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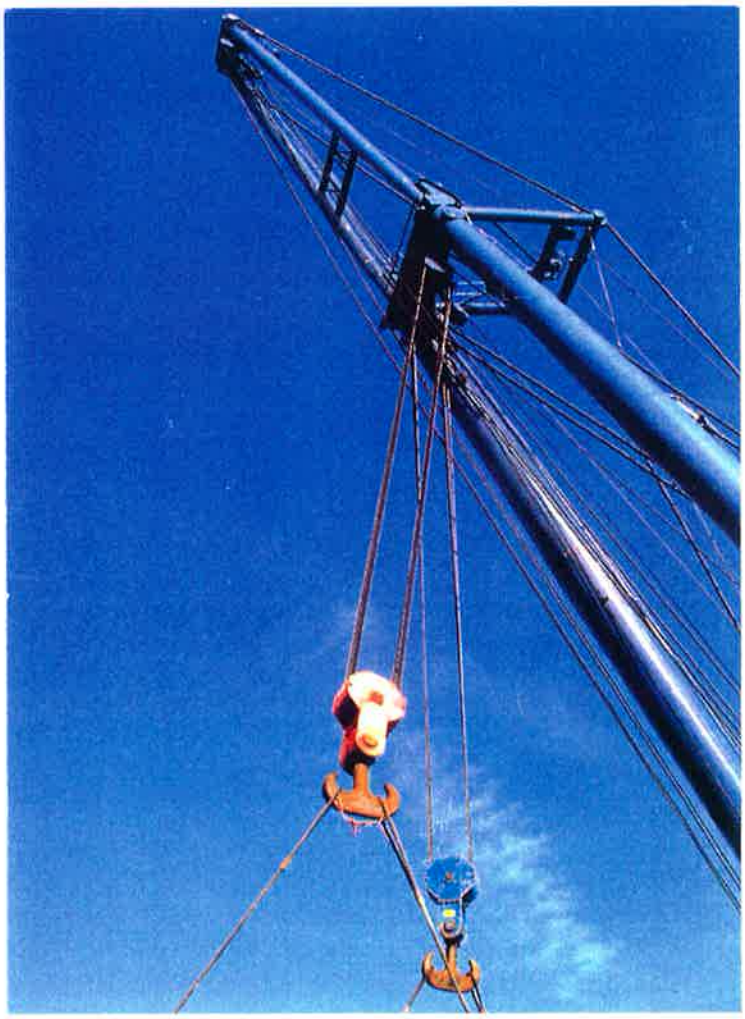
Netherlands Ministry of Foreign Affairs
Directorate General for International Cooperation

Palestinian National Authority
Ministry of Planning and International Cooperation
Environmental Planning Directorate

Environmental Impact Statement for the Gaza Sea Port



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1. INTRODUCTION

1.1. Background to the Environmental Impact Assessment

The Palestinian National Authority (PNA) intends to develop a sea port on the Gaza Strip as part of the economic development of the Gaza Strip and the West Bank. The initiative is part of the Declaration of Principles (DOP) signed in September 1993 which also foresees the establishment of the Gaza Sea Port Authority. The PNA will decide on the location and capacity of the sea port, and its phased development. The Government of the Netherlands will provide up to 40% of the funding for the port from the Government's ORET Programme.

Under OECD standards and international loan agreement conditions, an Environmental Impact Assessment (EIA) is required for the construction and development of a port. The EIA will provide the PNA and the Netherlands Government with relevant information about the impacts of the construction and operation of the port so that well-informed decisions can be made. The EIA will have an additional benefit of providing the PNA and the relevant Palestinian institutions with an opportunity to become familiar with EIA, and will assist in building capacity to produce and review Environmental Impact Statements (EIS), which are the product of the EIA procedure.

The Terms of Reference for the Environmental Impact Statement for the Gaza Sea Port was prepared by a working group of the Dutch Commission for Environmental Impact Assessment in close collaboration with the Environmental Planning Directorate (EPD) of the Palestinian Ministry of Planning and International Cooperation (MPIC).

1.2. The consultants

The Directorate General for International Cooperation of the Netherlands Ministry of Foreign Affairs has contracted Witteveen + Bos Consulting engineers, Deventer, the Netherlands to draft an EIS for the proposed Gaza Sea Port. For the preparation of this EIS Witteveen + Bos has founded a consortium with:

- TEAM Palestine, Engineering and Management Consultants investigated the socio-economic and institutional aspects.
- The State Museum of Antiquities, Leiden, investigated and reported on archaeological sites.

1.3. Factors influencing the EIS

Several factors have influenced the preparation of the EIS. Decisions regarding the Gaza Sea Port have been taken in a dynamic political and diplomatic context. The general desire for rapid development of the port has restricted the time available for the preparation of the EIS.

The approximate location of the port had already been decided before the EIS study commenced. Consequently, the EIS had to focus on the selected location, the proposed port capacity and lay-out, port operation and management, and port-related developments. Although it was understood that all relevant information on these aspects would be available when the study commenced, some essential information, such as traffic forecasts, was still not available.

Preparation of the EIS has been influenced by the availability of information. It was intended that the EIS would be undertaken the same time as the detailed design study for the port, which is being carried out by the port designers in cooperation with the contractors. However, for various reasons, survey work for the port design has been seriously delayed.

This has meant that essential data on soil and nautical conditions, borrow areas of sand and construction materials were not available on January 31, 1996, the contractual date for submission of the EIS.

Consequently, the EIS is based on the data available as at January 31, 1996. The gaps in information are set out in Table 10.1. Taking into account the fact that some data were not available and also the current political situation in the Gaza Strip, the EIS provides an adequate overview of the potential environmental impacts of the Gaza Sea Port.

1.4. Contents of the Environmental Impact Statement

The EIS is structured as follows. In Chapter 2, the problem analysis is presented and objectives for the port are formulated. In addition to economic considerations, the port will be developed in the context of a process of political and psychological awareness. Chapter 3 deals with the existing legal and governmental institutions within the PNA. The proposed port lay-out and alternatives are presented in Chapter 4. An alternative lay-out has been developed on the basis of the port lay-out selected in the Basic Engineering Study by Grabowsky & Poort. Chapter 5 presents the current environmental and socio-economic situation, autonomous developments and the alternative if the port is not developed. The description presented in Chapter 5 is the basis for the determination of environmental and socio-economic impacts described in Chapter 6. In this, a distinction is made between impacts during construction and operation, and between the initial phase and final phase of construction. The most environmentally sound alternative has been generated from a comparison of the alternatives. The mitigating and compensating measures for this alternative are set out in Chapter 7. Chapters 8 and 9 present recommendations with regard to legislation, port management and public participation. Chapter 10 gives an overview of the gaps in knowledge and information, and sets out an evaluation and a monitoring plan. The main text of the EIS is finished with a list of references.

2. PROBLEM ANALYSIS AND OBJECTIVES

2.1. Problem analysis

The peace process between the PLO and the State of Israel in the early 1990s led to the foundation of the Palestinian National Authority (PNA) in 1994. The PNA envisages for Gaza and the West Bank complete economic dependency on Israel. These areas have been completely dependent on Israel for the import and export of all capital goods, construction materials, fuels, consumer commodities and other goods. This dependency on Israel has contributed to the economic stagnation of these areas in the last few years. During this time, there has been very little public and private investment and as a result, there is high unemployment. The main source of employment is agriculture and this is being hampered by rapid deterioration of the environment.

The Gross National Product (GNP) in the Gaza Strip and the West Bank was estimated for 1991 to be U$ 1,715 per capita. GNP is lower for the Gaza Strip (U$ 1,230) than for the West Bank (U$ 2,000). Gross Domestic Product (GDP) is even lower than GNP because many Palestinians work in Israel. GDP is about 25% of GNP for the West Bank and the Gaza Strip as a whole; for the Gaza Strip this is about 50%.

Up to 90% of Palestinian trade is with Israel. A considerable proportion of the Palestinian industrial sector are subcontractors to Israeli industry. The import and export of goods leads to enormous costs, which do not benefit the Palestinian economy. Imports to Gaza via the port of Ashdod in Israel, which is the nearest international port, amount to 20,000 tons monthly, while export from Gaza through the same port amounts to 1,250 tons monthly. The largest proportion of imports (75%) transported via the checkpoint at Erez with Israel is containerized. Transport between Israel and Gaza is difficult. Palestinian traders are escorted by Israelis and goods are moved in convoys of 20-25 trucks. While the normal travel time between the port of Ashdod and Gaza City is about 3 hours, in this situation it takes about 24 hours. At present, about U$ 2 million a month goes to Israel as taxes and other costs. In the year after the agreement between the PLO and the Israeli Government, Palestinian traders lost U$ 130 million because goods had to be imported and exported through Israel. Another problem is the frequent closure of border checkpoints between Israel and the Gaza Strip. Table 2.1 gives an overview of the number of closures over the last few years. The Palestinian economy suffers a loss of U$ 6 to 8 million a day when the borders are closed.

Table 2.1. Closures of the borders with the Gaza Strip (1991-1995) in number of days

years	closures
1991	5
1992	22
1993	112
1994	88
1995 (until September)	79

Source: PNA/MPIC/Central Statistics Department, November 1995

A large number of measures are required to stimulate the economy, and particularly employment in Gaza. These are described and listed in extensive studies undertaken by international organizations such as the World Bank (1993) and the European Union (1993). One of these measures must be the liberation of imports and exports to Gaza and the West Bank.
This will help stimulate private sector confidence in economic development, and will lead to investments in employment-generating industries.

Photo 2.1. Border of the Gaza Strip: checkpoint Erez

Photo 2.2. Border of Gaza: checkpoint near Rafah

The general opinion is that a deep water sea port in Gaza would contribute greatly to improving trade. If possible, the port should function as an open transport corridor, and serve the Gaza Strip and the West Bank, and if economically feasible, also Jordan and other parts of the natural hinterland. Apart from economic reasons, development of a sea port would increase the legitimacy of the PNA as the legal authority. Furthermore, the Palestinian people wish to have the independence to choose whether or not to trade with Israel. The Palestinians also want to demonstrate that they can build up their new country themselves.

The Gaza Sea Port would improve trade to the Gaza Strip and the West Bank. The flow of goods through the port will depend on factors, such as the development of trade volume, trade patterns and channels.

trade volume
The Gaza Sea Port will be able to handle the volume of imports (circa 440,000 tons/year) which now flows through the port of Ashdod. It is estimated that the population of the Gaza Strip will increase to about 1 million inhabitants by the year 2000. Population growth and the associated economic growth will lead to increased imports (consumer goods), investment in infrastructure (construction materials) and other economic activities.

Exports are not likely to rise so easily because of the limited potential for agricultural expansion. New export products can be developed.

trade pattern
Currently, 90% of trade to and from Gaza is dominated by Israel. Trade will only shift to a port in Gaza if the Palestinians are able to develop their own trading channels and to import directly. To achieve this, storage and processing capacity will have to be developed and constructed. With regard to expanding the trade channels for export purposes, a complete shift of trade flows is necessary.

2.2. Objectives
The development of a deep water sea port will meet the deep felt needs and wishes of the Palestinian people to liberate themselves from import and export restrictions. The port will also give tangible expression to Palestinian sovereignty.

To achieve these objectives, the following aspects regarding the construction and operation of the port are essential:
- main port activities;
- capacity;
- flexible planning;
- competitiveness.

These aspects have been elaborated in further detail.

2.2.1. Main port activities
cargo port
The port will mainly be used for containerized and general cargo. Bulk imports will be limited to cereals, marble and petroleum products. Significant movement of bulk products is unlikely, except to serve the hinterland, and will only really be possible after large-scale investments in industry and transport.

fishing port
At present, the Gaza Strip has no fishing port. Small fishing boats are landed on the beach. A fishing port is needed if the country is to develop the fisheries sector.
Until the beginning of February 1996, a fishing port was part of the design. Because of cost effectiveness and the incompatibility of a general commercial port with a fishing port, the fishing port has been removed out of the design process.

port for small craft
There are four categories of small craft which require a port facility:
- small commercial crafts such as workboats, tugs and pilot boats;
- government craft such as the coast guard;
- cruise and ferry port operations;
- pleasure craft.

marina
Though the development of a complete separate marina for yachting in the Gaza Strip within or outside the commercial port has been under discussion in the past, this activity has not been incorporated in the proposed activity (Chapter 4). A marina an a commercial port do not mix together, moreover it is not of a urgent need for the Gaza Strip and there is no budget for its construction.

2.2.2. Capacity
In order to attract trade, the cargo port should have the capacity and modern facilities for vessels up to 15,000 dead weight tons (DWT) and a water depth of at least 10 m.

Only limited space is needed for a small craft commercial port for workboats, tugs and pilot boats and governmental vessels. No space has been allocated for the pleasure crafts and facilities. The vessels will have to use the space available and when numbers increase a dedicated facility should be constructed.

2.2.3. Flexible planning
Little information is available on regional transport flows. However, sound forecasts on transport and cargo can only be made for a stable, foreseeable future. The peace process is expected to change the whole economic system in the region, and particularly regional transport flows. Thus a forecast of future cargo flows for the Gaza Sea Port cannot be as accurate as normally would be required. For this reason, the first phase of the port should accommodate some type of worst case scenario in order to prevent too high investment and operational costs. By phasing development, the uncertainty regarding the quantity of cargo is transferred to the time domain. Rapid improvement in the Palestinian economy will result in fast expansion of the port. A slow or stagnating situation will delay port expansion after the first phase until demand increases.

This approach requires flexible planning of the port development. There needs to be a short initial phase which should be self-sustaining for a longer period, but with the potential for flexible phased expansion to a larger port.

2.2.4. Competitiveness
The competitiveness of the port is essential for its raison d'être in the long term, and will be determined by a number of factors, such as:
- tariffs: attractive for all who use the port;
- efficiency: short port handling times for vessels and smooth customs control preventing delays in ship transportation;
- safety: the degree to which the port can guarantee safety to vessels and crews;
- access to the hinterland to expand the feasibility of the port.

The objectives are discussed in Chapter 4 in which the proposed port lay-out and the alternative are worked out.

3. SETTING OF GAZA SEA PORT

3.1. Legislation

3.1.1. Development since 1900

The lack of policy and institutional framework for comprehensive physical and environmental planning is in itself a complication. The situation is also affected by a complex set of legislation dating back to the beginning of this century.

Up until 1917 the area was subject to the law of the Ottoman Empire. During the period of British Mandate from 1922 to 1948, many British laws and regulations were introduced. At that time, the Gaza Strip came under Egyptian control but this changed the situation little. Since 1967 the Israelis have applied a combination of laws from the three preceding regimes, modified by their own military orders. The situation changed in 1994 (Figure 3.1.).

3.1.2. Environmental legislation

the Peace Agreement and its implications for environmental protection

The political situation in the Gaza Strip and the developments since are the result of the Agreement on the Gaza Strip and the Jericho Area, concluded on May 4, 1994 in Cairo by the PLO, Israel, Egypt, the USA and the Russian Federation. The agreement funds the Palestinian National Authority (PNA) and established a schedule for the withdrawal of Israeli military forces. Furthermore it provides for the structure of the PNA and its responsibilities and legislative powers.

The second agreement signed on September 28, 1995 established the withdrawal of the Israelis from the West Bank. Agreements have also been signed regarding the elections in Gaza Strip and the West Bank (January 20, 1996).

Annex II to the first agreement incorporates articles dealing with the environment: Article 23 deals with the preservation of nature reserves; Article 30 with archaeology; Article 31 with water and sewage; and Article 32 with planning and zoning. The latter Article transfers all responsibilities to the PNA, except for those related to military matters. Article 35 deals with environmental protection and has sub-articles on protection of the environment, prevention of environmental risks, hazards and nuisances.

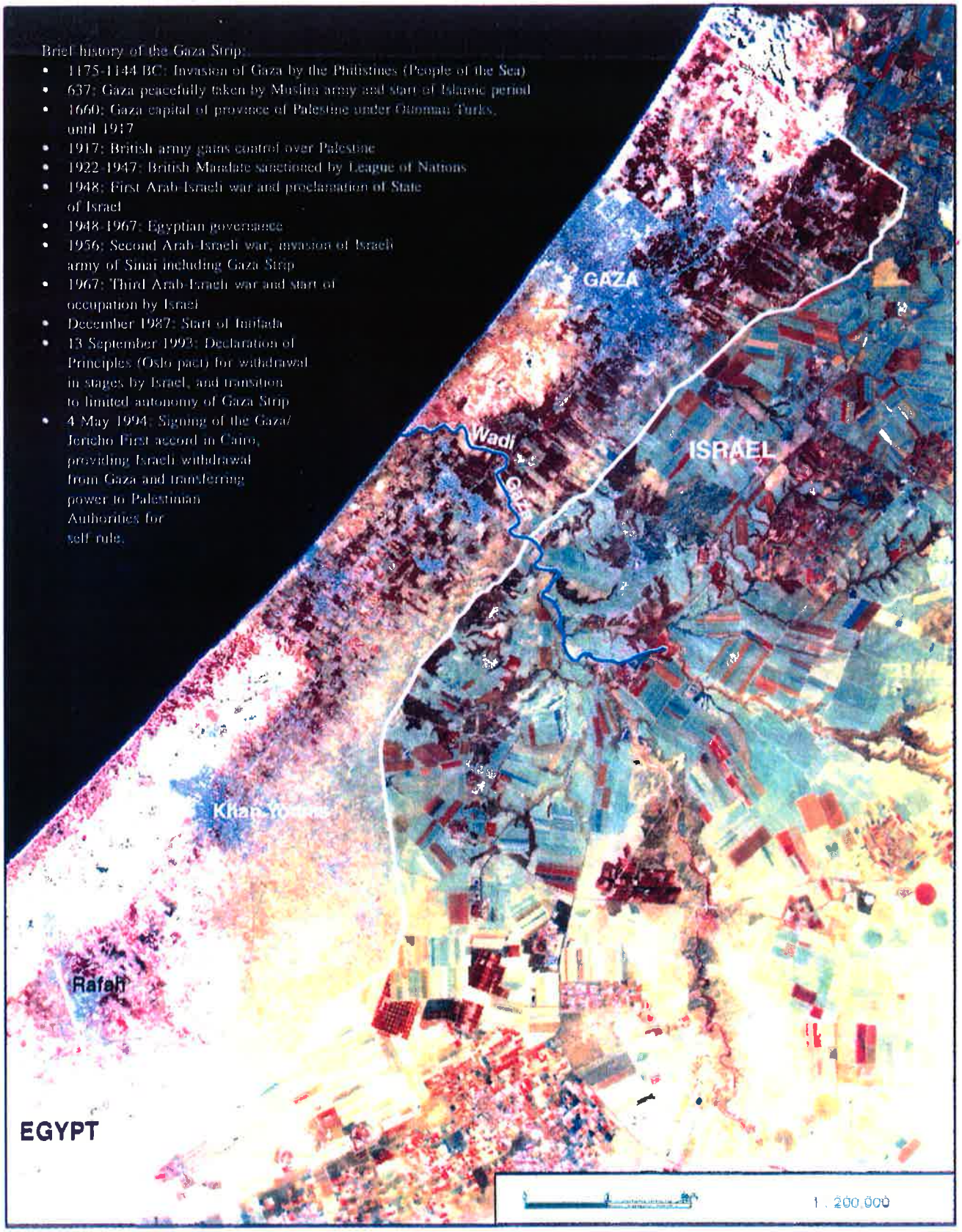
Both countries decided that they "... shall respectively adopt, apply and ensure compliance with internationally recognized standards concerning acceptable levels of land, air, water and sea pollution, and acceptable levels of treatment and disposal of solid and liquid wastes; for the use and handling of hazardous substances, including pesticides, insecticides and herbicides, and standards for the prevention and abatement of noise, odour, pests and other nuisances which may affect each side and the Settlements and the military installation area".

Other matters are mentioned in the sub-articles such as sewage, groundwater, water treatment, information on environmental impacts and an emergency warning system. This article concludes with "....the intention of using principles and standards of protection of the Mediterranean, the protection of the ozone layer, the control of movement of hazardous wastes and their disposal, the restriction of trade in endangered species of wild fauna and flora, and the conservation of migratory species of wild animals."

The environmental issue was on the agenda for the peace negotiations between the PNA and Israel in 1995.

Two years ago, a start was made on the Gaza Environmental Profile (GEP), which includes an inventory of resources, a view of the interactions between man and environment and a programme for sustainable use of resources. This profile forms the basis of environmental planning and managing of resources. The information can be used for the activities of the PNA and of other institutions. The GEP will be completed in 1996.

Figure 3.1. Gaza Strip



Source: Palestinian Environmental Protection Authority, 1994

In the last year, no new environmental legislation in general and related to the port in particular has been enacted or even developed by the PNA, but in the near future environmental legislation will be prepared.

Many activities have been undertaken in the second half of 1995 in which the Environmental Planning Directorate (EPD) has played an important role. These are:
- the Coastal Zone Management Plan (CZMP);
- the Mediterranean Environmental Technical Assistance Programme (METAP);
- an enforcement system of environmental regulation;
- the Emergency Resources Protection Plan (ERPP);
- the Palestinian Environmental Action Programme (PEAP);
- a plan for national environmental information.

These activities are described in Annex I. The results of all will be implemented by the PNA as for regulation of the coming activities of the port.

In many countries it is common use that polluters pay for the pollution they cause and this is enacted in environmental legislation. In the Gaza Strip there is no environmental legislation and no regulation to put this principle in practice. For that reason it is impossible to use this principle for the coming port activities. The PNA, however, can formulate prescriptions for port activities so that polluters will have to pay for pollution caused now and in the future.

international legislation and regulation
International legislation on prevention of pollution of the sea and coastal area and on harbour activities is important to the PNA. The country depends on good quality seawater, prevention of coastal erosion and therefore the PNA intends to implement the international treaties. At present, the PNA has not ratified any of these treaties. The most relevant international treaties for the Gaza Strip and the port are:
- the International Convention for the Prevention of the Pollution of the Sea from ships (MARPOL), 1973/1978;
- the International Convention of the Prevention of Marine Pollution of the Sea by Dumping of Wastes and other Matters (London Dumping Convention), 1972;
- the Convention for the Protection of the Mediterranean Sea Against Pollution, Barcelona, 1976.

For implementation Environmental Impact Statements the Convention on Environmental Impact Statements, Espoo, 1990 is important. In Annex I an overview of international treaties is given.

There are also regulations, for example, governing tank-washing activities on ships. These regulations are carried out according to regulations issued by the International Maritime Organization (IMO).

In developing international and national environmental policy, use needs to be made of international organizations so that know-how about legislation, monitoring, protection is made available. Important international environmental programs include:
- UNEP's IOC Global Sea Level Observing System (GLOSS) with a operating sea level observation station;
- IOC research program POEM (Physical Oceanography of the Eastern Mediterranean);
- UNESCO research program CIESM (Committee International pour l'Exploration de la Mediterranee);
- IBCM program (International Bathymetric Chart of the Mediterranean);
- Mediterranean Action Plan Priority Actions Programme.

main regional environmental activities
The Bahrain Environmental Code of Conduct for the Middle East was adopted at a meeting in Manama, the capital of Bahrain, in October 1994.

The 42 participating delegations included Israel, the Palestinians, Jordan and Egypt. In order to avoid protracted legal discussions, it was decided that the code of behaviour would be normally but not legally binding. The code defines the major environmental issues for regional cooperation, the means to ensure such cooperation, and guidelines for national development which will not lead to harmful environmental impacts on neighbouring countries.

There are two other major environmental actions in the area. One of these is the Barcelona Convention (1976) for the Protection of the Mediterranean against Pollution. The second is the Mediterranean Action Plan (MAP) adopted in 1975 under the auspices of the United Nations Environment Programme (UNEP). The MAP provides a vital forum for regional environmental activities and is widely acclaimed as a model of regional cooperation.

It may be useful for the PNA to follow the existing environmental legislation of neighbouring countries, such as Israel and Egypt, where the sea and harbour environments are similar.

Israel actively participates in the following major environmental action plans:
- Mediterranean Action Plan (MAP);
- Barcelona Convention for the Protection of the Mediterranean Sea against pollution and its related protocols of 1976; Israel has signed and ratified the convention and actively participates in all components of the plan (Blue Plan, Priority Actions Programme and monitoring and research program known as MEDPOL);
- MARPOL 73/78 Convention and Annexes I and II of the convention (signed and ratified);
- A systematic monitoring system and a Bathing Places Law (1964) to regulate the protection of beach and bathers.

A fund has been established for the prevention of marine pollution, to finance enforcement of marine pollution prevention measures and clean-up operations. The fund's income is derived from fees imposed on all oil terminals and ships calling at Israeli ports and from fines for violation of environmental regulations.

In Annex I a short overview on possible legislation is given.

3.1.3. Physical planning

The Gaza Strip has only a limited area available for human activities such as agriculture, industry, infrastructure, housing, water supply, waste disposal and recreation. Overpopulation, especially in the refugee camps, has an immense impact on the environment of the Gaza Strip and the well-being of its population. Population growth and expanding economic activities will only exacerbate the problem.

The shortage of land demands highly efficient and careful land use planning and development. Apart from some older town plans, which have no legal basis, there are no regulations for physical planning. There are no regional or local land use plans and no land use plans for the optimization of resource use and weighing of the various land use interests. Furthermore, there are no laws and regulations on physical planning. A properly empowered and effective governmental institute has not as yet been created. Developments in housing, infrastructure and waste disposal have been proposed without due consideration to the conflicts of interest that may arise with other physical developments. This situation will need to be changed in the future.

At the end of 1994, the Ministry of Planning and International Cooperation (MPIC) established planning units which will start up land use planning, physical planning and socio-economic planning in the Gaza Strip. Because of the urgent need to formulate and implement a physical planning policy for the Gaza Strip, or at least a zoning plan making allocations for the various sectors, MPIC has started a project on physical planning of the Gaza Strip and the West Bank. This project will continue for three years (1995 through 1997).

In phase 1, a pilot physical plan for the City of Gaza will be prepared to take account of all main functions, such as housing, industry, agriculture and transport. The project is still in progress and the plan has as yet no legal status.
There are no explicit hindrances in the physical plan to the proposed Gaza Sea Port. One of the draft maps (April 1995) for the physical plan locates the Gaza Sea Port at site IVA, according to the Basic Engineering Study. A port-related industrial area (400 ha) and a power plant are proposed for the port area. The draft map includes a west-east transport corridor, consisting of 2 x 2 lanes and a two rail tracks. A further industrial area of 70 ha is planned to the east of Gaza City between the main road and the frontier with Israel.

Physical plans for the development of the Gaza Strip have not yet received formal approval.

3.1.4. Port legislation

In the Gaza Strip there is no specific port legislation. Existing legislation comes from Israel and can be implemented by the new Palestinian Authority. The Israeli legislation consists of a Ports Authority Law (1961), which provides for a corporation to manage ports, previously managed by the government. The tasks of the authority are to plan, build, develop, manage, maintain, operate and control the ports as self-supporting enterprises. The Israeli Minister of Transport is responsible for the implementation of this law and the general supervision of the Ports Authority.

The Israeli Ports Ordinance (1971) provides regulations for the operation and management of ports in Israel. It contains a specific section on the handling of hazardous substances in ports. Regulations on collection of waste, bilge and ballast water are foreseen.

Regulations on Israeli Loading and Discharging of Oil, promulgated in 1975 under the Ports Ordinance, control all procedures for safe loading and discharge of oil. The regulations are supervised and enforced by the Ministry of Transport in Israel. The environmental issues are administered by the inspectors of their Ministry of the Environment.

3.2. Authorities and agencies

The construction and operation of a sea port, such as the proposed Gaza Sea Port, requires a well-organized and coordinated institutional framework of authorities and agencies. At present, there is no adequate organization to manage a port. The PNA set up a Port Committee of representatives of the most relevant ministries (Transport, Public Works, Physical Planning and International Cooperation). This committee has to prepare an institutional framework for the port.

The new framework has to have good links with institutions related to the port operations. It must also have clear and workable legislation and regulations, economic and marketing policy and procedures, and must recruit manpower in accordance with present criteria of qualifications and timing. These issues are essential in setting up the port authority.

present institutional framework

At present, the institutional framework for the port and associated activities comprises three categories as follows:

a. Governmental bodies:
   - Ministry of Transportation.
   - Ministry of Planning and International Cooperation.
   - Ministry of Agriculture and Fisheries.
   - Ministry of Tourism and Antiquities.
   - Ministry of Health Quarantine.
   - Ministry of Industry, Trade, and Economy.
   - Immigration Department.
   - Navy and Coast Guard.
   - Customs Department.

b. Non-governmental organizations (NGOs) and community institutions.
These bodies are central in developing community awareness and participation for the institutional setting of the port and include:
- Women Associations and Institutions.
- Child Affairs Institutions.
- Environmental Affairs Institute.
- Cultural Institutes.
- Scientific and Research Institutes.
- Labour Unions.
- Professional Syndicates.
- Agricultural Producers Union.
- Chambers of Commerce and Industries.
- Fishermen Associations.
- Development Oriented Institutions.
- Mass Communication and Press Institutions.

c. Potential port users and/or affiliated companies.
There are no organizations of port users or affiliated companies such as dredging companies, catering services and tank cleaning companies. These will need to be set up.

All the organizations under a) and b) are in existence but do not have any relationship to the port and port activities. Some of these organizations will be important in the coming years, and others in later years. At present, these organizations do not have close links with one another. The new Port Committee has to organize the management of the port and port activities.

3.3. Public participation

Before the establishment of the PNA, the political situation in the Gaza Strip prevented public participation. The people in the Gaza Strip did not participate in the Israeli Government. Thus the Palestinian community has little or no experience with public participation. Public participation has started within the scope of the EIS for Gaza Sea Port and will benefit not only the project but also future projects in the Gaza Strip and the West Bank. The results of the organized public participation are set out in Chapter 9.

3.4. Establishing the port authority and implementing legislation

A port authority must be established for the management and operation of the Gaza Sea port as soon as possible. It is envisaged that this will be an automonous body under the responsibility of the department or ministry for transport.

The PNA is currently setting up its administration and it is essential that the task, responsibilities and authorities of the port authority are clearly defined as soon as possible. The uncertain political situation, however, makes it difficult to establish a timetable for this. The port authority's relationship with the department or ministry responsible for transport and with other organizations such as the Environmental Planning Directorate and local authorities must also be clearly defined. Furthermore, links with organizations in neighbouring countries need to be established with regard to matters such as development and enforcement of environmental legislation, training and essential data collection.

A framework of legislation will need to be in place as soon as possible for the port authority to operate. The first priority must be to develop and implement regulations for the management of coastal erosion in the vicinity of the port. During port construction, there will need to be regulations in force on a wide range of matters such as zoning of activities, waste disposal, safety and traffic regulation. Furthermore, regulations governing waste disposal and pollution control must be developed and in force when the port enters the operation phase.

4. PROPOSED ACTIVITY AND ALTERNATIVES

The proposed port development and the alternatives are one of the main issues of the Environmental Impact Statement (EIS). A description of the proposed port in Gaza is, therefore, essential to defining its environmental impacts. Alternatives are developed to assess whether there are better solutions for the port from an environmental point of view. In developing alternatives for port planning, construction and operation in the context of a environmental impact assessment, the following variables are essential:
- port location;
- port lay-out;
- construction methods and materials;
- operation procedures and management.

The development of the alternative is based on an adaption of the selected lay-out of the Basic Engineering Study. Environmental considerations and recommendations has played an important role in the adaptions (Section 4.5). Of course the alternative has also been developed, within technical and financial conditions. Especially the financial conditions restrict the integration of environmental measures in the design to a certain extent.

The location for the Gaza Sea Port between the boundary of the Municipality of Gaza and Wadi Gaza has already been chosen (Figure 4.1.). In the Basic Engineering Study the IVA site has been selected from a comparison of six potential sites.

Location IVA is at the end of the road along the Israeli settlement of Netzarim. The EIS (Annex I) has investigated the exact optimum location of the port from an environmental point of view.

Before describing the proposed port lay-out and the alternative, the Programme of Requirements for the port is outlined.

4.1. Programme of Requirements

The Programme of Requirements (PoR) sets out the requirements for the design, construction and operation of Gaza Sea Port. These requirements are essential in developing a realistic and feasible alternative for the EIS.

The main requirements are as follows:
- the port site must have excellent potential and flexibility for expansion;
- use of the existing coastline and the hinterland in the port construction and related activities must be restricted;
- the port must offer optimal services to attract potential users in order to be able to compete with adjacent Mediterranean ports.

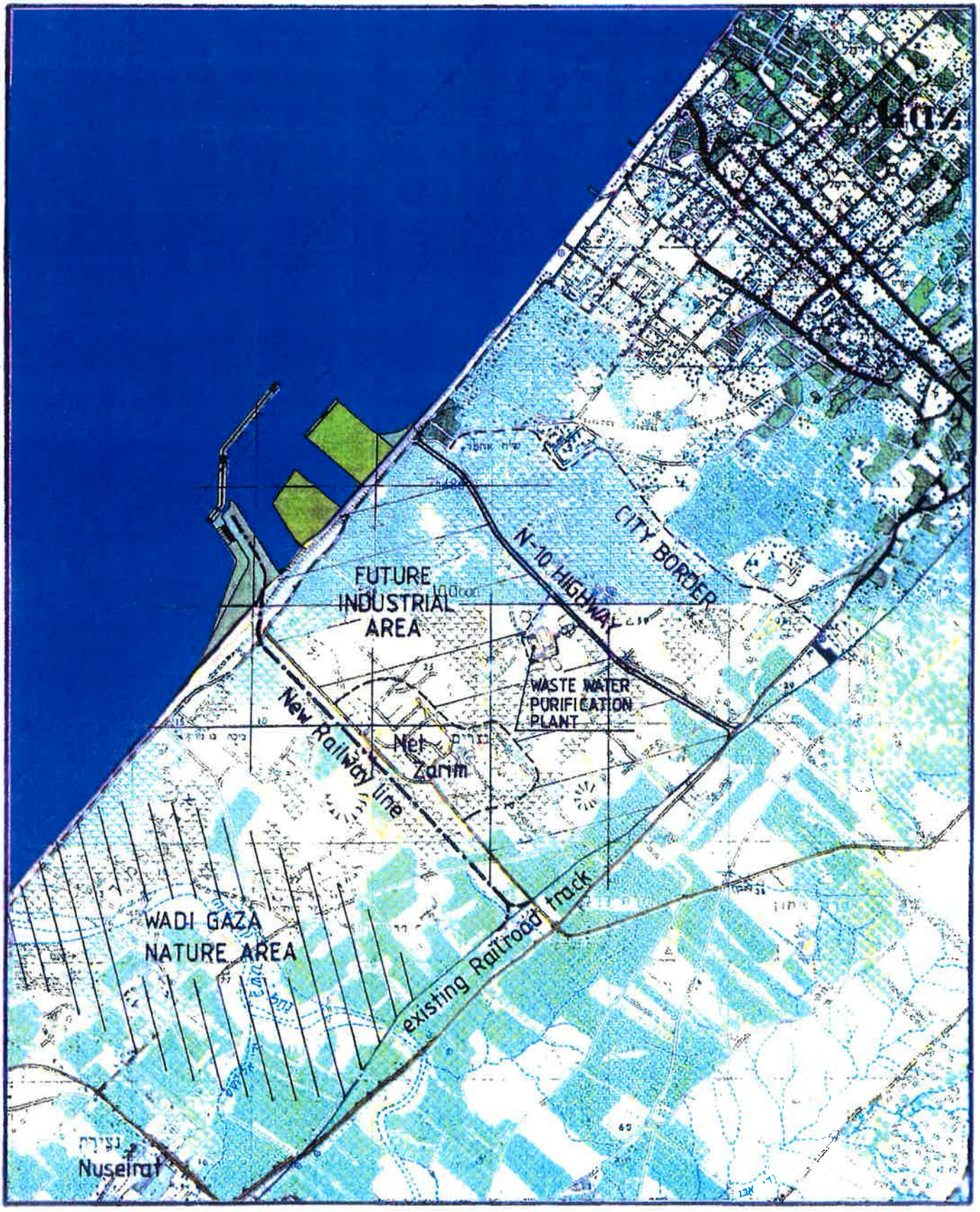
flexibility

The port lay-out must offer potential for expansion to accommodate an increasing number of vessels and cargo volumes. This means that preferably there should be no limitations with regard to land reclamation on either sides of the port. Expansion of the port must not lead to loss of investment. The future port must be able to meet the environmental requirements, which require optimal phasing of port development.

land use

Port development along the coastline and hinterland must be restricted as much as possible. Therefore land must be reclaimed and wherever possible there must be offshore construction. Optimum use must be made of land in the port area, the hinterland connections and industrial areas. It is obvious that the port area must be fully utilized before occupation of areas beyond existing port boundaries takes place.

Figure 4.1. Location of Gaza Sea Port



Source: Netherlands Ministry of Economic Affairs and Palestinian National Authority, 1994

Photo 4.1. Location of the port

Photo 4.2. Location of the port

construction
Port facilities should be available in the initial phase of the port development. The objective is to use imported construction materials as little as possible. Maximum use should be made of local labour in order to create employment in the area.
Future port expansion must be prevented from hampering port operations wherever possible.

ship manoeuvring
The length of the breakwater will determine the size of the protected port area. The approach channels must be constructed as far as possible perpendicular to the coast.

terminal operations
The quay must be aligned with the dominant west/north-west wind direction.

environment
Land is a scarce resource in the Gaza Strip. Therefore, the port development should take up as little of the existing area as possible and should not lead to deterioration of the area. Furthermore, the port lay-out must be such that there is minimum disruption to sediment transport along the coast. Port construction and operation should be prevented from contributing to marine pollution as much as possible.

safety
The international standards for safety will be applied in the construction and operation of the port. With respect to the nautical safety of the port investigations are taken place during the submitting of the EIS. The overflow frequencies will be no more than once a year.

4.2. Proposed activity
The elements of port construction and operation which are relevant to the environment are outlined in this section. Section 4.2.1 deals with traffic forecasts and the phasing of port construction. The main physical infrastructure for the port is discussed in relation to the water and land area. Services, utilities and port equipment, the inland transport system and the construction works are discussed in Sections 4.2.4 through 4.2.7; the port operations and maintenance are presented in Sections 4.2.8 and 4.2.9.

4.2.1. General
As stated in the Basic Engineering Study, it is proposed that construction of the Gaza Sea Port should be phased as follows:
- Phase IA.
  Initial Port 1996-1998, which includes a simple facility to handle bulk and break bulk, without major investments in ship-to-shore equipment (Figure 4.2.).
- Phase IB.
  Multi-Purpose Port 1999-2000 suitable for various commodities based on multi-purpose berths with minimum of ship-to-shore equipment.
- Phase II.
  Expanded Multi-Purpose Port 2001-2003, with modern ship-to-shore handling equipment for containers and bulk.
- Phase III.
  Specialized Terminals 2004-2020 (Figure 4.3.).

In the Basic Engineering Study, cargo forecasts and a shipping analysis were carried out to quantify the flow and type of goods and vessels. It must be emphasized that various assumptions had to be made as only limited information is available on the Palestinian economy. A breakdown of traffic forecasts is presented in Table 4.1. At this moment these forecasts are the only available source; this means that quantities could vary considerably due to changing political and economic circumstances.

Table 4.1. Traffic forecasts for the Gaza Sea Port (quantities in 1,000 tons)

goods	year					
	1997	1998	1999	2000	2001	2002
unloaded						
construction materials	120.0	156.0	218.4	262.0	327.6	400.0
- containers	12.0	20.0	25.0	50.0	100.0	150.0
- pallets	6.0	10.0	15.0	30.0	42.0	50.0
- bare	102.0	126.0	178.4	182.0	185.6	200.0
engines, parts	10.0	13.0	18.2	21.8	27.3	50.0
- containers	5.0	8.0	12.0	14.8	18.0	30.0
- pallets	3.0	3.0	4.2	5.0	7.3	15.0
- special	2.0	2.0	2.0	2.0	2.0	5.0
misc. goods	20.0	26.0	36.4	43.6	54.6	80.0
- containers	16.0	22.0	31.4	38.0	47.0	60.0
- others	4.0	4.0	5.0	5.6	7.6	20.0
fertilizers	10.0	13.0	18.2	21.8	27.3	50.0
- containers	8.0	11.0	16.0	18.8	23.0	40.0
- others	2.0	2.0	2.2	3.0	4.3	10.0
vehicles	2.5	3.5	4.5	5.4	6.8	20.0
dry bulk (grain, etc.)	180.0	186.0	192.0	198.0	205.0	215.0
liquid bulk (petroleum products)	100.0	258.0	366.0	825.0	887.0	970.0
total	442.5	655.5	853.7	1377.6	1535.6	1785.0
loaded						
seafood (fresh products)	3.0	3.3	4.3	6.0	9.6	20.0
- refrigerated containers	3.0	3.3	4.3	6.0	9.6	20.0
citrus fruits	15.0	16.5	21.4	30.0	39.0	60.0
- containers	13.0	14.5	18.4	25.0	32.0	45.0
- others	2.0	2.0	3.0	5.0	7.0	15.0
other food products	4.0	4.4	5.8	8.0	10.4	25.0
- containers	3.0	3.4	4.8	6.0	8.0	20.0
- others	1.0	1.0	1.0	2.0	2.4	5.0
industrial products	0.0	10.0	20.0	50.0	100.0	145.0
- containers	0.0	10.0	20.0	50.0	100.0	145.0
total	22.0	34.2	51.5	94.0	159.0	250.0
goods total						
unloaded	442.5	655.5	853.7	1377.6	1535.6	1785.0
loaded	22.0	34.2	51.5	94.0	159.0	250.0
total	464.5	689.7	905.2	1471.6	1694.6	2035.0

Source: Netherlands Ministry of Economic Affairs and Palestinian National Authority, 1994.

Ship manoeuvring area, berths, terminal areas, port buildings and equipment for the various phases of the Gaza Sea Port are presented in Table 4.2.

Table 4.2. Port dimensions for the four development phases of the Gaza Sea Port

requirements	phase IA	phase IB	phase II	phase III
ship manoeuvring area				
design Vessel (Dead Weight Tons-DWT)	5,000	5,000	15,000	70,000
water depth-entrance (m)- basin	9 8	9 8	12 11	15 13
length protected approach (m)	500	500	750	1,250
turning circle (m)	200	200	300	500
berths				
container (m)	0	0	0	700
multi-purpose Lift on-Lift-off (LO-LO) (m)	200	300	600	600
roll-on roll-off (RO-RO) (m)	150	150	200	400
bulk (m)	0	150	200	500
petroleum products (m)	0	150	200	400
fish (depth 4 m)	200	200	200	200
passengers/roll-on roll-off/cruise	0	0	150	300
terminal areas (including quays)				
container (ha)	0	0	0	30
multi-purpose (ha)	6	9	18	18
roll-on roll-off (ha)	4	4	4	4
bulk (ha)	0	5	10	15
products (ha)	0	4	4	8
fish (ha)	4	4	4	4
passengers (ha)	0	0	4	10
container Freight Station (ha)	0	2	2	4
port buildings and utilities (number)				
port administration	1	1	1	2
technical services	1	1	1	2
others	0	1	1	2
transport: roads, pipelines, conveyor belts	0	3	6	10

requirements	phase IA	phase IB	phase II	phase III
ship-shore cranes (number)				
container gantry crane	0	0	1	p.m.
30-ton mobile crane (floating provisional)	0	1	1	p.m.
portable grain pumps	0	1	1	p.m.
mobile 10-ton cranes	0	1	2	p.m.
horizontal transport (number)				
28-ton forklift truck	3	3	5	p.m.
6-ton forklift truck	5	10	15	p.m.
tractors	3	4	6	p.m.
trailers	6	12	18	p.m.
yard cranes				
20 ton mobile crane (tire)	0	0	1	p.m.
5 ton mobile crane (tire)	0	0	2	p.m.
marine equipment				
tugs	0	1	1	p.m.
pilot boats	1	1	2	p.m.
workboats	2	2	3	p.m.

Source: Netherlands Ministry of Economic Affairs and Palestinian National Authority, 1994.

The total area required for terminals, port buildings and utilities in each of the port development phases is, still according to the Basic Engineering Study, as follows:
- phase IA : 16 ha;
- phase IB : 34 ha;
- phase II : 55 ha;
- phase III : 109 ha.

The land area for each of the port development phases remains the same and was not a variable in the development and consideration of alternatives. Only the port lay-out in the different phases with respect to the shoreline was taken into account in the alternative lay-out for the port. This process resulted in the development of an alternative. After comparison of the alternatives, the most environmentally friendly alternative was developed, together with mitigating measures. These mitigating measures are recommendations regarding the zoning of activities, environmental measures and construction materials and operation procedures.

In the following section, the port lay-out, design of the major infrastructure, port construction and port operations are outlined for each of the four phases (IA, IB, II and III).

phase IA

In phase IA, the berth length for lift-on lift-off (LO-LO) operations is 200 m, and a berth for roll-on roll-off (RO-RO) is also planned. The berths are to be located on the seaward end of the causeway in deeper water in order to limit the dredging volume and costs. Vessels up to 5,000 DWT can be accommodated and goods transhipped by ships' gear.

The relatively high investments in quay cranes will be postponed to subsequent phases. Equipment for horizontal transport has been included in this phase.

phase IB
The LO-LO berth will be 600 m long. A petroleum berth is proposed alongside the far end of the breakwater and a storage yard on the landward side of the causeway. Dredging of the port basin is planned so that it can take vessels up to 15,000 DWT. Small container vessels will be served by mobile quay cranes.

phase II
A rectangular area of land will be reclaimed north of the groyne, which will provide space for a multi-purpose terminal with a berth length of 600 m. It will be equipped with modern gantry cranes to serve container vessels up to 15,000 DWT. A storage yard will be constructed on the reclaimed area. The breakwater will be extended to the north-west to provide sufficient shelter for the new berths. It is proposed to re-locate the petroleum berth further away from the other port operations. The LO-LO berths constructed in phase I will be converted into a bulk terminal.

phase III
A further area of land will be reclaimed within the harbour basin. The breakwater will be lengthened by about 400 m and a second berth for liquid bulk constructed on the lee side of the main breakwater.

The newly reclaimed land will be used for a multi-purpose terminal, while the existing multi-purpose terminal will be converted into a container terminal to accommodate vessels ranging from 50,000 to 70,000 DWT. Although the water area of the harbour basin will be reduced considerably, there will still be sufficient area for vessel manoeuvring and turning. A fishing port will be developed in the south-west part of the sheltered basin.

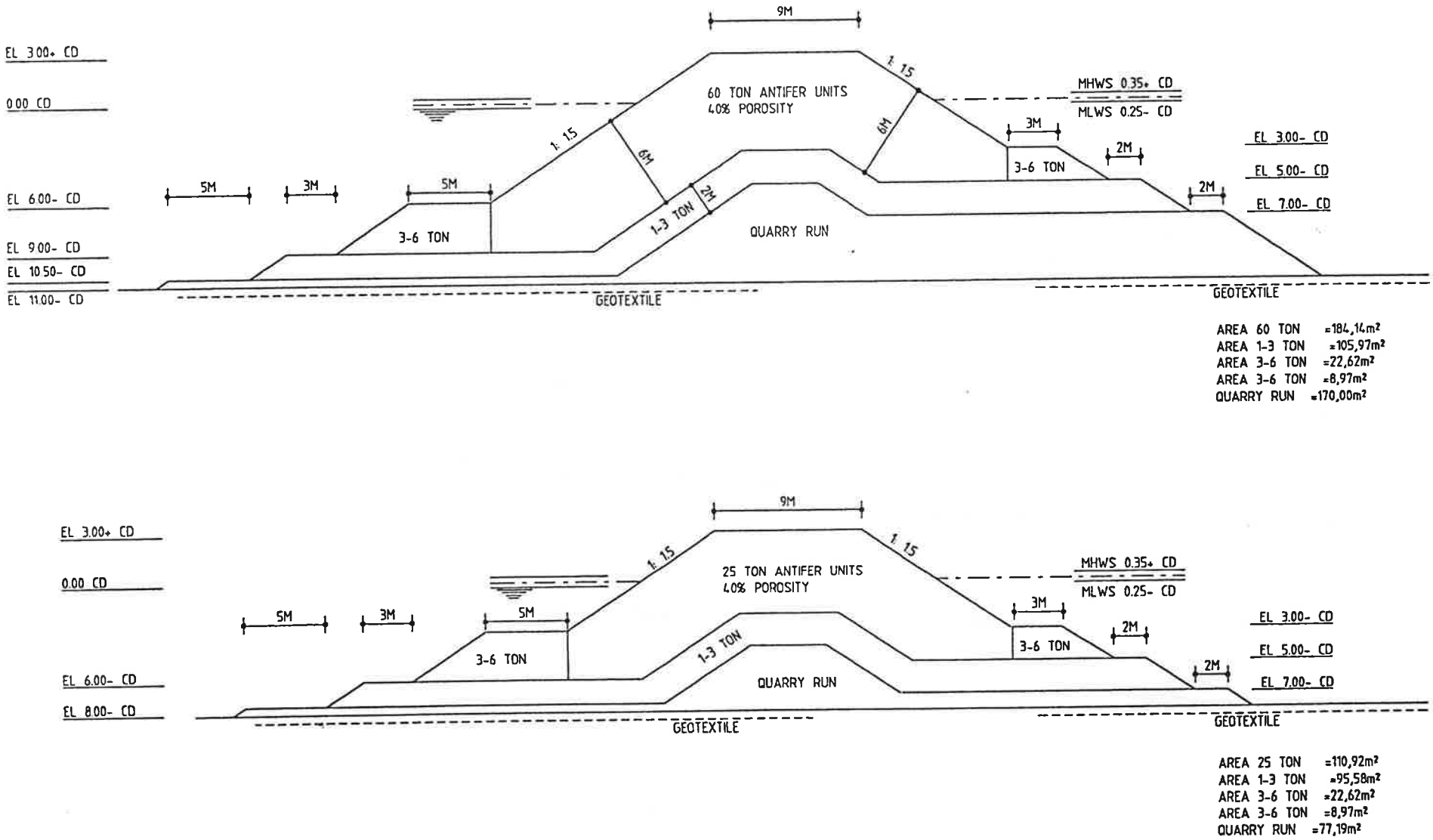
Sections 4.2.2 and 4.2.3 deal with phase III because the assessment of the environmental impacts of phase III represents the most severe situation. The descriptions focus on the port lay-out with all major infrastructure, port construction and operations.

4.2.2. Water area
The water area in phase III is determined by the required surface of the approach channel, turning circle and basins, but also by the spatial requirements of breakwater, causeway, groyne, land reclamation and quay structures.

approach channel, turning circle and basins
The water area will consist of a dredged channel (1,000 m long and 11 m deep). The depth of the dredging will range from 0 to 11 m. The diameter of the turning circle is 400 m. The depth of the basins will be 11 m. The slopes of the dredge area have not been determined yet, but will be in the range of 1:5 to 1:10. This means that some dredging work will be required for a section of the breakwater because the toe of the breakwater will intersect with the slope of the dredge area. It should be noted that the Programme of Requirements states the required depth is 15 m in the channel and 13 m at the berths.

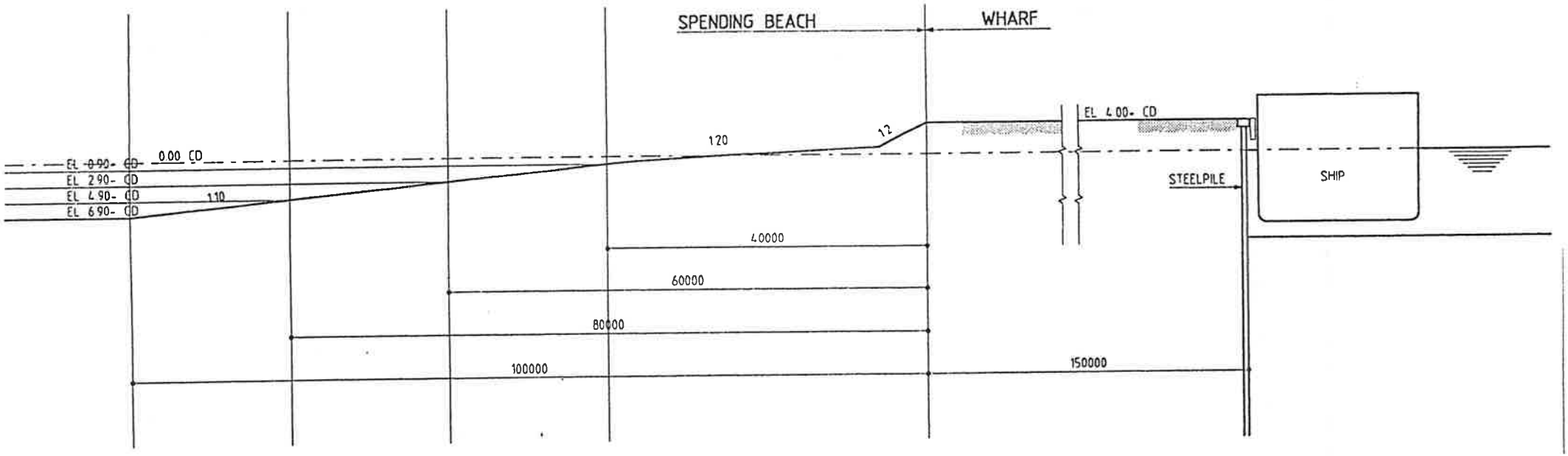
breakwater, causeway and groyne
The port basin is protected from waves from the north-western quadrant (the prevailing direction with also the highest waves) by:
- The causeway (Figure 4.5.), a strip of reclaimed land (sand fill) which is connected to the shore and which is used as port area. On the outer south side of the causeway, a natural beach will develop as sediments will be trapped by the causeway and no protective armour layer is foreseen. At the port side a sheetpile structure will retain the sand of the causeway and serve as a quay and/or a berth structure. The sheetpile structure is to be designed for the water depth required in the final phases.

Figure 4.4. Cross section of breakwater (0/-11 CD) and (0/-8 CD)



Source: Netherlands Ministry of Economic Affairs and Palestinian Authority, 1994.

Figure 4.5. Cross section causeway



Source: Netherlands Ministry of Economic Affairs and Palestinian Authority, 1994.

- The rubble mound breakwater (Figure 4.4.) which starts at the seaward end of the dam and runs in a north and north-easterly direction. The main armour units are designed as 25-tons Antifer Cubes. The breakwater will have a concrete capping which will make it accessible. The lay-out and the cross section (e.g. the top level) of the breakwater shall be such that the breakwater provides a sufficient level of protection and safety for all port and shipping operations. The overflow frequency will be no more than once a year.

In addition to the protective structures listed above, in phases IA and IB a groyne will be constructed to form the northern boundary of the port. Its main function will be to prevent sedimentation, and in the second instance, to serve as a breakwater. In the subsequent phases, the groyne will be incorporated in the reclaimed area for the port expansion and this reclaimed area will take over the groyne's function.
The entrance to the harbour will be on the north-eastern side of the basin so that sediments will not enter the basin.

reclamation
Land will be reclaimed for the site of the bulk terminal, the multi-purpose terminal and the container terminal. The elevation of the terminals will vary from Chart Datum + 3.0 to Chart Datum + 4.0 m.

There are no data available on soils and therefore no assessment can be made as to whether the material dredged from the channel can be used for reclamation purposes. For the time being, it is assumed that the material is suitable. It is estimated that the quantity of material from the dredged area will not completely meet the demands of the reclamation works. There will mostly likely not be sufficient sand for the reclamation and consequently this will need to be dredged from a borrow area offshore.

quay structures
There are quay structures at the berths for cargo and container vessels, RO-RO vessels and the small craft (fishing) harbour. The berths/quay structures consist of anchored sheetpile structures. The sheetpiles are piled or vibrated into the subsoil, subsequently anchor piles are piled or vibrated and connected to the sheetpiles. Finally, the sheetpiles are to be back-filled. The sheetpiling are to be capped with a concrete beam. Where the area has first to be reclaimed, the quay will be constructed "in the dry" and then the area in front of the quay dredged to the required depth. Depending on the depth required, the sheetpile will consist of either a combi-wall or a sheetpile wall.

anchorage
A safe anchorage area offshore with sufficient water depth and at sufficient distance from the approach channel will need to be designated for ships waiting to enter the port.

navigational aids
Navigational aids (navaids) will be installed to indicate the access channel and the entrance to the port. The navaid system will consist of floating navigation buoys and navigation beacons on the shore or the breakwater.

marine equipment
The following marine equipment is required for the operation of the port:
- pilot boat(s);
- work boats;
- tug boats (2 in phase III).

4.2.3. Land area
land use
The port lay-out is such that the entire land and water area required is mainly in front of the present coastline, and hence a limited section of the existing land will be used for port operations.

Some 200 m of cliffs will be included in the southern section of the port. In phases IA and IB, all land-based port activities will be undertaken on the newly constructed causeway and the areas obtained from the excavated cliffs. In subsequent phases, larger areas of land will be reclaimed on both side of the port basin.

civil engineering works
The civil engineering works for the port development are mainly:
- roads;
- drainage system;
- pavement for storage areas;
- structures for sewage collection;
- structures for solid waste reception facilities.

The following facilities are essential for a modern port:
- structures for ships (oily) wastewater reception facilities;
- structures for ships waste oil reception facilities;
- impervious pavement and oil separators are required for:
  . areas around workshops;
  . areas immediately behind the quay walls;
  . areas around waste reception facilities;
  . areas for the storage of hazardous cargoes;
  . areas around reefers;
  . areas where cleaning of equipment and containers takes place.

buildings
The following buildings are proposed:
- Main administration building to house the port administration, harbour master, communication centre, customs and others, such as agents and forwarders. The building will have three storeys and reach 10.4 m above ground level.
- Technical services buildings to house maintenance and marine workshops and spare part stores, offices.
- Several small buildings including a fire station, electrical substations, gate houses and security office. The electrical substation will house a generator and diesel tank.

Table 4.3. The area requirements of the port buildings

buildings	ground area (m^2)
main administration building (3 levels)	10,000
technical services buildings	10,000
several small buildings	10,000

Furthermore a transit shed and passenger terminal building are projected. The dimensions of the transit shed are 60 x 30 x 11.7 m, and of the passenger terminal building 35 x 20 x 12 m.

access roads and railway
It is anticipated that road no. 4 will become the artery road for the port. It is proposed to connect the port area to the artery road by a transport corridor (road no. 10) of a width of 100 m. It is recommended to reserve place for pipelines in this transport corridor. There will be transport connections to the West Bank (54 km), to the airport planned in the south and to Israel in the north and east. Finally, there are plans for the re-construction of the railway from Cairo to Lebanon (north-south) and from Haifa to Al Mafraq (east-west). A railway connection between the Gaza Strip and the West Bank is also planned.

4.2.4. Services and utilities

The following services and utilities are projected as part of the port development:
- water supply system for the buildings;
- fire alarm and fire fighting system;
- solid and wastewater disposal system;
- electricity supply;
- lighting of port area;
- weighbridge;
- fencing.

In addition to water for the buildings, fresh water will be required for:
- cleaning of equipment;
- washing of containers;
- supply to tugs, pilot and workboats;
- landscaping.

For fire fighting systems salt water will be used.

It should be noted that water will not be supplied to vessels calling at the port.

A modern port requires the following facilities:
- station for reefers (refrigerated containers);
- bunkering facilities for vessel;
- harbour reception facilities in accordance with the MARPOL regulations;
- cathodic protection system for the sheetpiles.

Mechanical and electrical works are required for the utilities and services listed above. The mechanical system will consist of pipes and pumps for the water, wastewater and fire fighting system. The electrical system will consist of a power generator, a connection to the public electricity net, a substation with transformers, power supply to the container crane, reefer station, navaids (on land), lighting system and buildings.

4.2.5. Port equipment and installations

vertical transport

For the vertical transport of cargo from the ships to the quay, the following equipment is projected:
- one container gantry crane;
- one 30-ton mobile crane;
- one 10-ton mobile crane;
- grain pumps;
- ships gear.

horizontal transport

For the horizontal transport of cargo from the quay to its destination within the port area, the following equipment is projected:
- one 20-ton mobile crane;
- one 5-ton mobile crane;
- fifteen 3-ton forklift trucks;
- five 20-ton forklift trucks;
- six tractors;
- eighteen chassis;
- grain pumps.

communication aids

Modern equipment for ship-to-shore communications is required.

4.2.6. Inland transport system

As stated in Section 4.2.3, the inland road transport system will be linked to the existing road no.4. There are plans to re-instate the rail system with a connection to the port. For the time being, however, it must be assumed that goods will be moved to and from the port by road.

4.2.7. Construction works

site preparation

The contractor will carry out the following site preparation works:

- mobilization of equipment and work force;
- setting out of works;
- clearing and grubbing of the site;
- construction of temporary access roads;
- erection of site offices, temporary workshops, stores, etc.

origin of materials

Generally, contractors are free to select their own sources of material as long as the specifications are met. The following information on availability of construction material was obtained:

- Rock: large rock units (basalt or similar) are available on the West Bank near Hebron (80 km) and Ramallah (100 km) or near Al-Arish city in Egypt, approximately 80 km from the border in Rafah or approximately 110 km from the proposed site. Rock is also available in Jordan.
- Concrete: gravel is generally obtained from Hebron or Ramallah in Israel. Sand is available in Gaza.
- Other construction materials such as steel, sheetpiles, wood, bricks, asphalt are available in Israel or should be imported.
- Sand for landfill: it is assumed that sand for landfill will be obtained from the cliffs immediately behind the port. No sand supply from offshore is foreseen. But if the quality and quantity of the material from the cliffs are insufficient, then other sources will need to be identified offshore.
- Initial beach nourishment: some 1.5 million m^3 is proposed for nourishment of the beach to the north of the port as a buffer against erosion for a period of 3 to 5 years. There is no indication as yet where this material will be obtained. It may be assumed that borrow areas offshore will be dedicated for this purpose.

construction

After an assessment of the quantities of materials for the construction works, as given in the Basic Engineering Study Part 7, the potential construction methods for the main infrastructure of the port are described. For the purpose of the EIS, phases IA and III are considered. The quantity of material for sand by-passing (1,500,000 m^3) has not been included in Table 4.4.

Table 4.4. Estimated quantities for construction of the port infrastructure proposed lay-out

elements	unit	phase IA	phase III
breakwater	m	700	1,280
causeway	m	780	780
berths	m	200	2,050
dredging and filling	m^3	1,250,000	4,500,000
small craft harbour	pc	1	1
roll-on roll-off berth	pc	1	1
groyne	m	450	-
sea wall	m	-	400
inshore earthworks and sand dam	m^3	1,000,000	2,000,000

Source: Netherlands Ministry of Economic Affairs and Palestinian National Authority, 1994

breakwater
The breakwater will be constructed by dumping stone or concrete elements on the sea bottom. Usually, a breakwater is constructed on top of a filter layer. The breakwater will be partly constructed from the sea and partly working over the top of the already constructed breakwater. Large areas will be required for the storage of the rock for the breakwater. Furthermore a loading-out facility will be required for the loading of the stone dumping barges and to receive rock when transported by sea. If concrete units are used in the breakwater construction, a casting yard will be required.

causeway
The construction method for the causeway is similar to that of the breakwater. The sand will be obtained from the cliffs immediately behind the port.

berths
The berths/quay structures of the wharf consist of anchored sheetpile structures. The sheetpiles will have a protective coating against corrosion. Before the coating can be applied, the steel sheetpiles will have to be sand-blasted. The sheetpiles will be driven or vibrated into the subsoil, subsequently anchor piles are piled or vibrated and connected to the sheetpiles. Finally, the sheetpiles are back-filled. The sheetpile is capped with a concrete beam. In some places the area will first be reclaimed, then the quay constructed "in the dry" and the area in front of the quay will be dredged to the required depth. Finally, the cathodic protection system (if any) will be applied to the sheetpiles.

dredging and filling
A substantial amount of material has to be dredged in the access channels and turning basin. Whether a Trailing Suction Hopper Dredger (TSHD) or Cutter Suction Dredger (CSD) is used will depend on the physical characteristics of the material to be dredged and the physical boundary conditions (especially waves). The dredging cycle consists of the following steps: excavation; vertical transport; horizontal transport and dumping.

In the dredging operations a part of the dredged material will be in suspension and will settle further on.

Table 4.5. Means of dredging and filling

dredger	excavation	vertical transport	horizontal transport	disposal
TSHD	dragging and water jetting	hydraulic	in own hopper	through bottom doors or by pumping ashore through pipeline
CSD	cutting	hydraulic	in a separate hopper or hydraulically in pipeline	hopper: dumping pipeline: directly

Depending on the quality, part of the dredged material may be used for land reclamation in the port area. The material will probably be transported hydraulically via pipeline. The fill material will be dumped in a prepared area within (bund) walls. The return water flow (only about 30% of the transported material will be solids) will carry suspended material and will lead to sediment dispersal through the water column.

If the dredged material is not suitable for reclamation purposes, it will have to be disposed of at designated disposal or dump sites. Such sites have not yet been indicated but will most probably be offshore.

small craft harbour
The construction method for the small craft harbour will be similar to that for the other quays.

roll-on roll-off berth
The piles for breasting and mooring dolphins for the roll-on roll-off berth will be piled into the ground from floating equipment. The roll-on roll-off ramp will be part of the quay structure for the cargo berths.

groyne
The groyne will be constructed using a similar method as that used for the construction of the breakwater.

seawall
The seawall will be constructed using a similar method as the construction of the breakwater. The core of the seawall, however, will consist of selected fill material instead of quarry run.

inshore earthworks
Inshore earthworks will be carried out as dry earth movement, using large-scale earth moving equipment. Some blasting may be required, depending on the quality of the material to be excavated. The following steps in the earth moving process are distinguished:
- excavation: by means of rippers, bulldozer, excavators, possibly blasting;
- vertical and horizontal transport: vertical transport by means of bulldozer or excavators, and trucks for horizontal transport;
- placing, grading and compaction: placing by means of dumping from the truck, grading and compaction by means of graders, vibro floatation, vibro compactors.

site clean-up
Cleaning up the site will generate a considerable quantity of building rubble and should be disposed of at an approved dumping site.

4.2.8. Port operations

port management

A Port Authority (see Chapter 8 for a detailed description) has to be developed for the Gaza Sea Port. In this Section it is described with respect to what (environmental) issues this authority will be responsible. The Port Authority is responsible for all activities within the port area, and the issue of guidelines, rules and regulations for the orderly operation of vessels and other port users in the form of Port Regulations. The Inter-Governmental Maritime Consultative Organization (IMCO) has made efforts to standardize procedures and practices in ports. Specimen Port Regulations are available.

type of cargo

It is anticipated that the port will handle the following types of cargo:

- general cargo:
  . unloaded: building materials, engines, parts, fertilizers, miscellaneous;
  . loaded: fruit, food products, industrial products.
- vehicles;
- containers: 20", 40", special, reefers;
- dry bulk: grain, cement;
- liquid bulk (diesel, fuel oil).

A throughput of 0.5 - 1.0 million tons is anticipated in the first year and some 2.7 million tons (year 2005) in phase III.

cargo handling

vertical transport at quay

In phase IA cargo handling will be done mainly by ship's gear and by means of 2 mobile cranes operating from the quay. In phase III this equipment will be augmented with a container crane and mobile grain pumps and possibly a grab unloader and conveyor belt system.

horizontal transport

Horizontal transport in the port area will be done by trucks, tractors and trailers.

vertical transport in yard

The vertical transport in the yard will be done by forklift trucks, mobile cranes and Rubber Tired Gantries (RTG's).

Liquid bulk will be transported from the vessels to the tanks by pipelines.

cargo storage

open storage

Open storage is required for containers, part of the general cargo and containers on chassis.

covered storage

A storage shed will be required for general cargo, perishable goods and for the stuffing and stripping of containers. Refrigerated storage will also most likely be provided.

tank farm

The total storage capacity for the tank farm has been estimated at some 150,000 tons in 22 tanks covering some 4 ha.

silos

Silos will be required for the storage of bulk grain and possibly also bulk cement.

port industrial area
The port industrial area should accommodate the power plant and the desalination plant. The total area required, including the tank farm, is some 50 ha.

waste handling

cargo waste
Waste from cargo handled on ship and on the quay will have to be disposed of.

ship's waste
Ships produce liquid waste including oily bilge water, oily ballast water, oily water from cleaning tanks and from purification of fuel and oil, polluted water from cleaning cargo holds, waste oil (used oil), ships sewage water. Solid waste from ships includes food waste and packaging.

hazardous cargo
The Basic Engineering Study does not indicate the potential for hazardous cargo. It may be assumed that hazardous cargo will pass through the port, such as gasoline, acids, other corrosive chemicals, pesticides and explosives. In phase IA the proportion of hazardous materials will not exceed 10% of the total quantity of cargo. In phase III this percentage will increase considerably by the transshipment of oil and oil products. It is important that the Port Regulations include the International Regulations for the Carriage of Dangerous Goods by Sea published by IMCO. These regulations are also referred to as the International Maritime Dangerous Goods Code (IMDG Code). If any hazardous cargo will be stored in the port area, a separate area should be allocated in order to prevent environmental risks as much as possible. The separate area should be in a quiet place of the port area. It should be protected by impermeable walls and floors. From the outside it should be clearly marked as a storage area of hazardous cargo.

container cleaning
Containers may need to be cleaned before they can be re-used. Appropriate provisions (like the re-use of water and impermeable floors) should be created in order to prevent environmental pollution to soil and water.

nautical management
The nautical activities in the port has to be under the control of the director of marine harbour master and consist of the following:

traffic in the port and at sea
The number of vessels calling at the port is not indicated in the Basic Engineering Study. For this reason this item was frequently discussed during meetings in Gaza. As a result of this meetings it is roughly estimated that by the year 2002 there may be some 500 - 1000 vessels or 2-4 calls per day.

All ships require the assistance of a pilot, who will need to be brought to and from a ship by the pilot boat. Smaller vessels will be able to berth without tug assistance, while larger vessels will require the assistance of one or two tugs.

berthing/mooring
On entering the protected area behind the breakwater, vessels will be turned and berthed at the quay. Therefore, the quay, fender and bolder configuration must allow safe mooring of the vessels under all circumstances.

bunkering of vessels
Vessels calling at the port will want to bunker fuel, oil, water and take on stores.

In phase IA water will not be provided to the vessels, in phase III facilities must be available to provide the vessels with fresh water. Fuel can be provided either by barges or by means of a pipeline. A fuel blending facility must be available.

anchoring
If a vessel has to wait to enter the port, it will need to drop anchor in a designated area.

vessel guidance from patrol boats
The nautical activities of the vessels offshore will be checked regularly by patrol boats. In this way, spills and illegal discharges from vessels can be detected.

damage survey
No specific equipment is necessary for damage survey. However presence of divers is required. It is assumed that no docking facilities will be provided in the port.

marine equipment
The marine equipment consists of pilot boats, tug boats and work boats.

calamity control
Within the port organization, a system is required for the prevention and control of calamities. Furthermore the Port Regulations must emphasize the execution of contingency plans in the event of calamities, such as:
- naval accidents;
- oil spills and other discharges;
- fire;
- accidents with hazardous cargo.

The MCA approach could be adopted for the Gaza Sea Port. MCA stands for Maximum Credible Accident, which is basically the worst acceptable situation. In addition, the credible accidents (accidents that can reasonably be expected to occur) must be analyzed and their impacts evaluated. But no in-depth study can be included in the framework of the EIS as no information is available on the type of dangerous cargo that may be handled in the port.

4.2.9. Port maintenance
Maintenance (i.e. preventive maintenance and repairs) of the major port infrastructure is not described in the Basic Engineering Study. The infrastructure that requires regular maintenance is described below. The management of Gaza Sea Port will be responsible for the entire coordination of the port maintenance works.

sand by-passing
It has been estimated in the Basic Engineering Study that approximately 350,000 m^3 of sand will be intercepted by the port and has to be by-passed from the south to the north along the port. The sand has to be dumped as close as possible to the beach, preferably on the beach. This sand by-passing will probably be done by dredging and the sand transported hydraulically to north of the port by pipeline. Alternatively, a trailing suction hopper dredger can be used with the capacity for self-unloading and jetting the sand onto the beach. This could be done in yearly or bi-yearly dredging campaigns or as a continuous process with a relatively small dredger.

the breakwater
The armour layer of the breakwater will require inspection and possibly repairs in the form of regular replacement or addition of armour units.

maintenance of the access channel and port basins
The access channel to the port will require regular maintenance dredging. The port basins are better protected and will require less maintenance.

quay structures
The maintenance may involve repairs to the concrete, the cathodic protection system, bolders, fenders, coating on the sheetpiles, etc.

roads
Normal maintenance is required.

pavement
Normal maintenance is required.

buildings
Normal maintenance is required.

cargo handling and marine equipment
Special care must be taken when ordering port equipment. Some modern port equipment is designed with much consideration for the initial cost but with little attention to the maintenance cost. Equipment maintenance could be carried out in the central workshop.

mechanical and electrical installations
Normal maintenance is required.

4.3. Alternative lay-out

4.3.1. Introduction

The environmental impact assessment procedures require that alternatives should be considered. An alternative lay-out was developed on the basis of the detailed design for the port. Various site surveys were carried out before the port designs were prepared. From the assessment of the port design a number of considerations emerged, which are essential to the port development:
- use of coastline and land area from a physical planning point of view;
- sea depth with regard to breakwater construction;
- location of the oil terminal from an environmental point of view.

These aspects have been taken into account in preparing an alternative. The lay-out of the alternative is described in Section 4.3.2. In preparing the alternative, the same data on traffic forecasts and port dimensions for the different port development phases were used as in the proposed port lay-out (Tables 4.1 and 4.2). The phasing of the port development in the alternative lay-out corresponds with that of the proposed lay-out (Figures 4.6. and 4.7.).

4.3.2. Alternative lay-out

The alternative varies from the proposed port lay-out on the following aspects:
- attachment of the coastline;
- sea depth at the tip of the breakwater;
- length and orientation of the causeway;
- location of the oil terminal.

attachment of the coastline
In phase IA the alternative makes somewhat less use of the existing coastline than the proposed lay-out (1.0 km as opposed to 1.2 km). For phase III, there is hardly any difference in the use of the coastline (approximately 1.7 km).

sea depth at the tip of the breakwater
As the construction of the main breakwater takes up a considerable proportion of the total costs, the sea depth at the site of the breakwater is of great importance. For cost reasons the ultimate depth at the tip of the breakwater in phase IA has been fixed at approximately 12 m. The results of the bathymetric survey show in greater depths than expected, in any case than anticipated during the Basic Engineering Study.

The greater sea depth combined with a maximum depth of 12 m which will be permitted for the outer side of the tip of the breakwater results in the alternative to a reduction of the distance to the coast (approximately 970 m in the alternative as opposed to 1120 m in the proposed lay-out).

There is no difference between the two lay-outs with respect to the distance to the coast in phase III.

length and orientation of the causeway
As the distance between the coast and the tip of the breakwater is less in phase IA of the alternative, the length of the causeway has also been reduced (780 m in the proposed lay-out as opposed to 570 m in the alternative). The area needed to meet the berth requirement (Table 4.2) has been found by making the causeway even more perpendicular to the shoreline than in the proposed lay-out. Space has also been saved by locating the fishing port closer to the secondary breakwater/groyne. This allows the length of berths along the quay in the alternative to be increased by about 200 m.

Table 4.6 gives an overview of estimated quantities for construction of port infrastructure in the alternative lay-out.

Table 4.6. Estimated quantities for construction of the port infrastructure, alternative lay-out

elements	unit	phase IA	phase III
breakwater	m	710	1,590
causeway	m	570	570
berths	m	200	2,000
dredging and filling	m^3	550,000	2,000,000
small craft harbour	pc	1	1
roll-on roll-off berth	pc	1	1
groyne	m	-	-
sea wall	m	-	400
inshore earthworks and sand dam	m^3	680,000	2,000,000

location of the oil terminal
In phase III the oil terminal for carriers up to about 20,000 tons will be located in the southern part of the port.

5. CURRENT ENVIRONMENTAL SITUATION, AUTONOMOUS DEVELOPMENTS AND NO ACTION ALTERNATIVE

The current environmental situation of the area which may be influenced by the construction and operation of the Gaza Sea Port is described in this chapter. The size of the area is determined by the various aspects under consideration. For example, the report on climate, geology, geohydrology and coastal morphology refers to a larger area than does the study of the landscape, the safety and noise-related aspects of port development.

The current situation and the likely developments without a port in the Gaza Strip are described under the following headings:
- current use of the area (Gaza Strip as a whole and the area of the proposed sea port);
- natural environment (environmental aspects);
- socio-economic environment;
- autonomous developments and no action alternative.

5.1. Current use of the area

Gaza Strip

The Gaza Strip is 365 km^2 in area and varies in width between 6 and 13 km. The Mediterranean shoreline is 40 km long. The area is a transitional zone between the semi-humid coastal zone of Israel in the north and the semi-arid loess plains of the Northern Negev in the east and the arid Sinai desert of Egypt in the south.

With an estimated population of 842,500 inhabitants the area is densely populated (mean population density of 2,300 per km^2). Two-thirds of the population live in refugee camps. The population density in the refugee camps, which cover no more than 5 km^2, is 64,000 persons per km^2 and is one of the highest in the world.

The Gaza Strip has one major town, Gaza City with a population of about 270,000. There are three smaller towns (Deir el Balah, Khan Younis and Rafah) and a number of villages. There are 16 Jewish settlements with an estimated total population of 3,000 to 5,000 settlers.

Outside the urban centres, the area is predominantly used for intensive cultivation of citrus, vegetables and other agricultural products. In some areas, light industrial zones have been developed.

the proposed sea port area

The location selected for the port is between Wadi Gaza and the border of the municipality of Gaza. Wadi Gaza is the main valley in the Gaza Strip and has a large catchment area in the Negev desert. The wadi's outlet to the sea is an important coastal feature. The wadi and its environment have a major nature potential. The area between Wadi Gaza and the border of the municipality of Gaza is sparsely populated with only a few scattered houses in the area. The Israeli settlement of Netzarim with about 30 inhabitants is dominated by agriculture (Figure 5.1.).
The area of the proposed sea port is owned by the government, farmers and other private owners. The beach strip, which is 35 to 100 m wide, is owned by the government. Behind this zone is an agricultural area, ranging in width from 750 to 1,050 m in the south between Gaza town and Wadi Gaza, to 450 to 700 m in the north between Gaza town and Wadi Gaza (Figure 5.2.). Much of the agricultural land is privately owned.

The location of the sea port and the industrial area (see Figures 4.2., 4.3., 4.6. and 4.7. for the proposed lay-out and alternatives) is 13.46 km^2 in area.

The present land use on the site of the sea port and the industrial area are shown in Table 5.1.

Table 5.1. Present land use on the site of sea port and the industrial area

land use	area (km^2)
agriculture:	
- citrus	1.78
- vegetables	2.02
- grapes	2.55
open area	5.14
housing	1.97
total	13.46

There are about 200 housing units in the area. With an average occupancy of five individuals per housing unit, there are about 1,000 inhabitants in the area. Close to the north-west of the area is Sheikh 'Aljin with some housing units.

5.2. Natural environment

5.2.1. Climate

temperature

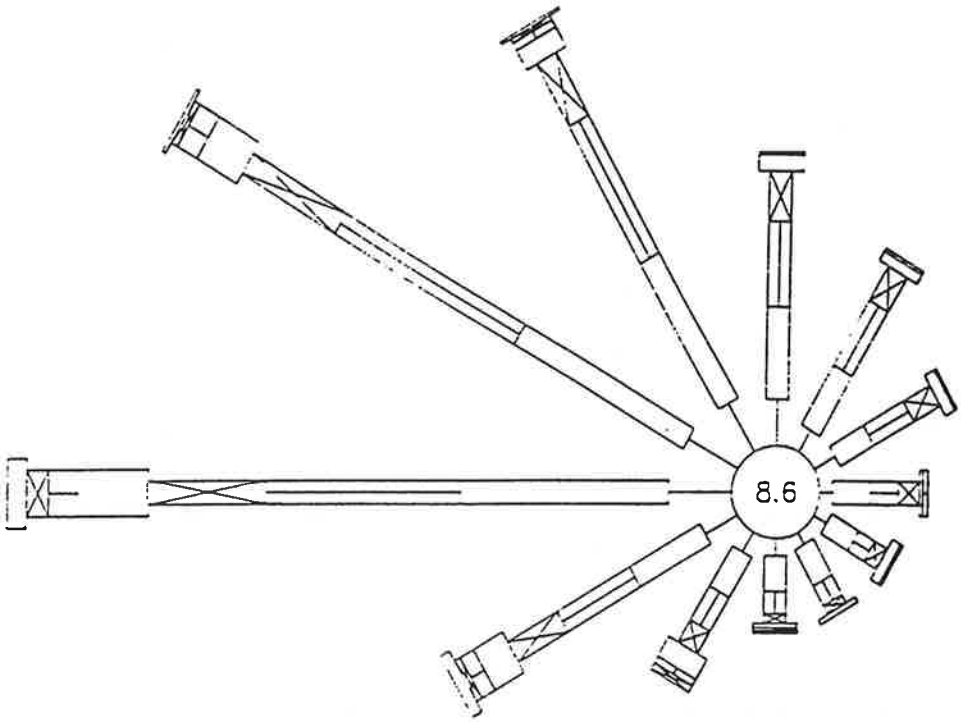
The climate of Gaza is subtropical (Mediterranean type) with hot, dry summers and short, mild winters. The maximum temperature between June and September is 30°C, while the average winter temperature is about 15°C.

winds

There is a difference in wind direction between summer and winter. In summer, there is an almost permanent low pressure region over north-east of Cyprus with increasing pressure towards the west. These atmospheric pressure conditions result in predominantly westerly winds over the eastern part of the Mediterranean. The wind speeds are usually less than 15 m/sec (at a height of 10 m). The winter is dominated by cyclones that pass in an easterly direction and result in rather unstable conditions with winds from directions between south-east and north-east (through north-west).

A windrose for Ashdod is presented in Figure 5.1. This is outside Gaza (6 km north of Gaza City) but as Ashdod is geographically similar to the port location (both near the sea), this windrose is assumed to be valid for the Gaza Sea Port area. The windrose shows the prevailing wind directions are north-west to south-west, with westerly winds predominating. A wind table for Gaza is given in Annex I.

Figure 5.1. Windrose at Ashdod



Source: Netherlands Ministry of Economic Affairs and Palestinian National Authority, 1994.

rainfall

In the period 1967-1992, mean annual rainfall was 405 mm at Gaza meteorological station. There are distinctly dry and wet years. Mean annual rainfall in the Gaza Strip varies from 200 to 900 mm. Since 1987, the measured rainfall at Gaza City has been above the 30-year average. In the past, there have also been frequent droughts. Rainfall decreases from 450 mm in the north to 200 mm south of the Gaza Strip. Most rain falls in the period mid-October to end-March. The period May to September is dry with almost no rainfall at all.

evaporation

Mean daily potential evaporation varies from 2.1 mm in December to 6.3 mm in July. The annual variation in evaporation is caused by radiation. The actual evaporation depends largely on the soil type, the vegetation and the availability of soil moisture. In the period December to February there is a rainfall surplus, while for the rest of the year, evaporation greatly exceeds rainfall.

Table 5.2. Climatological data for the Gaza Strip

mean annual rainfall	200-450 mm
variation in annual rainfall	95-100%
mean annual evaporation from open water surface	1200-1400 mm
mean daily relative humidity	70-75%
mean annual cloudiness	30-35%
mean annual temperature	19-21 °C
mean temperature of coldest month (January)	12-14 °C
mean temperature of hottest month (August)	26-28 °C

Source: Palestinian Environmental Protection Authority, 1994

5.2.2. Geology, geomorphology and soils

geology

The Gaza Strip is essentially a foreshore plain gradually sloping westwards, underlain by a series of geological formations from the Mesozoic to the Quaternary periods. An overview of the geological history is presented in Table 5.3.

tertiary formations

Throughout the Gaza Strip, the Quaternary deposits are underlain by the Saqiya formation deposited during Pliocene-Miocene. This formation consists of shallow marine clays, shales and marls, extending to a depth of about 1,200 m at the shoreline and fanning out on the eastern boundary of the Strip. Below the Saqiya formation other Tertiary deposits, such as chalks, limestones, sandstones and marls are found up to a depth of 2,000 m.

quaternary formations

The Quaternary deposits in the Gaza area are about 160 m thick and cover the Pliocene Saqiya.

Table 5.3. Geology and geological history of the Gaza Strip

era	epoch	age (million years BP)	formation	environment of deposition	lithology	max. thickness (m)	water bearing character
	HOLOCENE	0.01	Alluvial	Terrestrial Eolian/ Estuarine Fluvial	Sand, loess, calcareous silt and gravel	10-25	Locally phreatic aquifer
QUATER-NARY	PLEISTOCENE		Continental Kurkar	Eolian Fluvi-al	Calcareous sandstone and loamy sand	100	Main aqui-fer
		1.8	Marine Kurkar	Near shore	Calcareous sandstone, Limestone (sandy and porous)	10-100	Main aqui-fer
			Conglome-rate	Near shore		20	Base of the coastal zone aquifer
	PLIOCENE		Saqiya	Shallow marine	Clay, marl, shale	1000	Aquiclude
TERTIARY		12					
	MIOCENE	25		Marine	Marl, limestone, sandstone and chalk	500	Aquiclude alterna-ting permeable layers with saline water

BP = before present.
Source: Palestinian Environmental Protection Authority, 1994.

The overlying Pleistocene (from older to newer) deposits consist of:

- Marine Kurkar formation.
  This formation is composed of shell fragments and quartz sands which are cemented together by calcareous material, and sometimes by coarse calcareous sandstone that is hard to differentiate from the overlying Continental Kurkar. The thickness of this shell layer varies between 10 and 100 m in the Gaza area showing a tendency to be thicker towards the coast. Because of its high porosity and permeability, the marine Kurkar forms an aquifer from which most of the groundwater in the Gaza Strip is extracted. This layer is known locally as Fagra.
- Continental Kurkar formation.
  This calcareous sandstone can be divided into three distinct units with alternating red loamy sand beds (Hamra).
  The maximum reported thickness is about 100 m. Depending on the amount of cementation, this Kurkar layer varies from being friable to very hard.

Holocene and wind-blown deposits are found on top of the Pleistocene formation which can reach a thickness of 10 to 25 m in some places. Four different types can be distinguished:
- Sand dunes along the shoreline especially near Rafah of varying thickness up to 15 m. Further to the north, dunes become sporadic and the sand accumulations are scattered in a zone 2 to 3 km along the coast.
- Wadi fillings consisting of sand, loess and gravel beds. This formation can reach a thickness of up to 20 to 30 m.
- Alluvial and eolian deposits of varying thickness. Alluvial deposits are widely distributed in the area, extending from the Wadi Gaza northwards. Eolian deposits are dominant in the southern region of the Gaza Strip, are more loess-like and are frequently mixed with wind-blown sands.
- Beach formation (Zufzuf) consisting of a fairly thin layer of sand intermingled with shell fragments. At some places, this formation is heavily cemented as a result of the simultaneous deposition of calcium carbonate.

local geology
The information above is a general description of the geology of the Gaza Strip. There is little information available about the lithology of the coastal area between Wadi Gaza and Gaza City. Only one lithological log, southwest of Netzarim 3 km from the coast, is available from the Groundwater Information System of WRAP (Annex I).

In general this log reflects the geological conditions in the coastal areas of the Gaza Strip. The log shows succession of sand, clay, sandstone and in the lower part, at a depth of over 57 m, again sandstone. Unpublished information of the WRAP indicates that the thickness and distribution of the clay layers is irregular but little information is available on these layers. Detailed mapping of the occurrence of the intercalating clay layers has still to be executed.

geomorphology
The Gaza Strip forms part of the coastal foreshore plain bordering the Hebron Mountains. The coastal plain is dissected by three rivers: Wadi Gaza (Nahal Besor) in the central part, with a large catchment area stretching far beyond Beersheva; Wadi Halib draining the depression of Beit Hanoun, a tributary of Nahal Shiqma flowing near Erez in the north; and Wadi Silka a fossil river, now a dry wash only flowing after torrential rains and no longer reaching the sea.

The topography of the coastal plain is determined by the exposure of Kurkar ridges. The age of these ridges increases from the coastline eastwards. In the north of the Gaza Strip, there are four ridges: the coastal ridge (20 m MSL), the Gaza ridge (up to 50 m MSL), the el Muntar ridge (80 m MSL) and the Beit Hanoun ridge (90 m MSL). These ridges are separated by deep depressions (20-40 m MSL) filled with alluvial deposits. There is evidence that there are at least three to four younger Kurkar ridges on the continental shelf, parallel to the present coastline and several kilometres offshore.

There are active dunes near the coast, especially in the southern part between Deir el Balah and Rafah. Further inland (west of Khan Younis) older dunes are stabilized by vegetation, penetrating an area 4-5 km inland. There is a gradual transition from a sandy dune landscape towards the rolling loess plains of the northwestern Negev. Areas with a large accumulation of loess can be found 15 km south-west of the Gaza around Netivot, where these layers reach a thickness of 8 m, and east of Khan Younis.

The valleys between the sandstone ridges, such as Valley Beit Hanoun, have been filled up with alluvial sediments from the neighbouring hills. Similar sediments have also been deposited along the floodplains of the larger wadis, in layers up to 10 m thick in some places.

soils

sandy soils
Sandy soils of dune accumulations are regosols without a marked profile. Textures in the top few metres are usually uniform and consist of medium to coarse quartz sand with a very low water-holding capacity.

Other sandy soils may be derived from material from Kurkar ridges which can be seen from the presence of numerous carbonate nodules (0.5 - 1.0 cm) in the subsoil.

Loessial sandy soils can be found some 5 km inland in the central and southern part of the Strip, in a zone along Khan Younis towards Rafah, parallel to the coast. This belt forms a transitional zone between the sandy soils and the loess soils.

loess soils
Typical loess soils are found in the area between the city of Gaza and the Wadi Gaza. Most soils in the Gaza area are more or less influenced by deposition of eolian dust, since the Gaza Strip is on the flank of the main deposition zone in the northwestern Negev desert.

A sandy loess soil, which is a transitional soil characterized by a lighter texture, can be found in the depression between the Kurkar ridges of Deir el Balah. Another transitional form is the sandy soil over loess. These are loess or loessial soils (sandy clay loam), which have been covered by a layer (0.20 - 0.50 m) of dune sand. These soils can be found east of Rafah and Khan Younis.

alluvial soils
Alluvial and grumosolic soils, dominated by loamy clay textures are found on the slopes of the northern depressions between Erez and Wadi Gaza. Usually they are dark brown to reddish brown in colour, with a well-developed structure. Borings east of el Muntar ridge have revealed the occurrence of alluvial deposits of about 25 m thick.

5.2.3. Hydrogeology, water resources and water management

surface water
There is no permanent surface water in the Gaza Strip. Temporary flow of surface run-off of rainfall during the winter is the only source of ephemeral surface water. Possible sources of run-off water are:
- Wadi run-off from a number of small wadis and valleys within the area which may concentrate run-off water. The most important is the Wadi Gaza which drains 3,500 km^2 of the Northern Negev. This wadi only carries water for about ten days a year.
- Surface run-off on the loessial and alluvial soils where a surface crust has developed, and occurs only during intensive rainfall.

groundwater
The coastal plain aquifer stretches the entire 40 km length of the Gaza Strip from north to south over its total width, but varies significantly in depth and occurrence. It has a wedge-like cross-section with a maximum thickness of 180 m near the sea tapering eastwards. In the south, the saturated part of the aquifer appears to be negligible near the eastern border of the Gaza Strip, which is about 12 km from the seashore.

The aquifer is composed of clastic sediments of Pleistocene age, overlying impervious clays of Pliocene age. The Pleistocene sequence consists of interfingered continental and marine units composed of sandstone, calcareous sandstone, siltstone and red loamy soils. In the eastern half the aquifer is uniform and phreatic. Towards the west it is partially divided by intervening clay layers into subaquifers, of which the lower ones are confined. The separating clay layers are impervious to semi-pervious. The uppermost aquifer (referred to as A-aquifer) is mainly under the seabed and extends up to 2 km inland.

The further the lower subaquifer extends inland from the coast, the lowest (referred to as C-aquifer) extending up to 5 km inland.
The thickness of the unsaturated zone ranges from a few metres up to 90 m. The average transit time to the groundwater table is about 25 years and ranges from 1 to 50 years in most of the area. The aquifer is replenished by rain, 200 to 400 mm per year on average. Under natural conditions groundwater drains to the sea. The amount of water stored in the aquifer is estimated to be 5 billion m^3 (supposed: A = 365 km^2, Dsat = 40 m and Porosity = 0.30). In a year with average rainfall, it may be expected that one hundredth of the total volume of the aquifer will be replenished.

The water-bearing layers of the coastal zone aquifer consist mainly of sandstone, sand and gravel. The aquifer has a high transmissivity (T), which decreases to the east. T-values of 1,000-3,000 m^2/day are reported from the area of Gaza City with the thickness of the aquifer given as approximately 20 to 50 m. In the southern part of the Gaza Strip, values are generally smaller: 200-700 m^2/day. The existing groundwater contour maps indicate that the levels slope downwards and westwards. Thus the dominant direction of groundwater flow is from east to west.

Many studies have presented estimates of the annual groundwater recharge of the Gaza Strip. The total volume of groundwater recharge may vary greatly depending on the yearly rainfall because of the high infiltration capacity of the soil and the negligible natural drainage system. Groundwater level observations for some wells over the past 10 years show a yearly fluctuation of 0.2 - 1.0 m depending on the yearly rainfall.

Even during the very dry years from 1984 to 1986, there appears to have been significant groundwater recharge. The porosity of the sandy aquifers is supposed to be between 0.25 and 0.35. Based on these figures, the total groundwater recharge may vary between 20 and 125 million m^3 per year. At present, approximately 110 million m^3 of groundwater is pumped per year from about 2,000 wells.

groundwater quality
The quality of the groundwater in the Gaza Strip is generally poor. Because of the high salinity and nitrate content, the water is generally unsuitable for drinking. Water quality of the coastal aquifer underlying Gaza has drastically decreased for a number of reasons. The most important reason appears to be pollution by agricultural fertilizers, pesticides and 'soil-cleaners' such as methylbromide, which may also be the reason for the high nitrate content.

Another serious threat to groundwater quality is the uncontrolled discharge of sewage water at the soil surface. None of the existing water treatment plants are functioning properly. Sewage water is partly collected and discharged to the natural drainage system or at the seashore. The high nitrate content of the groundwater appears to be primarily caused by sewage and leachate of solid waste.

Yet another factor affecting the groundwater quality is salinity which has increased over the last 10 to 15 years. This may be the result of groundwater flow from the east, salinization at the surface, seawater intrusion from the west and possible interchange with high saline pockets in the underlying Saqiya formation.

In Annex I information is given about groundwater levels, chloride contents and electrical conductivity.

water use
Water is used in the Gaza Strip for domestic water supply and for irrigation; the latter consuming more than 72%. With the exception of the 5 million m^3 supplied by Mekoroth (Israeli National Water Supply Company) the rest is pumped from groundwater reserves by about 2,000 registered wells.

Domestic water supply (including network leakage and unaccounted for water) in the Gaza Strip is estimated at about 90 litres per capita per day (lcd). With a total population of about 850,000 inhabitants, the demand for domestic water in the Gaza Strip in 1993 was estimated at 28 million m^3/year.

In 1992, the total area cultivated with irrigated crops in the Gaza Strip was estimated at 115,000 dunums. The total water consumption for irrigation is estimated to be 80 million m^3/year. Thus, the present total water consumption is estimated at 110 million m^3 per year including the drinking water supply of the settlers and the relatively small quantity of water used by the industrial sector.

water balance
Water supply and demand are compared in order to illustrate the critical situation of the water resources in the Gaza Strip. Table 5.4 shows that the water demand greatly exceeds the available resources, which is heavily depleting groundwater reserves.

Table 5.4. Present water balance of the Gaza Strip (million m^3/year)

supply		
- effective recharge		40
- groundwater inflow from Israel		10
- irrigation return flow		20
- groundwater depletion		40
	total	110
demand		
- irrigation water use		80
- domestic water use		30
	total	110

The groundwater inflow from Israel and the natural recharge of the aquifer will diminish over the years because of groundwater extraction in the adjacent Israeli area and the construction of low dams upstream in Wadi Gaza. About 40 million m^3/year of the extracted groundwater is not replenished by natural recharge. This results in a drop in the groundwater table in the phreatic aquifer and an increase in the salinity content.

Overexploitation has led to a drop in the groundwater table throughout the Gaza Strip. North of Gaza and at Deir el Balah the groundwater table has dropped to 1-2 m below MSL some 2 km from the coast. The groundwater table has also dropped several metres in the eastern part of the Gaza Strip but is still 4 to 6 m above MSL. These low groundwater table levels result in seawater intrusion into subaquifers.

sanitation
Only three communities in the Gaza Strip have significant reticulation systems, operating conventional water-borne sewage networks. These are Gaza city (with the exception of the new area in the south-west), Jabalia - Nazla village and Jabalia refugee camp. In all cases, wastewater is conveyed to treatment plants. There are piped systems in isolated areas, such as Rafah town and camp but serve only limited areas. Wastewater is conveyed to a small treatment plant. In addition, many of the camps have open channels for conveyance of storm water to a suitable discharge point, either a wadi, an unused open field or a coastal area.

In those areas with piped systems, sewage is conveyed away from the dwellings, and there is no environmental health impact. There are three sewage treatment plants designed as stabilization ponds with mechanical aerators in the facultative mode. Unfortunately, none of these plants is functioning; they merely act as setting ponds and the sewage passes through without treatment except for the removal of solids.

Photo 5.1. Waste water treatment plant

Photo 5.2. Waste water treatment plant

Photo 5.3. Agriculture

Photo 5.4. Fishery

Photo 5.5. Small industry

Photo 5.6. Recreation

The untreated effluent from Gaza city passes directly into Wadi Gaza, where it eventually forms a lake of raw sewage discharging into the surf zone of the Mediterranean.

local hydrogeology

There is no detailed information available on the extent, thickness and depth of aquifers and aquicludes in the coastal area between Wadi Gaza and Gaza City. Information from pumping tests executed in the coastal zone directly to the south-west of Gaza City and south-west of Wadi Gaza indicate that the transmissivity of the main aquifer varies from 5,000 m^2/d near Gaza City to 1,700 m^2/d near Wadi Gaza. Missing data should be collected in the immediate future when the port will be constructed and used.

From the Groundwater Information System of WRAP 7 time series of groundwater levels and 6 time series of chloride contents and electrical conductivity for wells in the area are available (Annex I). Four of these wells are near the coast and the other three are located 5 to 6 km from the shore (see Figure 5.4.). The wells are distributed more or less evenly over the area between Gaza City and Wadi Gaza.

All time series show a clear relationship between rainfall and groundwater levels. Groundwater levels near the coast vary from 2 m above MSL in the extreme wet year of 1991 to 0.8 m below MSL in dry years, indicating that there is saltwater intrusion at least in dry years. Although no general trend of declining groundwater levels can be discerned from the short time series, information from the Gaza Environmental Profile indicates that groundwater levels have dropped about 2 to 4 m at some distance (1 to 3 km) from the shore. This is probably causing intrusion of saltwater especially near Wadi Gaza where groundwater levels well below sea level are observed during extensive periods.

The occurrence of saltwater intrusion is confirmed by the time series of chloride content and electrical conductivity in the same wells. All wells near the coast show a clear trend of rising chloride contents and electrical conductivity. In 1977 chloride contents in the groundwater near the shore varied from 400 to 700 mg Cl^-/l while in 1993 the chloride contents are between 500 and 900 mg Cl^-/l. In the same period, the electrical conductivity of the groundwater in these wells rose on average from 2,000 µS/cm to 3,000 µS/cm.

water resources management

During the Israeli occupation of the Palestinian territories the water resources were managed by the Israelian military authorities. The water management responded primarily to the needs and interests of the Jewish settlers and sustainability was not a priority. Following the signing of the Cairo Agreement by the Palestinian Liberation Organisation (PLO) and Israel, civil responsibilities including water resources in the self-rule areas of the Gaza Strip and Jericho were transferred to the Palestinian National Authority.

During the occupation Palestinian institutions were only responsible for delivery of water and wastewater services. Weak institutional structures and deteriorating infrastructure resulted in poor services and the absence of effective management of water resources. The problems were recognised, assessed and alternative structures for institutional development considered at a workshop held in April 1994. At this workshop a set of principles were adopted for establishing an institutional framework for water management, including the setting up of a Palestine Water Authority (PWA). The PWA will be responsible for the management and efficient allocation of all water resources.

In 1995, many development activities were conducted in the water sector involving different Palestinian and donor organizations. The Water Resources Action Programme (WRAP) is still active and a director for the Water Resources Department within PECDAR has been appointed. However, the PWA has still not been established and activities are somewhat scattered and need to be structured. Although the need for effective regional water management including the water resources shared with Israel is generally recognized, implementation still needs considerable organizational and political effort.

5.2.4. Oceanography

morphology

The coastal shelf near Gaza is part of the Nile littoral system extending from the Nile Delta to the Bay of Haifa (Israel). The coastal shelf up to a depth of 100 m extends some 14 km from the shoreline in the northern part to over 20 km in the southern part. Beyond the 100 m water depth, the coastal shelf ends with a steep descent to 1,000 - 1,500 m.

Kurkar ridges of calcareous sandstone appear along the coast in a south-west-northerly or south-northerly direction. The effect of these ridges on sedimentation and erosion is limited to local disruption of waves and currents. The extruding ridges in the sea form the only hard stable substrate in the shore zone, suitable for colonization of algae, weeds and macro-fauna.

erosion and sedimentation

Tidal motion, large-scale circulations and wind and wave action play a dominant role in coastal morpho-dynamics. The most important factor in shaping the Eastern Mediterranean coast, including the Gaza coast, is the slight imbalance between wave and current induced erosion and sedimentation.

Vast amounts of sediment are transported from the Nile delta in eastern direction towards the Sinai and, from there, in northern direction along the Israeli coast. For the Gaza coast, this longshore transport is estimated at 350,000 m^3 per year. A small part of this sediment is deposited in the nearshore zone. At the same time, there is an offshore directed transport of sediment, which is driven primarily by waves. The nett effect of these two transport mechanisms is a loss of sediment from the beach and nearshore. The persistent retreat of the coastal cliffs at Gaza is an expression of this imbalance.

Construction of breakwaters, piers and harbours disturb the longshore transport of sediment. This affect the erosion-sedimentation ratio in the vicinity of such structures. Locally gathered experience shows that this may very well result in severe beach erosion.

water chemistry

The water of the eastern part of the Mediterranean (Levantine basin) is extremely oligotrophic, which is reflected by low levels of primary and secondary production. The main source of nutrient inflow is the Nile River, which is relatively poor compared to rivers such as the Rhône. The completion of the Aswan Dam in 1967, withholding approximately 160 million tons of sediments per year, has led to a further reduction in productivity of the eastern Mediterranean.

The average water temperature in the summer is 29°C which is high and almost tropical. The salinity as high as 39.5 g/l is extreme as well.

Apart from the construction of the Aswan Dam, the impact of man on the water chemistry has been almost negligible until recently. The greatly increased population density in the Gaza Strip since the 1950s has dramatically increased pollution of the inshore zone. In total 31 point sources of pollution by untreated sewage and sullage have been identified on the beaches of the Gaza Strip. Wadi Gaza, which is the main outlet of the vast hinterland, is also heavily polluted over the last stretch to the strip and at its outlet. With major floods, the untreated sewage is a major contamination threat to seawater and pollution of fish and other marine organisms.

5.2.5. Conditions of the sea bottom

Information on conditions on the sea bottom was not available during the preparation of the EIS.

5.2.6. Coastal morphology

The coast of the Gaza Strip is part of a morphological system which ranges from approximately the Nile delta up to the north of Israel.

This is more or less a closed system in the sense that the sediment gain across its borders contributes little to the overall morphodynamics. In addition, there are permanent sediment losses across the borders. To gain insight into the morphology of this system, the sediment transport mechanisms need to be identified and also the main sediment sources and sinks.

In general, sediment transport in the coastal zone is determined by the capacity of the transport medium (water and air) and the availability of sediment. If there is less sediment than the capacity of the transport medium, then sediment will be withdrawn from any available source. Inversely, if there is more sediment to be carried than the transport capacity of the medium, then material will be deposited.

Changes in the motion (flow) of the transport medium will affect the transport capacity and hence, the pattern of erosion and deposition. Such changes may be caused by this erosion and deposition and also by other phenomena, such as sea level rise or human activities in the coastal zone.

In the considered morphological system, sediment transport is concentrated on the Eastern Mediterranean shelf. This area extends from the shore to approximately the 100 m depth contour. Beyond this contour, the water depth increases rapidly with increasing distance from the shore. Any sediment that crosses the shelf edge in an offshore direction is lost from the system.

Most of the sediment transport on the shelf takes place in the shallow nearshore zone. Seen from the shoreline, obliquely incident waves induce a flow which is concentrated in the surf-zone. The flow direction is identical to that of the deep water wave propagation. This longshore flow transports sediment which is stirred from the bottom. This stirring mechanism is directly related to the highly turbulent nature of the surf-zone, which is caused mainly by wave breaking. After it has been stirred, the sediment has the inclination to settle again. These stirring and settling processes tend towards an equilibrium in which they cancel out each other. In that case, the sediment load is constant. Its magnitude depends on the local wave conditions and it determines the amount of sediment transported by the wave-driven longshore flow.

In the southern part of the east Mediterranean coast, there are few waves from the south-west. Measured in this direction, the distance to the coast of Egypt is fairly small so that south-westerly winds cannot generate substantial waves. Moreover, the wind blows mainly from westerly to north-westerly directions in that area. The average direction of wave propagation is in the same sector. This, in combination with the orientation of the coastline (along the line SW-NE), results in a northward net sediment transport.

Further north, the distance to the coast of Egypt gradually increases. In addition, the contribution of south-westerly winds to the wind climate increases. This results in a slight shift in the average direction of wave propagation from W-NW towards SW-NW. The orientation of the coastline also rotates counter-clockwise. It shifts from SW-NE in the south to almost S-N in the north of Israel. The change in the orientation of the coastline is greater than that in the average direction of wave propagation. The combined effect is that waves approach the coast more obliquely in the south than in the north. The wave-induced longshore sediment transport, therefore, decreases in a northern direction. The net effect is that the coast will accrete, which usually happens if the coastline is concave in shape.

Seaward of the shallow nearshore zone but still on the shelf, waves contribute little to sediment transport. In that area a large-scale counter-clockwise circulation around Cyprus drives a northward sediment transport.

From a morphological point of view, the surf-zone and its direct environment is the most active part of the cross-shore profile. Apart from the aforementioned longshore sediment transport processes, there is an almost continuous on- and offshore transport of sediment.

Major part of this cross-shore transport is driven by waves, wind-induced vertical circulations and by wind directly (so-named aeolian transport).

Wave-induced cross-shore transport shapes the cross-shore profile. This profile tends towards an equilibrium which depends on the local wave conditions. It concerns a dynamic equilibrium as the wave conditions vary with time. Roughly, the actual shape of the profile is usually somewhere in between the equilibrium for storm conditions and that for moderate conditions. During storm conditions, sediment is being transported in offshore direction. Under normal, moderate conditions, on the other hand, there is usually an onshore directed transport. The net effect of these two counteracting phenomena depends on the intensity and the frequency of storms and on the restorative power of the conditions encountered between storms. The presence of the Kurkar layers may have an unfavourable influence on this net effect. On the one hand, these layers reduce the offshore transport of sediment as they are less erodible then the sandy material which forms major part of the coastal profile. On the other hand, they hamper restoration of the profile during moderate conditions.

The net wave-driven cross-shore transport inside and in the vicinity of the surf-zone, including the effect of the Kurkar layers, is hard to quantify accurately. That would require state-of-the-art physical-mathematical modelling, though it must be noted that presently available model formulations are known to yield significantly different results. Alternatively, a qualitative impression can be obtained from an assessment of the shape of the coastal profile.

At the Gaza Strip, the slope of the upper part of the average coastal profile is rather steep (about 1:50). Around the 5 m depth contour, the profile shows a relatively mild slope (approximately 1:100) over a distance of some 100 m, measured in cross-shore direction. Seaward of that, the slope is approximately 1:75, gradually reducing to 1:100 near the 10 m depth contour. In view of the local wave conditions and the sediment characteristics of the foreshore (roughly 200-400μ), one would expect less steep a slope. This suggests that the actual profile is not in equilibrium.

The comparatively steep slope of the upper part of the cross-shore profile leads to an offshore transport of sediment. With this transport, the profile evolves towards an equilibrium which is characterised by a slope milder than the present one. Simultaneously, the shoreline shifts landward.

This evolution towards an equilibrium profile is unfavourably disturbed by a rising sea level. The reason for this is that the shape of the equilibrium profile is not determined by the slope alone, but by a relation between slope and water depth. A rising sea level affects this relation in the sense that it draws the profile away from its equilibrium. Hence, it extends the mentioned offshore transport.

Another contribution to offshore transport is related to wind-induced vertical circulations. An onshore component of the wind drives a shoreward flow at and just below the water surface. As the beach forms a closed boundary, this surface flow will be compensated by a seaward flow near the bottom which, in turn, will result in an offshore sediment transport. Similarly, an offshore wind will result in an onshore transport. As onshore wind predominates at Gaza, the net effect is offshore transport.

As well as this indirect wind-driven transport, there is also a direct transport. The predominant onshore wind moves sediment from the beach and the cliffs inland. On the other hand, aeolian transport may also add sediment to the morphological system. In this respect, it is noted that sediment originating from the African continent is found frequently on the Israeli coast. Information on quantities of sediment involved in this type of transport, is not available.

Cross-shore transport of sediment is not limited to the relatively morphologically active upper part of the coastal profile. It occurs at deeper water as well. However, the transport rates in that region are relatively small and the time-scale of morphological changes is far greater than that in the active zone. This implies that sediment which is transported out of the active zone in seaward direction, is lost for short-term coastal evolution. Such losses occur, for instance, as storms and moderate conditions alternate. During storms, the morphologically active zone extends further seaward than during moderate conditions. Hence, the offshore transport which occurs during a storm, results in a loss of sediment across the seaward boundary of the active zone for moderate conditions. That sediment is then out of reach for the aforementioned restorative powers, associated with those moderate conditions.

The absence of a significant tide at Gaza affects this mechanism in the sense that it retains the restorative powers within a limited part of the coastal profile. The area in which these powers act is characterized by a range of water depths depending on the local wave conditions. It shifts in cross-shore direction with the tidal motion. In other words, the size (measured in cross-shore direction) of the area affected by the restorative powers, is proportional to the tidal range.

Summarizing, the morphological evolution of the sandy coast at Gaza is determined by the combined effect of longshore and cross-shore transport. The net longshore transport is directed northward and the transport rate decreases in northern direction. This by itself leads to accretion and, hence, to a seaward migration of the shoreline. However, the actual retreat of the shoreline of some 0.04 m/year, indicates that this accretion is exceeded by an offshore transport (and/or a net withdrawal of sediment from the coastal system by aeolian processes). The most probable causes for this erosive process are an adjustment of the comparatively steep slope in the upper part of the cross-shore profile towards an equilibrium shape, on the one hand, and a response to sea level rise, on the other hand. It is estimated that the latter yields a retreat of the coastline of the order of a few centimetres per year (see part 11 of the Basic Engineering Study).

5.2.7. Ecology, flora and fauna

There are many species in the marine and terrestrial environment of the Gaza Strip. An overview of the available information on these species is given in the Gaza Environmental Profile (GEP, 1994, 1995). Even if enough data on each species were available, it would not be possible to deal with them all in this EIS. Therefore, the current situation is described in a framework in which the ecosystem is summarized and analyzed according to the main ecological groups (organisms), independent variables (main steering factors) and ecosystem components (main habitats). The main aspects of the marine environment and the terrestrial environment are described below.

As very little specific information is available, the description of the marine and terrestrial fauna and the impact assessment focus on the identified ecosystem components, the independent variables and flora and vegetation. An exception is made for migrating birds. More information is available on this group and therefore it is treated separately.

marine environment

As described in Section 5.2.4., the south-eastern corner of the Mediterranean, known as the Levantine Basin, is characterized hydrographically by its extreme oligotrophy, high salinity and temperature. In addition, the dominant character of the coastal zone is the high sand transport in the inshore zone in a direction from south to north.

biogeographics

The high salinity and high temperature in the eastern Mediterranean limits the distribution of species originating from the Boreal and Atlantic regions, although present in the western Mediterranean. For instance, dolphins are far less common in the eastern than in the western Mediterranean.

The Suez Canal, inaugurated in 1869, launched a remarkable immigration of species from the Red Sea to the Levantine Basin. Over 300 marine fauna species of Indo-Pacific origin are reported to have become established in the Levantine Basin. The centre of the present distribution and massive appearance are the Gaza coastal waters. There is a spectacularly high abundance of immigrated species, for instance, the jellyfish *Rhopilema nomadica*, the prawns *Penaeus japonicus* and *P. monocerus* and the swimming crab *Charybdis longicollis*. In total, 26 of the 245 identified bottom-dwelling macrobenthic species in the coastal waters up to a depth of 80 m are of Indo-Pacific origin. From a total of 284 fish species identified in the eastern Mediterranean, 10% of known Red Sea origin and 7% (20 species) are endemic to the Mediterranean.

The extent to which the influx of Red Sea species has influenced the ecology of the Levantine Basin is not known.

ecosystem

The main relevant ecological groups, independent variables and ecosystem components in the marine environment are listed in Table 5.5. The most important variables and ecosystem components to be considered in the EIS are indicated with bold.

Table 5.5. Main independent variables and ecosystem components of ecological groups in the marine environment

ecological groups	Independent variables	ecosystem components
1. phytoplankton	**1. Water quality/contaminants**	**I. Pelagic system**
2. sedentary algae + weeds	**2. Nutrient influx**	**II. Benthic zone depth > 80 m; substrate muddy clay**
3. benthic macro-fauna	**3. Organic matter/silt influx**	**III. Benthic zone depth 50-80 m; substrate silty deposits**
4. juvenile fishes	4. Fresh water influx	**IV. Benthic zone depth 35-50 m; substrate sandy mud**
5. planktivorous fishes	5. Tidal movements	**V. Benthic zone depth 0-20 m; substrate sand**
6. herbivorous fishes	**6. Longshore currents**	**VI. Kurkar ridges with algae and seaweeds**
7. benthivorous fishes	**7. Erosion and sedimentation dynamics**	**VII. Saltmarshes**
8. piscivorous fishes	**8. Area and composition of ecosystem components**	**VIII. Estuarine/riverine habitat**
9. benthivorous birds	**9. Exploitation pattern**	**IX. Tidal flats**
10. piscivorous birds		

The functioning of the pelagic system is determined by the oligotrophic conditions, leading to a low primary and secondary production. The seasonal migration in May and October of sardine through the Gaza waters temporarily boosts the Gaza fish production. The low productivity of the pelagic zone may be considered to be reflected by the virtual absence of piscivorous birds in the Gaza area. Only restricted numbers of Cormorants *Phalcrocorax carbo* and Kuhl's Shearwater *Calonectris diomedea* are found foraging on pelagic fishes in the coastal zone of the Gaza Strip.

The functioning of the benthic system is mainly determined by the depth profile of the bottom, the distribution of the various substrates and by the longshore current and sand transport. The tidal dynamics are very small and are to be considered a minor steering factor. With regard to water quality/contaminants, nutrient influx, organic matter and silt influx, the conditions along the Gaza coast can be considered more or less homogeneous, except at the mouth of Wadi Gaza. Here temporarily, when the Wadi Gaza floods, inputs of nutrients, sediments and contaminants are increased. Due to south-north longshore current these inputs are distributed in a northerly direction along the coast.

There is no information about the precise area and distribution of exposed Kurkar ridges in the coastal zone.

As the areas of Kurkar ridges are overgrown with algae and sea weeds, the ridges represent the most productive areas in the shallow coastal zone and are an important component of the inshore zone. According to fishermen, the ridges are a favourable habitat for various fish species and host juvenile fishes of mainly bottom-dwelling species.

Due to the low tidal dynamics, there is a restricted area of tidal flats. As far as can be judged from the available information, the temporary estuarine/riverine habitat and the salt marshes at the mouth of the Wadi Gaza are important for local ecosystem development but do not constitute a major force in the functioning of the marine environment of the Gaza Strip as a whole.

The large amount of sand transported in the inshore zone creates a highly dynamic environment with a very unstable sand floor. The top layer of the sand bottom is continuously in motion. This means that the fauna and flora in this zone have to adapt to these dynamic conditions.

Interviews with experienced fishermen revealed no evidence that particular areas along the Gaza coast fulfil certain functions for fish and shrimp stocks as breeding or nursery grounds. The coast is said to be largely homogeneous in this aspect.

The major variables and ecosystem components to be considered in the EIS are set out in Table 5.5.

identification of vulnerable ecosystems and environmentally valuable areas
Mobile dunes and beaches constitute an unique ecosystem component along the Gaza coast, the outlet of Wadi Gaza, encompassing its adjacent salt marshes. These dunes and marshes form a more gradual transition from the marine environment to the terrestrial environment than other parts of the coast. The whole range of plant species of tidemarks and the mobile littoral sand dunes is still found here. Furthermore, it is the only place in the Gaza strip which hosts waterfowl and waders. The total area of salt marshes, mobile dunes and beaches is estimated to be 125 ha. A further 200 ha of marshes and bordering vegetation along Wadi Gaza in the hinterland is of special interest with regard to flora and fauna.

The exposed Kurkar ridges in the marine environment, overgrown with algae and weeds, represent areas of relatively high primary production. These areas are known to be preferred habitat for several fish species and for juvenile fishes.

protected areas
There are no areas protected on ecological grounds.

protected and endangered species
The following may be listed as endangered species: the marine turtles *Caretta* and *Chelonia mydas* and the monk seal *Monachus*. Hunting and egg collection have brought the marine turtles to the brink of extinction. The past status of the monk seal is unclear, but it might have been more common than today, with only very rare recordings. Awaiting national legislation, there are at present no protected marine species in the Gaza Strip.

ecological requirements of main fishery resources
Starting with the present situation, attention needs to be given to the following ecological requirements of the fishery resources:
- reduction and/or prevention of inflow of pesticides and contaminants through wastewater;
- protection of exposed Kurkar ridges in the coastal area;
- sustainable exploitation.

Considering the improvement of fishery resources, an additional ecological requirement is an increased area of high primary productivity, for instance by creating artificial reefs.

terrestrial environment
As the Gaza Strip is one of the most densely populated areas of the world, the terrestrial natural resources are under pressure. At present, there is very little natural undisturbed vegetation in the area and there are no populations of larger animals. The wildlife of mammals, for instance, is dominated by rodents such as the house rat *Rattus* and brown rat *Rattus norvegicus*. The main causes for the deterioration of the natural habitats and wildlife are extension of residential areas, overgrazing, hunting and agriculture. In addition, border fences between Egypt, the Negev and the Gaza Strip and between Israel and the Gaza Strip have drastically reduced the opportunities for wildlife to enter this area.

biogeographics
The Gaza Strip is in the transitional zone between the Mediterranean coastal region, the Irano-Turanian region (Jordan Valley and Negev Highlands) and the Saharo-Arabian region (Negev, Sinai). Although only a small territory, the Gaza Strip hosts flora and fauna from three different regions. Roughly drawn, the area north of Gaza city represents the Mediterranean region and south of Gaza city, along the coast, the Saharo-Arabian region. East of Gaza city an extension of the Irano-Turanian region reaches the Gaza Strip territory.

The highest concentration of endemic plants can be found (17 species) in the coastal zone on sandy soils.

ecosystem
On the coastal area from Wadi Gaza to the northern border of the Gaza Strip, five zones can be distinguished in the landscape, land use and (remaining) natural vegetation; numbered as follows:
1. Wadi Gaza and adjacent salt marshes, mobile dunes and beaches (see the description of the marine environment);
2. area between Wadi Gaza and southern border of Gaza municipality;
3. residential area including Gaza municipality and Beach Camp;
4. area between north of Gaza municipality and Beach Camp up to settlement area at the northern border;
5. area encompassing small zone near the settlement area up to northern border of Gaza Strip.

The proposed location for the port is in zone 2, the area between Wadi Gaza and southern border of Gaza municipality. Geomorphologically, this area is characterised by the Kurkar ridges along the coast and undulating stabilized dunes in the hinterland. The soil is sandy. The groundwater table is several metres below ground level and is therefore not an important steering factor for vegetation development, which is totally dependent on rainfall. Apart from the sewage treatment plant, there is no open surface water.

The area of the proposed port location is sparsely populated. The main agriculture is a rainfed, with low input-level grape cultivation, mixed with other field crops such as cucumbers, potatoes and eggplants. Between the agricultural lands, a substantial area of "wasteland" has remained, consisting of stabilized dunes with a more or less natural vegetation.

There is no intensive horticulture, extensive plantation, nor orchards. There are no data on the occurrence of mammals and reptiles in the Gaza Strip, nor on specific fauna of zone 2.

Conditions for the conservation of some natural values in the present situation are not unfavourable, considering the comparatively restricted anthropogenic geomorphological alterations in the area, the remaining natural ecosystem components and the generally low input level of agriculture. The reason why in the GEP and R(esource) E(mergengy) P(lan) zone 2 is indicated as "potential/valuable landscape and nature conservation area. The natural values of zone 2, for instance, are considered much higher than the natural values of the area north of Gaza city (zone 4 in the list above).

Roughly drawn, the area north of Gaza city is characterized by large sand quarry activities and intensive horticulture in the hinterland, only partially mixed with remaining natural elements (parts of stabilized dunes).

Zone 2 is bordered in the south by the outlet and river course of the Wadi Gaza. As already mentioned, Wadi Gaza and its direct surroundings encompassing salt marshes, mobile dunes and beaches constitute a unique ecosystem component in the Gaza Strip. Important considerations for defining the exact location of the harbour and the adjoining industrial area are the distance from the Wadi Gaza area and the resulting negative impacts on the outlet of Wadi Gaza (erosion/sedimentation pattern) and its natural environment, the area of zone 2 that will actually will be destroyed and the areas of Wadi Gaza and zone 2 that will suffer negative impacts from the industrial operations and adjoining activities. Important impacts to be considered in this respect are increased pollution (directly through solid and liquid waste disposal and indirectly through precipitation) and increased fragmentation of the landscape (through barriers and increased disturbation).

The major independent variables and ecosystem components of ecological groups in the terrestrial environment are set out in Table 5.6. The most important variables and ecosystem components to be considered in the EIS are indicated in bold.

Table 5.6. Major independent variables and ecosystem components of ecological groups in the terrestrial environment

ecological groups	Independent variables	ecosystem components
1. Flora 2. Fauna	**1. Geomorphology** **2. Soil type (area and composition)** 3. Groundwater level/dynamics 4. Groundwater quality 5. Surface water level/dynamics 6. Surface water quality 7. Precipitation 8. Saltwater influence 9. Wind dynamics **10. Land use** **11. Pollution** **12. Barriers** (fences, roads, wires, built areas)	Natural fysiotopes: **I Sandflats, beaches** **II Kurkar cliffs** **III Not stabilized dunes** **IV Stabilized dunes** **V Blown-out dune valleys** **VI Salt marshes** **VII Riverine forest** **VIII Freshwater pools** Anthropogenic elements: **A Rainfed, low input level field - crops** B Irrigated horticulture in open field C Plantations, orchards

In Table 5.6. the most important variables and ecosystem components to be considered in the EIS are indicated with bold.

identification of vulnerable ecosystems and environmentally valuable areas
In the densely populated Gaza Strip north of Wadi Gaza the following areas are of special environmental value (Figure 5.5.):

1. cliffs and beaches: except in front of Gaza city, the coast between Wadi Gaza and the northern border of the Gaza Strip has a valuable cliff face and good beaches;
2. Wadi Gaza and outlet (see description on the marine environment);
3. an undisturbed dune landscape on the northern border of the Gaza Strip;
4. the westward zone of the area between Wadi Gaza and the southern border of Gaza municipality, with rainfed, low input grape cultivation and remaining stabilized dunes with natural vegetation.

The cliffs and beaches are not only relatively undisturbed natural habitats (ecosystem components), but also have an important recreational value. In the GEP and R(esource) E(mergengy) P(lan) the last three areas mentioned above are indicated as "potential/valuable landscape and nature conservation areas".

protected areas
At present, there are no protected areas. As mentioned in the GEP and R(esource) E(mergengy) P(lan), the last three areas listed above are "potential/valuable landscape and nature conservation areas". It is not known whether these recommendations will be implemented.

protected and endangered species
According to the New Hunting Law of the State of Israel, enacted in 1954, all wild animals and birds in Israel are completely protected, apart from a number of pest species and species that are declared game species. The status of species in the Gaza Strip will depend on legislation to be developed.

There is no information available on the occurrence of protected and endangered species in zone 2. In the area around Wadi Gaza various species of waterfowl and waders are found. The most common species are ruff, black-winged stilt, black-tailed godwitt, spurwinged plover, little stint, snipe, redshank, coot, shoveler, teal, mallard, water rail, black-headed gull and common gull.

migrating birds
The geographical position of the Gaza Strip, in the corner of the land bridge connecting the continents Africa and Eurasia, makes it a bottleneck for migratory birds. Every year, an estimated 5 billion birds pass through the Gaza Strip from the Western and Central Palaearctic to and from Africa. Based on their flight/migrating characteristics, three types of species groups can be distinguished:
- non-soaring birds, especially passerines, waders and ducks;
- coastal and pelagic birds, such as cormorants, gulls, terns and shearwaters;
- soaring birds, mainly raptors, cranes, storks and pelicans.

For the EIS, mainly the non-soaring birds are important. The coastal and pelagic birds pass by the Gaza Strip some 10-20 km out to sea, taking a short cut between the Israeli harbour of Ashqelon and the northern Sinai coast. The soaring birds use the thermal lift above the land, pass the Gaza Strip and are not specifically dependent on the Gaza Strip as a bird habitat. The solid waste belts seem to attract large numbers of black kite *Milvus migrans*.

Large numbers of non-soaring birds especially passerines can be found in the Gaza Strip resting and refuelling during daytime hours. Waders and ducks are not numerous because of the lack of surface waters in the Gaza Strip. The most important bird habitats for the passerine migrants are the semi-natural vegetation along Wadi Gaza, the extensive citrus or olive plantations, cactus hedges and even well tended home gardens. The delta of Wadi Gaza is the most important spot for the waders and ducks and also terns.

A special case is the migration of large numbers of quail *Coturnix* through the Gaza Strip. In September/October millions of quail cross the Mediterranean and land in massive numbers between El Arish (Egypt) and Khan Younis. Hunting quail by netting is widespread along the northern Sinai coast and also in the southern Gaza Strip.

5.2.8. Landscape and archaeology
landscape
The landscape of the Gaza Strip is dominated by parallel ridges, which are dissected by Wadi Gaza. This river has formed a narrow incised valley, breaking through the Kurkar ridges. Active dunes can be found near the coast. At the proposed location of the port, there is a coastal ridge with a mean elevation of + 20 m. Further inland there are recent dune accumulations. The shore zone at the proposed port location, including beaches, dunes and cliffs, has a high aesthetical and nature value and a great potential for tourism and recreation. This potential is threatened by agricultural expansion and sand quarrying.

archaeology
The Gaza Strip is extremely rich in archaeological remains (Figure 5.6.). The region has a long and turbulent history and served as a main crossroad through the ages, linking the Levantine coast and Mesopotamia with Egypt. The Egyptian pharaohs, the Assyrian and Babylonian kings, Alexander the Great and many others marched through the Gaza region, incorporated the land in their empires and founded political, military and cultural centres in this area. Historic sources made it clear that the city of Gaza was a major centre in the later 2nd millennium B.C. It was the main seat of the local Pharaonic administration and later one of the major cities of the Philistine Pentapolis. In later periods, Gaza was a focus of cultural development.

However, despite its obvious importance, the Gaza region has received limited attention from archaeologists. The most noteworthy exceptions are the investigations of Flinders Petrie at Tell al-Ajjul near Wadi Gaza in the early half of this century, and more recently, the Israeli excavations at the Late Bronze Age cemetery of Deir el-Balah.

At present, social and economic development is often in conflict with the immense local archaeological heritage. Extensive building programmes, for example, threaten many ancient sites. Preservation and investigation of the past, wherever possible, will add to an increasing awareness of the rich cultural history of the Gaza Strip.

The area of the proposed port location revealed numerous Roman-Byzantine settlements, all situated in a rather homogeneous dune landscape. Most of the sites are small and inconspicuous. Little is known about the pre-Roman occupation of this location. No traces of ancient occupation have been found on the present beach and immediate surroundings. Moreover, ancient sites on top of the steep dune ridge along the beach have been completely destroyed by agricultural activities in recent years. The industrial area further inland seems to be rich in archaeological remains.

The area near Wadi Gaza is of archaeological importance. Here the very important site of Tell al-Ajjul is located. Additional sites and cemeteries associated with the ancient occupation at Ajjul can be expected in the close vicinity.

In Annex I the results of the archaeological study are given.

5.2.9. Safety
In the current environmental situation, there are no activities with considerable risk to the population and environment.

5.2.10. Air quality
As there are no data available for the Gaza Strip, the air quality cannot be quantified accurately. For the EIS, therefore, a more qualitative description is given.

dust
In the current situation, only natural sources of dust are relevant: the Mediterranean (salt-aerosols), the beaches and some roads. Other possible sources (industry and traffic) near the area of the proposed port location are of low intensities and are thus of minor importance. The dust concentrations are to be considered as normal for coastal areas. Dust winds can result in temporarily high dust concentrations. It is assumed that this does not occur frequently.

odour
The following odour sources can be distinguished near at the proposed port location:
- the Mediterranean;
- agriculture;
- untreated wastewater.

The first two sources mentioned above do not at present give cause for concern. The major odour source is the untreated wastewater discharged into Wadi Gaza and via pipes into the Mediterranean.

NO_x and SO_2
NO_x and SO_2 are emitted from furnaces and engines. Because of the absence of industries and the low intensity of traffic, these components are not emitted in large amounts into the surroundings of the proposed port location. Long distance transport of air pollution from Europe will probably be of more importance. This may lead to some photochemical pollution in the region. There are large industries around Ashdod, such as oil refineries and power plants, which lead to high concentrations of SO_2 in Israel. These emissions will have little effect on the Gaza Strip because of the predominantly westerly wind direction, although high concentrations may occur occasionally. Overall, NO_x and SO_2 concentrations are relatively low at present.

other components
The only other component that can be regarded as polluting are pesticides, which endanger the health of the people working in agricultural fields. This is considered to be a local problem.

5.2.11. Noise
noise
There are several sound sources due to human activities and nature in the area between Wadi Gaza and Gaza city. The main sound sources are:
- traffic;
- agricultural activities;
- recreation activities on the beach;
- natural sounds (wind, sea).

In the current situation the area between Wadi Gaza and Gaza city can be characterized as a quiet countryside. The background noiselevel is low, about 35 to 40 dB(A) in the daytime and about 30 to 35 dB(A) at night.

Within about 200 meter of the coastal road, the background noiselevel is about 5 to 10 dB(A) higher due to traffic. During the day, there are about 100 vehicles per hour, mainly cars but also heavy motor vehicles such as trucks and buses. At night this is reduced to less than a tenth of the daytime intensity. On fridays, the traffic-intensity increases to about 500 vehicles per hour. The increase on friday is due to beach recreation.

vibrations
In the current situation, there are no perceptible vibrations due to human activities between Wadi Gaza and Gaza City. When a heavy motor vehicle passes there is some vibration but this has no serious negative impact on humans or housing.

5.2.12. Solid waste
The refugee camps and the municipalities dispose of their solid waste in open dump sites throughout the Gaza Strip. Some of these are official sites, others are not. Sanitary land filling is not practised; the waste is simply dumped and spread out in open areas. These areas are uncontrolled and any kind of waste, liquid or solid, may be disposed of. At some sites the waste is burned, and at others a thin layer of soil may be placed over filled trenches at infrequent intervals. Furthermore, private sector collectors are prone to dispose of waste on any available space, for example, on the beach north of Gaza City. The natural and urban environment of the Gaza Strip is spoiled by the widespread presence of solid waste, which is a major public health hazard. Landscape pollution, affecting both inland and coastal areas, prevents any kind of recreation in these areas for the local population. In an area where land is scarce, this has particular negative social consequences.

5.3. Socio-economic environment

agriculture

Agriculture is the most important economic sector. Traditionally, agriculture was based on citrus growing and rainfed horticulture. The sector takes up almost half the available land area of the Gaza Strip of 365 km^2. The total agriculture area covered 170,000 dunums (170 km^2) in 1966, increased to a peak of 198,000 dunums in 1968 to decrease slightly to 179,400 dunums over the last ten years. In the same period, urban land use has increased from 11.2% to almost 19%.

Crops produced in the Gaza Strip include wheat, barley, corn, citrus, olives, almond, dates, vegetables and fruits. These crops are produced to meet local demand, and the surplus has to be exported. Export is difficult because of the restrictions imposed by Israel. Vegetable production makes high use of fertilizers, pesticides and fumigants. Furthermore, percolation losses through the coarse-textured, permeable soils lead to an increase in groundwater pollution.

fisheries

Recently, the free fishing zone for Gaza fishermen was extended to a 20 mile zone covering some 800 km^2. Fishing along the coasts of Beit Lahia as well as the Khan Younis-Rafah area is prohibited for Palestinians. Israeli fishermen are allowed to enter the Gaza free fishing zone. Landing places for Palestinian boats are found near Gaza city, Deir El-Balah, Khan Younis and Rafah.

The free fishing zone in Gaza is not rich in fish, but beyond that area fish may be found in considerable quantities. As can be observed at the beach at night Gaza fishermen are fishing as far as possible from the coast in order to catch as much as possible. Total catches by Gaza fishermen dwindled to an annual catch of some 229 tons in 1988/89 and gradually increased to 384 tons in 1989/1990, 1,200 tons in 1990 and 1,795 tons in 1993. Most prominent catches are sardines (42%), followed by lokhous (8%), sea bass (5.4%), Sultan Ibrahim (3.8%), sea bream (0.8%) and mullet (0.8%). Other types such as cuttlefish and shrimps account together for some 16.3% of the total. There are in total 2,000 licensed fishermen permanently or semi-permanently active, while a further 1,500 fishermen have applied for permits to fish. The composition of fishing fleet is set out in Table 5.7.

Table 5.7. Fishing fleet of Gaza

area	large boats	medium-sized boats	small boats
Gaza city	61	98	257
Deir El-Balah	3	11	51
Khan Younis	3	37	45
Rafah	9	31	56
total	76	177	409

industry

There are several industries and new industries are being established to meet local demand and for export purposes. There are no large industrial plants on the Gaza Strip. Small industries such as garages, steel construction, carpentry and citrus fruit packing and processing are located well within the municipalities or along the main road. There are also many small-scale factories producing clothes, plastic tools, furniture and food. Commercial and industrial waste is disposed of on the beach north of Gaza, which is deemed hazardous.

recreation
The beaches of the Gaza Strip have tourism potential not only for the local population but also for tourists from the West Bank and other Arab countries (Jordan, Egypt and the Gulf countries). A major problem, however, is the severe pollution of the seawater and beaches, which is a major health risk and which endangers marine life. The beaches in front of Gaza city, Beach camp and Deir el-Balah, are polluted by sewage outfalls and individual sewage and sludge drains ending either on the beach and cliffs or a short distance away in the surf zone. Consequently, the area close to these outlets is unsafe for swimming and the sludge and sewage running down the cliffs is seriously polluting the beaches. The odour from these sources of pollution is not only experienced on the beach, but extends some 50 to 100 m to the nearby camp and town. The beaches between Wadi Gaza and Gaza city are used especially for beach recreation. During holidays, like Fridays the beaches are visited by hundreds and sometimes, thousands of Palestinians

employment
Per 1 January 1995 approximately 40% of the total work force was unemployed, that is 136,290 people. This percentage will increase when Israel closes the border preventing Palestinians working in Israel. Skilled workers are available in many fields. There is a large number of graduates from post-secondary educational institutions in various fields, including medicine, dentistry, pharmacy, engineering, arts, natural sciences and social studies. However, a considerable number of these graduates needs further training in their fields in order to increase their capabilities.

5.4. Assimilative capacity of the environment
As said before the Gaza Strip is a small, densely populated area. The development of the port and affiliated economic activities will put a considerable stress on the environment of the areas because at a very early moment scarce resources, ground area, groundwater, agricultural land will be affected. The assimilative capacity of the environment of the Gaza Strip is relatively small in comparison with areas which are not so densely populated. Marine environments are almost always very vulnerable all over the world. With respect to the Gaza Strip the Mediterranean serves as an important source of nutrition (proteins) for the population. Additional stress on the marine environment can reduce this function considerably.

5.5. Autonomous developments and no action alternative
In the complex political and diplomatic situation of the Palestinian territories and the relation with Israel it is very hard to predict developments. Statements about (economic) developments are all very speculative. They all can not be well reasoned by quantitive data. The following autonomous developments and no action alternative are described with the present knowledge and general expectations.

In terms of the EIS for Gaza Sea Port, the autonomous developments are those developments which will take place without the sea port. These developments can be aggregated to a no action alternative which can be used as a reference situation for purposes of comparison with the proposed port development.

While the no action alternative means that no port will be established, there will, nevertheless, be economic growth in the Gaza Strip and the West Bank, probably more slowly than with a port. Without a Palestinian port, goods will have to be imported via the Israeli port of Ashdod and transported by land to the Gaza Strip and the West Bank. The borders between the countries will thus continue to be an important factor in the economic development of the Gaza Strip.
The description of the autonomous developments is very dependent on the frequency and duration of the closure of the borders. Thus, there is a distinct relation between the political future and the environmental and socio-economic impacts.

In the past, the border has been closed on many occasions for different reasons (political, safety, etc), with the result that Palestinians have not been able to work in Israel and goods imported via Israeli ports have not been able to enter the Gaza Strip. Information on border closures is given in Chapter 2.

It is not clear what will be happen with the border question in the near future. It is possible that the border will be open most of the time. If it is open all the year round goods can be transported from Israel to the Gaza Strip and the West Bank and vice versa. The Israeli Government will receive import dues paid by Palestinian companies. On the other hand the Israeli Government will incur the cost of construction, operation and maintenance of port infrastructure. It is difficult to assess the net result, which probably will also differ from year to year.

Closure of the border in the autonomous situation will have a major impact on the economic development of the Gaza Strip. If access via Israel is hampered, economic development of the Gaza Strip will be constrained. Factories cannot be built or construction will be postponed, construction of office buildings will be delayed and new housing for Palestinians from all over the world who want to settle in the Gaza Strip will be restricted. Thus the economic development of the Gaza Strip is highly dependent on the future political situation. These uncertainties make it difficult to describe the autonomous developments and consequently their potential environmental impact.

The no action alternative with frequently closed borders will mean very little change to the present environmental situation in the Gaza Strip. No industry with an international function (or ever for the Middle East) will be developed, because an industrial sector is dependent on export possibilities. The economy will grow slowly and there will be only a gradual environmental change. Without the port the physical environment and the archaeology will hardly be disturbed. No port also means no new roads or fewer kilometres of new roads with accompanying traffic noise, hazards and air pollution. It will increase the traffic density on the roads from Israel and Egypt to the Gaza Strip. No port also means no ship movements and fewer accidents, less wastewater and fewer oil spillages. Finally, no port means the proposed port site can be used for other purposes such as residential areas, recreation and agriculture. From an environmental point of view, the no action alternative is better for the environment than the proposed port development. On the other hand it is detrimental for the socio-economic situation. If the Gaza Sea Port will not be developed, "illegal" port developments are possible with potential environmental hazards (spillages).

The political decision for the new Palestinian port has already been made. It is now necessary to implement the economic prospects of the port and to minimize the environmental impacts. The present environmental impact assessment will assist in the process.

6. IMPACTS

6.1. Method of describing impacts

This part of the EIS is structured according to the impacts during construction and operation of the Gaza Sea Port. The environmental and socio-economic aspects discussed in Chapter 5 are considered for the construction and operation of Gaza Sea Port for the proposed activity and alternatives (Chapter 4) in phase IA and III of the port development. An overview of the major elements of the description of the impacts is given in Table 6.1.

Table 6.1. Overview of description of environmental impacts

phase of realization	main aspect	aspect	paragraph
construction phase			6.2
	abiotic aspects	coastal morphology soil groundwater surface water	6.2.1.
	biotic aspects: marine environment	flora fauna	6.2.2.
	biotic aspects: terrestrial environment	flora fauna	6.2.3.
	natural environment	landscape archaeology	6.2.4.
	hindrance	air quality noise safety	6.2.5.
	socio-economic environment	socio-economic environment	6.2.6.
operation phase			6.3
	abiotic aspects	coastal morphology soil groundwater surface water	6.3.1.
	biotic aspects: marine environment	flora fauna	6.3.2.
	biotic aspects: terrestrial environment	flora Fauna	6.3.3.
	hindrance	air quality noise safety	6.3.4.
	socio-economic environment	socio-economic environment	6.3.5.

The impacts are described in the following order, firstly the physical and operational activities and their possible impacts on the two port development phases under consideration. Secondly, the criteria used to describe the impacts are given and the alternatives assessed. Thirdly, the temporary and lasting impacts are described. Finally, the impacts of the proposed activity and the alternatives are assessed which is the basis for the comparison of the alternatives.

physical/operational activities and possible impacts
Each aspect starts with an overview of the physical/operational activities. The extent of the impact is considered in terms of the time of appearance, the frequency, the duration and the geographical scale. The impact becomes greater with increasing frequency, duration and geographical scale, while a number of impacts will show some degree of recuperation.

As already mentioned, the potential impacts can be divided into those resulting from the construction phase (partly temporary) and those from the operational phase (permanent) of the port. A further distinction can be made between primary and secondary impacts. Primary impacts result directly from the construction and the operation of the port, for example, changes in tidal flows, the geomorphology and the soil. Secondary impacts occur as a result of primary impacts and include changes in flora, fauna and ecology.

The impacts are described with respect to the current situation, supplemented with consideration of autonomous developments in the area.

criteria and measures
Criteria for the description and assessment of the alternatives were determined on the basis of the data on the current situation. There are no environmental standards for the Gaza Strip and so Dutch standards have been used as an example for several aspects.

Each criterion needs to be measurable, preferably quantifiable in terms of capacities, contents and areas. In some cases, the results are presented as a ratio-score, and in other cases, where information and the criteria are insufficient to quantify the impacts, a qualitative - ordinal - assessment has been given.

assessment
An overview of the assessments of the environmental impacts with the criteria are presented in tabular form in each Section. Where possible, the table gives quantification of the criteria, and where this is not possible, an ordinal assessment is given with the following explanation:

+ + +	very positive impact;
+ +	positive impact;
+	slightly positive impact;
0	neutral or no impact;
—	slightly negative impact;
——	negative impact;
———	very negative impact.

Section 6.4 deals with the environmental issues related to the places were construction materials are to be obtained. It is probable that the port construction and operation will lead to induced development, which are discussed in Section 6.5. Section 6.6. concludes with an overall comparison of the environmental and socio-economic impacts of the port development.

6.2. Construction phase
6.2.1. Abiotic aspects
physical activities
The activities in the construction phase which will affect the quality and quantity of soil, groundwater and surface water are:
- construction of the breakwater, sea wall, quay and associated physical structures;
- dredging;
- soil excavation and transport;
- occasional spillage;
- dumping construction waste.

possible impacts
Activities during port construction can lead to the following impacts:
- exhaustion of raw materials;
- changes in coastal morphology ;
- changes in groundwater resources and seawater intrusion;
- soil and groundwater pollution;
- surface water pollution.

criteria
The following factors were used as criteria in assessing the potential impacts:
- construction quantities (length of breakwater, causeways, etc.);
- disturbance of the morphologic dynamic equilibrium;
- amount of construction sand to be washed;
- inshore earthworks.

impacts
- exhaustion of raw materials.

When Table 4.4. and Table 4.6. are compared it appears that the breakwater will be shorter in the proposed lay-out than in the alternative lay-out, but that on the other hand the causeway will be longer. This means that approximately the same quantities of construction materials are needed in both lay-outs.

- Changes in coastal morphology.
  The time scale for morphological processes is longer than that of the port construction. For this reason, a distinction can be made between the morphological impact of the construction phase and that of the operation phase. Port construction will initiate a change in the present dynamic equilibrium by altering the pattern of erosion and sedimentation in the nearshore zone.

For the description of environmental impacts a reference is made to Section 6.3.1, in which the description is given of impacts during the operation phase, because impacts during both phases are comparible.

From a morphological point of view, the proposed port lay-out and the alternative lay-out do not differ very much with respect to environmental impacts. With respect to the impacts on coastal erosion a further reference is made to part 11 of the Basic Engineering Study.

- Changes in groundwater resources and seawater intrusion.
  During dredging, intercalating clay layers may be removed which will result in a decrease in resistance to groundwater flow and this will lead to additional groundwater flow seaward or landward depending on the piezometric levels at the location. It is not certain, however, whether intercalating clay layers are present since information on local lithology is not available. Sea water intrusion is a continuous process and the impact during the construction phase is considered to be less than during operation phase.
- Soil and groundwater pollution.
  The probability of soil and groundwater pollution is considered to be proportional to the amount of inshore earthworks and is therefore used as a criterion for the amount of pollution likely to occur. The activities of the contractor will have to be strictly controlled to ensure appropriate methods are used and to prevent the dumping of construction waste on land.
- Surface water pollution.
  The probability of an occasional spillage increases with increasing amount of construction work. Therefore, the construction quantities such as length of breakwater and berths, have been used as a criterion for the amount of surface water pollution. Strict control of the contractors activities will be required to ensure appropriate methods are employed and to prevent dumping of construction waste in the sea.

assessment of impacts
The assessment of the abiotic impacts of the port construction phase is presented in Table 6.2.

Table 6.2. Port construction phase: abiotic impacts

criteria	no action alternative	proposed activity		alternative	
		phase IA	phase III	phase IA	phase III
construction quantities (length of breakwater, causeways, etc)	0	—	——	—	——
dredged area	0	——	———	——	———
inshore earthworks	0	—	——	—	——

6.2.2. Biotic aspects: marine environment
Since very little site-specific information is available on the marine flora and fauna (Section 5.2.7), the assessment of the impacts concentrates on describing potential changes to marine habitats.

physical activities
The physical activities during the construction phase which are likely to affect the marine environment are:
- dredging works;
- disposal of dredged materials;
- seawall and breakwater construction works;
- quay construction;
- reclamation works.

possible impacts
Activities during port construction are likely to lead to contribute to the following:
- loss of natural habitat;
- creation of new habitats;
- destruction of flora and fauna;
- deterioration of habitat quality.

criteria
Changes in the marine environment are described in terms of habitat area and quality. Criteria used to describe changes in habitat area are as follows:
- area loss due to construction of breakwater, seawall, quay and associated facilities and land reclamation;
- area of new types of habitats;
- area destroyed by dredging and/or beach nourishment.

The following criteria were used to describe changes in habitat quality:
- increased turbidity;
- increased sedimentation;
- increased pollution;
- increased disturbance.

impacts
- Loss of habitats.
  There will be a permanent loss of habitat as a result of the construction of the causeway, breakwater and seawall, and land reclamation. The sediments and community in the port area will be disturbed by dredging works (see below).

The total harbour area is, therefore, considered to constitute a loss to natural sandy substrate habitat in the marine environment. In the proposed activity, this leads to an estimated loss of 78 ha in phase IA, and 112 ha in phase III. In the alternative, 77 ha will be lost in phase 1A and 112 ha in phase III.

The very oligotrophic marine environment exposed Kurkar ridges, overgrown with algae and weeds, are valuable areas (Section 5.2.7). In the proposed activity and the alternative, about 2 ha and 4 ha of the present Kurkar ridges will be lost in phase IA and III respectively. There is virtually no difference between the alternatives.

- Area of new types of habitats.
  A new hard-substrate habitat will be created by the construction of the breakwater armoured with artificial rocks and rock groyne. Artificial hard-substrate habitats inside the harbour are not considered valuable (see below). Only the seaward exposed parts of construction are likely to become a new hard-substrate habitat. In the proposed activity, this results in a hard-substrate shoreline of breakwater and groyne of 1150 m in phase IA.
  In phase III, the extension of the breakwater, the incorporation of the groyne in the reclamation and the construction of an artificial armoured seawall will result in a total of 1680 m of hard-substrate shoreline. In the alternative, no groyne is to be built and the breakwater will provide 710 m hard-substrate in phase IA and the breakwater and seawall will encompass 1990 m in phase III. There is virtually no difference between the two alternatives with regard to the character and scale of the area of new habitat. The construction of the port will result in a new artificial habitat in the shallow shore zone. The water body inside the port, replacing the shallow sloping zone from 0 - 8 m, will be relatively deep and almost stagnant with little exchange with the open sea. The water quality in the port as well as the provided habitats (sheetpiles) are not considered to be of value.
- Area destroyed by dredging and/or beach nourishment.
  Dredging activities will destroy the habitat because sediments will be removed and mortality of benthic organisms will increase as a result of the mechanical action of the dredger and smothering by increased sedimentation. A dredged site recovers slowly at times, with pioneering organisms initially recolonizing the site and are later replaced by equilibrium communities adapted to the new situation. The rate of recolonization depends on the location, sediment composition and types of organisms comprising the benthic community. Dredging will take place in the port area and probably also offshore for initial beach nourishment. The location and area of the offshore dredging site are not known. Dredging will have a very negative impact on the benthic system.

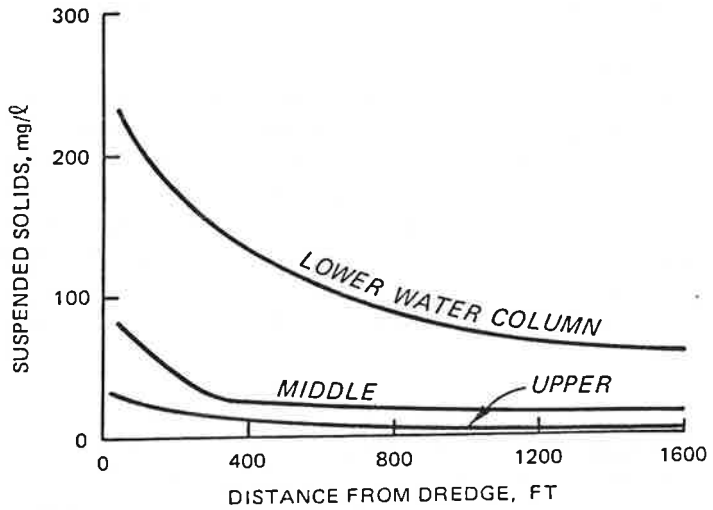
It is proposed that 1.5 million m^3 of sand will be required for the initial beach nourishment. Wherever this dredged material is disposed, the benthic community will be smothered. It is anticipated that the proposed quantity will provide a buffer for 3-5 years (Section 4.2.7), after which additional nourishment will be needed. This process of nourishment and erosion is unnatural and will have a negative impact on the benthic community at the nourishment site.

- Increased turbidity.
  Increased quantities of suspended sediments during dredging, reclamation and disposal operations may lead to increased turbidity and an increase in nutrients (phosphorus, nitrogen released from the dredged sediments). Taking into consideration the very oligotrophic conditions and the fact that the sediments in the inshore zone consist of predominantly coarse sands, an increase in nutrients is not anticipated. Heavy metals in the water usually adsorb to sedimented particles in suspension, thereby lowering the concentrations in the water column. Later, the sediments may release some of their heavy metal load, thus raising the metal concentration in the water. The coastal waters of the Gaza Strip are polluted because of the discharge of untreated sewage and domestic waste.

The actual pollutant loads are not known and neither is the concentration in the sea water nor the accumulation on the sea bed. Accumulation on the sea bed is expected to be low considering the bottom substrate of coarse sands and the large transport in northerly direction.

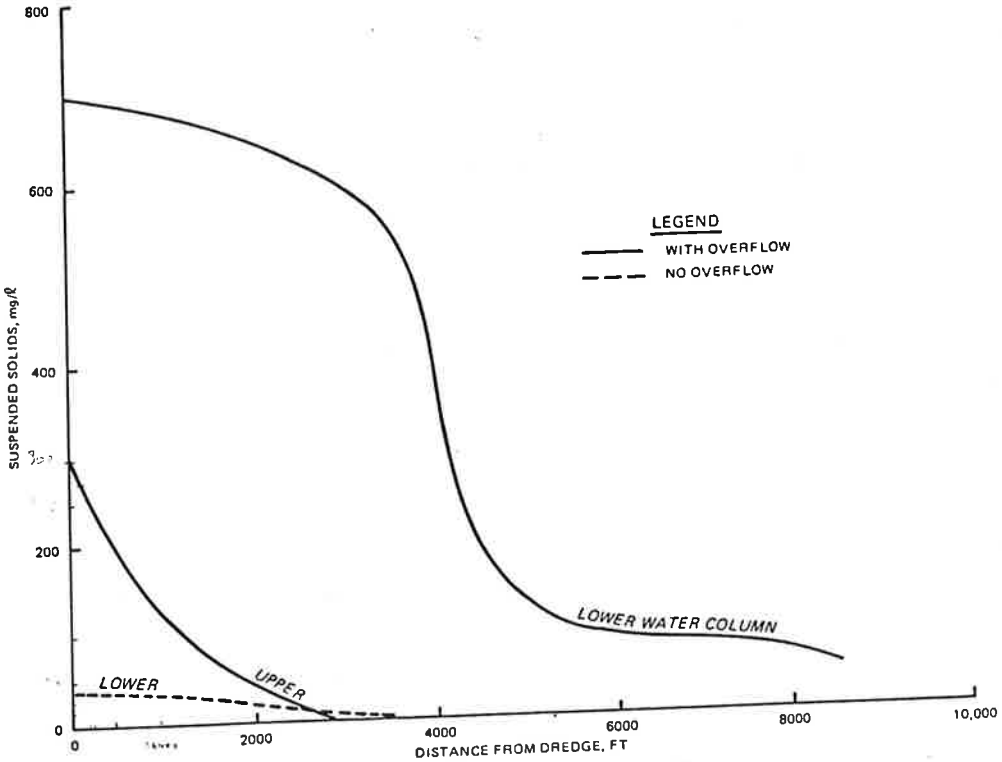
The main impact of dredging, reclamation and disposal in the marine environment is considered to be increased turbidity, which has a relatively high impact in oligotrophic clear water systems. The impact depends on the duration of the activity and the increase in concentration of suspended solids. The total duration of reclamation and dredging is expected to be about 8-12 months in both the proposed activity and the alternative. Re-suspended levels from cutter head dredging operations and from hopper dredger operations are given in Figures 6.1. and 6.2. The figures show that the impact on the surface layer of the water column is up to about 500 m (1,600 ft) with the cutterhead and up to almost 900 m (3,000 ft) with the hopper dredger. The impact on the concentration of suspended solids is much higher on the sea floor for the hopper dredger with overflow (600-700 mg/l at 500 m) than with the cutterhead (less than 100 mg/l at 500 m).
A level of less than 100 mg/l with the hopper dredger with overflow is only reached at distances greater that 1,800 m. The impact of a hopper without overflow is much less (Figure 6.2.). The background concentration for suspended solids at Gaza is not known, but considering the clear water conditions and coarse sediment particles, it is probably very low.

Figure 6.1. Resuspended sediment levels from cutterhead dredging operations



Source: US Army Engineer Waterways Experiment Laboratory, 1986.

Figure 6.2. Resuspended sediment levels measured behind the dredging during hopper dredging operations



Source: US Army Engineer Waterways Experiment Laboratory, 1986.

Because of the longshore current, mainly the area north of the port will be affected. If the dredged material in phase IA is not suitable for reclamation purposes, it will have to be disposed of at approved dump sites. Locations for these sites have not been indicated but will probably be offshore (Section 4.2.7). In phase III the landfill material will be obtained from other sources. Figures 6.1. and 6.2. show the results of silt and sand bottom sediments. It is anticipated that most of the dredged sediment will be coarse sediment but thin layers of finer material will also be present. Taking Figure 6.2. as an indication, the impact of dredging may extend several kilometres if a hopper dredger with overflow is used.

The exposed Kurkar ridges north of the dredging sites and overgrown with algae and weeds may be affected by this operation. Taking into account the duration, dredging in the very clear water will have very negative impacts locally. There is no difference in the impact of increased turbidity between the alternatives.

- Increased sedimentation.
  In the areas adjacent to the dredging and reclamation and at disposal sites, the benthic community may be smothered by increased sedimentation. The impact depends on the sedimentation rate, the duration of activities and on the composition of the benthic community. If high sand transport takes place as in the shallow shore zone, then the benthic community will adapt to some extent to the dynamic circumstances in the upper bottom-layer, but the induced increase in sedimentation is expected to exceed by far the natural patterns (see above). Dredging activities in the construction phase will probably go on for 12-18 months. The increased sedimentation will have a very negative impact. There will be no difference in the impact of increased sedimentation between the alternatives.
- Increased pollution and disturbance.
  Operation of equipment and construction of the port will lead to increased pollution and much disturbance in the area. As port construction in phases IA and III will go on for at least one year, the life cycle of various organisms in the area will be disturbed.

This is considered to be a very negative impact. There is no difference in the impact of the alternatives.

assessment of impacts
Assessment of the abiotic impacts (marine environment) of the port construction phase is presented in Table 6.3.

Table 6.3. Port construction phase: biotic impacts marine environment

criteria	no action alternative	proposed activity		alternative	
		phase IA	phase III	phase IA	phase III
habitat area					
permanent loss of natural sandy substrate habitat 0 - 11 m (ha)	0	78	112	77	112
loss of exposed Kurkar ridges (ha)	0	2	4	2	4
new hard-substrate habitat (m)	0	1150	1680	710	1990
new unnatural stagnant marine habitat of low quality (ha)	0	78	112	77	112
areas destroyed by dredging offshore (ha)	0	—	—	—	—
habitat quality					
increased turbidity	0	———	———	———	———
increased sedimentation	0	———	———	———	———
increased pollution through equipment operation	0	———	———	———	———
increased disturbance	0	———	———	———	———

6.2.3. Biotic aspects: terrestrial environment
Since very little site-specific information is available on the terrestrial flora and fauna (Section 5.2.7), the assessment of the impacts concentrates on describing changes in the terrestrial habitats.

physical activities
The physical activities in the construction phase which will have an impact on the terrestrial environment are as follows:
- excavation works;
- earthworks;
- roadwork;
- building construction;
- land transport.

possible impacts
Activities during port construction can lead the following impacts:
- loss of natural and semi-natural habitat;
- destruction of flora and fauna;
- fragmentation of natural and seminatural habitats;
- deterioration of habitat quality.

criteria
Changes in the terrestrial environment are described in terms of loss of habitat area and quality with regard to:
- Kurkar cliffs;
- valuable natural dunes and of low-input level agricultural area.

Changes in terms of habitat quality are described in terms of:
- increase in noise, dust, traffic, pollution and deposition;
- increase in solid waste pollution;
- habitat fragmentation.

impacts
- Loss of habitats.
  For the port construction, a part of the Kurkar cliffs will be excavated and about 1,300 ha in the hinterland will be turned into an industrial area adjacent to the port. The planned industrial area is on low-input agriculture land and with a substantial area of natural vegetation of stabilized dunes. This landscape is considered to be of "potential valuable and nature conservation area". Loss of an area of Kurkar ridges with its specific vegetation and the reduction of natural dune elements is considered to be a very negative impact.

  The impact of Kurkar cliff excavation in phase IA is the same in the proposed activity and in the alternative (30 ha). In phase III there is also no difference between the proposed activity and the alternative (46 ha). The impacts of this excavation are described in Section 6.2.4.

  In phase IA, about 20% of the industrial area will be developed. This means a loss of about 260 ha of an area with remnants of stabilized dunes and natural vegetation. In phase III the total area will be developed, resulting in a loss of 1,300 ha of this type of habitat. There is no difference in character and scale between the alternatives with regard to the impacts of the industrial development.
- New habitats.
  As a result of the earthworks, construction work and road building, there will be an increase in unnatural habitats. This usually leads to a shift within the community with more common species replacing the original and more characteristic species. The area of new unnatural habitats in phase IA and III is not known, but the low quality of these habitats means they are not valuable.
- Increase in noise, dust, traffic, pollution and deposition.
  The required earthworks, construction and transport activities impose greater stress on the habitats and the organisms because of the great increase in dust and noise, pollution and deposition and disturbance. In comparison with the present activities in the area which are mainly agricultural and with little use of large modern equipment, the impact is considered to be very negative. The time period for the port construction and development of the industrial area is not known for phase IA and phase III. For both phases and both alternatives, the impact is considered to be very negative. There is no difference in character and scale between the alternatives regarding the impacts of the industrial development.
- Increase in solid waste pollution.
  At present, solid waste disposal is uncontrolled throughout the Gaza Strip (GEP, 1994).

During the construction phase, solid waste will be generated in the form of packing materials (plastics, cans/drums, timber, paper boxes), unusable and/or surplus of construction materials (pieces of stone, steel, geotextile, etc.), unusable equipment or pieces thereof (rubber tyres, bolts, nuts).
It is strongly advised that these waste materials will be disposed of at approved dumping sites in acceptable manner so that negative impact is minimized. At all times it has to be avoided that construction waste will be buried or dumped in the core of the breakwater.

- Fragmentation of natural and semi-natural habitats
The development of the port and industrial area will separate the area to north and south of the development. The increased traffic along the route in transporting construction materials will affect the movement pattern of various types of animals and will contribute to the fragmentation of the landscape. In comparison with the no-action alternative, the impact is considered to be very negative. In phase III, with full development of the industrial area, the separation have a much greater impact than in phase IA. As to scale and character, there is no difference between the proposed activity and the alternative.

assessment of impacts
Assessment of the biotic impacts (terrestrial environment) of the port construction phase is presented in Table 6.4.

Table 6.4. Port construction phase: biotic impacts terrestrial environment

criteria	no action alternative	proposed activity		alternative	
		phase IA	phase III	phase IA	phase III
habitat area					
loss of natural dune area and low-input agricultural area (ha)	0	260	1300	260	1300
new unnatural, not valuable habitat (ha)	0	—	—	—	—
habitat quality					
increase in noise, dust, pollution and deposition	0	——	———	——	———
increase in solid waste pollution	0	——	———	——	———
habitat fragmentation	0	——	———	——	———

6.2.4. Natural environment

physical activities
During port construction, the coastal ridge will be excavated to obtain the required port area. An industrial area will be developed on the inland side of the port. These activities will have an impact on the natural environment.

possible impacts
Activities during port construction can have the following environmental impacts:
- changes of the coastline and coastal landscape;
- changes in functional and spatial structure;
- loss of archaeological sites.

criteria
The impact of changes to the coastline are described in terms of the removal of coastal ridge (in ha). Changes in functional and spatial structure are also used as criteria for impacts of the landscape image. For the assessment, unity and utilization are the most important criteria. The number archaeological sites which will be lost was used to describe the impact of port development on archaeology in the area.

impacts

landscape
The shore zone at the proposed location has a high aesthetic and nature value. In the current situation, this value is threatened by agricultural expansion and in the long term by urban expansion. If the port is not developed, the coastal ridge will not removed. The proposed activity will remove about 30 ha in phase IA and a further 16 ha in phase III. About the same amount will be removed in the alternative. In both cases, the agricultural and natural landscape will loss its unity as a result of the development of the industrial zone. The use of the area by the port and port-related activities will increase slowly in phase IA, but will be severe in phase III in both alternatives.

archaeology
The port construction will have a limited impact on archaeological features along the immediate shoreline. No traces of ancient occupation have been found on the beach and in the immediate surroundings. In addition, it appears that ancient settlements on top of the steep dune ridge along the beach have been completely destroyed by agricultural activities in recent years. In this respect, port construction will cause minimal or no additional damage. However, construction of the sea port will undoubtedly lead to erosion along the coastal zone and may, therefore, threaten archaeological sites elsewhere. It is clear from the archaeological point of view that further protection of the coast from erosion is required. Construction of the industrial area and associated roads further inland will unquestionably result in destruction of archaeological monuments. Many archaeological sites are located in the area chosen for industrial development.

Finally, attention is drawn to the area near Wadi Gaza. At the edge of the proposed port location, close to Wadi Gaza, is the very important site of Tell al-Ajjul. It is anticipated that additional subsidiary sites and cemeteries associated with the ancient occupation at Ajjul are located near the site. Here, too, port construction will undoubtedly cause considerable damage.

In fact, there is no real difference between both alternatives. With the removal of the coastal ridge, at least one archaeological site will be threatened. Only the ancient settlements on top of the steep dune ridge along the beach will be affected by the port and industrial developments.

assessment of impacts
Assessment of the impacts on the natural environment of the port construction phase are presented in Table 6.5.

As the Gaza Strip is only about 40 km, workers can return to their homes daily. It takes less than an hour by car from Gaza city to Rafah city in the south. However, the demand for goods and services will increase, such as food, clothing and other commodities. Provisions will be needed to be constructed for the removal of sewage and solid waste to prevent environmental deterioration and the spread of infectious diseases. There are no differences between the two alternatives, and in both cases more services will be needed in phase III than in phase IA.

- Effects on land prices and social impacts.
  During port development, land prices around and near the port area will rise, as usually occurs when a vital facility is established. It will become increasingly difficult for the local population to find acceptable accommodation. Urbanization towards the port area without zoning of industrial activities and without means to prevent illegal settlements could become a serious issue in both alternatives.

assessment of impacts

Assessment of the socio-economic impacts of the port operation phase is presented in Table 6.7.

Table 6.7. Port operation phase: socio-economic impacts

criteria	no action alternative	proposed activity		alternative	
		phase IA	phase III	phase IA	phase III
number of housing units removed	0	2	200	2	200
area (ha) (agricultural) land removed	0	2	11	2	11
financial losses	0	+	+ +	+	+ +
effects of temporary influx of workers	0	—	——	—	——
effects on land prices and social impact	0	——	———	——	———

6.3. Operation phase

6.3.1. Abiotic aspects

operational activities

In the operation phase, there are activities which might affect the quality of coastal zone, soil, groundwater and surface water as a result of a spillage.

The groundwater resources could be affected by the physical structures of the port starting right from the time of construction. The physical structures of relevance are discussed below. The only structure in the water that might affect the groundwater quantity and quality during the operational phase is the dredged area of the harbour. The structures such as the breakwater, causeway and groyne are located on the sea bottom and do not affect the groundwater quantity and quality. The sheetpiles of the berths in phase IA and III will be either piled or vibrated into the subsoil. The sheetpiles will be perpendicular to the coast and will therefore not affect groundwater flow.

The total area required for terminal areas, port buildings and utilities is 16 ha in phase IA and 109 ha in phase III (Section 4.2.1). This area could have an effect on the recharge of groundwater in the operation phase.

The presence of roads, pavement and buildings will accelerate surface run-off after rainfall. The increased surface run-off will reduce infiltration of rainwater which means reduced groundwater recharge.

possible impacts
Physical elements and activities during port operation can lead to the following impacts:
- changes in coastal morphology;
- change in groundwater resources and sea water intrusion;
- soil and groundwater pollution;
- pollution of surface water.

criteria
The following criteria have been used to assess the potential impacts:
- disturbance of the morphologic dynamic equilibrium;
- decrease in groundwater recharge;
- area occupied by terminals, port buildings and utilities;
- amount of loaded and unloaded goods.

impacts
- Changes in coastal morphology.
  The proposed port is connected to the shoreline and it extends seaward up to the 11 m depth contour (phase 1A). Its position in the cross-shore coastal profile covers the morphologically most active part of that profile. As a result, presently active cross-shore and longshore sediment transport processes will be affected. This way, the port has an impact on the autonomous coastal morphological evolution. This is addressed hereafter. Similar to the approach followed in describing the autonomous evolution (see section 5.2.6.), distinction is made between longshore and cross-shore transport in assessing the morphological impact of the port.

  The, on average, northward wave-driven flow in the surf-zone will be intercepted by the port. This flow will curve closely around the breakwater until it reaches its northern tip. Up to that point, this flow is concentrated in a comparatively narrow zone. Beyond the tip of the breakwater, however, the flow will spread in cross-shore direction. This is attended with a vast decrease of the flow velocity. North of the port, outside the lee of the breakwater, incident waves will generate a new, on average northward, longshore flow in the surf-zone. Inside the lee, on the other hand, the wave climate is affected by diffraction around the tip of the breakwater. This leads to a net southward wave-driven flow.

  The interception of the wave-driven longshore flow has major consequences for the longshore transport. When the longshore flow reaches the southern end of the port, it will be diverted away from the shoreline and, hence, out of the surf-zone. The amount of sediment being transported by this flow in the surf-zone is comparatively high, as the intensive turbulence resulting from breaking waves stirs a lot of sediment up from the bottom and it hampers settlement of sediment. When the flow diverts away from the surf-zone, it is separated from the stirring mechanism. This reduces the capacity of the flow to carry sediment. As a result, sediment will be deposited until a new balance between the sediment load and the transport capacity has been reached. This way, accretion will occur directly south of the port.

  Not all of the longshore transport will be intercepted by the breakwater. A part of it will pass along the breakwater with the longshore flow. The transport rate of this natural bypass depends on the progress in the accretion south of the breakwater. Seen from the south, the accretion intensifies towards the port. This results in a curved shoreline which evolves in seaward direction until it nears the tip of the breakwater, provided that nature is allowed to take its cause. During this process, the surf-zone (where major part of the longshore sediment transport takes place) will, together with the shoreline, shift seaward.

This means that the area in which the longshore transport is concentrated is gradually pushed seaward. Hence, the transport rate of the natural bypass will increase with time.

The breakwater will act as a bottleneck on both the wave-driven longshore flow and the large-scale counter-clockwise circulation in the eastern Mediterranean. The flow velocity will increase when this flow curves around the breakwater towards its tip. This is accompanied by increasing transport of sediment. This phenomenon will produce a scour hole directly in front of the breakwater, somewhat to the south of its tip. It is a process which counteracts itself. The increase of the water depth due to the scouring yields a reduction of the flow velocity which, in turn, reduces the scouring. This process evolves towards an equilibrium. It must be noted, however, that in equilibrium state, the scour hole may affect the stability of the breakwater. This must be taken into account in the design.

As mentioned before, the flow along the breakwater will spread in cross-shore direction as soon as it has passed the northern tip of that breakwater. It will spread in vertical direction as well when it reaches the entrance channel. This spreading is attended with a noticeable reduction of the flow velocity and, hence, of the sediment transport capacity. This means that sedimentation will occur around the entrance of the port. Major part of the material that is deposited in this area, originates from the longshore transport in the surf-zone (the natural bypass). Another part is related to the evolution of the mentioned scour hole.

Especially during the operation phase, sedimentation around the port entrance may be unfavourable as it may have a limiting effect of the size of ships that can enter the port. Computations, reported in part 11 of the Basic Engineering Study, have shown that ten years after construction of the port, the natural bypass will have reached a volume of up to about 5000 m^3/year. This necessitates minor maintenance dredging at the port entrance only. However, it the coast south of the port is allowed unlimited growth, the natural bypass will intensify and, hence, the requirement for maintenance dredging will increase.

North of the port, a new longshore flow is generated by waves. On average, this flow is directed southward inside the lee of the breakwater. Outside that lee, there will be a net northward flow. With the generation of this flow, the longshore sediment transport capacity is re-installed. To satisfy this capacity, sediment will be withdrawn from the nearshore zone. In other words, continuous erosion will occur. This process is the mirror image of the accretion south of the port.

At the proposed location of the port, the net longshore sediment transport amounts approximately 350,000 m^3/year (see part 11 of the Basic Engineering Study). Compared to this, the volume of the natural bypass is negligible. Hence, each year about 350,000 m^3 of sediment will be deposited south of the port and 350,000 m^3 will be withdrawn from the beach, the cliffs and the foreshore north of the port. This leads to a yearly gain of about 35,000 m^2 of beach area at the south and a yearly loss of some 18,000 m^2 of cliff area[2].

Apart from this longshore effect, the port has an impact on the cross-shore transport as well. The port itself can be seen as a practically non-erodible object which extends seaward across the morphologically active zone. In view of this, the port will yield, locally, a vast reduction of the offshore transport. South of the port, the accretion due to the interception of the longshore transport, provides the material which is needed to adjust the present steep foreshore towards an equilibrium shape. This will be attended with a reduction of the erosion at the beach and the cliffs. However, this reduction decreases with increasing distance from the port.

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2. These estimates are based on the assumption that accretion takes place in the surf-zone (which covers a height of approximately 10 m of the cross-shore profile), whereas erosion affects both the surf-zone and the cliffs (covering a height of about 20 m of the profile).

At the north side of the port, on the other hand, such an adjustment of the coastal profile will not occur as a result of the expected erosion. There, the net offshore transport will remain.

The effect of the port on the longshore transport will dominate the impact on coastal evolution. Already during the construction phase, this effect will be noticeable. This phase will last approximately 2.5 years. During that period, a total of approximately 40,000 m² of cliff area[3] will be lost by the end of the construction phase, unless appropriate countermeasures are taken.

- Change in groundwater resources and seawater intrusion

The change in groundwater resources and seawater intrusion is described in terms of the decrease in groundwater recharge caused by the presence of roads, pavement and buildings. Another criterion used is the dredged area in the harbour. Dredging may decrease resistance to groundwater flow. This may cause additional groundwater flow either seaward or landward depending on the piezometric level. This has a negative impact on the groundwater resources.

In the present situation, the area is threatened by agricultural expansion and in the long-term by urban expansion. Both cases will increase the demand for fresh groundwater. The port development will require limited quantities of freshwater for sanitation purposes. No water will be supplied to the vessels calling at the port during phase IA. In phase III water may be supplied to the vessels. The fresh water will not be extracted from the coastal aquifer but has to be produced in a desalination plant. Due to the high production costs of the fresh water the amount of water taken in by vessels will be limited. The demand of freshwater for industrial purposes will increase with the development of industrial areas in the hinterland. This demand has not been considered in the EIS.

The presence of roads, pavement and buildings in the port area will increase the surface run-off of rainwater and thus reduce the recharge of groundwater. An indication of the reduction of recharge can be calculated using the following assumptions:
. mean annual precipitation surplus: 150 mm/year;
. paved surface phase IA: 19 ha;
. paved surface phase III: 109 ha;
. reduction of mean annual precipitation surplus due to paved surface: 70%.

Reduction in groundwater recharge is calculated at about 20,000 m^3/year for phase IA. In phase III, the groundwater recharge will reduce to about 120,000 m^3/year. It must be stressed that these figures are indicative only.

The effect on dredging depends on the local geological situation. In phase IA, the access channels and the turning basin will be dredged to 9 m below MSL. In phase III, dredging will be carried out to 15 m below MSL. During dredging, intercalating clay layers may be removed thus decreasing resistance against groundwater flow. This will result in additional groundwater flow either seaward or landward depending on the piezometric levels at the location. It is not certain whether there are intercalating clay layers because no information on local lithology is available to the present day. Bathymetric data indicate a Kurkar ridge close to the surface of the sea bottom. Since the Kurkar Formation has a high transmissivity it can be expected that dredging and subsequent exposure of the Kurkar Formation to the sea water will reduce resistance to groundwater flow. In periods when groundwater flows to the sea, dredging will increase seaward groundwater flow and therefore reduce the groundwater resources.

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3. This figure is based on the estimated yearly loss of 18,000 m², reduced with 10% to account for the fact that the interception of the longshore transport will be introduced gradually as the construction of the breakwater progresses.

This will also be increased by dredging in periods of seawater encroachment (seawater flow into the aquifer). The presumed reduction of the resistance will have a negative impact on the groundwater resources in both seaward and landward groundwater flow. It should be noted that very fine sediments will settle on the bottom of the port as a result of the shelter of the breakwater. These sediments will increase resistance to groundwater flow and thus reduce the impact. When port sediments are dredged the resistance will again be reduced.

Information on the local geology and hydrology is essential to determine the impact on the groundwater resources. Increase of the contact possibilities between the coastal aquifer and the sea caused by the removal of intercalating clay layers, if present, may have considerable consequences for the fresh groundwater resources. However, there is no difference in impact between the proposed activity and the alternative.

- Soil and groundwater pollution.
  The probability of soil and groundwater pollution caused by spillage is considered to be proportional to the area of the terminal areas, port buildings and utilities and therefore this has been used as a criterion.

  For both the proposed activity and the alternative lay-out, measures have been taken to reduce the risk of soil and groundwater pollution by using sewerage and by applying impervious pavement on areas for storage of hazardous cargo and waste reception facilities.

- Surface water pollution.
  The probability of pollution of surface water is considered to be proportional to the total quantity of loaded and unloaded goods in Gaza port and therefore this has been used as a criterion.

  The calamity considered here is an oil spillage in the port area, as could occur when a ship is being fuelled or because of an accident with the oil terminal. In the alternative lay-out, the oil terminal will be located in the south part of the port. This location provides better control over the dispersal of an oil spot than the location in the proposed activity.

Assessment of the abiotic impacts of the port operation phase is presented in Table 6.8.

Table 6.8. Port operation phase: abiotic impacts

criteria	no action alternative	proposed activity		alternative	
		phase IA	phase III	phase IA	phase III
disturbance of the morphologic dynamic equilibrium	0	−−	−−	−−	−−
decrease in groundwater recharge (groundwater resources and seawater intrusion)	0	−	−−−	−	−−−
dredged area (groundwater resources and seawater intrusion)	0	−·	·−	·−	·−
paved area (soil and groundwater pollution)	0	−	−−	−	−−
loaded/unloaded goods (surface water pollution)	0	−	−−	−	−−

6.3.2. Biotic aspects: marine environment

operational activities

The port operational activities which may have an effect on the marine environment are as follows:

- maintenance dredging works;
- maintenance beach nourishment;
- disposal of dredged materials;
- shipping activities;
- anchoring of ships outside port;
- maintenance of port structures;
- calamities.

possible impacts

Changes in habitat area will occur during the construction phase but no significant changes are anticipated in the operation phase. The activities during the operation phase of the port and industrial area were examined with regard to:

- disturbance of habitats;
- destruction of flora and fauna;
- deterioration of habitat quality.

criteria

Criteria used to describe changes in habitat quality are:

- area destroyed and affected by dredging and/or beach nourishment;
- increased turbidity;
- increased sedimentation;
- increased pollution;
- increased disturbance.

impacts

- Area destroyed and affected by dredging and/or beach nourishment.
  The frequency of maintenance dredging and beach nourishment are not known but the latter may be required every five years. Maintenance dredging (exact quantities are unknown) and beach nourishment will regularly affect the areas concerned. This will lead to loss of diversity in the benthic community. More vulnerable species are likely to disappear and be replaced by more general species which can better cope with new extreme dynamics in the marine environment.

  As the length of dredging and beach nourishing activities is expected to be shorter in the operation phase than in the construction phase, the impact of increased turbidity and sedimentation during the operation phase is considered to be somewhat less negative.

  Disposal sites for material that will or can not be used for beach nourishment shall be located such that no precious habitat will be destroyed and that the dumped material will not enter the coastal beach zone in a latter stage.

- Increased turbidity and sedimentation by shipping activities.
  Apart from dredging and beach nourishment, turbidity and sedimentation pattern will also be negatively affected by the shipping activities in the harbour area. It is expected that shipping activities will have less effect on the concentration increase of suspended solids than dredging and beach nourishment activities, but the impact in almost continuously. The impact in phase III is assessed to be more severe, as the shipping activities are likely to be more extensive. There is no difference in character and scale between the two alternatives.

- Increased pollution.
  Pollution will mainly be caused by shipping activities, oil spillage, maintenance works on port constructions and operation of equipment in the port area and industrial activities in the hinterland. At present because there is no industry, pollution is mainly caused by domestic and agricultural sources, mainly organic substances and pesticides.
  The port and industrial activities may increase organic pollution and may lead to new chemical pollution. The scale and type of pollution depends largely on the scale and types of industries to be introduced and on the legislation (standards) to be developed. In comparison with the no action alternative, the impact is considered to be very negative but the impacts may be restricted if efforts are made to curtail waste and exhaust discharges.

  In relation to the no action alternative, the increase in pollution in phase IA is set at 100%. It is expected that port traffic in phase III (total 2,035,000 tons in year 2002) will be roughly 4.5 times higher than in phase IA (464,000 tons in year 1997) (Table 4.1). It is assumed that the resulting pollution in phase III will also be 4.5 times higher than in phase IA. There is no difference in character and scale between the two alternatives.

  In phase IA, 20% of the industrial area will be developed. In relation to the no action alternative, the resulting increase in pollution in phase IA is set at 100%. In phase III the total industrial area will be developed and this will result in five times more pollution (500%). There is no difference in character and scale between the two alternatives.

- Increased disturbance.
  The increased disturbance will be mainly caused by shipping activities and traffic and by anchoring outside the harbour. The impact is considered to be negative. In relation to the no action alternative, the increase in disturbance in phase IA is set at 100%. It is expected that the port traffic in phase III (total 2,035,000 tons in year 2002) will be roughly 4.5 times higher than in phase IA (464,000 tons in year 1997; see Table 4.1). It is assumed that the resulting pollution in phase III will also be 4.5 times higher than in phase IA. There is no difference in character and scale between the two alternatives.

- Potential impact of oil terminal.
  In phase III operation of the oil terminal will increase pollution. In the proposed alternative, control of calamities at the oil terminal, located at the entrance to the port, will be difficult. Wind-driven pollution of the area outside the port is foreseen. In the alternative, calamities at the oil terminal, located in the centre of the port, will be easier to control. Negative effects for the adjacent areas will be limited. Adequate port management and contingency plans will be required.

assessment of impacts

Assessment of the biotic impacts (marine environment) of the port operation phase is presented in Table 6.9.

Table 6.9. Port operation phase: biotic impacts marine environment

criteria	no action alternative	proposed activity		alternative	
		phase IA	phase III	phase IA	phase III
change in marine habitat quality					
area destroyed and affected by dredging + beach nourishment	0	——	——	——	——
increased turbidity + sedimentation due to shipping activities (%)	0	100	450	100	450
increase in pollution and deposition by harbour activities (%)	0	100	450	100	450
increase in pollution and deposition by industrial activities (%)	0	100	500	100	500
increase in solid waste pollution (%)	0	100	450	150	450
increase in disturbance	0	100	450	100	450
potential impact of oil terminal	0	0	———	0	——

6.3.3. Biotic aspects: terrestrial environment

operational activities

The operational activities which can have an effect on the terrestrial environment are:
- transport on land;
- industrial operations.

possible impacts

Habitat area will change in the construction phase, but no significant changes are anticipated in the operation phase. The habitat quality may deteriorate during the operation phase of the port and industrial area.

criteria

Criteria used to describe changes in habitat quality are:
- increase in noise, dust and traffic;
- pollution and deposition due to industrial activities;
- increase in solid waste pollution.

impacts

- Increase in noise, dust and traffic.
  Continued disturbance caused by noise, dust and traffic movement will put stress on the natural environment. The Kurkar Cliffs and stabilized dune area adjacent to the harbour location and industrial area will be negatively affected. Noise, dust and traffic will primarily affect larger reptiles, mammals and birds, and the vegetation will be negatively affected by dust deposition. The impact will be less in phase IA when only 20% of the industrial area is developed than during the operation phase III. In relation to the no-action alternative (impact is 0) the impact in phase IA is set at 100%. As to scale and character there is no difference between the proposed activity and the alternative.

  Careful planning of the major transport roads may be instrumental in minimizing the negative impact on the adjacent areas.

- Pollution and deposition due to industrial activities.
  Pollution and deposition will increase in the surrounding areas as a result of industrial activities. The oligotrophic sandy areas are very vulnerable to contamination because the buffer capacity is low. Increased and continuing pollution and deposition will affect the chemical environment. Sensitive plant and animal species will be affected.

The impact will be less in phase IA when only 20% of the industrial area is developed than in phase III. In relation to the no-action alternative (impact is 0) the impact in phase IA is set at 100%. There is no difference between the proposed activity and the alternative with regard to scale and character.

The actual development of the industrial area is not known. Careful planning (zoning) and adequate legislation and enforcement may well be instrumental in minimizing the negative impacts.

- Increase in solid waste pollution.
  At present, solid waste disposal is uncontrolled throughout the Gaza Strip (GEP, 1994). Operation of the port and industrial area will lead to an increase in solid waste pollution in the terrestrial environment. Dump sites will lead to a direct loss of habitat. Dump sites and non-point waste disposal will also lead to deterioration of habitat quality. At the same time, increase in undesired pest species, mostly insects and rodents, may be expected, which will most likely have a negative impact on the characteristic resident fauna. The extent is not known, but assuming a constant rate of increase of solid waste pollution per hectare of port and industrial area to be developed, the impact in phase III will be more negative than in phase IA. There is no difference between the two alternatives with regard to character and scale.

  The development of the industrial area is not known. Careful planning, controlled waste disposal at official sites, adequate legislation and enforcement may be instrumental in minimizing the negative impacts.

assessment of impacts
Assessment of the biotic impacts (terrestrial environment) of the port operation phase is presented in Table 6.10.

Table 6.10. Port operation phase: biotic impacts terrestrial environment

criteria	no action alternative	proposed activity		alternative	
		phase IA	phase III	phase IA	phase III
change in terrestrial habitat quality					
increase in noise, dust, traffic (%)	0	100	500	100	500
increase in pollution and deposition (%)	0	100	500	100	500
increase in solid waste pollution (%)	0	100	500	100	500

6.3.4. Hindrance
operational activities
The activities during operation which may create hindrance are as follows:
- cargo handling operations;
- cargo storage;
- industrial activities;
- waste handling;
- shipping traffic;
- berthing of vessels;
- bunkering of vessels;
- land transport;
- maintenance of port structures.

These impacts can be assessed in two ways as follows:
- description and assessment of the emissions of the construction activities and calculation of the resulting emissions;
- determination of the distance between construction areas and sensitive areas such as housing and recreation by zoning and monitoring.

The first approach is frequently used in environmental impact assessments but is not suitable for this EIS for various reasons:
- accurate calculations of the emission per day cannot be made because little is known about the extent of activities per day, the traffic movement per day, emissions per engine or machine and the background concentrations;
- at present, there is no environmental legislation in Gaza; results of assessments cannot be compared with standards;
- there is no dispersion model for the Gaza Strip for use in air pollution assessment.

Therefore, the zoning and monitoring approach was chosen. The general consideration is that the port, the industrial area and the road infrastructure should be located at a safe distance from sensitive areas (Table 6.11).

Table 6.11. Minimum distances between port activities and urban areas

activity	minimum distance (m)		
	air quality	noise	safety
port:			
- containers	30	300	100
- general cargo	10	500	100
- ores and minerals	100	1000	50
- grain	200	500	100
- coal	100	1000	100
- oil	300	200	1000
- tanker cleaning	300	200	200
industries	500		
road infrastructure	400		

Table 6.11 is visualized in Figure 6.3., in which for the port the largest distances for air quality (300 m), noise (1000 m) and safety (1000 m), for industries and road infrastructure a general distance (air, noise and safety) of 500 m, respectively 400 m are shown. From table and figure it appears that environmental limitions on spatial functions caused by the port itself are relatively limited. The industrial developments and road infrastructure will put considerable spatial restrictions on the land use of other functions.

It should be emphasized that the minimum distance for industries can be increased if very large industries are to be established.

possible impacts
It may be anticipated that the port development will have no positive environmental impacts. During the operation phase, safety, air quality and noise level will have an impact.

criteria
Activities during port operation can lead to a change in:
- air quality (including dust);
- noise level (including vibrations);
- safety at the port and industrial area.

impacts

air quality
In the operation phase there will be no difference in air pollution effects between the two alternatives. The main issue is to maintain a safe distance between the working zones and the urban areas. This distance should be at least 1,000 m and within this distance, concentrations will be higher than the background concentrations.

No differences between alternatives are not expected with regard to the socio-economic impacts. The motivation is the same as in the construction phase.

noise
- Occupational health impacts.
  The potential occupational health impact will be the same for both alternatives. Health problems such as deafness or other hearing problems only occur if people are exposed to a high noise level (over 80 dB(A)) for a period of several years. There are no specific occupational health problems due to noise in ports. There is also no difference between the alternatives.
- Noise sensitive areas
  In a comparison of the alternatives, the port and port-related activities such as services, industrial areas and traffic were taken into account.
  According to normal environmental quality standards, the noise impact of the port itself will be the same for both alternatives. There should be a safe distance (zone) between the port activities and the noise sensitive areas of at least 1,000 m. One can expect noise related problems to occur for people living on a shorter distance, for example for people living in Sheikh 'Aljin. For road infrastructure and port related industrial areas the safe distance will be about 400 m and 1,000 m. On shorter distances measures will be necessary to diminish or to avoid noise related problems (sound insulation, sound barriers e.g.).
- Vibrations.
  There is no change expected regarding the vibrations due to port and port related activities. Vibrations might be felt more often, but for both alternatives this will have no serious negative impact.

safety
The safety in the area may be affected by port activities and industrial traffic.

Safety aspects are distinguished according to the risks to the population in the neighbouring residential areas (individual risk and group risk) and risks to the environment (spillage of hazardous substances). Port and shipping activities are related to the port lay-out and the movement, berthing, loading and unloading of ships as well as stationary activities such as storage tanks for petroleum products, storage warehouses for containers and dangerous goods and the ammonia-based refrigeration plant for the refrigeration of fish-containing containers.

Risks to the environment are mainly due to spillage of hazardous substances to the surface water such as petroleum products and dangerous goods as pesticides in the transported containers. Spillages may occur inside or outside the port.

- Port and shipping activities:
  . events that may affect safety in the port area include:
- spillage of petroleum products and other dangerous substances;
- accidents at sea caused by shipping traffic;
- accidents during vessel berthing;
- explosions and/or fire.

At present, there are no data available on the type of cargo to be handled in the port. Furthermore, a complete safety or risk analysis is beyond the scope of the EIS. It is, however, clear that oil and oil products will be handled in the port.

PIANC provides guidelines for typical spill of liquid bulk cargo during cargo handling operations. According to PIANC a typical spill would have a duration of:
- 90 seconds before the spill is observed;
- 30 seconds before the ship and/or shore valves are closed.

Assume a pump capacity of some 1,500 m^3 per hour then a typical spill would amount to some 50 m^3. Emergency shut-down valves may again reduce the quantity of spill.

The facilities for oil handling are located at different sites in the two alternative lay-outs. In phase III, the alternative lay-out offers some advantages over the proposed lay-out, namely:
- the pipeline route is shorter;
- in case of spillage, oil can be easily confined to the oil terminal basin;
- oil spillages in the proposed lay-out are difficult to confine and are likely to disperse from the port and pollute the sea and the adjacent beaches (note: the prevailing wind direction is W to NNW);
- in the alternative lay-out there is less traffic of other vessels along the oil terminal.

A disadvantage of the alternative lay-out in this respect is the fact that the oil terminal is somewhat closer to populated areas. The alternative lay-out offers more advantages from a safety point of view than does the proposed lay-out.

Liquid petroleum products such as petrol, kerosene, diesel oil and fuel oil produce an oily slick on the surface water. Outside the port such a slick will move mostly in a northerly direction because of the sea current. Within the port, there will be no current and hence no movement of a slick.

Furthermore, wind direction and speed are of great importance to the movement of an oil slick. Wind will move oil at a speed of 2 - 4% of the wind speed. If the wind direction is north-west, the slick will move towards the beaches of Gaza city. The resulting direction and velocity of the slick movement is a vectorial composition of the movement speed by wind and current. If the wind direction is south-west, the slick will move parallel to the coast in northerly direction, and will have cross-border effects (pollution of Israeli coastal waters and beaches). Outside the port there are no differences between the proposed lay-out and the alternative lay-out.

The disappearance of an oil slick depends on the physical and chemical properties of the spilled material. Petrol and kerosine will evaporate while fuel oil or diesel will weather and emulsify. Weathering enhances evaporation, whereas emulsification will hamper evaporation.

Depending on physical properties such as density and water solubility, dangerous substances in containers can float, sink or dissolve. Undamaged containers lost from a ship outside the port will not give rise to sea pollution. But if these containers are not recovered, they will corrode and then spill their contents. Container damage with subsequent loss of dangerous substances will only occur during transshipment in the port. Due to the absence of current within the port area, there is no danger of pollution to the beaches and coastal areas.

In case of explosions and fire, vessels carrying hazardous cargo such as oil or petroleum products shall be capable to depart forthwith. Oil terminal berths and the like shall therefore be equipped with quick release hooks and the vessels shall be berthed low-out to allow for a fast departure with own propulsion (hence without the aid of the tug boats).

The shipping traffic to and from the port makes use of a dredged approach channel which shall have safe and sufficient depth and which shall be provided with a system of aids to navigation that is sufficiently accurate under the given circumstances (currents, winds, waves, channel width, etc.). The orientation of the approach channel is mainly determined by the direction of the main breakwater and by adopting a channel concept without bends. This has led to a channel direction which makes a small angle with the coast line and runs at a relatively small distance from the coast. Furthermore, the channel is almost perpendicular to the prevailing winds and waves. Introducing a bend at the breakwater end in phase IA, and thus an outer channel part which is more perpendicular to the coast, improve the situation from a safety point of view. However, assuming that phase III will eventually implemented, it is not considered advisable to dredge the area where the future breakwater is projected. Furthermore, the total amount of dredging work would increase if phase IA channel cannot be used in later project phases anymore.

As the alternative lay-out introduces a channel which has a direction that is slightly more seaward, the alternative is more attractive in this respect.

- Industrial activities
  Spillage of liquids due to industrial activities may occur at storage tanks for petroleum products or in storage sheds. Spillage to surface water from storage tanks may occur if the liquid petroleum products are not kept in the tank pits, that is if the drain off valves for rainwater are not closed.
  Petroleum products will result in an oily slick floating on the surface water. In the port itself, there is no current and hence there will be no movement of the oily slick.

  Spillage to surface water from storage sheds may occur if a fire is extinguished with large amounts of water. If the fire fighting water is not contained, large amounts of toxic substances will be flushed into the surface water. Depending on the physical properties, the substances will dissolve, float or sink. Risks to the population in residential areas of the Gaza Strip may result from the release of explosive or toxic substances. There are no differences between the two lay-outs.

  If an ammonia-refrigerating plant is to be established (phase III or later) another source of risk will be introduced. As specific data about lay-out, capacity and safety measures for the plant in Gaza are unknown, only international data can be used to assess the risks. From Dutch data on comparable refrigerating plants, it can be concluded that individual risk of 10^{-6}/year may be 500 m from the plant; 10^{-8}/year at 1,000 m from the plant.

  A toxic ammonia cloud will only cause risk to the population if the wind direction is west-south-west and the wind speed is up to 1.5 to 10 m/s. From the wind climate tables, it can be concluded that this is only the case in 3% of the time. If the probability of a serious release of a toxic ammonia cloud is set on 10^{-5}/y (once in 100,000 years), the probability for a toxic cloud reaching Gaza will be 10^{-7}/y (once in 10 million years). This is an acceptable risk. Criteria for group risks will not be exceeded. The risks from storage of dangerous cargo in containers are negligible. Amounts of dangerous goods in the containers are only a minority of the total stored goods.

  With respect to the zoning (Figure 6.3.) it should be noted that the port and related activities will have a considerable spatial impact of that part of the Gaza Strip. In view of the high population pressure adequate spatial planning and legislation is necessary in order to avoid serious conflicts between different spatial interests, like port-related functions, housing, agriculture and recreation. It is of the utmost importance that the physical plan, under preparation at the Ministry of Planning and International Cooperation will come into being as soon as possible.

assessment of impacts
Assessment of the impacts of hinderance in the port operation phase are presented in Table 6.12.

Table 6.12. Port operation phase: impacts of hindrance

criteria	no action alternative	proposed activity		alternative	
		phase IA	phase III	phase IA	phase III
changes in air quality	0	—	——	—	——
changes in noise level	0	—	——	—	——
changes in safety situation					
- inside port area	0	—	———	—	—
- outside port area (open sea)	0	—	——	—	—
- industrial area	0	—	—	—	—

It is assumed that all applicable international laws and guidelines related to safety and hindrance reduction and control are taken into account during the design works and will be fully reflected in the ultimate designs of the various port elements.

This means that services/utilities, technical installations and equipment, land and water infrastructure shall all meet acceptable safety standards.

6.3.5. Socio-economic environment

operational activities
The activities generated by a port and the industrial area will have socio-economic impacts on the Gaza Strip. Until very recently, the area had a rather traditional socio-economic, agricultural structure. The introduction of transport and industrial activities may lead to other labour relations and changes to the way of life of the people, for example, a move from a traditional to a more urban community.

possible impacts
Activities during port operation can affect:
- employment, immigration and incomes;
- urban population growth and urbanization of the port area;
- tourism patterns.

criteria
The expected increases in employment and incomes are expressed in numbers and percentages with respect to the current situation. Increasing immigration, urbanization of the port area and changes in tourism pattern can only be addressed qualitatively.

impacts
- Changes in employment and incomes.
  It is expected that the port development will create employment for 350 people in phase IA, and for up to 650 people in phase III. As the industrial development (area, number of companies, type of industries and phasing) is unknown, no statements can be made about the impacts of the port. Port employment will lead to a growth in overall employment in Gaza of 0.25% in phase IA, rising to 0.47% in phase III. Income levels, as a result, will increase and consequently the standard of living will improve. A skilled work force is available in most areas, but in some areas people will need additional training in new skills. Economic activities of the port and ancillary developments will attract more people to the area.

As the development of phase IA is relatively limited, the impact on employment will also be limited. Phase III is larger and will consequently attract more people to the area. The two alternatives will show no differences in increase in employment, immigration figures and income situation.

- Urban population growth and urbanization of the port area.
  As already stated, there will be rapid urban growth in the Gaza Strip. Despite the higher land prices, people tend to settle in areas of major economic development such as a port area. In Gaza this could lead to problems because the PNA has no instruments to stop uncontrolled building of housing units. Containment is possible if the Palestinian authorities adopt legislation and regulations to prohibit expansion southward. The two alternatives show no differences with regards to urbanization.
- Tourism.
  The beaches are potential areas for development, however, the construction and operation of the port will lead to loss of recreation possibilities at the location of the port and its direct vicinity. The loss will almost be the same in the proposed lay-out and in the alternative lay-out. Alternative possibilities for beach recreation are found more to the south of the Gaza strip and north of Gaza city.

assessment of impacts

Assessment of the socio-economic impacts of the port operation phase is presented in Table 6.13.

Table 6.13. Port operation phase: socio-economic impacts

criteria	no action alternative	proposed activity		alternative	
		phase IA	phase III	phase IA	phase III
changes in employment and income situation	0	+	+ +	+	+ +
urban population growth and urbanization of the port area	0	—	—	—	—
changes in tourism patterns: loss of beach	0	1.3 km	1.8 km	1.1 km	1.7 km

On the micro level there are some disadvantages with to the socio-economic conditions. For the Gaza Strip as a whole (macro level) the development of the port can give the economy an important stimulus.

6.4. Impacts at borrow areas

construction materials

Different types of materials are required in the construction of the Gaza Sea Port. From an environmental point of view, borrow areas are particularly importance because large quantities of material are needed for construction of the dam or causeway, the main and secondary breakwater, piers and terminal areas.

The following quantities of bulky materials will be required for the construction of the port:
- rock for breakwater and other structures: about 280,000 m^3;
- sand for concrete: 17,500 m^3;
- sand for the dam/causeway: 680,000 m^3.

Rocks in the quantities stated above is not available in the Gaza Strip and will therefore have to be obtained from other locations.

requirements
All grades of rock must meet the following requirements:
- water absorption when tested not to exceed 3% by weight;
- the specific gravity (saturated surface dry) when determined shall not be less than 2.6 ton/m^3;
- the minimum comprehensive strength when tested must not be less than 60 N/m^2;
- when subjected to five cycles of the soundness test magnesium sulphate solution of the rock must not show a loss exceeding 18%;
- when subjected to the resistance to abrasion the rock must not show a loss exceeding 25%;
- the dimension of the greatest axis of any piece of rock must not be more than twice the dimension of the smallest axis.

potential borrow areas
Suitable rock can be obtained from various locations, e.g. the West Bank, Turkey, Norway or Egypt. In January 1996, a borrow area was not yet selected. Thus only tentative conclusions can be made with respect to environmental impacts at borrow areas. As transport is an important item, attention is given to locations which are relatively close to the Gaza Strip: the West Bank. It is not known whether the rock of the West Bank meets the requirements listed above.

environmental considerations
There are a number of environmental considerations in selecting a quarry:
- site characteristics of the quarry:
- effect on landscape;
- effect on hydrology;
- loss of vegetation cover;
- effect on functional and spatial structure and land use:
- loss of archaeological sites;
- distance of transport to Gaza.

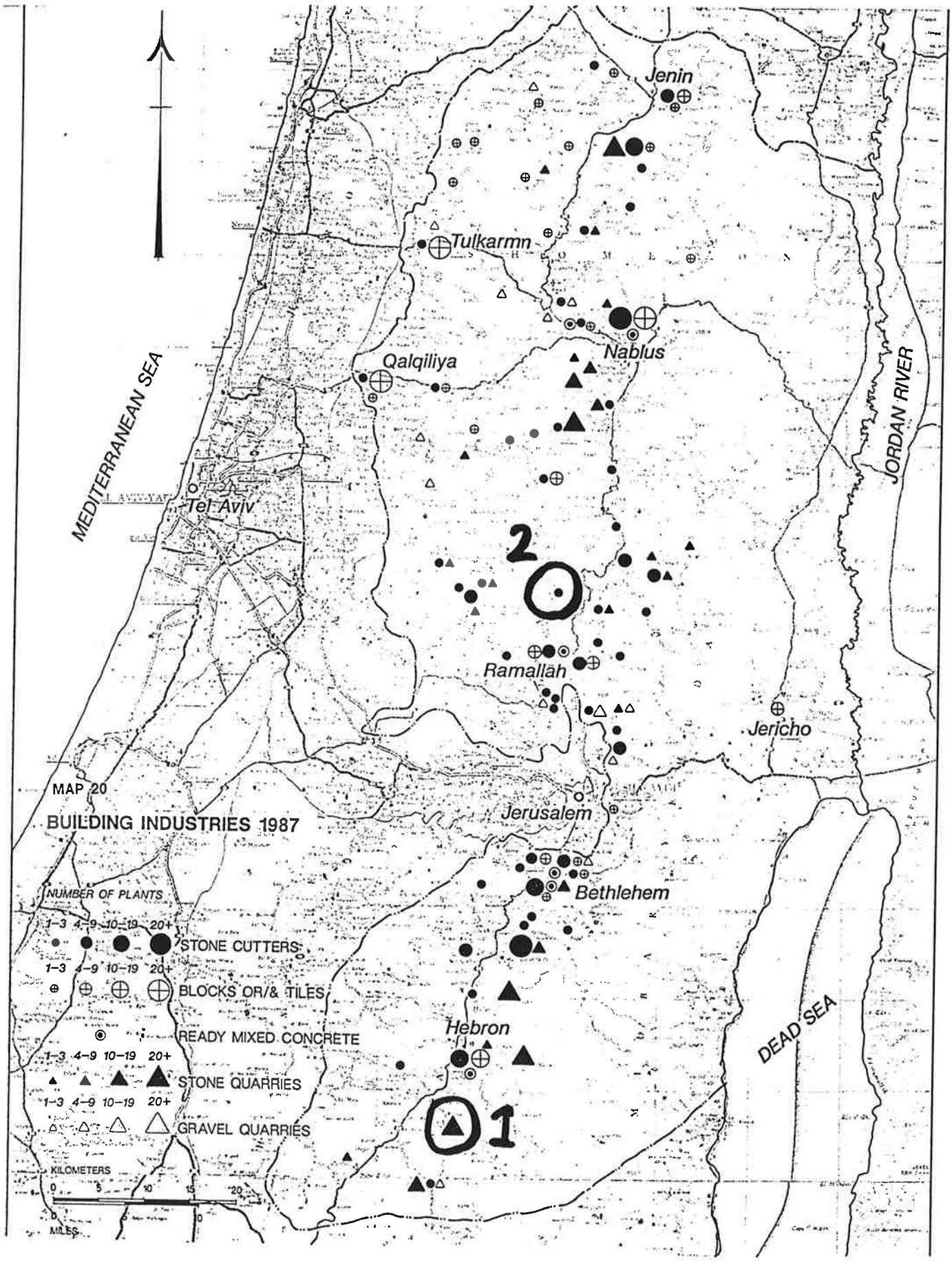
It is recommended to obtain the rock from an already existing quarry site and not to open a new one.

Two likely quarries have been investigated:
- Hebron quarries;
- Quarry Bir Zeit near Ramallah (Figure 6.4.).

Hebron quarries
The quarries owned by Osaily Trading are about 5 km south-west of Hebron in a relatively uninhabited area. The nearest dwellings are about 1 km away. The quarry is at the top of the hill in some sort of open cast mine. The landscape is rough and stony. Quarrying activities do not interfere with the groundwater table because of the relatively high location of the site. The vegetation cover is less than 5 cm very thick. Quarrying is greatly damaging the natural surroundings. The functional structure of the area does not change very much, as the spatial structure is affected by the digging up of the hills. As far as known, there are no archaeological features on the site of the quarries. The distance to Gaza City in about 60 km and by road (via Erez) is about 80 km.

quarry Bir Zeit near Ramallah
This quarry is near the centre of Bir Zeit, 7.5 km north of Ramallah. The nearest buildings are about 500 m from the site. The quarry is in a rough mountainous area and there is open cast mining in a rough landscape. The quarry is not much higher than its surroundings and quarrying may interfere with the groundwater table in the winter. Vegetation cover is less than 5 cm thick. Quarrying is doing considerable damage to the natural surroundings. The functional structure of the area will not change very much if the spatial structure is destroyed.

Figure 6.4. Potential quarries at the West Bank



1) Quarry at Hebron
2) Quarry at Bir Zeit

As far as known, there are no archaeological features at the quarry site. The entrance road to the quarry is very narrow and bumpy. The distance to Gaza City is about 85 km and by road (via Erez) about 100 km.

comparison of quarries
It is assumed that the quarries at both Hebron and Bir Zeit can provide enough stones of the specified quality and dimension and weight. A comparison of the features of the two quarries is set out in Table 6.14.

Table 6.14. Comparison of quarries at Hebron and Bir Zeit

environmental considerations	quarries	
	Hebron	Bir Zeit
site characteristics	+	—
landscape	0	0
hydrology	+	—
vegetation cover	0	0
functional and spatial structure	0	0
archaeological sites	0	0
distance to Gaza	+	—

0 no difference between quarry Hebron and quarry Bir Zeit;
+ Hebron is better than Bir Zeit; or Bir Zeit is better than quarry Hebron;
— Hebron is not better than Bir Zeit or Bir Zeit is not better than Hebron.

Under the given conditions, it seems that, from environmental point of view, Hebron is more favourable than Bir Zeit. The reasons for this are the less chance of influencing the groundwater table and the distance to the port is shorter.

6.5. Induced developments
It is probable that the development of the port will have some consequences for the spatial structure and socio-economic conditions of the Gaza Strip. Changes in these areas will have repercussions on the environment. As already stated, the port could introduce considerable industrial development. In the long-term this industrial development could take up much of the scarce space in the Gaza Strip. This fact is cause for concern because there is no legislation on physical planning and environment in the Gaza Strip. It is of the utmost importance that adequate legislation be enacted and implemented as soon as possible.

As it is unknown what the economic development of the port will produce, it is very difficult and not very useful to quantify the environmental and social-economic impacts of these induced developments. It will certainly increasing economic activity and population pressure will put additional stress on scarce resources. The impacts on the following aspects have been addressed:
- land use;
- waste water treatment;
- claim on water and energy supplies;
- loss of habitats and economic potential;
- loss of cultural heritage;
- social acceptance;
- air pollution and dust;
- noise.

With respect to land use, it should be noted that a limited number of 2 housing units will have to be removed in phase IA. Alternative accommodation will have to be found for the inhabitants of these houses. Resettlement should be available at the start of port construction.

6.6. Institutional impacts

The development of port means a heavy task for most authorities involved. Due to lack of knowledge and experience it is probable that specially in the beginning mistakes will be made by organizations and individuals, some of them may have a negative impact an the environment. Positive effects may appear from growing awareness and efforts with respect to environmental issues by capacity building of (environmental) staff and management within the responsible authorities.

The environmental effects and risks of institutional malfunctioning can not be computed at this moment as there are to many uncertainties in relation to the scale of port development. An important issue is the appointment of skilled labour with respect to environmental issues. This is a responsibility for the port authority.

6.7. Comparison of alternatives

The assessments set out in Tables 6.2 to 6.5 and Tables 6.7 to 6.13 are summarized in Table 6.15.

Table 6.15. Assessment of the impacts of the proposed activity and the alternative

impacts on main aspects	impacts on aspects	no action alternative	proposed activity		alternative	
			phase IA	phase III	phase IA	phase III
construction phase						
abiotic aspects	coastal morphology soil groundwater surface water	0	—	——	—	——
biotic aspects: marine environment	flora fauna	0	——	——	——	——
biotic aspects: terrestrial environ- ment	flora fauna	0	——	——	——	——
natural environment	landscape archaeology	0	—/——	——	—/——	——
hindrance	air quality noise safety	0	0/—	—	0/—	—
socio-economic environment	socio-economic environment	0	+/0	+/0	+/0	+/0
operation phase						
abiotic aspects	coastal morphology soil groundwater surface water	0	—	——	—	——
biotic aspects: marine environment	flora fauna	0	—	——/———	—	——
biotic aspects: terrestrial environ- ment	flora fauna	0	—	——	—	——
hindrance	air quality noise safety	0	—	——/———	—	—/——
socio-economic environment	socio-economic environment	0	0	+	0	+

From Table 6.15 it appears that there is very little difference between the alternatives from an environmental point of view. For phase IA there are no differences. In phase III the main difference is caused by the location of the oil terminal. Safety considerations and marine biology favour the location of the terminal closer to the coast. The little differences between the proposed activity and the alternative do not make it necessary to introduce weighting factors, for example to stress the importance of the impacts of coastal erosion against the appearance of other environmental impacts, in the comparison. Such procedures would always lead to the same results.

7. MOST ENVIRONMENTALLY FRIENDLY ALTERNATIVE, MITIGATING AND COMPENSATING MEASURES

7.1. Most environmentally friendly alternative

The environmental and socio-economic impacts of the proposed port development are set out in Chapter 6 in which two lay-outs for the port are compared - the proposed lay-out and an alternative - with a no action situation. The impacts of the construction and operation of the port are compared in the initial phase (IA) and the final phase (III).

It appears that the construction and operation of the port in both alternatives will have considerable environmental impacts in relation to the no action alternative. Furthermore, both alternatives differ mainly in impacts with regard to the location of the oil terminal.

From an environmental point of view, the alternative lay-out is slightly more preferable than the proposed lay-out. From an socio-economical point of view, there is no difference, only if the threat and the impacts of oil spillage or other such accidents are considered as socio-economic impacts as well. Before implementation of phase III, a detailed analysis should be made to determine the most favourable location of the oil terminal.

Based on the comparison of the environmental and socio-economic impacts of the proposed activity and the alternative, the alternative is recommended as most environmentally friendly alternative. In order to ensure that the negative environmental impacts of the Gaza Sea Port are minimized, a set of mitigating and compensating measures is recommended and these are set out in Section 7.2.

7.2. Mitigating and compensating measures

Mitigating and compensating measures are defined as follows:
- mitigating measures are measures taken in the region of the project and are intended to diminish the negative effects of the proposed activity;
- compensating measures are intended to create new values in another region comparable with the lost values in the region of the project.

7.2.1. Mitigating measures

Six categories of mitigating measures need to be formulated and implemented as follows:
- legal and institutional measures:
  . environmental legislation*;
  . environmental control unit;
  . a coastal management plan;
  . port management: port regulations and enforcement*;
  . effective supervision during port construction.
- safety measures:
  . a contingency plan.
- water an soil management measures:
  . MARPOL convention for the sea;
  . prevention of spillages;
  . prevention of waterfront discharges;
  . wastewater collection and treatment;
  . a water conservation and management plan*.
- physical planning measures:
  . zoning between the different artificial activities and nature and the environment*;
  . establishment of an industrial planning board;
  . a resettlement plan*.
- nature conservation and archaeologic conservation measures:
  . rehabilitation of valuable nature areas;
  . making a rescue plan for archaeology*.

- technical measures:
  . sand bypassing to minimize coastal erosion*;
  . solid waste handling*.

The items marked with a star (*) are of special importance. The following recommendations in sequence of importance are made (in which the establishment of a sound and responsible port management is an indispensable part of the whole project):

preventing and minimizing coastal erosion
The impact of the port on coastal evolution is that accretion will occur south of the port and at the north side of it, the coast will erode heavily. Especially this erosion necessitates effective counter measures to prevent far-reaching interference with existing values at and near the coast north of the port. Coastal defence works, such as groynes or a rock dump on the beach, will merely move the erosive process to where the defence works end. Hence, such works are appropriate only if they are used to divert the erosion to an area where it can be accepted. In view of the persistent nature of the erosion and the erosion rate, however, it is not possible to find such an area anywhere along the Gaza coast. This means that the erosion needs to be compensated by artificial nourishment of the shore. As the erosion results from intercepting the longshore transport, the need for nourishment will be present as long as the port exists, no matter whether it is in operation or not.

zoning between the different artificial activities and nature and the environment
As there is no specified legislation on environment and physical planning for the Gaza Strip, it is of the utmost importance that the Palestinian authorities ensure that sufficient distance is maintained between port activities and sensitive areas such as residential and recreational areas. As pointed out in Chapter 6, while zoning should aim to prevent noise hindrance, air pollution and other risks, there is no legislation on physical planning. The physical plan has to get a legal status in 1996 as soon as possible. It is advisable that the authorities establish as many physical obstacles as possible in the transitional zone between port and residential areas in order to prevent the development of scattered industries and houses which could give rise to hindrance. Another way to prevent environmental problems is for the authorities to acquire the land.

environmental legislation
It appeared that no environmental legislation is enforced in the Gaza Strip (Chapter 3). The Environmental Planning Directorate is developing an enforcement system; and other legislation is being prepared.

For the sustainable development of the Gaza Strip, a framework of environmental legislation is needed for the port and other infrastructure and for industrial activities. Legislation will need to be developed in the coming year for preservation of groundwater and surface water, zoning of industrial and other activities and pollution level in relation to the health of the population. Subsequently, legislation will need to be prepared on nature conservation, air pollution, water management, noise abatement, environmental impact assessment, and enforcement. It is preferable to start with a general framework of environmental legislation which can subsequently be expanded in more detail.

Some international treaties will require ratification by the parliament before they can be implemented, and other treaties will only need approval by the government.

It is not possible to formulate a time schedule for the preparation and enactment of environmental legislation. This will depend largely on the internal and external political situation in the country. The PNA, however, can draw on the experience of other countries.

An Integral Environmental Care System (IECS) of the Gaza Sea Port Authority to prevent environmental deterioration and pollution should be part of the port management. The development of the IECS should be a task of the environmental officer.

water conservation and management plan
In the proposed activity, rainfall will be collected from buildings and roads, and drained into the sewerage. As a mitigating measure, rainwater from buildings can be artificially infiltrated in, for example, an area with coarse grained material. The size of the infiltration area will depend on the amount and composition of the material, the area of the connected buildings, roads and rainfall characteristics of the location.
In all case it should be forbidden that fresh groundwater will be used for big scale applications during construction and operation of the port.

Instead of pumping groundwater from the coastal aquifer, fresh water may be obtained from sources outside Gaza or produced in a desalination plant. The environmental impacts of these sources will need to be assessed.

solid waste handling
Construction and operation activities will produce all kinds of solid waste. In all cases the production of solid waste should be prevented as much as possible. This could be realized by a low consumption of packing materials. Furthermore techniques of re-use of waste should be investigated and applied. The remaining waste after prevention and recycling should be processed in an environmental proper way, dumping should take place on so-called controlled dumping sites. This means that the underground of the site is protected by an impervious foil and the site is daily covered by ground in order to prevent the dispersal of rests of solid waste. Waste management should be a part of the Integral Environmental Care System.

resettlement plan
As stated in Chapter 6, only a few housing units (about 10 people) will have to be removed to make way for phase IA of the port development. The resettlement of these people is part of the project and the Palestinian authorities will take responsibility for this. It is recommended that the resettlement should be prepared in close cooperation with the people involved. The resettlement should be financed by the overall funds for port construction.

rescue plan for archaeology
Further archaeological fieldwork is recommended. A detailed archaeological survey of the entire area should be made before construction work starts. The survey results may lead to additional excavation of selected sites in order to minimize loss of archaeological material.

Various archaeological institutions around the world, especially those involved in Levantine archaeology, will have an interest in implementing rescue operations (survey and additional excavation) in the Gaza Strip. However, most institutions are already committed in fieldwork elsewhere and generally have restricted budgets. It is therefore unlikely that these institutions will be able to carry out additional fieldwork without external funding. It is strongly recommended that a proportion of the total funds for port construction be reserved for archaeological rescue operations (0.1 to 0.2% of the total budget for phase IA seems to be a reasonable indication, depending on the scale of the archaeological work). A detailed field survey is the initial step in any rescue plan. In addition, excavation may be required. The survey work will require a team of at least five archaeologists for a period of about 6 weeks in the field. Processing of the data from the field work will take a further three months.

port management
In Chapter 4, it is assumed that there will be a well-organized port authority, which will deal with environmental matters associated with the port. The organizational structures and procedures of the port authority are set out in Chapter 8.

A separate study on the establishment of a port authority started at the end of 1995 and will be completed early 1996. This study is financed by the Netherlands Government and is being carried out by IMTA (Port of Amsterdam), which is responsible for training and institutional building and by the Port Authority of Rotterdam, which is responsible for setting up a management system. The Port Authority will have an Environmental Officer, and fees and levies collected for port operations will contribute to coastal management and other environmental protection requirements.

Port regulations will have to be established and will need to address requirements for environmentally sound and safe port operations.

The cross-shore transport processes and the steepness of the upper part of the cross-shore profile (approximately above the 5 m depth contour) result in a net offshore transport from the surf-zone into deeper water. In view of this, it is advised to perform such nourishments in the surf-zone instead of at the foreshore.

Theoretically, it is possible to combine coastal defence works with nourishments. However, that is not attractive from an economical point of view. The defence works do not change the need for nourishments or the amount of sediment that needs to be nourished. Such a combination is advantageous only if the nourishments cannot be carried out at the location where erosion would occur without the defence works. This does not apply to the coast north of the port.

The sediment that is required for the nourishments can be withdrawn from the accretion south of the port. This source has various advantages. First of all, it concerns sediment which naturally occurs in the surf zone. Furthermore, the amount of sediment produced by this source covers major part of the volume needed for nourishments. In addition, it prevents a persistent increase of the natural bypass and, hence, it reduces the need for maintenance dredging in the port entrance.

Dredging of material from this source should be performed preferably just outside the surf-zone. The so-created deficit of sediment in this area will be supplemented by the net offshore transport at the expense of the beach. This way, the dredging will result in a retreat of the coastline which, in view of the accretion in this area, can be allowed. It must be noted, however, that dredging at the proposed location may not be possible due to the presence of Kurkar layers. As information on this matter is not available yet, it is advised that the contractor is commissioned to investigate the possibility of dredging just outside the surf-zone, south of the port and, if so required, to designate an appropriate alternative location. In this respect, it is noted that the position of possible Kurkar layers relative to the surf-zone varies with time as a result of the persistent accretion.

The processes of erosion (north of the location of the port) and accretion (south of that location), are initiated simultaneously by the construction of that part of the port which is located in the surf-zone and/or the foreshore. Already during an early stage of the construction phase, the erosion will endanger the coastal area as well as the corresponding nature values, socio-economic activities etcetera. Against this background, it is strongly advised to include preventive nourishment in the construction of the port. Planning of such nourishments in terms of time, frequency, location and volume should be part of the port design.

At the time that the preventive nourishment(s) are needed, the accretion south of the location of the port will not have progressed sufficiently to act as a sediment source. Hence, an alternative source is required.

The need for an alternative source also arises from unintended sediment losses inherent to periodic nourishments meant to compensate persistent erosion. Such losses occur for various reasons.

One of them is that part of the nourished sediment will be deposited outside the morphologically active zone. Another is that the nourishment affects the cross-shore profile, which may lead to an increased offshore transport.

A convenient alternative source is the sea bottom near the port and well outside the morphologically active zone. It is close to the deposition site and it has a minimum effect on coastal evolution. To ensure this latter point, it is advised to withdraw the sediment from the bottom seaward of the 20 m depth contour. For initial nourishment, however it is advised to use also material produced by deepening the port basin. This material is readily available and it matches the type of material found in the surf zone north of the port.

Dredging sediment for the nourishments has un undesirable impact on the natural environment. Beyond the 15 m depth contour, areas with algae and weed vegetation occur. They serve as spawning-ground and nursery for fish. Dredging at these areas has a devastating effect. That holds also for dredging in the vicinity of these areas. The reason for this is that dredging stirs a lot of material way up from the bottom. Settling of this material on the vegetation has a suffocating effect.

This potential negative impact of dredging on the natural environment should be taken into account in selecting a dredging location. Within the framework of the present study, insufficient data is available on the positions of the algae and weed areas. Therefore, it is not possible to advise on a suitable dredging location yet.

Another point of attention for dredging is the migration of sardines along the Gaza coast every May and October. In order to avoid a negative impact on this phenomenon, dredging should not take place in these two months.

Dredging and nourishment also have a negative impact on the marine life in the top layer of the sea bottom. The relative importance of this effect is limited as the restorative power is generally sufficient.

Initial beach nourishment north of the port will require 1.5 million m^3, which will come from material dredged to deepen the port basin. It is estimated by Grabowsky&Poort that sufficient material will be available in the port basin. This will have to be checked when the detailed design has been completed. This quantity will be sufficient for the first three to five years to prevent coastal erosion. After this time, a system of sand-by-passing will have to be implemented. This will involve transporting sand to the north side of the port annually, and will be similar in volume to the quantities of the natural situation.

It is important that the material deposited in the area of erosion matches the original material. Finer sediment is more easily transported, so more will need to be deposited than the amount eroded. Courser material will have the opposite effect. If the source for by-passing is on the accretion side, south of the port, the material will always match. If deep water is used as a source, finer material will probably appear (that is an area in which morphodynamics are less active; conditions at that depth have allowed finer material to settle in the past).

The beach nourishment north of the port should be extended north of the existing groynes. This will mean that the groynes can remain where they are and the accompanying erosion to be dealt with effectively. Beach nourishment should be a more or less continuous process, undertaken once every year or two. This activity is however, vulnerable to cutbacks in times of economic recession. But it is false economy to cut back on a beach nourishment programme because the cost of the damage caused by erosion will overrun any such economies.

Photo 7.1. Improvement of Wadi Gaza

Photo 7.2. Developing new recreational possibilities

The Terms of Reference for the EIS states that the financing agreement for the construction of the port, which is to be signed between the financier and the PNA, should carry a provision obliging the PNA to carry out sand by-passing. The EIS is to address the contract condition.

The yearly budget required for the sand by-passing operations of about 350,000 m^3 will be about U$ 2 million. The dredging operations required for the sand by-passing should most probably be carried out by a dredging contractor following an International Competitive Bidding (ICB) procedure.

The contract condition in the financing agreement should include the following:
- The PNA is to ensure that the position of the coastline north of the port does not recede beyond the position of January 1996.
- The PNA is to ensure that a reservation is made in the annual port budget of U$ 2 million. This amount is to be transferred to the next budget year if dredging is not carried out in that budget year.

7.2.2. Compensating measures

- Rehabilitation of valuable nature areas in the surrounding of Wadi Gaza by the removal of the dam in the mouth of Wadi Gaza. This will also help solve the problem of the stagnant pool at the outlet of Wadi Gaza to the sea.
- Making of artificial reefs for fishery activities. Hard substrate such as Kurkar ridges are areas of relatively high primary production of fish species. Some of the Kurkar ridges will disappear with the construction of the port. Artificial reefs can be created to compensate for this loss.
- Developing a new tourist area in another part of the Gaza Strip. Some 2.0 - 2.5 km of beach will be lost at the proposed location of the port. To accommodate tourists now and in the future, it is recommended that well defined beaches be designated for this purpose.

The mitigating and compensating measures discussed within the framework of the EIS will require further investigation and design studies.

8. MANAGEMENT OF THE GAZA SEA PORT

The port authority will be responsible for the organization, operation and maintenance of the Gaza Sea Port and port-related activities. For these tasks a port organizational structure will have to be established. The management of the port and the establishment of a port authority is subject of a separate study. The outcomes of this study were unknown at the moment of submitting the EIS. In this chapter a model for port management is presented in case of a port in phase III.

8.1. Port ownership

Currently, there is a Port Committee consisting of representatives of the Ministry of Transportation, the Ministry of Industry, the Ministry of Public Works, the Ministry of Planning and International Cooperation. A structure for the port ownership and management has to be established. Based on the study undertaken by the consultants (see Annex III) there are three main alternatives: 100 % private ownership; private/public ownership; and 100% government ownership. Combination of these three options can give some more alternatives.

While the government will play an important role in the initial stages, government involvement can be reduced as the private sector increases its involvement when port development enters the operational phases.

The private sector could participate in various ways, for example through shareholding, purchase of facilities, leasing facilities and contracting some services.

8.2. Port management structure

Whatever the selected ownership structure, the management structure of the port authority will be basically the same. A possible structure is as follows:
- board of directors;
- chief executive officer;
- management support and staff units;
- marketing department;
- marine department;
- engineering department;
- traffic department;
- finance and administration department.

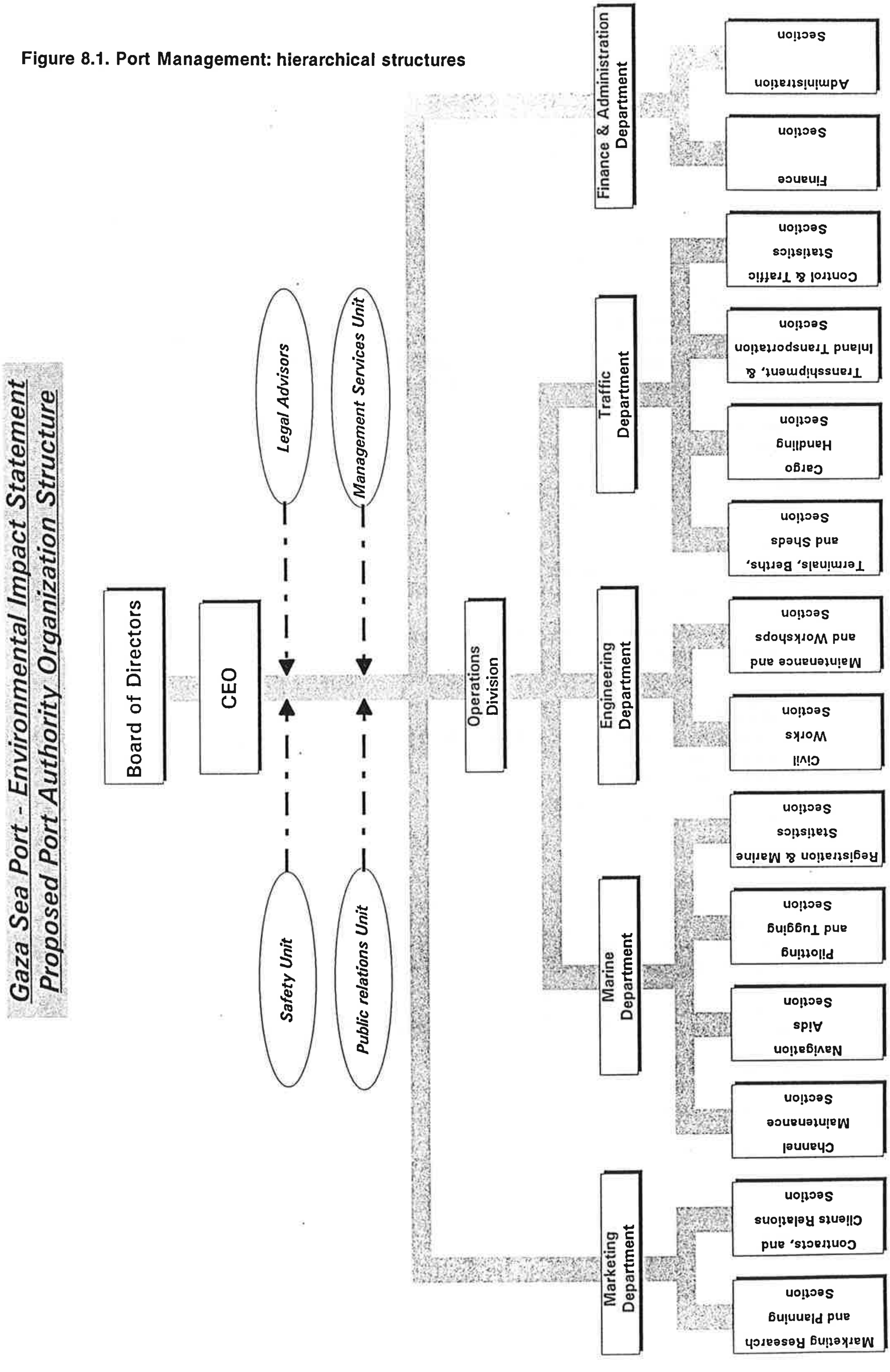
A diagram showing the hierarchical relations of the various bodies is presented in Figure 8.1.

Initially the units will be small, comprising only one or two persons.

For management purposes, the port authority should be divided into a number of divisions, each with a group of related tasks and responsibilities. Some port activities, however, will need to be managed by two or more divisions. The tasks of divisions as envisaged in the final situation are listed below:

marine operations
- channel maintenance;
- avigation aids;
- vessel movements;
- use of port craft;
- control of pilots and tugs;
- management of marine staff;
- registration of vessels;
- survey of vessels;
- control of signal tower;
- preparation of marine statistics.

Figure 8.1. Port Management: hierarchical structures



traffic operations
- cargo handling;
- allocation of berths;
- operation of terminals and sheds;
- submission of out-turn reports;
- supervision of vessels work;
- operational control of mobile equipment;
- operation of barges;
- control of gates and cargo deliveries;
- preparation of operational statistics.

engineering
- civil engineering works;
- maintenance of mechanical, electrical, marine, and civil engineering works;
- supervision of contractor's work and inspection of purchases;
- supervision of spillway and marine workshop.

management
- management information system;
- planning;
- organization and methods research;
- preparation of management reports.

marketing
- commercial correspondence and claims;
- market research;
- market planning;
- port promotion and customer relations;
- clients contract management.

safety
- safety monitoring;
- contingency planning and crisis management;
- oil spill combating;
- environmental control;
- medical services and first aid;
- safety reports preparation.

finance
- preparation and control of budgets;
- procurement (tendering - evaluation - contracting);
- warehouses management;
- collection of revenues;
- preparation of salary and bills;
- payments to staff;
- payment of public bills;
- preparation of periodic financial reports/statements/statistics.

administrative support
- personnel files and records keeping;
- archives and library;
- staff fringe benefits and social insurance;
- staff recruitment procedures management;
- staff training and development;
- communications and mail;
- secretarial services;
- port security;

- preparation of personnel reports;
- preparation of security reports.

other activities
- legal advice;
- public relations.

The final responsibility for the environmental aspects of the port and future port activities will be that of the general management. Some special tasks should be handled by one or more services, such as risk assessment by the technical division (safety division) and legal advice by the administrative division.

It is essential to have an appropriate organization and management structure in place at the required time. This means that phase IA (the first construction phase) will require a different management structure to that in the operation phase III. It is therefore recommended that the development of port services be implemented according to the requirements of the development phase.

8.3. Management during construction

The management during the construction phase will be oriented to supervision of the construction works. The essential tasks are planning, monitoring, reporting, financial administration and legal advising. As the construction phase comes to an end, management will gradually change to operational management, so during this transitional period both types of management will be required.

8.4. Management during operation

In the operation phase, the management capacity will grow to the proposed final situation. The divisions as well as the management structure, as given in Section 8.2, will need to be functioning. The size of the divisions will be determined by the volume and type of trade through Gaza Sea Port.

It is recommended to assign the property of the port to an independent public body, under the competence of the Ministry of Transportation. The Port Authority will have an Environmental Officer, and fees and levies collected for port operations will contribute to coastal management and other environmental protection requirements.

9. PUBLIC PARTICIPATION, CAPACITY BUILDING AND GENDER ASPECTS

9.1. Introduction

This chapter public participation, capacity building and gender aspects deals with relevant items to assess the position of the port and ancillary facilities in the Gaza Strip community.

Public participation in the EIA process is particularly important for the success of and the public support for the Gaza Sea Port project. However as outlined in Section 3.3, there is little experience with public participation in the Gaza Strip. Community awareness and participation is deemed necessary to safeguard the rights and interests of the general public. Furthermore, public participation is an essential factor in coordinating and integrating efforts for the success of the project and encouraging private sector involvement.

Since there is little legislation that incorporates public participation in decision making processes in the Gaza Strip; the following activities were undertaken to stimulate public participation:

1. A public opinion survey was undertaken by means of a questionnaire completed by selected institutions and organizations, representing the public in various ways (April, May and June 1995).
2. A series of personal meetings were organized with representatives of various ministries, departments and local authorities (April, May and June 1995). Reports of these meetings are presented in Annex II.
3. A public participation meeting was organized on 1 June 1995 in the Rashad Al-Shawa Cultural Centre in Gaza, at which the interim results of the EIA were presented and the results of the questionnaire discussed (see Section 9.4). A report of the meeting is included in Annex II.
4. A study visit to the Netherlands by a Palestinian delegation was organized in September 1995. (Section 9.5).
5. A second series of individual meetings with ministries, departments and local authorities was organized to ensure that environmental aspects were adequately taken into account in the decision making process on the port (December 1995).

The five activities above aimed to maximize public involvement in environmental issues related to the port and to obtain public input into the decision making process.

9.2. Public participation

A wide range of Non Governmental Organizations (NGOs) and community institutions participated in a questionnaire survey. The questionnaire was designed to make an inventory of the opinions and interests of these organizations and institutions with regard to the construction and operation of the Gaza Sea Port. The organizations approached were:

- women associations and institutions;
- children's affairs institutions;
- environmental affairs institutions;
- cultural institutions;
- scientific and research institutions;
- labour unions;
- professional syndicates;
- agricultural organizations;
- commercial and industrial organizations;
- trade unions;
- fishermen associations;
- development-oriented institutions;
- mass communication and press institutions.

The questionnaire was sent to the following specific organizations:
- Union of Labour Syndicates.
- Arab-Palestinian Medical Society.
- Union of Palestinian Women Committees.
- Human Rights Federation.
- Development Resources Centre.
- Gaza Environmental Programme.
- Chamber of Trade and Industry.
- UNRWA (United Nations Relief and Works Agency): Mass Communications Centre.
- Accountants and Auditors Society.
- National Federation for Investment and Development.
- Al Tawfic Fisherman Cooperation.
- Palestinian Agricultural Relief Committee.
- Benevolent Society for Gaza People.
- Palestinian Housing Council.
- Churches Union.
- Justice and Law House.
- Citrus Producers Union.
- Palestinian Planning Centre - President Office.
- Patient Friends Society.

The questionnaire consisted of a number of multiple-choice questions and an open-ended question to enable the respondents to express their opinions and comments as fully as possible. The questionnaire was written in Arabic and English. It is very pleasing to report that there was a 100% response rate to the questionnaire.

The findings of the questionnaire are summarized as follows:
- all respondents were aware of the ongoing study to establish a sea port in Gaza;
- approximately 70% stated that the port was "highly welcome";
- all respondents considered the movement of goods to be more important than movement of passengers;
- approximately 75% of respondents were concerned about the potential negative impacts of the port;
- the most serious negative impact was considered to be the danger to marine life followed by leakage from oil tankers;
- most respondents considered these negative impacts to be "probably" or "unlikely";
- the most important factors contributing to the success of the port are considered to be quality and speed of services, the ability to attract high calibre of management and the expected management flexibility and autonomy.

The responses to the open-ended question focused on the following points:
- the port should provide employment opportunities;
- where possible, use should be made of local resources;
- Israeli interference in the port should be prevented;
- design, construction and operation by professional organizations is required.

Four recommendations can be derived from the results of the questionnaire:
- The enthusiasm and encouragement of Gaza people for the sea port should be channelled to contribute to the sustainability of the project. Port management should maintain communication channels with the Non Governmental Organizations (NGOs).
- Most NGOs surveyed were concerned about some drawbacks or negative impacts associated with port construction and operation. These concerns should be addressed during port development and operation. However, it is advisable to launch a mass media campaign to inform the public of measures and safeguards being taken to mitigate any negative effects.
- The priority uses of the port such as the movement of goods and the prevention of marine life need to be considered in planning the phasing of port development.

- Other recommendations made by the respondents to the questionnaire should be considered, for example, private sector participation in funding and management, and avoidance of handling hazardous cargo through the port.

9.3. Personal meetings with representatives of authorities

Within the framework of collecting information for the EIA many representatives of ministries, local authorities and other organizations were visited. Detailed discussions were held on the port location, proposed port activities, possible environmental effects and the organization. During these meetings, held in April, May, June and December, useful information was obtained. Furthermore the meetings contributed to public involvement. The minutes of all the meetings are presented in Annex II.

9.4. Public meeting on Gaza Sea Port impacts

Those organizations and individuals most concerned with the Gaza Sea Port were invited to a public meeting at which information was given about the harbour, the proposed location and its likely impacts on the socio-economic, physical and biotic environment.

The meeting was held in the Rashad Al-Shawa Cultural Centre in Gaza City on 1 June 1995, and was attended by 50 people representing Palestinian organisations, ministries and municipalities, foreign and international organisations and universities.

The chairman of the meeting was Dr. Ala'a Sha'at of TEAM engineering and management consultants. The panel of speakers included Mr. Wouter Jan Bolkestein, Mr. Albert Treffers and Ms. Rianne Meester from Witteveen+Bos Consulting engineers and Mr. Mohammed Gobrail and Mr. Samir Shaat of TEAM. The speakers provided information about the port project and environmental legislation, about the proposed port location, the environmental impacts and organizational structure for the port.

The discussion that followed the speakers presentations, focused on the different locations for the port, the time period required to develop the port and the possible impacts of the port on the water quality and fishing capacity of the sea.

9.5. Capacity building

During the first week of September 1995, a study visit was made to the Netherlands by a Palestinian delegation, comprising representatives of the Ministry of Planning and International Cooperation, the Ministry of Transportation, the Palestinian Economic Council for Development and Reconstruction and the Gaza Sea Port Committee.

The visit to the Netherlands covered the following aspects with regard to the environmental impacts of port management:

- A visit was made to the offices of Witteveen+Bos to obtain more understanding of infrastructure and environment related to the port and port activities. A representative from the Netherlands Ministry of Housing, Spatial Planning and the Environment made a presentation on Dutch environmental policy and management.
- Excursions were organized to two Dutch ports: Vlissingen and Rotterdam. The situation at Vlissingen is of particular relevance for Gaza, while the visit to the Port of Rotterdam provided an opportunity to learn about port management, dredging management and water quality. A short visit to the Dutch Delta project demonstrated the meaning of water to the Netherlands.
- A visit was also made to the port of Rotterdam in connection with the management of the environmental aspects. In addition, visits were paid to the Booy Clean solid waste treatment plant and the wastewater treatment plant in Amstelveen.
- Visits were also made to a marine institute: a school for mariners, the Directorate General Navigation and Maritime Affairs in Rijswijk and the Directorate General for International Cooperation of the Ministry of Foreign Affairs.

Photo 9.1. Presentation of the formal results on the meeting of June 1, 1995

Photo 9.2. An attentive auditorium, June 1, 1995

- Finally a meeting was organized with the Chamber of Commerce of Rotterdam. Special attention was given to water and road traffic problems and the related possibilities of Rotterdam. The environmental emissions from traffic and the harbour were important items.

The programme was designed to provide the delegation with information about ports and the way environmental issues of ports are dealt with. The Dutch view on the EIA was discussed and how this can be extrapolated to the Gaza and the West Bank situation. During the debriefing at DGIS, the delegation expressed their appreciation of the visit.

In Annex IV more detailed information on Capacity building is given.

9.6. Gender aspects

The new sea port will bring economic and social changes to Gaza. It will provide employment for more people and will thus contribute to the development of the country.

The operation and management of the port will require people with a range of technical and management skills. People with various skills will be needed for port-related activities such as navigation management, wastewater treatment, education and training and other tasks. There is clearly a need to train and employ both men and women for these tasks.

In the initial stages of port planning, organization and construction it is difficult to single out gender-specific issues for special attention. However, there are a number of areas where special attention will need to be given by the government and port authority, the port users, port related organizations and industries and the Gaza people by themselves. Some of these issues which should be mentioned are as follows:

- as well as a formal market, a port generates an informal market of small traders and consumers, in which women play an important role;
- in the small port-related industries women have a role to play and it is therefore important that these activities are organized so that women can participate;
- a port produces considerable amounts of waste which form various types of commodities in the informal market where women can play an important role.

Special attention must be given to the organization of health care, education, urban areas and living conditions and also potential changes in agriculture. Women's involvement in these matters differs from that of men and thus the gender aspects require special attention in the future.

Most women and their small children are at home throughout the day, while the men are at work in the city or elsewhere, and older children are at school. Thus if housing is to be established near the port or on major roads, women and small children, who are the most vulnerable members of the population, will experience more of the environmental discomforts such as noise and air pollution.

In summary, the Gaza Sea Port will provide opportunities for women to play a role in trading and industrial activities related to the port. The port, however, will put pressure on women in the vicinity and will bring with it other undesirable elements which could threaten their safety and well being since port operations are still mainly a man's world.

10. GAPS IN KNOWLEDGE AND INFORMATION, MONITORING AND EVALUATION

10.1. Gaps in knowledge and information

10.1.1. Introduction

The Terms of Reference for this Environmental Impact Statement stated that most of the information required is available in existing documents. While there is a considerable amount of information, vital information required to describe and assess the current situation and the impacts of the port development is not available. The outcomes of a number of developments, which would help to clarify the impacts, are unsure:

- there are no spatial and environmental legislation and standards in the Gaza Strip to prevent environmental impacts;
- due to the political situation much is unsure about the prospects of the Gaza Strip economy;
- the development of the industrial zone is unknown.

This information is essential in assessing the impacts of port construction and operation. In particular, environmental legislation is an essential in preventing environmental damage.

During preparation the EIS close contact was maintained with the design activities for the port. However, as yet the design work is not finished. Soil surveys and nautical investigations required for the design study had not been carried out by the end of January 1996. Furthermore negotiations with the contractors regarding the selection of borrow areas for construction materials and hence the choice of quarries had not been finalized.

It appears that many aspects of the proposed port development are still being formulated. Consequently, at this stage it is difficult to obtain a total overview of the potential environmental and socio-economic impacts.

10.1.2. Specific gaps in knowledge and information

Specific gaps in knowledge and information with respect to the environmental aspects are given in Table 10.1. The importance of the missing information in decision-making about the Gaza Sea Port is also indicated in the table.

Table 10.1. Specific gaps in knowledge and information

lacking information	importance for decision-making
abiotic environment	
no detailed information available on the extent, thickness and depth of aquifers and aquicludes in the coastal area between Wadi Gaza and Gaza City	E
no information on recharge of groundwater in the present situation available and the reduction of recharge in the port operation phase cannot be assessed	E/M
no information on conditions of the sea bottom	E
borrow areas for construction materials are not decided	E
exact data on ground budget for all phases of port development are not available	E
exact data on quantities construction materials for all phase of port development are not available	E
nautical investigations have not been completed	M/M
biotic environment	
detailed information not available on all marine and terrestrial species of the ecosystem	M
the extent of the influence of Red Sea species on the ecology of the Levatine basin is not known	M
no information about the precise area and distribution of exposed Kurkar ridges in the coastal zone	E/M
no data of the occurrence of mammals and reptiles	M
not known when the recommendations of the Gaza Environmental Profile to allot potential/valuable landscape and nature conservation areas will be implemented	E
no information available on the occurrence of protected and endangered species at the Wadi Gaza area	M
archaeology	
little known about the pre-Roman occupation of the port area	M
air quality	
no data on air quality available for the Gaza Strip	M

E : Essential to the assessment of impacts;
M : Moderately important to the assessment of impacts.

10.2. Monitoring plan

The activities and consequences of port construction and operation should be monitored by the authorities responsible for port construction, operation and maintenance. Preferably monitoring should be done by PNA and/or in any case by Palestinian organizations. Advice and assistance could be obtained from organizations such as World Bank, European Union, UNEP and DGIS. Aspects which require monitoring and the responsible Palestinian organizations are set out in Table 10.2. Consideration will have to be given to sources of funding for monitoring.

Table 10.2. Aspects requiring monitoring

aspects for monitoring	responsible Palestinian organization
changes in coastal morphology	Ministry responsible for nature conservation
effectiveness of mitigating measures for coastal erosion	Ministry responsible for nature conservation
dispersal patterns of pollution from the port	Port Authority
changes in chemical and physical composition of the sea bed in the area influenced	Port Authority/environmental investigation institutions
pollution of the sediment deposited in the port	Port Authority
enforcement of environmental legislation and regulation	Port Authority/MPIC-EPD
emissions	Port Authority/environmental investigation institutions

10.3. Evaluation plan

The activities and the consequences of port construction, operation and maintenance should be evaluated by the responsible Palestinian authorities. PNA and/or other Palestinian organizations should undertake the evaluation themselves with advice and assistance from international organizations such as World Bank, European Union, the UNEP and DGIS. Aspects which should be included in the evaluation and the responsible Palestinian authority are set out in Table 10.3.

Table 10.3. Evaluation plan

aspects for evaluation	responsible Palestinian organization
development and implementation of legislation	PNA
institutional build up, staffing and training	Port Authority
implementation of archaeological inventory and rescue plan	Ministry of Tourism and Antiquities
implementation of land acquisition	Ministry of Public Works/Municipality of Gaza
implementation of resettlement plan	Ministry of Housing/Municipality of Gaza
construction activities	Port Authority

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Table 2. Activities during construction and operation, assessment of impacts

construction phase	physical activities	possible impacts	criteria	no action alternative	proposed activity		alternative	
					phase IA	phase III	phase IA	phase III
1. abiotic aspects	. construction of breakwater sea wall, quay and ancillary structures . dredging works . excavation and transportation of soil . occasional spills . dumping of construction waste	. changes of coastal morphology . changes in groundwater resources and seawater intrusion . pollution of soil and groundwater . pollution of surface water	. disturbance of morphologic dynamic equilibrium . amount of construction and to be washed . inshore earth works . construction quantities (length of breakwater, causeway, etc.)	0	–	––	–	––
2. biotic aspects: marine environment	. dredging works . disposal of dredged materials . seawall and breakwater construction works . quay construction . reclamation works	. loss of natural habitat . creation of new habitats . destruction of flora and fauna . deterioration of habitat quality	. habitat area loss . area of new types of habitat . area destructed by dredging and beach nourishment works . increased turbidity . increased sedimentation . increased pollution . increased disturbance	0	––	––	––	––
3. biotic aspects: terrestrial environment	. excavation works . earth works . road works . building construction . land transport	. loss of natural and semi-natural habitat . destruction of flora and fauna . fragmentation of natural and semi-natural habitats . deterioration of habitat quality	. area loss of Kurkar cliffs . area loss of valuable dune area and extensive low-input level agricultural area . increase in noise, dust, traffic, pollution and deposition . increase in solid waste pollution . habitat fragmentation	0	––	––	––	––
4. natural environment	. excavation of coastal ridge . erection of industrial area	. changes of the coast line and coastal landscape . changes in functional and spatial structure . loss of archaeological sites	. surface of coastal ridge removed . change in unity and utilization . number of archaeological sites lost	0	–/––	––	–/––	––
5. hindrance	. air and noise pollution by construction equipment and traffic . accidents, calamities	. changes in air quality . changes in noise levels . changes in safety situation in the port and industrial area	. air quality . noise quality . safety situation	0	0/–	–	0/–	–
6. socio-economic environment	. clearance of port area . displacement and resettlement of present inhabitants.	. loss of housing . loss of (agricultural) land . financial losses . changes in employment situation . changes in land prices . changes in social structure	. number of dwellings affected . surface loss of agricultural land . financial compensation . number of labour . development of land prices . social relations	0	+/0	+/0	+/0	+/0

operation phase	physical activities	possible impacts	criteria	no action alternative	proposed activity		alternative	
					phase IA	phase III	phase IA	phase III
1. abiotic aspects	. spills, calamities . presence of a dredged area . pervious natural and agricultural areas replaced by impervious paved surfaces (roads, buildings, etc.)	. changes in coastal morphology . changes in groundwater resources and sea water intrusion . pollution of soil and groundwater . pollution of surface water	. disturbance of the morphologic dynamic equilibrium . decrease in groundwater recharge . area taken by terminals, port buildings and utilities . numbers of loaded and unloaded goods	0	—	——	—	——
2. biotic aspects: marine environment	. maintenance dredging works . maintenance beach nourishment . disposal of dredged materials . shipping activities . anchoring of ships outside harbour . maintenance of port structures . spills, calamities	. disturbance of habitats . destruction of flora and fauna . deterioration of habitat quality	. area destructed and affected by dredging and/or beach nourishment . increased turbidity . increased sedimentation . increased pollution . increased disturbance	0	—	——/———	—	——
3. biotic aspects: terrestrial environment	. land transport . port operations	. deterioration of habitat quality	. increase in noise, dust, traffic . pollution and deposition due to industrial activities . increase in solid waste pollution	0	—	——	—	——
4. hindrance	. cargo handling operations . cargo storage . industrial activities . waste handling . shipping traffic . berthing of vessels . land transport . maintenance of port structures	. changes in air quality . changes in noise levels . changes in safety situation of the port and industrial area	. air quality . noise levels . safety situation	0	—	——/———	—	—/——
5. socio-economic environment	. port operations . industrial activities . transport activities	. changes in employment, immigration and income situation . urban population growth and urbanization of the port area . changes in tourism pattern	. increase of employment and income (expressed in percentages) . number of immigrants and new inhabitants . number of tourists attracted	0	0	+	0	+

+ + + very positive impact;
+ + positive impact;
+ slightly positive impact;
0 neutral;
— slightly negative impact;
—— negative impact;
——— very negative impact.

Thus during port construction and operation, measures will have to be taken to prevent or reduce harmful impacts on the environment and the population. The establishment of a sound and responsible port management is an indispensable part of the whole project.

The port has the potential to contribute to improvement in socio-economic conditions by providing income-generating activities, by reducing import and export restrictions and by creating employment opportunities. However, these developments are uncertain because of the very turbulent political situation in the region.

public participation
The study also aimed at stimulating public participation in environmental policy and planning. All respondents to a questionnaire were aware of the environmental study for Gaza Sea Port and 73% were highly in favour of the port and acknowledged its commercial importance. However, 74% were concerned about the potential negative impacts, especially endangering marine life and leakage from oil tankers. The efficiency of port services was considered to be very important. The interim results of the EIA were presented and discussed at a public participation meeting on 1 June 1995 in the Rashad Al Shawa cultural centre in Gaza city.

EIS capacity building
To ensure that environmental aspects are adequately taken into account in the decision making on the port, efforts were made to develop and strengthen capacity on environmental impact assessment within the Palestinian authorities. Activities included meetings with representatives of the Palestinian authorities, a study visit to the Netherlands by a Palestinian delegation and a further series of individual meetings with ministries, departments and local authorities. The overall result of the capacity building is increased awareness of the environmental impacts of major infrastructural developments.

5. Recommendations
The following recommendations, in sequence of importance, are made:

sand bypassing to minimize coastal erosion
Initial beach nourishment north of the port will require 1.5 million m^3 of sand which will come from material dredged to deepen the port basin. The port design consultants have estimated that sufficient material will be available for this purpose. This will have to be checked when detailed design has been completed. This quantity will be sufficient for the first three to five years to prevent coastal erosion. After that time, a system of sand-by-passing will have to be implemented. This will involve transporting a similar volume of sand as in the natural situation to the north side of the port annually. The material deposited in the eroded area should match the original material. If the source for by-passing is on the accretion side (south of the port) the material will always match. If a deep water source is used, finer material will probably appear. It is, therefore, recommended to go beyond the 20 m contour depth to prevent the morphodynamics being disturbed by the dredging as well as by the port. The same conditions also apply to establishing a source of material for land reclamation works. The beach nourishment north of the port should be extended north of the existing groynes. This will mean that the groynes can remain where they are and the accompanying erosion dealt with effectively. Beach nourishment should be a more or less continuous process, undertaken once every year or two. It should be stressed that any cutbacks in the beach nourishment programme would led to greater costs in restoring the damage caused by erosion than any economies in beach nourishment would achieve.

The EIS is required to address the contract conditions for sand bypassing to be incorporated in financing agreement for the port construction to be signed by the financier and the PNA. This provision obliges the PNA to carry out sand by-passing. The yearly budget required for the sand by-passing operations of about 350,000 m^3 will be about U$ 2 million.

The dredging operations required for the sand by-passing should be carried out by a dredging contractor to be selected under the International Competitive Bidding (ICB) procedure.

The financing agreement should include the following conditions:
- The PNA is to ensure that the coastline north of the port does not recede beyond its position in January 1996.
- The PNA is to ensure that a reservation is made in the annual port budget of U$ 2 million for this purpose. This amount is to be transferred to the next budget year if dredging is not carried out in that budget year.

zoning of port activities
As there is no legislation on environment and physical planning for the Gaza Strip, it is of the utmost importance that the Palestinian authorities ensure sufficient distance is maintained between port activities and sensitive areas such as residential and recreational areas. Recommended minimum distances between port activities and urban areas are set out in the report. The distances shown as zones around the port and related activities are presented in Figure 5. Furthermore, LPG/LNG transfer and storage should not be permitted in any phase of port operation.

As there is no legislation on physical planning, it is advisable that the authorities establish as many physical obstacles as possible in the transitional zone between port and residential areas to prevent the development of scattered industries and houses which could give rise to hindrance. Another way to prevent environmental problems is for the land to be acquired by the authorities.

environmental legislation
For the sustainable development of the Gaza Strip, a framework of environmental legislation is needed for the port and other infrastructure and for industrial activities. Legislation will need to be developed in the coming year for the preservation of groundwater and surface water, zoning of industrial and other activities and pollution level in relation to public health. Subsequently, legislation will need to be prepared on nature conservation, air pollution, water management, noise abatement, environmental impact assessment and enforcement. It is preferable to start with a general framework of environmental legislation which can be expanded subsequently in more detail.

Some international treaties will require ratification by the parliament before they can be implemented, and other treaties will only need approval by the government.

It is not possible to formulate a time schedule for the preparation and enactment of environmental legislation. This will depend largely on the internal and external political situation in the country. The PNA, however, can draw on the experience of other countries.

An Integral Environmental Care System (IECS) of the Gaza Sea Port Authority to prevent environmental deterioration and pollution should be part of the port management. The development of the IECS should be the task of the environmental officer.

water conservation and management plan
The proposed activity incorporates the collection of rainfall from buildings and roads, and drainage into the sewerage. As a mitigating measure, rainwater from buildings can be artificially infiltrated in, for example, an area with coarse grained material. The size of the infiltration area will depend on the amount and composition of the material, the area of the connected buildings, roads and rainfall characteristics of the location. In all cases, large-scale use of fresh groundwater should be prevented during port construction and operation.

Instead of pumping groundwater from the coastal aquifer for washing construction sand during the operation phase (and presumably also during the operation phase of industrial area), fresh water could be obtained from sources outside Gaza or produced in a desalination plant. The environmental impacts of these sources will need to be assessed.

solid waste handling
Construction and operation activities will produce all kinds of solid waste. In all cases the production of solid waste should be prevented as much as possible. This could be realized by a low consumption of packing materials. Furthermore techniques of re-use of waste should be investigated and applied. The remaining waste after prevention and recycling should be processed in an environmental proper way, dumping should take place on so-called controlled dumping sites.

This means that the underground of the site is protected by an impervious foil layer and the site is daily covered by ground in order to prevent the dispersal of rests of solid waste. Waste management should be a part of the Integral Environmental Care System.

resettlement plan
Only a few housing units (about 10 people) will have to be removed to make way for the first phase (IA) of the port development. The resettlement of these people is part of the project and the Palestinian authorities will need to take responsibility for this. It is recommended that a resettlement plan should be prepared in close cooperation with the people involved. The resettlement should be financed from the overall funds for port construction.

rescue plan for archaeology
A detailed archaeological survey of the entire area should be made before construction work starts. The survey results may lead to additional excavation of selected sites in order to minimize loss of archaeological material.

Various archaeological institutions around the world will be interested in implementing rescue operations (survey and additional excavation) in the Gaza Strip. It is unlikely, however, that these institutions will be able to carry out the fieldwork without external funding. It is strongly recommended that a proportion of the total funds for port construction be reserved for archaeological rescue operations (0.1 to 0.2% of the total budget for phase IA seems to be a reasonable indication, depending on the scale of the archaeological work).

port management
It is assumed that there will be a well-organized port authority, which will deal with environmental matters associated with the port. The organizational structures and procedures of the port authority have been proposed.

A separate study on the establishment of a port authority will be completed in early 1996. This study is financed by the Netherlands Government and is being carried out by IMTA (Port of Amsterdam) and the Port Authority of Rotterdam. The Gaza Port Authority will have an Environmental Officer, and fees and levies collected for port operations should contribute to coastal management and other environmental protection requirements. Port regulations will have to be established and will need to address requirements for environmentally sound and safe port operations.

It is recommended to assign the property of the port to an independent public body, under the competence of the Ministry of Transportation.

compensating measures

The EIS recommends that the following compensating measures be implemented:

- Rehabilitation of valuable nature areas in the surrounding of Wadi Gaza by removing the dam in the mouth of Wadi Gaza. This will also help solve the problem of the stagnant pool at the outlet of Wadi Gaza to the sea.
- Making of artificial reefs for fishery activities. Hard substrate such as Kurkar ridges are areas of relatively high primary production of fish species. Some of the Kurkar ridges will disappear with the construction of the port. Artificial reefs can be created to compensate for this loss.
- Developing a new tourist area in another part of the Gaza Strip. Some 2.0 - 2.5 km of beach will be lost at the proposed port location. It is recommended that well defined beaches be designated to accommodate tourists now and in the future.

The mitigating and compensating measures discussed within the framework of the EIS will require further investigation and design studies.