

**Netherlands Ministry of Foreign
Affairs
Directorate General for
International Cooperation**

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

**Additional Environmental Impact
Statement for the Gaza Sea Port**

**Further observations (including
conditions of the sea floor)**

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ANNEXES

- I Regulatory framework for marine pollution
- II Conditions of the sea bottom

number of pages

2
4

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) presents observations on shortcomings of the EIS which are not essential for decision-making on funding of the project. Information on these points should become available for the Palestinian authorities during construction of the port. One essential point refers to the conditions of the sea floor with respect of the suitability of dredged materials for beach protection purposes. This aspect has been processed in the part dealing with the dredging aspects.

The design process of the port has reached at the end of 1996 the status of a pre-final contract design, which means that the contractor can calculate a final price for construction.

This reports presents some issues related to the following aspects:

- port and port facilities (chapter 2);
- construction (chapter 3);
- dredging (chapter 4);
- natural values (chapter 5).

The issues which are mentioned by the Commission are dealt with in the following chapters.

2. PORT AND PORT FACILITIES

2.1. 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.

2.2. 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.

2.3. Liquid waste

In the first phase of the project facilities will be created for the reception of solid waste from the vessels. No details on these facilities are provided in the design documents.

No facilities have been planned for the reception and treatment of the various types of liquid waste from the vessels. This will have to be implemented by the port authorities once the port is handed over. In annex I 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 issues will be incorporated in the planned schemes for the institutional and management development.

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2.4. Sewage system 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.

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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 m³ per hour. For a schedule of the system reference is made to figure 2.1.

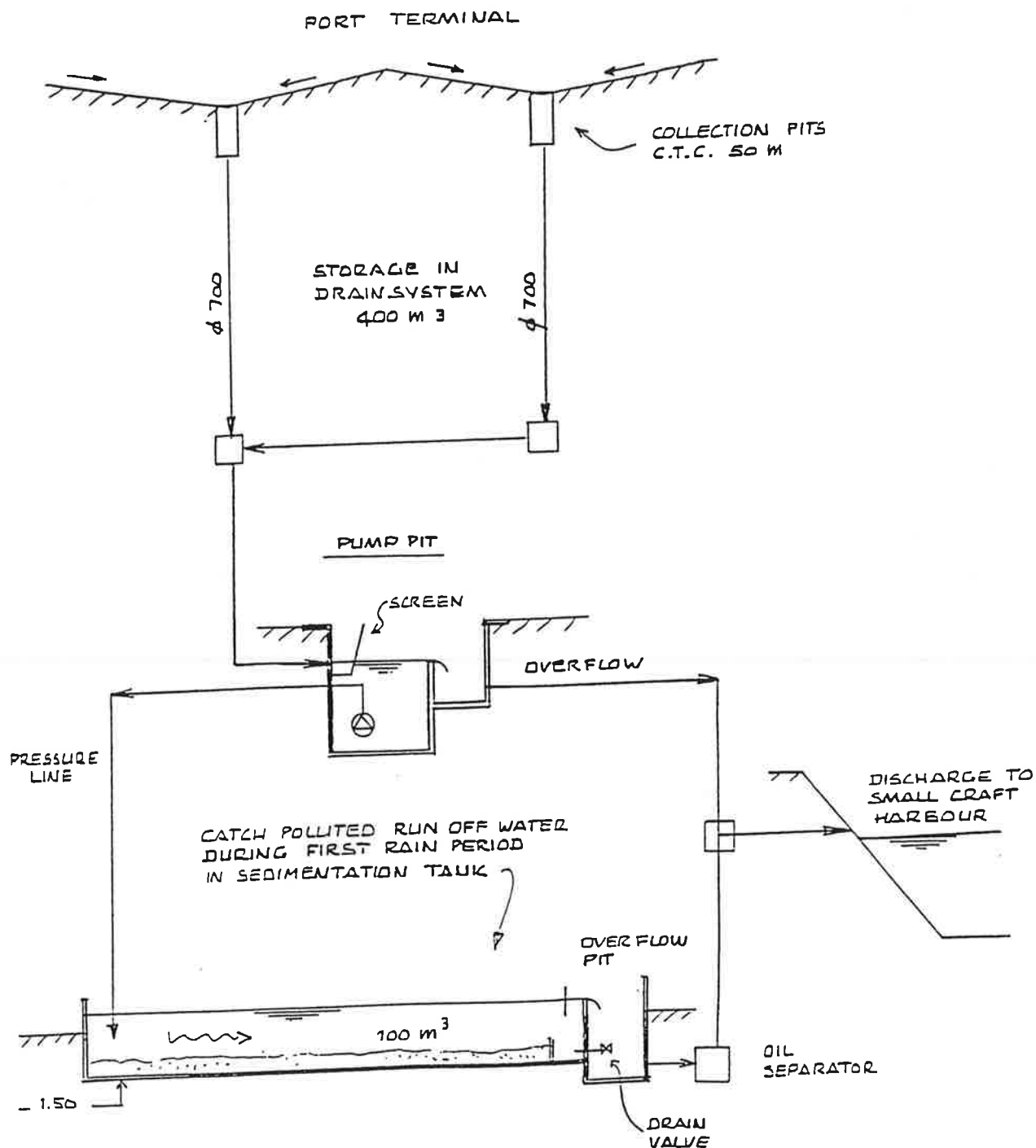
2.5. Liquid and solid waste handling

A reference is made to paragraph 2.3. in which the MARPOL is dealt with.

2.6. Equipment to control oil spills

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

Figure 2.1. 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.

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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.

3. CONSTRUCTION

3.1. 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.).

3.2. Concrete plant

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

3.3. Effects of transport

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

3.4. 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.

3.5. Dredging for 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 m³) with material from the cliffs and from other borrow areas on land.

3.6. Archaeological research and rescue operation

As it appeared from the EIS, paragraph 5.2.8 and figure 5.6 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. Although there are several proposals to investigate the region projects have not started until now. As it has already been indicated in the EIS, it is strongly recommended that 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).

3.7. 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.

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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 2.6.

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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).

4. CONDITIONS OF THE SEE FLOOR AND DREDGING

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 4.1.

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:

marine sand

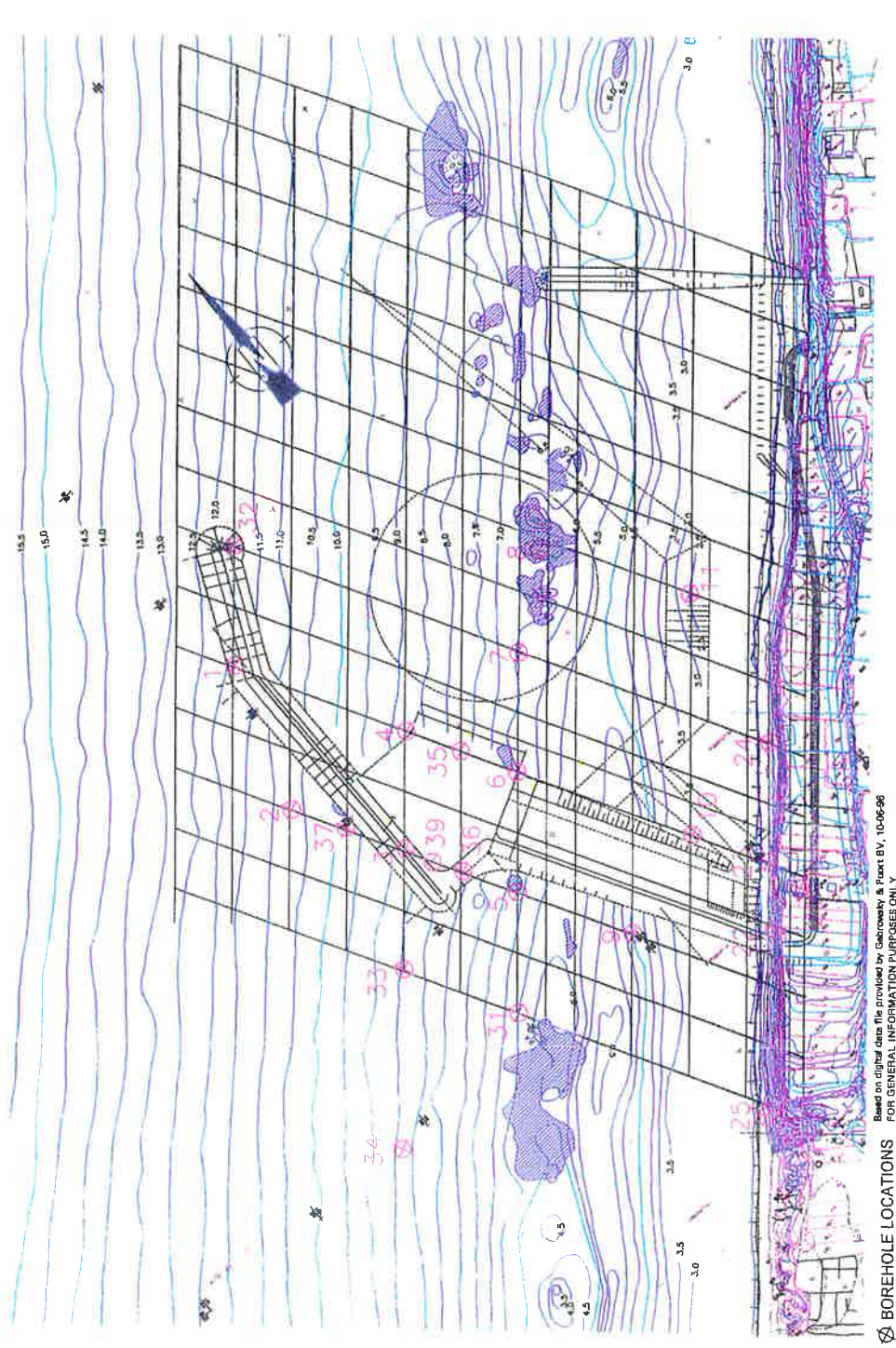
Recent Holocene marine deposits consisting of fine to medium sand, silty, medium dense to very dense, at the top very loose, grey (7.5Y-4/1) to greyish olive (5Y-4/2), with locally shells and shell fragments, with locally layers of greyish olive soft to firm clay. The thickness of the unit varies between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

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').

Figure 4.1. Detailed location plan



Source: European Gaza Development Group

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.

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.

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.

clays

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

4.2. 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.

4.3. 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. NATURAL VALUES

5.1. Wadi Gaza

5.1.1. 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.

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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 inputs 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.

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5.1.2. 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.

terrestrial flora and fauna

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.

5.2. Marine flora and fauna

5.2.1. 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.

5.2.2. 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: <i>Sicyonia carinata</i> <i>Philocheirus monocanthus</i> <i>Diogenes pugilator</i> <i>Spaeronassa mutabilis</i>
20-50 m	18-120 km	sandy mud	stomatopods: <i>Oratosquilla massavensis</i> gastropods: <i>Cerithium kochi</i>
50-80 m	120-180 km	silty deposits	echinoderms: <i>Brissopsis lyrifera</i> <i>Antedon mediterranea</i> decapods: <i>Parapeneus longirostris</i> <i>Macropipus pusillus</i> <i>Galathea intermedia</i> <i>Alpheus glaber</i> polychaete: <i>Sabella pavonia</i>
> 80 m	> 180 km	muddy clay	molluscs: <i>Turritella communis</i> <i>Nuclea sulcata</i> <i>Alcyonium palmatum</i>

The community of the sandy mud zone has no equivalent outside the Levantine 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 (<i>Epinephelus aeneus</i>)	45.0
Common Sea Bream (<i>Pegellus bogaraveo</i>)	1.7
Dogfish (<i>Scyllorhinidae</i>)	58.9
Sardines (<i>Sardinella aurita</i> , <i>S. pilchardus</i>)	1672.6
Atlantic Mackerel (<i>Scomber scomber</i>)	13.0
Amber Jack (<i>Trachurus</i> sp.)	17.9
Saurie (<i>Scomberesocidae</i>)	21.4
Striped Mullet (<i>Mullus barbatus</i> , <i>M. surmuletus</i>)	13.9
Moray (<i>Muraena murena</i>)	16.4
Variety of other species e.g.	96.3
- Little Tunny (<i>Euthynnus alleterata</i>)	
- Spanish Mackerel (<i>Scomber japonicus</i>)	
- Frigate Mackerel (<i>Auxis Thasard</i>)	
- Rabbit Fish (<i>Siganus luridus</i>)	
- Soldier fish (<i>Adioryx rubrum</i>)	
- Brushtooth Lizard fish (<i>Saurida undosquamis</i>)	
- Goatfish (<i>Upeneus moluccensis</i>)	
- Barracuda (<i>Sphyraena chrysotaenia</i>)	
- Rainbow Sardine (<i>Dussumieria acuta</i>)	
Shrimps (<i>Penaeus japonicus</i> ; <i>P. monocerius</i>)	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.

5.2.3. 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.

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.

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Phytoplankton

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.

algae and weeds growing on Kurkar ridges

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

macrobenthic communities

The dredging is expected to take place in the zone of 0-10 m. From the borings it 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.

fish and shrimps

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.

protected and endangered species

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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water

ANNEX I Regulatory framework for marine pollution

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ANNEX I 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 Part 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.

water

ANNEX II Conditions of the sea bottom

environment

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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 'dry' 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, its 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 $I_p(50)$ 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.

