emergency Shutdown Conditions

An emergency shutdown of the BSCS may be triggered by the CCR operator or by local intervention in the form of actuation of an emergency shutdown push button in the LCR of BSCS.

All ESD routines will be implemented and executed by the ESD control system integrated in PCS.

The emergency shutdown command will shut down and lock out all compressor units and close the station inlet and outlet valves, interrupting gas flow through the pipeline. If necessary, the station may be depressurised through the station venting system by appropriate action from CCR or LCR. The station can only be started again if the 'locked' condition no longer exists and the 'locked' condition has been acknowledged manually.

BSCS shutdowns are classified in levels from ESD level 1 to level 4, according to seriousness of the situation and risks to plant integrity.

Pipeline blow-down using BSCS venting system

A blow-down of the offshore pipeline is considered extremely rare, but is feasible using the BSCS station venting system. The following procedure could be adopted:

- The turbo-compressors at BSCS are stopped and the situation is assessed both at the CCR and the LCRs at BSCS and OPRT. If deemed feasible, delivering gas into the Spanish onshore pipeline system will be continued until the pipeline pressure will have reached a pressure of 45-50 barg.
- If still required, further pressure reduction would be possible by venting the remaining gas from the BSCS, and the receiving terminal in Spain, by opening the blow-down/outlet valves to the station vent system.

It is emphasised that a depressurisation of the offshore pipeline is considered improbable for the life or the project.

Risk and safety measures

Risks on the compressor station are associated with fire and explosion. All systems of the station are designed for safe operation, meaning the system shall be brought to a safe operating condition.

Measures to ensure a high level of safety consider:

- Access to the station premises is restricted by fencing and video monitoring, and in an emergency gates are provided for rapid exit from the station.
- Compressor units are installed with pressure monitors, shut down valves, venting in enclosure roofs, and control of unstable operation.
- Gas turbines fuel gas supply can only be opened after ignition is confirmed, fuel gas pipes include shut-off devices for vent line, and gas turbines are with air venting through exhaust system before the ignition.
- Machine enclosures are made with safe distance to other buildings, use of low-flammable materials, design in compliance with safety regulations, venting by natural and forced ventilation, gas detection system, flame detection system, fire alarm system, and fire extinguishing system for the machine housing.
- Electrical facilities contemplate definition of hazardous areas subject to explosion risk, stand-by power supply with automatic switchover, emergency illumination, and emergency cut off at the main entrance, in the control room and the emergency exits.
- Safety and protection systems on process equipment are with pressure limitation system for station and compressor pressure, and for pressure pipes and vessels, speed limitation for turbines, temperature monitors at compressor outlets and at cooler outlets, gas detection system with automatic switch off of machine units and shut off and depressurisation of gas pipes in machine room, fire alarm system with switch off of forced ventilation system and closure of automatic fire dampers, emergency

switches which further to the gas detection actions also automatically closes station inlet and outlet valves.

Before commissioning the station is inspected with regard to leakage, pressure shut-off fixtures, pressure regulators, pressure vessels, functionality, documentation and start-up procedure.

Operation of the station is subject to instructed and trained personnel, stand-by service for faults, preparation of alarm and fire protection plans, regular inspection of the gas-containing components, maintenance and repair work in compliance with the manufacturer's specifications.

Fire protection and gas detection systems are installed:

- Fire protection systems in turbo-compressor unit enclosures, fuel gas conditioning unit, vent stacks, main control building, electrical substation, and outdoors at buildings.
- Gas leakage detection systems in turbo-compressor unit enclosures, fuel gas conditioning unit, and externally around compressor enclosures.

Auxiliary processes

Fuel and starting gas conditioning units and their operation
The main purpose of these units is to supply pre-heated fuel and starting gas to turbines (compressors and power generator). The units will consist of the following parts:

- Fuel and starting gas-conditioning unit for turbo-compressors.
- Fuel and starting gas-conditioning unit for the power generator.

The fuel and starting gas conditioning units will be based on self-regulated pressure control valves, self-actuated block valves and gas turbine meters. The initial pressurisation will be performed locally and manually actuating over the inlet and outlet block valves.

These units will include local control panels, which will collect the main equipment status, alarms and measure flow, pressure and temperature. Local control panels will be connected to the station PCS.

Valve actuation
Actuation of station valves and compressor units valves is to be performed with pneumo-hydraulic actuators, incorporating a "fail-safe" mechanism to those valves which should adopt a safety position in case of power failure or blockage. The rest of the valves are manually operated.

Lube oil system
This system has two underground storage tanks, for clean and dirty oil, each with a capacity equal to the lube oil volume of one compressor plus 20%.

Discharge of oil from the compressor is by gravity and filling by means of a set of gear pumps. The total volume of lube oil for the compressors is around 10 m^3. Oil change is at 1-3 years intervals.

Wastewater treatment
Oily water from the workshop is collected in a pit. Washing waters from the compressor area is sent to the same pit. The oily water is discharged to an oil separation treatment, with an API or TPS type settler. The treated water is subject to quality control and either recycled or sent to the rainwater collecting system. The maximum admissible content of oil in the treated water is 10 ppm.

Domestic water from toilets, showers, kitchen etc is sent to a treatment package, with septic tank and biological treatment, both installed underground. The treated domestic water is discharged to the oily water collection pit.

Domestic and industrial use water supply and distribution
Domestic and industrial water is provided from a system comprising an above ground reinforced concrete storage tank, water distribution pump, a hypochlorite injection system, with storage vessel and injection pump, for the domestic water conditioning, an elastic membrane type accumulation vessel, to maintain the piping networks under pressure, a domestic use water supply network and an industrial use water supply network.

The water for domestic use is not drinkable water, but for supply to toilets, showers and workshop.

A connection, with block valve and quick connecting device is provided for washing facilities locally to each compressor, filter, air-cooler and in the emergency power generator room.

Connections for irrigating green areas will be located around the station.

Utilities and auxiliary consumables

Consumption comprises gas, electric power, lubricants, and water for domestic purposes and fire fighting. Gas is used for turbo-compressors, turbo-generator, for starting gas and for valve actuation. Gas is released occasionally for station depressurisation in planned cases (flaring) and emergency cases (cold venting). Electric power is supplied to the terminal at capacity 2500 KVA.

The gas consumption for compressors is estimated around 210-270 Mm^3/yr in the first years of operation with one pipeline installed, and around 270-324 Mm^3/yr at full capacity with two pipelines installed. The gas consumption is dependent on the turbo-compressor manufacturer. The quantity of gas released for planned and emergency station depressurisation will be around 60,000 m^3/yr each. Requirements will be set to apply modern technology to

guarantee reduction of emission levels to the lowest practicable, and flaring of gas releases will be applied for planned station depressurisations for eg station maintenance. Only emergency releases will be cold vented to the atmosphere.

Quantities of gas, electric power and water consumption are indicated in *Table 3.7.*

Table 3.7 Utility consumptions

Consumable	Consumption
Turbo-compressors, flow stage 1 (10.5 BCM/yr), low scenario	210 Mm^3/yr
Turbo-compressors, flow stage 2 (16 BCM/yr), high scenario	324 M m^3/yr
Gas for valve actuation	30,000 m^3/yr
Starting gas for turbo-compressors	30,000 m^3/yr
Flaring of gas	60,000 m^3/yr
Cold venting of gas	60,000 m^3/yr
Electric power	2500 KVA
Water	800 m^3/yr

Lubricants are used for process equipment, pumps, valves etc.
Gas is used occasionally for the backup turbo-generator.

Occasionally chemical substances, glycol or methanol, may be applied for injection in case of hydrate formation in pipeline, but this is considered an unlikely emergency situation and storage of chemicals at the compressor station is not anticipated.

Noise

Noise from station machinery and equipment will primarily be from the turbo-compressors. All machinery and equipment is specified with a sound level intended to guarantee acceptable levels in accordance with applicable standards, at the station premises, at the station fence and at neighbouring areas or habitation.

The acceptance levels applied to machinery and equipment are specified to comply with ISO noise curves at a distance of 100 m, NR 45 (equiv. 54 dB-A-). The vent system shall comply with the ISO NR 80 (equiv. 86 dB-A-) at 100 m distance, or 115 dB(A) at restricted area fence (at 50 m distance).

Air

Emission quantities for various scenarios are sources of emission to the air as indicated in *Table 3.8* based on the consumption quantities in *Table 3.9.*

Table 3.8 Flue gas and Ngas emissions

Source	Flue gas	N gas
Turbo-compressors, low	2,500 Mkg/yr	
Turbo-compressors, high	3,900 Mkg/yr	
Venting, flare	715,000 kg/yr	
Venting, cold		60,000 m^3/yr
Starting gas for turbo-compressors		30,000 m^3/yr
Gas for valve actuation		30,000 m^3/yr

Table 3.9 Gas composition

Component	Molar Percentage (%) Average gas composition
Methane (C1)	84.00
Ethane (C2)	9.21
Propane (C3)	2.24
I-Butane (i-C4)	0.26
N-Butane (n-C4)	0.35
I-Pentane (i-C5)	0.06
N-Pentane(n-C5)	0.05
Hexane +	0.04
Helium	0.10
Hydrogen	0.00
Nitrogen	2.57
Carbon dioxide	1.13
Molecular weight (kg/kg-mol)	18.92
Density (kg/Sm3)	0.800
Gross calorific value (Kcal/Sm^3)	9950
Water content (ppm)	40

Waste

Waste generated at the compressor station includes dust and condensate from filters, and domestic waste generated by the personnel at the terminal. The filters are cleaned or exchanged regularly. Minor quantities of used lubrication oil will be generated.

3.2.7 Decommissioning

The MEDGAZ transportation system is designed for a lifetime of 50 years. The plant may over the years be modified and upgraded and various measured may be taken to increase the life expectancy of the plant – if found economically advantageous. However, at some time in the future the plant will be obsolete and shall be demobilised.

The plant and equipment will be dismantled or cut in manageable sections, wiring and electronic boxes are removed and handled in accordance with the

above, and finally the items – predominantly steel sections – are carted away for reuse or reprocessing.

Building structures, including pits and culverts, and paved surfaces on the site are demolished and the used building materials are transported to an approved waste disposal site.

Finally, the area is reinstated by contouring the site to its original slope and undulation, and any scrubs and vegetation is planted. The reinstatement will be planned and drafted in co-operation with the relevant authorities, whose approval shall be in hand prior to commencement of any fieldwork.

A few years thereafter, the site should appear to be mingling with the general landscape, and any traces from past operations by MEDGAZ would be hard to detect.

3.3 DESCRIPTION OF THE PIPELINE

3.3.1 Introduction

The proposed pipeline system has been designed to transport natural gas at a maximum operating pressure of 250 barg. The pipeline will be of welded steel construction, with a nominal diameter of 24-inches. Externally, the steel will be protected by a polypropylene anti-corrosion coating. The parts of the pipeline nearest to the shores, down to depths of 250 m will also have an outside coating of reinforced concrete to provide stability and extra protection.

The system may be considered in terms of the three main categories of terrain in which the pipelines will be installed:

- **The onshore sectors**, from the so called "last dry weld", at the water's edge, to the Reception Terminal in Spain or Compressor Station in Algeria. In Spain the length of this sector is estimated to be circa 4.5 km while in Algeria it will be much shorter, around 1.0 km.
- **The shore approach sectors,** the Spanish shore approach extends from the Land Termination End (LTE) to a water depth of 30 m, a distance of approximately 1.3 km. In Algeria the shore approach extends from the LTE to a water depth of 20 m, also a distance of approximately 1.3 km.
- **The offshore sector,** the entire length of approximately 200 km, between depths of 30 m and 20 m off the Spanish and Algerian coasts respectively.

In the onshore and shore approaches sectors the pipeline will be buried. However, through the much longer offshore sector it will largely be laid on the seabed without any intervention. The exceptions being in some relatively short sections where correction will be required to prevent free-spans between high points on the seabed or to protect against geo-hazard and fishing activity risks.

Onshore and shore approaches sectors and near offshore sectors will include two parallel 24-inch pipelines, termed East and West. The East Pipeline is planned to be fully constructed approximately by the end of 2006. The onshore and shore approach sectors of the West Pipeline will also be installed co-incident with the initial construction of the East Pipeline, in order to avoid subsequent repetition of the onshore and near-shore disturbance.

The East onshore, shore approach and near offshore pipeline sections will connect to the East offshore section to complete the current development pipeline system.

The West Pipeline will be completed in 2012, by laying the offshore section and tying it into both ends of the previously installed shore approach sections.

3.3.2 Construction Strategy

Following the on-going Front End Engineering Design (FEED) phase, the project will be further developed by way of an Engineering, Procurement, Installation and Pre-commissioning (EPIC) contract awarded to a suitably qualified EPIC Contractor.

As part of their EPIC Contract responsibilities, the Contractor will be obliged to consider the requirements of third parties, the activities and impacts outlined in this Environmental Statement, the requirements for mitigation and monitoring, results of site investigations and any further conditions required by the National and Local Authority Development Consents. The EPIC Contractor will be required to produce a Project-specific Environmental Management and Monitoring Manual, to ensure that any effects of pipeline installations are minimised.

The EPIC Contractor will also be required to prepare detailed method statements covering construction activities such as landfall construction, road, river and service line crossings, pipeline installation, anchoring, dredging, dumping, pre-commissioning and waste management. These will be subject to approval by nominated design engineers and agreement with the relevant statutory consultees.

The EPIC Contractor will be audited to ensure that its operations are in accord with the approved method statements and the Environmental Management and Monitoring Manual.

3.3.3 Schedule of Work

The tentative date for start of construction is the third quarter of 2006. An indication of the envisaged time periods for each of the major activities is given in the bar chart below. The final, specific construction schedule will be

dependent on various technical and contractual matters and will take into account environmental and socio-economic factors, such as the times of sensitive wild fowl nesting and beach usage, as discussed in detail in the later chapters of the document.

Table 3.10 Pipeline Tentative Construction Schedule

Activity/ Month	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13	M14
Spanish Onshore														
Algerian Onshore														
Spanish Shore Approach														
Algerian Shore Approach														
Offshore Pipe Laying - Shallow Waters, Spain and Algeria														
Offshore Pipe laying Deep Water														
Intervention Works - Trenching/Cable Crossing/ Freespans/Rock Dump														
Testing/Pre-Commissioning Onshore														
Testing/Pre-Commissioning Offshore														
Available for First Gas														

It is anticipated that the completion of the West Pipeline will take place by 2012.

3.3.4 Onshore Construction

Land-take

During construction, normal usage of the land within the work strips in Algeria and Spain will be suspended. These work strips will have a nominal width of 30 m, to allow excavation of the trench, stock-piling of the earth, welding together of the pipeline sections, accommodation of the welded pipelines pending their burial in the trench and, at the same time, free movement of all the machinery and works vehicles, as shown in *Figure 3.7*.

To facilitate safe construction practices, restricted areas will also be required at the landfall and where the work strip crosses roads and rivers. The land take for these areas is summarised in *Table 3.11.*

Table 3.11 Land-take dimensions

Type of Works	ALGERIA			SPAIN		
	No.	Length x width (m)	Area (m^2)	No.	Length x width (m)	Area (m^2)
Landfall	1	30 x 20	600	1	30 x 20	600
River crossing	1	40 x 35	1400	1	100 x 35	3,500
Paved road crossing	0	0	0	2	20 x 30	600
Unpaved road crossing	1	20 x 30	600	15	20 x 30	600

After construction and during subsequent operation of the pipeline, a 12 m wide part of the work strip will be retained as a permanent right-of-way (ROW), to accommodate the pipeline separation and provide nominal clearance on both sides of the pipeline (See *Figure 3.8*). It will be used as a running track for periodic inspections and for the equipment in the event that maintenance or repairs are necessary.

The two river crossings, which involve only intermittent seasonal flows, will be by open cut method as for the rest of the pipeline. Two dykes will be built on either side of the work strip to temporarily block off the water, and after some drying, the pipeline installation will proceed. Hence the width of the work strip for the river crossings will be 35 m.

The paved road crossings will be facilitated by auger boring methods, so that public use of the roads will not be interrupted. Two pits (approx. 20 m long x 4 m wide x 2 m deep) will be required on either side of the road, but these will be within the 30 m work strip.

Crossings of the unpaved roads will be by the open cut method and hence will be within the normal work strip.

The land fall installation may be by shore pull, with the winch and related equipment installed on the beach front, or by an offshore pull where a return sheave and anchorage is installed on the beach and the winch pull is from offshore barge (see *Figures 3.10a* and *3.10b*).

When construction activities are complete, the work track will be reinstated as near as practicably possible to its former condition. All disturbed land, vegetation, walls and other structures will be restored.

Within the operation phase 12 m wide ROW, MEDGAZ will have the right to survey, maintain, and repair the pipelines. This will not generally affect the existing land use, although conditions are usually agreed in order to prevent damage to the pipeline and the installation of obstacles that could hinder urgent repair of the pipeline. Typically such restrictions preclude the planting of deep-rooted trees and erection of buildings. Any restrictions will be fully discussed and agreed with the landowners and occupiers; agreements will be established as part of the acquisition process.

Working Corridor Preparation

Before starting any construction work, topographic and photographic records will be made of the existing condition of the pipeline route and the access roads. These records will be used as the standard against which the quality of the restoration work will be judged when the construction work is completed.

The exact route of the pipeline will first be pegged out, while simultaneously staking out the width of the work strip on both sides of the route.

Obstructions such as walls, fences and paths will be disturbed to the minimum amount necessary for safe working. Wall material will be carefully dismantled and stored for reuse.

Records of buried facilities such as drains and irrigation pipe locations will be prepared and passed to the landowner/user.

Existing third party services will be located, marked, and either safeguarded or diverted. Warning posts will be erected for overhead cables, and temporary crossing points clearly identified.

Perimeter Fencing

The temporary work strip will be fenced to prevent people and animals gaining access to the site. Where necessary, and in consultation with the landowner/user, access points will be provided to allow safe passage across the work track.

Where any walls or fences need to be removed, particularly alongside roads and tracks, temporary gates will be installed to ensure that access can not be gained to the work site. This will help ensure public safety.

Topsoil and Vegetation Removal

Prior to topsoil removal, any native plant species of special importance will be gathered in sufficient numbers to be used for the reinstatement work after the pipeline has been laid.

Topsoil, which supports plant life and contains seed stock, will be removed from the work strip by suitable earth moving equipment, and stockpiled in the form of a continuous ridge along the edge of the strip. The topsoil stockpile will be typically no higher than 2m to prevent depredation of the soil, the stockpile will be kept free from disturbance to reduce the possibility of physical damage and compaction.

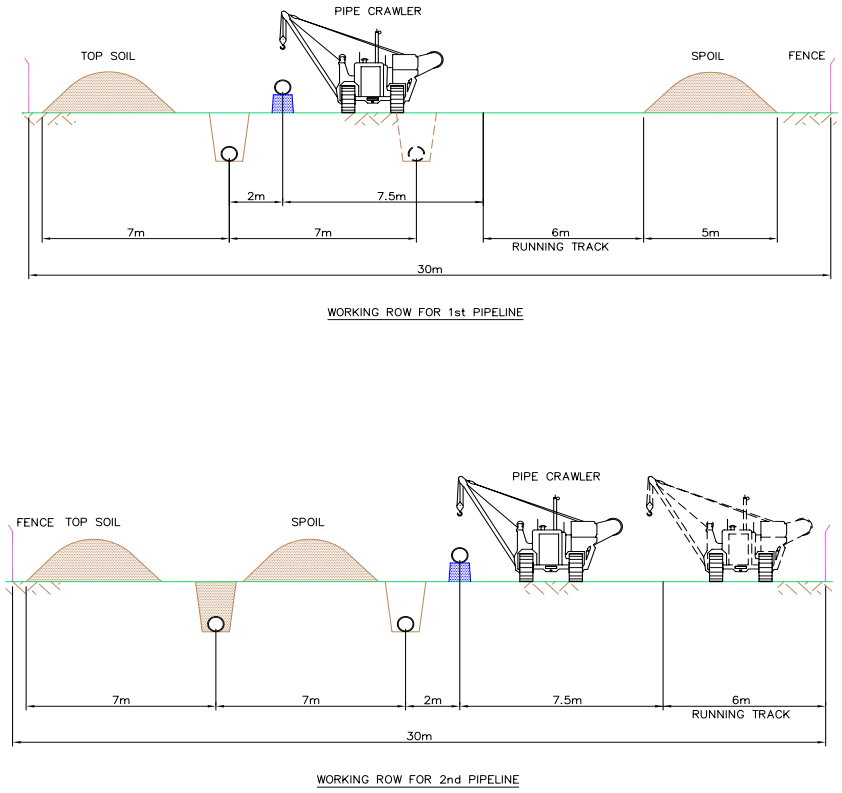
The work strip will then be made level, using typical construction site machinery to eliminate irregularities, large stones, tree stumps and other features.

Trenching and Boring

The East and West pipeline sections will be installed in separate, parallel trenches to achieve a nominal centre line separation of distance of 7 m. The trenches will be excavated using mechanical excavators straddling or running alongside the pipeline trench. The trench depth will be sufficient to allow a minimum pipeline burial depth (cover depth) of 2m within the beach areas and at road any river crossings. Outside of these areas a minimum burial depth of 1.2 m will be achieved.

The soil excavated from the trench will be stockpiled in the same way as for the topsoil, but will be stored on the opposite side of the work strip to prevent mixing of subsoil and topsoil.

Figure 3.8 Illustration of the Pipe-laying process



Pipe Haul and Fabrication

The pipes will be transported to the site from the pipe yard along the existing roads. On the Spanish side, one or more access roads will be chosen to transport the pipes from the ALP 202 (E340) main road to the work strip. These access roads will be existing, un-surfaced Park roads, which will be selected after the construction contractor has been chosen. Before selecting the access roads a study will be performed to minimise adverse effects on the local traffic.

From the access roads, all further transport will take place within the work strip, which will have several access points where it intersects the Park roads. The work strip and Park roads will be re-instated to their original condition on completion of the construction work.

The pipes will be supplied in single 12 m joint lengths and be distributed along the work strip using heavy machinery that can transport several pipe

lengths at the same time. All pipes will arrive in a pre-coated condition, externally with a polypropylene anti- corrosion coating and internally with an epoxy flow coating.

Following alignment, they will be joined together using both automatic and manual welding equipment that travels along the length of the pipeline. The process is carried out inside a mobile shelter that covers the section that is being welded and the people carrying out the work, thereby controlling the environment under which the weld is made. All welds will be subject to non-destructive examination (NDE) prior to application of the field joint coating.

Pipeline Lowering

Following weld NDE and field joint coating of the welds, the joined pipeline sections will be carefully laid in their individual, parallel trenches. This operation will be completed using side boom tractors in a continuous operation.

In rocky or uneven ground where the potential for pipe coating damage exists, the trench bottom will be given a protective 200 mm bed of sand.

Backfilling

The pipe trench will be backfilled in the reverse order in which it was excavated, and where possible, using the same soil that was taken from the trench. In areas where the backfill material is deemed likely to damage the pipe coating due to the presence of rocks or stones, sand will be used to protect the pipeline.

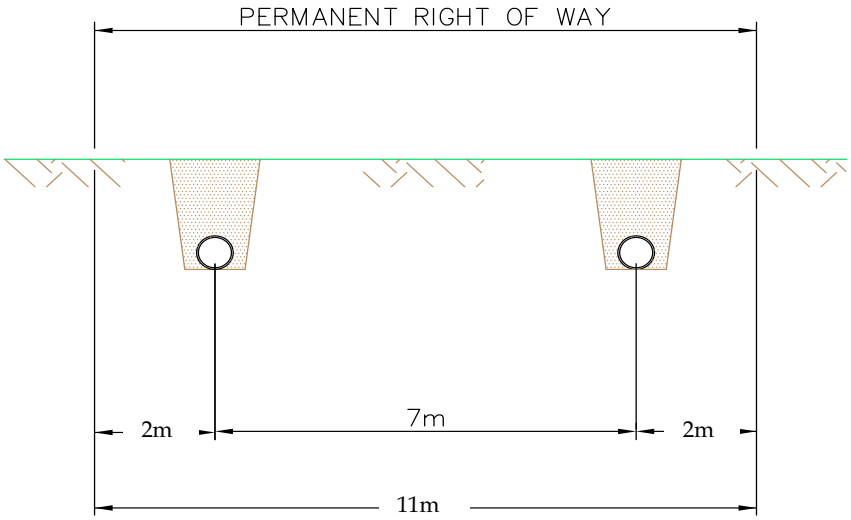
During the burial process, a brightly coloured plastic warning tape will also be installed above the pipelines, along the entire length of the trench at a depth of 0.6 m, in order to provide warning in the event of future excavations in the area.

At points where the pipeline crosses established tracks or rivers, it will be given the extra protection of an over-lying concrete slab. See previous section on special crossings.

Any severed water pipes will be reinstated across the trench as part of the backfilling process.

Backfilling will be completed by covering the trench with topsoil from the previously established stockpile. To minimise damaging exposure of the excavated soils while they are in storage, the trench will be back-filled as quickly as possible after each pipeline section is installed, so creating a single, continually advancing work-front.

Figure 3.9 Illustration of Twin Pipeline System after Backfilling



It will not be possible to return all the originally excavated material to the trench because of the volume taken up by the pipeline itself, so some will need to be either disposed of or, most likely, incorporated into landscaping initiatives. On the Spanish side, an upper estimate of this surplus material is 4,000 m^3. In Algeria, the figure is estimated to be circa 1,500 m^3.

Reinstatement

After re-grading of the work strip to reflect the original ground profile, it will be de-compacted using bulldozers to spike and drag the soil in all directions, followed by spreading of the remaining topsoil over the entire surface. Large stones and debris will be removed prior to topsoil replacement.

The plant cover will be restored on the affected land by means of planting, seeding or hydro-seeding of native species, including the species of special importance gathered from the track before the start of the construction work. (See later chapters).

The final step in the restoration process will be the reconstruction of walls, fences and other such features that may have been affected by the works.

After re-instatement, the area will be monitored and maintained, as required, over a five year period until normal growth patterns are re-established.

Pipeline Markers

After re-instatement, the only visible evidence of the pipeline will be marker posts placed along the route for future monitoring and line walking purposes. The posts will be installed at a maximum distance of 250 m to 300 m, depending on the type of terrain. Each marker will have line of sight to its

previous and following marker. A marker will also be installed wherever there is a change of direction.

3.3.5 *Shore Approach Construction*

General Overview

The shore approach sector is the route section between the areas where normal onshore pipeline installation techniques and normal offshore pipe lay techniques can be applied. Special pipe installation techniques are, therefore, needed for use in the shore approaches.

The distances over which these special techniques will be applied are dependent on the seabed profile and prevailing environmental conditions. The Spanish shore approach extends from the LTE to a water depth of 30m, a distance of approximately 1.3 km. In Algeria the shore approach extends from the LTE to a water depth of 20m, also a distance of approximately 1.3 km.

Site Preparation

Before starting any excavation work, topographic and photographic surveys will be carried out to determine the state of the coasts, the access roads and seabed. Their main purpose will be to establish records against which the site restorations will be judged when the construction stage is complete.

A temporary security fence will be installed around the perimeter of the onshore work area to prevent the entry of unauthorised persons. Universal signs will be erected to raise awareness of the hazards.

The topsoil will be removed from the excavation zone and stockpiled separately from the other excavated materials, so it can be re-used for site restoration work, in a similar manner to that already described above for the land sectors of the pipeline.

Materials will be transported to the site using the same arrangements as described previously for the land sector construction work. However, for these shore approaches sectors, maximum use will be made of the sea route for delivery of the larger items, to reduce road traffic impacts.

An area at the inland end of each shore approach will be levelled for installation of an anchorage, together with a return pulley or winch, dependent on which type of cable system will be used for pulling the pipeline ashore.

A construction safety zone, demarcated by buoys, will be established during dredging and pipeline installation. The EPIC Contractor will liaise with the appropriate authorities and area users, e.g. fishermen, to ensure that vessels are aware of the construction activities.

Dredging

To protect the pipelines against the effects of the sea and human activities close to the shore, they will be buried to varying depths of cover, dependent on the seawater depth. The burial depth will be achieved by forming a dredged trench, prior to installation of the pipelines. The profile of this pre-dredged trench will be as follows:

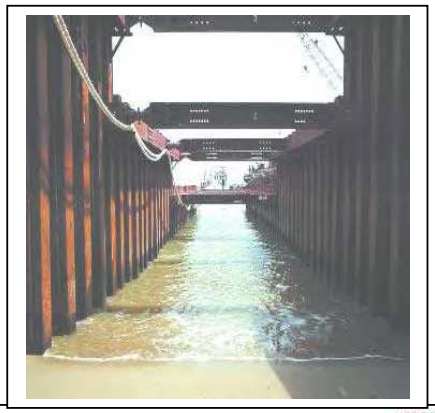
- For water depths of 10 m and shallower, the pre-dredged trench will be of sufficient depth to provide a minimum burial depth (depth of cover) of 2 m.
- Between 10 m and 20 m water depths a minimum burial depth of 1m will be achieved.
- Then, from 20 m depth, the 1 m cover will gradually reduce to zero at the 30 m depth.

To provide the required burial depth, and accommodate the necessary side slopes, pre-dredged trench widths of up to approximately 28 m are anticipated.

Trench excavation for the onshore sections of the shore approach will be performed in the same way as that described previously for onshore pipeline sectors.

Near shore trenching will be completed using dredging techniques. Trailer suction hopper or cutter suction dredging is expected for water depths in excess of approximately 3m. Onshore equipment will be required for the very shallow water depths of less than 3m. Because of the vigorous wave action in this very shallow band of water, it will also be necessary to install a temporary sheet pile cofferdam, circa 50 m in length, to protect the trench against natural backfill by waterborne sediments and prevent the creation of a suspended sediment plume along the coast. It will be in place on the Spanish side for about three months and on the Algerian side for four and a half months. The longer period on the Algerian side is due to the necessary scheduling of the marine equipment. The construction of a typical cofferdam is illustrated by the photographs below:

Figure 3.10 Illustration of a Typical Cofferdam Construction



The estimated total volumes of dredged material are shown in the table below:

Table 3.12 ***Estimated Volumes of Dredged Material from the Shore Approaches Works***

Country	Depth Range (m)	Volume (m^3)
Spain	0 -30	85,000
Algeria	0 - 20	65,000

Material removed from the trenches will be stockpiled within a designated seabed storage area for re-use in restoring the seabed to its natural condition after the pipeline is installed. Final stockpiling locations will be confirmed following consultation with local authorities. As a minimum, however, the stockpiling locations will be sufficient distance away from the areas of the sea grass discussed in detail in *Sections 5* and *6*.

Pipeline Installation

Following completion of the trench, pre-coated pipes are assembled on a lay-barge anchored typically 1.5 km to 2 km offshore. Pipe coating for the shore approach sections include; an external polypropylene anti-corrosion coating, a concrete outer coating for stability and protection, and an internal epoxy flow coating.

Following alignment, the pipes will be joined together using automatic welding techniques and pulled ashore using either land-based or vessel-based winches. All welds will be subject to non-destructive examination (NDE) prior to application of the field joint coating. Welding, NDE and field joint coating will be carried out by qualified staff employing approved processes and procedures.

This process is repeated until the pipe string has been pulled through the pre-dredged trench to a location suitable for connection to the onshore pipeline section.

Figure 3.11a Layout for Pulling the Pipeline Ashore using a Barge-mounted Winch

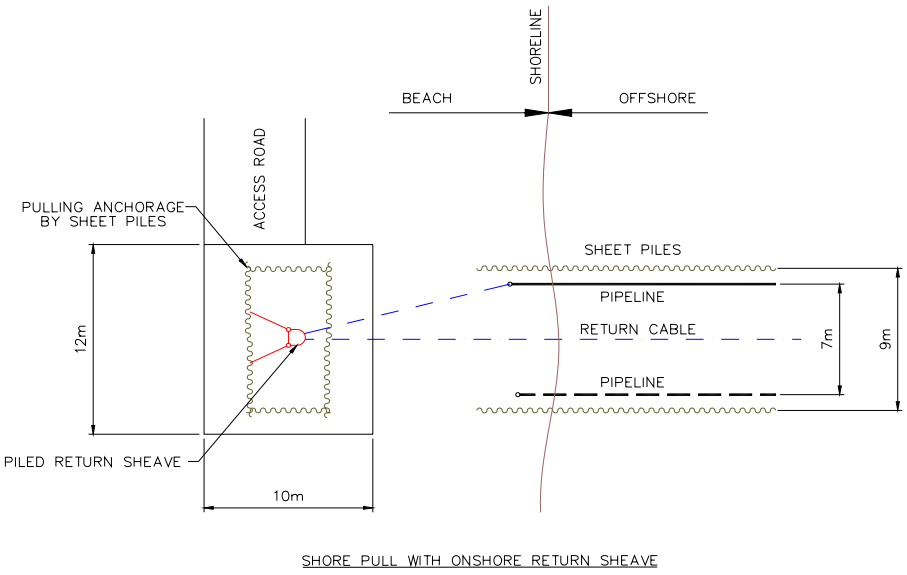
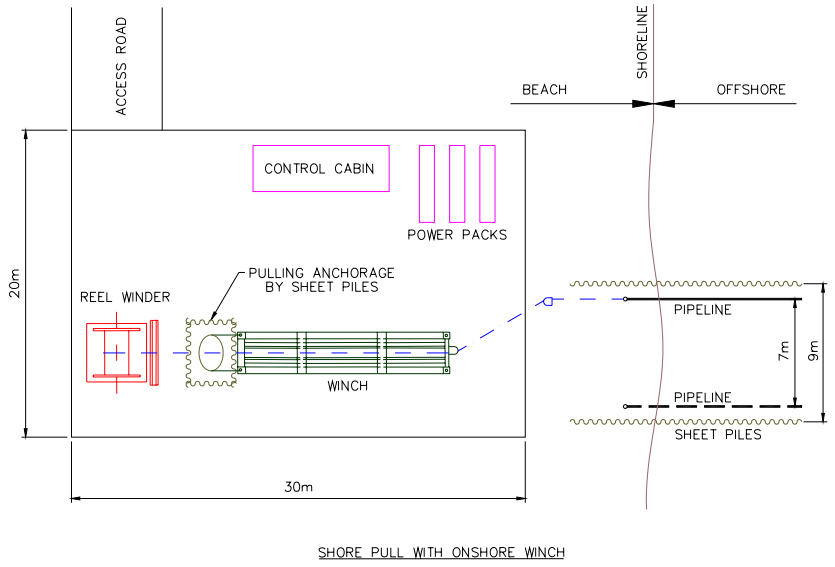


Figure 3.11b Layout for Pulling the Pipeline Ashore using a Beach-mounted Winch



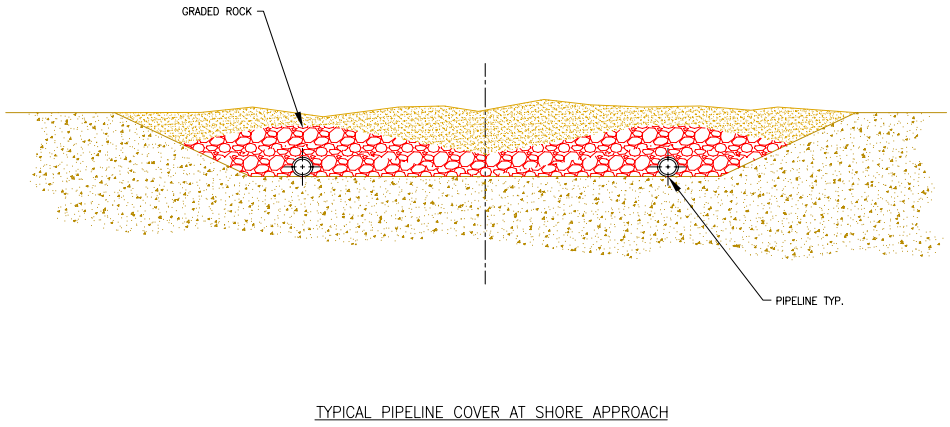
Backfilling

In general, the pre-dredged trench will be backfilled using the previously stockpiled materials.

For water depths less than 20 m, the trench will also include a graded rock/gravel armour layer to stabilise the pipeline in the event of future seabed mobility. The graded rock/gravel layer will have a nominal thickness of 1.3 m within water depths of 10 m and less, for water depths between 10 m and 20 m the nominal thickness will be 0.5 m. All sections of the trench will include

an upper layer of previously excavated material recovered from the sub-sea stockpile. The minimum thickness of this upper layer will be 0.5 m.

Figure 3.12 Illustrations of the Pipeline Backfill and Armouring Techniques to be used in the Shore Approach Sectors



Reinstatement

The onshore parts and the associated work sites will be returned to their original profile using typical mobile earth moving machinery, leaving the ends of the pipeline exposed, so that the regulatory hydrostatic tests can be carried out (see *Section 3.3.7*). The topsoil that was separately stockpiled at the outset of the works will then be re-laid across the sites.

Supervision of the final seabed relief and bathymetry restoration of the pipe trench and temporary storage areas will be performed using a remote observation vehicle (ROV) and a boat equipped with echo sounder equipment. Both this boat and the dredgers used in the works will be provided with a positioning system that allows them to work with the necessary precision.

3.3.6 Offshore Construction

General Overview

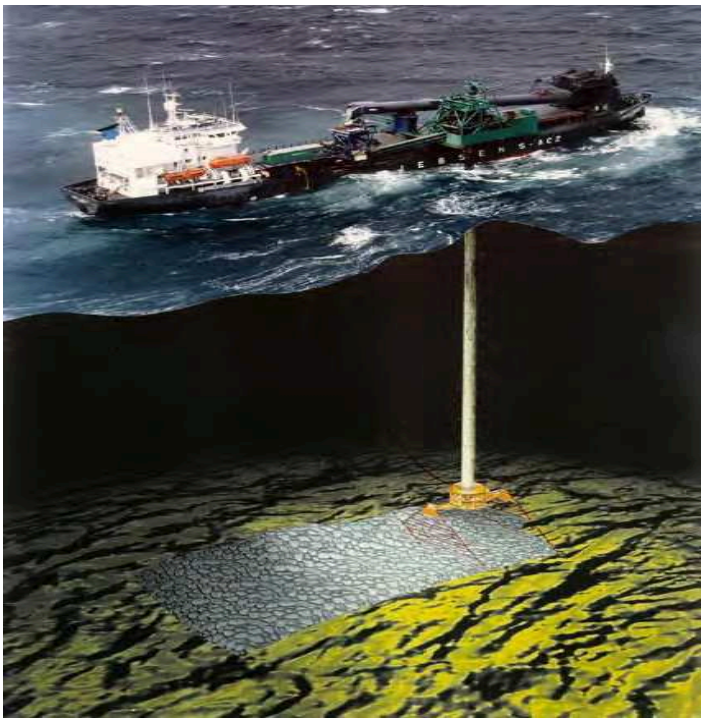
In the offshore sector, which is by far the longest, the pipeline will be laid on the seabed. This technique will avoid seabed disturbance over most of the 197 km sector. However, following installation of the pipeline, some intervention will be required in specific areas to limit pipeline free span lengths and to reduce possible interactions with fishing activities and a potential geo-hazard. Additionally, some extra stabilisation is required to control the displacements of the pipeline where it operates at elevated temperatures.

The type and extent of seabed intervention at the current state of knowledge is described in the following paragraphs.

Seabed Intervention

Rock dumping will be used for stabilisation where elevated temperatures are likely within the pipeline. That is in the section adjacent to the Algerian coast. It will involve the placement of rock berms to limit pipeline deflections. The berm length and spacing will vary with location, from between approximately 700 m and 240 m long, and with a spacing of between 1.5 km and 4 km. A total of 11 such berm locations are currently anticipated between the Algerian coastline and a water depth of 250 m. The total volume of rock required to complete these works is conservatively estimated to be about 80,000 m^3. The placement of all rock material will be subject to a licence from the local authorities. Accurate placement of rock materials will be assured through the use of fall pipe vessels, from which the rock is transported from the surface to just above the seafloor using suspended pipe sections, as illustrated in the diagram below. A post construction survey will be performed to confirm correct placement.

Figure 3.13 Illustration of the Rock Dumping Technique using a Fall Pipe



Trenching will be necessary for rectifying free-span sections of the pipeline route. It will be carried out by lowering the sections in question below natural seabed level using standard post-lay trenching techniques. The actual locations of the predicted free spans or shown in the table below:

Table 3.13 Locations of Predicted Free Span Areas on the Algerian and Spanish Continental Slopes

Country	Mid-KP(m)	Water Depth(m)
ALGERIA	70 793	1 320
	71 544	1 375
	71 621	1 385
	71 732	1 410
	71 859	1 435
	72 320	1 495
	73 455	1 595
	73 535	1 600
	73 620	1 605
	75 695	1 720
SPAIN	169 838	660
	169 913	655
	171 063	590
	171 510	570
	175 418	335
	175 993	285
	176 060	275
	176 868	220
	176 965	210

Trenching is also specified to lower a section of route which has been identified as a potential geo-hazard because it is subject to influence from a mud flow run out on the lower Spanish continental slope. The following table summaries the currently anticipated total extent of trenching required for free span correction, geo-hazard protection and, hence, mitigation of fishing interaction.

Table 3.14 Current Envisaged Total Extent of the Post-lay Trenching Requirements

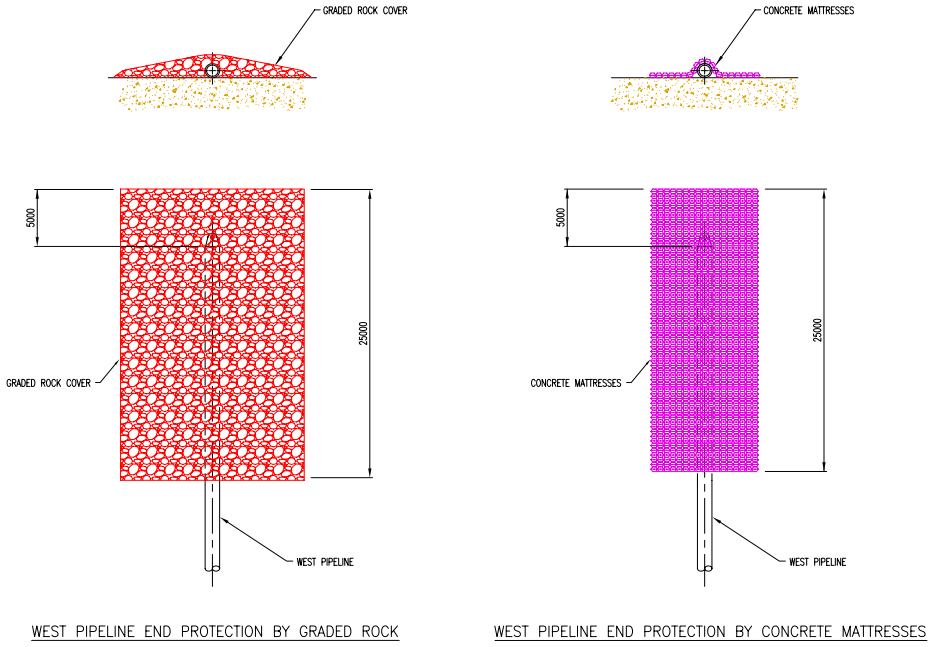
KP Range	Water Depth Range (m)	Purpose	Length (km)
70.8- 75.7	1320 - 1720	Free span correction by trenching	4.9
167.5 – 170.0	740 - 651	Geo-hazard mitigation and free span correction trench to 1m depth.	4.5

The exact extent of these post-lay seabed intervention measures may be adjusted during later design stages, and will be further reviewed after the pipeline has been installed and surveyed.

End protection will be required for the temporarily abandoned West Pipeline, which will be installed in water depths of 30 m and 51 m for the Algerian and Spanish end respectively. There are currently two options:

- Rock dump cover with 1m layer of graded rock extending 25 m along the pipeline and extending 5 m beyond the pipeline end.
- Articulated concrete mattress (thickness 300mm) lain over the pipe end, extending 25 m along the pipeline and 5 m beyond the pipeline end.

Figure 3.14 Illustration of the End Protection Techniques that will be used for the Temporarily Abandoned West Pipeline



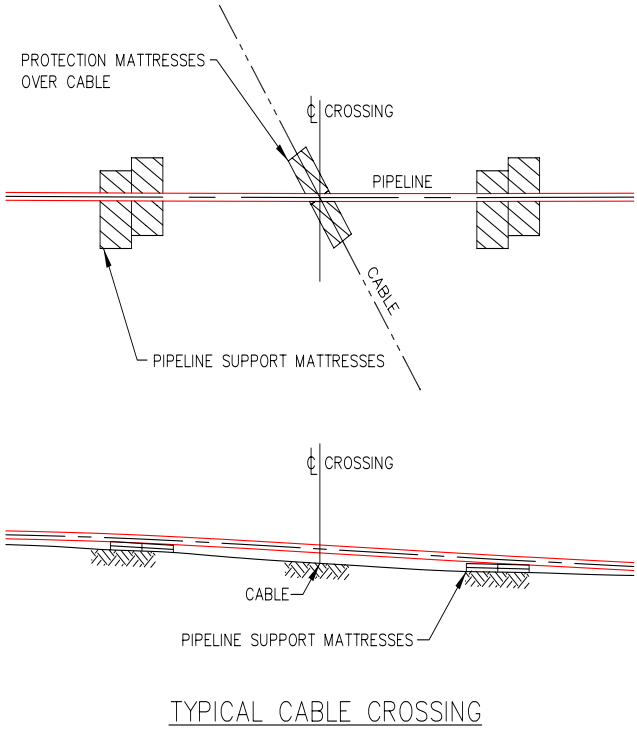
This temporary protection will be removed when the West pipeline is completed between Spain and Algeria.

Cable Crossings

The offshore pipeline will cross 18 cables. Five of these cables are currently in service. At out-of-service cables, the pipeline will be simply laid across the cable, no protection or separation measures will be installed. At in-service cables, pipeline supports will be installed on both sides of the cable, such that the pipeline will bridge across and not contact the cable.

Cable crossing support and separation will require the placement of two 0.45 m thick mattresses either side of the cable (Four mattresses for each crossing). A typical cable crossing configuration is shown in the figure below;

Figure 3.15 Illustration of the Cable Crossing Design to be used at the In-Service Cables



All in-service cables are in water depths greater than those anticipated for fishing. (i.e.>1000 m).Therefore, additional measures to avoid interaction with fishing activities, such as cable crossing support correction, are not necessary.

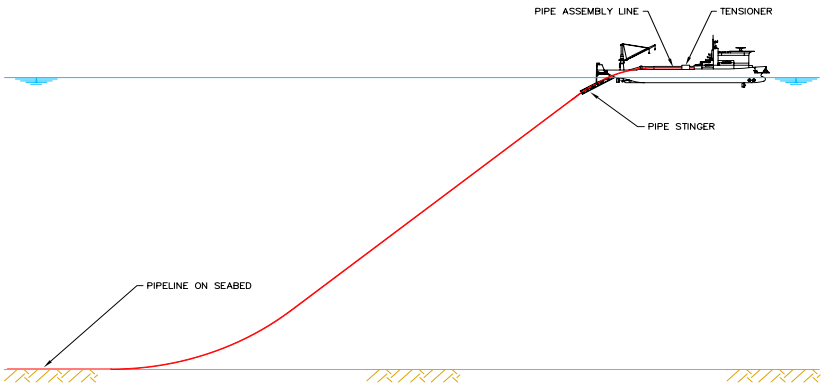
Offshore Pipe-laying

Offshore pipe-laying is accomplished by the sequential alignment, welding and lowering of pipe from special installation vessels. Pipe sections are transported to the installation vessels pre-coated externally with polypropylene anti corrosion coating and internally with epoxy flow coating.

Following alignment, the sections are joined together using automatic welding techniques and lowered under tension to the seafloor. The welds will be subject to non-destructive examination (NDE) prior to application of the field joint coating.

Offshore pipe-laying may be performed by the S-lay technique, or by a combination of S-lay and J-lay techniques. For S-lay, the end of the pipeline on board the pipe-laying vessel is held in an almost horizontal position, so that the pipeline is deployed behind the vessel in a vertical S-curve. For J-lay, the end of the pipeline is held in a near vertical position, so that the pipeline is deployed below and behind the vessel in a J-shape to the seabed.

Figure 3.16 Illustration of the "S-Lay" Technique



TYPICAL S-LAY CONFIGURATION

For the majority of pipe-laying work the vessel will be manoeuvred along the route using dynamic positioning (DP). DP is a system that uses vessel thrusters to maintain position without the use of anchors. The use of DP will avoid the potential to form anchor troughs and mounds that can interfere with fishing activities.

Anchoring may be used for the shallow water installation, ranging from approximately 250 m depth to shore, although this depends on the installation vessel. Typically, an anchored vessel deploys 8 to 12 anchors in a semi-circular pattern in the fore and aft position, generally from its four corners. The anchors are used for stabilising the vessel and for pulling it forward during the pipe-laying operations. They will extend a distance of two to three times the water depth, depending on environmental and pull force requirements. Anchor handling tugs are used to pick up each anchor and reposition it in a pre-established location, winching in of the anchor cables controls vessel movement.

Dewatering Spread

A dewatering spread, with an associated pigging station, will be installed adjacent to the Reception Terminal site in Spain, for two purposes:

1) De-watering the pipeline in case of a "wet buckle" during the deep-water pipeline installation, and
2) The final hydro static pressure testing and de-watering of the pipeline, as described in section 3.7.

The package must be sufficient to overcome the hydro static head of water and generate adequate flow rates. The size of such an installation is, therefore, very considerable, typically involving about fifty normal construction site compressors, delivered on flat bed trailers. However, all the compressors will

have four-stroke diesel engines that are of an up-to-date design, to ensure that they are compliant with the recently introduced changes to the United States emissions regulations. A typical spread is illustrated in the photograph below:

Photo 3.3 Illustration of a Typical De-watering Compressor Spread

The equipment will be present at the site for about eleven months for contingency purposes during offshore pipe laying operations. However, it will be operational only for a limited period during any contingency event and during the normal de-watering operations on completion of the pipeline.

If contingency de-watering is required, it would be a continuous process requiring up to circa 7 days for completion. Normal de-watering and drying operations, as part of system pre-commissioning, will take approximately 10 and 20 days respectively.

Offshore Pipeline Tie-in

Following installation of the offshore sections, the two ends of the pipeline will need to be joined offshore Algeria (tied-in). The tie-in will be performed using a davit lift method in a water depth of approximately 20m.

The davit lift method involves lifting of the two pipeline ends clear of the water to enable a dry welded connection. The weld will be subject to NDE prior to application of the field joint coating and careful lowering of the connected pipeline back to the seabed.

3.3.7 Testing and Commissioning

Flooding and Hydrostatic Testing of the Onshore Pipeline

The short onshore pipeline sections in Spain and Algeria will be flooded and tested separately prior to subsequent connection to the offshore pipeline.

The pipelines will be flooded with fresh water (132 m^3 in Algeria, and 830 m^3 in Spain), to avoid concerns with onshore handling and disposal of chemically treated or salt water. On completion of the flooding, the pipelines will be hydrostatically tested to demonstrate their integrity. The test pressure is defined in accordance with Algerian and Spanish regulations, i.e. 1.4 x design pressure in Algeria and 1.5 x design pressure in Spain. The pipeline will be continuously monitored during a 24-hour test period to detect any reduction in pressure due to leaks.

Following successful testing the pipeline sections will be de-pressurised and de-watered, to allow the tie-in to the offshore pipeline ends.

Flooding and Hydrostatic Testing of the Offshore Pipeline

Prior to hydrostatic testing, the pipeline will be flooded with filtered, chemically treated seawater (46,700 m^3) abstracted from the sea on the Algerian side. The filter will remove all particles above 50 microns diameter, to ensure that the majority of suspended matter is prevented from entering the pipeline. Oxygen removal, by the addition of a chemical oxygen scavenger, is recommended to prevent internal corrosion. The addition of biocide is also recommended to prevent development of harmful marine organisms inside the pipeline. These treatment chemicals and their concentrations will be selected during the EPIC stage of the project. However, all chemicals will be selected on the basis of lowest feasible toxicity and maximum feasible bio-degradability.

The flooding operation will be carried out by launching a train of pigs (pipeline integrity gauges). These are devices designed to fit inside and travel along the pipeline. The pig train will typically comprise two cleaning pigs followed by two pigs fitted with gauge plates. Filtered untreated water will be pumped ahead and between pigs. The train will be propelled from behind at a rate of between 0.5 m/s and 1.0 m/s using filtered, treated water.

The volume of untreated water ahead and within the pig train will be received, collected and disposed of in a controlled manner offshore, using an existing dedicated dump line. Storage and handling will take account of all applicable environmental legislation and consider appropriate protection against spillages, such as impermeable ground cover and the use of containment bunds.

On completion of flooding, the pipeline system will be hydrostatically tested to demonstrate its integrity. The test pressure is defined in accordance with

DNV FS-101 Design Code requirements, i.e. 1.1 x design pressure. The pressure will be continuously monitored during a 24-hour test period to detect any reduction due to leaks.

On completion of the test, the water will be removed from the pipeline using a pig train propelled by dry air from the same spread of compressors, installed on the Spanish side for contingency use in the event of a "wet buckle" during pipe-laying (*Section 3.3.6*, *Dewatering Spread*). The de-watering flow will, therefore, be from Spain to Algeria. The pig train will typically contain at least eight high seal bi-directional batching pigs.

Discharge will be at the Algeria end of the pipeline, initially into reception settling tanks, and then into the sea via the line previously installed for abstraction of the water. It will be performed in a controlled manner according to local authority approvals. Alternatively, consideration could be given to utilizing the West pipeline onshore/nearshore sections as the de-watering dump line in Algeria, provided the location and depth of the discharge by this method would comply with the local authority requirements.

After removal of the test water, the pipeline will be depressurised to atmospheric pressure.

This dewatering process will be continuous, and will take up to approximately 10 days, followed by about 20 days pumping only air for the purpose of drying.

Pre-commissioning

After de-watering, the pipeline will be dried to ensure the gas initially entering the Spanish transmission network will be compliant with the specified limit for water content and to prevent the formation of hydrates. This drying will be achieved by passing dry air through the pipeline to evaporate the remaining free water. It will take up to 20 days and will use the existing compressor spread. The pipeline will then be filled with nitrogen so that there is no potentially explosive interface with air when the natural gas is subsequently flowed into the pipeline.

Commissioning

The pipeline will be brought into service, by the introduction of gas from Algeria, only after all control and monitoring systems have been commissioned at both ends of the pipeline.

3.3.8 Safety

Pipeline Design

The pipeline system has been designed in accordance with relevant design codes and National Regulations. Design code and regulation requirements differ for the short onshore sections within Algeria and Spain where National Regulations apply, and for the offshore section where international codes are applicable.

The code break between onshore and offshore is taken as the first dry weld above the high water mark, designated the LTE. However, in order to provide additional levels of safety through the beach and near shore areas, applicable onshore code requirements have also been applied to the initial 100m at each end of the pipeline.

The primary international design codes and National Regulations applied during pipeline design are as follows,

International Design Codes,

- DNV OS-F101 "Submarine Pipeline Systems, Jan 2000" (Offshore).
- ASME B31.8 "Gas Transmission and Distribution Piping Systems, 2000" (Onshore).

National Regulations,

- "Reglamento de redes y acometidas de combustibles gaseosos" (Onshore Spain).
- « Règles De Sécurité Pour Les Canalisations De Transport De Gaz Combustibles » (Onshore Algeria).

The materials used and wall thicknesses have been selected to ensure that design factors (safety factors) specified by the design codes and National Regulations are not exceeded.

Primary anti-corrosion protection of the pipelines will be provided by high quality factory applied anti-corrosion coatings and associated field joint coatings. The field joint coatings will be applied following welding and inspection of the joint, either as part of a multi-jointing operation, or during pipe installation.

A cathodic protection system with a sacrificial anode will also be used along the entire pipeline, to provide a supplementary means of corrosion protection. The sacrificial anodes will be manufactured from an aluminium-zinc-indium alloy.

Risk Assessment

All potential hazards presented by the pipeline during operation have been identified by a formal HAZID (hazard identification) process. Risk assessments have then been undertaken during the current FEED phase to assess the risk presented by the identified hazards.

The risk assessments covered the probabilities and consequences of the potential pipeline failure modes. Qualitative and quantitative techniques were used during the risk assessment process, and where possible, measures have been integrated into the design to reduce the risks to acceptable levels. The principal code used for this exercise was DNV-RP-F107, "Risk Assessment of Pipeline Recommended Practice".

Risks that could not be fully addressed during the current FEED phase have been identified for re-consideration in the subsequent project phases.

3.3.9 Pipeline Operation

The pipeline system will be operated by MEDGAZ. Detailed operating procedures for the pipeline system will be developed in conjunction with those for the Compressor Station and Reception Terminal. These procedures will be in place ahead of pipeline operation.

The operating procedures will address the following,

- An administration system covering legal considerations, work control and safety.
- Clear and effective emergency procedures and operating instructions.
- Adequate and regular training of all personnel involved in operational and maintenance issues.
- A comprehensive system for monitoring, recording and continually evaluating the condition of the pipeline and auxiliary equipment.
- A system to control all development or work in the vicinity of the pipeline.
- Effective corrosion control and monitoring.
- A system to collect and collate information on third party activities.
- Regular contact with owners and users of the land through which the onshore pipelines pass.
- Monitoring of land restoration, and the undertaking or remedial work as necessary.

The offshore pipeline will be monitored and controlled from a central control room at a location yet to be confirmed, but potentially in Madrid. An emergency control room back-up site and response facility is foreseen, located near or at the reception terminal. Certain control functions for the offshore

pipeline system will also be executable from the Compressor Station and the Reception Terminal. These facilities will be designed for unmanned operation under normal conditions, with a local autonomous control system that may be over-ridden from the central control room. Each station will have maintenance and security staff, as required for continuous safe operation of the system.

During operation, leak detection will be by continuous measurements of pressure and flow rates at inlet and outlet of the pipeline. If a leak is detected, emergency shutdown procedures will be implemented.

The external condition of the sub-sea pipeline, including the condition of the cathodic protection system, will be monitored on a regular basis. To allow internal inspection, pigging facilities will be installed at the Compressor Station and Reception Terminal. The pipeline system has been designed to allow use of instrumented pigs, if necessary.

The onshore pipeline sections will have regularly visual inspections to ensure that there are no activities occurring along the right of way that could damage the pipeline or its coating.

3.3.10 Decommissioning

The expected service lifetime of the pipeline is 50 years. Decommissioning will be undertaken in accordance with the legislation prevailing at that time, in liaison with the relevant regulatory authorities.

The eventual decommissioning requirements have been taken into account in the design stage by ensuring that all possible options will be available, from leaving the pipeline in situ, to total removal.

The potential environmental effects of decommissioning related to the disturbance of the seabed are similar to those described for the construction phase. The pipeline will carry only processed gas, therefore it is unlikely that cleaning and, hence, the disposal spent cleaning fluid will be of concern.

SECTION 4

ANALYSIS OF THE TECHNICALLY FEASIBLE ALTERNATIVES AND JUSTIFICATION OF THE ADOPTED SOLUTION

MEDGAZ

4 ANALYSIS OF THE TECHNICALLY FEASIBLE ALTERNATIVES AND JUSTIFICATION OF THE ADOPTED SOLUTION

4.1 HISTORICAL PERSPECTIVE AND ROUTINGS

The possibility of connecting Algeria and Spain by gas pipeline directly via the Mediterranean Sea has been studied since the mid 1970's. During this time, various feasibility studies were conducted for the various routing alternatives. These routing alternatives can be summarised in four main corridors including :

- the **western corridor** runs from Cape Tarsa, in Algeria, to the area of Punta Entinas in Almería Province.
- the **eastern corridor** is from Mostaganem, in Algeria, to Cartagena.
- the **two central corridors** are from Oran and Beni Saf, in Algeria, to Vera, in the north of Almería Province, and the area between the city of Almería and Cabo de Gata, respectively.

These corridors were explored primarily in terms of their technical feasibility, for their physical characteristics, depth of the seabed and the distances from coast to coast.

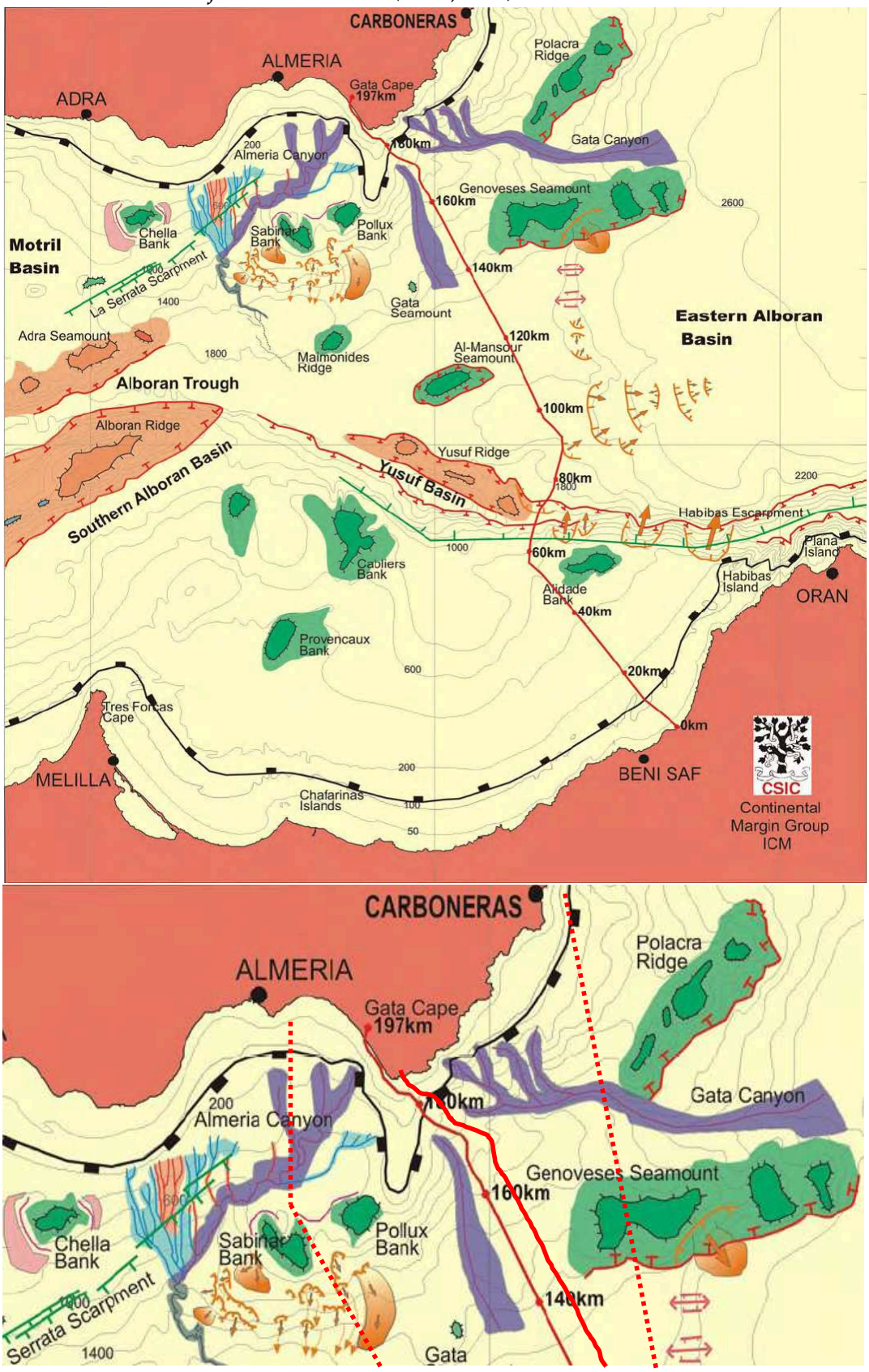
Over the years, the eastern, western and the Oran to Vera central corridor were gradually abandoned for different reasons, but largely because of the technical difficulties presented by the offshore sectors, particularly the depth of the sea bed. The one remaining conceptual corridor was, therefore, that which links the area of Beni Saf, in Algeria, approximately halfway between Oran and the Moroccon border, and the length of coastline between the city of Almería and Cabo de Gata (*See Appendix 1: Spanish Flora and Fauna Baseline Reports*). Later studies then identified a submarine canyon perpendicular to the coast in the Gulf of Almería, which would make it impossible to lay the pipeline in a direct route from Algeria to the city of Almería (*Figure 4.1*).

4.2 THE CURRENT PROJECT FOR THE MEDGAZ CONSORTIUM

In the beginning of 2000, the MEDGAZ consortium revisited the previous studies, up-dating them in the light of the technical advances made in offshore pipe laying over the last 20 years. However, it was concluded that the same factors on which the 1970's decision was based, especially the limitations imposed by the depth of the seabed, were largely still valid today. As a result the conceptual corridor from Beni Saf to the south of Almería Province was deemed to be the only feasible option for the present pipeline project.

Within this conceptual corridor, several alternatives have been studied, by considering various offshore routes and land approaches, as well as combinations of the two.

Figure 4.1 *Detailed figure of the environmental or geomorphological features found on the seabed of the Alborán Sea (CSIC, 2003).*



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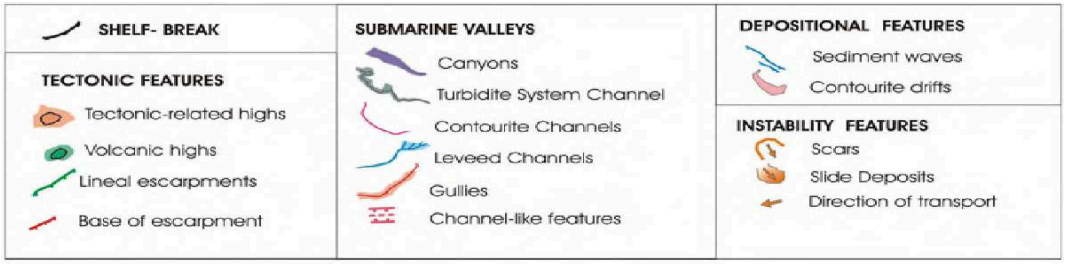


For example, a more detailed study was carried out to identify the technical constraints within a corridor with a width of about a maximum of 30 nautical miles, in order to identify the technical restrictions and select the optimum route for the offshore sector. In this regard it is important to emphasize that these studies have also included a possible direct path from the central point of the conceptual corridor in the Mediterranean Sea to the town of Carboneras, on the eastern coast of the Almería Province, or to a point further north that had been identified as a possible landfall point. The studies conducted showed that neither the direct route to the north of the Almería Province, nor the routes that would enter Spanish territorial waters to the south or south-west of Cabo de Gata, would be technically feasible. This is due to potential collisions with environmental or geomorphological features. *Figure 4.1* shows the central corridor (solid line or trajectory) which is a viable option, as well as those corridors that are not technically feasible due to the presence of marine canyons that intercept the route or trajectory (discontinuous lines to the Almería Bay and the east coast).

Once the most adequate and feasible corridor to reach proximity of the Spanish coast was determined, MEDGAZ then initiated an in depth study of the alternative routes to determine the best landfall point.

4.3 *ANALYSIS AND COMPARISON OF THE ALTERNATIVES*

As mentioned earlier, the constraints of the route through the deep offshore section crossing the Mediterranean Sea, determine at what point the route will enter Spanish territorial waters, which will be through a very narrow corridor as shown in *Figures 4.1* and *4.2*.

This limitation of the routing options, by constraints in the deep offshore sector, is further exacerbated as the conceptual corridor crosses the Spanish continental shelf and approaches the coast as well as the exact landfall point.

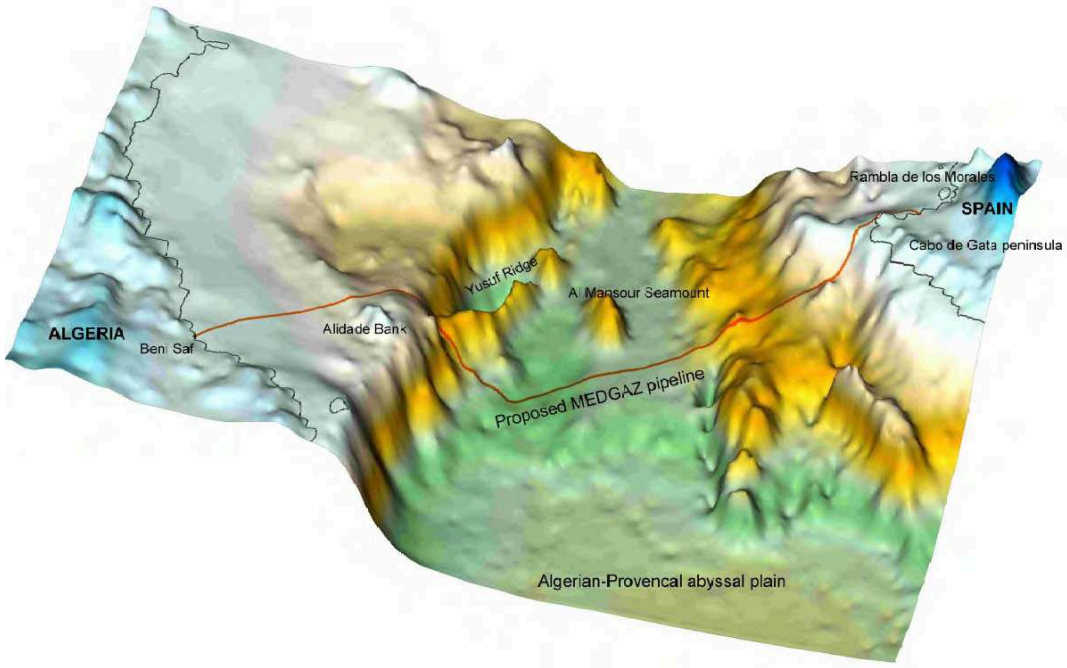
These near-shore constraints refer to the physical environment in the southeast of the Almería Province. The constraints are of two types:

- Environmental - a large part of the maritime-terrestrial territory is occupied by designated nature reserves, (ZEPA zone), or is a proposed Natural Habitat Types of Community Interest or EC priority habitat area

(LIC- *Lugar de Importancia Comunitaria*) under the European Council's Habitats Directive.

- Geo-physical – the characteristics of the seabed, coastline and land give rise to further technical difficulties and constraints.

Figura 4.2 ***3D Model of the Alborán Sea. The chosen pipeline route following the technically feasible corridor between Beni Saf and the Cabo de Gata (CSIC 2003).***



The combination of all of these factors meant that the location of the landfall point, to make the eventual connection with the Almería–Eje Central gas pipeline, will be very restricted. As a consequence, all of the technically feasible alternatives begin in Ben Safi and continue in a north-north-easterly direction until the Algerian coast with a similar marine routing or path. This route reaches the continental shelf at the Cabo de Gata (*see Figures 4.1* and *4.2*). Once the gas pipeline reaches this point, several alternatives have been developed and studied.

Amongst these alternatives, one possible route was initially studied which would reach Garrucha after having followed a path parallel to the coastline. This alternative was not taken into consideration due to the presence of multiple marine canyons on the continental shelf, found perpendicular to the coast, and therefore greatly reducing the width of the shelf (*Figure 4.3a* and *4.3b*).

Figure 4.3a *Marine canyons on the continental shelf shown along the route toward Garrucha (ESPACE Project; Ministry of Agriculture, Fisheries & Food)*

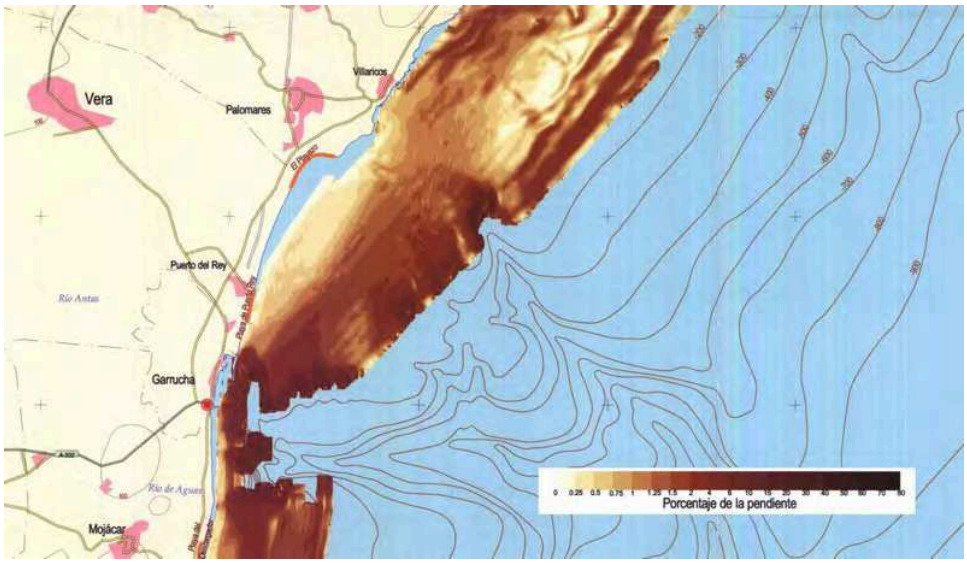
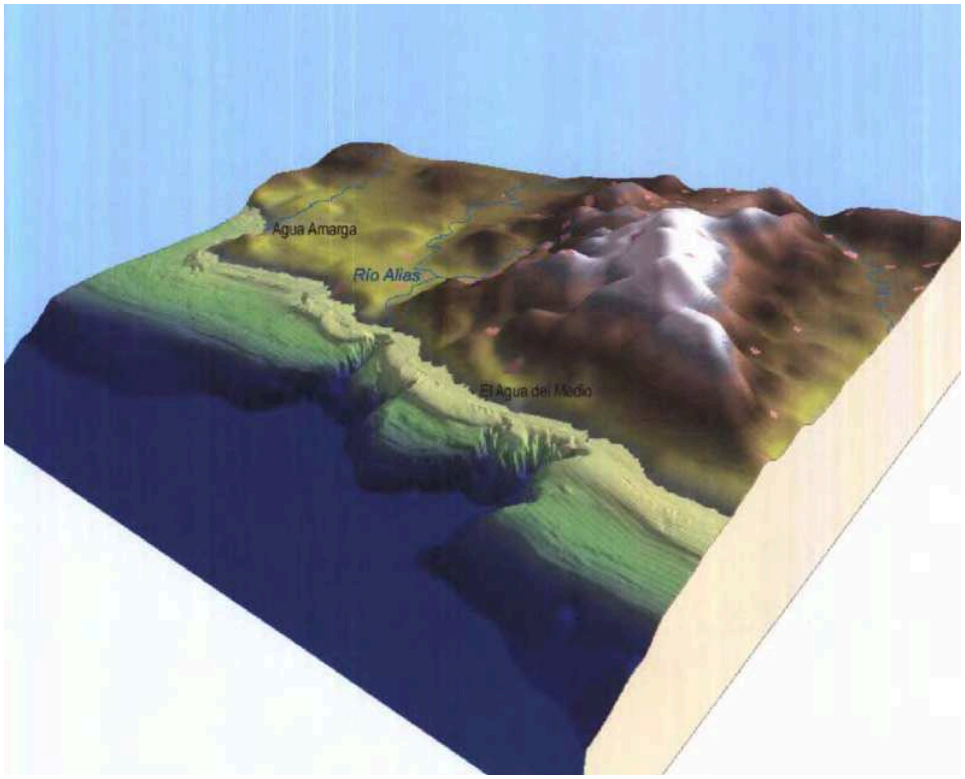
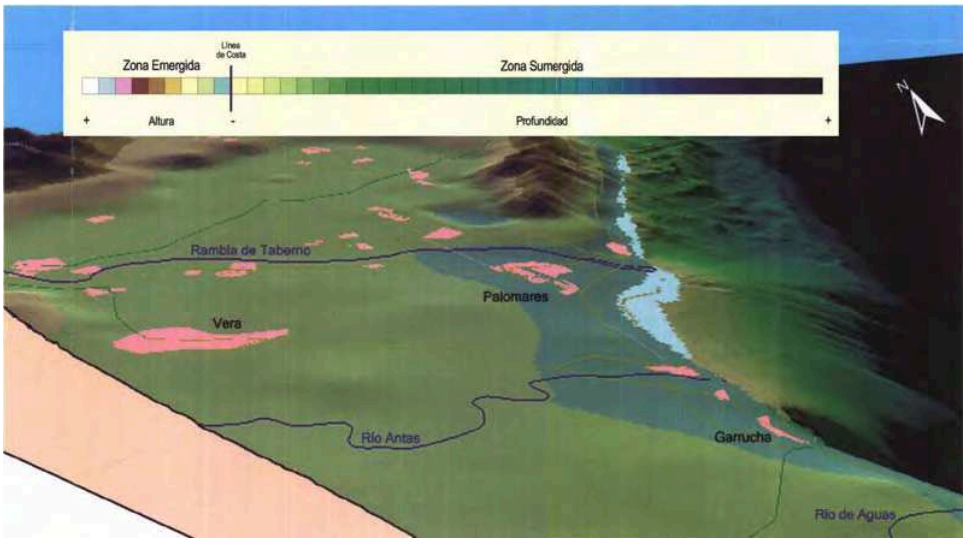


Figure 4.3b *Marine canyons on the continental shelf shown along the route toward Garrucha (ESPACE Project; Ministry of Agriculture, Fisheries & Food)*





As a result of studying the various alternatives, the only technically viable options that were considered for the path of the marine gas pipeline reaching land, and its approximate corresponding pathway to reach the central reception terminal and make the subsequent connection with the onshore Almería–Eje Central gas pipeline, are the following:

- Carboneras
- Rambla Morales
- Rambla del Agua-Retamar
- El Toyo

The next section gives detailed descriptions on the four options or alternatives.

As previously mentioned, all of the options that are considered above, share the same deep marine route, that is that they have a common path offshore. The route then begins to ascend to shallower depths from 12 miles off the coast (which is at a depth of about 1000 m) until it reaches the continental shelf, opposite the Cabo de Gata. The route goes up the marine slope and reaches shallower areas in a north-westerly direction, leaving to the west the extension of the continental shelf which corresponds to the foothills of the Cabo de Gata. From this point onwards, the route splits into the various routing alternatives.

4.3.1 Carboneras Route

The Carboneras route separates off from the 3 other potential routes off of the Cabo de Gata . From this point the route follows a north-easterly direction along the coast for 30 km, until it reaches the town of Carboneras. The path along the coast is designed, such that it runs at least 1 mile from the coast, which is where the marine reserve of the Cabo de Gata-Níjar Natural Park is located.

However, between the Genoveses Beach and the San José Beach, the presence of several marine canyons perpendicular to the coast which run to the limits of the marine reserve, mean that the route of the gas pipeline would need to partially enter the Natural Park. This zone would also be close to the Morrón de los Genoveses Integral Marine Reserve, although the pipeline never actually crosses into the reserve.

This route's path is generally at depths of around 70 to 90 meters.

The landfall of this route is near the centre of the town of Carboneras between the Martinicas Beach and the Torrevieja Beach. The Receiving Terminal (OPRT) would be situated to the southwest of Carboneras, on land which would not be in the Cabo de Gata-Níjar Natural Park.

4.3.2 Rambla Morales Route

From a depth of 80 m, opposite the Cabo de Gata, this route follows a northwesterly direction, maintaining a distance of 1 mile from the coast to avoid entering the marine reserve of the Natural Park. At this distance from the coast, the route is at depths of more than 50 m. Once it reaches the point which corresponds to the centre of the town of Cabo de Gata, the route changes direction and goes in a north-easterly direction and crosses the mile zone which separates it from the coast and goes on until the Cabo de Gata Beach. The landfall of the marine pipeline takes place halfway between la Rambla de Morales and the centre of the Cabo de Gata town. Once it has crossed the beach, the route approaches the Rambla de Morales to pass the area of El Huevo and reach the local AL-P-202 road (Ruescas-Retamar). At this point it crosses the Rambla Morales exactly where the road also crosses this area. The Offshore Pipeline Receiving Terminal (OPRT) would be located just south of the Cortijo de Abajo (See *Appendix 1*).

4.3.3 Rambla del Agua Route

From a depth of 80 m, opposite the Cabo de Gata, this route follows a north-westerly direction. The average depths in this area parallel to the coast are between 30 and 50 m. This ensures that the pipeline does not enter the marine reserve of the Natural Park. At the same time, the change of direction towards land just off of the Rambla del Agua, means that this it also minimises the direct affects on the marine reserve and the only potential affect would be on the western part of the Natural Park. The onshore pipeline route would then continue parallel to the Rambla del Agua and the urban area of Retamar. Approximately 1 km inland, the route then deviates towards the east to avoid any affect on the EC priority habitat area 5220 "Matorral Arborescente de *Zyziphus* " (*Mayteno europaei-Ziziphetum loti*+ Fernández Casas, 1970), until it crosses the local AL-P-202 road (Retamar-Ruescas). Finally, once it has

crossed the Hoya Altica zone, the route continues east for about 2 km where the Receiving Terminal (OPRT) would be located.

4.3.4 El Toyo 2 Route

This option is the most westward route out of the 4 technically viable alternatives. The marine pipeline portion is similar to the Rambla del Agua route, however the landfall is 2 km to the west of the urban area of Retamar, near the Rambla del Puente de la Quebrada. The criteria used to determine this route are common to those used for determining the other routes (minimise the affect on significant environmental features). In this case, the advantage is that the approach of the marine pipeline to the coast would be in an area which would be slightly further away from the Natural Park which avoids any type of direct affect on the Park itself, and on any associated protected environmental features. The onshore gas pipeline would be very short in this case, due to the Receiving Terminal (OPRT) being planned to be located immediately behind the beach, about 300 m inland.

4.3.5 The location of the Receiving Terminal (OPRT)

During the design phase of this project, various alternatives were studied to determine the appropriate location and distribution of the Offshore Pipeline Receiving Terminal (OPRT).

Determining the optimum location for the OPRT was conducted taking into account the various basic design criteria : (1) that the terminal should be placed along the path or route where the marine pipeline would pass or very near this area, (2) that the site location of the terminal is in line with where the marine pipeline reaches land around Albacete, however that its location should be adapted according to the specific features in each territory, and (3) that the distance to the coast is another important factor when determining the site location, such that the distance should be limited with a main objective of reducing the extension and pressure of the onshore pipeline.

For each of the technically viable routes that were considered, a different site location was considered for the OPRT. This site location was selected according to the previously mentioned criteria, such as the presence of significant environmental features (protected areas, presence of vulnerable species or those in danger of extinction and the presence of Natural Habitat Types of Community Interest and/or priority).

4.3.6 Selection of alternatives

Once the 4 technically viable routes were identified, a comparative study or route selection exercise was conducted. This study was based on calculating and comparing a series of indicators, the majority of which were quantifiable.

The results of this study are shown in *Table 4.1* and summarise many of the main environmental impacts of this project. This comparative study allowed the focus of the EIA work to be placed on those alternative routes with lower environmental impacts, and discarded those alternatives that may have been technically viable, but that had a larger impact on the environment.

It is also important to mention that this selection exercise not only took into consideration the section included in this present project (the marine section and onshore pipeline until the OPRT), but a similar evaluation was also undertaken to take into account the potential impacts for the connection from the OPRT to the main natural gas pipeline.

The next page presents a comparative table which shows the various technically feasible alternatives or routes. The indicators which were compared, show the significant differences between the various alternatives. These differences are shown in the table with a graduation of colours which indicate whether they are more or less significant.

Table 4.1 Comparative Table showing the various technically feasible alternatives or routes (I)

PROJECT (section included in the EIA)				
	Rbla. Morales	**Rbla del Agua**	**El Toyo**	**Carboneras**
Project: total distance of the onshore section (m)	4,131	4,054	372	792
Project: total distance of the marine section which is not shared by each route (linear meters)	23,643	31,591	32,939	47,578
Project: direct affect on the Marine Reserve of the Natural Park (linear meters)	2,320	1,900	0	7,062
Project: direct affect on the terrestrial portion of the Natural Park (linear meters)	3,463	2,147	0	0

CONNECTION*				
	Rbla. Morales	**Rbla del Agua**	**El Toyo**	**Carboneras**
Longitud total (linear metres)	7,455	8,680	15,503	14,860
Direct affect on the EC priority habitat area or LICs (linear metres)	0	3,273	5,396	6,486
Direct affect on the terrestrial portion of the Natural Park (linear metres)	0	0	0	4,800
Direct affect on the onshore priority habitats (linear metres)	0	0	230	2,319

Table 4.1 Comparative Table showing the various technically feasible alternatives or routes (II)

Other aspects (Project + Connection)				
	Rbla. Morales	**Rbla del Agua**	**El Toyo**	**Carboneras**
Artisanal fishery areas affected (linear metres)	409	3,392	2,553	9,759
Artificial reef areas affected (linear metres)	0	2,344	1,957	0
Urban determining factors			The terminal and the onshore section would occupy a large area of potential urban areas in the Almería municipality.	
Agriculture		The onshore section would affect a large area of agricultural land (intensive and under greenhouses-agricultura intensive bajo plastico), making it not appropriate for the gas pipeline to pass through.	The onshore section would affect a large area of agricultural land (intensive and under greenhouses), making it not appropriate for the gas pipeline to pass through.	
Priority Marine habitats affected			Would affect areas of *Posidonia oceanica* (priority habitat and an area which most probably cannot be recovered)	

* Section from the terminal to the main onshore *Almería-Eje Central* gas pipeline, which is contained in another environmental impact assessment study

From the analysis of the previous tables and comparison of the various maps, conclusions can be made with respect to the 4 technically viable alternatives:

Carboneras

The marine geomorphological characteristics, especially the marine canyon opposite the town of San José, means that the pipeline must pass through a considerable part of the marine reserve of the Cabo de Gata-Niíar Natural Park. Once the route has reached land it must then pass through a significant part of the EC priority habitat areas as well as the Cabo de Gata-Níjar Natural Park, to then be able to make connection with the main Almería-Eje Central gas pipeline. Entering these zones is inevitable due to the geomorphology near the town of Carboneras. Once the route leaves the Natural Park it continues through a considerable part of the EC priority habitat area of the Sierra de Cabrera-Bédar.

Without considering other possible advantages and disadvantages and only having looked at those mentioned above, in terms of the affect on the environment, this is clearly not a favourable or recommended alternative.

El Toyo

The main objective with this alternative was to avoid that the pipeline passed through the Cabo de Gata-Níjar Natural Park and for this reason the route must make a much larger angle to be able to reach a suitable landfall point. To the west of the Cabo de Gata-Níjar Natural Park is the Retamar urban area as well as the El Toyo 1 zone which is an area dedicated for urban development and which will contain a main road. This area will contain the Olympic Village for the Mediterranean Games in 2005 and construction has already started and will be finalised by 2005 prior to the gas pipeline works being initiated. The El Toyo 1 area extends westward nearly until the Rambla del Puente which implies that the landfall for the gas pipeline will have to be in this immediate area or to the west of the Rambla.

The location of the Receiving Terminal is restricted in both an East-West and North-South direction due to the safety of the terminal. Firstly it should not be located immediately adjacent to the El Toyo 1 urban area but at a distance of at least 300 metres. Furthermore, in terms of its location in a North-South direction, this will be influenced by the presence of the flight path and aircraft traffic near the Almería airport. The further north the terminal is located, the closer it will be to this area near the airport. In either case, without taking into account the environment, the gas pipeline route would need to cross one of these two areas mentioned above, to be able to avoid the Retamar area, which would mean having an effect either on the El Toyo or the Almería airport zone.

The presence of this Retamar area, which extends North of the N-344 road, requires the main Almería-Eje Central pipeline to bypass this area by coming from the North, to the South of the Prison, and then subsequently passing in a

southeasterly direction, where the pipeline would then continue and meet with the main pipeline just north of the terminal location for the Rambla del Agua route, and then continue northeast. This path would be taken to avoid entering the Cabo de Gata-Níjar Natural Park although it would pass very close to its limits. The end of this El Toyo route would connect with the section of the main Almería-Eje Central onshore gas pipeline and continue North.

As shown in the comparative table, this route implies direct environmental and other types of impacts.

As the main objective of this route is to avoid entering the Cabo de Gata-Níjar Natural Park, the advantage of this alternative is obvious. However it does have other inconveniences in that it may affect a *Posidonia oceánica* area which extends all along the coast from a few meters to the west of the Rambla del Agua all the way to the West of the Rambla del Puente, within the Torre Perdigal-Rambla Amoladeras Artificial Reef (Arrecife Artificial de Torre Perdigal-Rambla Amoladeras). This band of *Posidonia* was identified by a specific study on the aforementioned Artificial Reef, which was conducted by the Ministry of Agriculture and Fisheries (Consejería de Agricultura y Pesca) of the Junta of Andalucia. In terms of any environmental impact, the marine section of this pipeline route is very similar to the Rambla del Agua alternative.

On the other hand, both the location of the Terminal, and the route of the main Almería-Eje Central gas pipeline affect the EC priority habitat area of the Ramblas de Gergal, Tabernas y Sur de Sierra Alhamilla. This impact is over 5 kilometres and is inevitable due to the geographic extent of this EC priority habitat area, which is so large that it is unavoidable.

Furthermore the linear nature of the EC priority habitat areas which are found along the path of the Almería-Eje Central pipeline, mainly between the Retamar area and the Prison , means that the route is unable to avoiding or bypassing these habitats.

In terms of the socio-economic impacts, in particular in terms of the affect on the intensive agriculture (*agricultura intensiva bajo plástico*), the section of the Almería-Eje Central pipeline for this alternative would have to go through an area which contains many greenhouses. This would be to the East and West of the Rambla Morales in the area of Las Cruces- Cerro de Hacho, just prior to the pipeline connecting with the pipeline section which would be part of the Rambla Morales route. This would therefore affect a large number of these greenhouses. These greenhouses are also planned to be expanded to other areas where this El Toyo pipeline route would pass. This would be in the area between the Retamar zone and the Rambla de Morales, which is not in the EC priority habitat area of Gergal, Tabernas y Sur de Sierra Alhamilla or in the Cabo de Gata-Níjar Natural Park. This implies that the potential affect on these greenhouses may be significantly higher in two to three years, when the pipeline construction would begin.

To summarise, this alternative is clearly not the optimum or favourable option in terms of the environment, although it has initially been thought of as a viable option due to the fact that it avoided the Cabo de Gata-Níjar Natural Park. Moreover, the other routes or alternatives which may be passing through the Natural Park have been conceived such that they minimise the impact on the areas that they pass through.

An additional point which makes this alternative a clear disadvantage is with respect to the land use and town and country planning. The entire area to the West of the El Toyo 1, from the border of this area to the Almería airport, is classified in the 1998 General Report for Urban Planning for Almería (*Plan General de Ordenación Urbana de Almería de 1998*) as '*Suelo Urbanizable No Programado'* or land which may be designated for building in the long-term. This area has been given the name of 'El Toyo 2', following the main area of development to the East of the city of Almería.

MEDGAZ have made contact with the Almería Municipal Government (Ayuntamiento de Almería) with regard to the land use and town and country planning issue and their response was negative. This will therefore be revised in the next two years, however it is not envisaged that the circumstances of the El Toyo 2 will change. The municipal government of Almería considered that the location of the terminal and the passing of the gas pipeline through this zone, with its associated restrictions, would compromise the future planned development of this residential area.

In addition, the municipal government considered that apart from these urban planning considerations, in terms of safety, it would be best to avoid placing the pipeline in this area, which is planned to be developed into a residential area for a significant amount of people.

This urban planning aspect is the main reason why this EIA does not go into a full comparative analysis of this alternative.

<u>Rambla del Agua and Rambla Morales</u>

In the light of the systematic route selection study or exercise, these two routes were considered to be the most favourable alternatives. This EIA is focussed on the Rambla Morales Alternative, and includes a description of the environment (*Section 5*) and the associated impacts (*Section 6* and *7*). The Rambla del Agua alternative has been discussed in the Spanish EIA which covers only the Spanish side of the pipeline including its territorial waters.

SECTION 5

ENVIRONMENTAL BASELINE

CONTENTS

5 ENVIRONMENTAL BASELINE

5.1 INTRODUCTION

This section describes the existing environment through which the proposed pipeline will pass, in terms of the natural and man-made features that are of potential relevance, both in the marine and terrestrial environments.

5.2 METEOROLOGY

The Almería region has a xerothermic (semi-desert) climate, with annual rainfall levels around 130 mm per year. The infrequent rain falls that take place largely occur between October and March. The average temperature is around 20°C, and the area receives in excess of 3,000 hours of sunlight per year. The prevailing wind is from the west or southwest. Easterlies, in the form of the Levantine winds, also occur, but to a lesser extent.

5.2.1 *Climate at the Offshore Pipeline Receiving Terminal (OPRT)*

The area is characterised by relatively high average temperatures of around 18°C, and a low annual rainfall of around 225 mm. Monthly temperatures are given in *Table 5.1.*

Table 5.1 Monthly temperatures

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Avg. Temp.	13	14	16	17	20	24	27	28	25	21	17	15
Avg. Max. Temp.	17	18	20	21	23	28	31	31	29	25	21	18
Avg. Min. Temp.	9	10	12	13	16	20	23	24	22	18	14	11

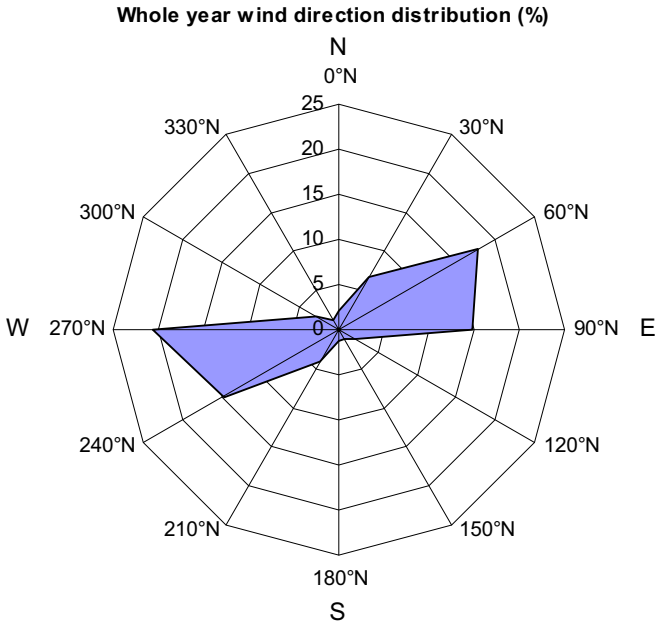
Average monthly temperatures are in excess of 18°C, with maximum temperatures exceeding 40°C. The maximum temperature recorded at the Cabo de Gata Weather Station is 40.8°C. The minimum temperature recorded is -2.0°C.

Average annual rainfall is less than 250 mm, while heavy rainstorms may yield considerable quantities of water, up to 200 mm in 1 hour. Maximum daily rain is 118 mm.

Wind

The dominant wind directions are west and east for about 70% of the year. For more than 77% of the time the wind speed is 12 m/s or less. The average wind speed is around 7 m/s. The distribution of wind directions over the year is shown in *Figure 5.1.*

Figure 5.1 ***Distribution in percent of wind directions over the whole year, average for the period 1961-1980***



5.2.2 *Climate at the Beni Saf Compressor Station (BSCS)*

In general the weather in the region is fine with brief periods of rough weather and storms. The summers are dry and hot and the winters are mild. The annual mean temperature is between 13°C and 25°C, with August generally being the hottest month. On account of the sea breeze, the summer maximum temperatures along the African coast are generally below 30°C. Monthly temperatures are given below in *Table 5.2* based on data obtained from the Beni Saf weather station.

Table 5.2 ***Monthly temperatures***

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Avg. Temp.	17	14	14	18	19	22	24	25	23	21	16	13
Avg. Max. Temp.	21	16	16	19	21	23	26	27	24	23	19	16
Avg. Min. Temp.	14	11	11	16	17	21	22	23	21	19	14	10

A sudden change in temperature of up to 20°C in a few hours is sometimes seen with the passing of a cold front. The annual maximum temperatures registered are up to 41°C and minimum temperature is 2.9°C.

The annual rainfall in the area of the Strait of Gibraltar is about 400 mm. The rain has a seasonal behaviour, summer being the dry season and winter and autumn the wet. The rainy season starts in October, frequently with heavy thunderstorms. Maximum daily rain is 62 mm. Most of the rain and storms occur in winter. The rain is mostly in the form of heavy showers alternated with clear weather.

5.3 *OCEANOGRAPHY*

On the general scale, water from the Atlantic Ocean entering the Mediterranean via the Straits of Gibraltar makes a large anti-cyclonic turn in the Alborán Basin, closely following the Spanish coastline. This current typically turns to the south, around Cabo de Gata, where it meets the Levantine Mediterranean Current travelling in the south-west direction. The combined flow (known as the Oran Front) then moves towards Oran on the Algerian coast. It then splits into two, with the eastern-most flow becoming the, so called, Algerian Current.

Extreme bottom currents (1 m above the seabed) for a one year return period are 0.64 to 0.81 m/s in the littoral area (water depth <30 m) on the Spanish side and 0.88 to 0.95 m/s on the Algerian side.

The temperature range of these shallow waters is between 14.5 and 24°C, with an annual average of 17 to 19°C. In summer, thermal stratification is observed between depths of 20 to 30 m. Hydrodynamic and physiographic factors lead to the up-welling on the coast, with sudden drops in surface temperature of the littoral waters and local proliferations of plankton. In the deep waters of the abyssal trough, the temperature is highly constant throughout the year, at 13°C.

The dissolved oxygen content of the water is inversely proportional to the temperature, in the deep waters, where the recorded minimum is 4.23 (summer) and maximum is 4.43ml/l (winter). In the shallower waters, however, the oxygen produced by phytoplankton also plays a role, so that the highest values are in spring and autumn, at about 5.5ml/l.

Salinity is constant at depths below 250 m, at the value of 38.4 Psu, which is characteristic of the Mediterranean as a whole. It is lower in the shallower waters, at 36.7 to 37.1 Psu, due to the ingress of Atlantic waters.

Tidal changes are small in the general areas of interest. They are 0.30 m (Lowest Astronomical Tide (LAT)) to 0.57 m (Highest Astronomical Tide (HAT)) on the Spanish side (Port of Almería) and 0.33 m (LAT) to 0.67 m (HAT) on the Algerian side (Port of Arzew). The strongest winds in the offshore area are from the NE-E and SW-W quadrants, with average annual of 20 to 22.5 m/s and 22.5 to 24.3 m/s respectively.

Extreme waves, recorded for a one year return period, are from the same directions are the strongest winds. They reach typical heights of 5.2 m (east) and 5.5 m (west). In the near-shore areas, where the wave directions are perpendicular to the pipeline route, the maximum recorded heights are 4.6 m and 5.5 m on the Spanish and Algerian sides respectively.

5.4 LANDSCAPE AND TOPOLOGY

5.4.1 *Land use and habitation in the area near the Offshore Pipeline Receiving Terminal*

The area identified for the receiving terminal is on the Cortija de Garrotera at the foot of the Morales Hill, 200 m west of Rambla Morales and 1.5 km west of the Ruescas village. The area is virgin land with a slope of up to 10 %, located next to the ALP-202 road from Retamar to Cabo de Gata.

The area is just outside the Parque Natural Cabo de Gata-Níjar at an altitude of about 12 m above average sea level. The distance to the coast is around 3 km. Otherwise the area is subject to intensive cultivation applying irrigation and greenhouse tomato cultivation.

The nature reserve, Parque Natural Cabo de Gata-Níjar, bordering the identified OPRT site, is characterised by volcanic rock, large wetland areas, sand dunes, mining plains, and the beaches and coastal settlements.

The area is of a volcanic and a semi-desert nature. While the climate is generally dry, the area can be subject to watercourse overruns and flooding, in combination with the scarce vegetation resulting in extensive soil erosion from heavy rainstorms.

The area is seen on the photo below, taken from the Morales Hill towards the southeast.

Photo 5.1 ***View from Morales hilltop on the identified OPRT site in front greenhouses and with Ruescas in the background***

The inhabited areas near the identified OPRT area are:

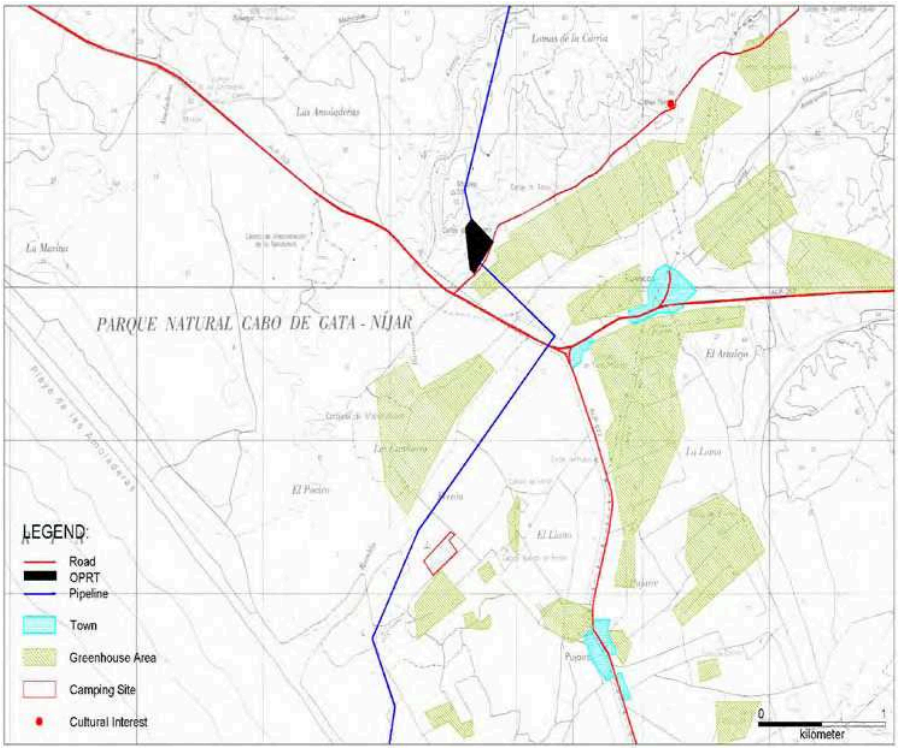
- Houses/buildings about 300 metres northeast of the site.
- Ruescas village about 1 – 1.5 km east of the site.
- Pujaire village about 2.5 km southeast of the site.
- Cabo de Gata village at the coast about 4 km southeast of the site.

Cabo de Gata, Pujaire and Ruescas, belonging to the municipality of Almería, have about 825, 65 and 100 inhabitants respectively. A part of the population of Pujaire and Ruescas is located in the Níjar municipality. Data from the municipality of Níjar shows 357 inhabitants in Pujaire and 205 inhabitants in Ruescas, respectively. In the summer period the number of inhabitants in El Cabo de Gata increases to more than 6,000.

Transport infrastructure in the area is the Retamar to Ruescas, road ALP-202, continuing at the roundabout at Ruescas into the ALP-822 road to Cabo de Gata via Pujaire. The road has an estimated average daily traffic of 3-4,000 cars. Minor dirt roads and tarmacked roads are traversing the area, providing access to greenhouses and other facilities. *Figure 5.2* shows areas under influence by human activities.

The Almería Airport is located at El Alquian, approximately 10 km west of Ruescas. East of Ruescas, at a distance of approximately 1 km, is a Michelin experimental centre, occupying an area of approximately 1,600 ha. A desalination plant is planned: "Rambla Morales" for irrigation with a capacity of 60,000 m^3/day.

Figure 5.2 ***Areas under influence by human activity (anthropogenic sites/areas)***



5.4.2 *Land Sector, Spain*

This section makes brief references to the ecology and man-made features along the proposed route for the sake of convenience. The ecology and these man-made features are, however, dealt with more fully in subsequent sections.

The general landscape from the Reception Terminal to the landfall on El Charco Beach is described in the following paragraphs, in terms of a walk along the 4.5 km sector.

Proceeding in an easterly direction from the Reception Terminal site, at an elevation of circa 12 m above sea level, the route immediately crosses a minor road running north-south off the ALP-202 main road. It continues in the same direction, running parallel to the main road, for about 200 m across an area of flat scrub land, presently occupied by one of the large, plastic-sheet greenhouses that are ubiquitous in this region. It then drops down to cross a 200m-wide terrace in the flood plain of the Rambla Morales, before crossing the Rambla itself, which, at this point, is about 100m from bank to bank. On the east side of the Rambla, the route crosses some 150 m of similar landscape and then makes a right angled turn to pass under the ALP-202 (E340) into the Cabo de Gata Natural Park and continue southwards. At the crossing point, the ALP-202 is an asphalt-surfaced, single carriageway road, raised 2 to 3 m above normal ground level.

About 15 m after crossing the main road, the route crosses a buried water main. For the first kilometre on the south side of the main road, the land is gently undulating, with scattered bushes, but it also shows much evidence of having been recently occupied by greenhouses. It is here where the route passes by its nearest permanent residence, about 100 m to the east, to the north west of Pujaire.

After another 120 m, it crosses the unpaved road that provides the main access to the Cabo de Gata Camp Site from the ALP 202. After another 230 m, it passes, the Camp Site itself, which is 100 m to the west at its closest point. For the next kilometre, or so, the route is through an area of small agricultural plots and greenhouses, some of which lie within a few metres of the route. These greenhouses, although large, are only of a tent-like structure, using plastic sheeting supported on poles and tensioned by guy ropes. Simple irrigation systems are also evident in the area, crossing the pipeline route in places. The last 0.5 km this section has a much more uneven terrain, with elongated mounds and hollows and a predominant vegetation of scattered bushes and cane thickets. In this area, the route passes close to, but avoids, the western extremity of an EC priority habitat area of the same type as that discussed previously.

Soon after leaving the greenhouse area, it crosses one of the more important unpaved roads connecting Cabo de Gata Village to the Rambla Morales, and

then makes an immediate 100^0 turn to follow a more easterly direction over unremarkable landscape for the next 300 m.

The route then turns to the south again, to enter the beach hinterland, about 500 m from the beach itself, where cane thickets are predominant. About 250 m from the shore, it passes through a relatively wet depression, about 100 m wide, with a heavy growth of reeds and other typical wetland species, but which is not designated for special protection other than those of the general C-zone. After emerging from this depression, it traverses a circa 100 m-wide band of low sand dunes, with heights up to circa 1 m, and sparse bushes. These dunes, which cannot be avoided, are an area of the type classified as a priority habitat by the EC Habitats Directive. After crossing the unpaved road at the back of the beach, the route finally runs down the beach to the shoreline, where the village of Cabo de Gata lies about 800 m to the south-east. The soil types along the route are summarized in the table below:

Table 5.3 Soil Types in the Spanish Land Sector

Approximate distance fro shore line (m)	Soil type
0 to 200	Fine to coarse sand
200 to 500	Fine sand and pebbles
500 to 1,000	Coarse sand with scattered conglomerates
1, 000 to 3,500	Clayey silt sands

On its course from the ALP-202 main road the route makes 15 crossings of local, unpaved public roads and, probably, a number of buried small scale irrigation pipes. No drinking water abstraction points are in the vicinity and the ground water is unsuitable for this purpose.

The whole general area through which the pipeline will be routed to the south of the ALP-202 is bounded by the Rambla Morales, the centre line of which lies between 250 m and 900 m to the west. This is an intermittent water course with its mouth blocked by a sand bar, which results in permanent water for about the first 300 m inland and flooding during heavy rain. Only storm floods and spring tides are capable of opening a channel through the sand bar.

5.4.3 *Shore Approaches Sector, Spain*

From the shoreline, the sea floor deepens gently toward the south-west with regularly spaced bathymetric contours at a slope of less than 1^o. The marine terraces are of stepped conglomerates in an over-laying and over-lapping pattern, which form a straight line parallel to the coast. The sediment is coarse sand, with a band of scattered sea grass patches (*Cymodocea nodosa*), between 300 m and 1100 m from the shore. This feature is more fully discussed in *Section 5.5*, which covers the ecology along the pipeline route. The results of a complete marine survey can be found in *Appendix 2*.

5.4.4 *Land Sector, Algeria*

The coastline around the proposed landfall near Beni Saf is characterised by rocky limestone cliffs, rising some 70 m above sea level and interrupted by isolated bays with sandy beaches. The development of the river network gives rise to quaternary terraces, which, where they are arranged in stepped form, outcrop on the surface. Above the cliffs, there is a coastal plateau with a covering of sandy/silty soil. The site of the landfall is at the north eastern side of Sidi Djelloul beach, approximately 10km south-east of Beni Saf.

On leaving the sandy beach, the route turns to the east, to travel away from a police station and bar, which, at the nearest point lie about 100 m to the west, respectively. It passes the corner of one of the beach camp sites and after 100 m it crosses a 40m-wide natural water channel, with bands of reeds and trees on both banks. In this way, the route circumvents the site reserved for the proposed desalination plant, which at its closest distance is 100 m away.

It should be noted that the water channel mentioned above cannot be avoided because it encircles the entire beach, with a connection to the sea, via a sandbar, at the north-eastern end of the beach. This channel does not have a regular flow of water. It is likely that in times of rain it is swollen by flash floods, causing over-flow onto the fields and breaching the sandbar at the beach. At other times there may be natural drainage from the high land behind and to the side of the beach, which would simply diffuse through the sandbar into the sea.

After crossing the water channel, the route turns through 100^0, to continue inland for another 400 m, running along the narrow strip of land between the water channel and the bottom of the headland. It then turns 90^0 to the east again, to climb 200 m up the steep, 1:3, slope, to the high ground where the Compressor Station will be situated, some 75m above sea level.

Soon after leaving the beach, the route is crossed by an over-head electricity line. The ground water is not suitable for drinking, so no abstraction points are in the vicinity of the route.

5.4.5 *Land use and habitation in the area near the Beni Saf Compressor Station*

The area identified for the Beni Saf Compressor Station (BSCS) is on the hills near Sidi Djelloul, approximately 1 km from the coast and 10 km east of Beni Saf. The area is located in the municipality district of Sidi Ben Adda in the Aïn-Temouchent wilaya (province).

The area is reasonably flat with very gentle slopes, dominated by vineyards not yet planted.

The selected BSCS site is on a plateau between a valley to the north with the D.59 road and a valley to the south with the D.20 road and the Oued Sidi

Rahmoûn. The altitude of the plateau is around 70 metres. The area required for the compressor station is approximately 13 ha.

The area is seen on the photo below, taken from the slope at the beach towards the southeast into the valley, with the selected site on the hilltop to the left.

Photo 5.2 ***View from the slope at the beach towards the southeast into the valley. The selected site is on the hilltop to the left***

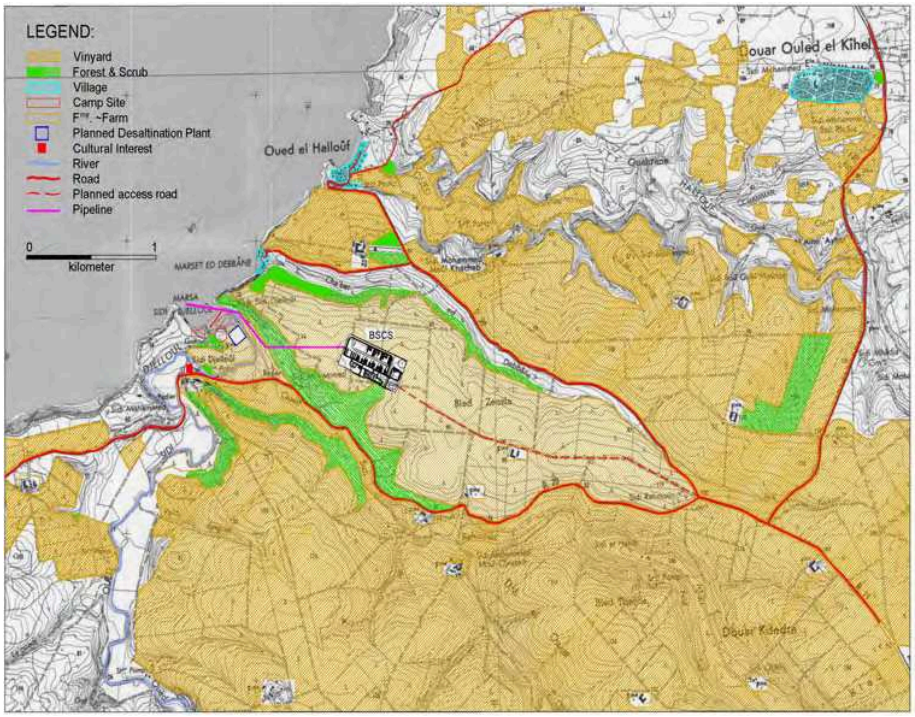
The Aïn-Temouchent wilaya covers an area of about 2,375 km², and includes around 80 km of the Mediterranean coastline. Its total population is 327,332 inhabitants. The wilaya comprises 28 municipalities of which 7 are administrative centres of the supra-municipal divisions (daira): Aïn-Temouchent, Béni-Saf, El-Malah, Hammam Bou Hadjar, Ain Kihal, Oulhaca and El-Amria.

As mentioned earlier, the landfall site and the selected BSCS site are located in the municipality of Sidi Ben Adda, which comprises nine districts with a total of 12,224 inhabitants.

Inhabited areas near the identified BSCS area are:

- Isolated vineyards north, east and southeast, in distances down to 0.6 km from the site.
- The village Marset Ed Debbane less than 1 km west of the site, and the village Oued el Hallouf 1 km northwest of the BSCS, both on the coast.
- The village Ouled el Kihel with 3,064 inhabitants about 3.5 km northeast of the BSCS.

Figure 5.3 Land use and habitation



5.4.6 *Shore Approaches, Algeria*

From 30 to 23 m depth the seafloor gently rises towards the south-east, with a mean slope of 1 º closer to the shore. Between 23 and 21 m, there is a small step, after which the smooth gently rising seafloor continues, gradually giving way to minor irregularities in the form of smooth channels perpendicular to the coastline. The landfall is in a small sandy cove with some seabed irregularities and almost vertical limestone cliffs forming a headland on both its sides.

Most of the seabed is sandy sediments, but some cobbles and boulders are present between 8 and 12 m depth. Some rocky outcrops are present further inshore. Grab samples showed the sediments to be mainly fine sand with shells, with minor fractions of either silt or clay.

5.4.7 *Offshore Sector*

Geological History

The Mediterranean Sea has had an eventful geological history, which has given rise to the features observed today, both under the sea and along the coastlines to both the north and the south. Approximately six and a half million years ago the sea, which then separated Europe from Africa, dried out over a relatively short period of time. This is considered to be due to the land mass of Africa moving north towards Europe, to seal off the sea at both its eastern and western ends, after which the sea emptied rapidly by evaporation. The movement of the land mass also gave rise to the mountainous nature of the seabed and the mountain ranges which border the sea, particularly on its

northern side but also in evidence on the Algerian coastline in the region of the proposed landfall. About 5 million years ago the compacted junction of Morocco and Spain dropped, and water from the Atlantic cascaded over 3000m cliffs into the dry basin to form the Mediterranean Sea that we know today.

After the western emplacement of nappe piles, the thickened crust of the Betic-Tell Orogen underwent extension along large detachment faults. The present tectonic activity is characterised by north-south shortening stress. A correlated east-west lengthening by lateral compression transport also occurs, with a subsequent stretching and cumulative motion along strike-slip faults. Several sub-basins, ridges and seamounts can be identified. To the east and north of the Alborán Ridge, the Eastern Alborán Basin, the Yussuf Basin the Al-Mansour Seamount, and the Cabo de Gata area exist near the pipeline route.

The Alborán Ridge is a linear bathymetric high that extends some 180 km with a north-east to south-west trend, and is locally emergent, forming the volcanic Alborán Island. The ridge terminates abruptly to the north against the Alborán Channel, which constitutes a narrow east-west trending connection between the western and eastern sides of the Alborán Basin.

The Alborán Basin appears to be floored predominantly by continental basement, which largely corresponds to rocks belonging to the internal complexities of the Betic-Tell Orogen. However, most bathymetric highs in the central and eastern parts of the basin are of volcanic origin

General Overview of the Sub-sea Route

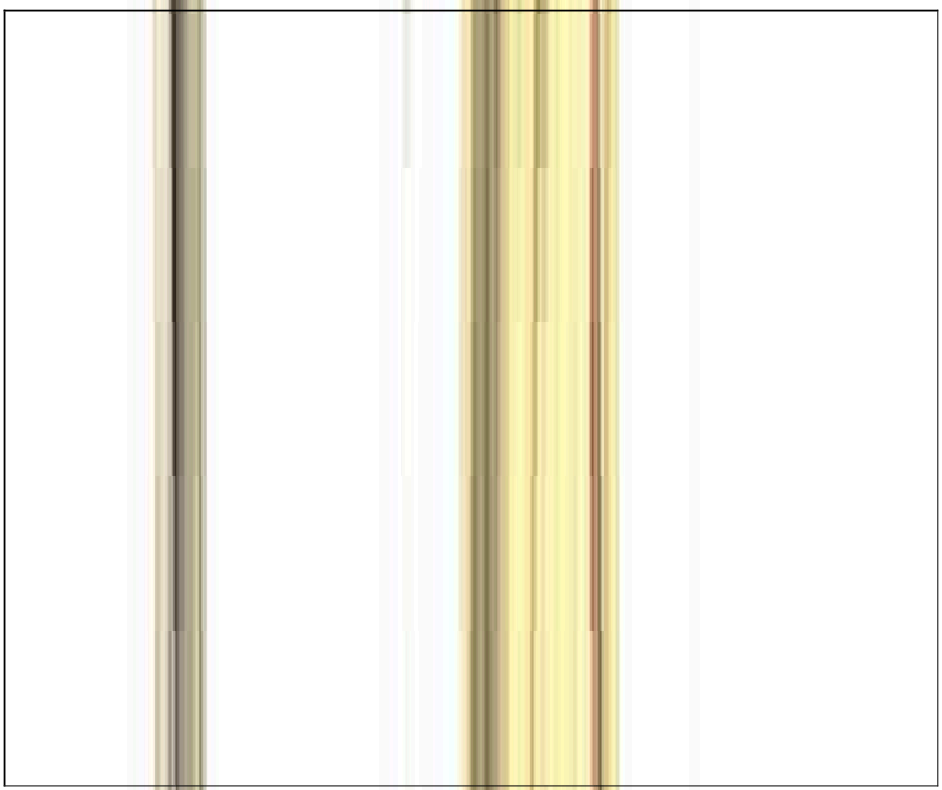
In the region of the Beni Saf landfall, the continental shelf is approximately 20 km in wide, with the depth at the shelf break of about 150 m. The continental slope in this area can be sub-divided into an upper and a lower slope, separated by a marginal plateau, the Alidade Bank, whose seaward extent appears to be the Habibas Escarpment on the Beni Saf slope. Seaward of the lower slope, the pipeline route traverses a narrow submarine ridge, the Yusuf Ridge, and descends on to the continental rise across the deepest regions of the Alborán Sea (2,200 m).

The continental rise descends to the east into the Algerian-Provencal Abyssal Plain. The Al Mansour Seamount occurs along the route, with water depths ascending from approximately 2,000 m to 1,300 m.

The route then traverses a relatively small marginal plateau, avoiding the major constraints of the Almería and San Jose Canyon Systems, to ascend the continental shelf on the western side of Cabo de Gata, where the width is approximately 20 km at a corresponding depth of 130 m. The key features are shown in the two figures below:

Figure 5.4

Figure 5.5



Sub-sea Route in Detail

From the foregoing paragraphs it is clear that the Alborán Sea Basin is an area of very uneven and complex physiology, with banks, mountain ranges, valleys, plateaux and the potential for seismic activity. The proposed pipeline route passes through depths down to circa 2000m, but avoids the main mountainous features (see *Maps 5.1, 5.2 and 5.3*).

From the Beni Saf shoreline, the seabed slopes steadily at about 2º to the 90 m water depth, over a smooth surface of clay with a thin covering of sand. Some rocky outcrops have been identified.

The route then descends the Alidade Bank (KP12.5) to the lower shelf slope and continues to slope gently (<1.5º) from 90 m to 120 m depth. In the deeper section some sub-cropping and out-cropping causes minor undulations. Here, the seabed is mainly clay with patches of coarse sand. This gentle slope continues to the shelf break at KP20/21, (depth 150 m), where the route descends the break at a slope of approximately 6º before resuming its gentle descent to 290 m depth at KP27.5, with no change in seabed composition. Near to this point gas seepage has been observed. The route crosses the Algerian 12 nautical mile territorial limit (KP35) at a depth of 390 m.

The smooth descent continues to 1270 m depth, at KP68, with an increasing gradient (up to 9.4º). Some faults, both on the seabed and buried to 3 m, have been detected, but the soil remains unchanged as soft to hard silty clay. Several areas of isolated pockmarks have been noted.

From KP70 to KP80, the route descends from 1280 m to 1800 m depth while the previously smooth sea bed gives way to a series of ridges and valleys, with faults. However, core samples have shown that the soil here is still soft silty clay.

At KP85 the route descends a 5.3º slope from 1955 m to 2050 m depth, where the seabed once more becomes relatively flat and smooth. This sea floor continues through the lowest point of the route (2154 m, at KP94 to KP107, where the route then quickly ascends from 2020 m to 1970 m over 1 km. It continues its gradual ascent (slope<1º), with the exception of occasional short, steeper rises, but with no significant topographical features. No geo-technical data are available for the deepest section.

The route then runs along the axis of a 15 to 50 m high ridge from KP152.9 to KP156.3, as it rises from 1170 to 1030 m, and then along the ridge flank, from KP156.3 to KP162.6, but the overall ascent is smooth and gradual. At KP162, there is a mound of soft slumped material, indicating a possible area of surface instability. Core samples taken at this point indicated slightly silty to slightly sandy clay. The route enters Spanish territorial waters (12 nautical miles) at KP160, at a depth of circa 1000 m. The seabed continues to be mainly smooth,

but with some localised gradients of up to 5º, with some seabed slump zones and a sea floor composed of clay and silty sandy clay.

On climbing the slope of the European continental shelf, from 630 m to 130 m depth, between KP170 and KP178, the seafloor is predominantly clay and silt, with outcroppings of rock, surrounded by coarse sandy sediments. A route alignment has been identified which avoids these obstructions. Core samples showed that the seabed along this section consists of 30-75 cm of silty sandy clay over-laying silty clay, with patches of fine to medium sand.

When the route approaches the Spanish landfall and levels out onto the continental shelf at around KP178 and circa 130 m depth, the seabed becomes more varied, with out-crops and sub-crops of rock and a region of very coarse sediment (sand to pebbles). Again, however, a route has been identified which largely avoids these features, to follow a corridor of coarse sand. (Core samples taken here consisted of fine to medium sand clay/sand/silt combinations, with some gravel and shells). The exceptions are the crossing of a large rocky area between KP179 and KP181 and a small area. Just off the Cabo de Gata there is an artificial reef, but it is almost 2 km away from the route. At this point the route turns more towards the north-east and then, for the next 10 km, it runs between circa 3.0 and 2 km offshore and parallel to the Playa de Cabo de Gata. Finally, it turns through ninety degrees, to cross the 1.85 km width of the Marine Reserve and reach the landfall at KP197.

Map 5.1 ***Topography of the Spanish territorial waters of the pipeline route***

Map 5.2 ***Topography of the Algerian territorial waters of the pipeline route***

Map 5.3 ***Seabed Geology***

5.5 *ECOLOGY*

5.5.1 *Land Sector, Spain*

General Overview

With the exception of the final 1 km north of the ALP-202 (E340) main road, the remaining 3.5 km of the route in the Spanish land sector will be entirely in the Cabo de Gata Natural Park. However, the route has been optimised to pass mainly through the areas categorised as C-zones by the Park Authority, as explained in *Section 4*.

- C1-Zones are "general interest natural areas". That is spaces with natural plant formations and sometimes, abandoned crops, now left to undergo natural regeneration. No special protection is required.
- C2-Zones are "traditional crop areas". In spite of their agricultural exploitation, it has been acknowledged by the Park Authority that such areas have, nevertheless, integrated into the landscape. Therefore, the purpose of this designation is to conserve such traditional production methods, rather than protection of the natural landscape.

The Natural Park is also a designated IBA (Important Bird Area) and a proposed Site of Community Importance according to the European Birds and Habitats Directives. Moreover, the salt marsh, with an area of 300 Ha, to the south-east of Cabo de Gata village, is a RAMSAR site (number 448) of international importance for the protection of birds. Another wetland feature is the mouth of the Rambla Morales, on the other side of the route, where, for example, flamingos are common and white headed duck have recently started to breed (this matter is discussed in more detail later). These wetland areas, however, are well away from the route, at distances of 2 km and approximately 1 km respectively, so will not be affected by the construction works.

The values of the Park are also of a botanical nature, including numerous endemic and rare species and habitats that are unique within Europe. The route across the Park, as previously described, has been chosen to avoid significantly affecting any of these features.

Protected or Classified Areas

Nature reserves under national jurisdiction

The nationally declared nature reserve Parque Natural Cabo de Gata-Níjar is located at the extreme southeast of the Iberian Peninsula, and located inside the study area of the planned OPRT. The legislative framework of this protected site is designed by the Decree 418/1994 of 25 October approving the Natural Resources Regulatory Plan and the Master Plan for the Use and Management of the Parque Natural Cabo de Gata-Níjar.

The Parque Natural Cabo de Gata-Níjar covers an area of 46,000 ha of which 12,000 ha are in the marine zone to a depth of 60 metres. The Park is characterised by its volcanic rocks and a great scenic diversity: the salt mines, the largest wet area of the province; the dunes, formed by sand transported by the wind and proceeding from the beach which accumulates around obstacles; the sierra of Cabo de Gata of volcanic origin, the great mining plain of Rodalquilar, the beaches, the seabed and the coastal towns (San Miguel of Cabo de Gata, San José, Los Escullos, Isleta del Moro, Las Negras and Aguamarga).

The high average temperatures, above 18°C, and the scarce rainfalls - about 200 mm annually - are the causes of the predominating flora of Cabo de Gata having adapted to the scarcity of water during long periods. Species like *Ziziphus lotus* and the Mastic tree (*Pistacia terebinthus*) from the family Anacardiaceae, which only developed here and in the arid regions in the north of the African continent, and also important formations of the only autochthonous palm tree on the European continent, the European fan palm, (*Chamaerops humilis*) stand out.

The community of birds is wide and varied due to the location of this natural park, to the ecological peculiarity which means the presence of a swamped surface of more than 300 ha, and to the volcanic mountain range with many ravines and cliffs. The area is important for breeding, staging and wintering of various species of water birds. More than 169 recognised species exist in the entire park. The pink flamingo (*Phoenicopterus ruber*) stands out with more than two hundred of them.

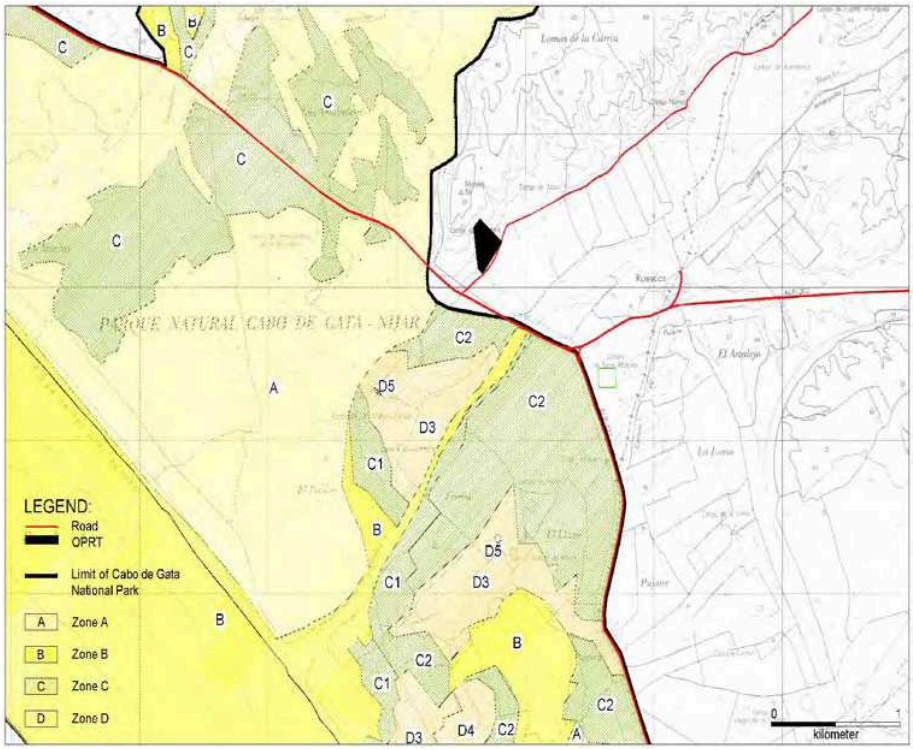
The area of the nature reserve is divided in sub areas/zones as shown below in *Table 5.4*.

Table 5.4 Parque Natural Gabo de Gata-Níjar. Sub areas/zones of the park

Parque Natural Cabo de Gata – Zonation	
Zone	**Description**
A	Ecosystems with exceptional naturalistic, scientific, cultural and landscape values.
B	Doubtless ecological, scientific and landscape values. May include some types of primary productive exploitation (cattle raising, industry-specific already consolidated).
C	Spaces with natural or semi-natural formations holding a general interest, with specific peculiarities that do not need to be included in any of the previous categories.
C1	*General interest natural areas.*
C2	*Traditional crops areas.*
D	Spaces considered of no specific environmental interest.
D1	*Urban areas.*
D2	*Areas capable of being urbanised.*
D3	*Intensive agriculture areas.*
D4	*Mining sites.*
D5	*Existing inhabited areas.*

The area of the nature reserve north-northwest, near the identified OPRT site, is designated as Zone A. The zones to the south/southeast of the planned OPRT are designated as zones C2, D3, D5, and with zone B and C1 as narrow zones located along the Rambla Morales in the northeast/southwest direction.

Figure 5.6 ***The Parque Natural Cabo de Gata-Níjar and the division of the park area in zones***



Areas classified under international agreements

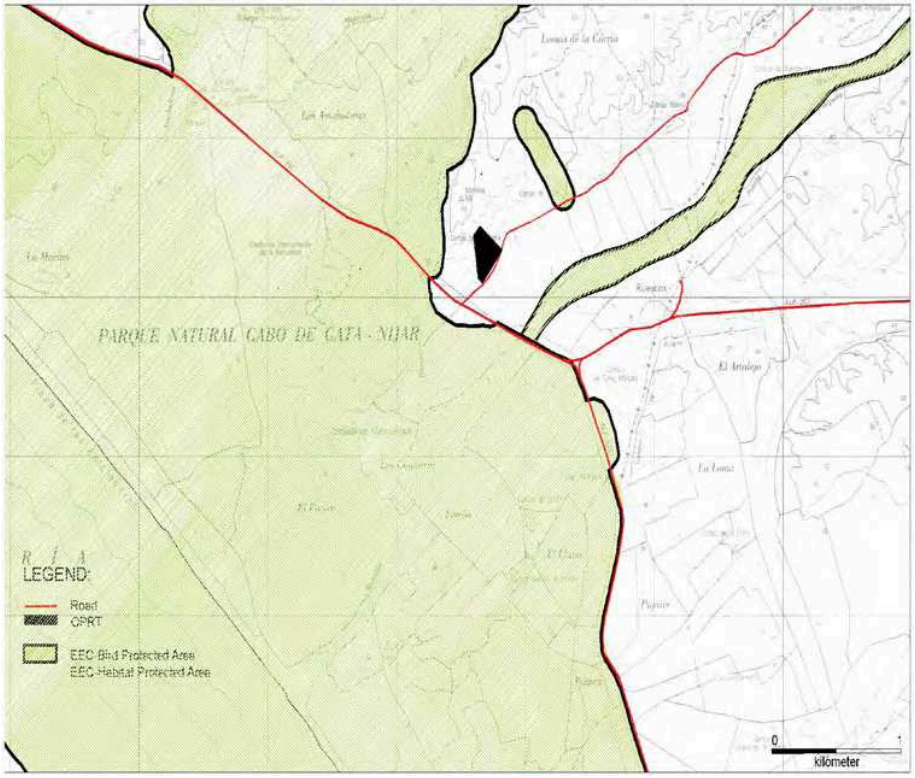
Areas under this heading comprise areas designated pursuant to the EC Birds and Habitats Directives. They are Special Protection Areas (SPA) according to the EC Birds Directive, Council directive 79/409/EC, and special Areas of Conservation (SAC) according to the Habitats Directive, Council Directive 92/43/EC.

The heading also concerns Ramsar sites designated under the Ramsar Convention on wetlands of international importance, especially waterfowl habitat.

Special Protection Areas (SPA) and Special Areas of Conservation (SAC)

The Parque Natural Cabo de Gata-Níjar is both an EC Bird protection area and an EC Habitat protection area. The classified areas near the identified OPRT site are shown in *Figure 5.7.*

Figure 5.7 ***Areas protected under international agreements, the EC Birds and Habitats Directives, designated Natura 2000: Special Protection Areas (SPA), Sites of Community Interest (SCI), Special Areas for Conservation (SAC) near the identified OPRT site***



The EC Birds Directive concerns the conservation and protection of all wild bird species in the European territory of the Member States of the European Union. The network of Special Protection Areas (SPA) for bird species shall, together with the Sites of Community Interest designated under the EC Habitats Directive, form the ecological network Natura 2000, of Special Areas of Conservation (SAC), which is required completed in 2004.

Taking into account only the principal habitat types, Annex I of the Habitats Directive lists today 198 (originally 164) European natural habitat types, including 65 (originally 46) priority habitats. Considering sub-types, the figure increases up to more than 200 habitat types. Habitats of community interest present in the study area are shown in *Table 5.5* .

According to the Natural Resources Regulatory Plan and the Master Plan for the Use and Management of Gata-Níjar Natural Park, the environmental authorities shall prohibit free access to threatened or endangered species reproduction areas, with the purpose of avoiding any alterations in the reproductive process that may jeopardise their continuity in the Natural Park.

Habitats of community interest presents in the study area correspond to 8 EC habitat types, as defined in
Table 5.5.

Table 5.5 EC habitats of community interest

Habitat Code	Habitat
1210	Annual vegetation of drift lines.
1420	Mediterranean and thermo-Atlantic halophilous scrubs (*Arthrocnemetalia*
1430	*fructicosae*).
2120	Iberia halo-nitrophilous scrubs (*Pegano*-Salsoletea).
2210	Shifting dunes along the shoreline with *Ammophila arenaria* (white
2230	dunes).
5220*	*Crucianellion maritimae* (fixed beach dunes).
92D0	*Malcolmietalia* (dune grasslands).
	Arborescent matorral with Zyziphus.
	Thermo-Mediterranean riparian galleries (*Nerio*-Tamariceteae) and south-west Iberian Peninsula riparian galleries (*Securinegion* tinctotiae).
*: Priority Habitat.	

The 8 different habitats inside the study area are described in more detail in *Table 5.6*.

Table 5.6 Description of the habitats inside the study area

Habitat code	Description and location,
5220	**Matorral with *Zyziphus*. Areas 11, 12, 42, 50, 52** Only the habitat coded 5220 (Matorral with *Zyziphus*) is considered a priority habitat. This habitat corresponds to pre-desert deciduous scrub confined to the arid Iberian south-west under a xerophytic thermo-Mediterranean bio-climate; corresponds to the mature phase or climax of climatophile and edapho-xero-psammophile vegetation series. It is only found in south-western Spain, from Mar Menor (Murcia) to cape Sacratif (Granada). The basic species in this habitat is *Zyziphus lotus*. Other common species are *Lycium intricatum*, *Asparagus stipularis*, *Asparagus albus*, *Calicotome intermedia*, *Chamaerops humilis*, *Maytenus senegalensis ssp. europaeus*, *Periploca laevigata ssp. angustifolia*, *Phlomis purpurea ssp. almeriensis*, *Rhamnus oleoides ssp. angustifolia* and *Withania frutescens*.
1210	**Area 38** Habitat coded 1210 (annual vegetation of drift lines) is formations of annuals or representatives of annuals and perennials, occupying accumulations of drift material and gravel rich in nitrogenous organic matter. Plants presents are *Cakile maritima*, *Salsola kali*, *Polygonum sp.*, *Elymus repens*, *Glacium flavum*, *Matthiola sinuata* and *Eryngium maritimum*.
1420	**Mediterranean and thermo-Atlantic halophilous scrubs (*Arthrocnemetalia fructicosae*) Area 43** Perennial vegetation of marine saline muds (schorre) mainly composed of scrubs, essentially with a Mediterranean-Atlantic distribution (*Salicornia*, *Limonium vulgare*, *Suaeda* and *Atriplex* communities) and belonging to the *Sarcocornetea fructicosi* class.

Habitat code	Description and location,
1430	**Iberia halo-nitrophilous scrubs (*Pegano*-Salsoletea). Areas 44, 54** Halo-nitrophilous scrubs (matorrals) belonging to the *Pegano-Salsoletea* class, typically dry soils under arid climates, sometimes including taller, denser brush. Vegetation of *Peganum harmala*, *Artemisia herba-alba*, *Lycium intricatum*, *Capparis ovata*, *Salsola vermiculata*, *Atriplex gluca* etc.
2120	**Shifting dunes along shoreline with *Ammophila arenaria* (white dunes). Areas 38, 42, 50, 51, 52** Habitat coded 2120 (white dunes) are mobile dunes forming the seaward cordon or cordons of dune systems of the coasts, from *Ammophilion arenariae* and *Zygophyllion fontanessi Alliance*, with plants as *Ammophila arenaria*, *Euphorbia paralias*, *Calistegia soldanella*, *Otanthus maritimus*.
2210	**Areas 38, 49** Habitat coded 2210 (*Crucianellion maritimae* fixed beach dunes) corresponds to fixed dunes of the western and central Mediterranean, of the Adriatic, of the Ionian Sea and North Africa. Basic plants of this habitat are *Crucianella maritima* and *Pancratium maritimum*.
2230	**Areas 38, 42** At last, habitat coded 2230 (*Malcolmietalia* dune grasslands) is associated with many small annuals and often abundant ephemeral spring bloom, with species as *Malcolmia lacera*, *Evax astericiflora*, *Anthyllis hamosa* and *Linaria pedunculata*, of deep sands in dry interdunal depressions of the coasts.
92D0	**Thermo-Mediterranean riparian galleries (*Nerio*-Tamariceteae) and south-west Iberian Peninsula riparian galleries (*Securinegion* tinctotiae). Areas 43, 46, 53** Tamerisk, Oleander, Chaste tree galleries and thickets and similar low ligneous formations of permanent or temporary streams and wetlands of the thermo-Mediterranean zone and south-western Iberia, and of the most hygromorphic locations within the Saharo-Mediterranean and Saharo-Sindian zones.

Only habitat code 5220 is a priority habitat. It is seen in the sub areas 11, 12, 42, 50 and 52. As indicated in the Habitats Directive, 'priority habitat' means a natural habitat in danger of disappearing. The European Community has a particular responsibility for the conservation of a priority habitat, due to the proportion of its appearance in the considered territory.

Further information on the different types of habitats/vegetation inside the study area are shown in *Appendix 1*. The figure shows that the areas on both sides of Rambla Morales are predominantly cultivated areas applying irrigation. The vegetation will be discussed in more detail in a later section.

Ramsar sites

Ramsar site no. 448, Salinas del Cabo de Gata, with an area of 300 ha, is located about 5 km southeast of the identified OPRT site. It is an area of saltpans occupying a coastal depression at the foot of the mountains and

separated from the sea by a dune complex. The immediate vicinity of the saltpans supports salt-resistant vegetation. The area is important for breeding, staging and wintering of various species of water birds 3.

Vegetation

This section describes the present vegetation in the area. A complimentary study was conducted by the University of Almería and the Autonomous University of Madrid which looked at the vegetation and the flora and fauna in the Rambla Morales area. This is available in the *Appendix 1*of this EIA. Furthermore, the Spanish EIA contains a deep description of these issues.

The combination of the marine environment and semi-arid conditions, are the main factors that have determined the vegetation types along the pipeline route in the Spanish land sector. Along the route, a gradient is apparent, from the areas of high salinity and poorly fixed sandy soils, to areas where the marine influence is small enough to allow the existence of species typical of inland environments.

Among the species of plants, those, that because of their current status of conservation or sensibility, can be considered to be most important are:

- *Androcymbium europaeum*
- *Ziziphus lotus*
- *Cynomorium coccineum*
- *Caralluma europaea*

The characteristics of the vegetation at the area around the identified OPRT site are determined both by the local climate, of a sub-arid nature, with high average humidity, evaporation and solar exposure, and by conditions, with poorly fixing soils. It is classified in the Murciano-Almeriense biogeographically unit, on the Thermo Mediterranean belt. The most outstanding elements include the European fan palm (*Chamaerops humilis*), the only native palm of the European continent, and *Ziziphus lotus*, a shrubby deciduous plant species from the Rhamnaceae family, uniquely adapted to the environment. Thickets of this plant *Ziziphetum loti* alliance form the potential woody vegetation of the area considered. Other notable species include the endemic *Teucrium charidemi*, *Dyanthus charidermi* and *Antirrhinum charidemi*, whose distribution is limited to the area of Cabo de Gata Natural Park.

The most abundant vegetation types near and at the planned OPRT is the thyme scrub, resulting from the degradation of the previously existing woodland (spiny thickets and palm groves) due to its overexploitation for firewood, grazing or due to fires. Another less abundant element is the *Tamaricaceae* scrub, located in the vicinity of the Morales intermittent river, along with various types of pasture. Typical formations of littoral vegetation appears in the proximity of the coast.

The dominant species in the thyme scrub are *Limonium* sp. and *Salsola* sp., which constitute the only elements present in the littoral scrub, which in turn is enriched inland with different species of the family Labiatae and Cistaceae. The abundance of chlorides in the soils also gives rise to the appearance of species such as *Arthrocnemum fruticosum* from the Goosefoot family. The only woody species that appear are occasional stands of *Periploca angustifolia* (family Asclepiadaceae), *Maytenus senegalensis* (family Anacardiaceae), *Phlomis caballeroi* and Jerusalem sage (*Phlomis purpurea*) from the family Lamiaceae, and the Small-flowered gorse (*Ulex parviflorus*). On litho soils, alongside more common species, the most notable element is *Thymelaea hirsuta*.

As mentioned before the vegetation is conditioned by several obvious factors, as follows:

- Geographical location, at the far southeast of the Iberian peninsula.
- Soil features, with poorly fixing soils.
- Climatic features, especially marine influence in a semi-arid environment.
- Relatively soft human influence.

The sum of these factors defines rich vegetation, dominated by spiny species of desert areas, with *Chamaeropo-Rhamnetum lycoidis* or *Zizyphetum loti* as climax associations. The destruction and regression of the climax vegetation conduct to the development of maquia ("matorrales") from *Rosmarinetalia* order and, if adverse factors continued, to open bush semi-arid formations ("tomillar").

One of the scarce wood species is Carob/St. John´s Bread (*Ceratonia siliqua*) considered as subspontaneus species. Other species of wooded bushes typical of the study area are the botanical ancestor of the modern olive tree *Olea sylvestris*, the Mastic tree (*Pistacia lentiscus*), *Daphne gnidium* (family of Thymelaeceae), *Rhamnus lycioides* and Italien buckthorn hedge (*Rhamnus alaternus*), both from the family Rhamnaceae. The extreme aridity of the environment makes the presence of these species very rare, limited to humid places, in contact with the European fan palm (*Chamaerops humilis*) and spiny shrubby formations from the *Mayteno-Periplocetum angustifoliae* association, with detached Mediterranean and North African species as *Periploca laevogata* (family of *Asclepiadaceae*) and Withania frutescens (family *Scrophulariaceae*).

In more adventageous biotopes, the *Mayteno-Periplocetum angustifoliae* association is replaced by *Zizyphetum loti*, an association from the same alliance. In sandy and arid places, Zyziphus lotus forms big cushions that shape a unique landscape.

Over poorly developed soils appears a shrubby and herbaceous formation endemic of the Cabo de Gata area called *Phlomidi-Ulicetum canescentis* association, part of *Genisto-Phlomidion* alliance, with charactristic species as the Small-flowered gorse (*Ulex parviflorus*) and Jerusalem sage (*Phlomis purpurea*). Over clay or stony soils appears the *Limono-Anabasetum hispanica* association

(*Anthyllido-Salsolion papillosae* Alliance), with a sub-association endemic of the Cabo de Gata area, *Teucrietosum charidemi.*

The beach itself is not regarded as a significant habitat for birds. Marine turtles have not been recorded in the area.

Fauna general

This section describes the present fauna in the area but, as mentioned earlier, it is important to mention that a complimentary study was conducted by the University of Almería and the Autonomous University of Madrid which looked at the vegetation and the flora and fauna in the Rambla Morales area. This is available in *Appendix 1*.

The most notable elements of the fauna are related to the bird life, in particular the Flamingo (*Phoenicopterus ruber*) and different species of gulls and sandpipers, such as the Manx shearwater (*Puffinus puffinus*), *Procellaria diomedea*, the Snowy plover (*Charadrius alexandrinus*) and the Storm petrel (*Hydrobates pelagicus*). The steppe influence leads to the appearance of birds such as Dupont´s lark (*Chersophilus duponti*). The most outstanding of the Anatidae present are the White-headed duck (*Oxyura leucocephala*) and the Common Shellduck (*Tadorna tadorna*).

Birds

This sub-section provides a general overview of birds known to be present on, or in the general vicinity of, the route:

The abundant and diverse bird life is, by far, the most dominant feature of the fauna in the general area of the proposed route, especially in the Rambla Morales wetland. However, particular mention must be given to the following species:

- White headed duck (*Oxyura leucocephala*), which has started to breed in the Rambla wetland during the last two years.
- Greater flamingo (*Phoenicopterus ruber*), not because of its rarity, but because the flocks of these birds on the Rambla wetland are an integral component of the local tourist attractions.
- Dupont's Lark (*Cherophilus dupontii)* and other bird species typical of the steppe environment. They are threatened through degradation of their natural habitat (the expansion of dry cultivation and forestation) and fragmentation of their range.

An extensive, categorised listing is given in the table below. The seasonal presence of each species in Southern Spain has been included. Where a species designated under the EC Habitats Directive occurs it has been marked by an asterisk and notes on its key local sensitivities provided, if available:

Table 5.7 Bird Species Potentially Present in the Spanish Land Sector

Category	Common name	Latin name	Seasonal presence (See footnote)	Key sensitivities
Ducks Waders	*White headed duck	*Oxyura leucocephala*	Year round	Breeding period from April to July, principally in small, shallow, brackish wetlands with abundant submerged vegetation and extensive reed beds
	Common shellduck	*Tadorna tadorna*	Small numbers winter around the Mediterranean	
	Mallard	*Anas platyhynchos*	Resident	
	Garganey	*Anas querquedula*	Spring / summer nesting, some may winter	
	Teal	*Anas crecca*	Resident / Winter	
	Marbled duck	*Mararonetta angustirostris*	Some birds disperse from breeding areas, some remain all year.	
	Red breasted merganser	*Mergus serrator*	Winter visitor	
	Pintail	*Anus acuta*	Winter visitor	
	Gadwall	*Anas strepera*	Winter visitor	
	Wigeon	*Anas penelope*	Winter visitor	
	Shoveler	*Anas clypeata*	Winter visitor	
	Pochard	*Aythia ferina*	Winter visitor	
	Red crested pochard	*Netta rufina*	Resident	
	*Greater flamingo	*Phoenicopterus ruber*	Some populations resident,	Nesting from May to June. Non-breeders are often present on wintering grounds all year. Very likely to desert breeding and wintering sites.
	Little grebe	*Tachybatus rukkicollis*	Resident	
	Black necked grebe	*Podiceps nigricollis*	Resident	
	Great crested grebe	*Podiceps cristatus*	Winter visitor	
	*Spoonbill	*Platalea leucorida*	Resident	Nesting in Spring
	Grey heron	*Ardea cinerea*	Resident	
	Purple heron	*Ardea purpurea*	Summer visitor	
	*Night heron	*Nycticorax nycticorax*	Summer visitor	Breeds during the summer. Breeds and roosts in trees and bushes usually close to shallow, reed-fringed lakes, marshes or fishponds where they feed
	Cattle egret	*Bulbulculus ibis*	Resident	
	*Little egret	*Egreta garzeta*	Winter visitor	Wide spread
	Kentish plover	*Charadrius alexandrinus*	Nester	

Category	Common name	Latin name	Seasonal presence (See footnote)	Key sensitivities
	Black-winged stilt	*Himantopus himantopus*	Nester	
	*Avocet	*Recurvirostra avosetta*	Summer visitor	Breeds in shallow brackish lagoons and also near estuaries
	*Little bittern	*Ixobrychus minutus*	Summer visitor	Breeds in reed beds around lakes, dykes and fish ponds
Sea birds	*Manx shearwater	*Puffinus puffinus*	Winter visitor	
	Cory's shearwater	*Calonectrix diomedea*	Passage visitor	
	*Storm petrel	*Hydrobates pelagicus*	Winter visitor	
	Yellow-legged gull	*Larus cachinnans*		
	Black-headed gull	*Larus ridibundus*		Breeds in Cabo de Gata (10 pairs recorded in 2000)
	shag	*Phalacrocorax aristotelis*		
	Common tern	*Sterna hirundo*		Breeds in Cabo de Gata (80 pairs recorded in 2000)
	Little tern	*Sterna albifrons*		Breeds in Cabo de Gata (90 pairs recorded in 2000)
	*Audouin's gull	*Larus audouinii*	Winter visitor	
	Northern gannet	*Sula bassana*	Winter visitor	
Perching birds	House sparrow	*Passer domesticus*	Resident	
	Chaffinch	*Fringilla coelebs*	Resident	
	Spotted flycatcher	*Muscicapa striata*	Resident	
	Reed bunting	*Emberiza schoeniclus*	Winter visitor	
	Rock bunting	*Embereiza cia*	Resident	
	Corn bunting	*Miliaria calandra*	Resident	
	Linnet	*Carduelis cannabina*	Resident	
	Robin	*Erithacus rubecula*	Resident	
	Serin	*Serinus serinus*	Resident	
	Siskin	*Carduelis spinus*	Resident	
	Goldfinch	*Carduelis carduelis*	Resident	
	Greenfinch	*Carduelis chloris*	Resident	
	*Trumpeter finch	*Rhodopechis gigantea*	Resident.	A rare North African species that is now colonising south-east Spain. In winter, the species frequents coastal zones.
Warblers				
	Cetti's warbler	*Cettia cetti*	Resident	
	Willow warbler	*Phylloscopus trochilus*	Passage visitor	

Category	Common name	Latin name	Seasonal presence (See footnote)	Key sensitivities
	Chiffchaff	*Phylloscopus collybita*	Resident	
	Fantailed warbler	*Cisticola juncidis*	Resident	
	*Dartford warbler	*Sylvia undata*	Resident	Breeds and winters on heaths and scrub, mainly in gorse
	Sub-alpine warbler	*Sylvia cantillans*	Summer visitor	
	Whitethroat	*Sylvia communis*	Resident	
	Sardinian warbler	*Sylvia melanocephala*	Resident	
	Blackcap	*Sylvia atricapilla*	Resident	
	Garden warbler	*Sylvia borin*	Resident	
	Spectacled warbler	*Sylvia conspicillata*	Resident	
Thrushes	*Black wheatear	*Ornanthe leucura*	Resident	Habitat deterioration, afforestation and severe winters may cause extinctions locally
	Northern wheatear	*Oenanthe oenanthe*	Summer visitor	
	Black-eared wheatear	*Oenanthe hispanica*	Summer visitor	
	Stonechat	*Saxicola torquata*	Resident	
	Redstart	*Phoenicurus phoenicurus*	Resident	
	Black redstart	*Phoenicurus ochruros*	Resident	
	Rufous bush robin	*Cercotrichas galactotes*	Summer visitor	
	Mistle thrush	*Turdus viscivorus*	Resident	
	Fieldfare	*Turdus pilaiis*	Winter visitor	
	Blue rock thrush	*Monticola solitarius*	Resident	
	Song thrush	*Turdis philomelos*	Winter visitor	
	Black bird	*Turdis merula*	Resident	
	Redwing	*Turdis iliacus*	Winter visitor	
Birds of prey	*Honey buzzard	*Pernis apivorus*	Autumn Winter visitor	
	*Hen harrier	*Circus cyaneus*	Winter visitor	
	*Short-toed eagle	*Circaetus gallicus*	Summer visitor	Breeding period in summer
	Montagu's harrier	*Circus pygargus*	Passage migrant, April to October	
	*Marsh harrier	*Circus aeruginosus*	Resident	Breeds and winters in extensive reed beds, often hunting in open country nearby
	*Bonelli's eagle	*Hieraaetus fasciatus*	Resident	Winter time frequents low land areas

Category	Common name	Latin name	Seasonal presence (See footnote)	Key sensitivities
	*Peregrine falcon	*Falco peregrinus*	Resident	Winter time frequents low land areas
	*Osprey	*Pandion haliaetus*	Passage migrant	
	*Eleanora's falcon	*Falco elanorae*	Summer visitor	Breeds colonially on sea cliffs or islets, but may travel a few miles inland to feed, especially on insects over marshes
	Kestrel	*Falco tinnunculus*	Resident	
	*Egyptian vulture	*Neophron percnopterus*	Present from February to September	Breeds on high ground (cliffs), but may frequent low land areas
	*Griffon vulture	*Gyps fulvus*	Resident	Breeds on high ground (cliffs), but may frequent low land areas
	Eagle owl	*Bubo bubo*	Resident	Generally only occurs where relatively undisturbed by man. Usually in rocky areas with cliffs and gorges, rockfalls and caves. Some cover in the form of trees or bushes is needed and also found in forest and woodland, often in mountains.
Steppe birds	*Dupont's Lark	*Cherophilus dupontii*	Resident	A specially protected species typical of the steppe environment. It is threatened through degradation of its natural habitat (the expansion of dry cultivation and forestation) and fragmentation of its range
	Stone curlew	*Burhinus oedicnemus*	Resident	Breeds on dry stony heaths and arable land. Present in areas of plains, dry, open country, including grassland, sand-dunes, and heath land with sparse vegetation, open pine woods, farmland and areas of bare ground, stones or sand along riverbanks. Also found in steppe and semi-desert, open plains and bare hillsides. Chiefly crepuscular or nocturnal, more active during the day when feeding young.

Category	Common name	Latin name	Seasonal presence (See footnote)	Key sensitivities
	Theklas lark	*Galerida theklae*	Resident	Found in similar habitats but usually occurs away from man and less often on roadsides and on cultivated land. In some areas found at higher levels on rocky and bush-covered hillsides. Locally common, for example in the hills near Almería and on the Zaragoza Plains
	Lesser short-toed lark	*Calandrella rubescens*	Resident	Occurs in stony or rocky areas on steppes, semi-desert and open cultivated land with short vegetation especially where wetlands such as salt-pans, lakes or marshes have dried out. Numerous in the hills around Almería and the plains near Zaragoza.
	Roller	*Coracias garrulus*	Summer visitor	Leaves in August-October to winter mainly in East Africa. Return movements occur in April-May. Occurs often in steppe and semi-desert in the east of the range. Nests in holes in trees, rock faces or buildings. Feeds in open or semi-open areas often perching on wires.
	Little Bustard	*Tetrax tetrax*	Resident	Is found in open habitats, mainly grasslands on steppes and plains, also cereal and clover fields
	Alpine swift	*Apus melba*	Summer visitor	Breeds in the area on tall buildings and crevices in cliff faces. It is migratory, leaving breeding areas in September-early October and wintering in sub-Saharan Africa. Return movement is mainly in April.
	Pin tailed sand grouse	*Pterocles alchata*	Resident	Typically found and breeds in open sandy areas with sparse vegetation, often on sandy river banks.
	Crane	*Grus grus*	Winter passage visitor	
Others	*White stork	*Ciconia ciconia*	Summer visitor	Breeds in towns and villages on roof tops and poles or, in colonies, in trees in open parkland. Feeds mostly in fields and meadows

Category	Common name	Latin name	Seasonal presence (See footnote)	Key sensitivities
	*Black stork	*Ciconia nigra*	Summer visitor	Breeds in wooded areas or on riverside cliffs. Feeds beside lakes and rivers or in marshy fields

Footnote: Sources references are as follows: Birdguides (1999). Eurobirding (accessed 2004). EU threatened birds list (accessed 2004). Bird watching in Spain (accessed 2004). Paracuellos (2003).

Mammals

Typical mammals in the study area through which the pipeline will cross are listed below:

Table 5.8 Mammals Potentially Present in the Spanish Land Sector

Common name	Latin name
Western hedgehog	*Erinaceus europaeus*
Algerian hedgehog	*Atalerix algirus*
Pygmy white-toothed shrew	*Suncus etruscus*
Greater white-toothed shrew	*Crocidura russula*
Iberian hare	*Lepus granatensis*
Rabbit	*Oryctolagus cunniculus*
Mediterranean pine vole	*Microtus duodecimcostatus*
Wood mouse	*Apodemus sylvaicus*
Black rat	*Rattus rattus*
House mouse	*Mus domesticus*
Red fox	*Vulpus vulpus*
Weasel	*Mustela nivalis*
BECh marten	*Martes foina*
Eurasian badger	*Meles meles*
Small spotted genet	*Genetta genetta*
Wild boar	*Sus scoffa*

Reptiles

The most notable reptile is the snub-nosed viper (*Vipera latasti*), which is found in low-lying hill areas, in rocky or forested areas and occasionally in sandy habitats. Although diurnal by nature it may also be nocturnally active if the weather is warm. Other examples are the ocellated lizard (*Lacerta lepida*) and Montpellier snake (*Malpolon monspessulanum*).

Amphibians

Only species such as the common toad (*Bufo bufo*) are likely to be present, because of the arid nature of the area and the dependence of amphibians on permanent surface water.

5.5.2 *Land Sector, Algeria*

The land sector route from the Sidi Djelloul beach is through an area that is mainly devoted to agriculture, leisure and tourism. It is, therefore, not likely to be of great significance with regard to important species or habitats for flora or fauna. The only exceptions are, perhaps, the local and migratory birds which use the cliffs for breeding or resting during migration. The main areas are the cliffs close to the sea, which are well away from the pipeline route and the bird species are likely to be common and widespread, including gulls, gannet, storm petrel and shearwaters. There are no national parks, areas of sensitivity, or potentially designated areas of special interest within a distance where they could be affected by this project.

5.5.3 *Marine Sectors*

Benthic Communities

General Overview:

The determining factors for a particular benthic habitat are depth, light penetration, substrate composition, currents, tides, wave action, and anthropogenic activity. Taking these factors into account, a study of the literature has identified the potential for several relevant habitat types along the pipeline route which are discussed below. Some habitats occurring in the Alborán sea are not present along the pipeline route, and are not described in detail.

Generally the habitats in the Alborán Sea can be classified into hard substrates and soft substrates. The areas of hard substrate are often the more significant, as they are normally small and may support significant and diverse communities; however, they only cover a very small proportion of the pipeline route. Soft substrates cover most of the seabed and although several different habitats may be characterised, they do not support such a range of communities, neither in terms of abundance nor diversity. Species are generally common and widespread and not of special scientific interest or concern.

Depth-related environments include:

- Bathyal depths
- Continental slope
- Continental platform

- Circalittoral (approx 40-80 m depth, reduced light penetration)
- Infralittoral (approx 0-40 m depth, includes photophyllic vegetation)

Maps 5.4 and *5.5* show Potential Benthic Communities on the Spanish and Algerian side of the pipeline route.

As committed by MEDGAZ, a detailed ROV seabed survey along the pipeline route has been carried out (summer/2004) by using side-scan sonar to identify potential habitats, supported by video and still photography to confirm locations of special interest and determine whether or not these habitats are actually present. The results of this survey are included as *Appendix 2* (Marine Biology Survey Report).

Hard Surface Habitats

AFIC	Photophyllic algal communities. Not encountered along the pipeline route.
AECMC	Coralligen communities.
FRB	Bathyal hard substrates

Note: Maerl could be associated with the soft detritic substrate circa-littoral community FDC, but only appears where the substrate is firm, either due to a layer of bio-genous remains, on sub-cropping rock, or close to rock outcrops.

Soft Surface Habitats

The following types of habitat may be found along the pipeline route, either as distinct areas or else as mixed areas where the composition of clay, sand and silt may vary, or where the layer of detritus (generally shells) is exposed on the surface.

AS	Shallow water fine sand
AFC	Well sorted fine sand
PP	*Posidonia* seagrass beds
CY	*Cymodocea* seagrass beds
AFMC	Silty sand in standing waters
FB	Bathyal silts
FDBP	Detritic bottoms of the shelf margin
FDC	Detritic coastal bottoms
FTP	Teluric silts of the continental shelf

Other soft surface habitats

Other Mediterranean marine habitats include:

FAT	Slope sandy bottoms
FDE	Detritic clay bottoms
FDT	Slope detritic bottoms

However, survey data so far gathered indicate that these habitat types may not be present along the pipeline route corridor.

Map 5.4 ***Potential Benthic Communities Spanish side***

Map 5.5 ***Potential Benthic Communities Algerian side***

Communities typical of hard seabed surfaces

On the hard rocky substrates, which are encountered in short sections of the continental shelf and slope the following communities may be present:

(i) Photophyllic algal communities (AFIC)

These tend to occur on well-lit rocky surfaces at depths down to 30m. They are dominated by macro-algae and are abundant with fish life. However these conditions are not encountered along the pipeline route.

(ii) Coralligen (coral forming) communities (AECMC)

Communities of calcareous algae occur principally in the circa-littoral zone, but may also be found in the infra-littoral zone at the limits of light penetration, on rocky outcrops generally within 40 to 100m water depth. The structure-building organisms are calcareous, or coralligen algae, including *Lithophyllum expansum*, M*esophyllum lichenoides*, and *Plocamium cartilagineum.* They grow in continuous horizontal planes, to take advantage of the limited light, presenting ideal habitats for highly rich and diverse communities. The principal species occurring include suspension-feeding invertebrates such as sponges (eg. *Ircinia oros* and *Petrosia ficiformis*), sea squirts, polyzoa, violescent sea-whip (*Paramuricea clavata*) sea fans (gorgonia), sea urchins, lobsters (eg. *Homarus gamarus* and *Scyllarides latus*), common brittle star, (*Ophiothrix fragilis*), the jelly fish head coral (*astrospartus mediterraneus*) and various fish species such as conger eel, (*Conger conger*); blunt-headed holy fish (*Anthias anthias*); and cardinal fish (*Apogon imberbis*). They are common in similar depths and substrates in the whole of the Mediterranean and are well known to divers. They are present in Spain, in especially well preserved communities, in the Medas Islands, the Columbretes Islands, the Balearics, and Alborán Island.

These structures are included in the EC Habitats Directive, Category 1170, Reefs, and are regarded as being of high value for their rich biodiversity and their visual beauty.

Within the communities supported by the coralligen structures are some species which are accorded special status:

Red Coral (*Corallium rubrum*), also known a Precious Coral, is classified as Ct by the IUCN Red Book (invertebrates). However it is exploited in many Mediterranean countries, including Spain, where it is controlled under fishing regulations. It lives mostly between 60-100m water depth, or in shallower areas where light is depleted. It is particularly abundant in the Alborán Island Park.

Diadem, or long-spined sea urchin (Centrostephanus longispinus). This appears in Annex II of the Habitats Directive, as well as Annexes II and IV of the Barcelona Convention. It is also included in the Spanish Catalogue of

Endangered Species under the category of "Special Interest" (the lowest danger category). Its preferred habitat is rocky outcrops below 50 m, and is believed to be widespread in the Balearics, Mediterranean and Alborán Sea.

Gorgonians (Seafans) (*Paramuricea* sp.)

These species are considered one of the most beautiful and characteristic of the coralligen. Although not legally protected, there is concern over threats to them from their attraction to sports divers, trawling, and possibly increases in seawater temperature.

A study of the seabed and bathymetry survey data indicates that there are some rocky out-crops near to the pipeline corridor in Spanish waters, between KP177 and 186 in depths of 209 to 59 m. As the route passes NW towards the landfall, parallel to the Cabo de Gata coastline, but outside the designated marine nature reserve, more rocky outcrops are encountered at KP180/181 (depth 80/84m), and sub-cropping at KP181/183 (depth 90/84m). Between KP190 and 194 there is a band of rock to the SW of the pipeline route at a depth of 70 m which is known to support a very rare corralligen community. However, the pipeline is at a water depth of 60-61 m and at least 300m from the rocky band. At this location, the pipeline will be laid in the seabed surface, with no trenching or post-lay stabilisation required. On the Algerian side, a rocky out-crop has been recorded between KP15 and 20, in depths of 120 to 140 m. The rocky areas which the pipeline route crosses could support coralligen communities, but they are at depths where growth is not likely to be vigorous, due to being at the deeper extreme of their depth distribution range. Moreover, their possible locations are at depths where no trenching will take place, where the pipeline will be laid directly on the seabed.

(iii) Bathyal hard substrates (Habitat FRB)

Cold Water Corals

Cold water corals thrive at the present time in the deep waters of the eastern Atlantic Ocean. During the Pleistocene epoch, these corals (*Lophelia pertusa* and *Madrepora oculata*) were equally common in the Mediterranean basin, as evidenced by submerged and out-cropping fossil assemblages. Remains of white corals (*lophelia)* may be found on bathyal hard substrates in deep waters beyond the continental slope. Changes to the sea conditions due to the post-glacial transition are believed to have led to their decline (Taviani, M. et al).

The EC Habitats Directive has motivated intensive searches for evidence of present day occurrences of these corals and they have been found in many parts of the Mediterranean, at 300 to 1000 m water depths These could be included in EC habitat category 1170 (reefs). Occasionally they are found in shallower waters, as for example in Norwegian waters, and on the Galicia Bank. In Spain, as well as the Galicia Bank, *Lophelia pertusa* has been found in the Straits of Gibraltar and offshore of Granada Province, 200 km from the

planned pipeline landfall as well as on La Polacra ridge 20 nautical miles offshore in 1000m water depth. Therefore the potential for deep water corals along the pipeline route cannot be discounted, as it would be associated with habitat FRB (bathyal hard substrate). Research shows that the greatest concentration of coral fragments are on the shelf slope, where the rising deep water currents carry the nutrients favouring coral growth. However, a study of the bathymetric and substrate data from the several route surveys for this project has not identified any outcrops which could be interpreted as coral structures, so the probability of their presence is believed to be low (Alvarez-Perez et al).

Communities typical of soft seabed surfaces

The seabed along the proposed route is mainly soft sand, silt, and clay, so the benthic communities are mainly typical of these substrates; sandy sediments in the shallow waters on the continental shelves and general soft substrates on the continental slopes and deep waters. Most of the categories described provide habitats for species which are common, widespread, and occur in low to medium densities, the exceptions being sea grasses (see below).

(i) Shallow water fine sand community (Habitat AS)

This inshore strip of sandy beach between the shoreline and depths of about 4 m is subject to constant wave action. It is included in EC Habitat Code 1110, and is poor in species, and those which are found interact to form an ecological community (biocoenosis). The habitat is dominated by bivalve molluscs, but crabs (*Pugilator digenes* and *Portunus latipes*) and polychaetes (eg *Glycera convoluta*) are also found. This habitat extends to approximately 300m from the shoreline on both the Spanish and Algerian coasts.

(ii) Well sorted fine sand (Habitat AFC)

This habitat forms a band between the AS and the seagrass beds (if present), in the depth range of 4-20 m. It does not present vegetation, but is more diverse than AS, with the appearance of different species of molluscs, crustacea, echinoderms and fish. On the Algerian side it extends from 4 m down to 40 m depth at KP2. On the Spanish side it extends down to just below the 30 m water depth at KP196 (including the *Cymodocea* seagrass beds).

(iii) Sea Grasses, (Habitats CY, PP)

Two species of sea grass, *Posidonia oceanica* and *Cymodocea nodosa,* included in the EC Habitats Directive, occur along or in the vicinity of the pipeline route. The conservation values of sea grasses lie in the fact that they are an important marine community, and these particular species are only found in the Mediterranean basin. The *Posidonia* sea grasses are important as hatcheries for a variety of fish, they retain sediments and oxygenate seawater. One hectare of *Posidonia oceanica* produces 21 ton/year of biomass, similar to the productivity of a tropical forest (22 ton/year/ha) (UNEP/WCMC 2003).

Cymodocea has a high re-colonisation capacity, so functions as a pioneer habitat, but is included in the EC Habitat Code 1110 (sandbanks slightly covered all the time), which is not considered to be a priority habitat. However, it may also represent a stage in the degradation of pre-existing formations of *Posidonia,* which is a much more vulnerable species (EC Habitat 1120, *Posidonia* beds).

A broken band of *Cymodocea nodosa*, which typically occurs on fine or sludgy sands in areas of moderate hydrodynamic conditions, has been charted adjacent to the Spanish landfall at KP197 to 198. It lies between water depths 5-20 m and within the B-zone protection area. The pipeline route will cross this band. It has also been observed as an extended patchy bed at a depth of 30-40 m from approximately KP192 to KP189. However, the pipeline passes at least 1.5 km from this bed, at a water depth of 60 m.

Further out to sea, from KP185 to KP188, an extensive band of *Posidonia oceanica* has been identified, reaching a maximum depth of 40 m. This is consistent with the ability of this species to also thrive on a hard substrate with thin sedimentary cover, because it is confined to the rocky platform that forms the marine extension of the Cabo de Gata. The pipeline passes at a distance of 0.8 to 1.5 km to the south of this seagrass band, at water depths of 50-70m

Two patchy distributions of the sea grass, *Cymodocea nodosa*, have also been observed at the outer margins of the proposed route on the Algerian side, at distances of 200 m and 600 m, respectively.

Map 5.6 ***Sea Grass Areas in the Spanish Approaches***

Map 5.7 ***Sea Grass Areas in the Algerian Approaches***

(iv) Silty sand in standing waters (Habitat AFMC)

This habitat is a sludgy-sandy sediment resulting from high inflows of terrestrial silt in a low energy marine environment. It is normally present in the upper infra-littoral area where light penetration is high, (generally less than 40 m water depth), but may also appear at greater depths. It is generally relatively poorer in species than non-sludgy sands.

(v) Detritic coastal bottoms (Habitat FDC)

This habitat is characterised by a mixture of sands and biogenous remains (mollusc and echinoderm shells, calcareous algae, byozoans, etc). It is usually present in the circalittoral zone, up to depths of 100 m, generally associated with rocky bottom communities close to coralligen communities. It is relatively rich in invertebrate species. Maerl is most likely to be found in this habitat

Maerl

Maerl develops when coralline red algae (seaweeds), which have a hard calcium carbonate skeleton, accumulate into flat beds, ripples or large banks. The resulting interlocking lattice can harbour a high diversity of organisms, mainly invertebrates. Although some maerl beds may be up to 8000 years old, little is known about their life cycle dynamics. In support of the EC Habitats Directive, an extensive study is currently being carried out under the EC Bio-maerl Programme. Maerl beds are known to exist on the Mediterranean coast of Spain, off Punta de la Polacra, within the Cabo de Gata National Park but some 30km NE of the project area and further north near Alicante. Similarly, off the Algerian coast, they are far to the east of the proposed landfall (Birkitt et al). It has also been found in the Alborán Island Park.

It is most likely to be found in habitat type FDC (detritic coastal bottoms), which is comprised of a mixture of sands and bigenous remains, and likely to be found in the circalittoral level at depths of down to 100m. It is generally associated with rocky bottom communities close to coralligen communities. It is possible that this habitat may be found below the seagrass band on the Spanish side, from KP196 to KP179.4, and between 20-100 m water depth, from KP2 to KP10, on the Algerian side. However, the substrate is principally fine sand along these sections of the route, and detritic material is not observed shallower than KP192 (63 m water depth), and even then it is covered by a layer of fine sand and silt, leading to the conclusion that the chances of occurrence are quite low.

(vi) Bathyal Silts and Clays (Habitat FB)

These are found both at the deep end of the continental slope and on bathyal bottoms. The sedimentation of sludge at great depths supports communities which are fairly impoverished and are comprised of sponges, crabs,

gasterpods and the occasional crinoid. Pockmarks create special conditions in these deep water habitats.

Pockmarks

Pockmarks are designated as potential habitats under the EC Habitats Directive, Category 1180, submarine structures made by leaking gases, and have been identified along the pipeline route. They are mainly formed by leaking natural gas (methane), but can also be formed by escaping groundwater. The escaping fluid erodes the seabed sediments to form a crater, which in the North Sea can vary in size from 50-300 m diameter and 1-6 m deep (DTI 2001). They are important as habitats because the methane reacts with seabed salts to form a carbonate, which can cement the normal sediments to form MDAC (Methane-Derived Authigenic Carbonate). The resultant concretions can grow in size to form structures up to 4 m high. These structures may shelter a highly diverse ecosystem, often with highly coloured species (Judd 2001). They may also be significant because of the utilisation of methane and associated hydrogen sulphide by chemo-synthesising organisms, which are a potential food source for other organisms, such as filter feeders. Furthermore, MDAC provides a hard substrate suitable for colonisation by benthic organisms

Seepage or pockmarks has been identified alongside the pipeline route at the following locations; however, it should be noted that the only active seepage is from the clay/shale domes at KP26. All other pockmarks are believed to be relics (non-active) probably from a historic single event. No marine life or structures of any kind have been observed at any pockmark location.

Table 5.9 Locations of Seepage Points and Pockmarks alongside the Route

KP	Water Depth (m)	Description
25.5-26.5	277-289	Gas seepage from clay domes (diapirs) 10-20m high, at a distance of 300m from route. Potential slow clay/shale uplift with associated gas seepage.
47-51	479-530	Numerous pockmarks up to 50m diameter 3-6m deep. Minimum proximity 50m
56		Linear pockmark cluster. Potential thermogenic gas seepage. Minimum proximity 50m, but West pipeline route may cross individual depressions.
59.7	742	Line of densely spaced pockmarks 30 to 50m diameter x 2 to 3m deep.
63-68	874-1276	Isolated small pockmarks 8m x 2m deep.
162	965	Fluid release pockmark depressions to the North-west. Route is on the southern margin of an extensive pockmark area.

KP	Water Depth (m)	Description
163.5-177.3	893-181	Numerous fluid release pockmark depressions 3-6m deep, up to 50m diameter. Adjacent to, and locally on the pipeline route. Route selection will minimise crossing of these features, but 16 individual pockmarks have been identified within 25m of the east or west pipeline routes..

Pelagic communities

This section describes communities and species which occur in the marine water column.

(i) Plankton

The plankton community structure in this region is controlled by hydrodynamics, particularly the interface between Atlantic and Mediterranean waters. Atlantic surface water enters the Alborán Sea through the Straits of Gibraltar and circulates anti-clockwise. Due to evaporation, this surface water (0-200 m deep) increases in salinity, and sinks to become the Mediterranean intermediate water (200-600 m deep), which eventually (residence time up to 80 years) flows back into the Atlantic. This mixing of cold, less saline Atlantic water with warmer highly saline Mediterranean water, combined with the topography of the Alborán Basin results in important thermoclines, haloclines, and up-welling of plankton that attract many populations of marine species (*Schembri P*).

Plankton is generally found in the upper 100 metres of the water column, and the Andalusian coast is regarded as important area for plankton (Reul 2001).

(ii) Crustacea, Fish and Cephalopods

The most commercially important crustacean found in the area is the red shrimp, *Aristeus antennatus,* which is the most common in the Alborán Sea, and generally found between 400 and 950m water depth. Almería is a very important port for the red shrimp. However, there are seasonal variations in the catches, with the highest yields in the summer (COMEPED-FAO). The red shrimp is also the most commonly occurring species in Algerian waters. The associated industry is centred on the port of Cherchell, to the west of the Algerian landfall.

The following table shows the most important fish and cephalopods in the North Alborán Sea, as identified by from a survey of catches carried out as part of earlier planning considerations for the proposed MEDGAZ project (Anatec, 2003):

Table 5.10 Depths for Commercially Important Fish and Cephalopods (North Alborán Sea)

Approximate depth range.	<50 m	50-180	50-300	>300
Species	Sparids, mullet and cephalopods	Octopus, sardine, anchovy, sparids, squid, horse mackerel, mackerel and Atlantic saury.	Hake, squid, sole, mullet and fork-beard.	Norwegian lobster, selachians, fork-beard and red bream

The survey is discussed in more detail in the socio-economic context of fisheries later in *Section 5.17*.

(iii) Marine Mammals

Cetaceans

Cetaceans are more abundant in the Mediterranean than is commonly believed. Eighteen species feature in Annex II of the Protocol Concerning Specially Protected Areas and Biological Diversity I the Mediterranean. Most of these species are rare visitors from the Atlantic, and are recorded as occasional sightings or strandings. However, there are also stable breeding populations of the following species:

- Long finned pilot whale (*Globicephala melas)*
- Common dolphin (*Delphinus delphis)*
- Risso's dolphin (*Grampus griseus)*
- Striped dolphin (*Stenella coerueoalba)*
- Bottlenose dolphin (*Trusiops truncate)*
- Cuvier's beaked whale (*Ziphius cavirostris)*

In addition, the sperm whale (*Physeter macrocephalus*) is found throughout the Mediterranean, although the evidence for breeding is based only on sightings of young specimens.

Most data have been collected from the Spanish sector of the Alborán Sea, which is regarded as an important area for cetaceans because of frequently used migration routes from the Atlantic into the Mediterranean. The most commonly sighted species are the striped dolphin and common dolphin, followed by the long finned pilot whale, the bottlenose dolphin, Risso's dolphin and the sperm whale. Over the last ten years there has been an increase in the observations of the fin whale (*Balaenoptera physalus,)*, which seem to be heading towards the Cabo de Gata and the Bay of Almería which, as explained above, are known for their important plankton concentrations, (ECT 1996/2000).

It is to be noted that although sightings are naturally at the sea surface, the preferred habitats, in terms of water depths, are as listed below:

- Risso's dolphin and striped dolphin 1000 to 1500 m
- Long-finned pilot whale 500 to 1000 m
- Bottlenose dolphin and common dolphin 200 to 500 m

Other Marine Mammals

The monk seal (*Monachus monachus*), a previously common but now highly endangered species, is restricted to very small numbers in the western Mediterranean. There have been no sightings of this seal in mainland Spain for many years. The nearest point to the southern end of the pipeline route where the monk seal is known haul-out point is 150-200 km to the west, in Morocco. The nearest point in Algeria is at the rocky Cornice des Dahra, some 300 km to the east, where the seal is known to breed in shoreline caves. It has been estimated that there are only several hundred seals in the whole of the Mediterranean, with 10-30 in Algerian waters, and 10-20 in Morrocan waters. (IUCN-CITES).

(iv) Reptiles

The only reptiles found in the Mediterranean are sea turtles, of which the only species occurring are the loggerhead turtle *(Caretta caretta*), the green turtle *(Chelonia mydas*), and the leatherback turtle (*Dermochelys coriancea*). Most colonies are found in the eastern Mediterranean, but on the Spanish coast the loggerhead turtle is common. Although no egg-laying has taken place here for a century, recent important development was the successful nesting, in 2001,of a loggerhead turtle on Vera beach on the eastern coast of Almería Province, about 100 km to the north of Cabo de Gata. (WWF/Adena)

There are no reports of sea turtles in the area around the Algerian landfall.

5.6 AIR QUALITY

There are no major industrial sources of air pollution likely to have a significant effect on the air quality of either land sector, but elevated concentrations of exhaust gas pollutants, such as nitrogen and sulphur dioxides, can reasonably be expected close to the main roads and other localised areas where motor vehicles accumulate.

No data are available on the concentrations of airborne particulate matter. However, it is probable that concentrations are naturally high because of the arid and frequently windy, conditions of both land sectors.

5.7 NOISE

In the Spanish land sector, the single major source of continuous noise is the ALP-202 main road. Because of the flat nature of the landscape the traffic hum from this source can be easily heard from a distance a kilometre or more. The nearest sensitive receptors for noise from the pipeline construction activities will be the permanent residential areas and the Cabo de Gata Camp Site. At these locations, traffic movements and the other normal day-to-day human activities are the main sources of noise. This type of noise significantly increases during the summer tourist season. The beach is naturally noisy because of the vigorous wave action on this part of the coast.

The main noise sources on the Algerian side are of the same type as those described above In this case, however, the leisure activities are much more concentrated, closer to the pipeline route.

5.8 SURFACE WATER QUALITY

The Rambla Morales and the channel that encircles Sidi Djelloul Beach have running water for only a few days per year. There is no information available on the quality of the permanent standing water. However, it can be assumed from the soils of the catchment area that, when in flood, the suspended sediment concentrations are naturally high.

5.9 SOIL AND GROUNDWATER QUALITY

The land on both sides of the route has never been subjected to large scale industrial usage, therefore soil and groundwater contamination, on anything other than the most minor scale, is highly unlikely. Walk-over visual surveys have supported this conclusion.

The soils are generally of a permeable type that would not provide significant protection of the underlying groundwater in the event of a contaminant spillage. However, the groundwater is not abstracted for drinking purposes. It is, in fact, not suitable for the purpose because of excessive pumping for irrigation, which has caused saline intrusion from the sea, and intensive agricultural practices that have led to chemical contamination.

No information is currently available on soil and ground water quality on the Algerian side, or whether the groundwater is used as a source of drinking water.

5.10 LANDFILL SITES, WASTE DUMPS AND BORROW AREAS

No waste disposal sites have been identified along the land sector routes, neither properly authorised landfills nor informal waste dumps.

There is evidence of a former borrow area on the Spanish route, to the south-west of the Camp Site.

5.11 TERRESTRIAL ARCHAEOLOGY AND CULTURAL HERITAGE

There are not any registered buildings or features of cultural, historical, archaeological or technical interest that could be directly affected by the project. However, the area is very rich in terms of its cultural heritage. One of the closest buildings in the the Spanish sector is the Cortijo Nuevo farm located to the north of the identified OPRT site, which is currently pending a procedure for its declaration as a Site of Cultural Interest. According to a bibliographic information search and surface survey by local specialists, there is no visible evidence or other reasons to suspect significant archaeological remains in the Spanish sector.

Following consultations made with the Protected Cattle Roads Section of the Almería Provincial Delegation of the Regional Government of Andalusia's Environment Ministry, it has been determined that no protected cattle roads exist in the municipal district of Almería.

A similar survey has not yet been carried out for the Algerian land sector. On the Algerian land sector route the only cultural heritage inside the study area is a murabit (cemetery) at Sidi Djelloul 1 km west-southwest of the selected BSCS site, located along the D.20 road. The selected BSCS site is more than 1 km away from the murabit and behind the border of the hills.

5.12 SEABED WASTE DUMPS AND DREDGING AREAS

There are no known locations along the seabed route with a history of having been used for the disposal of polluting or hazardous materials, such as toxic chemicals or military ordnance.

Similarly, no designated areas for the dredging of seabed aggregates or sand have been identified.

5.13 SHIPPING AND NAVIGATION

The proposed pipeline crosses one of the most active shipping zones in the world. The Straits of Gibraltar funnel large numbers of cargo ships, freighters and oil tankers to and from the Mediterranean and Middle East. In addition, this area is a very active military zone, with movements of convoys comprised of aircraft carriers, battleships and frigates. Submarines might also be active in the area.

Off the Cabo de Gata a Traffic Separation Scheme is in place to control the heavy shipping. It is estimated that 60% of all traffic between the Straits of Gibraltar and Europe pass through this Scheme, The records also show that some 30,000 vessels passed through the Scheme in 2002, of which 27% transported hazardous goods.

The Separation Scheme is between 10 and 20 km (6 to 12 nautical miles) off the Spanish coast. The west to east traffic uses the northern lane while the east to west traffic uses the southern lanes. In the vicinity of the pipeline, these lanes are in water depths of more than 350 m, so no special design features have been deemed necessary. However, to minimise the crossing distance, the proposed route is at a right angle to the Scheme.

Algerian coastal shipping is not controlled by a formal separation scheme. The traffic is light, with vessels bound along the North African coast expected to pass at a distance of circa 20 to 37 km off Beni Saf, equating to water depths in excess of 200 m in the vicinity of the pipeline. Again, therefore, no special design features have been deemed necessary.

5.14 MILITARY ACTIVITIES

No permanent firing and military exercise areas have been identified along the proposed pipeline route. Spanish and other European submarines are expected to exercise off the east coast of Spain between Cabo de Gata and Cabo San Sebastian, away from the route, along the coast to the north-east.

5.15 CABLES AND PIPELINES

The seabed survey report, mentioned above, lists eighteen points where the proposed pipeline corridor possibly crosses existing cables. However, because the survey equipment was not adequate for direct identification in situ, these points were simply obtained from an existing international cable data base. The majority are known to be out of service. However, a more complete and reliable location of cables and other potential service lines will be carried out before starting to lay the pipeline, making use of in-situ identification equipment such as a ROV-mounted with a gradio-meter or an Innovatum Cable Tracker.

The proposed route passes through an area designated for hydrocarbons exploration under Algerian Licence No. 143-1. However, no oil or gas installations were identified anywhere on the route by the 2002 survey. The nearest known offshore installation is the abandoned Habitas-1 Well (Total Oil Co., 1976), which is 20 km west of KP50.

5.16 SHIPWRECKS AND MARINE ARCHAEOLOGY

The coast to coast seabed survey that was carried out by C & C Technologies in June and July 2003 identified five shipwrecks and fifty-eight unidentified sonar targets within the limits of the survey, which extended to some 5 km on both sides of the route

A well documented protected area exists just off the Cabo de Gata (see *Map 5.8*):

- The zone named "Cabo de Gata Corralete" was the main point of safe shelter for ships in the past. It is known to contain diverse materials from at least two wrecks; "Pecio Dressel 20" and Pecio Medieval".
- The smaller zone entitled "Pecio Medieval" contains a wreck that had a cargo of blue china.

Even at its closest point, the proposed pipeline route is 170 m west of the former zone, near KP182, and more than 2 km from the southern-most extension of the smaller zone.

With the exception of these examples, no other significant items of marine archaeology have been identified. However, the survey mentioned above did not employ techniques for the detection of buried metallic objects, so magnetometer inspections will be completed before pipe-laying, coincident with the ROV survey mentioned in *Section 5.15*.

Map 5.8 ***Cabo de Gata Marine Archaeological Zones***

5.17 *FISHERIES*

5.17.1 *Overview*

In 2001, as part of the Phase 1 Engineering Study, Anatec UK Limited were commissioned to identify the fishing activities in the vicinity of the proposed pipeline route (Anatec 2003).
In the absence of fully reliable statistics for the western Mediterranean, the study was based on collation of information from published research and liaison with experts and fishing industry organisations. The authors considered this information to be the best available, but acknowledge a degree of uncertainty in the results. Therefore, more project-specific knowledge was obtained in the preparation of this Environmental Statement, by a data gathering exercise which focused on the Almería Province and, in particular, the Almería Port. The information from both studies is summarised in the following sections. *Map 5.9* shows human elements of the Spanish territorial and nearby waters (mainly fishing and transport information).

5.17.2 *Alborán Sea*

The pipeline will pass through two of the 30 Fisheries Management Units (MU) into which the Mediterranean is divided: The Algerian Waters MU and the North Alborán Sea MU. For the sake of fisheries management in each MU, each fishing activity is categorised into, so called, Operational Units, dependent on the target species and the type of fishing method employed. A major factor in defining the Operational Units is water depth.
Basic data on the seven main Operational Units identified in the North Alborán Sea MU are provided in the table below:

Table 5.11 Basic Data on the Seven North Alborán Sea Fisheries Operational Units

Ops. Unit	Shallow trawl	Middle trawl	Deep trawl-1	Deep trawl-2	Artisan net and long line	Dredge	Purse seine
Depth (m)	50-180	50-300	>300	>300	Mainly <50 m	Mainly <50 m	<150
No. of vessels	76	46	30-35	8	873	181	136
Mean length of vessel (m)	11.5	15.5	17.6	17	7.1	6.2	15
Season	All year	All year	All year	All year	All year	All year	All year
Target species	Octopus	Hake and white shrimp	Red shrimp	Norwegian lobster	Sparids, mullet, cephalo-pods	Bi-valves	Sardine and anchovy
By-catch	Sparids and squid	Squid, sole, mullet, fork-beard	Selachians and fork-beard	Fork-beard, sable and red bream	Scarce	Scarce	Horse mackerel, mackerel, Atlantic saury and gilt sardine
Trip time	1 day	1 day	1 day	1 day	<1 day	<1 day	<1 day

Map 5.9 Human elements of the Spanish territorial and nearby waters

The bulk of Mediterranean fisheries are traditional artisan fisheries, which use only light equipment, close to the coast. The main gear in Spain and Algeria are gill/tangle nets and hooks and lines. These methods would not interfere with the operational pipeline, or the nearshore installation works if normal precautions and work scheduling are properly implemented.

For similar reasons, purse seine netting presents no significant risk of interaction and, irrespective of this fact, most of the purse seine fleet (85%) is now concentrated in Malaga Bay, which is 200km west.

It is the deep trawling that presents the significant potential of snagging because it implies contact with the sea bed, typically down to depths of 800m.

The Algerian Waters MU has not been categorised in terms of Operational Units, so it was not possible to provide the same level of detail as that given above for the North Alborán Sea. However, one of the largest fishing fleets in North Africa is located in Beni Saf, with an annual catch of around 45,000 tonnes. Based on the general statistics available for the Algerian fishing fleet, it was possible to deduce that the potential area of fishing activity possibly extends to a depth of 1000 m, which would be equivalent to about 66 km along the sub-sea section of the proposed pipeline. Moreover, it is known that red shrimp fishing is also gaining in importance in Algeria, so increasing the tendency to bottom trawling.

Map 5.10 ***Potential areas for the various fishing techniques with respect to depth in Algeria***

Almería Province

To supplement the more general information given above, a study was carried out, focused on the fishing practices of Almería Province itself. The results have been presented in a report by Inypsa, Spain, dated July 2003. This sub-section provides a summary of the findings.

The fishing fleet in the Province of Almería consists of 296 vessels, which can be divided into the following categories:

Table 5.12 Province of Almería Fishing Fleet; Equipment and Number of Vessels

Type of fishing equipment	Number of vessels
Bottom trawling	64
Purse seine netting	48
Drift lines	49
Bottom lines	8
Traditional (trammel and tangle nets, multi-hook lines etc)	127

These vessels are based in Almería, Garrucha, Carboneras, Roquetas de Mar and Adra. The fleets from the first three of these ports are those that are most active in the general area. However, Almería port is the closest to the pipeline, so it is the vessels of this fleet that are of most interest because of their natural preference for the specific area in question.

As shown in the table above, most vessels are of the smaller type, dedicated to traditional fishing techniques. However, bottom trawling is the main type of fishing practiced in the Province in terms of engine power and capacity. The current fleet of 64 trawlers has a total engine power of 14,758 kW and a total capacity of 4,334 GT. Landings have declined in recent years, after reaching peaks in the 1991 to 1994 period but, nevertheless, the market value today remains similar to that of 1985, because of a corresponding increase in prices.

The main species landed with each of the fishing methods listed above are shown in the table below:

Table 5.13 Almería Fleet; Fishing Techniques and Main Species Landed

Fishing method	Species landed
Bottom trawling	Red shrimp (*Aristeus antennatus*), white shrimp (*Aarapenaeus longirostris*), Norwegian lobster (*Nephrops norvegicus*), anglar fish (*Lophius piscatorius*), poutassou (*Micromesistius poutassou*), forkbeard (*Phycis physics*), sole (*Solea vulgis*), prawn (*Palaemon sp.*), European hake (*Merluccius merluccius*), red mullet (*Mullus barbatus; M. surmuletus*) and Octopus (*Octopus eledone*).
Purse seine netting	Sardine (*Sardine pilchardus*), horse mackerel (*Trachurus sp.*), common mackerel (*Scomber scombrus*), anchovy (*Engraulis encrasicholous*), twaite shad (*Alosa fallax*), frigate mackerel (*Scomber thazard*) and bogue (*Boops boops*).
Drift lines	Swordfish (*Xiphias gladius*), garfish (*Belone belone*), dog shark (*Galeorhinus galeus*), tuna (*Thunnus thynnus*), allice shad (*Alosa alosa*) and various sharks/selechians.
Bottom lines	Red bream (*Pagellus bogaraveo*), sea bream (*Pagrus pagrus*), forkbeard (*Phycis phycis*), allic shad (*Alosa alosa*) and European hake (*Merluccius merluccius*).
Trammel nets	Sole (*Solea vulgis*), red mullet (*Mullus barbatus; M. surmuletus*), black scorpion fish (*Scorpanea porcus*), common cuttlefish (*Sepia officinalis*), sea bream (*Pagrus pagrus*) and octopus (*Octopus eledone*).
Tangle nets	Common cuttlefish (*Sepia officinalis*), sea bream (*Pagrus pagrus*), black scorpion fish (*Scorpanea porcus*), European hake (*Merluccius merluccius*) and ray (*Raja sp.*).
Multi-hook lines	Long finned squid (*Loligo vulgaris*).

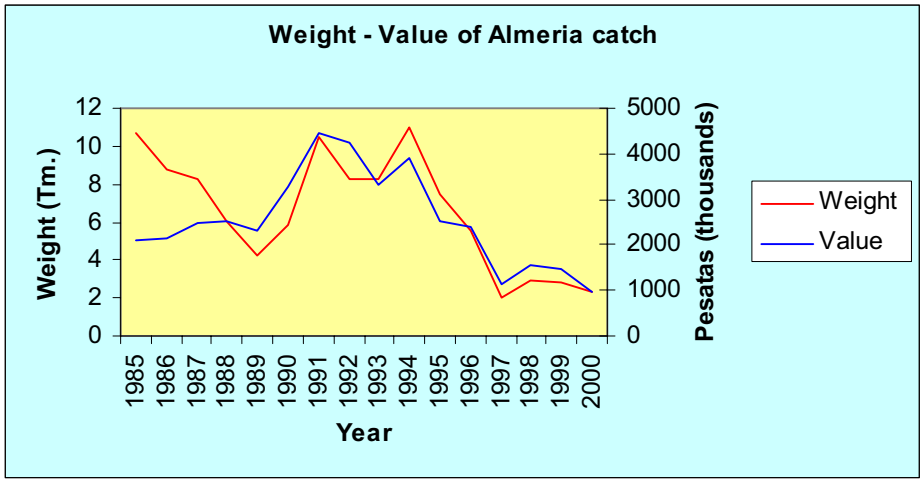
The most important species in order of their economic importance are listed below:

1) The red and white shrimp, which accounted for about 40% of the total value over the last four years.
2) Pelagic species such as sardines and mackerel, by purse seine netting.
3) Octopus, by trammel nets, and demersal species such as hake and Norwegian lobster which, like red and white shrimp, are also caught by bottom trawling.

This listing clearly illustrates the economic importance of bottom trawling in the Province.

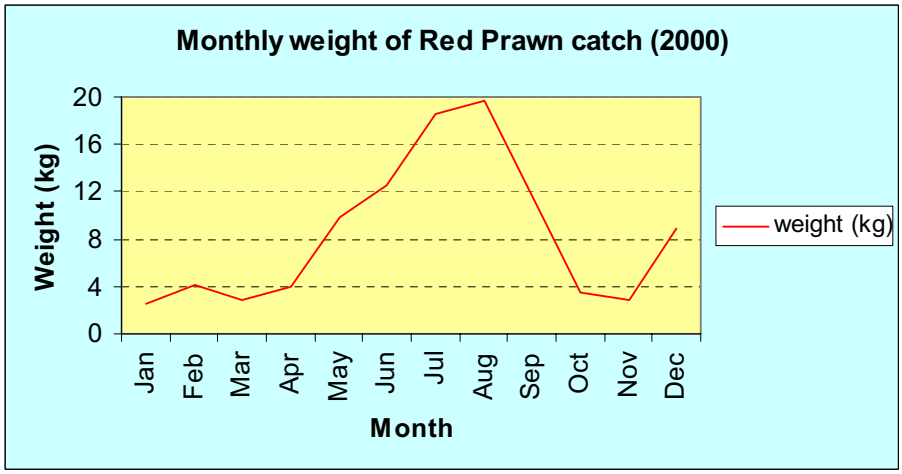
The Almería fishing industry itself has been in decline since 1994, as shown by the graph below:

Figure 5.8 *Almería Port; Weights and Catch Values 1995 - 2000*



The red shrimp monthly catch data for 2000 indicates that the peak period for the species is during the summer, from June to September:

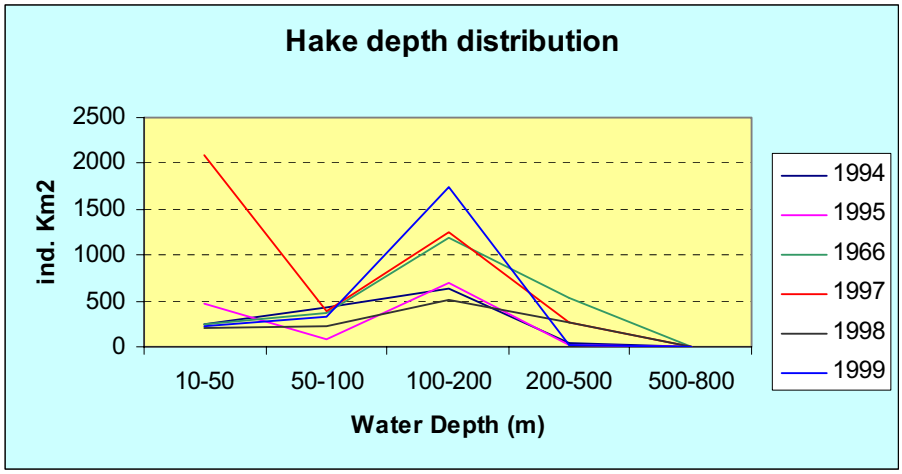
Figure 5.9 *Almería Port; Monthly Weights of Red Shrimp Catches, 2000*



In 2001 the red shrimp accounted for 37 % of the total income generated by fishing activity from Almería Province. In 2002 this figure decreased to 32 %. The average weight of a catch decreased from 293 kg in 2001 to 173 kg in 2002, a decline of 8.5 %, which is in keeping with the overall trend in fish catch data since its peak in 1994.

Hake is the most commercially important demersal fin-fish species landed in Almería. The depths for hake occurrence in the Alborán Sea are provided below:

Figure 5.10 Almería Port; Hake Distribution versus Depth



These data further emphasise the commercial importance of deep/bottom trawling to the area but, like those for red shrimp, levels of hake catch are declining. For 2001 and 2002 they were 187 kg and 114 kg respectively, representing a 6 % decrease.

An important deep trawl area, known as Canto del Monsul, crosses the proposed pipeline corridor. However, it is not completely accessible to the fishing fleets, because it also crosses the Cabo de Gata Traffic Separation Scheme (See *Section 5.13*), where fishing is prohibited in the resultant over-lapping area.

5.18 OTHER SOCIO-ECONOMIC ISSUES

5.18.1 *Population*

At the Spanish end of the pipeline, the landfall on El Charco Beach is in the Municipal District of Almería. The actual urban district of Almería is 18 km to the west. The closest inhabited area is the coastal village of Cabo de Gata, to the south-east. The inland village of Pujaire is also 1 km from the landfall and Ruescas is 2 km from envisaged Reception Station site.

The Municipality of Almería has 171,000 inhabitants. The previously mentioned settlements of Cabo de Gata, Pujaire and Ruescas have permanent populations of 827, 421 and 305 respectively. However, it is important to note that, because of the importance of tourism in the area, the population is highly variable, dependent on the time of year. In the summer time, Cabo de Gata for example, can have a population of more than 6000. It may therefore be preferable, or even necessary, to schedule certain parts of the construction works to avoid such peak periods.

On the Algerian side, the area in question is Sidi Djelloul Beach and its immediate hinterland, in the Province (Wilaya) of Ain-Temouchent or, more specifically, the Municipal District of Sidi Ben Adda. The town of Beni Saf, the

name that has been adopted for the Algerian side of the pipeline, is actually some 10 km to the south-west of the landfall. The other nearest urban area, Sidi Ben Adda, is also 10 km away, to the south-east. At Sidi Djelloul beach there are recreational facilities with a campsite and car park.

The Wilaya of Ain-Teouchent is in the north-west of the country. It has an area of about 2,400 km2, 80 km of coastline and a population of approximately 330,000. That is, circa 125 inhabitants / km2. The populations of the municipalities closest to the landfall and the BSCS are as follows: Ouled el Kîhel (3,100), Sidi Safi (6,300), Beni Saf (39,700) and Sidi Ben Adda (12,200). There is also a small settlement with 20-30 houses in Oued el Halloûf about 1 km from the BSCS site.

Hematite mining is made from several deposits in the area with extraction of around 22 million tonnes of ore annually. Major deposits are located in the massif Cape Oulhassa, near Sidi Djelloul beach, which also has quarries for extraction of construction materials such as sand, clay and marble. Major industrial complexes in the area are the cement factory in Beni Saf, one of Algeria's largest, the ENAD/SOREOR detergent plant at Chabaat El Ham, and the EMECAT brickworks at El Malah.

5.18.2 *Tourism and recreational areas*

Tourism is a significant issue for both Algeria and Spain. In Spain, both El Charco Beach and the village of Cabo de Gata are summer tourist attractions. The proposed route passes through the Cabo de Gata Camp Site, which consists of 200 to 250 camping places. Many tourists visit the area in summer and the following list includes places and/or attractions for tourists near the planned OPRT in Spain:

- The beaches Playa de las Amoladeras 2.5 km to the southwest and Playa del Charco 3.5 km to the south-southwest of the identified OPRT site.
- The campsite "Camping Cabo de Gata" (with an area of 3.6 ha) is located about 2 km south of the identified OPRT site. The location of the campsite is shown on.
- About 0.5 km west of the identified OPRT site, inside the Natural Park, is an information desk (Centro de Visitantes Las Amoladeras) and parking space for visitors of the park.
- Trekking routes (trekking route no. 3 passing the information centre and continuing north) and bike routes (bike route no. 3 following the ALP-202, bike route 1 passing Ruescas, the crossroads at Rambla Morales and the village Pujaire etc).
- The youth hostel (Albergue Las Amoladeras) about 2 km west of the identified OPRT site.
- The village El Cabo de Gata with Playa de San Miguel about 4 km south of the planned OPRT.
- The "Cortijo Nuevo" farm about 0.5 – 1.0 km north of the identified OPRT site.

The Algerian landfall is on Sidi Djelloul Beach, which is included among the designated recreational resources of Ain Temouchent Wilaya. The spa resort of Hammam Borhadjar is in Ain-Temouchent and the religious monument of the Three Marabouts is in Sidi Ben Adda. However, two major tourist attractions are 10 km or more inland and, therefore, too far away to be even indirectly affected by the development.

5.18.3 *Agriculture*

Agriculture provides a large source of employment in the general area of the Spanish landfall. The statistics for the administrative region of Níjar, for example, show some 50% of the workforce employed in agriculture. More specifically, however, the land immediately to the east of the Rambla Morales through which the pipeline will pass has a great importance for greenhouse cultivation, using irrigation by pumped ground water, within the limits imposed by the Park Management Plan. It appears that there are many complexes of greenhouses situated to the east, the southeast, the northeast and in close vicinity of the planned OPRT.

In Algeria, the area near the landfall at Sidi Djelloul and near the BSCS is largely devoted to agriculture (probably rain-fed, but possibly supported by pumped water). Agriculture occupies just over 200,000 ha or 85% of the wilaya area. The main crops are cereals (75%) followed by vegetables (7%) and forage crops (6%) and the land also contains vineyards (6%) as well as tree plantations (3%), which have recently been expanding after a period of decline.

5.18.4 *Traffic*

The Retamar to Ruescas road, the ALP-202, is passing next to the selected OPRT site. At the roundabout south of Ruescas the ALP-202 is intersecting with the ALP-822 road going to Cabo de Gata village via Pujaire and onwards to the cape Cabo de Gata. The ALP-202 continues into Ruescas after the roundabout and further towards the east via El Pozo de los Frailes to San José and La Isleta del Moro.

Minor dirt roads and tarmacked roads are traversing the area, providing access to greenhouses and other facilities Right next to the selected OPRT site a minor tarmacked road is connecting to the ALP-202 and going to the north alongside the greenhouse areas to Cortija de Abajo.

The ALP 202 has an estimated average daily traffic of 3-4,000 cars. The secondary roads have an estimated daily traffic around 50 cars.

In Algeria, the Beni Saf Road is the main road near the pipeline however, little information was available for the traffic in this area.

SECTION 6

POTENTIAL CONSTRUCTION IMPACTS AND MITIGATION

MEDGAZ

CONTENTS

6 POTENTIAL CONSTRUCTION IMPACTS AND MITIGATION

6.1 INTRODUCTION

Gas pipelines that are buried in the land and shore approaches sectors are environmentally benign installations when in operation. Therefore, considerations of the possible adverse effects of such projects are almost entirely with the short-term construction phase. These impacts are similar to those from other, more familiar linear development projects, such as road or railway construction, the major difference being that after completion, the landscape through which a buried pipeline passes is virtually unchanged.

The activities most affecting the environment during this phase of the work are anticipated to be land reclamation and haulage of major equipment. The extent of land reclamation for the BSCS and OPRT are 13ha and 3h respectively. Additional areas of minor extent may be required for the temporary work site installation. Haulage of large and heavy equipment to the site includes major pieces of equipment like filters, heaters, vent/flare and transport of materials for construction purposes like reinforcement steel, pipes and piping components, structural steel items and aggregates for concrete fabrication.
Furthermore, there will be some noise in connection with the earth works and soil compaction, concrete casting, and construction vehicles working on and driving to/from the construction site.

In keeping with recognised best practice for such projects, this environmental impact assessment has been preceded by a systematic route selection process, involving different stages of increasing refinement, from the inter-continental down to the local community scale, as explained in Section 4. The major onshore and shore approaches construction activities have then been scheduled to avoid the main tourism and bird nesting seasons. In this way, it has been possible to mitigate most of the potential environmental problems by simply circumventing them. This Section discusses the remaining potential impacts with a view to establishing the techniques that will be required to mitigate them to acceptable levels.

These control requirements will be integrated into a Project Environmental Management and Monitoring Plan, based on the principles of International Standard ISO 14001, "Environmental Management Systems". Full and proper implementation of this Plan, under the day-to-day supervision of a qualified Site Environment Manager, will be made a condition of the EPIC Contracts.

6.2 SURFACE WATER QUALITY

6.2.1 Suspended particulates

Terrestrial

The most common pollution of inland water courses during construction work is by the release of soil particulates from direct rain water run-off or from the pumps used for trench de-watering. Well established formal guidelines are therefore, available if required. Some examples of the commonly used control techniques are listed below:

- Fences draped with a fabric silt filter across areas of low level sheet flow.
- Straw bale barriers for short-term use in higher levels of flow.
- Jute matting on slopes, to prevent erosion of the soils.
- Settlement ponds for treatment of de-watering pump effluent before discharge to the water course.
- Fluming or horizontal drilling for crossing of water courses.

They are, however, unlikely to be required for the land sectors of the MEDGAZ project because only intermittent water courses are involved which, even when in flood, will already be loaded with high concentrations of suspended soil particles.

Shore Approaches

The shore approaches extend to a water depth of 30 m in Spain and 20 m in Algeria. In contrast with the situation in the land sector, the control of suspended matter in these sectors is a key issue, so will be given considerable attention because of its importance in the conservation of the seabed habitats discussed later in this Section.

The seabed consists of medium to fine clayey/silty sands along almost the entire pipeline route, but courser sediments predominate in the shore approach sectors. Sediment plumes created by the works are, therefore, unlikely to have a significant impact on more than a narrow strip of seabed immediately adjacent to the trench and containment within the coffer dam will prevent release of the dredging sediment from the first 50m of the trenching operations.

An estimate of the distribution has been made, based on information that the suspended material will have an average particle size about 0.4 mm (medium sand) and will be mixed into the water column up to 10 m from the seabed, with an average current speed of 0.1 ms^{-1}. Such a plume will travel only over a distance of about 20 m. In actual practice, the majority of the material is likely to be suspended less than 5m from the seabed, so re-deposition will take place much closer to the point of origin, probably within 10m.

When the same estimation method is applied using the known annual maximum current speed of circa 1 ms^{-1} average over the bottom 10 m of water depth , the estimated plume deposition range is much greater, at about 200 m, but dredging would not be carried out under any such extreme conditions.

Within the deposition range from the trench, the plume will smother the seabed, but because the sediment material is homogenous over the entire area, there will be no significant change in the seabed composition. The finer fractions will be transported greater distances. However, these fractions are a much smaller proportion of the whole, so they will be dispersed over a much larger area and, therefore, have no significant effect on the wider area of seabed.

Nevertheless, for the shore approach sectors, measures to limit the creation and dispersion of sediment plumes to a practicable minimum have been integrated into the project design and will be included in the Project Environmental Management and Monitoring Plan. They include:

- Suction-cutter or hopper suction, rather than mechanical/bucket, dredgers will be used in the open waters outside the coffer dam.
- The cofferdam will not be the dry type with a sealed end, so there will be no de-watering pumps to produce a sediment-loaded discharge to the sea.
- Turbidity monitoring will be used for any works in the vicinity of sensitive areas, such as the sea grasses.
- This monitoring will compare the seawater particulate contents, up- and down-current of the works.
- Turbidity tolerance limits will be established by expert advice and if exceeded, the dredging rates will be modified accordingly.
- Such modifications will typically include a decrease in the rate of dredging or, in more extreme cases, the use of silt curtains around the dredging head to contain the spread of suspended matter.

In order to identify the precise extent of these sediment plumes, a Prediction model was set up for the deposition of sediments and turbidity originating from the dredging work and temporal deposition of material. This was part of a study commissioned by MEDGAZ (currently under development).

The impact in the shore areas produced by the dispersion of suspended particles will vary according to the environmental sensitivity of the affected area. However, the implementation of the preventive and corrective measures will maintain it low. Therefore the impact is considered to be moderate.

6.2.2 Offshore

In the offshore sector the trench works, which are only required at points listed in *Table 6.1*, can be expected to produce a plume with a much higher concentration of sediment because use of a mechanical excavator is necessary at these depths. Furthermore, because the seabed material is of much smaller particle size, typically 0.002 to 0.006 mm on the Spanish continental slope, the same formula as used above predicts plume deposition distances in the order of many kilometres. For the same reason, however, the material will be

diluted and dispersed over a much larger area of seabed.

Table 6.1 Current Envisaged Total Extent of the Post-lay Trenching Requirements

KP Range	Water Depth Range (m)	Purpose	Length (km)
70.8- 75.7	1320 - 1720	Free span correction by trenching	4.9
167.5 – 170.0	740 - 651	Geo-hazard mitigation and free span correction trench to 1m depth.	4.5

In view of the short time period over which these works will be carried out, circa 7 days for the whole 4.5 km length on the Spanish continental slope, and the distances and depth differentials to the sensitive areas discussed later in this Section, no special mitigation measures will be necessary for these offshore works.

The proper implementation of the Project Environmental Management and Monitoring Plan ensures that the impact will be kept low (negligible / moderate).

6.2.3 Oil and fuel spillages

Even small spillages of oil (including fuel oil) on a water body can create a highly visible form of pollution and a large scale spillage could have a quite significant effect on tourism, fisheries and other socio-economic aspects of the project areas. Therefore a high standard of maintenance will be enforced to prevent small scale chronic leakages from machinery and vehicles and, especially, on board the barges and other vessels. This will apply to the pipeline and terminals construction.

Preventive and corrective measures will include:

Bulk storage of lubricants and fuels will be permitted only within a bund designed to contain the entire contents of the container(s) in question. Disposal of waste oils and fuels to the sea, water courses or drains will be forbidden. The vehicle maintenance and refuelling areas will not be located within 50 m of a surface water course or shoreline. Refuelling on the work-strips of the land sectors will be carried only if absolutely necessary, only under strictly controlled conditions and never within 50 m of a surface water body.

On the terminals area an accidental spill is assessed to be limited to spill of oil products (as diesel, hydraulic oil etc) and the odorant tetrahydrothiophene. All these products/chemicals will be used and stored inside the area of the OPRT/BSCS. Impact from an accidental spill of these products is assessed to be restricted to contamination of the soil where the spill happens (i.e. inside the area of the OPRT/BSCS). However observance of preventive measures will reduce the probability of occurrence.

Environmental Management should provide for a contingency plan taking care of actions in case of spill, so that polluted soil is removed immediately after a spill. Adequate equipment (drip trays, absorbants, floating booms, pumps etc) will be available for the immediate containment and clean-up of any oil spillage from the land and marine activities. Workers will be provided with training in the proper use of this equipment.

The project standard of acceptability will be no visible oil films on the water body surfaces.

The magnitude of the impact is assumed to be low due to the implementation of an extensive number of mitigation measures. However, due to the magnitude of the works to be developed, a conservative judgement has been made and the impact is considered to be moderate.

6.2.4 Chemicals

Use of herbicides for the clearance and control of vegetation will be forbidden and only fresh, untreated water will be used for hydro-testing the onshore sections of the pipeline.

The only intended release of chemicals to the environment will, therefore, be by disposal of the water from hydro-testing the sub-sea section of the pipeline. This will be filtered seawater with depleted oxygen content, containing additives to prevent corrosion and growths of marine organisms inside the pipeline. The volume of the discharge will be large (circa 46,700 m^3), sufficient to fill the entire 190 km of the pipeline. However, the additives will be present in only trace concentrations (parts per million). The formulation will be selected during the later, detailed design stage, but only chemicals of minimum toxicity and maximum bio-degradability will be used, consistent with the need to achieve effective protection of the pipeline.

The point of discharge for the hydro-test water will be selected by means of a fully systematic risk assessment, taking into account the presence of sensitive ecosystems and other receptors, currents, tidal flows, dilution and dispersion factors etc. Impacts will then be reduced to an insignificant minimum by controlling the release to a rate at which the receiving waters can easily assimilate the discharge. This potential impact is assumed to be negligible.

6.2.5 Sewage

The influx of some 50 temporary workers on both sides of the route raises a significant question of sewage disposal. Releases of untreated sewage to surface water bodies will, therefore, be forbidden. Modern toilet facilities of adequate capacity will be provided well in advance and in agreement with the local authorities. The first option will be to dispose of the effluent directly to an existing public sewer system that is connected to a municipal sewage treatment plant. If this option is not feasible, suitable site facilities will be

installed based one of the following two alternatives:

- On-site treatment by use of septic-tanks or other means of achieving an acceptable standard for soak away to the ground at a location not less than 100m from a surface water body.
- Collection in cesspits followed by regular collection and transport for treatment at a municipal facility off-site.

No untreated sewage will be discharged from the work vessels in the shore approaches sectors. Arrangements will be in place for treatment onboard or containment for emptying when in port, for treatment onshore.

Moreover, the disposal of sewage will be according to the country's practices, so that all practices are consistent with current legislation. The impact is considered to be negligible.

6.3 SOIL AND GROUND WATER QUALITY

The project presents a risk of small scale soil and ground water contamination, largely associated with the vehicle and plant maintenance work. The soils are generally of a type that offers little protection to underlying groundwater, because they would be easily permeated by spillages. However, the ground water does no constitute relevant aquifer and is not abstracted for drinking and is, in fact, not suitable for this purpose.

Moreover, in order to protect soils and potential ground water resources against a major bulk spillage, any liquid fuel tanks that will be placed inside a containment bund with impermeable floor and sized to hold the entire capacity of the tank plus 10%. They will also be fitted with a sight-glass to prevent spillage by over-filling. If an underground tank is to be installed, tests will first be carried out to ensure that it is leak-free. Both types of tank will be emptied and removed when the site is vacated.

The refuelling areas will have an impermeable surface, drained to an oil interceptor. Refuelling on the work-track will be carried out only if absolutely necessary and always under strictly controlled conditions
Disposal of oils and chemicals to the ground will be forbidden. Drip trays will be required to contain any leaks under stationary vehicles and items of plant.

If disposal to the ground is the chosen option for the treated sewage effluent, the soak-away will be located on a remote part of the site and well away from any residences, ensuring the soil has sufficient permeability to prevent pooling and that there is no drinking water abstraction point within 100 m**.**

Because of the implementation of the mitigation measures and the Environmental Monitoring Plan, this potential impact is considered to be minor.

6.4 AIR QUALITY

6.4.1 General overview

The main air quality issues of pipe-laying works on land are the same as those for any project that involves large scale earth moving and excavation activities and deliveries by heavy vehicles to and from the site. The same applies to the terminal construction. They are concerned with the creation of airborne soil dust and releases of exhaust gases from the various internal combustion engines of motor vehicles and stationary plant.

6.4.2 Airborne Dust

The arid, frequently windy, conditions of both land sectors of the MEDGAZ project will easily give rise to airborne dust. Although no data are available, it can be reasonably expected that concentrations of airborne particulates in the land sectors are already naturally high.

Airborne soil dust from construction activities involves two potential impacts:

- Health risks from long-term exposure to the finer fractions, which can be inhaled.
- General nuisance from the courser components.

However, in contrast to industrial particulate emissions, for example, dust from construction sites is released at ground level and has a large particle size. Consequently, the problems above tend to be restricted to the construction site itself and its immediate environs. The larger particulates quickly settle and, further away, dilution with distance ensures that the finer particulates are not in sufficient concentrations to prevent a health risk.

- In Spain, the nearest dust-sensitive locations are the Cabo de Gata Camping Site and Pujaire Village, which are 100 m from the work-strip to the west and east respectively. They are, therefore, well beyond the range of significant impact.
- In Algeria, the camp site is close enough to be significantly affected by airborne dust. For any single location, the work-strip will present a potential source of dust for only one or two days, as the work-front passes by. However, the beach construction site will be a potential source for about five months. Appropriate mitigation will, therefore, by agreed in consultation with the owners and users of these facilities.

Irrespective of the distances to sensitive locations, the Project-specific Environmental Management and Monitoring Plan will include requirements for suppression of airborne dust at source, by the use of covers to prevent wind-blow from stock-piles and transport loads, water spraying of roads and washing facilities to limit transfer off the site on the wheels of delivery vehicles. Where access roads require hard surfacing, this work will be carried out at the very beginning of the construction programme.

The traffic management measures that will be taken for the primary purpose of public safety, as described below, will also be of benefit with regard to control of airborne dust along the access routes to the sites. The decision to use horizontal drilling for avoidance of traffic flow disruption at the main road crossings will also avoid airborne dust creation at these crucial points.

The impact associated to airborne dust during the project work is considered to be negligible.

6.4.3 Engine Exhaust Gases

Exhaust fumes from internal combustion engines present another risk to air quality on and close to construction sites. A maintenance scheme will, therefore, be imposed to ensure efficient combustion by the prevention of "black smoke". Drivers of vehicles will be required to switch off engines when not in use and stationary equipment, such as compressors, will be located away from the areas of prolonged human occupation, such as the site offices and eating places.

Operation of the dewatering compressor spread presents a special case. The simultaneous operation of around fifty construction site compressors in a small area will create a major pollution source. However, all the compressors will have four-stroke diesel engines that are of an up-to-date design, to ensure that they are compliant with the recently introduced changes to the United States emissions regulations, they will be in operation for only a few days. Nevertheless, the potential impacts on local air quality will be quantitatively assessed when sufficient information on other relevant factors, such as the exact configuration and location of the spread, become available in the detailed design stage. Standard pollutant dispersion modelling techniques will be used as necessary, to predict any likely increases in concentrations at nearby sensitive locations for comparison with the recognised national and international criteria for the protection of human health. Appropriate mitigation measures, such as changes to the layout and increased exhaust pipe heights, will then be implemented as required. The option of temporary voluntary resettlement of any seriously affect residents will also be available, if necessary.

The measures that will be included in the Project-specific Environmental Management and Monitoring Manual primarily for prevention of traffic accidents (see *Section 8*) will also considerably reduce public and worker exposure to exhaust gas pollutants.

The overall magnitude of this impact will be very low, and the implementation of the mitigation measures ensures that the effects will be negligible.

6.5 NOISE

6.5.1 General Overview

The construction phase activities that will cause significant levels of noise can be divided into three categories:

- Normal routine construction site activities, which tend to emit continuous noise at low to intermediate levels.
- Particular high intensity events, such as percussion piling for the coffer dam, or use of the de-watering compressor spread, which will emit high levels of noise, but only for short periods.
- Road traffic movements to and from the work-strip and work sites.

They present a potential nuisance for the communities. These impacts and the proposed mitigation measures for each category are discussed in the following paragraphs.

6.5.2 Routine Construction Noise

At both the Spanish and the Algerian ends, the shortest distances between the route and the nearest noise sensitive receptors are over flat land and without natural or man-made acoustic barriers. Under such conditions, noise from a point source decreases at a rate of circa 6 dB for every doubling of the distance. This simple formula can, therefore, be used to provide reasonable quantitative estimates of the impacts at the various noise sensitive locations alongside the route. The results are shown in the table below, assuming the source is one of the most noisy items of plant, such as a compressor, producing 90 dB(A) at point 1 m from the source:

Table 6.2 Estimates of Routine Construction Noise Impacts at the Nearest Sensitive Receptors

Noise sensitive location	Distance from work strip	Estimated noise impact
Cabo de Gata Village	800 m	32 dB(A)
Cabo de Gata Camp Site	100 m	50 dB(A)
Pujaire village	100 m	50 dB(A)
Sidi Djelloul Police Station	100 m	50 dB(A)
Sidi Djelloul Beach Bar	100 m	50 dB(A)
Sidi Djelloul Camp Site	10 m	71 dB(A)

Using the widely recognised standard of 55 dB(A) (e.g. World Bank, 1998, and Andalusian Decree 326/2003) for assessing the acceptability of day-time noise at dwellings, the estimated levels shown above for the Spanish land sector would not add significantly to the existing levels of ambient noise from traffic and normal everyday human activities. By the same criterion, it can be

inferred that even the continuous use of a typical noisy item of plant on the work-strip without acoustic screening, is unlikely to cause disturbance at the camp site and permanent residential areas. A similar practice on the Algerian land sector, however, would lead to unacceptable noise at the camp site, because of its much closer proximity to the work areas, so mitigation arrangements will be agreed with the local authorities and the people directly concerned. However, the scheduling of the work to avoid the summer will significantly reduce the impacts on the recreational users of the beach.

While such calculations are useful for making worst-case assessments of noise impacts, in actual practice all major sources of routine noise will be positioned as far as possible from sensitive areas, including not only residential areas, but also the camp sites, temporary workers' camps and site offices. Maximum use will also be made of existing screening features, such as hillocks and buildings. If necessary to maintain noise levels within the acceptable limits, additional acoustic screening and silencers will be employed. The decision to use ready-mixed concrete will also contribute considerably to these objectives, because a concrete batching plant would, otherwise, be a major source of routine noise. Furthermore, it will be project policy to restrict noisy work to day-time hours.

The overall magnitude of this impact is moderate as it can not be completely avoided. However, due to its temporality, limited extension and the application of corrective or mitigation measures, it is not of much relevance.

6.5.3 Particularly Noisy Events

It may not be feasible to reduce the noise from pile driving to the same level as discussed above. Mitigation of the impacts will, therefore, be by carrying out the activity only during the least sensitive times of the day and providing forewarnings, on the grounds that it involves only a series of very short-term events, over a few days.

The dewatering compressor spread will be in place, probably in the vicinity of the Reception Terminal site, for about eleven months. However, it will be used for only a few days within this period. For removal of the hydro-static test water, circa ten days will be required, followed by about 20 days for the less demanding air drying stage. During pipeline laying the spread will be used only if a "wet buckle" occurs. This is an event that is avoided by all practicable means and so occurs only by accident but, if necessary, the dewatering of the pipeline takes only about seven days.

The configuration and precise location of the spread will be decided during the detail design stage, using standard computer modelling techniques that predict the likely noise levels at the nearest sensitive locations. The results of a first conservative estimate of the noise levels at various distances from the spread are given in the table below:

Table 6.3 Estimates of Noise Levels at Various Distances from the De-watering Compressor Spread

Distance from the Spread (m)	Estimated noise level (dB-A-)
100	62
500	48
1,000	42
1,500	39
2,000	36

Assumptions: Hemispherical noise emission pattern, from a spread of 50 compressors in a 5 X 10 configuration. Each compressor emitting 85dBA, as measured at one metre from the source.

Therefore, using the same criterion of dB(A) for assessing the acceptability of day time noise at dwellings, as discussed above, the residential areas of potential concern, Ruescas and Pujaire, appear to be well outside the circa 500 m zone of significant influence.

Nevertheless, if necessary, acoustic screening will be installed. A common technique is to make use of the excess spoil excavated from the site or work-strip to construct earth bunds, which may can then be left in place, to permanently landscape and visually screen the Reception Terminal. Such beneficial use of this large volume of construction waste would be compatible with the project waste minimisation objectives. The option of temporary voluntary resettlement of any seriously affect residents will also be available, if necessary.

The impact associated to the use of compressors is considered to be moderate, mainly due to the fact that they will only be used a few days and will be located as far as possible from sensitive receptors.

6.5.4 Traffic Movements

The public safety measures, will also be of benefit for preventing excessive exposure of the local communities to the noise from the traffic travelling to and from the work-sites.

Development of mitigation measures will ensure that local residents and other relevant parties still have access to the entire area where the project will be taking place. All current accesses will be maintained and if this is not possible then alternative routes will be created. Therefore this impact is considered negligible.

6.6 WASTE MANAGEMENT

A formal Waste Management System will be implemented at the construction sites, based on best international practice, and according to local legislative requirements. The project will produce wastes from all the normal categories used in the development of such a scheme:

- Domestic refuse will arise from the offices, workers' accommodation and eating facilities.
- The pipe-laying process itself will result in large volumes of typical inert construction site wastes, dominated by the excess spoil from excavation of the trench, which has been conservatively estimated as 4,000 m^3 on the Spanish side and 1,500 m^3 in Algeria.
- Hazardous wastes will be produced in only very small quantities and consist almost entirely of lubricating oils from plant, vehicle and vessel maintenance.

The waste management arrangements will be based on the European Union "hierarchy of waste minimisation", which requires consideration of the following options in the order shown:

- Reduce waste production at source.
- Recover waste for reuse on the site.
- Recycle by use off-site.

Disposal, by landfill or incineration, is to be considered only as the very last option.

To this end, mixing of different waste types and disposal on the work sites or to the sea will be forbidden. Purpose-designed centralised compounds will be established for segregated storage of the wastes while awaiting reuse, transport off the site or, in the case of the work vessels, unloading when in port. A service will be operated, using suitable containers, for collection and delivery of the wastes to the central compound.

Before start of the construction work, arrangements will be made with the local authorities and an approved transport and disposal contractor according to the European Union "Duty of Care" principle, whereby formal records are kept to ensure that all waste removed from the site is managed and disposed of in the correct manner.

Materials Safety Data Sheets will be obtained from the manufacturers for all chemical formulations, or other hazardous substances, before use. Management of the resultant wastes will be strictly in accordance with the instructions laid down in these data sheets.

Therefore the impacts associated to the waste management are considered to be minor and the overall impact negligible.

6.7 LANDSCAPE AND ECOLOGY

6.7.1 Terrestrial

General Overview

In view of the proposed routing through the Cabo de Gata-Nijar Natural Park

and across the specially protected sand dune habitat, preservation and the possibilities for enhancement of landscape and ecological value are key issues of this project. The routing around the B-zone that provides a buffer area for the permanently water-logged lower reaches of the Rambla Morales has removed any risk to the many species of birds that frequent this wetland. Scheduling of the construction work to take place in the late summer and autumn period provides additional protection, by avoiding the main nesting season, especially for the two most important species, the white headed duck (*Oxyura leucocephala*) and the greater flamingo (*Phoenicoperus rubber*). The only ecological impacts of potential significance are, therefore, concerned with the flora. The soils of semi-desert and sand dunes are typically fragile and sensitive to disturbance. They are, therefore, difficult to reinstate, with direct implications for the flora which they support. However, the flatness of the terrain in the Spanish land sector and small scale of the habitats in question leaves considerable scope for attention to detail, so the difficulties should be easily manageable.

Flora Conservation

Inside the OPRT area of 3 ha it is expected that the existing vegetation will be eliminated. In case the establishment of parking area, area for facilities for workers, store facilities for materiel and equipment, is located outside the OPRT area, existing vegetation at these areas will be eliminated as well.

Pipeline routing and terminals have been designed so that occupation of areas with relevant vegetation is minimised. Only on the Spanish side few habitats of interest are affected (protected under Habitats Directive), however none of these are defined as priority habitats.

A full description of the vegetation in the area, as a result of specific field studies on the flora and fauna for the onshore section of the pipeline, is included in *Appendix 1*.

On the Algerian side the onshore the hillside slopes north and south of the selected compressor station location: The hillside is overgrown with a mixed stand of different species of grass, herbs, and with scattered growth of scrubs and trees. The western part of the hillside to the north is forest with trees of up to about 5 m height.
The plain plateau: The plain plateau, where the selected compressor station site is lying, is at about 70 metres height, and the plateau is on the topographical map marked as cultivated land used as vineyards. The European fan palm (*Chamaerops humilis*) can be found scattered inside the study area.

An extensive description of the onshore vegetation and species affected by the project is provided in *section 5.5*. Moreover, *Appendix 1*(in Spanish) includes specific field studies on the flora and fauna present on the onshore section of the pipeline.

The overall impact on the vegetation is considered moderate due to the extensive number of mitigation measures and the fact that the route has been designed to minimise the direct adverse effects to vegetation (species and habitats).

For instance, a conservation strategy for the construction phase will be implemented to add an extra stage of refinement to the routing decisions taken in design stages. It will be based on the following hierarchy of preferences:

- Suitably qualified staff will carry out detailed inspections before the advancing work-front to add specific information to the inventory of plants that has already been prepared. If more species of interest are identified, avoidance by micro re-routing will be the first consideration.
- Where this is not feasible, the species will be re-planted nearby, in the same type of soil, to be returned to the site when the pipeline installation is finished.
- In any cases where this temporary removal method is unsuccessful, the vegetation will be reinstated by use of species of the local germoplasm, from local nurseries.
- If such a local source is not already available, site-specific germoplasm will be collected and cultivated for the purpose, in a timely manner, well before the construction work begins.

Soil Conservation

Soil from both terminals will be lost due to the permanent occupation of land. All earthworks related with temporal occupation of land and pipeline construction will be carried out by the well-proven practice of separating, retaining and then replacing the existing sub-soils and top soils, as described in *section 3.3*. To avoid excessive compaction of the sub-soil that is left in place along the work-strip, tracked vehicles and protective cover, such as boarding or mats, will be used, as and where necessary.

To minimise damaging exposure of the excavated soils while they are in storage, the trench will be back-filled as quickly as possible after each pipeline section is installed, so creating a single, continually advancing work-front. For example, the entire pipe laying process across the 4.5 km of the Spanish land sector will take only three months, so the time between excavation and backfilling at any one point on the route will be only a matter of two or three days. The same principle will apply to the operation on the Algerian side of the project.

Given the short time period of the pipe laying stage and the arid nature of the region, erosion and damage of the soil structure, by the action of rainfall, and changes in the hydrology are not a significant issue for this project.

There will be no land-take for construction of temporary access tracks to the

work-strip. Deliveries will be only via the existing surfaced roads, such as the ALP 212 (E340), and those within the Park area. Use of vehicles off designated roads or the work-strip will be strictly prohibited. A similar policy will also apply to the establishment and use of the off-site construction facilities, such as the pipe yards and plant and vehicle maintenance areas. The land used for off-site facilities will be restored to its former condition when the construction phase is complete, following the same strategy as that described above for the pipeline installation work-strip.

The overall impact on soils is considered to be negligible.

Fauna

Terrestrial fauna is one of the main issues to be studied in order to minimise environmental impacts. *Appendix 1* (in Spanish) includes specific field studies on the flora and fauna present on the Spanish onshore section of the pipeline and OPRT.

Due to the limited extent of noise and air emissions, impacts on fauna outside the work areas will be limited to a small area. During construction works it is expected that existing fauna will be able to move away and will leave the area due to human presence and disturbance.

Moreover, the implementation of a wide range of mitigation measures will ensure that impacts on fauna are kept to a minimum and therefore this can be considered as a moderate impact.

Among the most relevant mitigation measures the following can be specified and detailed:

A Fauna Management Plan will be developed. This plan will include, as a minimum, surveys before and during the construction works in order to identify those animals that may be threatened by the project. Management Protocols for those species of high interest will be developed. These protocols will have to be approved by the competent environmental authority. The surveys will be carried out by specialised and knowledgeable personnel.

Landscape Restoration Plan

Impacts on the landscape during the development of the project are considered moderate and are a consequence of the movement of soils, presence of heavy equipment, and accumulation of construction materials such as pipeline sections, concrete materials, etc. This impact will be limited to the project construction phase. Moreover the implementation of a Landscape Restoration Plan will be developed as an integral part of the overall, Project-specific Environmental Management and Monitoring Plan, described in Section 8. It will be based on world-wide experience in the restoration of sand dune and semi-desert landscapes and the results of the experimental nursery trials at the actual site, using the local species. A five-year period for after-care and any necessary remedial actions will be included. Photographic and

topographic records of the existing landscape will be made. These records, along with a visual comparison with the adjacent undisturbed land, will then be used for setting the standards against which the acceptability of the restoration work will be judged.

In view of the existing amount of historical damage by human activities along the route, the project could offer considerable scope for landscape improvements. On both onshore areas (Spain and Algeria) the Spanish side, Authorities and other stakeholders will, be consulted to explore how possible enhancements to the present situation can be reasonably integrated into the project objectives.

The Plan will be submitted for approval by the relevant authorities before start of the construction work and implemented immediately following installation of the pipeline.

6.7.2 Marine

General Overview

Over the largest proportion of the route the pipeline will be laid on the seabed, with little intervention work, and therefore the ecological impacts are considered to be insignificant. However, over the circa 3km of the shore approaches, where the pipeline will be buried, and in those parts of the offshore sector, where sea bed intervention is needed to correct free spans, for example, the installation process will have considerable effects on the benthic flora and fauna.

These impacts will be by way of the direct physical disturbance and the indirect effects of suspended sediments, which include smothering, reduced penetration of light needed for bio-synthesis and blocking of the feeding organs. Spawning grounds could be of concern, because fish eggs can be highly susceptible to smothering, although it is known that most of the fish in this area are pelagic spawning species. The means by which these potential adverse effects from the suspended sediment plume will be mitigated are described in the Water Quality section *(5.8*).

The pipeline for the most part, will be laid well outside the designated area of the Cabo de Gata Marine Reserve, which extends to one nautical mile (1.85 km) from the shoreline. That is, approximately equivalent to the 65m depth contour**.** However, when the route turns towards the landfall, it must unavoidably cross circa 2 km of the Marine Reserve B-zone. Certain activities, such as fishing, are permitted in this zone, under controlled conditions. It serves, amongst other things, as a buffer for protection of the highly sensitive A-zone, which is just off the Cabo de Gata, some 10 km away from the area likely to be affected by the shore approach works and 1.7km at its closest point to the pipeline route.

Although there are no designated protected areas on the Algerian shore, the

environmental impacts due to the construction works on the shore approach sectors are comparable.

Shore Approach Sectors

Sea Grasses:

In the shore approach sectors, between the coastline and the 30 m depth contour, where dredging will take place, the route must unavoidably cross, or pass by, areas of sea grasses that occur in the Cabo de Gata-Nijar Marine Reserve and, to a lesser extent, also on the Algerian side.

Together with wetlands, sea grass meadows are believed to produce more than 80% of the annual fish yield in the Mediterranean and the sustainability of important fisheries is directly connected with the presence of sea grasses. They rank with mangroves and coral reefs as the World's most productive coastal habitats. According to the World Atlas of Sea Grasses (UNEP, 2003), the world-wide stock of these species has suffered a 15% loss in the last ten years. Human disturbance by coastal developments is acknowledged as the main reason for loss of habitat on a large scale. However, it must be noted that this threat comes primarily from population and agricultural expansion and the resultant degradation of water quality by nutrient over-loading, causing excessive algal growths (Smithsonian, 2003). This type of damage is not relevant to a pipeline project, where the source of potential damage is dredging. This is a very different, short-term activity, which does not lead to a long term degradation of water quality.

The anticipated impacts for the dredging work can, therefore, be divided into two categories:

- Along the dredged strip there will be damage of the most severe type, because of the direct mechanical action of the dredging equipment.
- In the immediate vicinity of the dredged strip, the sea grasses will suffer only transient damage, due to the plume of suspended sediment temporarily settling on the foliage and reducing sunlight penetration of the water column. The sea grasses can, therefore, recover in a few weeks. Moreover, the species in question (*Cymodocea sp.*) is typical of sea bed environments where concentrations of suspended sediments are often naturally high, because of vigorous wave and current action.

Therefore, in view of the precautions explained in the *Section 5.8* to limit the spread of suspended sediments beyond the work corridor, the only significant impact will be restricted to the circa 28 x 1000 m strip, dredged through the band of fragmented *Cymodocea nodosa.* This strip is only 3% of the total habitat, which extends over circa 10 km^2 between the Rambla Morales and Cabo de Gata. The beds of the more vulnerable and economically important *Posidonia oceanica* are more than 8km further to the south-east, so will not be affected. The absence of *Posidonia oceanica* in this area was confirmed by ROV surveys (see *Appendix 2*). These surveys also confirmed the presence of

Cymodocea but this is restricted to a strip beginning at a depth of 19m. Similarly, there will be no effects on the two small beds of *Cymodocea* on the Algerian side, which are more than 200m away from the proposed dredging strip.

To further mitigate the damage caused by dredging, the Project-specific Environmental Management and Monitoring Manual will include a comprehensive Sea Grass Restoration Plan, incorporating the closely associated requirements for sea bed re-profiling described in Section 3. It will allow for both natural and aided reinstatement. Replacement of the lost sediments of the trench and profiling to restore the original topography of the seabed is known to be essential for the success of such plans. Where no sediment is present, rhizome extension stops, but careful sediment replacement promotes natural re-colonisation. Furthermore, it is important to transplant sea grasses from the same eco-system, because those from elsewhere are likely to have different genotypes and require acclimatisation to the sediment composition, seawater chemistry, currents, etc. (Precht, 2003 and Walker, 2003).

The Sea Grass Restoration Plan will be based on the above and other world-wide experience of enhanced re-generation projects and the results of experimental nursery trials at the actual site, using species taken from the actual habitat in question. It will also require the temporary stockpiling of the trench materials to be only in specified areas safety away from the known sea grass beds, or other sensitive areas, and at depths below 40m, where sea grasses do not occur. The Plan will be completed for approval by the relevant authorities before start of the construction work and implemented immediately following installation of the pipeline. An adequate period for after-care and any necessary remedial action will be described and specified.

Given the reported high re-colonisation capacity of *Cymodocea nodosa,* its ability to function as a pioneer species and a considerable amount of available research data on this particular species, a high degree of success can be anticipated for the Restoration Plan (Vidondo. B et al, 1997; Duarte. C and Sand-Jensen. K, 1996; Marba. N. and Duarte. C, 1994, 1995, 2001). In the area in question, the sea grasses occur only in patches, so it is possible that such a programme will also lead to a richer habitat than that which presently exists.

The criteria for defining an acceptable standard of rehabilitation will be established in a manner analogous to that described for the Landscape Restoration Plan. *Appendix 3* gives specific sources related to obtaining further information on sea grass restoration techniques and practices. Underwater photography and an echo sounder will be used to compare the density of the sea grasses and sea bed profiles before and after the construction work. Further information on a ROV survey conducted prior to the work is found in *Appendix 2*.

The magnitude of the impact on the sea grass habitats could be high due to the importance of this kind of habitat. However, the affected area is limited to a

small area, with no *Posidonia oceanica* affected (confirmed by ROV surveys), and an extensive Sea Grass Restoration Plan will be developed making this impact moderate.

Benthic Fauna:

Benthic fauna will be affected by both direct disturbance and sediment resettlement. However, these effects are normally very temporary on continental shelves, because they are essentially no different to those from storms, where recovery is normally well underway within a year as the species present are those that are naturally adapted to frequent disturbance of the seabed and water column. These same forces also ensure that disturbances of the seabed profile, such as the formation of mounds and troughs by anchors, are only short-lived with rapid habitat recovery.

Moreover, because the area affected by the pipeline installation will be only a relatively narrow strip, the benthic communities are expected to quickly return. No contaminants will be introduced during the pipe-laying process, so the disturbed seabed will be suitable for immediate re-colonisation by larval settlement, mobile specimens entering the area and from buried animals migrating back to the surface. An assessment of benthic re-colonisation following extensive sand dredging off the Dutch coast estimated that full recovery of benthic faunal communities takes approximately three years (De Groot, 1979). Recovery from trenching works is expected to be much quicker, because the boundary length over which the original species will return is much greater in ratio to the overall dredged area (i.e. the well know "edge effect")

In the Spanish shore approach sector, the present intention is to have imported rock armouring above the pipeline, but all parts will have seabed material in the trench above the rock, so that the natural seabed surface is re-instated. The detailed engineering stage will include further studies to ascertain the feasibility of completely remove the need for use of imported material at the Spanish end of the pipeline.

In Algeria, where rock cover will be necessary for the other reason of preventing buckling under the elevated temperatures, it will be covered by seabed material over the majority of the shore approach trench. The descriptions of the additional rock berms between 1.5 and 4km off shore, as described in *Section 3.3.6*, are conservative and optimisation studies in the detailed design stage are expected to significantly reduce the quantity of rock involved.

In the areas where gravel/rock armouring is exposed, a more diverse faunal community may develop, in which hard substrate species are predominant. Although this outcome represents a change from the existing environment, it can also be regarded as beneficial, because of the resultant increase in bio-diversity. The existing environment in terms of the benthic fauna can be found in more detail in *Section 5.5.3* and detailed studies have been conducted

of which these are included in *Appendix 2*.

The overall magnitude of the impact on the benthic fauna is considered to be moderate due to it being limited to a small area and also due to the very high potential for natural recovery (due to the shape and limited extension of the affected area). Only those species of fauna associated with sea grass meadows will require a longer period of recovery.

Fish and Marine Mammals:

Fish, and any unlikely marine mammals in the vicinity, will not be directly affected. They will simply avoid the immediate area of seabed disturbance, returning rapidly when the installation work has ceased. However, any permanent damage to the sea grasses or benthic fauna would also have an indirect adverse effect on these species.

The mitigation measures developed to prevent water pollution due to oil spills, sewage, etc, will also contribute to minimise any indirect effects on fish, mammals and other pelagic fauna. The overall impact on pelagic fauna is therefore considered to be negligible.

6.7.3 Offshore Sector

This section addresses the pipeline route over the whole of the seabed between the shore approaches sectors, where the pipeline will be largely laid directly on the seabed, with no trenching nor remediation work (for exceptions see below). However, if the post-lay survey identifies sections where remediation may be necessary, perhaps because of excessive spanning, then localised rock dumping may be required. The impacted area will be in the form of only a narrow band where the pipe is in direct contact with the seabed. Allowing for some settling into the sediment this band width may be up to 300 m, giving an approximate area of impact of 300 m^2 / km.

This section of pipe will be laid by the deep water lay barge, which will use a dynamic positioning system, and hence will not cause anchoring impacts.

The exceptions are a 4.9 km length of trenching from KP70.8 to KP75.7 in a water depth of 1320-1720m, and a 4.5 km length of trenching on the Spanish slope from KP167.5-KP170.0 in a water depth of 740-651 m.

The section in the circa-littoral region, from approximately KP184 to KP196 contains several rocky outcrops, and soft substrate habitats. The pipeline route has been carefully routed to avoid hard substrates and potentially sensitive habitats and communities such as coralligen. The pipeline route has been designed to avoid all known sensitive communities, including the *Cymodocea* and *Posidonia* sea grass communities between KP189 and 192 and KP185 and 188 respectively, and the important coralligen community in the rocky band between KP194 to 194. The avoidance of rocky outcrops has the double benefit of firstly ensuring pipeline stability by enabling it to settle into

the soft substrate, and secondly to reduce the risk of impacting hard substrates which may support sensitive or protected communities.

Further offshore, from KP184 to KP177, which covers the outer edge of the Spanish continental shelf, the seabed is mostly sandy (fine/medium) overlaying a layer of shell fragments which can be up to 1m thick. Rocky outcrops and sub-crops occur, and the pipeline will unavoidably cross some of these, but at the prevailing water depths of 75 to 200 m light penetration is very low (zero below 100 m). A recent ROV survey (see *Appendix 2*) showed that sandy communities dominate from KP175 to 179 and that due to a reduction in trawling activity, demersal fish on the slope are more abundant. Moreover, from KP 179 to 181, where the probability of sensitive communities such as coralligen was higher, the ROV survey showed that typical Mediterranean hard bottom communities were present, predominantly sponges and echinoderms. Only occasional live maerl on the coralligen sands.

The Spanish slope, from KP156-177 consists of very soft lightly silty clay, with patches of sandy silt. The pipeline will be trenched in this section for 4.5 km to a 1 m depth of cover to protect against mud flow in the event of a seismic event, but as these sediments support only very sparse marine life, and with the slope showing instability, it is considered that trenching will have a negligible effect on marine life.

The abyssal plain, from KP93 to 156, has a seabed surface of very soft clay. Little is known about benthic ecosystems in this area, but they are believed to be sparse or non-existent. The impact of the pipeline is therefore believed to be insignificant.

The Algerian slope, from KP21 to 93, consists of very soft slightly silty clay, and in this section a 4.9 km length of the pipeline will be trenched. This sediment is not known to support benthic communities, and the slope instability renders their presence even more unlikely. The trenching is, therefore, not expected to have any significant impact.

The Algerian shelf, from KP0.5 to 21, comprises fine sand out to KP2, and then silty clay, or silty fine sand. There are some rocky outcrops, but these are in depths greater than 100 m, and therefore are unlikely to support sensitive communities such as coralligen structures. No impacts are predicted in this section.

The Algerian landfall approach is 500 m wide, and is of habitat type AS, shallow water fine sand, although the sand is locally coarse, and there are some small fields of boulders and cobbles. As this shallow water is relatively energetic, and includes the surf zone, it is not believed that benthic or demersal communities of special interest or significance are likely to be present. The identified *Cymodocea* beds, at distances of 200 m and 600 m are from the pipeline, are at risk from the anchor spread of the lay barge, so their locations will be taken into account when laying out the spread.

A recent ROV survey (summer 2004) conducted along the pipeline route (see Appendix 2) confirmed the above description of the sea-bottom and showed the following:

Seabed sediments

- KP12 to 17.2 predominantly sandy silts over patchy areas of sub-cropping rocks.
- KP 17.2 to 175 soft surface silts over cohesive clays
- KP175 to179 sediment becomes sandier silts over clays
- KP 179 to 181 mixed sub-cropping, rock outcropping and corraligen sands.
- KP 181 to 196 predominantly mixed sands, occasional sub-cropping & corralligen.
- Hard substrates recorded off line with sand-stone outcropping on Algerian slope in 800m and slope failure on Spanish side in 565m

Faunal distribution

- KP12 to 22 Low energy soft sediment communities predominate with sessile Sea pens (*Pentatula*) and holothurians, and occasional mobile crustaceans and several species of fish. Significant surface bioturbation was recorded with regular surface burrows.
- KP22 to 175. Consistent, but sparse low energy communities, with malacostracans (predominantly *Aristaeomorpha* and *Aristues* red shrimp) , and large worm casts.
- KP117 to 122 incidents and of deep water stalked sponge
- KP175 to179 sandy communities with greater incidents of demersal fish on slope where trawling activity reduced.
- KP 179 to 181 typical Mediterranean hard bottom communities, predominantly sponges and echinoderms. Occasional live maerl on the corralligen sands.
- KP196 Sea grass, *Cymodocea*, begins in 19m of water.

Anthropogenic artefacts

- KP12 to 46 Significant trawl scarring down to 460m.
- KP168 to 175 Significant trawl scarring from 713m. This dominates the seabed between 400 and 650m water depth.
- Occasional items of debris throughout, slightly more prevalent on the Spanish slope KP150 onwards.

Marine Mammals:

Cetaceans are indigenous to the Mediterranean, and in addition several species migrate into this area at certain seasons; the main migration route is believed to be parallel to the Spanish coast through the Alboran Sea.

The pipe laying operation will inevitably form a temporary barrier across changing sections of the Alboran Sea. The vessel may be moving at rates typically of up to 3 or 4km per day, and the obstruction, including the vessel on the surface, and the pipe string in the water column may extend 2-3 km, depending on the water depth, making avoidance a simple matter. Cetaceans are known to attempt to avoid sources of noise, and avoidance of the DP turbine noise should ensure that the pipe string is also avoided. However, considering the dynamics of the pipe laying process, and the marine traffic in one of the world's busiest shipping channels, it is considered that this operation will not have any significant effect on cetaceans.

Fish and Fisheries:

This sector of the Alboran Sea is particularly important for crustacea, which are harvested by trawling down to depths of up to 800 m. A corridor commonly used by trawlers crosses the pipeline route, although all fishing is banned within the traffic separation zone. During installation the vessel and pipe string can be easily avoided by liaison with fishing boats in the area. During operation it will be possible to trawl over the pipeline. Down to depths of 250m it will have the additional protection against impact damage by the concrete coating that has primarily been added to increase its stability, but even in the deeper waters, the pipeline wall thickness alone will provide sufficient protection.

The risk of snagging an on-bottom part of the pipeline is considered to be very low, as the substrate is almost wholly soft sand, silt or clay, into which the pipeline will settle for a few centimetres. A post-lay survey will identify any sections of free span which were not anticipated at the design stage, and a decision will be taken on possible remedial action. MEDGAZ will specify that the industry-accepted guideline for a maximum span height of 500 mm is complied with. Available remediation measures include trenching of the pipeline to enhance settling, or to deposit rock to physically block the gap. Therefore it is considered that neither the installation nor the pipeline's presence on the seabed during operation will present a significant risk to fishing activities.

Any disturbance to fishing activities will be limited to the time during the pipe laying, which will only be relevant to those areas where fishing activity takes place. Therefore, the impact on fishing will be very low. Moreover, the fishermen and the maritime authorities will be informed of the work programme, so that interested parties will be able to plan their activities.

6.8 SOCIO-ECONOMICS

The site identified for the compressor station (BSCS) is located is on the hills near the Sidi Djelloul beach, 10 km east of Beni Saf. It is on a plateau between a valley to the north with the D.59 road, and a valley to the South with the D.20 road, and the river Sidi Oued. The altitude of the plateau is around 70 metres. The area is reasonably flat with very gentle slopes. The compressor station (BSCS) will affect the agricultural areas. An area of around 16 ha actually dedicated for vineyard, will have to be acquired for the station and the access road, and 1 or 2 of the nearest farms may have to be moved. However, although the compressor station is not a labour intensive facility will carry employment opportunities in relation to operation and maintenance of the plant.

The compressor station is a fairly comprehensive installation, occupying an area of around 13 ha, and it will be visible from all sides with the location on the plateau. Obviously, the station will be more hidden from distant positions if installed in the valley at the beach.

The selected OPRT site is located at the Morales Hill, next to the ALP-202 road from Retamar to Ruescas. The nearest neighbour to the site is extensive greenhouse complexes, separated from the site by a minor road. South and west of the site is the Parque Natural Cabo de Gata-Nijar in about 200 m distance.

On the Spanish side, the terminal (OPRT) will affect the nearest greenhouses. Otherwise socio-economic impacts of any significance are not anticipated.

The terminal will be visible from all sides, while assessed mainly to affect the impression of the area from the ALP-202 road, where most people will pass the area. Obviously, the terminal will also be visible from the nearest areas of the nature park.

6.8.1 *Employment, tourism and livelihood*

The impact on tourism and recreational areas will be restricted to visual impacts, especially tourists who are driving from the ALP-202 road to the north for visiting the Cortijo Nuevo farm, will pass the OPRT, and to the short period of about 15 minutes per year from cold venting/emergency depressurisation.

Impact will occur on the beach and camping facilities in terms of noise and air quality impact and visual impact. The noise, the air quality and the visual impact to the beach and campsite are obviously lower for the selected BSCS site than an alternative behind the beach.

The construction works will cross land that is in private ownership and, in some cases, also used for income generation. Arrangements may, therefore,

be made to compensate the affected parties for the temporary losses within the established Spanish and Algerian legal frameworks for such purposes.

Disruption of fishing activity will be limited only to a temporary loss of access to waters in vicinity of the shore approaches works and the lay vessels, so will not significantly affect fisheries resources.

In Spain, the most affected waters will be those adjacent to the El Charco Beach and Playa de Cabo de Gata but, with reference to *Map 5.9* and the dimensions and construction schedule given in *Section 3,* it can be seen that only a maximum of about 2% of the artisan small gear fishery will be lost for a period of about seven months, due to the shore approaches works. For the much larger purse seine and trawling zones further off the coast the proportion of lost area is so small as to be immaterial.

At the usual speed of circa 3 km per day, pipe-laying through the entire purse seine and trawling areas will take only about 5 days and, because this is a moving activity, disruption at any particular location will be for only a few hours at the most. The post-lay trenching, at a typical rate of 750 m per day, will require about six days to complete the 4.5 km in question but, again, this is also a moving process, so the presence of the work vessels at any one point will be for only a few hours.

Nevertheless, a Fisheries Liaison Officer will be employed for the course of the construction phase to maintain continuous consultation with fisheries and fishermen's organisations.

Scheduling of the land and shore approaches works to avoid the summer months is the over-arching measure for mitigating the impacts on the local tourist economies. Therefore only the far less important autumn and winter tourism requires consideration here:

- On the Spanish side, any adverse effects on this autumn and winter tourist economy will be small. Even at its closest point, the proposed route is 100m from Cabo de Gata Camp Site and the pipe-laying work-front will pass by the closest proximity within a few days. Avoidance of the Camp Site vicinity will be a major consideration in the Traffic Management Plan discussed in the previous sections of this Section. Although the shore approach works will take place over circa seven months, the affected area is only about 1% of the entire El Charco Beach and some 800m from the main tourist centre of Cabo de Gata village, at the end of the beach that is not served by the main access road and at time of the year when there is virtually no beach tourism.
- By contrast, the far more confined situation at Sidi Djelloul Beach, on the Algerian side, will lead to major disruption of the tourist and the associated leisure activities. However, it is possible that the facilities could also be adapted to serve the pipe-laying work-force, so providing a beneficial impact at a time when income from tourism is at its lowest.

It will be project policy to locally acquire as much labour and materials as possible, which will undoubtedly stimulate of the local economies prior to and throughout the construction phase. The influx of a temporary workforce of circa 50 personnel, at each side of the pipeline, will also contribute significantly to this effect.

6.8.2 Severance of Access Routes and Utilities

On Land

The locations of all buried service lines, such as water pipes and electricity cables have been identified as part of the early project planning studies. Precautionary arrangements will be put in place to ensure local residents and authorities are consulted, well in advance, so that any services requiring severance can be carefully scheduled and alternatives provided, if necessary. Similar procedures will be implemented for the overhead electricity line that crosses the Algerian land sector and for the local unpaved roads in both sectors. Significant, long term, inconvenience from the loss of services is, therefore, very unlikely.

In the more extreme cases of crossing the ALP-202 (E340) main road and the minor parallel road on its northern side, in Spain, and the Beni Saf Road, in Algeria, the special technique of horizontal drilling will be used to avoid the serious inconvenience that would, otherwise, be the result of trenching.

The full implementation of the mitigation measures will ensure that there are no significant impacts.

At Sea

The analogous severance situation in the shore approaches sectors is the obstruction of the small vessels that use these waters, including their access to fishing grounds. Again, therefore, this issue will be dealt with by liaison with the local fishermen, other stakeholders and the authorities, well in advance and throughout the six or seven months that the cofferdams, dredgers, pipe-laying barges and other facilities associated with the works will be in place.

The pipe-laying offshore pipe-laying is a moving activity, so disruption at any particular point is only very temporary. Six months have been scheduled for completion of the whole sector of circa 197 km, but the pipe laying part will be finished in a much shorter time, at the typical rate of 3 km per day. In keeping with normal national and international requirements, the main methods for mitigating any problems of obstruction will be by the various official channels for mass communication with other sea users.

No other oil or gas pipeline is in place along the route. However, it will cross a number of cables that are still in use. At present, information on the location of these cables is available only from an international data base. Therefore, more exact positioning is necessary, by way of detailed, in situ detection, This exploratory work will be carried out prior to, or as an integral part of, the

pipe-laying stage itself. Where the pipeline crosses an in-service cable, a rock berm or concrete support will be installed to achieve the necessary protection.

6.8.3 Infrastructure and Services Capacity

Such short-term but large changes in the balance of populations as a result of construction projects commonly raise questions of whether the local infra-structure is able to meet the increased demands. Typical examples are the provision of adequate drinking water, electricity and services for the collection and disposal of household waste. However, in this project, the communities have the necessary extra capacity due to the high level of tourism in the summer on both the Spanish and Algeria sides. They should, therefore, easily assimilate the additional requirements of the work forces throughout the autumn and winter months, which are scheduled for the land and shore approach works. Nevertheless, these matters will be fully addressed in consultation with the local authorities and the public, and formal arrangements will be implemented to continually maintain the channels for liaison and corrective action throughout the construction phase. No negative impacts are foreseen.

6.8.4 Public Safety

On land

The temporary large increase in heavy vehicle movements in the area presents potentially important questions of public safety. The decision to carry out the land sector construction works outside the main summer tourist season has already provided a fundamental contribution in this regard. However, before start of the construction activities, a Project-specific Traffic Management Plan will be completed in liaison with the local authorities and communities

Routes will be selected to avoid, or at least minimise, increased traffic on high risk public roads and in populated areas such as the villages and near the camp sites. Movements will be scheduled to avoid maximum periods of risk, such as school opening and closing times.

In the surrounding area and on the work sites themselves; speed limits will be imposed, barriers will be erected to separate traffic and pedestrians, warning signs and lighting will be installed at the necessary locations and dedicated parking and waiting areas will be established. Unattended reversing of vehicles will be forbidden.

A strict regime of vehicle maintenance and load security will be in place, including the use of covers over loads of excavated soil. For particularly heavy traffic, personnel will be appointed to supervise road crossings and other high risk points. Road deliveries of very heavy loads, such as the pipes and rock armouring, will be reduced to an absolute minimum by making maximum use of the sea route.

Perimeter security fences with warning signs will be erected around all work

sites and entry will be forbidden for unauthorised personnel. Warning signs will be erected where the work-strip passes under overhead electricity cables.

At Sea

The boundaries of an exclusion zone around the shore approaches construction sites will be marked with buoys. Lights, radio communications systems and other safety devices will also be installed where necessary and as required by the relevant authorities. Well before start of the works, a public awareness campaign will be prepared and implemented in liaison with the various beach and near-shore water user groups, such as the local fishermen and tourist organisations. Liaison and continuous dissemination of public information will continue throughout the construction phase to ensure that all these groups are keep fully up to date on progress and any changes from the original plans.

Due to the implementation of the mitigation measures, no relevant impacts are expected. Furthermore, any construction work will be temporary and once the pipeline is built there will be no disturbance to the local population.

6.8.5 Archaeology

Terrestrial

No areas of major archaeological importance are within significant distance of the Spanish land sector route. A specialist walk-over survey, similar to that already carried out in Spain, will be completed on the Algerian side before start of construction. Throughout the construction phase, local archaeologists will be available to carry out inspections, with authority to stop work if necessary. The only indirect effects will be the visual impact to tourists visiting the area.

On the Algerian land sector route the only cultural heritage inside the study area is a murabit (cemetery) at Sidi Djelloul 1 km west-southwest of the selected BSCS site, located along the D.20 road. Direct impacts on identified cultural heritage, being the murabit next to the beach, are not expected. The selected BSCS site is more than 1 km away from the murabit and behind the border of the hills. The alternative site would be very close to the murabit, only 2-300 m away.

Marine

Off the Cabo de Gata, the pipeline has been routed to be more than 250m away from the Corralete Archeological Zone and 1.5 km from the Medieval Wreck Zone. With the pipeline at a depth of about 70 m, the depth differential with the nearest point of the former zone is about 5 m and for the latter it is more than 40 m. These Zones are, therefore, well outside the sea bed area likely to be affected by the proposed pipe-laying activities.

With the exception of these examples, no other significant items of marine

archaeology have been identified along the route. However, before the start of construction, detailed magnetometer inspections will be carried out for the detection of any buried metallic objects. Moreover, according to a recent ROV survey (summer 2004), no archaeological resources on the seabed surface have been identified.

6.9 MOST RELEVANT POTENTIAL IMPACTS

On the basis of the discussion presented above, the potentially significant impacts associated with the construction phase of the MEDGAZ project can be summarised as follows:

- Water, soil and groundwater pollution by uncontrolled releases of oils, fuels, particulate matter, chemicals, sewage and disposal of wastes.
- Reduction of air quality by dust from traffic movements, excavation and stockpiling of soils, and by engine exhaust emissions from the delivery vehicles, and stationary equipment, especially the dewatering compressor spread.
- Noise, at intermediate levels from the routine construction site activities and at high levels from short-term events such as piling or use of the dewatering compressor spread.
- Degradation and possible enhancement of the landscape and seabed, especially the important terrestrial and marine habitats in the Cabo de Gata Natural Park and Marine Reserve.
- Temporary effects on livelihood by loss of access to land or fishing grounds, degradation of tourism appeal or, by contrast benefits to the economy by local procurement of project materials and services.
- Public inconvenience because of excessive demands on or damage to, drinking water and electricity supply lines, severance or overloading of the road and pathway systems and poor management of the wastes produced by the construction activities.
- Local community hazards from the increased heavy vehicle and vessel movements, bulk storage and use of hazardous liquids such as fuels and lubricants.

In the previous sections, the impacts associated to the project implementation have been discussed. These evaluations have been made assuming that all mitigation measures are implemented.

The means by which the impacts will be mitigated and controlled to be within acceptable levels have been summarised in the Project Environmental Management and Monitoring Plan, which is presented in *Section 8*.

SECTION 7

POTENTIAL OPERATIONAL & DECOMMISSIONING IMPACTS AND MITIGATION

MEDGAZ

CONTENTS

7 POTENTIAL OPERATIONAL & DECOMMISSIONING IMPACTS AND MITIGATION

7.1 INTRODUCTION

Pipelines of this type, which are buried in the land sectors and in those parts of the sub-sea sector that have potential for interference by human activities are acknowledged as the most environmentally acceptable method for transporting hydrocarbons over long distances.

The proposed materials of construction, design, testing, commissioning, monitoring and maintenance of the MEDGAZ pipeline system, as described in the previous sections of this Environmental Statement, are consistent with best available technology and current best international practice. The operation of such pipelines has no significant effect on the environment in the normal terms of water, air, land or noise pollution and, because the pipeline will carry only gas that has been prepared ready for direct market use, neither will routine inspection and cleaning ("pigging") produce significant amounts of waste for disposal.

Operation of Compression Terminal and Receiving Terminal, however, implies various potential impacts. Therefore, Implementation of an environmental plan for establishment and operation of the terminal would facilitate compliance to environmental objectives and compliance to requirements, regulations and conditions in relation to environment. An environmental plan can build on the principles of environmental management in ISO 14001, and contain description of environmental aspects, requirements and regulations and activities related to monitoring and follow-up on environmental issues.

7.2 OPERATION ON LAND

After completion of the land restoration processes, the marker posts, typically spaced at distances of 250 to 300 m, will be the only visible indication of the pipeline's presence. Regarding the pipeline, there will be no adverse effects on the local landscape and ecology, and hence, the local tourist economies. It will be possible to resume former agricultural practices, even ploughing to normal depths on the right-of-way if required. All transport routes, built structures, water pipes and other buried facilities will be returned to service, mainly in an improved condition.

Regarding the BSCS terminal it will appear dominant on the location on the plateau. A plantation belt around the installation could mitigate this considerably and would further reduce noise in the neighbourhood. Other landscaping and architectural measures such as use of colours and materials should be considered.

Regarding OPRT, the terminal will have an effect on the impression of the area, which is dominated by greenhouses. The terminal will mainly be seen from the south and east, where the main road and Ruescas are lying and where the area is visible from longest distances. Landscaping and architectural measures, like vegetation and use of colours, could be considered to mitigate the effect of the terminal on the area.

The establishment of both terminals (BSCS and OPRT) will have an effect on the land during construction works, however most of the impacts will be limited to this phase and cease once the terminals have been built.

7.2.1 Impact on protected/classified areas

The establishment of the OPRT will not have any direct impacts on the Parque Natural Cabo de Gata-Nijar or on the internationally protected areas because the areas to be occupied are located outside designated protected areas.

The only potential impacts during the operations of the terminals would be the potential increase of acoustic contamination and potential increase of atmospheric contamination.

From modelling of the noise from the boilers (period from 2008 – 2012) it can be seen (see *Section 7.2.2*) that the noise level outside the OPRT will be <55 dB(A), and at the border of the protected areas the noise level will be 40 dB(A).

From modelling of the noise from venting (anticipated once every year, with a duration of 15 minutes, in planned depressurisations for maintenance and occasionally for emergency depressurisations) it can be seen (*Section 7.2.2*) that the noise level will be up to around 90 dB(A) outside the OPRT, and at the border at the protected areas around 75 dB(A) for both the selected site and the alternative site.

The results from modelling air emission of NO_x indicate that for the continuous boiler operation scenario the 1-hour peak air quality limit 200 $\mu g/m^3$ will be exceeded just outside the terminal for around 24 minutes in the 4-year period considered. The annual average limit is exceeded for 1 hour in a year. For the venting scenario air quality limit exceeding frequencies are 1 hr in 100 years or lower.

Even though the critical level of NO_x to terrestrial vegetation is as low as 30 $\mu g/m^3$ (yearly average), it is not assessed that emission of NO_x will have any impact on protected areas because of the short time with increased concentrations.

In summary it is assessed that there will be no direct impact on the protected areas. Indirect effects from noise and air emissions are considered to be negligible since they do not have a significant impact on flora and fauna inside these areas.

7.2.2 *Noise*

OPRT (Spanish Terminal)

Noise from the terminal is appearing mainly from 2 sources: the boilers and the vent stack.

> **Boilers**: according to the forecasted flow build-up rate, the boilers may be in continuous operation in the period 2008 to 2012 and otherwise only occasionally during start-up.
>
> **Vent stack:** venting is anticipated once every year in planned depressurisations for maintenance and occasionally for emergency depressurisations. A depressurisation of the terminal has a duration of 15 minutes.

Noise calculations are made for the boilers and the vent stack applying a noise level complying to the equipment requirements described in *section 3*. These requirements correspond to a Sound Power Level L_{wa} equal to 101 dB(A) for the boilers and L_{wa} equal to 135 dB(A) for the vent stack.

The noise scenarios studied are:

Table 7-1 Noise scenarios.

Source	Sound Power Level L_{WA}	Source height
Boiler	NR 45 (equivalent 53 dB(A)) at 100 m distance corresponding L_{WA} = 101 dB(A)	2 m above the ground
Vent Stack	NR 80 (equivalent 86 dB(A)) at 100 m distance corresponding L_{WA} = 135 dB(A), which is more restrictive than 115 dB(A) at the restricted area fence	24 m above the ground

Calculations are made with the model "General Prediction Method" that is a common Nordic model for calculation of industrial noise. Practically the calculations are made by means of the PC-model SoundPLAN.

Calculations are made under the following assumptions:

- Noise levels in the environment are calculated as the sound power level with corrections due to the transmission path. Corrections due to the transmission path include divergence, air absorption and ground effect.
- The ground effect is calculated applying hard surface inside the station and porous surface outside the station.
- Noise levels are calculated in 1/1-octave frequency bands. Sound Power Levels of the sources are defined according to the relevant NR ISO curve.
- Noise levels are calculated 2 m above the ground.
- Noise levels are calculated on the assumption of flat ground. This means that the ground absorption may be overestimated, while attenuation due

to screening is not taken into account. Attenuation due to vegetation is not taken into account.

The results are assessed against the acceptance levels in the Spanish regulation of the Andalusian Decree 326/2003 on acoustic contamination. The regulation stipulates:

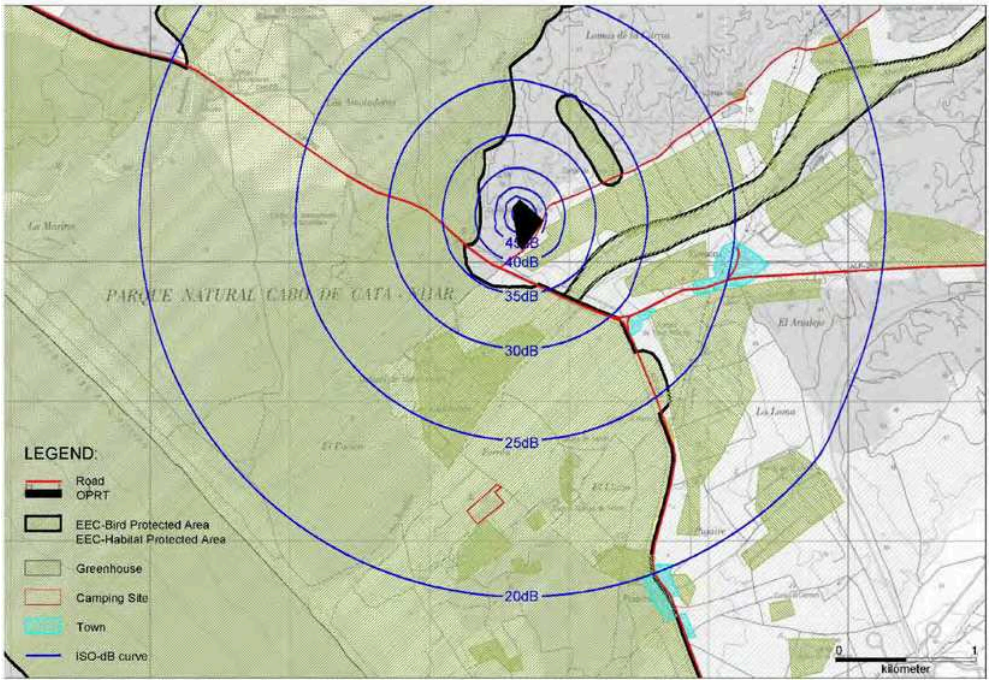
- In the area near the station fence it should be a maximum of 75 dB(A) during the day and 70 dB(A) during night hours.
- In the surrounding urban or residential areas, the maximum accepted noise levels are specified to be 55 dB(A) during the day (7h-23h) and 45 dB(A) at night (23h-7h).
- In non-residential areas within the Natural Park, levels should be maintained below acoustic levels of 55 dB(A) during the day (7h-23h) and 40 dB(A) at night.

The results are presented as iso-dB curves with 5 dB intervals in *Figure 7-1* and *Figure 7-2*. Summary of the results and comparison to noise ceilings is presented is provided in *Table 7-2*.

Table 7-2 Summary of noise levels vs. noise ceilings.

Location	Noise level, dB(A)	
	Boiler	Vent
Site fence	55	90
Greenhouse	45	75
Residence	30	60
Protected area	40	75

Figure 7-1 Noise from boiler.

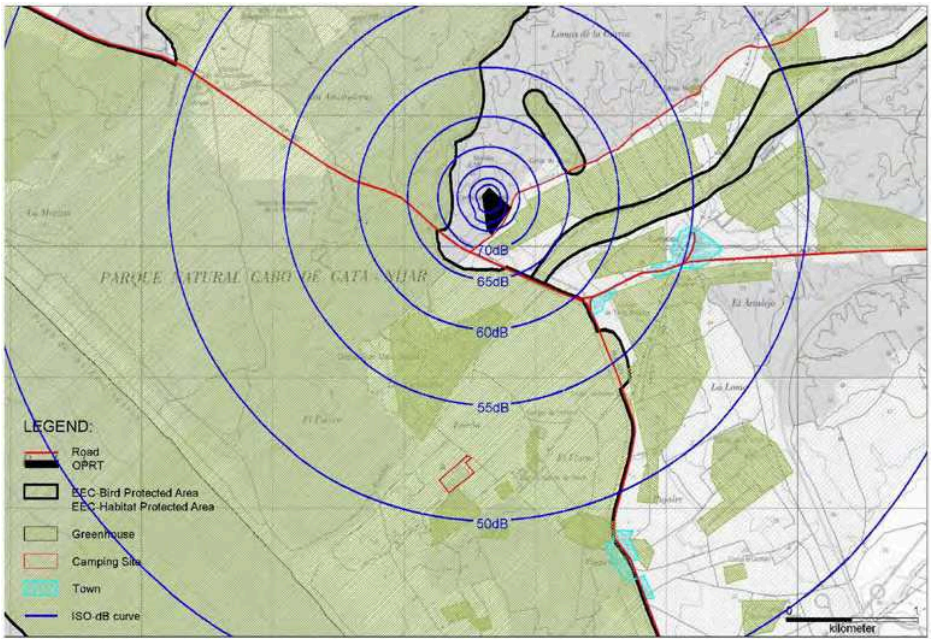


The resulting noise levels seen are:

- 55 dBA at the terminal fence
- 45 dBA at nearest greenhouse
- 30 dBA at nearest residence in Ruescas
- 40 dBA at the protected area border

These levels are within acceptable levels.

Figure 7-2 ***Noise from vent stack.***



The resulting noise levels seen are:

- 90 dB(A9 at the terminal fence
- 75 dB(A) at the nearest greenhouse
- 60 dB(A) at the nearest residence in Ruescas
- 70-75 dB(A) at the protected area border

These levels are all considerably in excess of the noise ceilings, but of a short duration, 15 minutes once every year in normal scenarios.

BSCS (Algerian Terminal)

Noise from the terminal is appearing mainly from 3 sources: the turbo-compressors, the gas air-coolers and the vent stack.

Turbo-compressors: two scenarios are analysed corresponding a low scenario at start-up flow rate with one compressor in operation, and a high scenario at maximum flow rate with five compressors in operation.

Air-coolers: combined with the two scenarios for turbo-compressors, with one set of air coolers in operation at the low scenario and two sets of air-coolers in operation at the high scenario.

Vent stack: venting is anticipated once every year in planned depressurisations for maintenance and occasionally for emergency depressurisations. A depressurisation of the station has a duration of 15 minutes.

Noise calculations are made for the turbo-compressors and the vent stack applying a noise level complying with the equipment requirements described in *section 3*. These requirements correspond to a Sound Power Level L_{wa} equal to 101 dB(A) for the turbo-compressors and the air-coolers, and L_{wa} equal to 135 dB(A) for the vent stack.

The noise scenarios studied are:

Table 7-3 ***Noise scenarios.***

	Scenario	Sound Power Level L_{WA}	Source height
1	1 turbo compressor 1 set of air-coolers	NR 45 (equivalent 53 dB(A)) at 100 m distance corresponding L_{WA} = 101 dB(A)	2 m above the ground
2	5 turbo-compressors 2 sets of air-coolers	NR 45 (equivalent 53 dB(A)) at 100 m distance corresponding L_{WA} = 101 dB(A)	2 m above the ground
3	Vent stack	NR 80 (equivalent 86 dB(A)) at 100 m distance corresponding L_{WA} = 135 dB(A), which is more restrictive than 115 dB(A) at restricted area fence	75 m above the ground

Calculations are made with the model "General Prediction Method" that is a common Nordic model for calculation of industrial noise. Practically, the calculations are made by means of the PC-model SoundPLAN.

Calculations are made under the following assumptions:

- Noise levels in the environment are calculated as the sound power level with corrections due to the transmission path. Corrections due to the transmission path include divergence, air absorption and ground effect.
- The ground effect is calculated applying a hard surface inside the station and a porous surface outside the station.
- Noise levels are calculated in 1/1-octave frequency bands. Sound Power Levels of the sources are defined according to the relevant NR ISO curve.
- Noise levels are calculated 2 m above the ground.
- Noise levels are calculated on the assumption of flat ground. This means that the ground absorption may be overestimated, while attenuation due to screening is not taken into account. Attenuation due to vegetation is not taken into account.

The results are assessed against acceptance levels specified in Danish guidelines. Night hour limits are applied, as the station will be in 24-hour operation. The guidelines stipulate night hour time weighed noise ceilings as follows (daytime values indicated in brackets):

- 60 dB(A) at industrial areas (60 dB-A-)
- 40 dB(A) at commercial (50 dB-A-)
- 35 dB(A) at residential areas (45 dB-A-)
- 35 dB(A) at open field, villages (45 dB-A-)

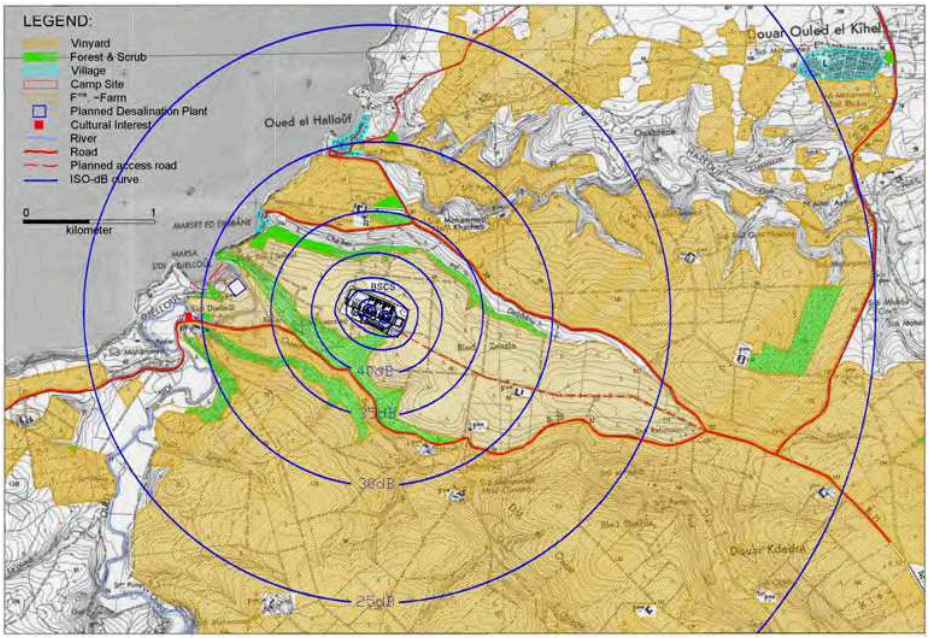
The results are presented as iso-dB curves with 5 dB intervals in *Figure 7-3* to *Figure 7-5*. Summary of the results and comparison to guideline noise ceilings is provided in *Table 7-4*.

Table 7-4 ***Summary of noise levels vs. noise ceilings.***

Location	**Noise level, dB(A)**			**Noise ceiling**
	1 **1 turbo-c** **1 air-cool**	**2** **5 turbo-comp** **5 air-cool**	**3** **Vent**	
Site fence	50	60	85	-
Residence	35	40	65	35
Beach	30	35	60	35
Open field	30	35	60	35

As it appears from the table, noise ceilings are exceeded at residence area for the compressor high scenario and generally exceeded considerably for the vent scenario, which is however of short duration, 15 min once a year in normal scenarios.

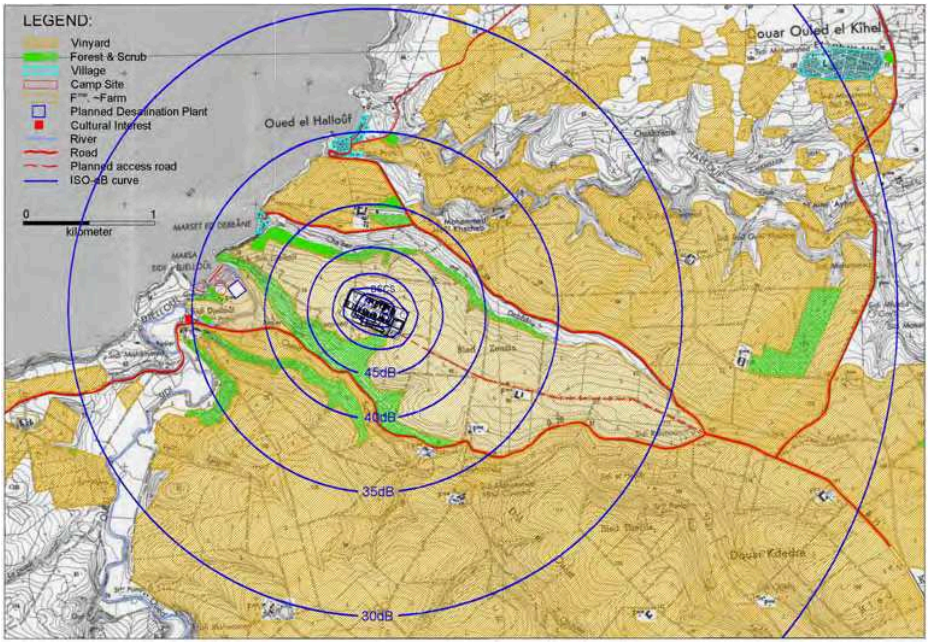
Figure 7-3 ***Noise, scenario 1, 1 turbo-compressor 1 air-cooler.***



The resulting noise levels seen are:

- 50 dB(A) at the terminal fence
- 35 dB(A) at the nearest farm or residence
- 30 dB(A) at the beach and open field in 1 km distance

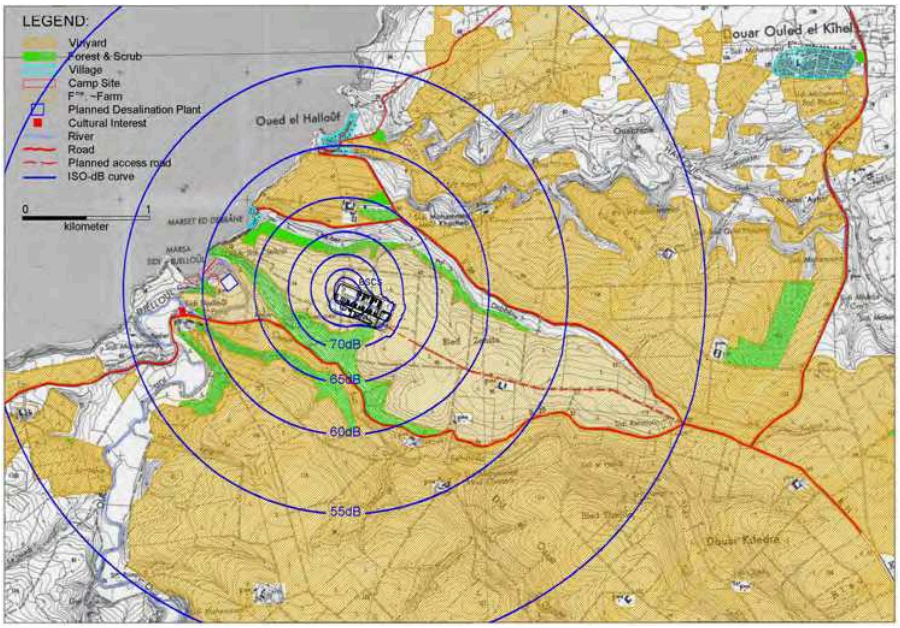
Figure 7-4 ***Noise scenario 2, 5 turbo-compressors and air-coolers.***



The resulting noise levels seen are:

- 60 dB(A) at the terminal fence
- 40 dB(A) at the nearest farm or residence
- 35 dB(A) at the beach and open field in 1 km distance

Figure 7-5 ***Noise scenario 3, vent stack.***



The resulting noise levels seen are:

- 85 dB(A) at the terminal fence
- 65 dB(A) at the nearest farm or residence
- 60 dB(A) at the beach and open field in 1 km distance

These levels are all considerably in excess of the noise ceilings, but of a short duration, 15 minutes once every year in normal scenarios.

OPRT and BSCS noise mitigation measures

In either case, OPRT or BSCS, Noise levels are not exceeding guidance limits except for short durations in connection with terminal depressurisation. Noise levels are noticeable though in the neighbourhood of the terminal and noise should be reduced to the lowest practicable. A plantation belt is recommended for consideration as discussed above under visual impact. A plantation belt should have a width of 20-50 m and a height of 8-10 m to have an effect on noise.

Monitoring of noise levels should be made, to control that equipment meets specified noise requirements and that noise levels are not exceeding accept levels at neighbouring areas.

7.2.3 Air pollution

This section develops the assessment of air pollution concerns effects on air quality from emission of pollutants from combustion and greenhouse effect from emission of Carbon Dioxide (CO_2) or Methane (CH_4).

Impacts on the air quality during operation of the BSCS and OPRT will appear as a consequence of emission from combustion of gas and other combustibles, and emission of gas from cold venting in case of emergency depressurisation, emission of service gas for valve actuation and starting gas for turbines.

Dispersion analysis and carbon dioxide balance are made for pollutants from boiler (OPRT), turbo-compressors (BSCS) and from venting scenarios (both terminals). An additional assessment is made of gas releases related to service gas for valve actuation and an alternative vent system with a pilot burner compared to the combined vent/flare system chosen.

The following scenarios are studied:

OPRT

- Boiler with a gas consumption of 750 m^3/h (years 2008-2012 if continuous heating is required) and 75,000 m^3/yr (start-up scenarios).
- Venting (flaring) once every year for planned depressurisation of the station, volume 38,000 m^3 and once every 5 years in emergency cases (cold venting).

- Release of service gas for valve actuation.
- Alternative vent system with pilot burner with a flow at 0.1 m/s in flare head.

BSCS

- Turbo-compressor operation, low scenario, with a gas consumption of 210 Mm^3/yr.
- Turbo-compressor operation, high scenario, with a gas consumption of 324 Mm^3/yr
- Venting (flaring) once every year for planned depressurisation of the station volume 60,000 m^3 and once every year in emergency cases (cold venting).
- Release of service gas for valve actuation and turbine starts.
- Alternative vent system with pilot burner with a flow at 0.1 m/s.

Determination of the pollutants emitted is made on the basis of the quantities of gas consumed in combustion and in venting, estimate of flue gas quantities and composition of flue gas on the basis of the gas composition, determination of pollutant flue gas components on the basis of requirements to machinery emission ceilings.

The flue gas components considered are mainly carbon dioxide (CO_2), nitrogen dioxide (NO_x) and water. Carbon monoxide and formaldehyde may also appear in the flue gas, depending on the combustion control.

Air quality guidelines

The results are assessed against air quality limits given in EEC regulations and WHO guidelines and against current greenhouse gas emission figures.

The NO_x emission limit value specified for gas turbines for mechanical drives is 75 mg/m^3, as per the EEC emission limitation directive, Council Directive 2001/80/EC.

Spanish National emission limits to be met by 2010 according to Council Directive 2001/81/EC EU on national emission ceilings for certain air pollutants for Spain, NO_x: 847 ktonnes/yr. National emission limits for Algeria are not known. For comparison the Spanish National emission limit is used.

Acceptable air quality ceilings for NO_x are based on EEC and WHO guidelines:

1 hour: 200 $\mu g/m^3$ for 1 hour
Annual mean: 40 $\mu g/m^3$

Global fossil fuel burning is around 6 Pg C/yr, equivalent to emission of around 22,000 Mt CO_2/yr.

The total yearly greenhouse emission form fossil fuel burning in Western Europe is around 2,500 Mt/yr and in Spain around 300 Mt/yr.

Dispersion

Dispersion of pollutants is simulated applying numerical analysis. The computer package QRA2000 has been applied, with the program PAPA used for estimation of consequences from different emission releases, and the program RISKMAP used for calculation of iso-emission curves. The calculated distance to concentration limits are best estimates not including a safety margin. PAPA calculates distances to given specific levels of concentration of different emission component. These calculations are based on information like type of releases, fraction of emission component and data about the surrounding environment. The models implemented in PAPA are from work by TNO /19, 20, 21, 22/.

Dispersion is calculated assuming a continuous release from a point source. Using information about the yearly frequency of flue gas emissions, iso-emission curves are calculated. At each iso-emission curve there is a constant frequency of experiencing a given concentration.

The dispersion scenarios analysed for the OPRT with corresponding releases are given in *Table 7-5*, with flue gas temperature taken as 550ºC for boiler and 900ºC for flaring.

The dispersion scenarios analysed for the BSCS with corresponding releases are given in
Table 7-6, with flue gas temperature taken as 550ºC for turbo-compressors and 900ºC for flaring.

Flue gas composition is given in *Table 7-7*.

Table 7-5 Release rates for scenarios studied.

Scenario	Consumption, Natural gas	kg/s	Flue gas release kg/s
Boiler	750 m^3/hour	0.2	2.5
Flaring	38,000 m^3 in 15 minutes/yr	33.8	503
Pilot burner	58,000 m^3/yr	0.001	0.022

Table 7-6 Release rates for scenarios studied.

Scenario	Consumption, Natural gas	kg/s	Flue gas release kg/s
Turbo-compressor, low scenario	210 Mm^3/yr	5.3	79.2
Turbo-compressor, high scenario	324 Mm^3/yr	8.2	122.2
Flaring	60,000 m^3 in 15 minutes/yr	54.2	806

Pilot burner	700,000 m^3/yr	0.02	0.26

Table 7-7 ***Flue gas composition.***

Component	Contents per kg N-gas combusted Calculated	Specified maximum allowed 1)
CO_2 NO_2 Inerts	2.6 kg 430 mg 12.2 kg	- 30 ppm equiv. to 56 mg/m^3 or 70 mg/kg -
1) Equipment specified with dry low emission system/low-NO_x burners to reduce engine emissions		

Dispersion analysis is made for NO_x with results presented as iso-emission curves, indicating frequency of reaching the air quality ceilings specified; 200 µg/m^3 for 1 hour and 40 µg/m^3 annual mean.

Following the results are presented for both terminals OPRT and BSCS

A) Dispersion results for OPRT

Figure 7-6 ***Dispersion of NO_x, 40 µg/m^3, boiler in case of continuous operation, years 2008-12.***

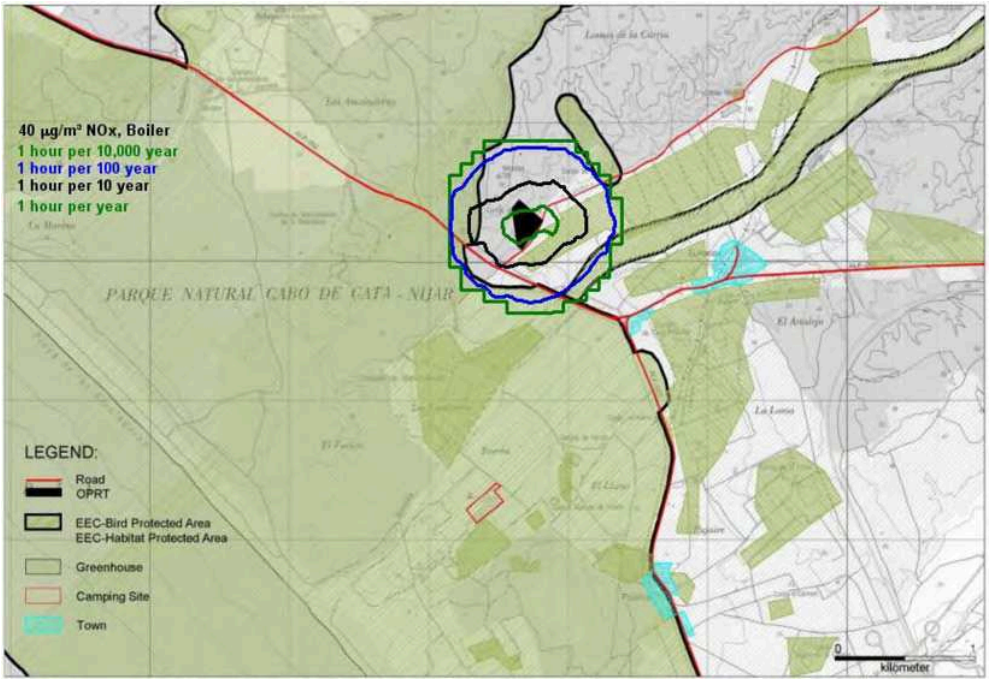


Figure 7-7 Dispersion of NOx, 200 µg/m3, boiler in case of continuous operation 2008-12.

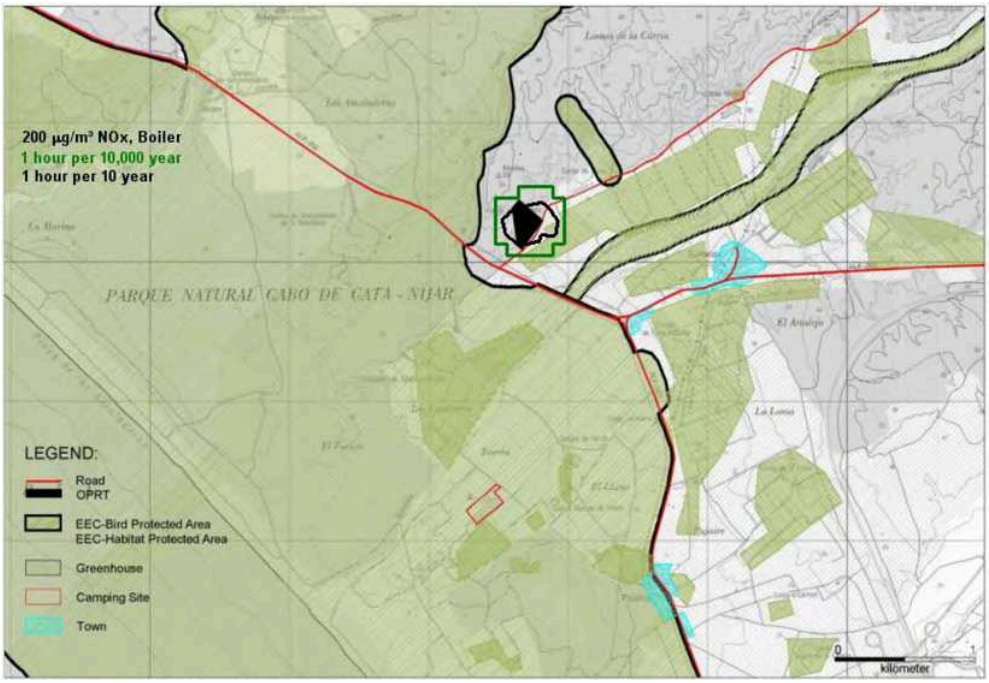


Figure 7-8 Dispersion of NO_x, 40 µg/m³, flaring.

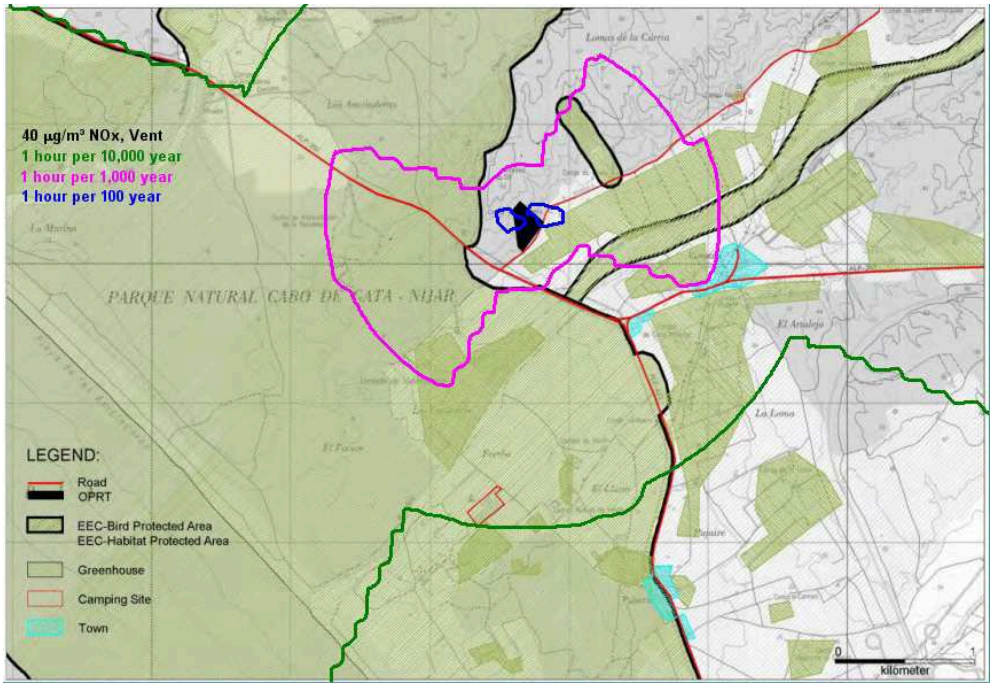


Figure 7-9 Dispersion of NOx, 200 µg/m3 , flaring.

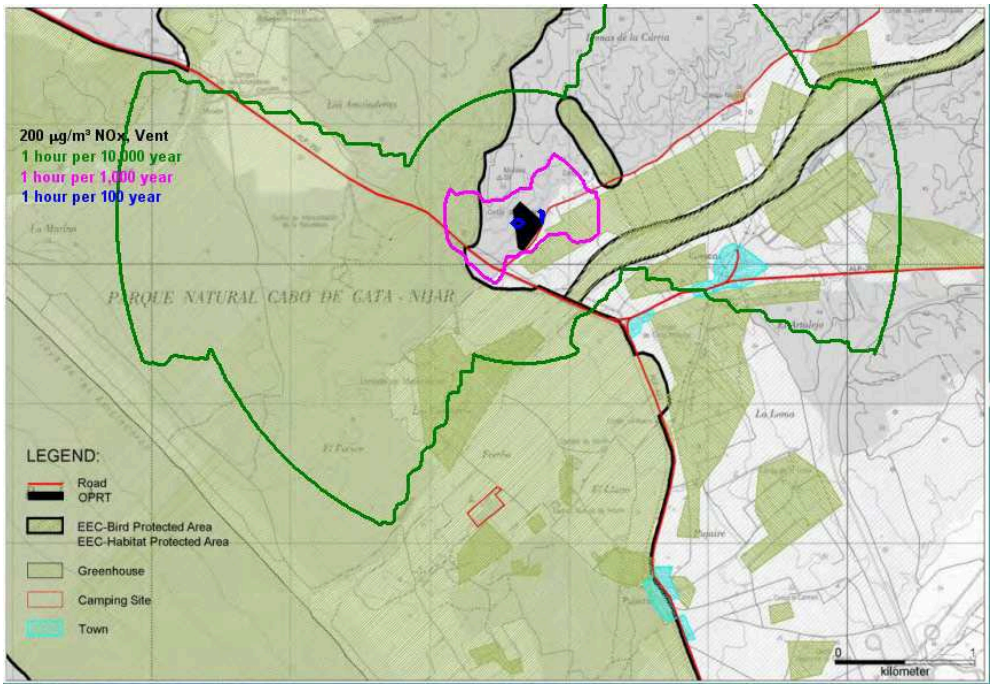


Figure 7-10 Left: Dispersion of NO_x, 40 µg/m³, pilot burner, alternative vent system. Right: Dispersion of NO_x, 200 µg/m³, pilot burner, alternative vent system.

These results are summarised in *Table 7-8* as air quality standard exceeding frequencies vs distance.

Table 7-8 NO_x air quality standard exceeding vs distance.

Distance	Frequency of exceeding NO_x air quality standards			
	40 µg/m³		200 µg/m³	
	Boiler	Vent	Boiler	Vent
100 m	1 hr in 1 yr	1 hr in 100 yrs	1 hr in 10 yrs	1 hr in 100 yrs
200 m			1 hr in 10,000 yrs	
500 m	1 hr in 100 yrs			1 hr in 1,000 yrs
600 m	1 hr in 10,000 yrs			
1.5 km		1 hr in 1,000 yrs		
3 km				1 hr in 10,000 yrs
6 km		1 hr in 10,000 yrs		

The air quality levels are generally within accepted limit values. Exceeding the annual average air quality limits are very local to the station and of very low frequency when more than 100 m from the terminal. Peak levels are not exceeded as the highest frequency calculated is 1 hr in 10 years for the boiler scenario, compared to the required frequency of 1 hr 18 times in a year.

For the boiler continuous operation scenario 2008-12 the annual average air quality level (40 µg/m³) is exceeded in distance up to 100 m from the terminal for 1 hr in 1 yr. The 1-hour peak value (200 µg/m³) is reached for 1 hr in 10 yrs in distance from the terminal up to 100 m, or around 24 minutes in the four-year period considered. In further distance, up to 200 m from the terminal the limit is exceeded for 1 hr in 10,000 years.

For the vent scenario the annual average air quality level (40 µg/m³) is exceeded in distance up to 100 m from the terminal for 1 hr in 100 years. The 1-hour peak value (200 µg/m³) is exceeded at the terminal area and to distance less than 100 m for 1 hr in 100 years.

For the alternative vent system with pilot burner the air quality levels are only reached in the immediate vicinity to the vent.

Therefore, the impact due to atmospheric contamination will be negligible.

Dispersion results for BSCS

Figure 7-11 Dispersion of NO_x, 40 g/m³, compressors, low scenario.

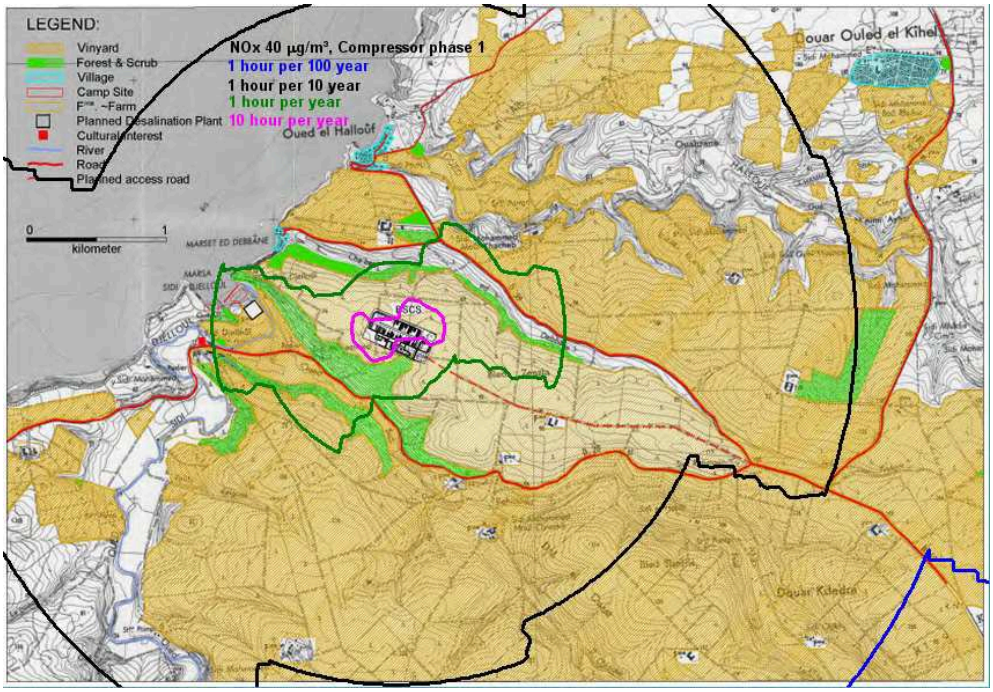


Figure 7-12 Dispersion of NO_x, 200 g/m³, compressors, low scenario.

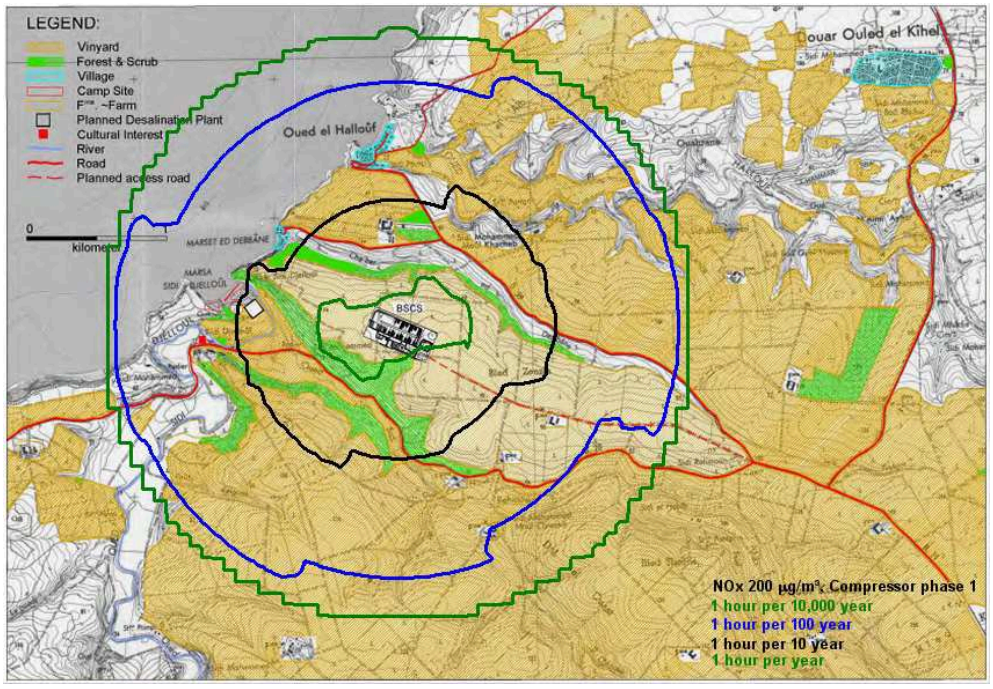


Figure 7-13 Dispersion of NO_x, 40 g/m³, compressors, high scenario.

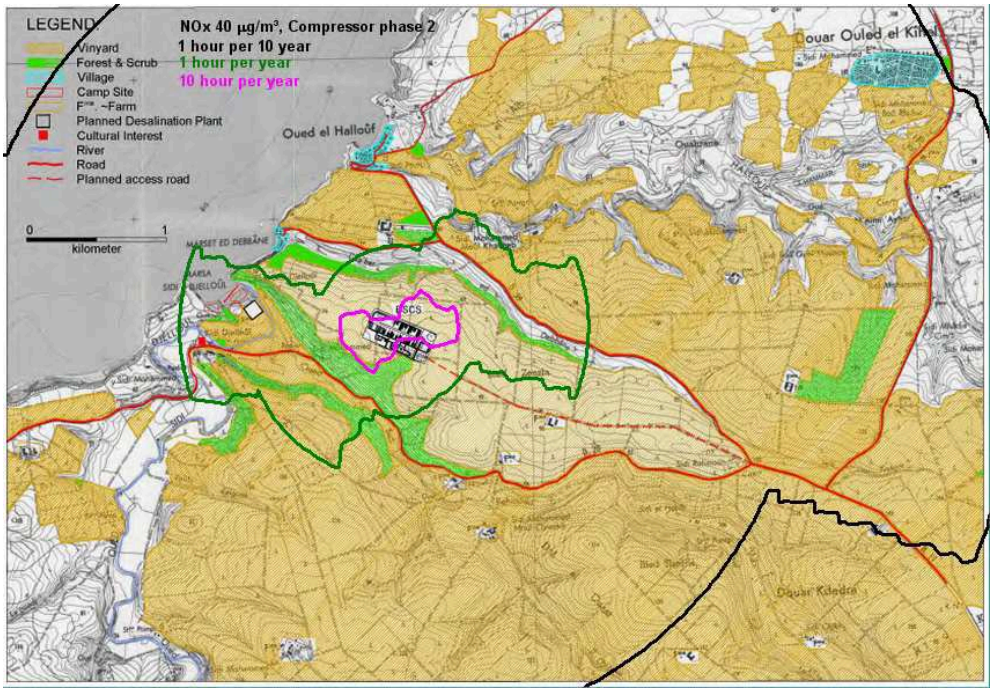


Figure 7-14 Dispersion of NO_x, 200 g/m³, compressors, high scenario.

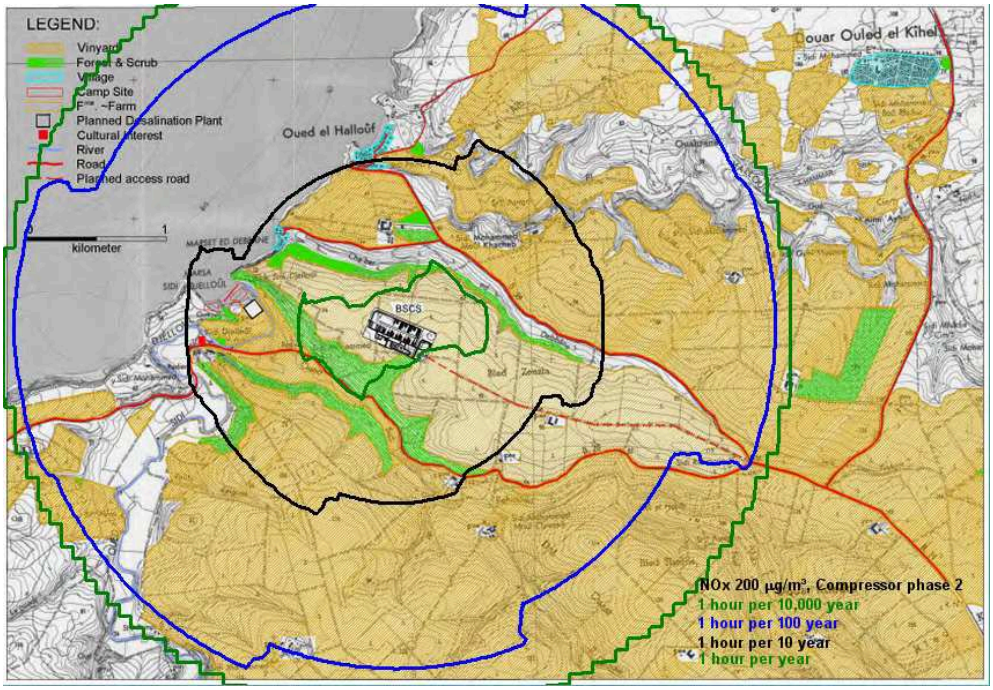


Figure 7-15 Dispersion of NO_x, 40 g/m³, flaring.

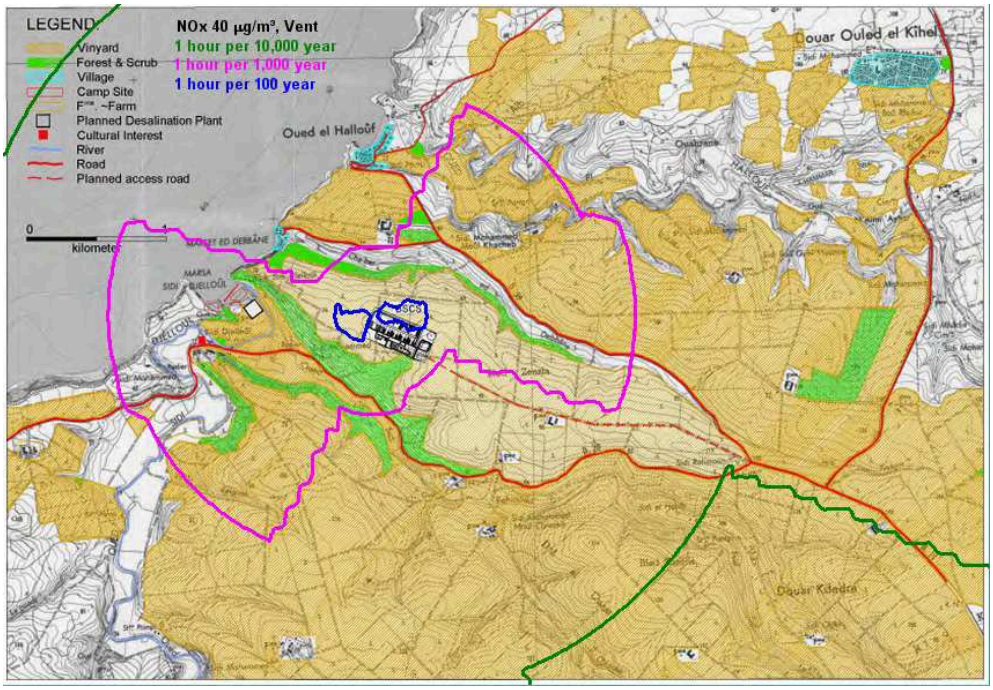


Figure 7-16 Dispersion of NO_x, 200 g/m³, flaring.

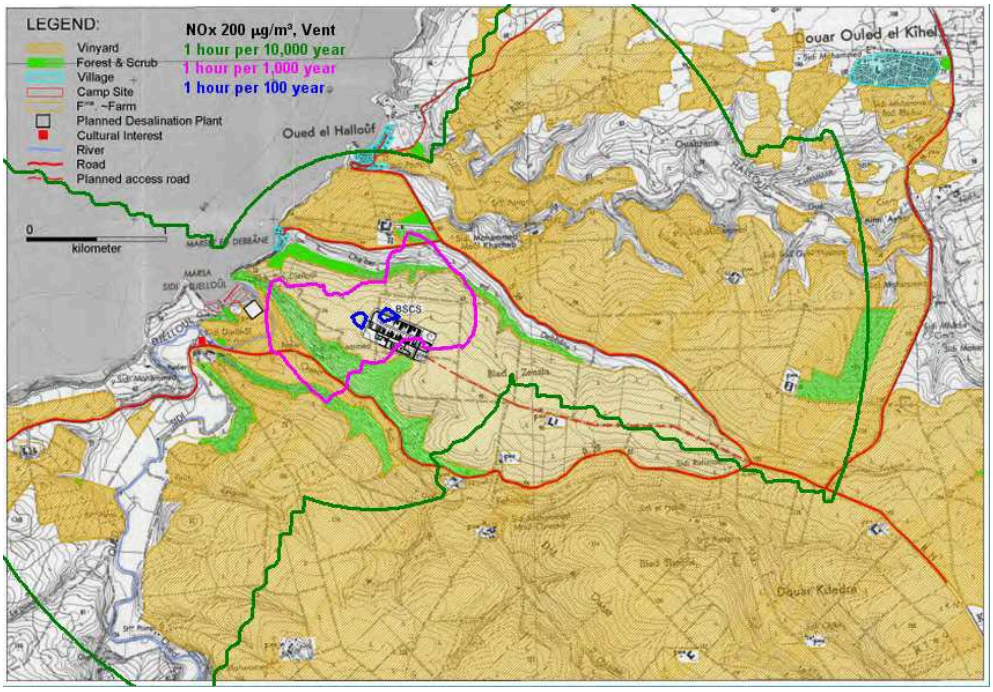


Figure 7-17 Dispersion of NO_x, 40 g/m³, pilot burner, alternative vent system.

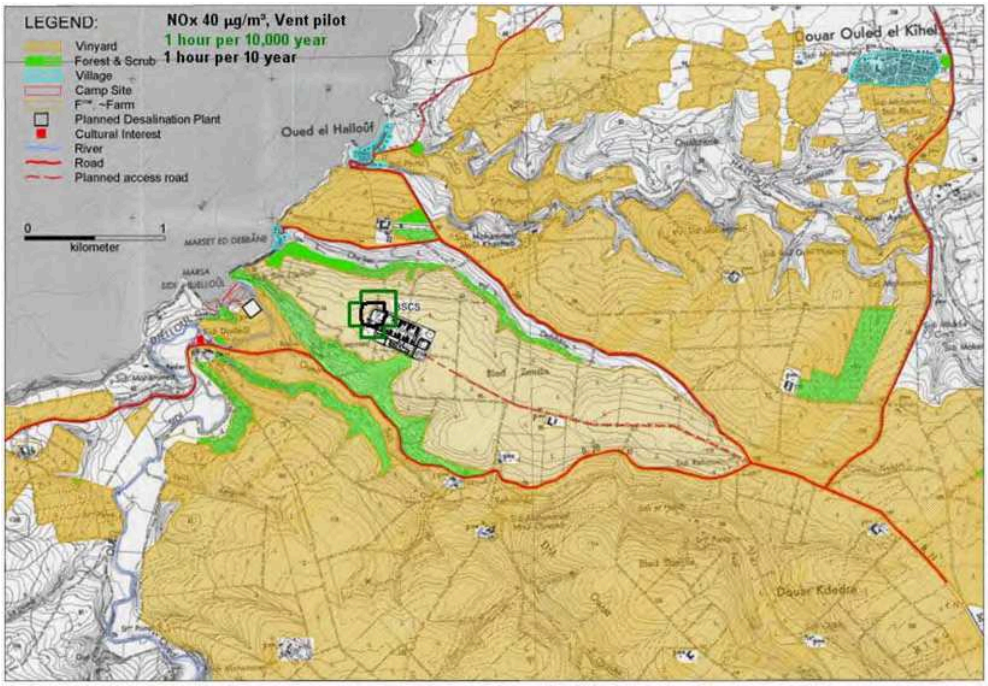
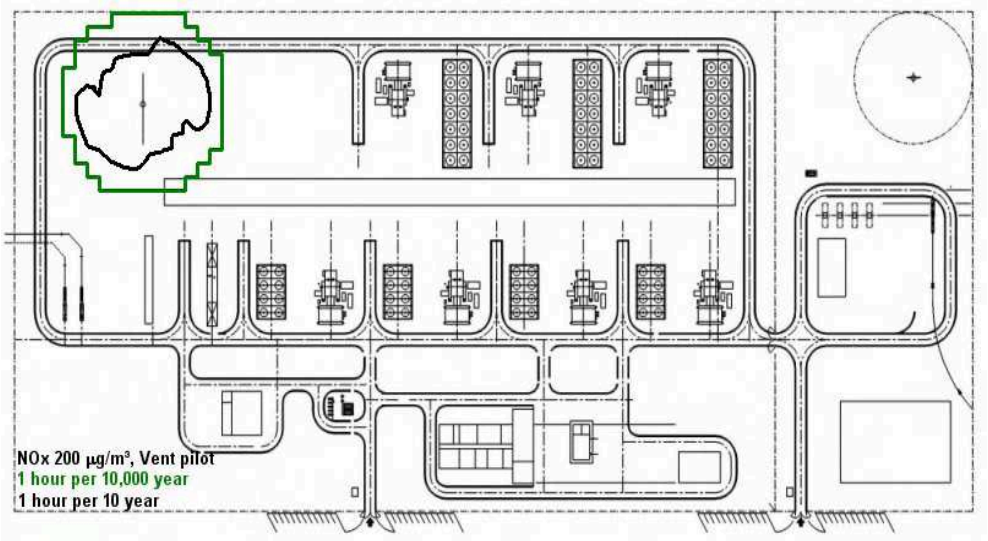


Figure 7-18 Dispersion of NOx, 200 g/m3, pilot burner, alternative vent system



The results are summarised in

Table 7-9 and *Table 7-10* as air quality standard excess frequencies vs distance.

Table 7-9 NO_x air quality standard 40 µg/m³ exceeding vs. distance

Distance	Frequency of exceeding NO_x air quality standard 40 µg/m³		
	Compressor	Compressor	Vent
100 m			
200 m	10 hrs in 1 yr		1 hr in 100 yrs
300 m		10 hrs in 1 year	
500 m			
600 m			
1 km	1 hr in 1 year		
1.5 km		1 hr in 1 yr	
2 km			1 hr in 1,000 yrs
3 km	1 hr in 10 years		
5 km	1 hr in 100 years	1 hr in 10 years	1 hr in 10,000 yrs

Table 7-10 NO_x air quality standard 200 µg/m³ exceeding vs. distance

Distance	Frequency of exceeding NO_x air quality standard 200		
	Compressor	Compressor	Vent
100 m			1 hr in 100 yrs
200 m			
300 m	1 hr in 1 yr		
500 m		1 hr in 1 yr	
600 m			1 hr in 1,000 yrs
1 km	1 hr in 10 yrs		
1.5 km	1 hr in 100 yrs	1 hr in 10 yrs	
2 km	1 hr in 10,000 yrs		
2.5 km		1 hr in 100 yrs	
3 km		1 hr in 10,000 yrs	1 hr in 10,000 yrs
5 km			

The air quality levels are generally within accepted limit values. Exceeding the annual average air quality limits are very local to the station and exceeded for 1 hr in a year to a distance up to 1.5 km from the station in the worst case compressor high scenario. Otherwise exceeding frequencies are low when further away from the station. Peak levels are not exceeded as the highest frequency calculated is 1 hr in 1 year to 500 m distance for the compressor high scenario, compared to the required frequency of 1 hr 18 times in a year.

For the compressor high scenario the annual average air quality level (40 µg/m³) is exceeded in distance up to 300 m from the station for 10 hrs in 1 yr. The 1-hour peak value (200 µg/m³) is reached for 1 hr in 1 yr in distance from the station up to 500 m. In distance over 3 km frequency of exceeding the limit is 1 hr in 10,000 years.

For the vent scenario the annual average air quality level (40 µg/m³) is exceeded in distance up to 200 m from the station for 1 hr in 100 years. The 1-hour peak value (200 µg/m³) is exceeded for 1 hr in 100 years in distance from the station up to 100 m.

For the alternative vent system with pilot burner the 40 μg/m^3 annual average air quality limit is reached just outside the station border for 1 hour in 10 years and to distance from station up to 200 m for 1 hour in 10,000 years. The 200 μg/m^3 1-hour peak limit is only reached within the station fence and for 1 hour in 10,000 years at the station fence.

Therefore, the impact due to atmospheric contamination will be negligible.

Emissions balance and greenhouse effect

Emissions balance for the OPRT

An evaluation is made of emissions against limit values and greenhouse effects on the basis of an emission balance for CH_4, CO_2 and NO_x presented in *Table 7-11.*

Table 7-11 Emission balance of CH_4, $C0_2$ and NO_x for scenarios studied.

Scenario	N-gas	Flue gas	CH_4	CO_2 equiv	CO_2	NO_x
Heating boiler, years	6 M	72 M	-	-	12.5 M	5,040
Heating boiler, flow	75,000	894,000	-	-	156,000	63
Venting flare	38,000	450,000	-	-	79,000	30
Venting, cold	7,500	-	5,000	105,000	-	-
Service gas valves	30,000	-	20,000	420,000	-	-
Alternative vent system						
Pilot burner	50,000	596,000	-	-	104,000	42
Flaring only	45,000	536,000	-	-	94,000	35
Alternative vent system	45,000	-	30,000	635,000	-	-
GWP = Global Warming Potential. GWP of methane is 21 compared to carbon dioxide as reference						

The emission of NO_x from the terminal: around 5 t/yr with the gas flow rate anticipated for the period 2008 to 2012, and otherwise around 100 kg/yr. The national emission limits to be met by 2010 for Spain is 847 ktonnes/yr.

As concerns the greenhouse effect it is concluded that:

- The contribution to the greenhouse effect in the period 2008 to 2012 is around 13 Mkg CO_2/yr (equivalent to 6.5 E^{-5} % of global fossil fuel burning or 0.004 % of total yearly greenhouse gas emission in Spain.
- Except for the period 2008-2012 the contribution to the greenhouse effect is around 700,000 kg CO_2/yr, from boiler, venting/flaring and service gas.
- The vent system chosen has a contribution to the greenhouse effect of around 184,000 kg CO_2/yr.
- An alternative vent system based on flaring only would have a contribution to the greenhouse effect of around 198,000 kg CO_2/yr.
- An alternative vent system based on cold venting only would have a contribution to the greenhouse effect around 635,000 kg CO_2/yr.
- The service gas contribution is relatively high, 420,000 kg CO_2 equiv/yr.

Emissions balance for the BSCS

An evaluation is made of emissions against limit values and greenhouse effects on the basis of an emission balance for CH_4, CO_2 and NO_x presented in *Table 7-12.*

Table 7-12 Emission balance of CH_4, $C0_2$ and NO_x for scenarios studied.

Scenario	N-gas	Flue gas	CH_4	CO2	CO_2	NO_x
Turbo-compressors,	210 M	2,500 M	-	-	436 M	175,000
Turbo-compressors,	324 M	3,900 M	-	-	674 M	273,000
Venting flare	60,000	715,000	-	-	125,000	50
Venting, cold	60,000	-	40,000	840,000	-	-
Service gas valves	30,000	-	20,000	420,000	-	-
Service gas turbine	30,000	-	20,000	420,000	-	-
Alternative vent						
Pilot burner	700,000	8.3 M	-	-	1.4 M	581
Flaring only	120,000	1.4 M	-	-	250,000	98
Alternative vent	120,000	-	114,000	2.4 M	-	-
GWP: Global Warming Potential. The GWP of methane (CH_4) is 21 compared to carbon dioxide (CO_2) as reference gas whose GWP is 1.						

The emission of NO_x from the station is around 175 t/yr at the low scenario and 273 t/yr at the high scenario, which is 0.02 % to 0.03 % of the national emission limits to be met by 2010 for Spain.

As concerns greenhouse effect it is concluded that:

- The contribution to the greenhouse effect is from 436 Mkg CO_2/yr to 674 Mkg CO_2/yr (equivalent to approximately 0.002 to 0,003 % of global fossil fuel burning or around 0.15 to 0.2 % of total yearly greenhouse gas emission in Spain).
- The vent system chosen has a contribution to the greenhouse effect around 965,000 kg CO_2/yr.
- An alternative vent system based on flaring only would have a contribution to the greenhouse effect around 1.65 Mkg CO_2/yr.
- An alternative vent system based on cold venting only would have a contribution to the greenhouse effect around 2.4 Mkg CO_2 equiv/yr.
- The service gas contribution is relatively high, 840,000 kg CO_2 equiv/yr.

Regarding mitigation measures in both terminals, considerations should be made to reduce emission levels to the lowest possible, although air quality levels are within accepted limits. The selected solution for valve actuation with gas has a relatively high greenhouse effect from the directly vented gas. An alternative system could be considered with a service compressor.

Air quality monitoring should be implemented, to control that equipment meets specified emission requirements, specifically to measure and evaluate

that emissions are within assumed levels and air quality standards are met at neighbouring areas

7.3 OPERATION AT SEA

7.3.1 Interaction with Fishing Activities

Interaction with fishing activities is generally regarded as the only major potential impact of operational sub-sea pipelines. This is also the case for the proposed MEDGAZ pipeline. Such interaction can result in damage to both the fishing equipment and the pipeline, with attendant concerns for the safety of the vessel itself. Much information and practical experience is already available on procedures for the management of this interface from areas such as the North Sea, where intensive hydrocarbon developments and fishing activities have co-existed for three decades or more (UKOOA and UK-DEFRA). The equipment used in artisan or purse seine fishing is not of a type that will snag on the pipeline and neither is it heavy enough to present a risk of damaging the pipeline. It is bottom trawling that involves the significant risks, which lie mainly with the use of otter board, rather than beam trawling. (UK-HSE, 1999, SUT, 2002)

Therefore, the area of concern along the MEDGAZ pipeline route is between the depths of about 300 to 800m, especially in view of the red shrimp deep trawl industry, which represents a large proportion of fishing activity in the region. As shown in *Map 5.9*, there is an established trawling area parallel to the Playa de Cabo Gata, between about 4 and 6km offshore, but the pipeline route is only on the margins of this area. Between KP169 and 173, the route passes directly over another trawling area of some that runs in a south-easterly direction, between 10 and 14 km offshore. Fishing in this particular zone is currently hindered because it overlaps with the Traffic Separation Scheme, as shown in *Map 5.9*. However, this situation may change in the future, so the mitigation methods, as discussed in the following paragraphs have been selected irrespective of the fact that, presently, there is only limited fishing activity around this part of the pipeline route.

The intention to place the MEDGAZ pipeline on the seabed, with only minimum intervention as necessary, is international best practice. As explained in the previous section, it minimises the ecological damage of trenching. However, it is also acceptable in terms of fisheries interaction, because pipelines of this size (24 inch diameter) are too large to be seriously damaged by normal fishing activities but are not large enough to cause significant damage to trawling equipment. The trenching, or in-fill placed under and alongside the pipeline, over those relatively short lengths that require free span correction, will also remove the possibility of fishing equipment snagging.

In keeping with normal national and international requirements, the main procedural method for mitigating the problems of interaction with fishing activities will be the use of official publications, the advice notes on

navigational charts and computer data bases for recording the positions of pipeline routes. These official sources are also the main means by which information is disseminated to other mariners, to mitigate the potential hazards of practices such as anchoring, ship groundings or the seabed activities of submarines.

At the outset, an intensive general awareness campaign will implemented using methods such as meetings and prominent posters in places frequented by fishermen. Throughout the operation phase, fishermen and other relevant sea-users will be given prior notification of any works that are planned on the pipeline and, because fishing equipment and practices are constantly changing, MEDGAZ will regularly monitor and maintain an up-to-date data base on trends in the fishing industry, as well the changing activities of other users of the route.

Although, under maritime law, fishermen are liable for damage caused to pipelines, it is common knowledge that many do trawl along them, because they are believed to attract a better catch. A recent study from the North Sea, for example, showed that 73% of fishermen engage in this practice. The otter board trawlers tend to place their nets in the most risky position, over the pipeline, while beam trawlers tend to run alongside it (SUT 2002). Furthermore, it is mainly this practice, rather than the crossing of pipelines, that leads to snagging of fishing equipment (UK-HSE, 1999). Therefore, in addition to the procedural mitigation measures summarised above, the safety of sea users has also been a primary concern in the design of the pipeline, particularly to ensure that, if it is trawled over, fishing equipment cannot become snagged.

The post-lay techniques of trenching and filling between the seabed and the pipeline with graded gravel/rock, as described in section, to remediate free span and geo-hazards, will also remove the possibility of snagging. In this regard, particular attention will be given the critical free span area between depths of about 200 m and 650 m on the Spanish continental slope, which is close to the local trawling grounds off the Playa de Cabo de Gata.

Voids under the pipeline will also be created by the installation of separators where it crosses the five in-service seabed cables. However, all these crossings are beyond the depth limit of the trawling, so the use of infill material has been deemed unnecessary at these locations.

The shallower waters, less than about 50 m, are not subjected to the same use of heavy fishing equipment. Therefore, there is no risk of pipeline damage in these depths. Where the gravel/rock armour needs to protrude above the natural seabed profile, as in the Algerian shore approach, it will be laid with gentle side slopes of 1:4, to deflect any fishing equipment, and the use rock fill with an average fragment size of only 250 mm, which is too small to cause any significant damage to the equipment, whatever the relative direction of trawling.

The proportion of seabed rendered unadvisable for fishing due to the presence of a pipeline is insignificant in comparison with the area of the fishery as a whole. For example, if we assume no fishing within 50 m either side of the pipeline where it crosses between KP169 and 173, as mentioned above, this loss represents less than 1% of the entire 2 X 20 km area of that zone. Moreover, cessation of fishing in the vicinity of a pipeline does not adversely affect catch sizes, because the activities can simply be diverted to other places, so that the loss of area does not cause a proportional loss of catch. The affected seabed itself is so small that it can never significantly obscure any fishing ground. Conversely, there is anecdotal evidence to support the assertion that pipelines protect populations from capture, so playing a useful role in conservation of the overall fish stock.

Due to the information provided above, the impact on the fishing activities during the operation of the pipeline is considered to be negligible.

7.3.2 Sacrificial Anodes of the Cathodic Protection System

For the sub-sea section of the pipeline, the sacrificial anodes, which will corrode in preference to the pipeline in the event of coating imperfections or damage, will be manufactured from an aluminium-zinc-indium alloy (circa 94%, 6% and 0.02% respectively). It will be positioned in sections along the entire 190 km, or so, and have a total mass of circa 300 tonnes.

If activated, sacrificial anodes serve their purpose of corrosion protection by dissolving in the seawater which, especially in enclosed water bodies, carries the risk of toxic metal bio-accumulation in filter-feeding species such as shellfish. However, these conditions do not exist along the proposed route and the chosen alloy is almost entirely composed of aluminium and zinc, two metals that are present in seawater, and not particularly toxic.

7.3.3 Seismic Activity

The Alboran Sea Basin is an area with potential for significant seismic activity. Therefore, this issue has been the subject of detailed and thorough consideration in the safety design studies. The following paragraphs provide a brief overview:

Seismic Faults

The only fault on the route that has been identified as active is the Yusuf fault on the Algerian slope. The most likely location for a surface-breaking fault movement is at KP74 to KP76. To reduce the risk to the internationally accepted principle of "As Low as Reasonably Practicable" (ALARP), the pipeline in this area will not be constrained by laying it in a trench and seabed obstacles, such as boulders, will be removed.

Slope Instability

Near the Algerian and Spanish shorelines (KP0 to KP21 and KP177 to KP198 respectively), surface sand deposits are found in certain areas. These soils will be liquefied by even minor, relatively frequent earthquakes, but analysis suggests that the consequences of such events will be limited to lateral spreading, which as been judged to hold insignificant risk of pipeline failure. Sustained flow would be caused by earthquakes that are likely to occur only once in 10,000 years.

Over most of the route, the soils consist of soft clays. These are not expected to be liquefiable. However, slopes in these soils may fail due to ground shaking, or strength degradation because of excess pore pressure (fluid or gas). These potential slope failures may be categorised as surface or deep-seated:

- Surface failures may take the form of limited slides or sustained flows. Analysis suggests that an event of the type that will cause surface slope failure is likely to occur once in about 1,000 years.
- Deep-seated failures would typically involve displacement of massive volumes of soil. The only available mitigation measure has, therefore, been to select the optimum route. Any residual risk must be accepted in the understanding that the probably of a deep-seated failure is only once in 10,000 years, for both Algerian and Spanish sides.

Pipeline response analyses have shown limited ability of the pipelines to resist lateral debris flows. However, axial debris flows may be resisted provided the bends higher up the slope remain stable, so preventing feed-in that might cause buckling. Lateral debris flows are possible on the Spanish slope. On the Algerian slope the potential flows are restricted to the canyon in which the pipelines will be routed and therefore predominantly axial; the bends higher up the slope have been demonstrated as stable under the anticipated flows. The pipeline will, therefore, be trenched in areas of the Spanish slope where it could be impacted by debris flows. Using engineering judgement, this trenching has been assumed to reduce the damage and gas release probabilities by a factor of 5. On the other hand, trenching is undesirable on the Algerian slope because, as noted above, this is a fault zone.

These slope instability issues are complex and have been studied only at a preliminary level in the FEED stage. The next design stage will include a more detailed assessment to improve understanding, produce better estimates of the risks, ensure the optimum route has been selected and determine exactly which parts of the pipeline should be trenched.

7.4 *DECOMMISSIONING*

Pipeline

At the end of its service life, expected to be in the order of fifty years, the pipeline will be decommissioned in full accord with the regulations and the acknowledged best international practice prevailing at the time. Presently, there are no formally agreed international guidelines specifically for the decommissioning of pipelines. However, an indication of probable future developments can be gained from conventions that are already in place for other offshore installations, primarily the UN Convention on the Law of the Sea, 1982, which includes the following requirement:

> *"Any installations or structures which are abandoned or disused shall be removed to ensure safety of navigation, taking into account any generally accepted international standards established in this regard by the competent international organisation. Such removal shall have due regard to fishing, the protection of the marine environment and the rights and duties of other states. Appropriate publicity shall be given to the depth, position and dimensions of any installations or structures not entirely removed"*

The competent international body referred to in the statement is the International Maritime Organisation (IMO) which, in 1989, published the IMO Guidelines and Standards, setting global minimum criteria for removal of offshore installations.

A later piece of legislation is the OSPAR Agreement, 1992, which is primarily intended for protection of the north-east Atlantic. It embodies the IMO Guidelines and Standards, but also introduces the more recent concept of "sustainability", which will be fundamental driving force behind new environmental legislation for the foreseeable future. The European Union "hierarchy of waste minimisation options", with its emphasis on re-use and re-cycling of materials (6.6), is a key derivative of this concept. This Agreement allows scope for decommissioning programmes to be approved on a case-by-case basis. This implies the need for systematic risk assessments of the various options, essentially covering the same range of issues as this Environmental Statement.

The fundamental question for the MEDGAZ pipeline, as for other pipelines, will be which sections, if any, are best left in place. The pipeline has been designed so that all possible options will be available for consideration.

OPRT and BSCS

The future activities related to de-commissioning of the OPRT and BSCS will depend on the practice and technology available at that time.

Being an industrial petrochemical plant, the decommissioning thereof may pose an imminent risk for polluting the adjacent environmental setting.

MEDGAZ will therefore well in advance plan this operation and prepare detailed procedures for the safe demobilisation thereof as may be required by the authorities at that time.

By present day's technology the operator will – once the plant is shut permanently down – identify and drain from the plant and equipment all oil-based liquids and lubricants, empty all filters and separators for any extracted substances, and collect these for transport to an approved dump site for chemical waste or chemical disposal plant. All electrical equipment, wiring, electronic equipment and monitors are dismantled and sorted for the purpose of reprocessing where possible – otherwise for disposal at a controlled depot.

SECTION 8

MONITORING PLAN

MEDGAZ

CONTENTS

8 MONITORING

8.1 OBJECTIVES OF THE MONITORING PROGRAMME

A formal and systematic environmental monitoring programme will be essential to ensure that the mitigation measures derived from this environmental assessment are properly adopted and implemented, to minimise or avoid adverse effects on the environment. This programme will therefore include all of the preventative and corrective measures or mitigation measures described in the Environmental Impact Assessment as well as any additional ones stipulated in the Environmental Impact Declaration (Declaración de Impacto Ambiental -DIA-).

The Monitoring Programme will be detailed in a Project Environmental Management and Monitoring Plan which will include all methodologies necessary to (1) implement the mitigation measures, (2) the supervisory procedures to ensure their implementation, and (3) the methods to modify them if necessary. This will be verified by means of regular reports which will reflect the progress of the project, the environmental effects and the adoption and implementation of the mitigation measures.

It is essential to be very strict and particular when developing the Project Environmental Management and Monitoring Plan (MP), as the Plan is the key element that ensures that the mitigation measures are applied and adopted, and theses mitigation measures are the basis of the impact assessment for this EIA. Should the MP not be applied and developed correctly, this could potentially mean that there would be far greater impacts on the environment than those that were originally assessed in this EIA.

The Site Environment Manager, along with any manager who may be responsible for implementing the environmental management systems for the project, should permanently assess the possibility of applying new technologies and procedures which may improve the effective management of any actions that have an effect on the environment.

The specific objectives of the MP can be summarised as follows:

- Ensure that the mitigation measures identified in the EIA are applied and implemented
- Assess and review those impacts, where it may be potentially difficult to identify the magnitude of the impact.
- Suggest and apply new mitigation measures to correct any deviation from those impacts that were originally identified or for any new impacts that may arise.
- Record useful data for future projects that may take place in similar types of areas.

- Identify the control measures in place, including a specific control system which will be used, its monitoring frequency and when it should be applied.
- Identify easily measurable indicators which are representative of the affected system.
- Verify compliance with the environmental standards required through adequate control measures.

The Project Environmental Management and Monitoring Plan will, therefore, include a full set of instructions to describe to following:

- potential impacts that must be monitored;
- parameters to be measured;
- measurement or assessment methods;
- monitoring frequency and locations;
- control limits;
- record-keeping, reporting and corrective action procedures.

For the correct application of the MP, there is a need for all personnel that may involved in the MP, are aware of its content and assumes the roles and responsibilities that he or she has within the plan. They must also be aware that the execution and completion of their tasks are very much linked to the environmental commitments and therefore requires them to complete their tasks in order to comply with the strict standards of the operational procedures.

Responsibilities of the Site Environment Manager

Responsibility for the day-to-day operation of the monitoring programme and the environmental management system will be with the Site Environment Manager. The Environment Manager will be under the direct supervision of the Project Director and the relevant competent authority. The findings of the monitoring programme will be a standard item in the agenda and minutes of the normal site progress meetings. The Environment Manager will be a required participant in these meetings.

8.2 EXECUTION OF THE PLAN

In the section on mitigation measures, it suggests that specific plans should be produced to refer to the various environmental measures or aspects. These plans integrate most of the mitigation measures and therefore are a very useful tool to organise and manage the MP tasks. The outstanding mitigation measures can be integrated into these plans or subsequent plans can be developed to specifically include these tasks.

The specific plans which should be produced as a minimum are the following:

- A Traffic Management Plan
- Machinery or Equipment Management Plan
- Wastewater, Hydrocarbon and Oil Management Plan
- Fauna Management Plan
- Plan for Revegetation and Site Restoration
- Global Restoration of the *Cymodocea nodosa*

The MP should be executed with by a technical assistant who will be present on-site. This person will also assess any subcontractors in terms of any environmental aspects of the works. Good coordination should be present between the Project Development Manager and the Environment Manager and these will both be under the direct supervision of the competent authority.

8.3 GENERAL OVERVIEW

Construction work is widely acknowledged by environmental protection authorities as only a temporary event, so national and international quantitative limits for control of the pollutant releases are generally not available for most of the activities. Therefore, in keeping with recognised best practice, the large majority of the monitoring effort for the MEDGAZ project will be via walk-round visual inspections, which will be carried out by the Environment Manager, or delegated staff members. These inspections will be on a daily basis, arranged so that all parts of the work site and relevant locations in the surrounding area are visited at least once every week. The remaining sections of this chapter explain the more specific aspects of the monitoring programme.

8.4 SURFACE WATER QUALITY

8.4.1 Suspended Particulates from Dredging

Before start of any dredging work in the vicinity of sensitive areas such as the sea grasses, a turbidity tolerance limit for the species in question will be established with expert advice, knowledge of the typical range of normal baseline concentrations and in liaison with the local authorities.

Turbidity monitoring will then be carried out at appropriate water depths, from a small boat positioned between the dredger and the protected area. If a risk of exceeding the limit arises, the dredger operator will be immediately informed so that corrective action can be taken.

The usual practice is to carry out the turbidity measurements at a relatively high frequency at the outset. A gradual reduction of the frequency can then be considered based on experience. For example, when the tidal flow is away from the sensitive area, monitoring may prove to be unnecessary.

8.4.2 Oil and Fuel Pollution

A project control limit will be established that will require no visible oil or fuel films on water surfaces. This requirement will, therefore, be a standard feature in the awareness training of the general work-force and the Environment Manager's site walk-round procedures. These procedures will also include routine inspections to ensure the proper maintenance and use of the various facilities for prevention of oil and fuel pollution: storage tank containment bunds, oil interceptors, drip trays etc.

8.5 SOIL AND GROUND WATER QUALITY

8.5.1 Oil and Fuel Pollution

The monitoring procedures described above for the prevention of oil and fuel release to surface waters will also serve for the protection of soil and ground water.

8.5.2 Sewage Pollution

If effluent from treatment of the site sewage is to be discharged to a soak-away on the site, the control limits for an acceptable quality of effluent will be agreed with the local authorities. Routine monitoring according to these control limits will then be included in the programme.

8.6 AIR QUALITY

8.6.1 Road Traffic Pollution

The prevention of excessive air-borne dust and black engine exhaust smoke from vehicles travelling to and from, and on the site, provides another example of mitigation measures that will be monitored by way of the routine walk-round inspections. In the event of any public complaints, special monitoring emphasis will be given to the location in question until the matter is resolved.

8.6.2 Emissions from the De-watering Compressor Spread

If the proposed detailed computer modelling of the pollutant dispersion from the de-watering compressors does not indicate an adequate margin of safety, concentrations of nitrogen dioxide, the primary pollutant, will be continuously monitored at the nearest sensitive receptor whenever the spread is in use.

8.7 NOISE

8.7.1 Emissions from the Work Strip and Traffic Movements

The preliminary conservative assessment presented in *section 6* for the Spanish land sector has strongly indicated that no noise disturbance should be experienced at the nearest sensitive receptors as a result of the construction activities on the work-strip. Similarly, the traffic management initiatives described in *section 6* should protect the local communities against excessive exposure to road vehicle noise. Noise monitoring as a matter of routine has, therefore, been deemed unnecessary. Nevertheless, noise measurement facilities will be available through the construction phase for use in the event of any complaints.

On the Algerian side, where sensitive receptors are currently much closer to the proposed construction activities, the need of noise monitoring will be assessed in association with the wider mitigation measures that will be agreed with the local authorities and community.

8.7.2 Emissions from the De-watering Compressor Spread

The results of a first conservative estimate, as presented in Chapter 6, suggests that no noise problems should be experienced at the nearest residential areas as a result of operating the de-watering compressor spread. If the proposed, more detailed computer modelling suggests a need, monitoring will be carried out at the nearest sensitive location while the spread is in use. Irrespective of the modelling results, however, facilities for carrying out noise measurements will be available for use in the event of any complaints.

8.8 WASTE MANAGEMENT

Proper implementation of the formal waste management system, described in Chapter 6, will also largely be by way of routine inspections of the collection and storage facilities. A consignment note system of "closed-loop" reporting will be established to ensure that wastes are transported and disposed of, or recycled, off the site in compliance with the "Duty of Care" principle. Similarly, it will be the responsibility of the Environment Manager to monitor the handling and disposal of any chemical or other hazardous substance in accordance with the instructions given in the manufacturers' Materials Safety Data Sheets.

8.9 LANDSCAPE AND ECOLOGY

8.9.1 Terrestrial

Scheduled inspections will be established to ensure correct implementation of the soil and vegetation conservation techniques required during the pipe laying work. The 5-year Landscape Restoration Plan, which will be submitted for approval by the relevant authorities prior to start of construction work, will contain its own monitoring programme, covering the same range of issues as those listed in the introduction to this section. The standard of acceptability will based on photographic and topographic made throughout the year before start of the construction work and no significant visual differences in comparison with the adjacent undisturbed land. A more detailed, pre-construction, inventory of significant individual plant species, general coverage density and diversity will also be taken into account.

8.9.2 *Marine*

The arrangements for monitoring the conservation and restoration of the *Cymodocea* sea grass beds, and the associated matter of the seabed profile, will be analogous to those described for the terrestrial conservation procedures described above. An adequate period for after-care will be established with expert advice so that the detailed monitoring programme can be included in the Sea Grass Restoration Plan, which will be agreed with the relevant authorities before start of the dredging work. The primary standard of acceptability will be a seabed profile the same as that recorded in the remote observation vehicle (ROV) and boat-mounted echo-sounder survey carried out before start of the dredging work and, at least, a similar percentage of sea grass cover as that shown by the pre-dredging underwater photography.

8.10 SOCIO-ECONOMIC ISSUES

The daily inspection routine will also cover the various socio-economics issues of severance, infrastructure and services capacity, public safety etc. A formal public complaints procedure will also be established. If any complaints are received, they will be recorded, acknowledged in writing and investigated in a timely manner. If justified, corrective action will be taken immediately.

SECTION 9

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