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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
Additional report

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TABLE OF CONTENTS

TABLE OF CONTENTS

1. INTRODUCTION

In the advisory review of the Environmental Impact Statement (EIS) for the Gaza Sea Port (April 29, 1996), the Commission for Environmental Impact Statement (the Commission) has concluded that "on a number of essential points information was not available due to delays in the execution of the design studies." These essential points are the local hydrogeology, the borrow areas for construction materials and the conditions of the sea bottom. Under the heading of further observations the commission recommended to complete the information on a number of points (port and port facilities, construction, dredging and natural values) which are not essential for decision-making on funding of the project.

This additional report of the environmental impact statement for the Gaza Sea Port presents the following items:
- local hydrogeology (chapter 2);
- borrow areas (chapter 3);
- conditions of the sea floor (chapter 4);
- further observations (chapter 5).

This additional report is based upon the evaluation of the pre-final contract design (December 1996). As construction until now has not started, it is possible that some aspects related to the design, the construction methods and the operation phase will change.

From the EIS it appeared that realization of Gaza Sea Port with serious attention for the environment, is a complex process. During and after preparation of the EIS, several supporting measures and surveys are or will be carried out. With respect to this the government of the Netherlands assists the Palestinians with the development of environmental and spatial legislation. For the institutional set-up of the port management a study of IMTA and the Port of Rotterdam has been carried out. Very recently (April 1997), a provisional agreement between the Gaza Sea Port Authority and the Port Authority of Amsterdam has been concluded in order to support the Palestinians with technical assistance and training.

As a result of the EIS, funding of sand by-passing for a period of five years has been guaranteed by the government of the Netherlands. It should be assured that after this period sand by-passing will be continued by the Palestinians themselves or with the aid of the international community.

Issues concerning legislation, institutional development, resettlement and funding of sand by-passing have the attention of the authorities. However, development of legislation is one thing, enforcement of regulations is another thing. The problem of enforcement as well as the sand by-passing should get careful attention continuously.

2. LOCAL HYDROGEOLOGY

2.1. Effect on groundwater of dredging of the port basin

During the construction of the port, the access channel and the turning basin will be dredged. In phase IA, the dredging will be carried out to 9 m below MSL, and in phase III to 15 m below MSL. When intercalating clay layers and silty sandlayers of considerable extend are removed during dredging, the resistance to groundwater flow will diminish. This may have a negative effect on the groundwater resources.

In the period April 21 to June 8, 1996 a geotechnical investigation was carried out by Fugro (Fugro, September 1996). Nineteen nearshore boreholes were drilled. Field testing and laboratory testing were carried out on samples and cores taken from the drillings.

The borehole logs show that within a distance of 300 to 400 m from the coast cemented dune deposits, known as the Continental Kurkar Formation, are buried under silty and non silty marine sands. These marine sands range in thickness from 1 to 3 m. At a larger distance from the coast the marine sands become thicker and more silty, and clay layers appear at the base of the sands.

During dredging, both in phase IA and phase III, the (silty) marine sands within a distance of 400 m from the coast will be removed from the Kurkar Formation, which is considered to be the main aquifer. The clay layers at a larger distance from the coast will not be removed during dredging. In annex I the location of the survey is presented, including two cross-sections.

From the marine sands, which will be removed during dredging, the particle size distribution has been determined. From this distribution the permeability of the sands can be derived. The permeability of the sands as derived from the particle size distribution ranges from 6 to 60 m/day, which is comparable to the permeability of the Kurkar Formation as reported from the area of Gaza City.

It may therefor be concluded that dredging activities will not remove significantly clay layers or silty sand layers with a resistance to groundwaterflow, and dredging activities will therefor not affect the groundwater resources, nor induce or increase seawater encroachment.

2.2. Effects of groundwater extraction from coastal aquifer

The present land use on the site of the sea port and the future industrial area is shown in figure 5.1 of the EIS. The size of the future industrial area is about 7 km^2. Approximately 3.5 km^2 of this area is used for agricultural purposes, and roughly 1.5 km^2 of the cultivated area is used for intensive cultivation of citrus, vegetables and other agricultural products. These crops are intensively irrigated. From the mean water consumption of these crops it can be estimated that in the current situation approximately 1.3 million m^3 groundwater is used for irrigation.

During construction of the port, some 33.000 m^3 of fresh groundwater will be used for concrete production and other purposes. This amount of water, which is only necessary during port construction, is less than 3% of the present annual groundwater use for irrigation, and will not have a significant effect on the groundwater resources.

During port operation, industrial activities in the future industrial area will demand the use of groundwater. On the other hand, it is very likely that groundwater extractions for irrigation will stop. So future groundwater extractions may never exceed the amount of groundwater which is extracted in the current situation.

2.3. Water supply to ships

Since groundwater resources are scarce and diminishing, no groundwater will be supplied to the vessels calling at the port. For the supply of fresh water to ships, water has to be produced in a desalination plant. Due to the high production costs of the fresh water (more than \$2 - \$3 per m^3), the water will only be taken in by fishing boats. Large vessels produce their own fresh water, or will take water in at sea ports where prices are less.

The estimated demand of water is 10 to 15 m^3 per day. For the production of 15 m^3 of fresh water, 22 m^3 of sea water is needed. During production, the salts are concentrated in the remaining 7 m^3, which will be flushed into sea.

The use of energy for the production of 1 m^3 of fresh water is approximately 4 kilowatts. The filters of the desalination plant must periodically be cleaned with a small amount of chloride.

2.4. Monitoring

Before the start of the construction works, three boreholes are drilled on land. Two boreholes are drilled to a depth of approximately 30 m below MSL. In these two boreholes, piezometers are placed at different depths if one or more clay layers are found. The third borehole is drilled to a few meters below the groundwater surface, and only one piezometer is placed in this borehole.

The borehole logs give additional information on the extent of the coastal aquifer. Measurements of groundwater levels and groundwater quality will take place prior to, during and after port construction. The measurements will, together with the measurements carried out at different locations by the Water Resources Action Program, give information on the direction of groundwater flow and the quality of the groundwater, and probable changes as a result of the port construction and operation.

3. BORROW AREAS

3.1. Quantities of materials

The quantities refer to the construction of the initial phase (IA) of port development. Quantities required for construction of phase IB (additional 400 m quay), IC (liquid products berth, ID (dredging to 12- MSL), IE (bulk terminal), II (container terminal and breakwater) and III (fully developed port) are not known in detail. In table 3.1 a summary of the quantity of materials is presented. As far as it is relevant for the EIS also the quality of the material required for the construction will be mentioned.

3.1.1. Concrete

Concrete is required for the following purposes:

- accropodes in the breakwater;
- cap on the breakwater;
- coping on the combi wall (sheet piles);
- concrete block pavement;
- buildings etc.

In total some 75,000 m^3 of concrete is required for the works.

3.1.2. Aggregates for concrete

fine aggregate

The fine aggregate for concrete will be sand. It is estimated that some 32,000 m^3 of fine aggregate is required.

coarse aggregate

The coarse aggregate for the concrete will be crushed rock. It is estimated that some 51,000 m^3 of coarse aggregate is required.

3.1.3. Cement

The cement (Ordinary Portland Cement) will be used for concrete, mortar, sand-cement stabilization under pavement (if required). It is estimated that some 27,500 tons of cement is required.

3.1.4. Reinforcement

A relative small quantity of steel for reinforcement is required. Some 400 tons will be required for the capping beam of the combi wall and the buildings. It is unknown yet whether reinforcement is required in concrete cap of the breakwater.

3.1.5. Water

Potable water is required for concrete and for general cleaning/washing purposes. It is expected that some 11,000 tons of water will be required for concrete mixing. For cleaning and other purposes it is a guesstimate that 2 times this quantity of water will be required, thus totally some 33,000 tons (see also paragraph 2.2). Water required for the workforce is assumed not to increase the normal water demand in Gaza.

3.1.6. Fill material

Fill material is required for:

- the land reclamation of the port area;
- the erosion buffer north of the port.

In total some 1,150 million m^3 of fill material is required.

3.1.7. Asphalt

It is not expected that asphalt will be used in the port construction.

Table 3.1. Estimated quantities of materials for construction of the port

	Quantity	Unit	fill material m3	stones m3	200kg/m3 steel ton	370 kg/m3 cement ton	1150 kg/m3 course aggreg. m3 (17kN/m3)	150 kg/m3 water m3	680 kg/m3 fine aggreg. m3 (16kN/m3)
DREDGING AND RECLAMATION									
nautical dredging	847,000	m3	847,000						
imported fill	260,000	m3	260,000						
cliff excavation	44,250	m3	44,250						
CAUSEWAY SLOPE PROTECTIONS									
1-1000 kg	33,560	m3		33,560					
1-200 kg	4,109	m3		4,109					
200-1000 kg	12,030	m3		12,030					
1-3 T	15,805	m3		15,805					
3-6 T	6,875	m3		6,875					
6-9 T	11,200	m3		11,200					
geotextile	36,790	m2							
BREAKWATER									
concrete cap	9,212	m3				3,408	6,232	1,382	3,915
1-1000 kg	231,717	m3		231,717					
1-200 kg	5,846	m3		5,846					
1-200 beddinglayer	32,498	m3		32,498					
200-1000 kg	46,802	m3		46,802					
1-3 T	48,335	m3		48,335					
3-6 T	6,132	m3		6,132					
6-9 T	22,498	m3		22,498					
accropode 12 m3	5,271	m3				1,950	3,566	791	2,240
accropode 9 m3	32,985	m3				12,204	22,313	4,948	14,019
accropode 4 m3	14,000	m3				5,180	9,471	2,100	5,950
geotextile	66,556	m2							
GROYNE									
1-3 T	7,567	m3		7,567					
200-1000 kg	7,169	m3		7,169					
1-200 kg	7,634	m3		7,634					
BEACH PROTECTION									
1-3 T	2,000	m3		2,000					
COMBI-WALL									
steel incl. anchorage	3,868	T							
cap beam	1,028	m3			206	380	695	154	437
geotextile	3,120	m2							
BOLLARDS									
lo-lo berht+roro berth 50T	20	each							
small craft harbour (25T)	8	each							
FENDERS									
ro-ro (timber)		each							
lo-lo berth + roro berth (rubber)	28	each							
small craft harbour (timber)	30	each							
DOLPHINS	2	each							
SMALL CRAFT LANDING	1	each							
RESCUE LADDRERS	4	each							
SHEETWALL SMALL CRAFT HARBOUR									
steel excl. anchorage	265	T							
cap beam	30	m3			6	11	20	5	13
1-1000 kg	160	m3		160					
REVETMENT SMALL CRAFT HARBOUR									
1-3 T	3,920	m3		3,920					
1-1000 kg	1,440	m3		1,440					
200-1000 kg	3,523	m3		3,523					
geotextile	5,380	m2							
retaining wall	104	m3			21	38	70	16	44
GROYNE SMALL CRAFT HARBOUR									
1-1000 kg	320	m3		320					
1-3 T	500	m3		500					
PAVEMENT concrete blocks									
causeway + onshore	103,366	m2				3,825	6,992	1,550	4,393
DRAINAGE SYSTEM	1	each							
FENCING	1,000	m							
barrier	2	each							
gates	12	m							
BUILDINGS									
gatehouse, weighbridge, etc.	1	each			200	370	1,150	150	680
total quantities			1,151,250 m3	511,640 m3	432 ton	27,368 ton	50,510 m3	11,095 m3	31,691 m3

Concrete blocks and sand-cement stabilisation

pavement	103,366 m2
concrete for blocks (10 cm)	10,337 m3
sand for paving (5cm)	5,168 m3 (included in fill)
sand-cement stabilisation (30 cm)	31,010 m3 (included in fill)

3.1.8. Stones

Stone suitable for the use in marine conditions are required for:
- the breakwater;
- the groyne;
- the beach/slope protection;
- the revetment for the small craft harbour;
- the scour protection in front of the sheet pile combi wall.

In total some 511,000 m^3 of stones is required. The required quality of stone is of importance as not every quarry will be capable to deliver this quality and has been set by the designers at (in general terms):
- specific gravity at least 2,600 N/mm^2;
- compressive strength at least 60 N/mm^2;
- soundness loss by ASTM C88-test not more than 18%;
- abrasion less than 25%.

3.2. Borrow areas and transport routes

The materials mentioned in chapter 3.1 have to be transported to the location of port construction. Some materials are available in the Gaza Strip, or will be produced on location, other materials have to be transported from areas in the region to the port. The Netzarim road, located in the port area is open to the traffic and may be used for the supply of materials from the hinterland. The use of this road has the relative advantage that materials does not have to be transported through densely populated areas of Gaza City.

3.2.1. Concrete

Despite concrete can be purchased from local batchplants in the Gaza Strip, it has been decided that a batchplant to produce concrete with armour units precasting on or near the port site will be economical and will ensure quality requirements and safeguard continuous production of armour units.

Supply routes on to the port site are not suitable for large pours as concrete-mix trucks will have to pass through Gaza City and are subject to delay in traffic. A concrete plant on the port site has the advantage that sufficient quantities of sand, aggregate and cement could be delivered to the concrete yard during night hours. So the concrete will be produced in a special batching plant that will be erected near the port. Its exact location is not known until now. Transport of the concrete to the site will be by means of truck mixers.

The concrete plant will only in use during construction of the port. The size of the plant will be limited with regard to the size of the construction works of Gaza Sea Port. In first instance the plant will cause dust and secondly some noise. People will not be hindered by the plant because there is no occupation in its near vicinity.

3.2.2. Aggregates for concrete

fine aggregate

The initial need for fine aggregate for the construction of the causeway (circa 200,000 m^3) will be answered by a sand quarry at Beit Hanun in the Gaza Strip, just south of checkpoint Erez. This source is an existing quarry with a remaining capacity of about 1 million m^3. The particle size of the Beit Hanun material is bigger than that of usual sand particles. For construction purposes the material is less suitable, for port construction the suitability is perfect. It is expected that the environmental impacts will be limited, because no new sand quarry will be opened. After the exploitation period of the Beit Hanun quarry the area can be used for agricultural purposes. Transport is by truck along Gaza City over Road No 4 and the Netzarim Road.

coarse aggregate
Until now it not known whether the course aggregate in the form of crushed rock will be imported from Israel, the West Bank, Egypt or Turkey. It is the intention of the contractor to obtain stones only from a limited number of large quarries. Moreover, borrow areas will be from existing quarries, no new quarries will be opened. As the EIB requires a separate tender procedures for the supply of crushed rock, it is unknown yet where the location of the quarries will be. At this very moment, May 1997, it seems probable that the coarse aggregate will be borrowed from two or three quarries in Israel and Egypt.

If possible the borrow method will be by means of sawing and hydraulic pressure. The rock will be crushed and sorted in a stone crusher on the borrow site. Transport is by truck with transshipment from Israeli to Palestinian trucks at the border. This is an existing procedure in other construction projects in the Gaza Strip at this moment.

3.2.3. Cement
Cement will be imported from the usual sources in Israel. Transport will take place in bulk trucks or in bags on ordinary trucks. Supply is subject to conditions at the checkpoints. Early and timely arrangements with the suppliers can safeguard the supply to a fair extent.

3.2.4. Reinforcement
Reinforcement will be needed for coping of the quay structure. The minimum quality of reinforcement is available in the Gaza Strip. Ordinary steel bars and high yield steel bars are supplied through specialized firms. A survey at other projects under construction in the Gaza Strip revealed that both steel and specialized cutting and bending subcontractors are sufficiently available in the Gaza Strip or Israel. Transport will be on ordinary trucks.

3.2.5. Water
Water is a scarce natural resource in the Gaza Strip. Its supply is made from a variety of wells and systems. A well will be made during construction. Purification needs to be done.

The quality of water from wells ranging in depths from 10 to 40 m is generally poor and only suitable for compaction and maybe cooling. The quality of water coming from wells ranging in depths from 40 to 80 m is generally suitable for domestic purposes and also for concrete, although tests are required. Beyond 80 m in depth, one can in most cases find water suitable for drinking purposes

3.2.6. Fill material
The fill material will be derived from several sources:
- 44,250 m^3 from excavation of the cliff;
- 260,000 m^3 from external borrow areas (see borrow areas for fine aggregates);
- 847,000 m^3 from nautical dredging works.

3.2.7. Asphalt
In case asphalt will be used for pavement purposes the bitumen have to be imported from Israel. The construction works on the Rafah airport has shown that the import procedure of asphalt is no problem.

3.2.8. Stones
The delivery of the stones still have to be tendered by the contractor. Like the delivery of coarse aggregate (see paragraph 3.2.2), it is not known whether the stones will be imported from Israel, the West Bank, Egypt or Turkey.

3.2.9. Transport
Transport of the majority of the material for the construction of the port will be by means of truck. To get an impression of the traffic intensity which will be generated the following estimates can be made. In total some 870,000 m^3 of material (sand, stones, aggregates and cement) have to be transported from its source to the port site. This material is expected to

be transported by truck. Assume an average truck size of 15 m^3 then in total some 58,000 truck loads are required, or some 116,000 vehicle movements. Assume a construction period (actual construction) of 12 months, then this implies some 390 movements a day on average. With a rush factor of 1.5 this means some 580 movements a day or some 1.0 movement per minute during daytime.

The 116,000 vehicle movements during the 12 months construction period implies an impact on the environment and safety situation. As it is unknown until now from which area the construction materials will come, no location specific statements can be done with respect to environmental impacts of transport. Otherwise it is very probable that the road connecting checkpoint Erez and the transport corridor (road no. 4) to the port will be used for construction transport. Standard calculations give an indication of the zone in which environmental hindrance can be expected due to the increase of traffic. When transport is in daytime, hindrance will occur in a zone of approximately 200 meter on each side of the road. Normally a busy road, such as road no. 4 has a zone of approximately 400 meter on each side of the road. When transport also takes place at night, hindrance will occur in a zone of approximately 500 m on each side of the road. One can conclude that when the transport takes place along a existing road, such as road no. 4, the extra hindrance will be negligible. It should be noticed that the hindrance is only temporary, during a period of 12 months;

The transport route must be implemented by contract between the authorities and the local transport contractor(s) before mobilization of construction works starts. The longitudinal section of the road should be smooth. In any case it should be prevented that construction traffic will pass densely populated areas of Gaza City.

3.2.10. Storage

The storage of the material for as far as required will be in the area near the batching plant.

4. CONDITIONS OF THE SEE FLOOR

4.1. Dredge material

In support of the design of the port an elaborate soil investigation programme has been carried out in the period April-June 1996. The soil investigation programme included several borings in the dredge area. For the locations of the borings reference is made to figure in annex I.

The results of the borings are summarized hereunder. Borings 6, 7 and 8 were all taken approximately on the 6.5 meter depth contour line.

- boring 6: dredging depth some 4 meters:
  - . 2 meters calcareous silica Fine Sand spt-N value some 47, D_{50} = 0.6 mm;
  - . 2 meters slightly cemented calcareous silica Fine Sand spt-N value some 70, D_{50} = 0.2 mm.
- boring 7: dredging depth some 4 meters:
  - . 2 meters calcareous silica Fine Sand, spt-N value some 34, D_{50} = 0.2 mm;
  - . 2 meters slightly cemented calcareous silica Fine Sand spt-N value some 50, D_{50} = 0.5 mm.
- boring 8: dredging depth some 4 meters:
  - . 3 meters calcareous Sand Stone, moderately weak no SPT's, D_{50} = (no info);
  - . 1 meters slightly cemented calcareous silica Fine Sand spt-N value some 70, D_{50} = 0.4 mm.
- boring 4: dredging depth some 2 meters:
  - . 2 meters fine to medium sands, silty, dense to very dense, spt-N value some 66 after 1 meter, D_{50} = (no info).
- boring 11: dredging depth some 4 meters:
  - . 4 meters slightly cemented calcareous silica Fine Sand spt-N value some 20 after 1 meter and 60 after 2 meters, D_{50} = 0.4 mm.

  And in the small port:
- boring 23: dredging depth some 4 meters.
  No information on this borehole is available in the report.
- boring 10: dredging depth some 2 meters:
  - . 1 meter of fine to medium Fine Sand, loose, D_{50} = 0.2 mm;
  - . 1 meter calcareous silica Fine Sand, dense, some shells and gravel, spt-N value some 50, D_{50} = 0.2 mm.

A more detailed description of the material to be dredged is provided in the report of Fugro. The relevant parts are included in annex II. For the material to be dredged these descriptions are:

4.2. Marine sand

Recent Holocene marine deposits consisting of fine to medium sand, silty, medium dense to very dense, at the top very loose, grey (7.5Y-4/1) to greyish olive (5Y-4/2), with locally shells and shell fragments, with locally layers of greyish olive soft to firm clay. The thickness of the unit varies between 2 m (at location BH6) and 11.5 m (at location BH32).

N-values range typically from approximately 15 to 50 with peaks of over 60 (at locations BH1 and BH4) with very low values at the top of the unit. The SPT tool generally sank under its own weight in the seabed. N-values within the clay layers are of the order of 2 to 9, implying an undrained shear strength of about 10 to 50 kPa.

4.3. Cemented sand

Calcareous silica fine to medium sand, locally very clayey at the top, locally slightly cemented, bright yellowish brown (10YR-7/6), with moderately to well cemented nodules or zones, with some shell fragments at the bottom. The sand itself mainly consists of quartz grains, the calcareous material consists largely of the carbonate cement. This unit is interpreted to consist of cemented dune deposits ('Kurkar').

Four varieties of cementation in Kurkar have been distinguished in the literature (Frydman 1980):
1. pebbly concretions floating in loose sand;
2. solid laminar sheets, interbedded in loose sand;
3. non-concretional rock, similar in appearance to type 3 but very friable.

Types 1 to 3 have been observed or deduced to be present in this investigation. The term 'loose' refers here to non-cemented (granular) state.

The upper boundary of this unit dips steeply towards the west. At location BH6 the depth of the boundary is at 2 m below seabed and at location BH4 at 9.1 m. The unit was not encountered in locations BH32 and BH1. The maximum thickness of approximately 16 m is found at location BH6. The variation in unit thickness and the pronounced topography of the top of the unit is related to its genesis as coastal dunes.

The SPT N-values range between approximately 30 to refusal, with the majority of the measurements having a value greater than 50. As the unit is partly cemented, no correlation can reliably be made between N and the relative density. For this reason borehole logs do not contain a density description for this unit.

4.4. Sand

Mainly fine to medium sand, locally coarse, slightly to well cemented, with locally concretions and seams of sandstone, locally grading to sandstone, yellow orange (10YR-8/6), with locally shell fragments. The depth below seabed at which the top of the unit was encountered is 19.4 m at location BH4 and 24.4 m at location BH6.

4.5. Beach rock/cap rock

This unit has been drilled in only one location (BH8) but has also been interpreted from the geophysical investigation to be present as a number of rock outcrops on the seabed. In BH8 this unit consists of a zone of rock of about 3 m thick which is hard at the top and becomes less hard and less cemented with depth and finally grades to sand. It has been classified at the top as moderately weak calcareous sandstone with numerous vugs. With depth more non- to slightly cemented sand layers are present and the estimated rock strength of the sandstone layers decreases to very weak at the bottom. It must be noted that due to the presence of many cracks it is not possible to perform meaningful strength testing on this material. All strength indications are based on visual/manual estimations. At the seabed this material is overgrown and has probably been broken down by marine life. From observations by the drilling crew during a diving inspection it appears the rock surface is rough and has a variable surface relief.

The carbonate content also decreases with depth from 40% at the top to about 20% at 10 m depth (in the unit below). High carbonate contents are associated with a high degree of cementation and with relatively high rock strength.

This unit is interpreted as a cap rock layer, formed by strong lithification of a sand deposit - probably the underlying cemented sand - during a prolonged period of non-sedimentation, biological activity or possibly exposure to the atmosphere.

4.6. Clays

It is not expected that the areas to be dredged contain any clays.

5. FURTHER OBSERVATIONS

5.1. Port and port facilities

5.1.1. Limits to land reclamation

The limits to land reclamation for the final phase (III) has been set in the port development plans at:

- northern boundary 1.9 km north of the Netzarim road;
- southern boundary 400 m north of the Netzarim road.

The accretion south of the port will create additional land off-shore. However part of this material will be used for sand suppletion for erosion control north of the port.

The tip of the breakwater in the Phase IA will reach till the 12 m depth contour line, and in Phase III till the 14.5 m depth contour line.

5.1.2. Passenger terminal

In the present plans for the port development no passenger terminal is foreseen, this in contradiction to previous plans. In case in future it appears to be feasible to introduce passenger liner services the safety aspects in relation to the other port activities will need due attention.

5.1.3. Liquid and solid waste

Only limited data are available concerning volumes ship-generated wasted handled by ports. Estimates of waste from ships are based on data found in literature and the traffic forecasts of Gaza Sea Port, which were presented in the EIS. From the latter data a forecast can be made about the total quantities of liquid and solid waste. Based of a transshipment of 2.035 million tons in 2002, the following quantities of wastes can be expected:

- vessel waste: 0.9 m^3 per 1,000 ton, which means a quantity of about 1,830 m^3 ;
- waste generated from general cargo: 2.0 litre per ton handled, which means a quantity of 4,070 litres

The total number of people working in the port and related activities can only be estimated. If the employment is stated at 250 persons, the following quantities of wastes can be expected:

- waste from premises 2.0 litre per person per day: 500 liters;
- area cleaning: 0.6 litre per person per day: 150 litres.

According to the design a separate port facility for the reception, treatment and disposal of ship will not be erected, because Gaza Sea Port will be only a small port in phase IA. moreover it will not be the home port of ship owners. Disposal of bilge water will not be expected. Port regulations must prevent discharging of liquid waste. Liquid waste will be collected and transported by mobile systems (vehicles of private enterprises) to the waste water treatment plant in the neighbourhood of the port. Solid waste will be collected centrally in the port and transported and treated by the public waste service of the city of Gaza. The Gaza Sea Port Authority will be supported by the Port Authority of Amsterdam with respect to technical assistance and training. This guarantees to a certain extent that waste management of the port will be organized in a proper way.

Ratification of the MARPOL Convention by the Palestinian is very important to prevent further pollution of the eastern part of the Mediterranean. Until the MARPOL convention has been ratified, it is recommended to provide services for the reception of wastes. This will be an addition to the contract design. In annex III a short summary of relevant elements of the MARPOL Convention resolutions is presented. At present PNA has not ratified the MARPOL Convention. Nevertheless it is suggested that this aspect will receive sufficient attention at the start of the port operations and preferably before the start. It is suggested that the

lukt nooit!   milieuregistratie en beheersystemen issues will be incorporated in the planned schemes for the institutional and management development.

Port regulations of waste management should come in force when the port will come in operation.

5.1.4. Sewage system

It is expected that sewage of the port is mainly domestic. Cleaning facilities of ships will not be erected at the port. Domestic sewage of ships will be treated on the ships or will be transported on-shore, where it will be transported to the waste water treatment plant near the port area. In any case no sewage system will be constructed in phase IA. Septic tanks will be used for domestic waste water. This waste water will be treated like the water coming from the ships.

water from buildings

Waste water from the buildings will be taken to a septic tank. The effluent from this tank will be suitable for irrigation purposes like irrigation of landscape areas.

surface water

Surface water on the paved port area will be collected collecting pits which are connected by means of pipes. This water will enter into a pump pit. From this pump pit the first 2 mm of rainfall will be pumped into sedimentation tank where solids will settle. The retention capacity of the tank is 2 mm of rainfall over the paved area, water in excess of the 2 mm will overflow into the sea. The outflow of the sedimentation tank will run through an oil separator and then into the sea. Also the pump pit has an overflow. The capacity of the pump is 200 m^3 per hour. For a schedule of the system reference is made to figure 5.1.

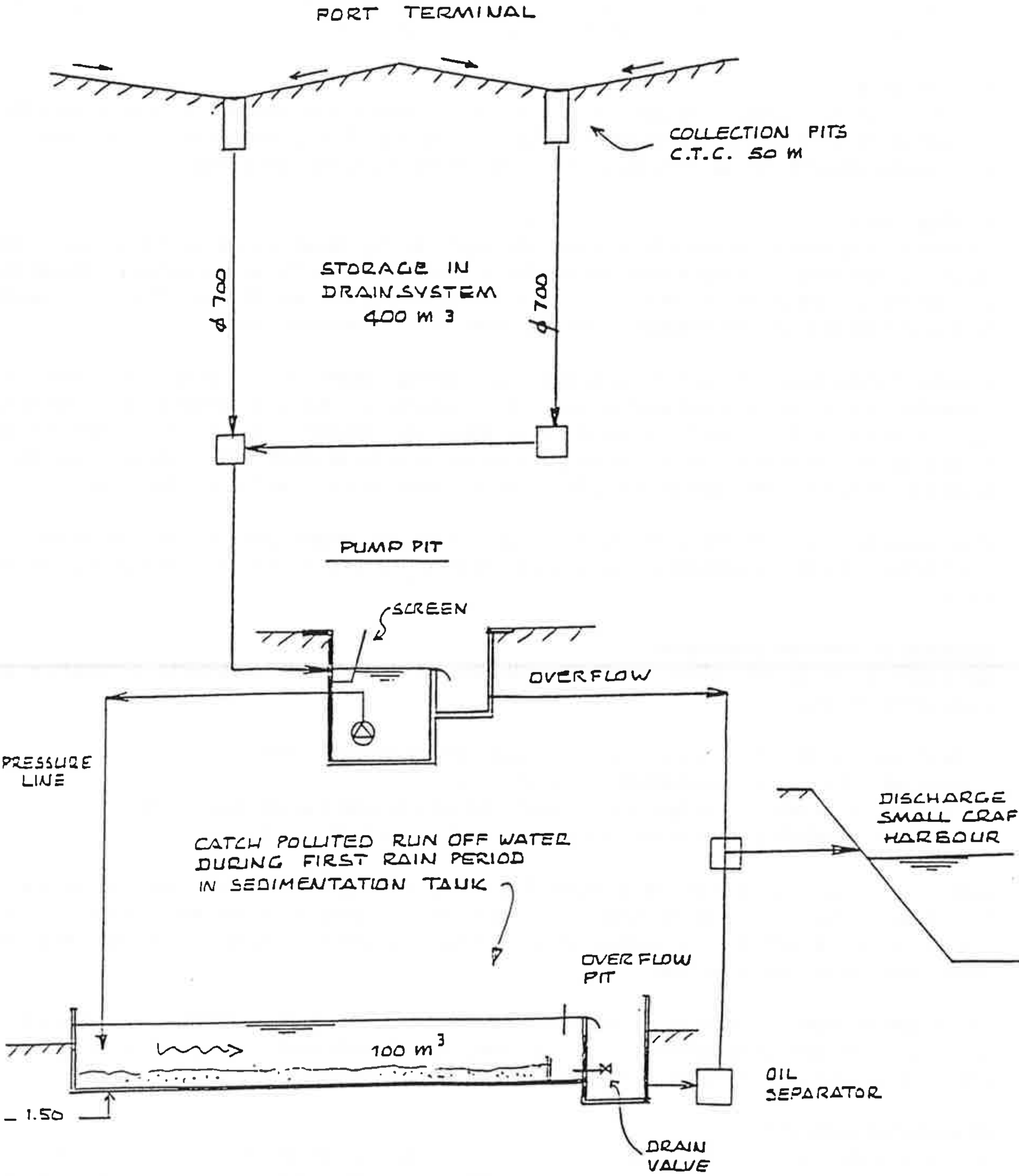
5.1.5. Liquid and solid waste handling

A reference is made to paragraph 5.1.3. in which MARPOL is dealt with.

5.1.6. Equipment to control oil spills

Various techniques and equipment may be used for the containment and cleaning of oil spills.

Figure 5.1. Surface water drainage system



Source: European Gaza Development Group.

oil booms
Floating barriers or booms are usually required to remove oil spilled on the sea surface or to deflect the spilled oil from sensitive areas. Currents, tides, wind and waves as well as the spreading of the oil impose restrictions on the effective use of oil booms. Design features and proper deployment can to a certain extent alleviate these restrictions; however, there is no universal approach suitable for all situations and on some occasions the use of oil booms is inappropriate. Often it is better to deflect the oil to relatively quiet waters, where it may be recovered, rather than to attempt direct containment.

oil skimmers
Skimmers are designed to recover oil or oil/water mixtures from the water surface, usually in combination with containment devices like oil booms. The performance of skimmers is affected by wave motions. Few types function effectively in the open sea.

oil dispersant
Chemical dispersant is used to combat oil pollution by breaking up oil slicks into small droplets, followed by suspension respectively distribution in the water column. Dispersion and dilution prevent the formation of oil-in-water emulsions which are difficult to handle. Dispersed oil is more accessible to bio-degradation by micro-organisms.

Chemical dispersion is applied to prevent oil coming ashore and to protect resources and amenities when containment and recovery are impractical. The application of dispersant has its limitations and should be carefully controlled. The effective distribution of the surface active agent throughout the oil is very important and most dispersant therefore contain a suitable solvent system, penetrating the oil and acting as a carrier for the surfactant.

Due attention should be paid to the application of dispersant in the elaboration of contingency plans (stockpiling and storage, equipment and materials, procedures, training etc.).

cleaning of polluted shorelines
Oil spills in open sea often result in pollution of the shoreline, despite combating and protecting efforts.

With respect to the clean-up process 3 stages can be distinguished:
- removal of heavy contamination and floating oil;
- clean-up of moderate contamination, stranded oil and oiled beach materials;
- clean-up of lightly contaminated shorelines and removal of oily stains.

Basic cleaning approaches have been developed for: sandy beaches, pebble or shingle beaches, boulders, scattered rocks and tidal pools, cliffs, salt marshes, muddy coasts, estuaries, small islands and deltas, amenity beaches, marinas, fishery harbours, industrial ports and coastal installations.

The local oil spill contingency plan should describe sources of manpower and equipment, training of supervisory personnel in cleaning techniques and management of shoreline clean-up. Proper communication means are of essential importance.

disposal of collected oil
Oil spill clean-up operations may result in substantial quantities of (contaminated) oily material, especially in case of shoreline clean-up. This may present major problems. Although re-use via refining or recycling operations is clearly favoured, weathering and contamination of the oily product often prohibits such operations.

Depending on oil quality, recovery may be possible via refineries, (waste) oil recovery contractors, power stations or cement works. Important considerations are: pumpability, solids content and salt content of the recovered oil. Tanker de-ballasting stations and oily waste reception facilities may also be used.

Oil spill contingency plans should pay full attentions to potential disposal options available for different amounts and types of oily material. This includes temporary storage options and facilities. Larger spills will undoubtedly present logistic problems as no single disposal technique can directly accommodate the quantities to be handled. A buffer storage is therefore essential.

5.2. Construction

5.2.1. Water

The source of water and the quantities of water needed for port construction are dealt with in the report on the borrow areas (paragraphs 2.5. and 3.5.).

5.2.2. Concrete plant

A concrete batching plant will be erected near the port. Until now the exact location is not known.

5.2.3. Effects of transport

The effects of transport of construction materials have been described in the report on the borrow areas (chapter 5).

5.2.4. Resettlement

In the first phase of port development only a very limited number (10) of people will have to be removed. The completion of phase III will result in the loss of about 200 housing units. Resettlement of people, also when it is not under discussion at this very moment, should be anticipated by the Palestinian authorities. It is recommended that the resettlement in phase III should be prepared in close cooperation with the people involved.

5.2.5. Dredging during construction period

The duration of the actual dredging works is expected to be some 8 months. The dredger will be a smaller Cutter Suction Dredger (CSD). The landfill works will be initiated (300,000 m^3) with material from the cliffs and from other borrow areas on land.

5.2.6. Archaeological research and rescue operation

As it appeared from the EIS, paragraph 5.2.8, the Gaza Strip is extremely rich in archaeological remains. The area of the proposed port location revealed numerous Roman-Byzantine settlements, all situated in a rather homogeneous dune landscape. So the existence of archaeological remains is sure; the real importance of it should be evaluated by further field investigations. A proportion of the total funds for port construction should be reserved for further archaeological field investigations and 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). As a result of these recommendations, which were already stated in the EIS, the Ministry of Foreign Affairs of the Netherlands, has funded an archaeological survey in the area of the proposed port location. Until now the study has not been finished.

The archaeological survey should register and document the remains and artifacts in the port area before construction starts.

5.2.7. Risk assessment

The goods that will be transported through the port in phase I in accordance with the economic study as carried out by SOFREMER are expected to be.
imports:
- building materials;
- engine parts;

- vehicles;
- metal products;
- flour;
- dry bulk (wheat, barley, corn, protease);
- liquid bulk (petroleum products).

exports:
- seafood;
- citrus fruits;
- other food products;
- industrial products.

It is beyond the scope of this EIS to prepare a full fledged risk assessment. From the list of cargoes that are expected may be concluded that no specially hazardous cargo (with possible exception the oil products) is expected to be handled in the port. A quantification of the risks is therefor not possible. The handling of oil and oil spills is elaborated a little more in detail hereunder.

In the present phase IA design no facilities have been incorporated for the reception of tankers and the handling or storage of liquid bulk. These facilities will have to be incorporated when the actual demand for the handling of liquid bulk will arise. It is strongly advised to implement these facilities in a professional way as soon as oil products are being handled in the port to prevent oil spills. Provisional oil handling facilities (flexible hoses, mobile pumps, filling of trucks along the quay) will increase the risk of spills.

oil spills

An oil spill is a release of oil in a marine environment. This can occur on high seas, near shore or in the port. The chances of oil spills on the high seas will not be increased due to the Gaza Port development plans, the chances on oil spills near shore and in the port will increase due to the related vessels movements. It is not expected that the international transport routes of crude oil will be affected by the Gaza port.

contingency plans

IMO has published a manual on contingency planning to assist governments to draw up contingencies plans of international and national standards. Also on a local level (port) contingencies plans should be drawn up. The port contingency plans should follow the IMO guideline, should fit into the national and international plans and should clearly indicate lines of authority, coordination and response activities and means.

As stated before, it is not expected that in the first phase of the project oil will be handled in the port. As soon as this is done the usual preparations for combatting oil spills will have to be taken. It is suggested also to make this issue also a subject of the planned institutional and management development and training programmes. Options to combat oil spills have been elaborated a little more in detail in paragraph 5.1.6.

It is not known at this stage, and also rather impossible to predict with any accuracy, what type of cargo will be transported through the port in the subsequent phases of the port development. According to the designers of the port it may be possible that in future LPG will be handled in the port. It is not expected by them that LNG will be handled in the port. In case dangerous goods are handled in the port then sufficient safety measures with respect to port operations and zoning of port activities are of course required. Suggestions with respect to zoning are already indicated in the EIS (page 74).

5.3. Dredging

5.3.1. Possibilities of dredging of the material
It is expected by the combination of the contractor that all of the material can be dredged by means of a Cutter Suction Dredger. As the SPT-N values are rather high it is expected that the required cutting force will be high, specially in the beach rock/cap rock. It is not expected by the contractor that blasting will be required.

5.3.2. Disposal of dredge material
The disposal of the dredge material will be immediately north of northerly groyne in the buffer area. The dredge material has a D50 of 0.2 - 0.6 mm. This material is relative similar to the material that is transported as sediment along the coast and is therefor suitable as material for the buffer.

It may be noted that the D50 (used in the report on morphological modelling in the Bijker sediment transport formula is 0.25 mm.

5.3.3. Dredging for beach nourishment
At the moment construction of the breakwater starts, conditions of beach erosion north of the breakwater are created. However, during the spring of 1997, the conditions of this erosion has changed significantly. At the location of the present fish-auction in Gaza City (about 3 km north of Gaza Sea Port), a breakwater with a length of about 300 m is under construction. Already now the effects of sanding at the southern side of the breakwater can be noticed (see figure 5.2). These accumulation of the beach, which has reached a distance of about 150 m will have a mitigating effect on the erosion of the beach north of Gaza Sea Port.

117.302 m^3

As about 200,000 m^3 sand will be left over from dredging of the port basin, this material can be used for beach nourishment. The contractor will start beach nourishment after 8 months port construction has started.

During the soil investigation indications for seabed pollution have been observed, such as very organic and badly smelling soil. These may be related to the disposal of untreated sewerage from Gaza City in the sea. An environmental investigation would be required to delineate the seabed soil pollution. Anyhow, as the pollution is organic it may be expected that the dredged material is suitable for beach protection, because the smell will disappear after a few days nourishment has been carried out. The quantity of this dredging for this purpose is enough. The environmental impacts, e.g. on the groundwater level will be negligible, because no unpermeable layers will be perforated.

5.3.4. Maintenance dredging
At this moment it is not possible to make a sound estimate about the quantity of maintenance dredged material. The material will be used for beach protection purposes. For the environmental impacts a reference is made to paragraph 5.3.3. In a further future perspective material obtained by maintenance dredging can contribute to plans for coastal management, c.q. extension.

5.4. Natural values

5.4.1. Wadi gaza
status
As stated in the EIS, within the Gaza Strip the outlet of the Wadi Gaza, encompassing its adjacent salt marshes, mobile dunes and beaches, constitutes a unique ecosystem component. It covers a more gradual transition from the marine environment to the terrestrial environment than other parts of the coast. The whole range of plant species belonging to vegetation of tidemarks and the mobile littoral sand dunes are still found here and 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 at circa 125 ha; another 200 ha of marshes and bordering vegetation along Wadi Gaza in the hinterland is of special interest with regard to flora and fauna.

Figure 5.2. Breakwater Gaza City

As 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, locally increased inputs of nutrients, sediments and contaminants takes place. Due to south-northerly directed longshore current the imputs are distributed in a northern direction along the coast.

Presently the outlet of the Wadi Gaza is closed off from the sea by a dam, resulting in a unnatural stagnant pool. The water quality in this pool is very poor as untreated waste water is discharged in Wadi Gaza. At the same time though the stagnant pool represents the only permanent substantial fresh-water habitat in the Gaza Strip, attracting various waterbirds.

The unique character and ecological value of Wadi Gaza is recognised and it is intended to declare Wadi Gaza as protected area.

impact of project implementation
The port and the adjoining industrial area will be developed at close distance of Wadi Gaza. The harbour is situated circa 3 km from the actual outlet and the industrial area will be developed adjacent to an area with rainfed, low input level field crops (mainly grapes). This anthropogenic area is considered of special environmental value as well (Witteveen+Bos, 1996).

The main impacts of the port and industrial area as to the Wadi Gaza and surroundings are:
- increased marine pollution;
- increased air pollution and deposition;
- increased habitat fragmentation;
- increased disturbance.

marine and fresh-water flora and fauna
As the long-shore currents along the Gaza coast are in a northerly direction, the increased marine pollution due to the construction and operation of the port will not affect marine and fresh water flora and fauna in the Wadi Gaza area.

air pollution and deposition
The construction and transport activities in the construction phase and the operation of the port and industrial area in the operational phase will result in an increased air pollution and increased deposition of especially NO_x and SO_2. The actual deposition depends on the wind direction. As the wind is predominantly in a westerly direction, the resulting deposition in the Wadi Gaza area is expected to be restricted.

However, the sandy dune areas along Wadi Gaza are very oligotrophic ecosystems. Oligotrophic ecosystems are very vulnerable for contamination as the buffer capacity is very low. The increased pollution and deposition affects the chemical environment, resulting in changes in the microflora and fauna, with cascading effects on higher trophic levels. Sensitive species will disappear. Thus, although the immediate effect may be restricted, the long term effects of deposition of NO_x and SO_2 will lead to deterioration of the oligotrophic ecosystems.

habitat fragmentation
The development of the port and industrial area will isolate Wadi Gaza and surroundings of the area north of the port and industrial area. This will reduce the migration potentials for the resident reptile and (small) mammal fauna.

disturbance
Noise, traffic movements and the presence of people disturb larger animals like reptiles, mammals and/or birds, especially in open landscapes. Compared to the present situation, which can be characterized as a quiet country side, noise, traffic movements and presence

of people will increase severely. The impact will be relatively high in the zones directly adjacent to the port and industrial area and will diminish with increasing distance from the hindrance sources.

5.4.2. Marine flora and fauna

flora

As to flora in the marine environment only phytoplankton and algae and weeds are of importance. Due to the very low oligotrophic conditions, the concentrations of phytoplankton are low. We have no information on the specific species composition.

Based on the available information it seems that algae and weeds grow predominantly on Kurkar ridges. These exposed Kurkar ridges overgrown with algae and weeds represent areas of high primary production in the otherwise highly oligotrophic marine environment. These areas are known to be preferred habitat for several benthic fish species and for juvenile fishes. The specific fish species are not known though. Obtained information through interviews indicates that algae and weeds may occur upto depths of circa 60 m. The abundance and relative importance of algae and weed fields as a nursery habitat at different depths is not known.

fauna

macrobenthic communities

From about 245 identified bottomdwelling macrobenthic species in the coastal waters up to a depth of 80 m, 26 are of Indo-pacific origin.

In the EIS it is indicated that based on the available information in the benthic zone 4 ecosystem components can be distinguished, each characterized by a specific macrobenthic fauna. The zones encompass (table 5.1.).

Table 5.1. Characteristics of depth zones and macrofauna communities (Galil & Lewinsohn, 1981)

depth (m)	distance from shore	substrate	characteristic macrofauna species
0-20 m	0-18 km	sandy	crustaceans: *Sicyonia carinata* *Philocheras monocanthus* *Diogenes pugilator* *Spaeronassa mutabilis*
20-50 m	18-120 km	sandy mud	stomapods: *Oratosquilla massavensis* gastropods: *Cerithium kochi*
50-80 m	120-180 km	silty deposits	echinoderms: *Brissopsis lyrifera* *Antedon mediterranea* decapods: *Parapeneus longirostris* *Macropipus pusillus* *Galathea intermedia* *Alpheus glaber* polychaete: *Sabella pavonia*
> 80 m	> 180 km	muddy clay	molluscs: *Turritella communis* *Nuclea sulcata* *Alcyonium palmatum*

The community of the sandy mud zone has no equivalent outside the Leventine basin, due to the virtual absence of typical Atlantic-Mediterranean species and the presence of Indo-Pacific species.

fish and shrimps
In the coastal waters of the Levantine basin a total of 248 fish species have been identified. 70% are Atlanto-Mediterranean; 13% are cosmopolitan and 10% are of Red Sea origin and 7% (20 species) are endemic for the Mediterranean. Very little is known about the influence of the Red Sea immigrants on the Levantine ecosystem. However, since these immigrant species form an important part of the total biomass (and of the commercial fish catches) these immigrants must play an important role in the food web. In table 5.2 a summary of the most important fish and shrimp species is given, indicating as well the commercially important immigrant species.

Table 5.2. Commercially most important fish and shrimp species (after DANIDA, 1994), with indication of immigrant species from the Red Sea (bold) based on GEP (1994)

species	commercial catch 1993 (metric tons)
Grouper (*Epinephelus aeneus*)	45.0
Common Sea Bream (*Pegellus bogaraveo*)	1.7
Dogfish (*Scyliorhinidae*)	58.9
Sardines (*Sardinella aurita, S. pilchardus*)	1672.6
Atlantic Mackerel (*Scomber scomber*)	13.0
Amber Jack (*Trachurus* sp.)	17.9
Saurie (*Scomberesocidae*)	21.4
Striped Mullet (*Mullus barbatus, M. surmuletus*)	13.9
Moray (*Muraena murena*)	16.4
Variety of other species e.g.	96.3
- Little Tunny (*Euthynnus alleterata*)	
- Spanish Mackerel (*Scomber japponicus*)	
- Frigate Mackerel (*Auxis Thasard*)	
- **Rabbit Fish** (*Siganus luridus*)	
- **Soldier fish** (*Adioryx rubrum*)	
- **Brushtooth Lizard fish** (*Saurida undosquamis*)	
- **Goatfish** (*Upenus moluccensis*)	
- **Barracuda** (*Sphyraena chrysotaenia*)	
- **Rainbow Sardine** (*Dussumieria acuta*)	
Shrimps (***Penaeus japonicus; P. monocerus***)	13.8

protected and endangered species
The following species may be mentioned as protected and endangered species:
- dolphins Delphinidae: regularly reported in off-shore waters;
- marine turtles Caretta caretta, Chelonia mydas: through hunting and egg collection at the brink of extinction;
- monk seal Monachus monachus: only very seldom recorded.

For the densely populated Gaza Strip the marine turtles and monk seal can probably be considered extinct.

impact of project implementation
The main impacts of the construction and operation of the port are:
- habitat loss;
- increased turbidity and sedimentation due to dredging activities;
- increased marine pollution.

At present the main pollution of the marine environment along the coast of the Gaza Strip concerns discharge of untreated sewerage from Gaza City. There is evidence that this discharge of organic substances has resulted in pollution in the inshore zone, i.e. during soil investigations very organic and badly smelling soils were observed (Fugro, 1996). The bad smelling soil indicates the occurrence of inoxic bottomlayers which are very detrimental for the resident flora and fauna. Beside anoxic circumstances due to eutrophication, also negative effects may occur due to contaminants (like PCB's, heavy metals and chlorinated pesticides) sorbed to particle surface of the sludge. The exact type and scale of the organic soil pollution inshore is not known (Fugro, 1996). When large quantities are present, resuspension of the organic and inoxic soil due to dredging will have serious negative effects on the organisms (e.g. phytoplankton, zooplankton, fishes) living higher in the watercolumn.

The main impact of dredging activities in the marine environment is considered to be the increased turbidity. Due to the decreasing light intensity macro-algae and seaweed biomass decreases. Because of the longshore current especially the exposed Kurkar ridges north of the dredging sites may be affected by the dredging activities. This area is overgrown with macro-algae and seaweeds and represents the most productive area in the shallow coastal zone and is an important component of the inshore zone.

Due to the habitat quality and diversity the Kurkar ridges are a favourable nursery and feeding habitat for various fish species. The decreasing biomass of macro-algae and seaweeds affects important ecological groups such as juvenile and herbivorous fishes that depend on macro-algae or seaweed as a habitat or as a direct or indirect food supply.

The ecological impact of construction dredging 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 12 months. The concentration of suspended solids mainly depends on the type of dredger (cutter head or hopper with or without overflow). The impact on the concentration of suspended solids on the sea floor within a distance of 500 m is much higher for the hopper dredger with overflow (600-700 mg/l) than with the hopper dredger without overflow (less than 50 mg/l) or the cutterhead (less than 100 mg/l). The most effective mitigating measure therefore is the use of a dredger with a low impact on turbidity.

In the future an increased marine pollution is to be expected because of the increased intensity of shipping activities and operations, terminal loading and accidents in the port and the development of the industrial area.

flora
Locally, in the area affected by increased turbidity due to the dredging and shipping operations, phytoplankton growth will be reduced by deteriorated light conditions. As the dredged material will consist mainly of rather coarse materials the impact on the pelagic zone will be restricted.

As stated in the EIS due to the construction of the harbour a habitat loss results of 2 ha in phase IA and 4 ha in phase III of the valuable Kurkar ridges overgrown with algae and weeds.

Lasting for circa 8 months in the construction phase, the increased turbidity and sedimentation due to dredging will have a very negative but local impact on the Kurkar ridges with algae and weed vegetation and the dependant benthic fauna (macrofauna, shrimps, fish). The overall impact on fish species and juvenile fishes cannot be assessed as the relative importance of the algae and weed vegetation in the zone affected by dredging is not known.

fauna
The dredging is expected to take place in the zone of 0-10 m. From the borings is appears that the soil consists of coarse sands. This means that the resulting turbidity and sedimentation will be restricted to an area directly adjacent to the dredging spots. Using a Cutter Suction Dredger increased turbidity and increased sedimentation may occur over a distance of over 1 km from the dredging spot (Witteveen+Bos, 1996; figure 6.1). Due to the longshore current this effect only reaches in a northerly direction.

The above implies that only the macrobenthic community in the sandy inshore zones are affected. As stated in the EIS due to the construction of the harbour a direct habitat loss of natural sandy substrate results of: 78 ha in phase IA and 112 ha in phase III.

Some species live well off-shore and or in deeper waters, like the Sardines, Groupers, Dogfish, Mackerel, Jacks and Saurie. The impact of the port on these groups can be considered negligible. The construction and operation of the port is expected to have a serious negative impact only on the specific inshore fish and shrimp community. The exact species composition of this inshore fauna is not known, as well as the age structure (juvenile abundance), but the reduction of the algae and weed beds, the increased marine pollution and increased disturbance will negatively influence the local resident fish and shrimp community.

The listed impacts are not expected to be relevant for the protected and endangered species (dolphins occur off-shore; turtles and monk seals are virtually absent).

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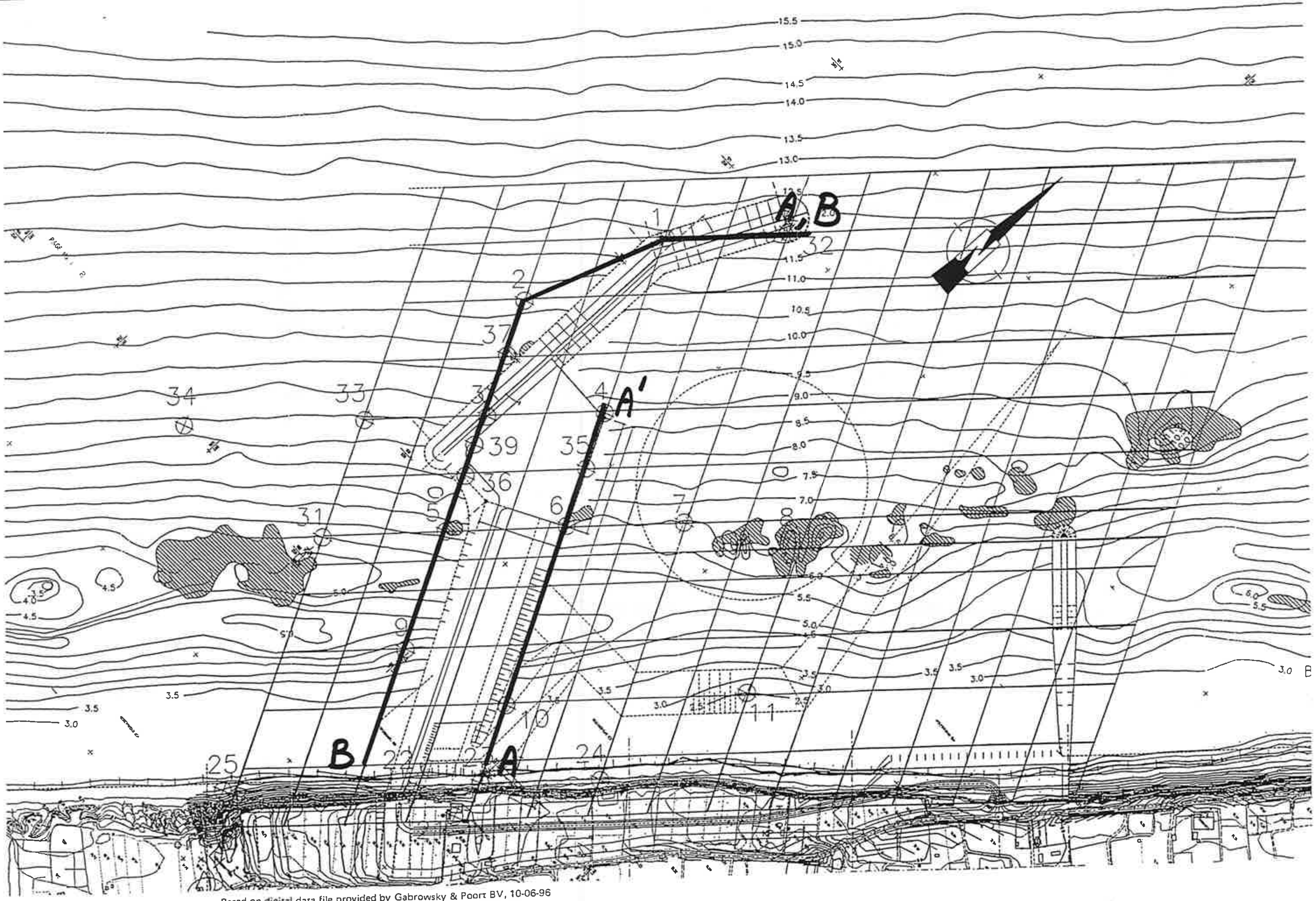
ANNEX I Geotechnical survey

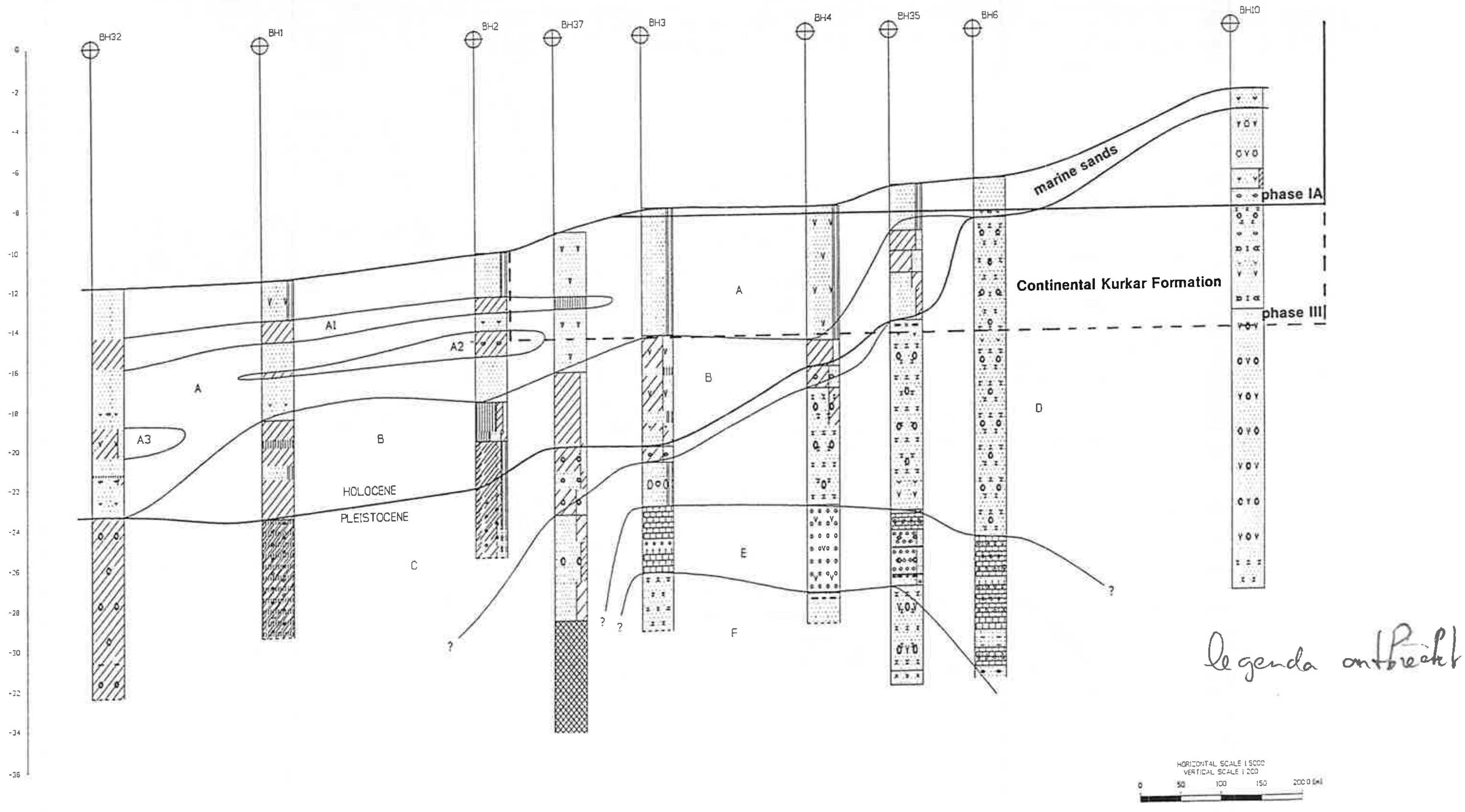


⊗ BOREHOLE LOCATIONS

Based on digital data file provided by Gabrowsky & Poort BV, 10-06-96
FOR GENERAL INFORMATION PURPOSES ONLY

DETAILED LOCATION PLAN
EGDG - Port of Gaza - Palestine

Plate 2



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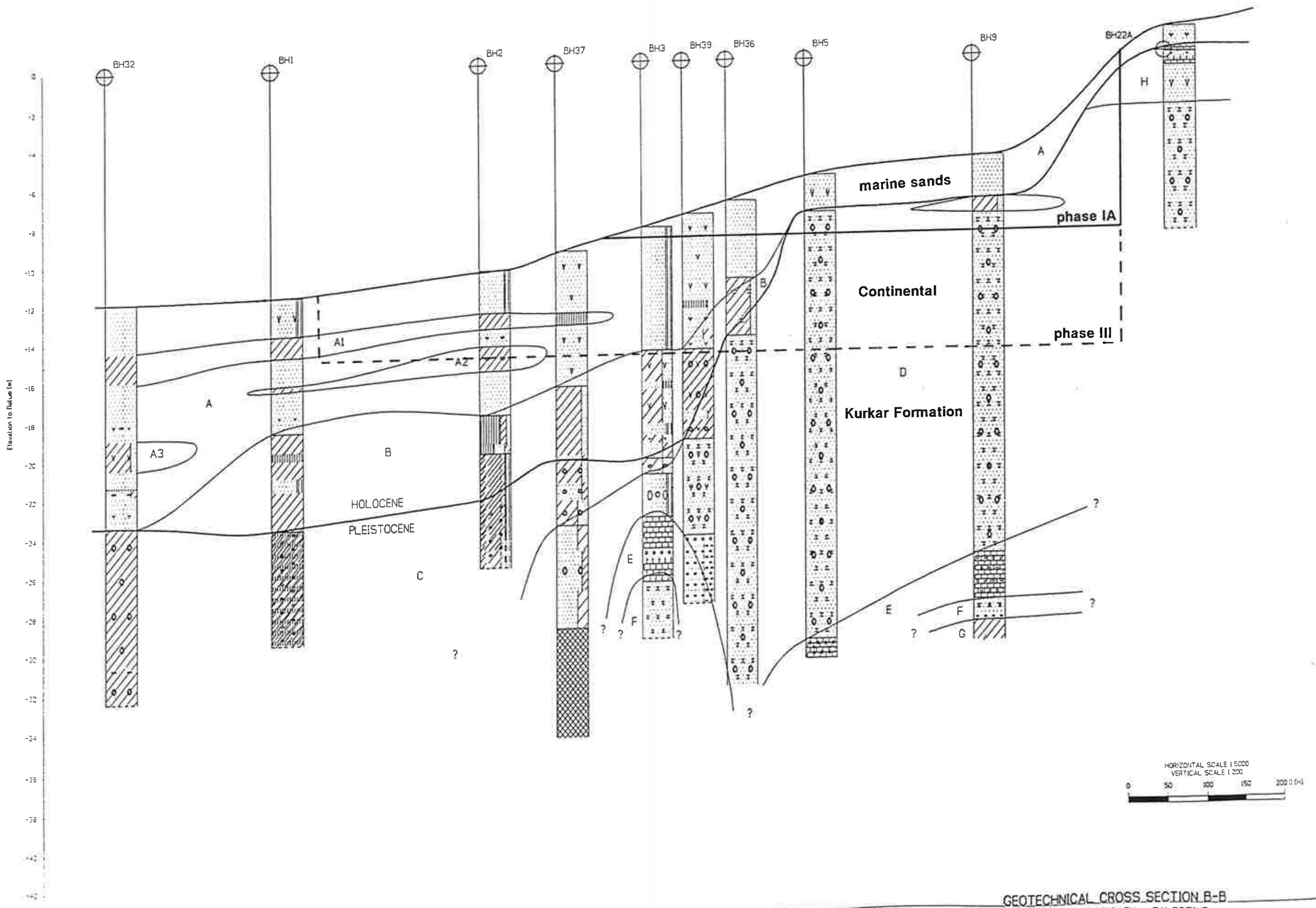
GEOTECHNICAL CROSS SECTION A-A
EGDG - PORT OF GAZA - PALESTINE

Plate 4



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Report No.: K-2426/01

GEOTECHNICAL CROSS SECTION B-B
EGDG - PORT OF GAZA - PALESTINE

Plate 5

ANNEX II Conditions of the sea bottom

ANNEX II Conditions of the sea bottom

The Report of Fugro provides in summary the following information on the subsoil conditions prevailing at the planned site of port.

geological setting
The main geological processes which have affected the local shallow ground conditions in the area are the deposition of sediments originating from the Nile, global sea level variations due to the Pleistocene glaciations, tectonic activity and cementation. These sediments consist of marine, fluvial and eolian deposits. Minor quantities consist of alluvial material.

The majority of the sediments deposited along the coast of the eastern Mediterranean are fluvio-marine and originated from the river Nile (and from the Nile Delta after the Aswan Dam came into use). These predominantly sand sized sediments are transported by anti-clockwise long shore currents along the coast and are then deposited by water and wind.

The Quaternary formations of the coastal region developed during a series of interchanging regressions and transgressions of the Mediterranean Sea that took place in cycles during glacial and intra-glacial periods (Frydman, 1983). These sea level variations were accompanied by sedimentation cycles of marine and continental deposits. The greater part of the formations consists of Pleistocene and Holocene layers of sands with varying degrees of cementation by calcite. During periods where sea level was not fluctuating, dune ridges formed along the coast.

During regression, when the climate was humid and vegetation developed, these dune ridges were covered by red soils, known as 'Hamra'. The lower parts of the ridges became cemented by leached carbonates to form the so-called 'Kurkar' formations. Greenberg (1976) defined a general stratigraphy observed along the coast consisting of the following four major units.

holocene Units
Dune Sands - An accumulation of littoral or marine sand blown inland by onshore winds, which can become cemented into calcareous sandstone. 'Plata' - Bioclastic calcarenite in the form of cemented biogenic debris weakly cemented by calcite. Generally only a few meters thick.

pleistocene Units
'Hamra' - Reddish brown clayey sand with a low calcium carbonate content, 3 to 4 m thick, lying on an erosional surface of the underlying 'Kurkar' unit. 'Kurkar' - Calcareous sandstone derived from littoral and coastal dune sand and diagenetically hardened by calcareous solutions. Carbonate content is reported as 20 to 50%. This material is reported as extremely variable along the coast ranging from small concretions floating in uncemented sand to quasi-solid rock.

Both the 'Hamra' and 'Kurkar' units have been tentatively identified as present at Gaza, but the Holocene 'Plata' has not. Recent dune sands, which occur both as slightly cemented layers and non-cemented layers, are observed forming the dune ridge of Gaza. Furthermore, clay units and recent marine sand units have been observed which are not listed in the above stratigraphy.

During the transition from the Pleistocene to the Holocene (approximately ten thousand years ago), the eastern Mediterranean subsided (possibly due to the deposition of Nile sediments), while the continental crust was uplifted by tectonic activities associated with the Jordan-Dead Sea Rift. The coastal belt then functioned as a hinge. After the uplift stopped (approximately four thousand years ago), the resultant stresses in this belt caused (re-)activation of old coast-parallel faults. These coastal faults run through the area of investigation. The coast line is said to be formed by a 'coastal cliff' running from Rafah, in the south of Gaza to Mount Carmel in Israel (Port of Gaza Basic Engineering Study, Part 4, 1994). The cliff resulted from the action of vertical faulting. In the geological time scale these faults may be regarded as 'active'.

surface conditions
The seabed slopes down approximately towards the north west, with a gradient of about 1:100. Contour lines are essentially parallel to the shoreline. The minimum seabed elevation in the area of investigation relative to the datum (Mean Sea Level; MSL) is about MSL - 12 m at location BH32.

A geophysical survey was carried out by Fugro ISM (Fugro ISM, 1995). Side-scan sonar results indicate that the seabed is a uniformly sloping featureless area, with the seabed soil consisting of a thin layer of sand. A weak seismic reflector horizon was reported at 1 to 3 m depth from sub-bottom profiler results. Outcrops of sandstone or calcarenite can be found between the shoreline and approximately 10 m water depth. These outcrops have been encountered on the seabed during the geotechnical investigation and during the geophysical survey. Similar outcrops are found in the surf zone below the beach.

stratigraphy
The subsurface within the area of investigation has been divided into eight main geotechnical stratigraphical units, as shown on Plates 3 to 5. The units are described below. The description is based on borehole data and correlation between adjacent boreholes.

unit A Marine Sand
Recent Holocene marine deposits consisting of fine to medium sand, silty, medium dense to very dense, at the top very loose, grey (7.5Y-4/1) to greyish olive (5Y-4/2), with locally shells and shell fragments, with locally layers of greyish olive soft to firm clay. The thickness of the unit varies between 2 m (at location BH6) and 11.5 m (at location BH32).

N-values range typically from approximately 15 to 50 with peaks of over 60 (at locations BH1 and BH4) with very low values at the top of the unit. The SPT tool generally sank under its own weight in the seabed. N-values within the clay layers are of the order of 2 to 9, implying an undrained shear strength of about 10 to 50 kPa.

unit B Clay
Clay probably of Holocene age, locally sandy, soft to firm, greyish olive (5Y-6/2) to yellowish brown (2.5Y-5/3), with layers of silt and silty of clayey sand. The maximum thickness is 5 m (at location BH1). The top of the layer is found at 2.3 m below seabed at location BH35 and at 7 m below seabed at location BH1. The unit is absent in locations BH32 and BH6.

The typical N-value is of the order of 4, implying an undrained shear strength of about 20 to 25 Kpa. The average undrained shear strength estimated from field pocket penetrometer readings is approximately 40 Kpa at location BH1 and 60 Kpa at location BH35. Values obtained from the field torvane are somewhat lower probably due to the sand and silt content.

unit C Clay
Clay with locally sandy and silty zones, firm to hard, yellowish brown and dark olive brown (2.5Y-5/4) to brown, with light grey cemented nodules, with locally traces of organic matter. The clay has a 'dray' appearance. Its grainy texture disappears when the clay is mixed with water.

This unit's thickness ranges from 0 m (it is absent in location BH6) to greater than 9 m (the lower layer boundary was not encountered in location (BH32).

The upper layer boundary was encountered at 8 m below seabed at location BH4 and at 12 m below seabed at location BH1.

The shear strengths estimated in the field range from approximately 40 Kpa in the top of the unit to 100 Kpa at the maximum borehole depth, with local maximum values in excess of 250 Kpa which are caused by cemented nodules.

The colour of the clay and the colour variations, it's random shear strength variations and the silt-like texture are indications that this is not a normally consolidated clay which has been deposited in water. It is more likely that it is a continental deposit such as a paleosol of a loess-type deposit which has been affected to a variable extent by exposure to the atmosphere.

This unit may correspond to the 'Hamra', although the thickness exceeds the figures quoted for Hamra deposits and the main component is clay as opposed to sand.

unit D Cemented Sand
Calcareous silica fine to medium sand, locally very clayey at the top, locally slightly cemented, bright yellowish brown (10YR-7/6), with moderately to well cemented nodules or zones, with some shell fragments at the bottom. The sand itself mainly consists of quartz grains, the calcareous material consists largely of the carbonate cement. This unit is interpreted to consist of cemented dune deposits ('Kurkar').

Four varieties of cementation in Kurkar have been distinguished in the literature (Frydman 1980):
1. pebbly concretions floating in loose sand;
2. solid laminar sheets, interbedded in loose sand;
3. non-concretional rock, similar in appearance to type 3 but very friable.

Types 1 to 3 have been observed or deduced to be present in this investigation. The term 'loose' refers here to non-cemented (granular) state.

The upper boundary of this unit dips steeply towards the west. At location BH6 the depth of the boundary is at 2 m below seabed and at location BH4 at 9.1 m. The unit was not encountered in locations BH32 and BH1. The maximum thickness of approximately 16 m is found at location BH6. The variation in unit thickness and the pronounced topography of the top of the unit is related to its genesis as coastal dunes.

The SPT N-values range between approximately 30 to refusal, with the majority of the measurements having a value greater than 50. As the unit is partly cemented, no correlation can reliably be made between N and the relative density. For this reason borehole logs do not contain a density description for this unit. See section 4.3.4. for a discussion on this matter.

unit E Coarse Sediments
This unit consists of variably cemented coarse sediments such as conglomerate, calcirudite and calcarenite, which are generally weak to moderately weak, but locally very weak or moderately strong, dull orange (7,5YR-6/4) to greyish yellow (2,5Y-7/2), with layers of sandy gravel, locally cemented gravelly sand and fine sand with sandstone and shell fragments. Due to the variations in the carbonate content, the degree of cementation and the grain size the classification terms vary from borehole to borehole and from layer to layer in what is basically one geological unit deposited in stream channels (wadi of river beds). The unit was encountered at locations BH4, BH35 and BH6. The thickness varies between 3.6 m at location BH35 to 6.4 m at location BH6. The top of the unit was encountered between 15 m and 18 m below seabed.

Point Load Test results show values of Point Load Strength Index $I_s(50)$ varying from 0.33 MPa to 2.63 Mpa. For carbonate rocks the correlation factor between Point Load Strength Index and Unconfined Compression Strength (UCS) may be taken as 4 to 8, for siliceous rocks it may be up to 20-25. Therefore, for these intermediate rocks a correlation factor has to be selected from this wide range. Using 4 as a lower bound and 20 as upper bound it may be concluded that the UCS of these rocks lies somewhere between 1.3 Mpa and 52 Mpa. Thus these rocks are classified as generally weak to moderately strong.

unit F Sand
Mainly fine to medium sand, locally coarse, slightly to well cemented, with locally concretions and seams of sandstone, locally grading to sandstone, yellow orange (10YR-8/6), with locally shell fragments. The depth below seabed at which the top of the unit was encountered is 19.4 m at location BH4 and 24.4 m at location BH6.

unit G Clay
This unit, which has only been found in borehole BH9, consists of stiff to very stiff dull yellowish brown (10YR-5/4) clay with scattered pebbles of flint.

unit H Beach rock/Cap rock
This unit has been drilled in only one location (BH8) but has also been interpreted from the geophysical investigation to be present as a number of rock outcrops on the seabed. In BH8 this unit consists of a zone of rock of about 3 m thick which is hard at the top and becomes less hard and less cemented with depth and finally grades to sand. It has been classified at the top as moderately weak calcareous sandstone with numerous vugs. With depth more non- to slightly cemented sand layers are present and the estimated rock strength of the sandstone layers decreases to very weak at the bottom. It must be noted that due to the presence of many vugs it is not possible to perform meaningful strength testing on this material. All strength indications are based on visual/manual estimations. At the seabed this material is overgrown and has probably been broken down by marine life. From observations by the drilling crew during a diving inspection it appears the rock surface is rough and has a variable surface relief.

The carbonate content also decreases with depth from 40% at the top to about 20% at 10 m depth (in the unit below). High carbonate contents are associated with a high degree of cementation and with relatively high rock strength.

This unit is interpreted as a cap rock layer, formed by strong lithification of a sand deposit - probably the underlying cemented sand - during a prolonged period of non-sedimentation, biological activity or possibly exposure to the atmosphere.

ANNEX III Regulatory framework for marine pollution

ANNEX III Regulatory framework for marine pollution

The most important set of laws relating to prevention of marine pollution are contained in the MARPOL Convention regulations.

MARPOL

The 1973 MARPOL Convention aims to prevent pollution from ships. It is applicable to ships flying the flag of, or operating under the authority of parties to the convention. Violations are prosecuted under the parties' national law. As proof that a ship is designed, equipped, and maintained in accordance with the provisions of the regulations stipulated in the Annexes to the convention, Parties may issue an International Oil Pollution Prevention (IOPP) Certificate. Port states are expected to carry out inspections of ships calling at their ports. However, the Convention stresses that no undue delay may be caused to the ship for the purpose of inspection. Should undue delay occur, the ship is entitled to compensation.

The pollution control provisions of MARPOL are contained in five annexes, as follows:

Annex I	Regulations for the Prevention of Pollution by Oil (dirty ballast water; oily tank washing; oily bilge water; slops; sludge; fuel residues; waste oil).
Annex II	Regulations for the Prevention of Pollution by Noxious Liquid Substances (from chemicals in bulk; tank cleaning after discharge of cargo).
Annex III	Regulations for the Prevention of Pollution by Harmful Substances in Packaged Form (in freight containers, portable tanks or similar)
Annex IV	Regulations for the Prevention of Pollution by Sewage.
Annex V	Regulations for the Prevention of Pollution by Garbage (garbage; trash; foodstuffs; oily rags; plastics; packing materials and dunnage).

Parties to the Convention are bound by Annexes I and II. Annexes III, IV, and V are optional.

annex I - Oil

Oily wastes from ships can be classified in two main categories, oily waste from machinery spaces (applicable to all ships), including sludge from engines and oily bilge water; and a tanker cargo related category, including oil contaminated ballast water and tank washing.

Any ship of 400-10,000 GRT must have oil-water separating equipment. Ships > 10,000 tons must also have an oil discharge monitoring and control system, together with oil filtering equipment (limiting the oil content of discharge to 15 ppm).

Every oil tanker > 150 GRT and every non-oil tank ship > 400 GRT must have an oil Record Book Part I (Machinery Space Operations). Every oil tanker > 150 GRT must also have an Oil Record Book Pad II (Cargo/Ballast Operations).

annex II - Noxious Liquid Substances

Annex II entered into force in April 1987 and is mandatory for states accepting MARPOL 73/78. Noxious liquid substances can be divided into four categories depending on their toxicity to the marine environment and requiring different types of anti-pollution measures:

Category A	- major hazard to marine resources or human health. - stringent anti-pollution measures required.
Category B	- hazard to marine resources or human health. - special anti-pollution measures required.
Category C	- minor hazard to marine resources or human health. - special operating conditions.
Category D	- recognizable hazard to marine resources or human health; - some attention in operational conditions required.

annex V - Garbage from Ships

Solid waste generated in the port environment is either directly related to ships and the cargo, or to port-based sources. MARPOL Annex V is restricted to garbage, generated during the normal operation of the ship and liable to be disposed of continuously or periodically. However, besides the waste generated on-board, there is an amount of waste generated inside the port area itself. The total volume can be subdivided into five categories.

MARPOL waste:
- ship waste, generated during the voyage and during a stay in port;
- cargo waste, generated during loading and unloading of ships at berth.

port waste:
- floating waste, mainly originating from land based sources;
- waste from premises inside the port area;
- waste from port area cleaning activities.