



Sultanate of Oman
Ministry of Transport & Communications,
Directorate General of Ports

**Preliminary Environmental Impact Assessment Study
Commercial, Governmental Berths and
Pre-Gate & Inspection Zone**



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**Preliminary Environmental Impact Assessment Study
Commercial, Governmental Berths and Pre-Gate & Inspection Zone**

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Executive Summary

The Proposed Development

The new Port of Duqm is being developed on behalf of the Ministry of Transport and Communications (MOTC) to provide facilities for commercial, navy and coastguard vessels at a site approximately 450km south of Muscat in the Sultanate of Oman. The operation of the port will be managed by the Port of Duqm Company S.A.O.C, a 50: 50 joint venture between the Omani Government and the Consortium Antwerp Port (CAP). The Port's operations will include a variety of port activities (some of which are already taking place), principally comprising activities associated with operations at a dry dock area (for ship repair and maintenance), a commercial quay (for a container terminal, dry bulk terminal and multi-purpose terminal), government berths, a fast ferry terminal, liquid berths, a variety of storage areas, port gates and offices, utilities etc.

The Port of Duqm is to be developed in phases, with the first phase being the development and operation of the navigable areas within and outside the port, the commercial quay on the main breakwater (multi-use, container and bulk terminals), government berths, fast ferry terminal, finger pier, dry storage areas and all associated landside supporting infrastructure (e.g. gates, entry, buildings, offices, utilities, etc.). The second phase will see the development of the and operation of the liquid berth and liquid storage areas on the lee breakwater, whilst the third phase is envisaged to involve the increase mineral export, and the fourth phase will be when the commercial quay is fully operational as container terminal.

The Proposed infrastructure packages

RH-K&A's involvement in this project includes port planning (macro planning), grading, roads and infrastructure as well as port facilities planning (micro planning) and design of buildings. The presented preliminary Environmental Impact Assessment covers the provision of certain infrastructure services for the development of the First Part of the Commercial Berths in terms of three packages as follows:

- Package (IP2): Construction, commissioning and maintenance of the Construction of Roads, Infrastructure & Buildings at the Commercial Terminal & Operational Zone Areas, Port of Duqm.

- Package (IP3): Construction, commissioning and maintenance of the Construction of Roads, Infrastructure and Buildings at the Commercial Pre-Gate, Gates and Inspection Zone, Port of Duqm.
- Package (IP4): Construction, commissioning and maintenance of the Construction of Roads, Infrastructure and Building Works at the Government Berth Area, Port of Duqm.

Tentatively the required manpower for construction phase of the three proposed packages in terms of technical, administration, skilled and non-skilled labors is about 900 to 1000. The time for completing the each Package is 30 months including mobilization and period for maintenance is 365 days.

Justification for Environmental Impact Assessment

The primary environmental law in Oman is the Royal Decree No 114/2001 entitled 'Law on Conservation of the Environment and Prevention of Pollution' establishes a legal structure that controls the disposal of pollutants in a manner that minimizes environmental harm. The enforcement agency is MECA. Guidelines laid down by MECA set out eight groups which could require EIA. The proposed development falls into 'Group 6, Marine and Coastal Projects' as a commercial port.

Objectives of Preliminary Environmental Impact Assessment Study

The main objective of this environmental study is to furnish the appropriate information about the outcome and Preliminary environmental impacts of this project for the following Environmental Impact Assessment to be conducted by the contractor. This will allow the assigned contractor(s) to start construction works with Preliminary Environmental Approval (EP) by MECA. Furthermore, the decision maker will want to know if the proposed project is likely to produce the stated results.

Sources of Information

The project has been on running for a number of years, and there is existing data and reports available for use in the preparation of this PEIA report. The several key documents are: the 2007 Environmental Statement for the construction of the original

port design¹, the 2010 Ship Repair Yard and Dry Dock Complex in Duqm², Environmental Impact Assessment of the operation Phase the 2012 Port of Duqm Extension, Oman Environmental Scoping Report³. As far as possible, the data and reports were collected during the PEIA Study from data holders.

During the next phase of carrying out the Environmental impact Assessment of the proposed three packages, it's recommended to update and conduct measurements for noise and ambient air.

General Methodology

The PEIA assignment of this task should be accomplished in 6 weeks, so rapid consultation has been undertaken through a series of meetings during December 2014. The PEIA techniques in the study include Identify impact of intervention (single impact), accumulative impacts and quantifying the impact using modeling technique when possible (such as noise and emissions impacts)

Findings of Preliminary Environmental Impact Assessment Study

Socio-Economic

Positive impacts will be achieved from the project in terms of the employment of the local workforce and migrating workers. Employment opportunities will be available for both skilled and unskilled workers and vessel and equipment hire. Indirectly, the local economy will be enhanced due to the increase in personnel in the area (direct spending potential) and the associated opportunities for businesses and industries in the area (e.g. ship hiring, accommodation). Where possible, personnel should be pooled from the local community and within Duqm area. Overall the Project site will offer several thousand jobs directly serving the proposed new facilities and several times this amount for jobs indirectly linked to the port and industrial activities. Training will be necessary to prepare the new staff, ensuring that the new skills and techniques are also transferred to the local

¹ Royal Haskoning, 2007: New Port and Dry Dock Complex, Duqm. Environmental Statement. Final Report 3H6503.

² COWI, 2010, Ship Repair Yard and Dry Dock Complex in Duqm, Environmental Impact Assessment of the operation Phase

³ Khatib & Alami and Partners, 2012: Port of Duqm Extension, Oman Environmental Scoping Report, Ministry of Transport and Communications, Sultanate of Oman 17 January 2012, Final Report - 9S8605

market. The increase in available jobs will give the local economy a significant boost. There is minor impact of construction and operation phases on fisheries until new Fisheries Harbor is completed;

Wastewater

The wastewater generated during construction is limited by the contractors' staff and manpower. The total manpower for three packages estimated at 900 to 1000 capita. The estimated generated wastewater is less than 100 m³/day and dry sludge is about 1.0 tons/day. The generated wastewater during construction will be treated through compact wastewater treatment unit similar to the one for the ongoing construction work as shown in the following Figure (STRABAG contractor). The assigned contractor has to try first if he can keep sending the pre-treated sludge by thickener to Duqm STP temporary during construction through an agreement. If not, the generated sludge can be treated by sludge thickener & air-drying using drying beds and composting. Mechanical devices to turn over the sludge in the initial stages of the drying process are also available on the market. The position of the drying beds should be downstream the wind and away of any community by at least 2.0 km or through other proposed treatment scenarios.

The generated wastewater during operation will be treated through Sewage left station and sewage treatment plant (STP) at (IP3 and IP4). The normal sewage effluents will be treated to acceptable standards for reuse at the facility's own sewage treatment plant and is not considered to pose an environmental problem. Normally, sewage from ships will be kept inside the ships but can, if specially requested by the customer, be treated at the on-site treatment plant. The treated sewage effluent (TSE) will be recycled for plantation and green belt. The current practice that the STP treats only the wastewater and wet sludge evacuated and transported to be treated in the Duqm STP. This situation is not sure for future by the Duqm STP operator because they cannot manage more sludge for treatment. They can receive dry sludge only (this issue has been raised through the environmental department of (SEZAD). So, it's recommended to treat the sludge using sludge thickener and dried through incinerator or drying beds. Other scenarios are proposed to treat the generated sludge. The treated sludge can be used for land application to improve soil characteristics for landscape and green belt matching

with Omani regulation MD 17/93. Other scenarios are proposed for recycling & disposing the treated generated sludge.

Solid waste

Regular non-toxic solid waste generated due construction and operation works will be collected and dispose into dumping site. Other non-hazardous solid waste will be produced in office buildings, canteens and other general facilities for staff working at the site. This waste shall include food residues and other organic material, paper, cardboard etc. and will be collected at regular intervals, brought to an intermediate on-site storage area and from there be transported to the off-site landfill designated for disposal of the solid waste. The Project is yet to be awarded; the exact location of dumping yard will be defined by the employer during the mobilization period.

Oil, chemical and hazard wastes

The oil water separators along the Commercial and Governmental Berths are mounted downstream the screen chamber and upstream the pump well. The separator shall be cleaned periodically to ensure proper separation efficiency. Other oil sources from leakage from workshops and accidental spills collected as well. The collected and treated oil can be recycled and others collected and stored in oil pit at temporary hazardous waste area with total served area 40,000 m² east of Pre-gate area (IP2). In later stage the disposed oil will be transported to the designed dump fill for the project area. Some chemical waste will be treated and recycled and other toxic and disposed chemicals will be collected and stored within the same temporary hazardous waste area to be transported to the designed dump fill for the project area.

In case the contractor cannot get approval or no objection for receiving all hazard wastes that would be generated from Duqm Port during construction and operation, treatment facilities should be provided to treat all the toxic wastes or get an approval from Be'ah for having hazard wastes dump site.

Traffic and transport demand forecast

It is realized that there will be developed traffic due to the planning and development activities in the port and most generated and developed traffic will be heavy vehicles. This may average the percentage of the heavy trucks in the traffic mix on the proposed

road to about 60% while light traffic to about 40% of the total traffic. The average daily traffic volume on the proposed roads at ultimate year (2040) can be projected to be within 12,397 for the Duqm Port ⁽⁴⁾, ⁽⁵⁾. It is assumed that as a worst case scenario, 100% of the traffic generated by Commercial Berths (262 vehicles during the peak-hour in each direction) and 20% of the traffic generated by Commercial Quay (347 x 20% = 69 vehicles during the peak-hour in each direction).

Noise and vibration accumulation impacts

The Federal Highway Administration (FHWA) of USA, Office of Natural and Human Environment, released the FHWA Traffic Noise Model (TNM 2.5, 2003), a state-of-the-art computer model for highway traffic noise prediction and analysis has been applied to three packages (IP2, IP3 and IP4) road network. Summary of maximum noise impact of the three packages at ultimate limit stage 2040 (Maximum traffic volume) for design speed 60 km/hr is as follows:

- Commercial Berths, IP2: 64.6, 57.9 and 53.2 (L10 , dB) at distance of 20, 50, 100 m respectively:
- Commercial Quay, IP3 (worst scenario): 68, 61 and 56 (L10 , dB) at distance of 20, 50, 100 m respectively:
- Governmental Berths, IP4: 57.8, 51.9 and 47.6 (L10 , dB) at distance of 20, 50, 100 m respectively:

The noise accumulation impacts results shows that:

- The noise level from operations are expected to be below 50 dB(A) at each package scheme boundary during operation.
- The impact of noise is very local to some operation facilities and doesn't impacting sensitive receptors. Workers in the immediate proximity of noisy tools and machinery to be protected from damage to their hearing by the use of PPE in accordance with Oman regulation.

⁴ Khatib & Alami and Partners and Royal Haskoning 2013 Traffic Impact Study for IP4, April 2013

⁵ Khatib & Alami and Partners and Royal Haskoning 2014 Traffic Impact Study for Port of Duqm – Commercial Quay "Zones 1, 2, 3 & 4" October 2014

- There is no potential impact to other sites environment out of the three packages zone including the nearest industrial, commercial or residential areas due to operation work.
- There is no impact on three packages; Commercial Berths (IP2), Commercial Pre-Gate, Gates & Inspection Zone (IP3) and Governmental Berths (IP4) from the surrounding environment (the only facility on operation is the Dry Dock⁶):

Air Quality and emissions accumulation impacts

The source of air pollution during operation of the proposed facilities of the three packages are roads carrying traffic flows greater than 5,000 vehicles per day) in-addition to number of small capacity pumps. The impact of the activities is estimated using the US-EPA AERMOD dispersion model. Output from model includes ambient HC, CO and NOx concentrations for ultimate stage (2040).

- **Surrounding environment impacts⁷**
 - The impacts of the repair and maintenance activities on ambient air quality outside the perimeter of the dry dock and shipyard premises have been assessed for dust resulting from blasting activities, organic solvents (represented by xylene) from hull painting processes, general air pollutants from stacks and exhausts (NO_x and SO₂) and dioxins (from the incineration plant).
 - For the general air pollutants it is found that the emissions are limited and do not result in violations of international criteria for ambient air quality outside the perimeter of the dry dock/shipyard and for dioxins the emissions are considered to be negligible.
 - With regard to dust, the standards for PM₁₀ will be exceeded up to 300 meters outside the perimeter in the worst case, i.e. if NIX blasting is carried out with- out any measure to mitigate the influence of wind.

⁶ COWI, 2010, Ship Repair Yard and Dry Dock Complex in Duqm, Environmental Impact Assessment of the operation Phase

⁷ COWI, 2010, Ship Repair Yard and Dry Dock Complex in Duqm, Environmental Impact Assessment of the operation Phase

- For organic solvents (xylene) no Omani or internationally recognized (e.g. EU or US EPA) standards exist for ambient air and as such no limits or regulations are violated. However, if comparing with standards from Denmark and Ontario (Canada) the xylene levels are found to exceed the (Danish) standard for annual average concentrations at a distance up to 4.5 km from the source.
- **Proposed Packages impacts**
- No sources of other emission pollutants are expected where no real industrial activities within the three packages facilities which are limited by small capacity pumps with limited fuel consumption. The main source of emission due to operation of the three proposed packages is the Roads carrying traffic flows greater than 5,000 vehicles per day (IP2 and IP3: Commercial Berths and Quay).
- For the general air pollutants (HC, NO_x and CO) it is found that the emissions are limited and do not result in violations of international criteria for ambient air quality outside the perimeter of and for dioxins the emissions are considered to be negligible.
- Dust and particulate emissions (PM₁₀) that will result from the movement of site vehicles and mobile plant will be negligible where all roads will be well paved;
- There is no potential impact to other sites environment out of the three packages zone including the nearest industrial, commercial or residential areas due to operation work.

Cultural heritage

The impact is limited to vehicle movements, personnel and tourists in the landside port areas out of the three packages zone. All sites remain vulnerable until mitigation measures have been implemented. Ideally pre-Islamic burial cairns can be built into landscaping works, that include appropriate barriers, notices etc. but with some interpretative material to explain to people the importance of each site and its local context. There is no site for cultural heritage has been found during land reclamation of the three packages. So, this impact can be classified as minor impact on cultural heritage and recreation landscape sites.

Recreation Landscape

During construction activities, the site would not be in a suitable state for recreation. Construction machinery, movements of traffic on land, and the location of office buildings on site will give a different characteristic to the area from an undeveloped, pristine beach to a construction site. Bird watchers will not be able to continue their hobby in the area (at the time of construction) as the birds may temporarily move away to other areas, such as Ghubbat Quwayrat bay to the north. However, as this site is not frequently used by recreational users, the anticipated impact will be of minor adverse significance.

This impact during operation phase can be classified as minor to moderate positive impact on recreation landscape sites. Depending on the availability of space, the plans can incorporate development of recreational areas and tourist attractions for all age groups.

Soil and groundwater

Site operations during construction phase may lead to impact of soil and or groundwater beneath. Potential areas of concern are recognized as follows:

- Fuel and lubricant storage areas and fuel stations;
- Maintenance areas and waste storage areas;
- Plant & equipment holding areas.

The soil in the Duqm area is not suitable for agriculture, as the area is mainly comprised of Quaternary sub-recent to recent Sabkha deposits, meaning that it is likely to be too saline for commercial crops. In addition, limited sites will be used to support construction activities and measures will be taken by the contractors to minimize leakage to soil and groundwater. So, there would be limited impact to soil and groundwater within the some facilitates within the three packages and no potential impact to other sites out of the three packages zone due to construction works.

Geology

There is only one geological site (Ras Duqm) nearby the three packages found south of Commercial Berths. Ras Duqm has been protected and care has been taken during land reclamation of the proposed packages.

Hydrogeology

The wadis channel and the rerouting path within the port area is not part of the proposed packages, however, uncontrolled wadis flow can cause slight to moderate damage to geological site and soil due to erosion. Moreover, it would impact the existing road network and any the development scheme to be implemented within the project area. Drainage hydraulic structures have been designed to allow smooth flow of water during the peak flow of the wadis. So, the proposed project will have major positive impacts in terms of wadis flow movement within project area.

Coastal and Aquaculture Ecology

The impact is limited to landside works and potentially could be due effect of surface water run-off from the proposed development on water quality and accidental spillage and run-off of contaminants from onshore activities and ships during transit to the Port and inside the Port. The impact can be classified as a minor due to well design and mitigation measures will be considered.

Terrestrial Ecology and Ornithology

The terrestrial and intertidal sand and mudflat habitats in the project area will be disturbed or removed due to the landside construction infrastructure works (roads, buildings etc) and operation. However, the three packages is contributing to limited impact on landside works and potentially could be due potential for the transfer of pollutants from port construction and operation activities, noise and light disturbance impacts. The impact can be classified as

minor to moderate in case well design and mitigation measures related to noise and light disturbance are considered.

Climate Change and Sustainability Assessment

The potential impacts they may arise on the parameter as a result of construction and / or operational activities are

- Inefficient use of energy with implicit carbon dioxide emissions
- Selection of refrigeration plant not using coolants with high global warming potential
- Use of paints and solvents with high volatile organic compound content
- Incomplete treatment of sewage and consequent generation of methane

The potential impact can be classified as minor impact and measures and adaptation can reduce the impact further:

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Abbreviations

CAP	Consortium Antwerp Port
CD	Chart Datum
CD	Chart Datum
CDM	Clean Development Mechanism
CFCs	Chlorofluorocarbons
CFCs	Chlorofluorocarbons
CO	Carbon Monoxide
DRH	Diesel Range Hydrocarbons
DSME	Daewoo Shipbuilding & Marine Engineering Company
DSME	Daewoo Shipbuilding & Marine Engineering Company
EAC	Early Action Compact
EEZ	Exclusive Economic Zone
EIA	Environmental Impact Assessment
EPA	Environmental Protection Agency
FHWA	Federal Highway Administration
HC	hydrocarbons
HCFCs	Hydrochlorofluorocarbons
IMO	International Maritime Organization
IP	Infrastructure Package
IWC	International Whaling Commission
K&A	Khatib & Alami and Partners
MECA	Ministry of Environment and Climate Affairs
MOAF	Ministry of Agriculture and Fisheries
MOAF	Ministry of Agriculture and Fisheries
MOCI	Ministry of Commerce and Industry
MOTC	Ministry of Transport and Communications
MRMWR	Ministry of Regional Municipalities and Water Resources
NOC	No Objection Consent
NOSPC	National Oil Spill Contingency Plan



NOSPC	Oman National Oil Spill Contingency Plan
NO _x	Nitrogen Oxides
ODC	Oman Dry dock Company
OEMP	Operational Environmental Management Plan
OISC	Oman International Shrimp Company
OMCD	Oman Cetacean Database
OOMCO	Oman Oil Marketing Company
PEIA	Preliminary Environmental Impact Assessment
PPE	personal protective equipment
RHKA	Royal Haskoning and Khatib and Alami Joint Venture
RON	Royal Oman Navy
ROP	Royal Oman Police
ROPME	Regional Organization for the Protection of the
ROY	Royal Oman Yacht
RW	Random Walk
SEMP	Scoping Environmental Management Plan
SEZ	Special Economic Zone
SEZAD	Special Economic Zone Authority at Duqm
SEZAD	Special Economic Zone Authority at Duqm
SSF	Sultan's Special Force
STP	sewage treatment plant
TEU	Twenty Foot Equivalent Units
ToR	Terms of References
TSE	The treated sewage effluent
UN	United Nations
UNCLOS	United Nations Convention on the Law of the Sea
VOC	Volatile Organic Compound



CHAPTER (1)

INTRODUCTION

1 INTRODUCTION

1-1 Background

The sultanate of Oman occupies the South-Eastern corner of the Arabian Peninsula and is located between Latitudes 16o 40' and 26o 40' East. The Sultanate of Oman has a variety of topographical features consisting of plains, wadis and mountains. The most important area is the coastal plain which represents about 3 % of the total land area. The mountain ranges occupy about 15%. The remaining area which occupies 82% of the country is mainly sand and gravel desert and includes part of the Empty Quarter.

The climate characterized by semi-arid climate, with hot dry summer and mild winters except in the Southern region of the country. The average rainfall in the country is less than 100 mm per year ranging from about 350 mm in the mountains to 10 mm in some parts of the desert. The semi-arid climate result in excessive evaporation losses

There are no permanent rivers in the country. Some wadis occasionally flow to the sea during floods usually lasting several hours. The mean rate of renewal of country's water resources is of the order of 1.5 billion m³/year. This corresponds to a per capita rate of 750 m³/year, which is among the lowest in the world.

1-2 Geology and Topography

The north of Oman is dominated by the Hajar Range, a chain of rugged limestone and dolomite mountains, stretching from Musandam to Sur and rising to just over 3,000m at the highest point of the Jebel al Akhdhar. They are flanked by lower mountains of ophiolite, an igneous rock originating from upheavals of oceanic crust. Along the north-east of the range is the alluvial plain of the Batinah region, whilst to the west and south gravel plains stretch to the southern governorate of Dhofar. These plains cover some 80% of the surface of Oman and border the Arabian Sea. In the west the extensive sand dunes of the Rub' al Khali stretch beyond the border with Saudi Arabia. The separate Sharqiyah Sands, covering some 9,300 sq km, lie to the east, near the southern extremity of the Hajar range. In the Governorate of Dhofar the gravel plains rise southwards to the escarpment of the Dhofar

Mountains, reaching 1,800 m and comprising mainly tertiary rocks, including calcareous shale, limestone, and massive gypsum.

1-3 Climate

With the exception of the mountain regions, the climate is hot and dry, with annual rainfall less than 100 mm. The Hajar range attracts higher but sporadic rainfall, more often in the winter months, but also from occasional thunderstorms in the summer. The climate of Dhofar is dominated by the southwest monsoon, which brings dense mists and some rain to the escarpment and the Salalah plain during the months of July, August and September, resulting in a belt of grass and woodland in the mountain region, densest on the steep slopes facing south to the Arabian Sea. The remainder of the country is arid with sporadic winter rain and occasional thunderstorms in the summer. Rainfall is higher in the Hajar range, bringing more vegetation, though limited by lack of soil in the rugged terrain. Fog moisture, especially in the spring and autumn, benefits the vegetation of the central plains of the Jiddat al Harasis. The mean annual rainfall over most of the country is less than 100 mm.

1-4 Ecology

The flora of the Sultanate reflects the influence of that of Iran in the north, with an increasing influence of African species from the Eastern Hajar Mountains southwards to Dhofar. of approximately 1,200 species found in Oman, some 87 are endemic or near-endemic – occurring only in Oman or shared with its immediate neighbors and nowhere else in the world of these, 75 are endemic to Dhofar, mainly found in the mountains within the monsoon belt.

Some 86 mammal species or sub-species occur in Oman. of the regionally endemic large mammals, the Arabian tahr - Wa'al al Arabi (*Hemitragus jayakari*), classified as Endangered, occurs only in the northern mountains including those of the UAE. The Critically Endangered Arabian leopard (*Panthera pardus nimr*), a regionally endemic subspecies, occurs in the Dhofar mountains. Over 480 species have been recorded in Oman, the majority being migrants traveling seasonally between northern Asia some as far north as the Arctic, and Africa. Around 100 species are breeding residents. Many species of reptiles, arthropods, amphibians, insects and lower

order fauna occur throughout Oman. A visit to the Oman Natural History Museum at the Ministry of Heritage and Culture is strongly recommended for a closer look at the full range of Oman's biological diversity.

Oman's natural and cultural landscapes are famous for their astonishing beauty, from dramatic high peaks and canyons, ancient oasis settlements with their traditional forts and houses, dense monsoon forests, barren gravel wildernesses, sand seas furrowed by high dunes, to coastal cliffs and fiords. To geologists they tell the story of millions of years of Oman's history because, unlike temperate countries where rock formations are mostly covered by soil and vegetation, the geology of Oman is visible for all to see. In today's crowded industrial world, wildernesses have a special appeal to the international tourist, many of whom wish to go to places where they will not be among crowds of other tourists: Oman is able to offer this experience as well as the more conventional types of holiday. The landscape is the foundation of responsible tourism, a sustainable way to support the economy of rural areas, through employment. It contains all Oman's terrestrial species, so care of the landscape helps to protect what is within it. Aside from tourism, a beautiful landscape sustains the quality of life for all those who live and work within it, encouraging their sense of ownership and pride.

1-5 Port Facilities in Oman

Sultanate of Oman ports will have positive implications both domestically and internationally. The majority of the benefits will no doubt be economic, but we are likely to witness political reverberations as well. A significant factor is Oman's strategic location. Situated roughly halfway between India and the Suez Canal on the Saudi Arabian peninsula, Oman provides a convenient transit port for cargo heading along the main Asia-Europe shipping lanes. For example, the Port of Duqm requires a mere 200 kilometer diversion from the shipping lanes, whereas Dubai, a much more well-known port, is over 2,100 kilometers away.

The Port of Duqm has also managed to attract huge investment from the Oman Oil Marketing Company (OOMCO), which is keen on setting up an enhanced hydrocarbon and petrochemical industrial center in the area. With oil-based products being Oman's top exports, this will help to spur domestic growth and

employment, while providing a more convenient energy source for fuel-hungry countries in East Asia.

In relation, crane productivity at Oman's largest port in Salalah has increased by double digits, while truck and gate turnaround times have been cut by 50 percent. The local government has likewise increased spending on water, rail, and road infrastructure, and the nearby Salalah airport and free economic zone serve to magnetize more investment projects. As an indicator of these improvements, the Port of Salalah was ranked 6th last month on the global trans-shipment list, and 18th in overall global ports. This puts Oman on par with many of its neighbors including the United Arab Emirates. As a result, it is unsurprising that this port is attracting extra attention, and altogether foreign direct investment into the Salalah hub was valued at \$3.5 billion for 2012. Just last month, the major U.S. port Virginia International Terminals signed a Memorandum of Understanding to increase cooperation with its counterpart in Salalah. These sorts of developments also reflect the 2011 Trade Agreement between the U.S. and Oman, and the fact that Oman claims the speediest transit times from the Persian Gulf to the U.S.

Oman has three Sea Ports and two industrial Ports, which are:

AD Duqum Port

AD Duqum Port in Al Wusta Governorate enjoys a superior and open location. It is a multi-purpose port and its importance has increased after building a dry dock for ship repair to be added to the many facilities already present in the port.

<https://www.portduqm.com/>

Khasab Port

This port lies in the District of Khasab in Musandam Governorate and is used for traditional tourist ships.

Salalah Port

Salalah Port of is one of the most distinguished ports regionally and internationally. Its strategic location on the Arabian Sea plays an important role in attaining this distinguished status. Salalah Port receives cruise ships:

<http://www.salalahport.com/>

Sohar Port

This industrial port is located in Sohar in Al-Batinah North Governorate.

<http://www.portofsohar.com/>

Port Sultan Qaboos

Port Sultan Qaboos is considered the main maritime gateway to the Sultanate of Oman. Because of its prime location, it is one of the major ports in the region and receives cruise ships.

<http://www.pscoman.com/arabic/index.htm>

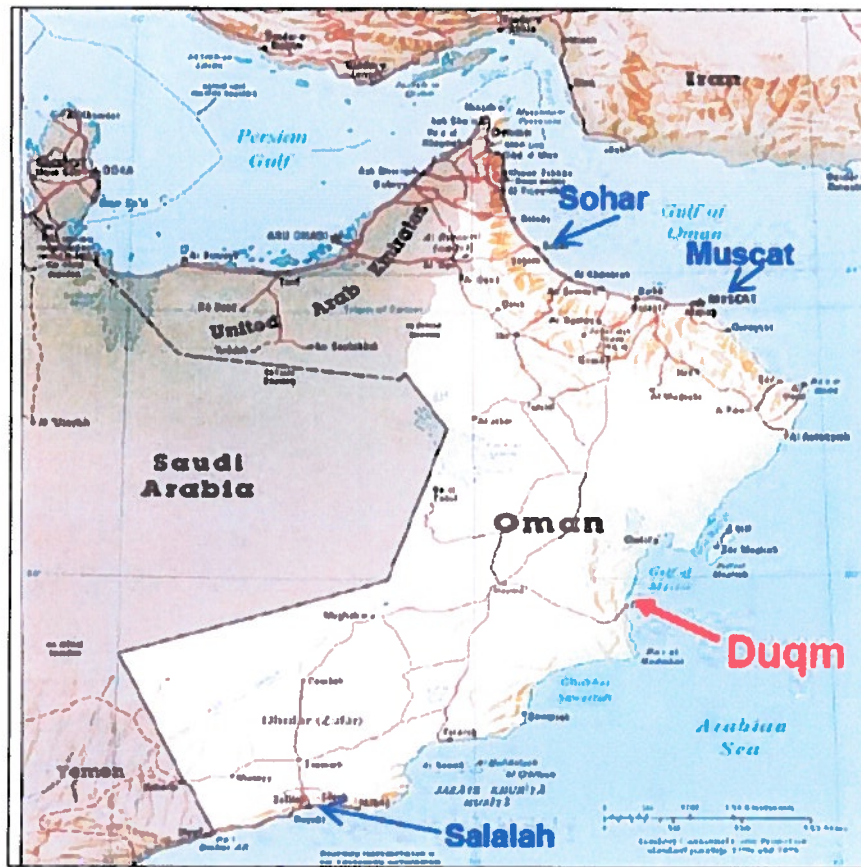


Figure (1. 1): Port facilities in Oman

1-6 Port of Duqm and the Proposed Project

1-6-1 Port of Duqm development background

The Duqm Port is seen as a catalyst for the development of Al Wusta region. The Port and Dry Docks are being developed to increase trade; i.e. cargo transshipment, ship repair, manufacturing industry and tourism. The site enjoys proximity to the busy regional sea-lanes of Oman's coastal waters, and is characterized by a friendly climate. The Port is currently under construction and it is considered among the strategic projects implemented by the Government of Oman to support the national economy. Future plans for port include: ship building, oil refinery, port expansion and bulk liquid storage.

The new Port of Duqm is being developed on behalf of the Ministry of Transport and Communications (MOTC) to provide facilities for commercial, navy and coastguard vessels at a site approximately 450km south of Muscat in the Sultanate of Oman. The facilities would include ship repair and maintenance, together with berths for strategic traffic.

Marine construction works of the port commenced in April 2007 upon the contraction of a Joint Venture of contractors. The original date for project completion was May 2010. However, due to the port expansion, the marine works are due to be completed in early 2012, with the Port infrastructure works commencing in late 2011 / early 2012 and expected to be complete by late 2014. A small proportion of operational activities are envisaged to commence in early 2012 along the Commercial Quay and the Government Berth. It is presently envisaged that the Port will reach 100% operational capacity after 2015.

The original contract for the development of the Port was awarded in 2002 with initial environmental surveys commencing the following year. Further environmental surveys and assessments have been undertaken with a preliminary approval granted by the Ministry of Environment and Climate Affairs (MECA) in July 2007.

Since then the Port design has expanded with the latest design including a larger lee breakwater to the northeast with the original lee breakwater now becoming a 'Government Berth'.

Although environmental studies have been ongoing and temporary environmental approval exists, there remains the requirement, in accordance with Royal Decree No. 114/2001, for a formal Environmental Impact Assessment (EIA) that covers both the construction and operations of the port completed in January 2012 for the purposes of obtaining an environmental approval or permit from MECA. This Environmental Scoping Report has been prepared by Royal Haskoning in partnership with Five Oceans W.L.L as the first stage in fulfilling this requirement.

1-6-2 Entities Involved in the Port of Duqm Project

The Port of Duqm project is being managed, planned, and studied by different entities. The general roles and responsibilities of each entity are as follows:

The Ministry of Transport and Communications (MOTC): currently 'Project Owner' and acting for the Government of Oman to manage the development, design and construction of the Port of Duqm project;

Port of Duqm Company SAOC (PDC): the 'Future Port Authority and Operator', a 50:50 joint venture between the Omani Government and CAP (operators of Port of Antwerp, Belgium). PDC has a 28 year concession agreement to co-invest, operate, manage and market the Port of Duqm, and to manage and maintain navigation within and around the Port and the wider bay of Masirah;

Ministry of Environment and Climate Affairs (MECA): the 'Environmental Regulator'. MECA is the government organisation responsible for the environment and climate affairs in the Sultanate of Oman by the mandate of the Royal Decree No. 90/2007. MECA is responsible for issuing environmental permits to allow the construction and operation of developments within Oman after review of any required environmental assessment submitted by the project owner in accordance with Royal Decree 114/2001;

Special Economic Zone Authority at Duqm (SEZAD): the future 'Project Owner' and 'Environmental Regulator'. SEZAD is a statutory institution empowered under the Royal Decree No. 119/2011 with regulatory, administrative, fiscal and economic responsibilities within the Duqm Special Economic Zone (SEZ). Within the Project, SEZAD is the Planning and Environmental Regulator responsible for the approval of the EIA and also responsible for granting environmental permitting to developments taking place within the Duqm SEZ. SEZAD is currently required to coordinate with MECA who have final approval on environmental permits until SEZAD is fully established. The EIA consultant for this project will need to coordinate closely with SEZAD to ensure that all relevant data and projects / activities relevant to the Port are considered;

Royal Haskoning / Khatib & Alami and Partners (RHKA): 'the Consultant' responsible for the Port master planning, design and construction supervision of the marine and onshore infrastructure of the Port of Duqm. RHKA were responsible for the initial 2007 EIA and gaining the Preliminary Environmental Permit for the Port's construction;

CCC/STFA-JDN: the 'Marine Contractor', a consortium of contractors (Consolidated Contractors Company, STFA Group and Jan de Nul) procured for the construction of the marine works, which included the breakwaters, berths, reclamation and dredging;

STRABAG: the 'Roads Contractor', responsible for the detailed design and construction of the main roads within the Port; and

Oman Dry Dock Company (ODC): 'the Ship Repair Yard Developer and Operator', established in 2006, by the Government of the Sultanate of Oman with 100% investment and is operated by Daewoo Shipbuilding & Marine Engineering Company Limited (DSME) of Korea.

1-6-3 The Proposed infrastructure packages

The Government of Oman is in the process of developing Duqm Port in Duqm Town as a strategic dry dock, free trade zone, industrial and tourism destination. The overall master plan for the Duqm Town which includes the town's own airport was prepared by Oman's Supreme Council for Town Planning, which designated land/sites for various components of this ambitious project since 2007. RH-K&A's involvement in this project includes port planning (macro planning), grading, roads and infrastructure as well as port facilities planning (micro planning) and design of buildings.

As part of this overall initiative, the Employer intends to develop a world class administrative / office residential complex to promote Duqm Port, which in turn will create more skilled jobs and private Investment opportunities. The presented Preliminary Environmental Impact Assessment covers the provision of certain infrastructure services for the development of the First Part of the Commercial Berths in terms of three packages as shown in Figure (1.2) and as follows (Details of the project description presented in Chapter 3):

- Package (IP2): Construction, commissioning and maintenance of the Construction of Roads, Infrastructure & Buildings at the Commercial Terminal & Operational Zone Areas, Port of Duqm.

- **Package (IP3):** Construction, commissioning and maintenance of the Construction of Roads, Infrastructure and Buildings at the Commercial Pre-Gate, Gates and Inspection Zone, Port of Duqm.
- **Package (IP4):** Construction, commissioning and maintenance of the Construction of Roads, Infrastructure and Building Works at the Government Berth Area, Port of Ductal.

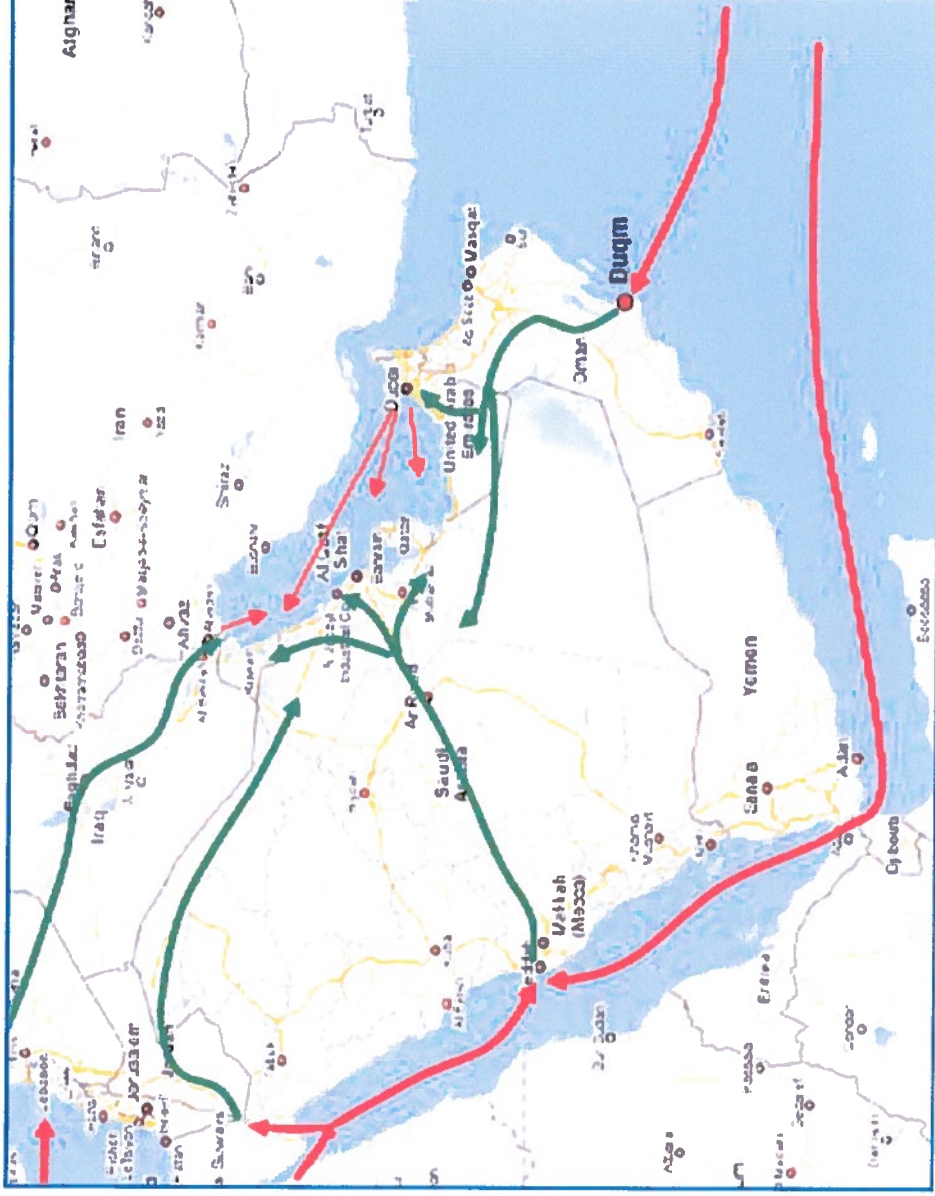


Figure (1. 2): Port of Duqm Al Wusta Governorate and Possible Trade Routes

1-7 Study Objectives

The main objective of this environmental study is to furnish the appropriate information about the outcome and Preliminary environmental impacts of this project for the following Environmental Impact Assessment to be conducted by the contractor. This will allow the assigned contractor(s) to start construction works with Preliminary Environmental Approval (EP) by MECA.

Furthermore, the decision maker will want to know if the proposed project is likely to produce the stated results. A review of the natural process operating in the region is necessitated so that the proposed project objectives are not in conflict with prevailing environmental scenario. The following objectives are to be considered:

- Providing a description of proposed works within Port Duqm;
- Setting out legislative requirements for environmental impact assessment;
- Documenting the results of the existing baseline
- Preliminary statement of the significant environmental impacts during construction and operation of the proposed project.
- Suggestion of mitigation measures to enhance positive impacts and reduce negative impacts.
- Proposed scoping environmental management plan including monitoring program for both construction and operation phases.
- Application for Permanent environmental permit (EP) to MECA

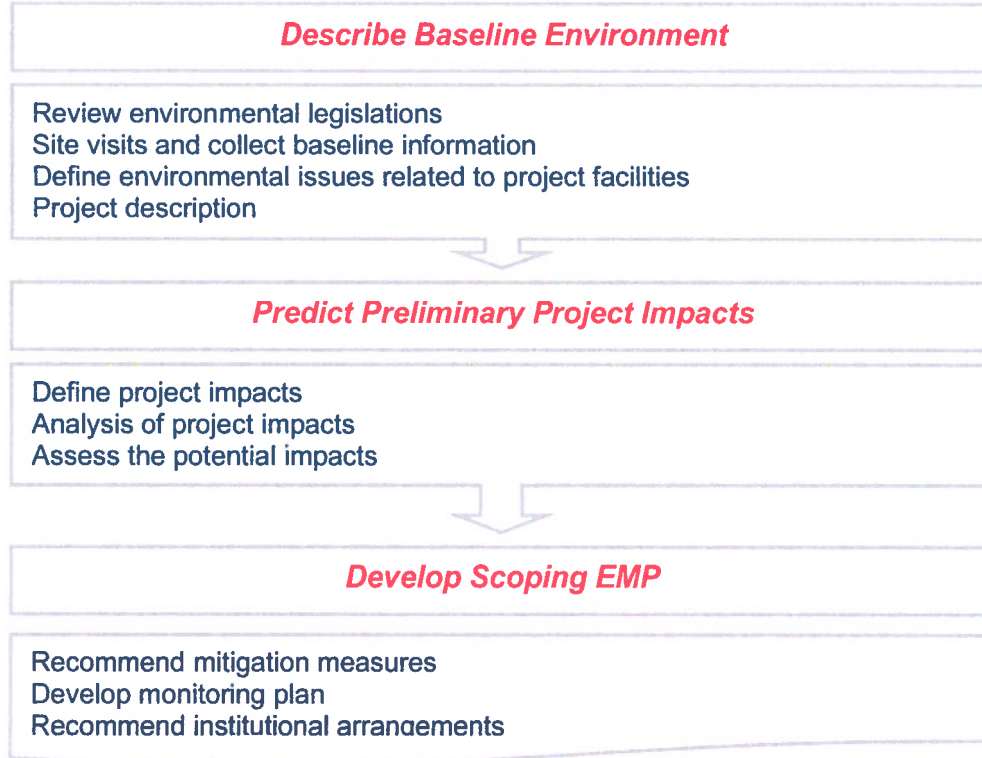
1-8 Justification for Environmental Impact Assessment

An Environmental Impact Assessment (EIA) is a public document written in a format specified by authorized national agencies; Ministry for Environment and Climate Affairs (MECA). A review of the natural process operating in the region is necessitated so that the project objectives are not in conflict with prevailing environmental scenario .

The primary environmental law in Oman is the Royal Decree No 114/2001, entitled 'Law on Conservation of the Environment and Prevention of Pollution', which has replaced Royal Decree No. 10/82. The Decree establishes a legal structure that controls the disposal of pollutants in a manner that minimizes environmental harm. The enforcement agency is MECA. Guidelines laid down by MECA set out eight groups which could require EIA. The proposed development falls into 'Group 6, Marine and Coastal Projects' as a commercial port.

1-9 General Methodology

The study shall retain the basic premise of the TOR of the proposed infrastructures of Duqm port development, Al Wusta Governorate and significantly expand the wide range of activities to be undertaken by the project technical team. The aim is to produce an Preliminary Environmental Impact Assessment study (PEIA) incorporating environmental issues in conjunction with the project activities through three main elements as defined in Figure (1.4).



**Figure (1. 4): PEIA main elements for the proposed infrastructures
Duqm port development, Al Wusta Governorate**

The PEIA assignment of this task should be accomplished in 6 weeks, so rapid consultation has been undertaken through a series of meetings and written correspondence. The organizations involved to date include:

- Ministry of Regional Municipalities, Environment and Water Resources;
- Ministry of Environment and Climate Affairs;
- Oman Drydock Company;
- Port of Duqm Company;
- Khatib and Alami and Partners;

The PEIA techniques in the study include:

- Identify impact of interventions (The project impact)
- Accumulative impacts (The surrounding environment and the project)

- Accumulative long term impacts (up to the ultimate stage (2040)
- Quantifying the impact using modeling technique when possible (such as noise and emissions)

1-10 Project Team

The core team of environmental experts who have been involved in undertaking this preliminary Environmental Impact Assessment study have originated from our offices in Oman, Sharjah UAE and Egypt as presented in Table (1.1) below). In addition, a number of local experts with specific knowledge of key resources are also an integral part of the team.

Table (1. 1): Study Team

Staff	Qualification	Role
Amr Sharaf	BSc Eng, PE	Project Director
Moustafa abdel Warith	BSc, MSc, PhD, Prof	Project Manager and Solid Waste Expert
Ashraf El Sayed Ismail	BSc, MSc, PhD, Prof	Project Coordinator & Main Editor and Environmental Engineering Assessment Expert
Alaa El Zawahry	BSc, MSc, PhD, Prof	Environmental hydrology, advisor and reviewer
Mohamed Abdel Salam	BSc, MSc, PhD, Prof	Marine ecology / marine water and sediments
Mohamed Shabaan	BSc, MSc, PhD	Environmental analysis
Ahmed Amin	BSc, MSc, PhD	Drainage water and Waste assessment
Tarek Ismail	BSc, MSc, PhD, Prof	Water and wastewater assessment
Mhamoud Solyman	BSc, MSc, PhD	Traffic noise and air pollution
Ahmed Abdellah	BSc, MSc, PhD	Environmental statistics and GIs

1-11 Report Structure

This report is composed of seven chapters which provide a concise and stepped approach to the PEIA for the construction (extension) and operation of the Port of Duqm. Description of report contents is briefed below:

- Chapter 1: Introduction covering general information about Oman, Port of Duqm, proposed project, EIA objective, justification, methodology and project team.
- Chapter 2: Describes the environmental legislative requirements for developing related to the proposed project in Oman;
- Chapter 3: Describes the proposed project, including the port of Duqm and packages element's , development process (i.e. construction details);
- Chapter 4: This chapter describes the baseline conditions in the study area and provides summarized information on the physical, biological and socio-economic environment. The purpose of this chapter is to facilitate the evaluation of project impacts.
- Chapter 5: This chapter identifies all the important possible change that might occur because of the proposed project including both positive and negative impacts. The identified impacts cover activities during construction
- Chapter 6: This chapter identifies all the important possible change that might occur because of the proposed project including both positive and negative impacts. The identified impacts cover activities during operation phases. Identification of impacts is followed by environmental assessment to predict the degree of impact (long term and accumulation).
- Chapter 7: Presents recommended appropriate mitigation measures for both construction and operation phases to minimize/ offset the impacts.
- Chapter 8: Presents recommended scoping environmental management plan. Moreover, it will proposed the required monitoring plan for both construction and operation phases.
- In addition to the above chapters, there are also cited references used to inform the report and appendices that provide further information.



CHAPTER (2)

POLICY AND LEGAL FRAMEWORK

2 POLICY AND LEGAL FRAMEWORK

2-1 Introduction

This Preliminary Environmental Impact Assessment report has been prepared will inform the decision-making authority (in this case, MECA), in order to obtain preliminary environmental permits for the proposed port development (packages IP2, IP3&IP4) at Duqm.

This section therefore outlines the consent and regulatory requirements relating to the proposed port development of Duqm in Oman. Also included is a summary of the EIA process, consultation process and how responses from key stakeholders (e.g. MOTC, MECA and the others) and the public will feed into the PEIA process. The information provided in this chapter helps to define where the project lies within national policy and what legislation and standards the project should adhere to.

2-2 Current Environmental Management in Sultanate of Oman

Royal Decree No. 90/2007 establishes Ministry for Environment and Climate Affairs to which environment-related works, allocations and assets transferred from the Ministry of Regional Municipalities, Environment and Water Resources. Employees working in the environment field in the same ministry also transferred to the new established ministry with the same financial grades. The decree cancels all that contravenes or contradicts with its provisions. Ministry for Environment and Climate Affairs (MECA) has the main responsibility of managing all environmental related issues in Oman. Ministry for Environment and Climate Affairs works with lead agencies to ensure a proper environmental management. A lead agency can be any ministry, department, local government system, public officer in which or whom any law vests function of control or management of any segment of the environment. The Omani regulations on environmental protection, control and management are covered under two basic laws i.e., the “Law for the Conservation of the Environment and the Prevention of Pollution” promulgated in November 2001 as Royal Decree-RD 114/2001 (superseding RD 10/82) and the “Law on Protection of Potable Water Sources from Pollution” promulgated in November 2001 as RD 115/2001. The responsibility of implementation of these laws rests with

the Ministry for Environment and Climate Affairs, which issues regulations, standards and guidelines through Ministerial Decisions (MDs). MECA has the responsibility for environmental permitting, inspection and control in the Sultanate of Oman. The Royal Decree 114/2001 included articles covering provisions, definitions, conservation of environment and prevention of pollution, application of the law, measures and penalties.

2-3 Omani Environment Related Legislation and Guidelines

The current Omani environmental laws and regulations pertaining to the protection of groundwater from pollution are detailed below: RD 29/2000: Issuing the law of Water Resources Conservation Water Reserves as a National Wealth directs the Ministry for Environment and Climate Affairs to issue the necessary regulations and decisions for the execution of the provisions of the Law on Water Resources Protection. RD 29/2000 prohibits activities/work that negatively affects the supply for groundwater to the aquifer. It authorizes the MECA to execute all the necessary producers and precautions to avoid reduction in quantity of water at any area in the Sultanate of Oman. If there should be such an occurrence, MECA shall enforce necessary action to be taken to remediate the effect.

2-3-1 Royal Decrees for Conservation of Environment

The Law on the Conservation of Environment and the Prevention of Pollution promulgated in November 2001 as Royal Decree-RD 114/2001 (superseding RD 10/82) represents the encompassing environmental law in the Sultanate of Oman. It defines the environment to include without limitation air, water, soil, land life, marine life, the different food, mineral and chemical resources, energy sources, and the different social factors. Further, the decree defines environmental pollution to mean physical, chemical, or biological materials or factors that, discharged into the environment, induce deterioration of the quality of the environment, sensitive resources within the environment, or the quality of life associated with the environment. The Decree authorized the establishment of the Council for the Conservation of Environment and Prevention of Pollution (CCEPP) with the following mandated authority:

- Issue regulations necessary for implementing the law;

- Establish, administer, and operate a central laboratory and network for the purpose of monitoring environmental quality; and
- Prepare reports on the status of pollution levels, specifications for the work place, identification of protected areas and cultural heritage sites.

Resources categories defined in Royal Decree 114/2001 include the following:

- The physical components of the environment (air, water, soil, mineral and chemical resources; energy resources such as wood, coal and oil materials; non-traditional energy sources such as sun, wind, water and nuclear materials);
- Natural resources (plant life, wildlife, animal life, including marine fishes, freshwater and brackish water aquatic life, reptiles, birds and mammals, their habitats including sensitive and vulnerable species and areas); and
- Social resources (aesthetics, educational resources, archaeological resources and cultural resources).

Royal Decree 114/2001 defines water resources to include fresh water, semi-salt water, and economic sea waters. A number of Ministerial Decisions including standards affecting water quality have been established. The potable water quality standards include limits for the treatment of potable water supplies. The Department of Health Affairs maintains records on public health and executes the disease prevention protocol including the control of communicable water-borne diseases. The basis of its authority is derived from Royal Decree 114/2001 and subsequent Decrees. Among the duties of the Department are the following

- Conduct water quality analyses of the public water supply for the presence of coliforms, BOD, and other biological parameters; and
- Investigate public health threats and the control of communicable disease vectors, such as the spraying of mosquitoes, testing of khor waters for pathogenic contamination, and the poisoning of bilharzia-bearing snails in the various springs.

The Ministry of Housing (Royal Decree No. 93/2007 amends the name of ministry from The Ministry of Housing, Electricity and Water) is responsible for the specification of set-back zones with coordinating input from the Ministry of

Commerce and Industry (MOCI). No license should be issued for the construction of any tourist project on the coast until necessary studies involving coastal erosion, natural factors, and planning have been completed. Articles 5, 6 and 7 of the Decision address the physical boundary guidelines as follows:

- The zones along the coast would be specified with horizontal measurements from the maximum points of the tidal cycle;
- The traditional boundaries of zones should be considered by the MOH in coordination with MECA; and
- Open and undeveloped coastal areas having good scenic value should have a setback of 300 m. No project should be established within these setback zones without approval of Ministry of Housing.

The laws and traditions of Oman give top priority to water supply for domestic use and secondary priority to agricultural and industrial uses. The laws and traditions further specify regulatory compliance with regard to preservation of the environment and adherence to established health and safety standards. Royal Decree 114/2001 establishes the following:

- Technical Secretariat of the CCEPP Council shall provide reports on the following:
- Pollution levels appropriate to the Omani environment.
- The Omani environment may not be used to dispose of pollutants of the types and in quantities which may lead to disturbances in its normal balance, to its natural resources, to protected areas or to the historical and cultural heritage.
- Safe areas, determined by the Council, may not be used for any purpose which leads to contravention of the provisions of the law;
- Degree of environmental pollution may not exceed levels determined by the Council;
- Disposal of environmental pollutants is forbidden by an owner other than within limits determined by the regulations;

- Project must obtain a license from the Council that it is “environmentally sound”. Application for the license must be submitted to the Technical Secretariat along with an Environmental Impact Statement.

Royal Decree 114/2001 has replaced the Royal Decree 10/82. Among other aspects addressed by the Royal Decree 10/82, section III “Conservation of the Environment and Prevention of Pollution”, articles 5 to 17 are of high relevance to this environmental quality status. Article 6 addresses the use of the Omani environment. Articles 13 and 14 address the conditions for obtaining the ministry’s approval for setting-up a source or work area, and conditions for feasibility studies on projects affecting the environment; respectively. This RD states that, “it is not permitted to use Oman’s environment for the disposal of environmental pollutants in such quantities and types that may adversely affect its intactness and its natural resources or nature conservation areas and historical and cultural heritage of the Sultanate. The establishment of any source or area of work shall not be started before first obtaining an environmental permit confirming its environmental soundness”. Royal Decree 114/2001 is the most tolerant law regulating the development activities and considering the environment and ecological system as a dimension. It includes 43 articles and two annexes.

The Royal Decree 115/2001 on Protection of Potable Water Sources from Pollution issued in November 2001 address, amongst others, issues concerning wastewater treatment, reuse and discharge; wastewater standard; and the reuse of sludge in agriculture. The RD contains general provisions on objectives, duties of individuals, Ministries and organizations relating to the disposal of pollutants in such a manner as to minimize environmental damage. It states, “ The Ministry shall, in co-ordination with concerned bodies, specify zones of protection of potable water sources from pollution, and the activities prohibited to be practiced within such zones, which may pollute water and its sources. The Ministry shall also specify terms, specifications and requirements of maintaining safety of drinking water and its sources, protection from pollution and conformity to the standards. The Ministry shall monitor the implementation of the same.” RD 115/2001 presents detailed provisions for wastewater reuse and discharge.

The Royal Decree 29/2000 called the law of Water Resources Conservation. In which, Water Reserves as a National Wealth directs to put the necessary regulations and decisions for the execution of the provisions of the law on Water Resources Protection. This RD prohibits activities/works that negatively affect the supply of groundwater to the aquifer. It authorized the MRMWR to execute all the necessary procedures and precautions to avoid reduction in quantity and quality of water at any area in the Sultanate of Oman. If there should be such an occurrence, MRMEWR shall enforce necessary action to be taken to reduce or remediate the effect.

2-3-2 Royal Decrees for Safety and Health Protection

Handling and Use of Chemicals: RD 46/95 provides the framework for the handling and use of chemicals (this would be applied for disinfection substance for the treated effluent). Relevant Articles of this RD are listed below

- Article 2 states persons involved in manufacture, import, export, transport, handling, storage, and use of chemicals must satisfy requirements of this RD ;
- Article 8 states that transport and storage of hazardous chemicals require permits from the Director General of Civil Defense – Royal Oman Police (ROP).
- Article 9 states import, export, transport, or handling of any hazardous chemicals requires packing in special containers ;
- Article 11 requires the user of any hazardous chemical to dispose at his expenses empty container and hazardous wastes, under supervision of the Ministry, per requirements of MD in force; and
- Article 12 requires training and provision of personal protective equipment to staff. It further requires maintaining records of staff handling hazardous chemicals, quantities, and handling process.

Registration of Chemical Substances and Relevant Permits: MD 248/97 provides regulations for the control and management of chemical substances. The relevant articles promulgated under this regulation are presented below

- Article (2) – Any natural or juridical person who intends to deal with any hazardous chemical by manufacture, import, export, transport, storage,

handling, use or disposal shall apply to the Ministry, by filling the designated form, obtain the environmental permit after paying the necessary fees ;

- Article (4) – Any person dealing with hazardous chemicals shall maintain a valid environmental permit and chemical safety data and shall keep copy of the permit and the data in a safe place far from where the chemical is kept or transported ;
- Article (5) – The dealer shall abide to carry out all condition, follow all procedures specified in the chemical safety data or any other conditions or procedures required in the environmental permit or in the Law .
- Article (6) – Staff designated by decision of the Minister shall have the powers to examine any chemical transaction, activity, or conduct necessary tests and investigations to enforce the provisions of these regulations .
- Article (7) – Offenders of the provisions of these regulations shall be liable to penalties stated in the Law.

Air Emission from Stationery Source: Omani standards for air emissions from stationary sources are specified under MD 118/2004. Applicable limits for emissions from stationary point sources in the present project are provided in Table (2.1). The key provisions of this regulation applicable for the project are presented below :

- Article (2) – Emission controls have to be provided to emission sources from the facility in order to prevent noxious or offensive emissions ;
- Article (3) - the emission standards specified by this regulation are to be complied with. Further, the monitoring of emissions from sources within the facility is to be conducted and reported to the Ministry. The Ministry has the right to request to improve the monitoring method and equipment used in such monitoring ;
- Article (4) – Necessary action shall be taken by the operator of the facility to eliminate any harmful effects to public health, nuisance or emission of noxious odours arising from the work area ;
- Article (5) – Dark smoke shall not be emitted from chimneys unless specially permitted by the Ministry for specific reasons and periods. The smoke shall not



be as dark as or darker than shade one on the Ringlemann scale (20% opacity ;(20% opacity)

- Article (6) – The facility shall submit an application for an environmental permit and shall not commission or operate the plant unless the height of the chimney serving the plant has been approved by the Ministry that it is sufficient enough to prevent the smoke, grit, dust and toxic gases from becoming prejudicial to health or nuisance. The minimum stack heights for power plants, from ground level shall be as follows :

Power plants (Natural gas fired)	-26 m
Power plants (Diesel fired)	-35 m
Boiler plants (Natural gas fired)	-15 m
Boiler plants (Diesel fired)	-20 m

In other cases, the chimney height shall be calculated as “2.5 times multiplied by the height of the highest building (in meters) in the concerned establishment complex .”

- Article (7) – The permit to operate shall be issued for a period of three years, renewable for a same period within one month from the date of expiry ;
- Article (8) – Concerned inspectors from the Ministry may enter the facility to inspect any processes causing emission of any noxious or offensive substances, to ensure efficiency of emission controls and to ascertain the quantity and quality of emissions and suggest requirements for further controls or measurements ;
- Article (9) – The facility shall provide access and assistance to the concerned environmental inspectors from the Ministry to perform their duties for inspection and monitoring of the sources at the facility ;
- Article (10) – Any change of ownership or production process of the facility shall be communicated to DGEA; and
- Article (11) – Failure to comply with any provisions of this regulation will result in penalties and the Ministry may close down the establishment if there is prejudice harm to the public health or environmental damage .

Table (2. 1): Emission Standards as per MD 118/2004

Pollutants	Maximum permissible limits
General	
Grit and dust Dark smoke products of combustion shall not emits smoke as dark as or darker than shade one on the Rigelmann scale (20% opacity)	0.050 g/m ³
Power Plants – Natural Gas Fired	
Nitrogen dioxide	0.150 g/m ³
Particulates	0.050 g/m ³
Unburnt hydrocarbons	0.010 g/m ³
Carbon dioxide	5 g/m ³
Power Plants – Diesel oil fired (less than 0.5% Sulphur)	
Sulphur dioxide	0.035 g/m ³
Carbon monoxide	0.050 g/m ³
Nitrogen dioxide	0.150 g/m ³
Particulates	0.100 g/m ³
Unburnt hydrocarbons	0.010 g/m ³
Combustion Sources – Diesel oil fired (Industrial boilers, furnaces, industrial ovens)	
Carbon monoxide	0.050 g/m ³
Sulphur dioxide	0.035 g/m ³
Nitrogen dioxide	0.150 g/m ³
Particulates	0.100 g/m ³
Unburnt Hydrocarbon	0.010 g/m ³
Combustion Sources –Natural Gas fired (Industrial boilers, furnaces, industrial ovens)	
Nitrogen dioxide	0.150 g/m ³
Particulates	0.050 g/m ³
Unburnt Hydrocarbons	0.010 g/m ³
Carbon dioxide	5 g/m ³

Noise: The regulations for noise control are applicable to workplace noise levels and ambient noise levels. The ambient noise standards are issued under MD 79/94 and

the limits for ambient noise levels from industrial sources are summarized in Table (2.2) .

Table (2. 2): Ambient Noise Standards

Maximum Permissible Noise Level [as Leq in dB (A)]			
Type of District	Day Time (7 AM – 6 PM) workdays	Evening Time (6 PM – 11 PM) workdays	Night Time (11 PM – 7 AM) on workdays and all times on holidays
Rural residential and recreational	45	40	35
Sub-urban residential	50	45	40
Urban residential	55	50	45
Urban residential with some workshops or business city hub	60	55	50
Industrial and commercial	70	70	70

MD 80/94 specifies the regulations for noise pollution control in working environment. These regulations state that no employee shall be exposed to noise levels exceeding 85 dB(A). If the workplace noise level exceeds 85 dB(A), suitable ear protection devices shall be provided. The attenuation of such protection devices shall reduce the noise level to 80 dB (A) or lower.

2-3-3 Others relevant national legislation

Other policies, laws and guidelines, which are relevant to this project, should be taken into consideration, include but not limited to the following table:

Table (2. 3): Relevant environmental legislation

Reference	Title
General Environment	
RD 114/2001	Law on Protection of the Environment and Pollution Prevention
MD 39/2004	Marine Environmental Management Bylaws
MD 169/2000	Ban on cutting green trees
Environment Permits	
MD 187/2001	Issuance of Environmental Approvals and Environmental Permits
MD 20/1990	Rules Regulating and Specifying Coastal Setbacks
MD 68/2004	Amendment to articles of Regulations for organizing obtaining environmental approvals and final environmental permits
Water	
MD 145/93	Regulations for wastewater re-use and discharge
MD 18/93	Regulations for the management of hazardous wastes
D 421/98	Regulations for septic tanks, soak away pits and holding tanks
MD 159/2005	Regulations for discharge of liquid effluents to marine environment
Chemicals	
RD 46/1995	Law of Handling and Use of Chemicals
MD 248/97	Regulation for the handling of hazardous chemical substances
MD 316/2001	Regarding barring of circulation and sage of some hazardous chemical substances including PCBs, brown and blue asbestos
Waste	
MD 17/93	Regulations for the management of the solid non-hazardous wastes
Noise pollution	
MD 79/94	Regulations for noise pollution in public environment
MD 80/94	Regulations for noise pollution in the working environment
Air pollution	
MD 118/2004	Regulations for Air Pollution Control from Stationary Sources
MD 37/2001	Regulations for management of ozone depleting substances
Crushers	
MD 200/2000	Regulations for crushers, quarries and transport of sand from Coasts, beaches and Wadis
Health and safety	
MD 19/82	Occupational health and Industrial safety precautions

2-4 Protected Areas in Oman

Fourteen protection areas designated as the nature conservation by Royal Decree are shown in Table (2.4). These areas are highly regulated and controlled by Ministry for Environment and Climate Affairs (MECA). On the marine environment, the Regulation for Conservation of Marine and Coastal Environment as MD20/90 and Decision no: 19/90 of the Supreme Committee for Town Planning (SCTP), which was instituted in 1990, is established control zone of development being within 50 to 300 meters from natural coastal line.

Table (2. 4): Protection Areas in Oman

Name of area	Location (Region)	Reserve resources (Biological, others)
The Arabian Oryx Sanctuary	Al Wusta	Arabian oryx, Nubian ibex, etc., conserving biodiversity
As Saleel natural Park	Ash Sharqiyah	Simr, Arabian gazelle, Gordon's wild cat, protecting wildlife
Ra's al Hadd Turtle Reserve	Ash Sharqiyah	Turtles, Coral reefs, mangroves, Prosopis cineraria wildlife
Jebel Samhan Nature Reserve	Dhofar Governorate	Leopard, Ibex, Arabian wolf, Gazelle, Blandford's fox, protecting wildlife
Dimaniyan Islands nature Reserve	North of Muscat	Coral reefs, fish, birds and turtles, conserving wildlife
The Khawrs Reserve of Dhofar Coast	Dhofar Governorate	Khawrs, springs, and archaeological sites, Mangroves, sustainable use of the resources
Wadi Al Sarin	South of Muscat	Arabian tahr and mountain goat

2-5 Environmental Impact Assessment Interim Guidelines

The Interim Guideline on Environmental Impact Assessment was issued in 2001. The legislative authority of the guideline is based on the Royal Decree 114/2001 and its amendments "Amending some provisions of the law on Conservation of The Environment and Prevention of Pollution (Royal Decree 10/82)". However, this Interim Guideline on Environmental Impact Assessment has been replaced with EIA Guideline called "Guidelines for Obtaining Environmental Permits for year 2001". The Interim Guideline lists the projects, which are subject to a detailed EIA study. At the initial of the project stage, the Ministry for Environment and Climate Affairs conducts an environmental screening to ensure the proposed project is subject to

an appropriate environmental assessment. Based on the screening results, the projects are classified into projects that in the proposed location have negligible environmental impacts, and projects that likely to have significant environmental impacts.

2-6 Regional and International Conventions

2-6-1 General Conventions

Apart from the National Laws, Acts and Regulations, Oman is a signatory or party to many international Environmental Conventions and Treaties and has participated in many related conferences. A list of some of the relevant International Environmental conventions and Treaties ratified by the Government of the Federal Republic of Oman are presented below in Table 2.5.

Table (2. 5): Summary of relevant international agreements and conventions

Regulation	Year adopted
Convention on International Trade in endangered Species of Fauna	2008
Amendment to the Basel Convention on the control of transboundary movements of hazardous wastes and their disposal	2004
Stockholm Convention on Persistent Organic Pollutants	2001
Amendment to Montreal Protocol on substances that deplete the	1999
Kyoto Protocol to the UN Framework Convention on Climate Change	1997
International Plant Protection Convention - New revised text approved by resolution 12/97 of 29 th Session of FAO Conference in	1997
Amendment to the Montreal Protocol on substances that deplete the ozone layer, adopted at the ninth meeting of the Parties	1997
Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea of 10 December 1982 relating to the conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks	1995
Agreement relating to the Implementation of Part XI of the United Nations Convention of the Sea of 10 December 1982 (UNCLOS)	1994
United Nations Convention to Combat Desertification in Countries Serious Drought and/or Desertification, Particularly in Africa	1994
Amendment to the Montreal Protocol on substances that deplete the ozone layer (London Amendment)	1992
Convention on Biological Diversity	1992

Regulation	Year adopted
United Nations Framework Convention on Climate	1992
Amendment to the Montreal protocol on substances that deplete the ozone layer (London Amendment)	1990
Basel Convention on the control of transboundary movement of <u>hazardous wastes and their disposal</u>	1989
Montreal protocol on substances that deplete the ozone layer	1987
Vienna convention for the protection of the ozone layer	1985
United Nations Convention on the Law of the Sea (UNCLOS)	1982
Convention on the Protection of the World Cultural and Natural Heritage (world Heritage Convention), Paris	1981

2-6-2 Conventions related to marine environment

Of particular relevance is the marine environment, with the ratification to the Regional organization for the Protection of the Marine Environment (ROPME) and the International Convention for the Prevention of Pollution from Ships 1973 and modified by Protocols 1978 & 1997) discussed further below.

ROPME: Oman is a member of the ROPME, which was established in 1979, with its headquarters in Kuwait City. ROPME aims to promote environmentally sound practices, prevent pollution and encourage sustainable development in Arabian Gulf waters. Oman was one of the first ROPME member states to become signatory to the following conventions:

- International Maritime Organization (IMO) Convention, MARPOL 73/78;
- London Convention 1972; and
- United Nations (UN) Convention on Law of the Sea 1982.

MARPOL : The Sultanate of Oman has applied for an extension of the Special Area (i.e. protection area) in line with Annexes I and V of MARPOL 73/78⁸, which extends between Ras Al Hadd (22°30'N; 59°48'E) and Ras al Fasteh (25004'N; 61°25'E) to include the Arabian Sea. This is in order to maximize protection of highly significant

⁸ International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 relating thereto (MAR POL 73/78)



and sensitive marine habitats along the coast (MEPC, 2002). These habitats are threatened due to serious pollution incidents that have caused by the high numbers of oil tankers that pass through Omani waters. It is estimated that between 20,000 and 35,000 tankers pass through the Strait of Hormuz every year (MEPC, 2002).

The MARPOL convention requires signatories to ensure the provision of reception facilities to deal with the ship-generated waste "without causing undue delay" to the ships using them. Annexes I, II and V, defines a Special Area as:

"a sea area, where for recognized technical reasons in relation to its oceanographic and ecological condition and to the particular character of its traffic, the adoption of special mandatory methods for the prevention of sea pollution by oil, noxious liquid substances or garbage, as applicable, is required' (MEPC, 2002).

Under this Special Area designation, no discharges are permitted except clean or segregated ballast. It is therefore proposed to extend the Gulf Special Area to include the entire coastline of Oman bordering the Arabian Sea from Ras Al Hadd in the North to the southern border with Yemen, extending out 200 nautical miles in the Exclusive Economic Zone (EEZ). This is in order to maximize protection of significant and sensitive marine habitats along this coast (MEPC, 2002) that are threatened due to serious pollution incidents caused by the high numbers of oil tankers that pass through Omani waters. It is estimated that between 20,000 and 35,000 tankers pass through the Strait of Hormuz every year (MEPC, 2002).

CHAPTER (3)
PROJECT DESCRIPTION

3 PROJECT DESCRIPTION

3-1 Overview

This Chapter describes the proposed project, including the port of Duqm and design layout, development process (i.e. construction details). Moreover, it provides the 'source' description of activities that have the potential to impact upon the environment thus forming the basis for the impact assessment covered in Chapter five.

The new Port of Duqm is being developed on behalf of the Ministry of Transport and Communications (MOTC) to provide facilities for commercial, navy and coastguard vessels at a site approximately 450km south of Muscat in the Sultanate of Oman. The facilities would include ship repair and maintenance, together with berths for strategic traffic. Marine construction works of the port commenced in April 2007 upon the contraction of a Joint Venture of contractors. The original date for project completion was May 2010. However, due to the port expansion, the marine works are due to be completed in early 2012, with the Port infrastructure works commencing in late 2011 / early 2012 and expected to be complete by late 2014. A small proportion of operational activities are envisaged to commence in early 2012 along the Commercial Quay, Dry Dock and the Government Berth.

The original contract for the development of the Port was awarded in 2002 with initial environmental surveys commencing the following year. Further environmental surveys and assessments have been undertaken with a preliminary approval granted by the Ministry of Environment and Climate Affairs (MECA) in July 2007. Since then the Port design has expanded (see Figure 3.1) with the latest design including a larger lee breakwater to the northeast with the original lee breakwater now becoming a 'Government Berth'.

3-2 Port Duqm Master Plan

The Government of the Sultanate of Oman is presently launching the first phase of a major development project at and around the small town of Al Duqm in the Al Wusta Region of Oman, which approximately half-way between Muscat and Salalah.

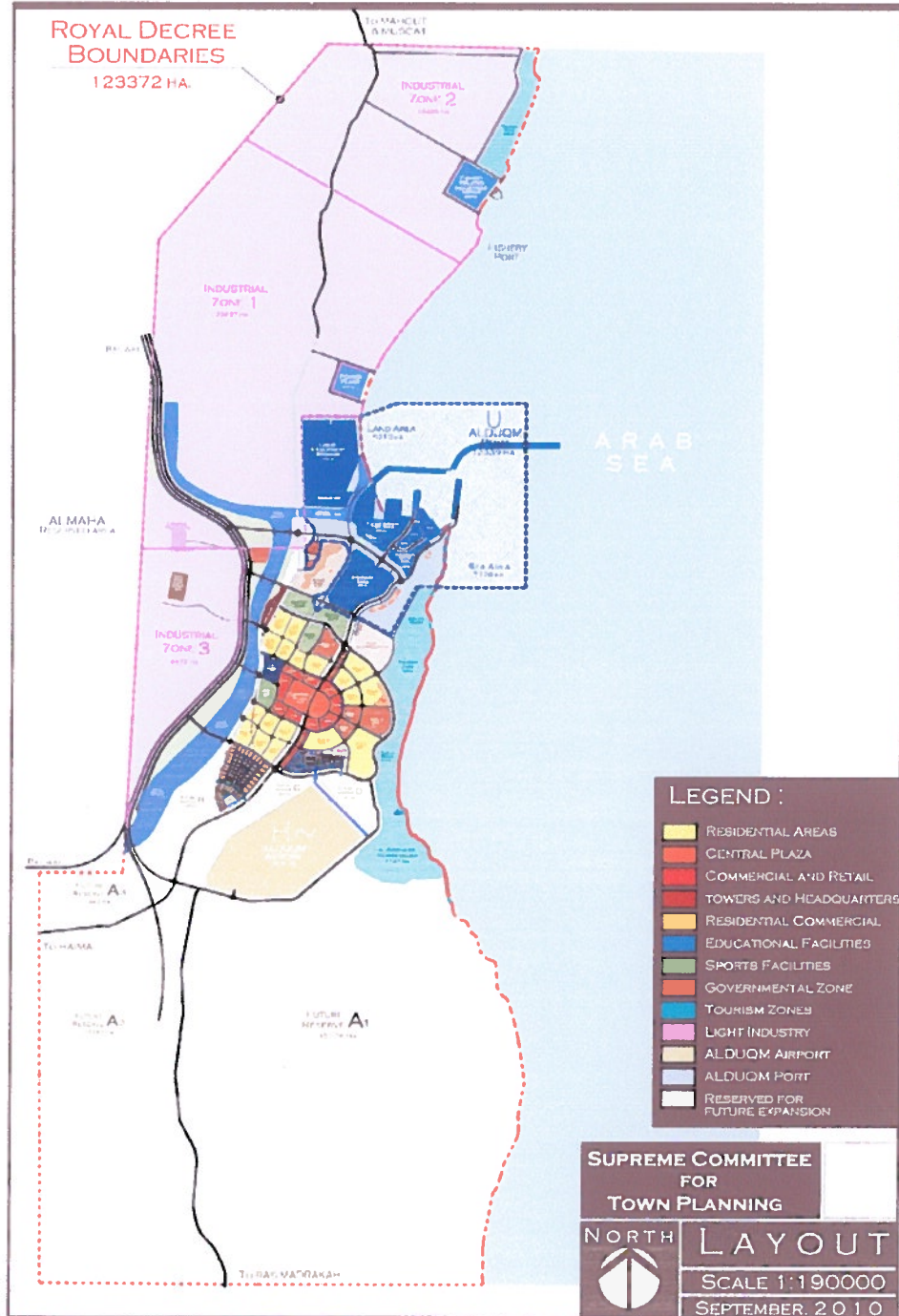


Figure (3. 1): Master Plan for Duqm Town

According to the Master Plan for the area prepared by the Supreme Committee for Town Planning, the project not only includes the new port with a ship repair yard and drydock complex, refinery and crude oil terminal, a strategic storage facility, and a free trade zone (FTZ), but also an adjacent industrial area, an airport, commercial and residential areas, as well as some tourism development (ODC, 2010). In total, the area assigned in the Master Plan to these activities and facilities exceeds 200 km², and the population to be accommodated is expected to increase during the next 20 years from around 3,000 to around 64,000 with provision to expand later to up to 100,000 residents (ODC, 2010).

3-3 Port of Duqm Development Phasing

This sub-section describes the Port of Duqm project in terms of how the port is planned to be developed and operated over a series of phases.

The Port is to be developed and operated in full through a number of phases⁹, as summarized below, and further expanded following this:

- Phase 1: the development of the approach channel and port navigation areas (which have been dredged), the commercial quay on the main breakwater (container terminal, dry bulk terminal and multi-purpose terminal), government berths, fast ferry terminal, dry storage areas and supporting landside infrastructure and operational areas (e.g. roads, utilities, drainage, buildings, gates etc);
- Phase 2: the development and operations of a liquid berth and liquid storage areas on the lee breakwater;
- Phase 3: the development and operations of a dedicated bulk terminal to increase mineral export (i.e. potentially relocated from the commercial quay to the future port basin); and
- Phase 4: the development and operations of a dedicated, full capacity container terminal at the commercial quay (i.e. expand into area of the bulk terminal).

⁹ excludes the development of the ship repair yard, which has been built and operational since April 2011 by the Oman DryDock Company (ODC)

3-4 The Phase 1 Development

The Phase 1 development considered under this 2015 Preliminary Environmental Impact Assessment (PEIA) comprises the construction and/or operation of various items of landside infrastructure, as identified in Table 3.1 below and described in detail in the following sections.

Table (3. 1): Development included in the Phase 1 Preliminary EIA

Phase 1 Development	Activities Included	Scope
Navigable areas	Not included	All navigable areas for all vessels (leisure, commercial and Government) associated with the port, which includes the wider Masirah Bay, approach channel, maneuvering basin and berth pockets for the Commercial Quay, Government Berths, Fast Ferry and Finger Pier. This also includes any navigation activities and issues in association with the Dry Dock area.
Landside infrastructure	Included Construction and operation for three packages (IP2), (IP3) and (IP4)	The landside infrastructure under Phase 1 includes the following infrastructure package (IP) items: roads and infrastructure (IP1), Commercial Quay infrastructure and operational zone (IP2), pre-gate, gate area and inspection zone (IP3), Government Berth infrastructure (IP4), fences, main gates and main admin building (IP5), and storage areas (IP6). Previously there was not enough detail to assess the onshore infrastructure as this was related to the Port Master Plan which had not been developed in sufficient enough detail to assess in the 2007 EIA – there is now enough detail and needs assessing
Marine infrastructure	Not included	The operational elements under Phase 1 includes any operations (marine or landside) in association with the breakwaters, reclaimed land areas, Commercial Quay, Government Berths, Fast Ferry, and Finger Pier.

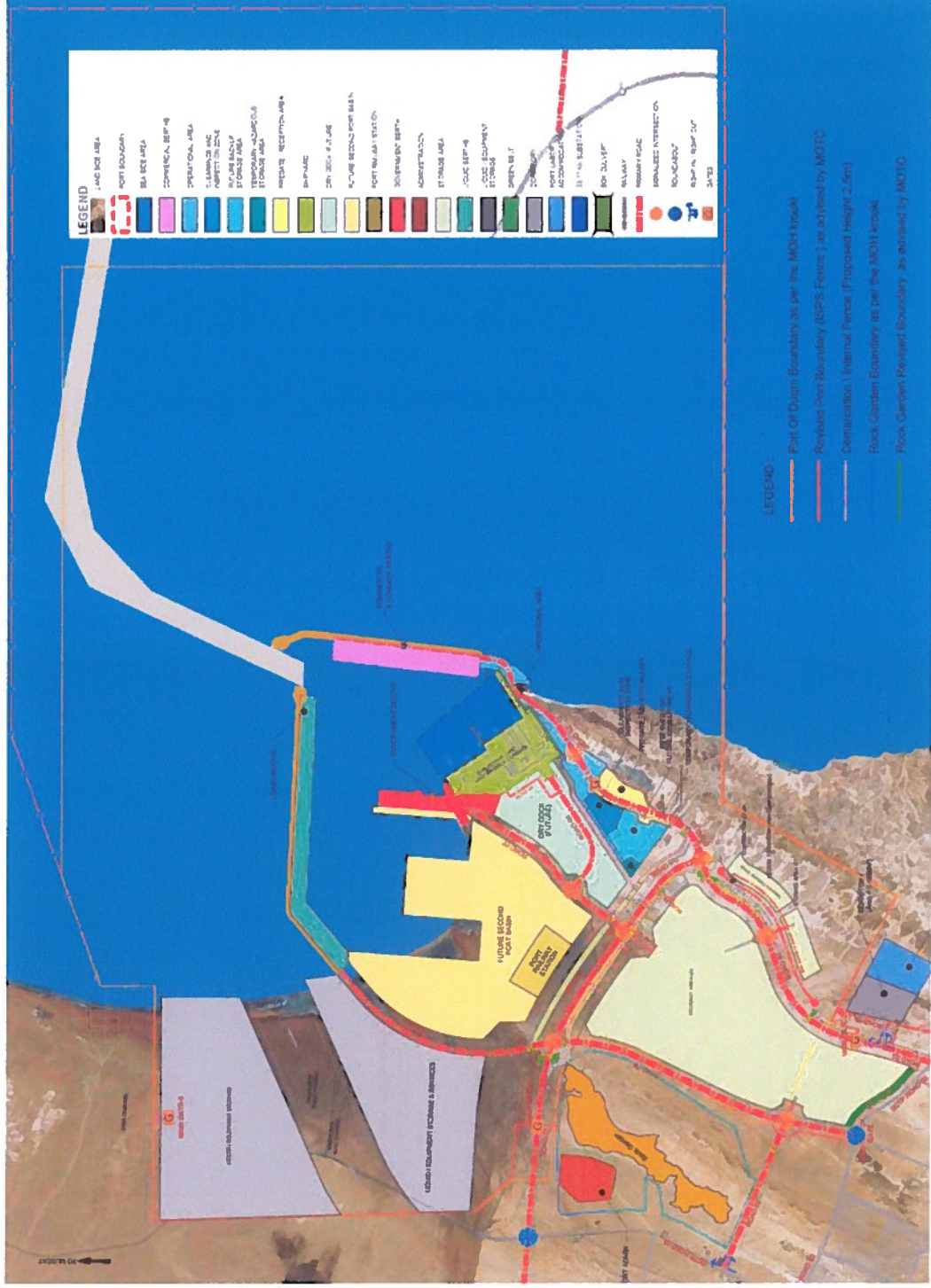


Figure (3. 2): Master Plan for Port of Duqm

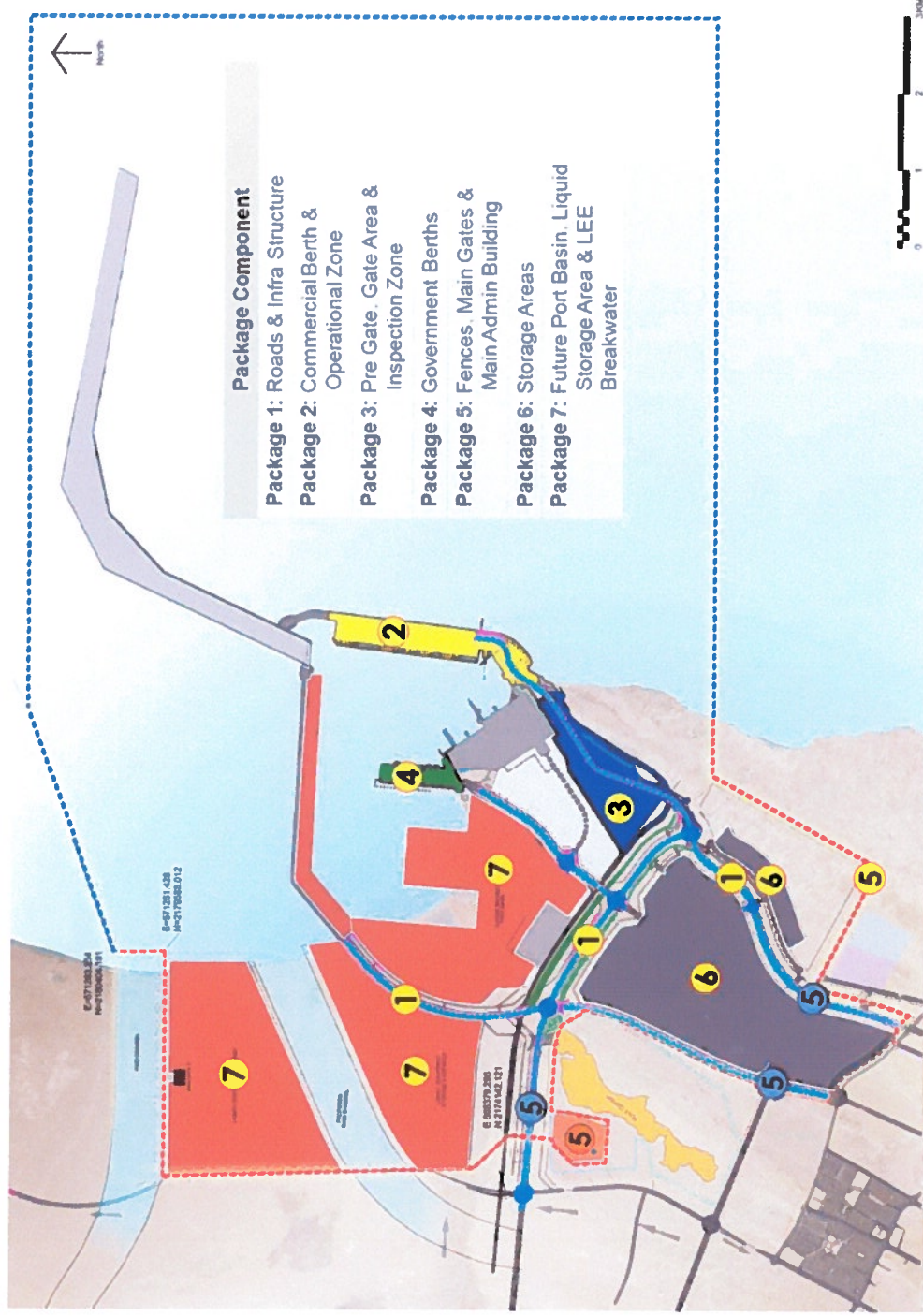


Figure (3. 3): Port of Duqm Package components

3-5 Proposed Landside Infrastructure Packages Description

The presented Preliminary Environmental Impact Assessment covers the provision of certain infrastructure services for the development of the First Part of the Commercial Berths in terms of three packages as shown in Figure (3.3) and as follows:

3-5-1 Package 2 (IP2) Commercial Terminals & Operation Zone

The Scope of Works to be executed under this Contract for the Commercial Terminal & Operational Zone Areas, Port of Duqm shall include, but not be limited to, the construction, installation, testing, commissioning and remedying of defects of the following (See Figures 3.4 and 3.5):

- **Road and Paving Works:**
 - Construction of 3.00 km of double lane 2(Two) way carriageway,
 - Construction of all internal roads as access to buildings and Parking areas.
 - Construction of yard and terminal areas.
 - Construction of 1 Helipad with an approximate area of 1,100 sq. meter.
 - Construction of parking areas to serve all activities.
 - Construction of retaining wall.
 - Supply and Installation of Traffic Signals (One Location). The schematic design is provided and the detailed design shall be subject to the Approval and requirements of the relevant Authorities. This design shall include supply, installation and commissioning of Traffic Signals, including all signal heads, loop detectors, ducting/cabling, controllers and power supply.
 - Construction of 1 No. of helipad with a total area of 1,965 m² in the Zone (3), Operation area.
- **Infrastructure Works**
 - Potable Water Network and Fire Fighting Network
 - Storm Water Drainage and Sewerage Network
 - Pump Stations and Electrical works



- Telecommunications
- Street Lighting and Yard Lighting
- Spare Ducts
- Lightning Protection
- Reefer Gantry (Provisional)
- Ground Improvement Works and Fencing and Gate Works
- **Building Works**
 - **C.1 Operation Zone – (ZONE 3)**
 - Block 3A - Terminal administration building
 - Block 3B - Training & amenities center
 - Block 3C - PDC Emergency & Firefighting center
 - Block 3F - Electrical service building (Type-2)
 - Block 3G - Electrical service building (Type-3)
 - **C.2 Multipurpose Terminal (1) – (ZONE 4)**
 - Block 4A - MPT warehouse & offices
 - Block 4B - MPT workshop & maintenance building
 - Block 4C - MPT gatehouse
 - Block 4J - MPT Electrical service building (Type-2)
 - **C.3 Container Terminal (2) – (ZONE 4)**
 - Block 4E - CT workshop & maintenance building
 - Block 4F - CT gatehouse
 - Block 4K - CT electrical service building (Type-1)
 - Block R-4K - CT electrical service building (Type-1)
 - **C.4 Dry Bulk Terminal Area – (ZONE 4)**
 - Block 4H - DBT workshop & maintenance building
 - Block 4I - DBT Gatehouse
 - Block 4L - DBT Electrical Service Building (Type-1)
 - **C.5 Container Terminal (2) (Optional) – (ZONE 4)**



- **Crane Beam and Track Works**

The Scope of work for this part will include the provision of a crane beam and track, rear crane beam supported on bored concrete piles. The rear crane beam is approximately 2.3m wide and 2m deep, supported on a total of 562 piles of which 549 piles are 1.2m diameter and 13 piles are 0.9m diameter with a nominal length of 35m at 4m centers. The Scope of Work for this item includes, but is not limited to the following:

- Part 1: Investigation and site preparation
- Part 2: Construction and testing of piles, rear crane beam and main drainage
- Part 3: Design, installation and testing of rail track
- Part 4: Commissioning



Figure (3. 4): Location of Package 2 (IP2) Commercial Terminals

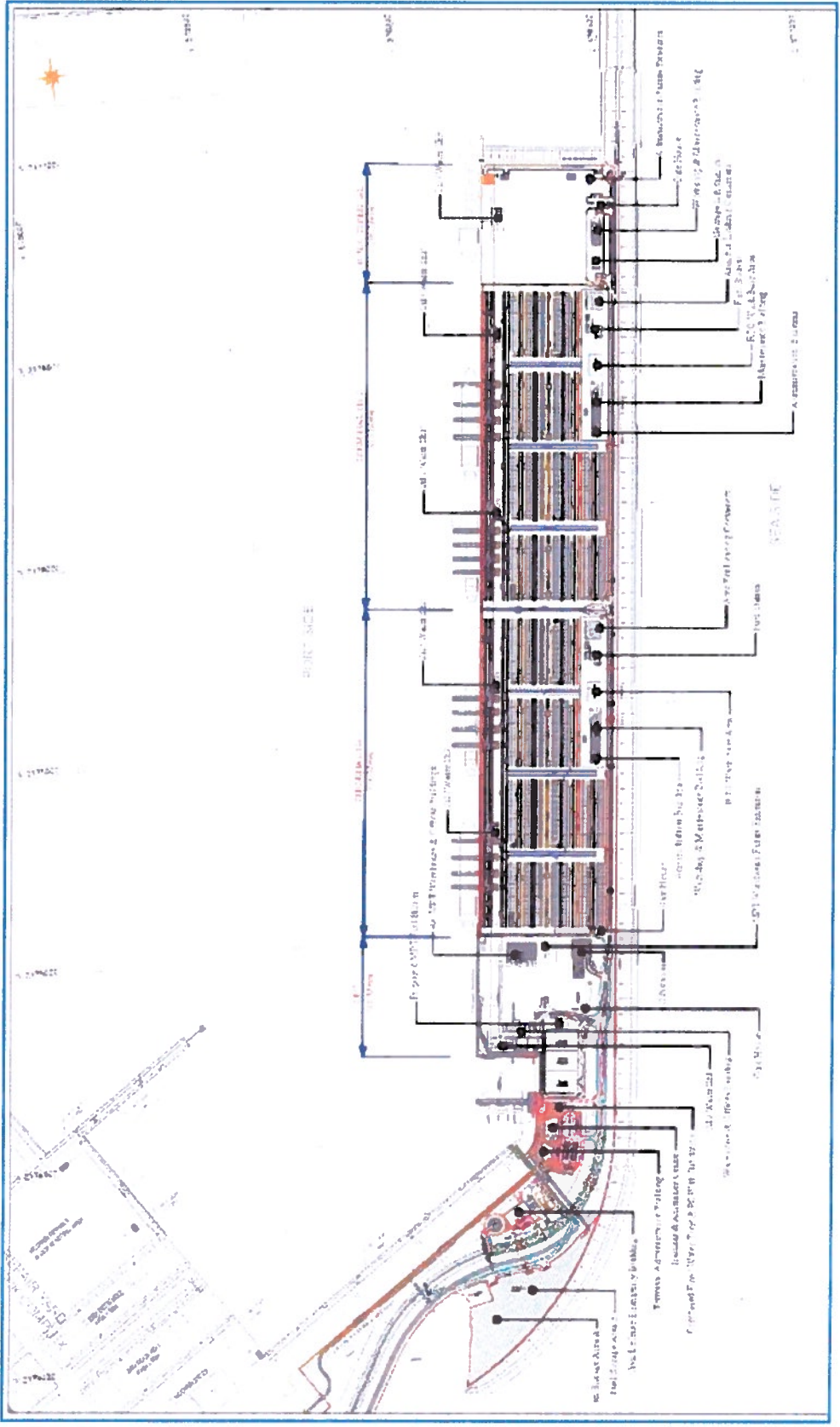


Figure (3. 5): Layout of Package 2 (IP2) Commercial Terminals

3-5-2 Package 3 (IP3) Pre-Gate, Gates & Inspection Zone

The Scope of Works to be executed under this Contract for the Pre-Gate, Gates & Inspection Zone, Port of Duqm shall include, but not be limited to, the construction, installation, testing, commissioning and remedying of defects of the following (See Figures 3.6 and 3.7):

- **Road and Paving Works**
 - Construction of 8.00 Km roads with varied cross sections including the junctions on these roads. The roads are ROAD 02-2, ROAD 02-3, ROAD 02-4, ROAD 02-5, ROAD 02-6, ROAD 02-7, ROAD 02-8, ROAD 02-9, ROAD 02-11.
 - Construction of all internal roads as access to buildings and Parking areas.
 - Construction of Parking areas to serve all activities.
 - Supply and Installation of Traffic Signals. The Contractor shall carry-out the design, supply, installation and commissioning of Traffic Signals, complete, including all signal heads, loop detectors, ducting/cabling, controllers and power supply. Traffic Signal design shall be as per site requirements.
 - Construction of 2 Nos. of Helipad with an approximate area of 2,200 m² in Zone 2 – Inspection Zone.
- **Infrastructure Works**
 - Potable Water Network and Fire Fighting Network
 - Storm Water Drainage and Sewerage Network
 - Pump Stations and Electrical works
 - Telecommunications
 - Street Lighting and Yard Lighting
 - Spare Ducts and Fencing and Gate works
- **Building Works**
 - **C.1 CQ Gate and Pre-Gate Area (Zone – 1)**
 - Block 1A – Gate House & In Gate – Out Gate Booths
 - Block 1B – One Stop Station – Transaction Building
 - Block 1C – Pass Office Building
 - Block 1E – Mosque



- Block 1G – Electrical Service Building (Type-1)
- Block 1G – General
- Block 1H – Electrical Service Building (Type-2)
- Block 1J – Fire Fighting Water Tank
- **C.2 Inspection Zone (Zone – 2)**
 - Block 2A – Custom – MoH Administration & Inspection Building
 - Block 2B – MAF Inspection Building
 - Block 2C – MoH Clinic
 - Block 2D – Gate House
 - Block 2E - Electrical Service Building (Type-1)
 - Block 2F - Electrical Service Building (Type-2)
 - Block 2G - Fire Fighting Water Tank
 - Block 2G – General
 - Block 2K – Custom Inspection Staff Building
 - Block 2L – Ammunition Building

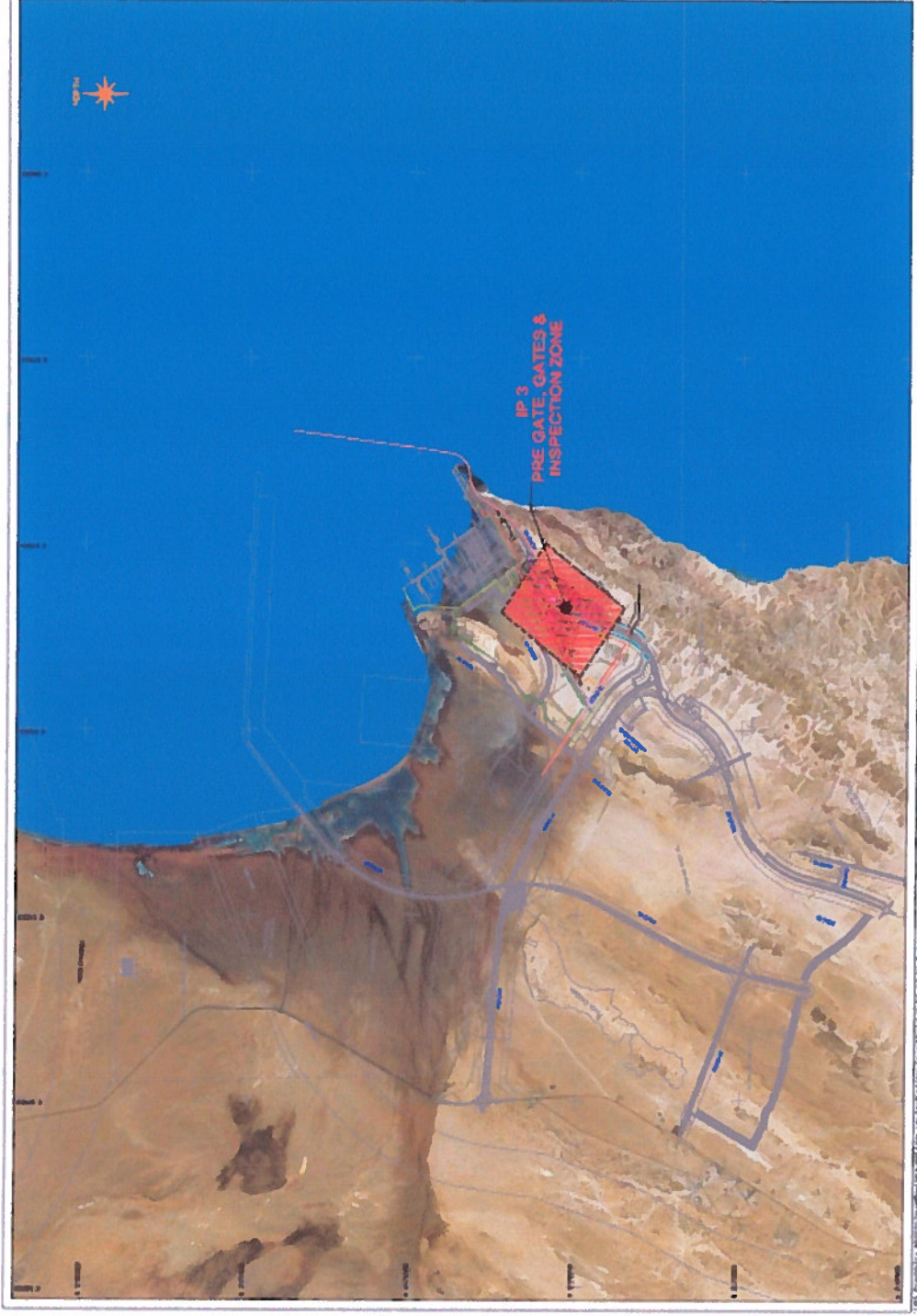


Figure (3. 6): Location of Package 3 (IP3) Pre-Gate, Gates & Inspection Zone

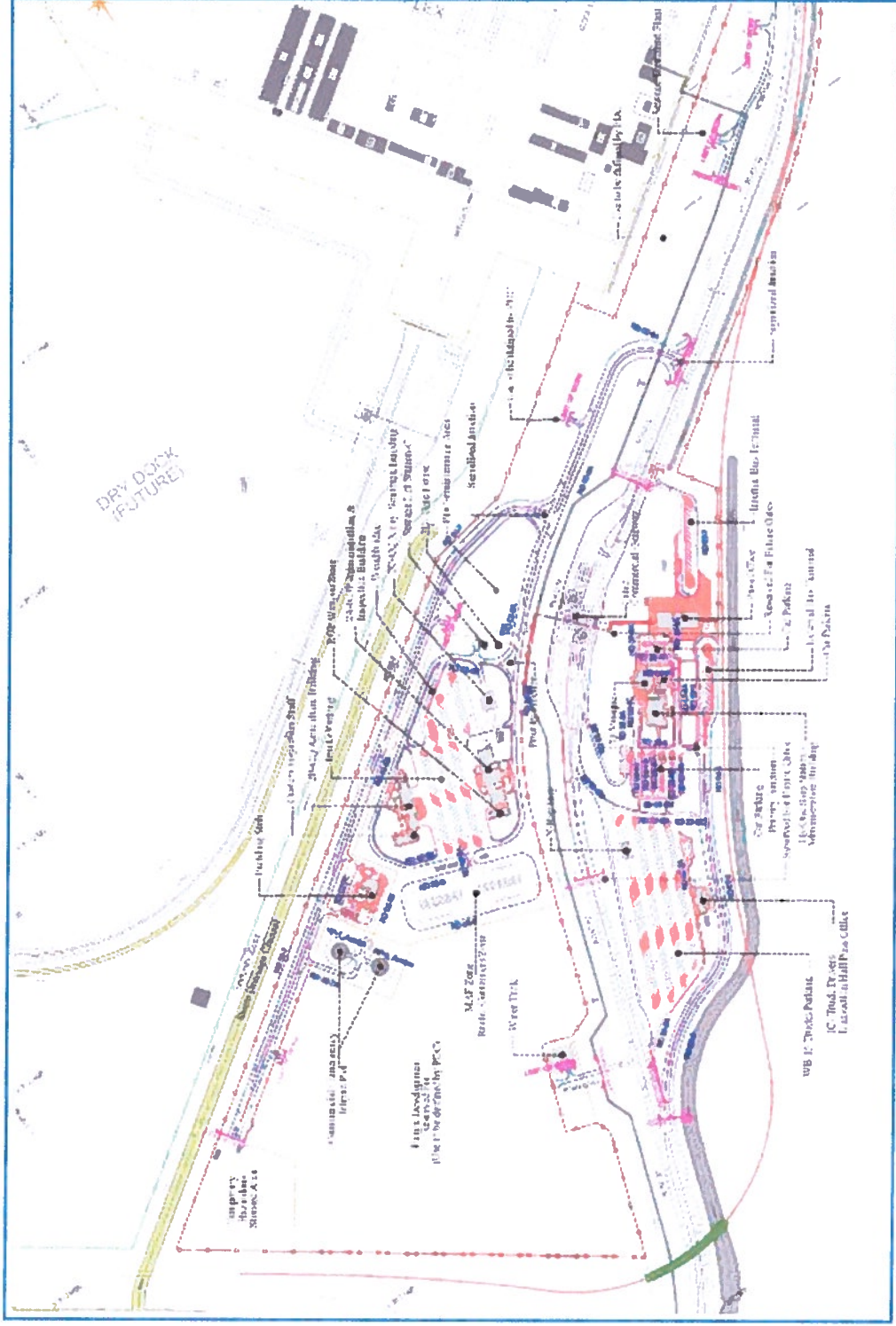


Figure (3. 7): Layout of Package 3 (IP3) Pre-Gate, Gates & Inspection Zone

3-5-3 Package 4 (IP4) Government Berths

The Scope of Works to be executed under this Contract for the Government Berths, Port of Duqm shall include, but not be limited to, the Construction, commissioning and maintenance of the Construction of Roads, Infrastructure and Building Works of the following (See Figures 3.8 and 3.9):

▪ **Road and Paving Works:**

- Construction of 1.3 km of the extension of road RD of dual carriageway between the government berth zones building and the marine area. This road extended along five zones and will be constructed with various types of pavements: Flexible and rigid pavements and heavy duty concrete pavement as per each zone requirements.
- Construction of single carriageways one lane each direction of 0.80 km of road Rd -1- ,access road to fast ferry terminal (zone-5) and STP & water tank. This road will be constructed with flexible pavement (Asphalt pavement).
- Construction for the junctions along road RD-7-,RD-1- and access road which control traffic movement to government berth zones, Fast ferry terminal and STP & water tank, including one (1) Roundabout and three (3) priority signals.
- Construction of all the platform areas for government berth zones with rigid pavement (concrete pavement and heavy duty concrete pavement) as per each zone requirements.
- Construction of fast ferry terminal as platform areas with rigid pavement (concrete pavement) in the area which service the marine and flexible pavement (Asphalt pavement) in the area service buildings and parking areas as per the zone requirements.
- Construction of all internal roads as access to buildings and Parking areas.
- Construction of parking areas to serve all activities.



- Design, Supply and Installation of Traffic Signals. The Contractor shall carry-out the design, supply, installation and commissioning of Traffic Signals, complete, including all signal heads, loop detectors, ducting/cabling, controllers and power supply. Traffic Signal design shall be as per site requirements.
- Construction of 3 Nos. of helipad with a total area of 3,225 m² in the following zones:
 - ✓ 1 No. in Zone 1 RY
 - ✓ 2 Nos. in Zone 5 SSF
- **Infrastructure Works**
 - Potable Water Network and Fire Fighting Network
 - Storm Water Drainage and Sewerage Network
 - Fuel Network and Pump Stations
 - Electrical works and Telecommunications
 - Street Lighting and Yard Lighting
 - Spare Ducts and Fencing and Gate works
- **Building Works**
 - **C.1 Royal Oman Yacht (RY) - (ZONE 1)**
 - Block 1A - Administration Building (G +R)
 - Block 1B - Staff Accommodation (G+F+R)
 - Block 1C - Boat Shed (G +R)
 - Block 1D - VIP Majlis (G +F+R)
 - Block 1G - General
 - Block 1S - Service Buildings



- House & Screening Office
- Electrical service Building
- Fire Fighting Water Tank
- Gate house & Screening Office
- **C.2 Royal Oman Navy (RON) – (ZONE 2)**
 - Block 2A - Administration Building (G +R)
 - Block 2B - Staff Accommodation (G+F+R)
 - Block 2B1 - Staff Accommodation& Dining
 - Block 2C - Boat Shed (G +R)
 - Block 2G - General
 - Block 2S - Service Buildings
 - Electrical service Building
 - Gate House
 - Screening Office
 - Fire Fighting Water Tank
- **C.3 Royal Oman Police (ROP) – (ZONE 3)**
 - Block 3A - Administration Building (G +F+R)
 - Block 3B - Staff Accommodation (G+F+R)
 - Block 3C - Boat Shed (G+R)
 - Block 3D - Main Gate (G+F+R) – Government Berth Security Gate
 - Gate House
 - Booth House
 - Check-in Booth
 - Block 3G - General

Block 3S - Service Buildings

- Electrical service Building
- Gate House
- Screening Office
- Fire Fighting Water Tank

○ **C.4 Sultan`s Special Force (SSF) – (ZONE 4)**

Block 4A - Administration RHQ Building (G + R)

Block 4B - Staff Accommodation (G+F+R)

Block 4C - Boat Shed (G +R)

Block 4D - Amenity Building

Block 4G - General

Block 4S - Service Buildings

- Electrical service Building
- Armory Store
- Guard House & Screening Office
- Fire Fighting Water Tank

○ **C.5 Fast Ferry Terminal (FFT) – (ZONE 5)**

Block 5A - Terminal Building

Block 5G - General

Block 5S - Service Buildings

- Check-in House
- Electrical service Building
- Fire Fighting Water Tank

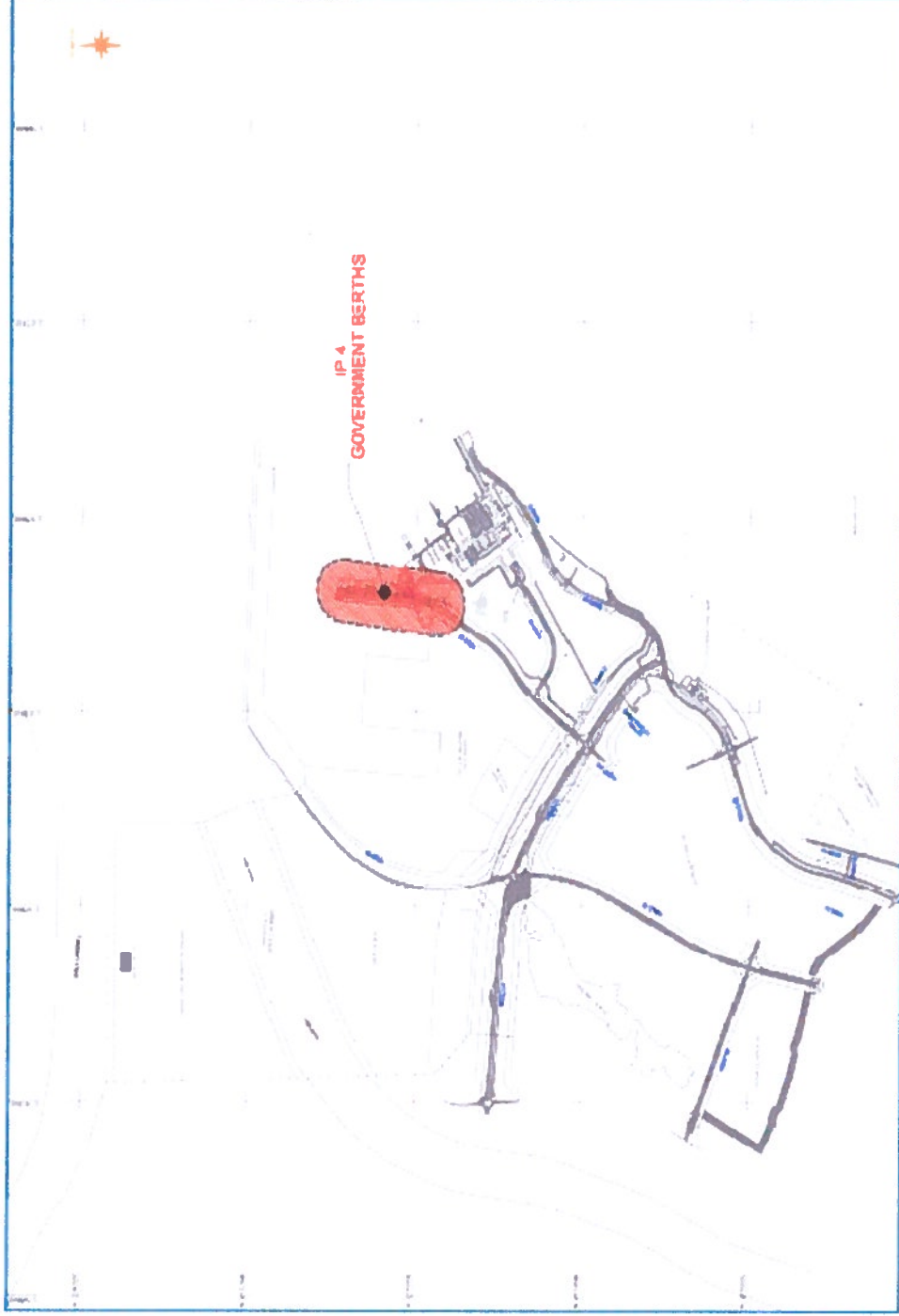


Figure (3. 8): Location of Package 4 (IP4) Government Berths

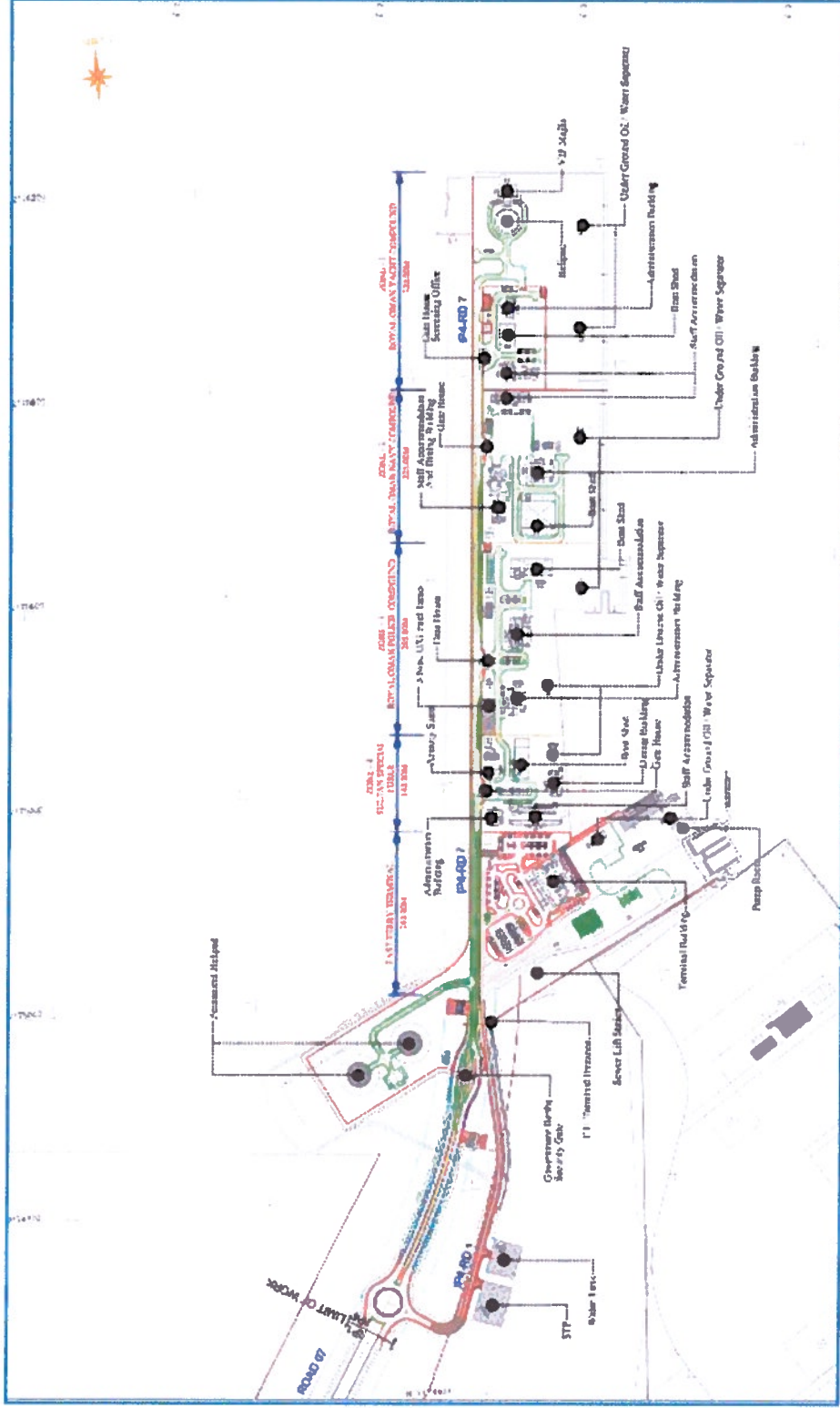


Figure (3. 9): Layout of Package 4 (IP4) Government Berths

3-6 Equipment and Raw Material Requirements

Equipment, machinery and raw materials to be used in construction would include the several items presented in the following Tables.

Table (3. 2): List of equipment and machinery for construction Tentative)

SL No.	Equipment/Machinery Type	Numbers
1.	Tower crane	06
2.	Mobile Crane	03
3.	JCB	02
4.	Air Compressor	02
5.	Hilti Breaker	05
6.	Pick-up	02
7.	Dumper	04
8.	Bobcat	02
9.	Water pump	04
10.	Vibrators	10
11.	Wood Cutting Machine	06
12.	Steel Cutting Machine	01
13.	Hilti Drilling Machine	09
14.	Fork Lift	02
15.	Mixer Machine	09
16.	Block cutter	05
17.	Water jet machine	01
18.	Steel cutter	03
19.	Power floating machine	05
20.	Shovel	02
21.	Asphalt,-Concrete,-Crusher,-Plant	02
22.	Dozer, CAT D8R	10
23.	Excavator	7
24.	Water Tanker, 5000 Gallon	15
25.	Wheel Loader	20
26.	Tipper truck	25
27.	Trailer	20
28.	Dumper	15
29.	Travel Mixer	10
30.	Single/Double drum steel roller/Tire Roller	12
31.	Asphalt Paver	6
32.	Grader	8

Table (3. 3): List of raw materials

Material	Source
Borrow materials	Locally acquired
Gravel	Locally acquired
Aggregate	Locally acquired
Sand	Locally acquired
Road {rip rap material} and Stone Block	Locally acquired
Clean Water for Concrete	Locally acquired
Other Water for Compaction	Locally acquired
Reinforcing bar	Imported Manufactured
Cement	Locally Manufactured
Steel beams	Regionally Manufactured
Steel Rails	Imported Manufactured

3-7 Manpower Required

The following table illustrates tentatively the required manpower for construction phase of the three proposed packages in terms of technical, administration, skilled and non-skilled labors.

Table (3. 4): Required manpower for construction phase of the proposed packages

Technical & Administration Staff		Laborers - Civil	
Category	Numbers	Category	Numbers
Senior project Manager	01	Carpenters	40
Project Manager (Buildings)	01	Steel fixers	35
Project Manager (Roads)	01	Masons	60
Project Manager (MEP)	01	Helpers	200
Construction Manager (Buildings)	01	Operators	25
Construction Manager (Roads)	01	Painters	40
Sr. Project Control Engineer	01	Skilled Labor	30
Asst. Project Control Engineer	01	Other Staff	10
Sr. QA/QC Engineer	01	Laborers - MEP	
Sr. Safety Engineer	02	A/c Mechanics	15
MEP Coordinator	01	Electrician	80
Project Engineer	03	Plumber	60
Site Engineer (Civil & MEP)	08	Duct man	50
Site Supervisor	12	Insulator	40
Foremen	20	Pipe fitter	30
MEP Supervisor	06	Welder	15
QA/QC Engineer (Civil & MEP)	02	Skilled Labor	20
Quality Inspector	03	Unskilled labor	25
Safety Officer	02	Fire Fighting	30

Safety Supervisor	04
Technical Engineer	01
Project Quantity Surveyor	02
Secretary cum Document Controller	03
Project Clerk	02
Draughtsman (Civil & MEP)	02
Storekeeper	04
Logistic Assistant	02
Timekeeper	04
Office Boy	04

Works	
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3-8 Construction Programme

The time for completing the each Package is 30 months including Mobilization and period for maintenance is 365 days. The proposed implementation schedule for this project is outlined in Table (3.5) and table (3.6) for road works.

Table (3. 5): Project implementation Schedule

Description	period	Remarks
Construction Stage		
Mobilization	1 Month	Considering that the project three packages may be constructed by more than contractors
Construction	29 Months	
Maintenance Stage		
Maintenance Period	12 Months	From the Project completion date

Table (3. 6): Tentative construction program for road works (month)

Activity	Month														
	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30
Mobilization															
Setting out of alignment															
Cleaning of site															
Earthwork															
Subgrade preparation															
Base course layer															
Wearing surface layer															
Drainage structures															
safety barriers															
Road sign & marking															
Demobilization															

3-9 Construction Methodology

No details of the construction methodology are available as the construction contractor, who would devise the construction methodology, has not as yet been appointed. It has however considered that traditional methods of construction will be used and consequently such methods have been assumed to enable prediction of the impacts that may result.

3-10 Health, Safety and Environmental Policies

All work on site will be carried out in accordance with the Standard Omani Conditions of Contract, which specify compliance with the appropriate health and safety and environmental policies. In addition, clauses have been inserted into the conditions of contract for the maritime works to require the contractor to comply with the mitigation actions, which have been identified in this report, and this compliance will be monitored by the Resident Engineer and his staff.



CHAPTER (4)

BASELINE INFORMATION

4 BASELINE INFORMATION

4-1 Introduction

4-1-1 Scope

The Government of Oman is in the process of developing Duqm Port in Duqm Town as a strategic dry dock, free trade zone, industrial and tourism destination.

The new Port of Duqm complex will provide facilities for commercial, navy and coastguard vessels and ship repair together with berths for strategic traffic. The site is located approximately 450 km south of Muscat, at Ras Duqm, approximately 7 km from the town of Duqm in the Al Wusta Region of the Sultanate of Oman¹⁰.

The construction of the port marine works started in April 2007 and it is expected that the Port will reach 100% operational capacity by 2015.

The overall aim of this report is to promote the assessment and uniform observation of environmental impacts of the new Port of Duqm complex (Packages 2, 3 and 4) in planning and decision making in addition to increasing the opportunities for citizens to receive information related to the project.

In this chapter, the results of the baseline survey are presented. It includes the following main items:

- Description of Study Area – This section provides a justification of the study area. It comprises the area over which the direct and indirect impacts of the proposed development could potentially occur (including the proposed development footprint). Maps are provided;
- Overview of Existing environment – It provides an overview description of the existing environment.

4-1-2 Sources of Information

The project has been on running for a number of years, and as such, there is existing data and reports available for use in the preparation of this EIA report. The two key documents are: the 2007 Environmental Statement for the construction of the

¹⁰ **Khatib \$ Alami and Partners, 2012:** Port of Duqm Extension, Oman Environmental Scoping Report, Ministry of Transport and Communications, Sultanate of Oman 17 January 2012, Final Report - 9S8605.

original port design ¹¹ and the 2012 Port of Duqm Extension, Oman Environmental Scoping Report.

As far as possible, the data and reports were collected during the PEIA Study from data holders, such as the construction and dredging contractors, Royal Haskoning reports, Parsons Brinkerhoff, and various Ministries (through consultation).

During the next phase of carrying out the Environmental impact Assessment of the proposed three packages, it's recommended to update and conduct measurements for noise and ambient air.

4-2 Socio-Economics

4-2-1 Geographic and Administration

There are no local families actually living within the boundary of the Port of Duqm, however, there is potential for impacts to occur to those living in the Duqm settlements and the village of Shuw'ayr. The study area for this parameter is illustrated in Figure (4-1).

Al Wusta is one of the governorates of Oman. Its capital is Haima. It was previously a region. It became a governorate on 28 October 2011. There are four areas that comprise Al Wusta Region^{12, 13}:

- Wilayat Haima to the west mainly covers the traditional grazing areas of the Harsusi tribe;
- Wilayat Mahawt to the north has its administrative centre at Hij on the edge of the Barr al Hikman peninsula. The tribes of that wilayah are mainly Al Wahibah and Al Hikman, although some Janabah live along the coast especially at Khaluf.

¹¹ Royal Haskoning, 2007: New Port and Dry Dock Complex, Duqm. Environmental Statement. Final Report 3H6503.

¹² David Insall & Five Oceans, 2010: Socioeconomic survey for Duron (Industrial Zone Masterplan Scoping Study)

¹³ David Insall & Five Oceans, 2010: Socioeconomic survey for Duqm Airport: Scoping Study

- Wilayat Jazir lies down the coast to the south of Duqm, with its administrative centre at Kahil. The population is almost entirely Janaybi.
- Wilayat of Duqm includes the coastal village of Nafun to the north and stretches southwards through Duqm to Shuw'ayr, Madrasah, Adh Dhahir and Haytam, the population almost entirely Janaybi.

The Duqm is located at 19°39'42"N 57°42'17"E and is an industrial oil town with a notable port, and the town has been looking to increase tourism in the area with the Oman Tourism Development Company, and is now central to the state's development goals.

4-2-2 Population and Land-Use

The total population of the Al Wusta Governorate is estimated over 26881 capita for year 2010. The population for Al Wusta will reach over 35270 capita by year 2030 as presented in Table (4-1). The most populated towns located in Al Wusta Governorate is Mahawt city. Duqm is the third town in Al Wusta Governorate according to the population. Moreover, Duqm represents about 18.93% of the total population in Al Wusta Governorate (for year 2010).

Table (4. 1) : Present and future population by zone for Al Wusta Governorate

	2005	2010	2015	2020	2025	2030
Oman Total	2.421.050	2.558.805	2.692.54	2.787.34	2.921.512	3.027.38
Al Wusta	23.947	26.881	29.600	31.389	33.677	35.270
Haima	3.314	3.756	4.174	4.468	4.838	5.115
Mahout	10.131	11.275	12.309	12.939	13.761	14.284
Duqm	4.440	5.089	5.720	6.189	6.772	7.230
Al Jazer	6.062	6.761	7.397	7.793	8.306	8.641

The Number of employed persons by zone is estimated on residence base and on workplace base as presented in Tables (4-2) and (4-3). The employment estimated on residence base (for year 2010) in Duqm town is about 1537 persons (30.2% of the population). While the employment estimated on workplace base (for year

2010) is about 1085 persons (21.32% of the population). Duqm is the third town in Al Wusta Governorate according to the number of employees in year 2010 (about 19.04% and 20.74% of the employees in Al Wusta Governorate on residence and workplace bases, respectively).

The indigenous population of Duqm itself, currently just over 1000, is changing for the following reasons:

- The potential for employment in the developed areas has drawn people away from desert 'firqan' locations towards the hub of future development in industrial and tourism zones. Of the approximately 550 workers currently employed at the Port, 50 are Omani.

Table (4. 2) : Present and future number of employed persons by residence base

	2005	2010	2015	2020	2025	2030
Oman Total	822.877	895.637	983.093	1.066.460	1.160.377	1.265.344
Al Wusta	7.066	8.074	9.215	10.317	11.548	12.890
Haima	986	1.144	1.321	1.492	1.680	1.884
Mahout	2.996	3.378	3.816	4.238	4.713	5.233
Duqm	1.303	1.537	1.796	2.047	3.326	2.628
Al Jazer	1.781	2.015	2.282	2.540	2.829	3.145

Table (4. 3) : Present and future number of employed persons by workplace base

	2005	2010	2015	2020	2025	2030
Oman Total	822.877	895.637	983.093	1.066.460	1.160.377	1.265.344
Al Wusta	4.121	5.232	6.431	7.603	8.876	10.235
Haima	778	942	1.122	1.296	1.483	1.685
Mahout	1.520	1.924	2.361	2.789	3.256	3.754
Duqm	812	1.085	1.376	1.661	1.970	2.298
Al Jazer	1.011	1.281	1.572	1.857	2.167	2.498

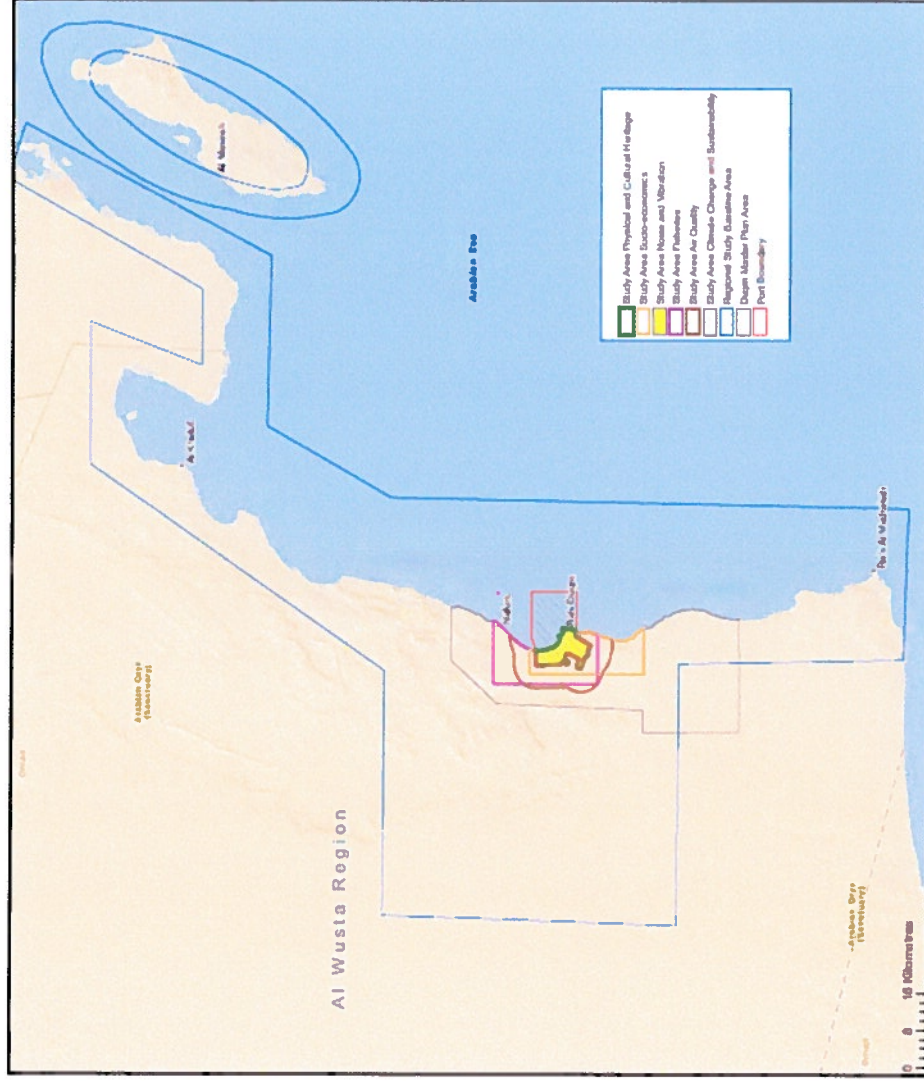


Figure (4. 1) : Geographic Scope of the Port of Duqm (Socio-economy) ¹⁴

¹⁴ **Khatib & Alami and Partners, 2012: Port of Duqm Extension, Oman Environmental Scoping Report, Ministry of Transport and Communications, Sultanate of Oman 17 January 2012, Final Report - 9S8605.**

- The Government's program of providing Buyut Sha'abiyah (social housing) has drawn most families away from their former temporary structures to settlements where most families have now built at least one concrete house, qualifying them for connection to an electricity supply. Whole villages of plywood and corrugated iron structures now lie empty.
- Those with children want to be close to schools and medical facilities.
- Livestock keeping appears to be unchanged, but dependent on grazing resources they remain in 'azbahs looked after by expatriate herdsmen. The 'azbahs may be co-located with the main dwelling (but not by buyut sha'abiyah) or away from the main residence in an area where grazing is available.
- Livestock rearing is heavily dependent on bought-in supplementary feed, both hay and concentrates. This saps available disposable income.
- Fishing remains a major source of income amongst a proportion of Duqm residents, but actual income figures are difficult to collect, due to the variable nature of returns which are both seasonal and influenced by market factors.
- Minor commercial development in Duqm is beginning to make it more locally attractive as a shopping centre. Supplementary animal feed is now available in designated stores. With 500 expatriates working at the site, there is a market for fish sales and small amenity goods, soft drinks etc.
- Summer migration to the piedmont towns, mainly Adam and Mudhaibi, for the date harvest is now falling, as electricity and more permanent housing becomes available. This change predates the announcement of plans to create the Duqm harbor and industrial estate.

4-2-3 Local Economic

The Duqm port has undergone development and shipbuilding, breakwaters and quay walls were built. In March 2005, Oman's Ministry of Transport and Communications study and design a new Duqm Airport in hopes of increasing tourism. Oman Air has begun services at the airport on July 23, 2014. The planned Oman Railways project will also include a link to Duqm Port. In 2008, the government announced that a 213-room hotel - Crown Plaza Duqm will be built. A

coal-fired power plant has also been approved in Duqm with the aim of reducing dependency on natural gas.

Table (4-4) displays the present and future number of private vehicles by zone. Some of the residents are employees and they have to go and return back every day to their work. Duqm is the third town in Al Wusta Governorate according to the number private vehicles (646 vehicles in year 2010). It represents about 17.95% of the total number of vehicles in Al Wusta Governorate. This also means that, there is one car for every 7.87 persons in Duqm. The finished goods are estimated as presented in Table (4-5). Duqm is the third town in Al Wusta Governorate according to the number of the finished goods. It represents about 18.66% of the total number of the finished goods in Al Wusta Governorate.

Table (4. 4) : Present and future number of private vehicles by zone

	2000	2005	2010	2015	2020	2025	2030
Oman Total	285.428	305.836	355.581	393.822	438.687	502.748	577.759
Al Wusta	2.129	2.601	3.598	4.176	4.756	5.571	6.473
Haima	288	364	566	672	785	945	1.129
Mahout	1.061	1.243	1.439	1.646	1.845	2.124	2.424
Duqm	401	472	646	761	877	1.038	1.217
Al Jazer	379	522	947	1.097	1.249	1.464	1.703

**Table (4. 5) : Present and future finished goods manufactured by zone
(RO 1000)**

	2000	2005	2010	2015	2020	2025	2030
Oman Total	1.150.998	2.157.817	3.780.494	8.272.411	11.938.27	16.346.709	21.217.698
Al Wusta	0	591	461	942	1.546	6.783	12.815
Haima	0	70	58	120	197	1.431	2.836
Mahout	0	278	209	425	695	2.124	3.802
Duqm	0	104	86	175	286	1.559	3.013
Al Jazer	0	139	108	222	367	1.669	3.165

4-3 Coastal Morphology

This parameter relates to the coastal geomorphology, hydrodynamics (winds, waves and currents) and sedimentary pathways.

Duqm is located on the east coast of Oman, approximately 600 km from Muscat. It is central to the Bay of Masirah, between cape Ras Sarab in the north and cape Ras Al Madrakah in the south. The study area relating to sea bed morphology covers an area 60km by 30km, which will be used as the basis for the offshore sediment (and water quality) studies (as illustrated in Figure 4-2).

4-3-1 Overview of Existing Environment

The coastline in the wider area comprises sandy beaches backed by sand dunes, sabkha, khawrs (lagoons), tidal inlets and cliffs of soft rock, which have and are being eroded by wave and current processes, forming a relatively indented coastline. Immediately north of Duqm these processes have formed a crenulate bay, which is held by the Ras Duqm headland in the south, where it sweeps northwest, and then in a north easterly direction up to its northern boundary, marked by the town of Nafun. Here, is a small rocky headland separating the bay from the larger bay to the north, Ghubbat Quwayrat. A Wadi discharges into the bay immediately to the north of the port.

The main natural topographical feature of the coastline is the Ras Duqm headland, at over 100 m high. The headland runs north-south from the root of the Main Breakwater to Duqm Port which is located at the southern end of the crenulate bay. Ras Duqm is an inter-bedded mudstone and siltstone outcrop approximately 75 m high, which extends southwards to Ras Madraka.

The bay immediately to the north of Ras Duqm comprises silts and fine sands. The foreshore is flat and over low water periods a small sand bar is visible adjacent to the head of Ras Duqm. Offshore from the bay the 5 m contour is approximately 1,200 m from the shoreline¹⁵.

¹⁵ Khatib \$ Alami and Partners, 2012: Port of Duqm Extension, Oman Environmental Scoping Report, Ministry of Transport and Communications, Sultanate of Oman 17 January 2012, Final Report - 9S8605.

4-3-2 Developments

Since 2002, in the southern part of the crenulate bay, the Port of Duqm has been in development by the Ministry of Transport and Communications. The port comprises two breakwaters, a main and lee, which effectively extend the southern headland of the crenulate bay in a northerly direction and protect the area from the effects of waves and tides. Where the southern, Main Breakwater connects with the cliffs to the south, a small beach exists in its lee. A dredge channel is located between the Main and Lee Breakwaters, extending to the north northeast for over 4km where it then curves around to the east for approximately 5km.

4-3-3 Hydrodynamic Processes

▪ Climate

The climate along the east coast of Oman is dominated by the winter (November-March) north-east monsoon (NEM) and the summer (May-September) south-west monsoon (SWM). In conjunction with other factors, this has a large bearing on the hydrodynamic drivers which exist in the area, as is shown below.

A significant number of reports have been prepared and surveys undertaken during the planning, design and construction of the port ^(16, 17, 18, 19, 20, 21 and 22).

¹⁶ **Royal Haskoning, 2004:** Consultancy Services for Design, Supervision and Operation & Management Studies for a New Port Complex at Duqm (Final Feasibility Study Report).

¹⁷ **Royal Haskoning, 2007:** Environmental Statement.

¹⁸ **Horizon Geotechnical Company FZC for JDN, 2008:** Nearshore Marine Geotechnical Investigation (Factual Report & Addendum)

¹⁹ **JDN, 2008 & 2011:** Hydrodynamic and Dredge Plume modelling Preliminary study and final report

²⁰ **Royal Haskoning, 2008:** Draft Environmental Statement

²¹ **Royal Haskoning, 2009:** Hydrodynamic and Sediment Transport Desk Study

²² **Royal Haskoning, 2010:** Siltation at Main Breakwater Study

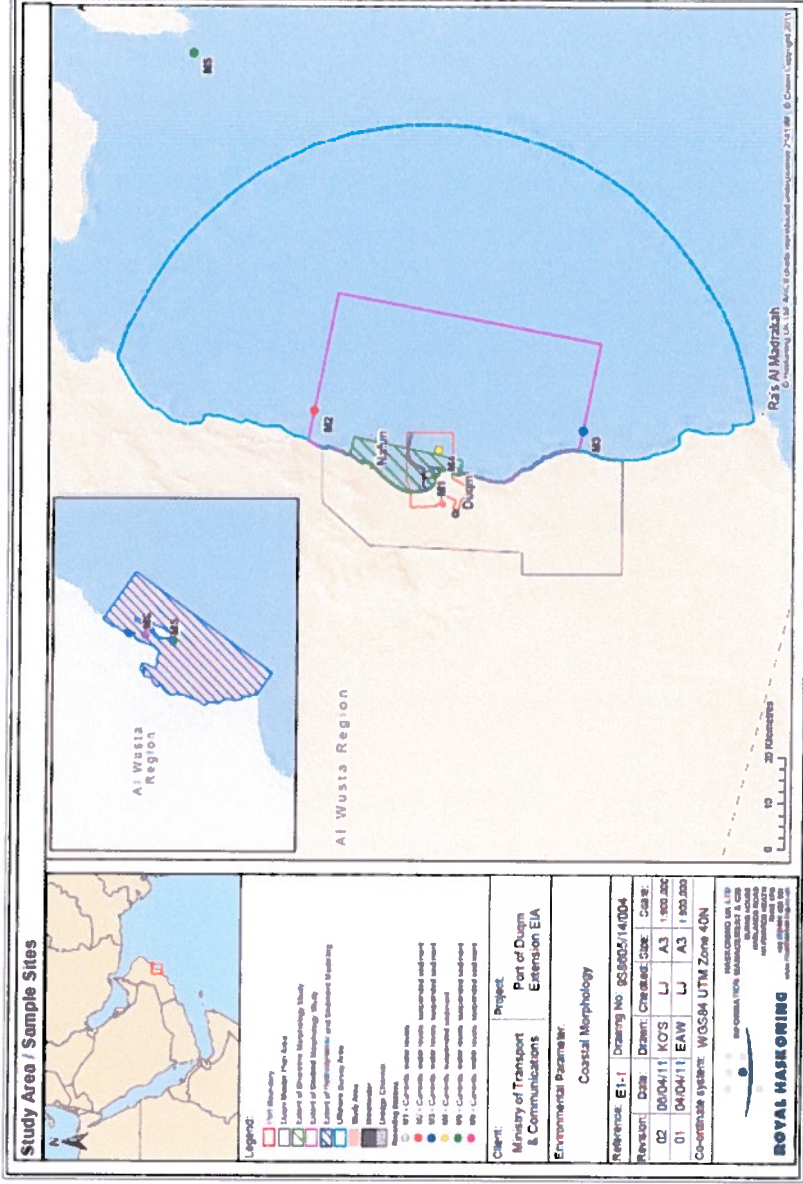


Figure (4.2) : Coastal morphology (Study Area / Sample Sites)²³

²³ **Khatib \$ Alami and Partners, 2012: Port of Duqm Extension, Oman Environmental Scoping Report, Ministry of Transport and Communications, Sultanate of Oman 17 January 2012, Final Report - 9S8805.**

▪ **Water Levels**

Table (4-6) shows water levels that have been obtained from a number of sources. Included in the table are water levels for Duqm as well as neighboring areas. The spring tidal range is 1.6 m CD, whilst the neap tidal range is 0.6 m. It should be noted that storm surges, associated with cyclones, have the potential to increase water levels. An extreme water level of +3.2 m CD has been adopted for Duqm, which combines MHHW with a surge of approximately 0.7m.

Table (4. 6) : Water levels for Duqm as well as neighboring areas

Tide Levels	Rounders Bay ¹	Sirab ²	Duqm ³
Highest Astronomical Tide	-	-	3.60 ⁴
Mean High High Water	2.4	2.36	2.53
Mean Low High Water	2.3	2.29	2.29
Mean High Low Water	1.6	1.48	1.69
Mean Low Low Water	0.8	0.70	0.90

¹ UK Admiralty Publications

² Royal Navy of Oman Publications

³ Halcrow (1992)

⁴ Gibb (1999)

▪ **Currents**

Currents in the area are forced by a number of parameters. These are:

- Wind conditions (local and at the water's surface only);
- Tides; and
- Oceanic circulation (the summer SWM) and winter north easterly NEM.

Tides in the area are semi diurnal and produce two unequal tides per day. Tidal flows are more apparent in the nearshore and circulate in a clockwise direction, creating net flood tidal currents flowing in a northwesterly direction along the coast and net ebb currents which flow in a southeasterly direction.

Numerical modeling indicates that nearshore currents generally flow north past Ras Duqm and into Duqm Bay at a speed of 0.25 m/s. During the ebb tide there is a ~4 hour period where this direction is reversed and current velocity is reduced.

The general circulation of the Indian Ocean, driven by the monsoon seasons has a larger effect on currents offshore of Duqm. In winter (NEM) the circulation flows anti clockwise, producing a southwesterly offshore current. In the summer (SWM) this flows in a clockwise direction, producing a northeasterly current.

Currents tend to be stronger in the summer monsoon season, where currents flow to the northeast. Measurements of currents and waves at two locations near Duqm Port were taken between January and November 2008 ²⁴). During the winter NEM maximum currents were in the range of 0.12 – 0.25 m/s. During the summer SWM current speeds of between 0.17 – 0.50 m/s were recorded.

Despite there being drivers for it, any flows to the southwest can be variable, with potential eddy development over the shallow area of Khalij Masirah (the bay formed between Ras al Madrakah and Masirah Island), which results in a northerly current along the coast during the NEM months.

▪ **Waves**

As suggested, the summer SWM is stronger and is characterized by a mean wind direction of south-southwest (mean wind speed of 7-11 m/s). This drives a wave climate with a mean direction of south-southwest, with a mean wave height of 2-4m (wave period 7-9s). During the winter NEM, the wind predominantly comes from a north-easterly direction, which drives a mean wave direction of east/north-east and mean wave height of 0.5-1m (wave period 6-8 seconds) ²⁵. Offshore, the wave climate reflects the summer SWM and winter NEM, and wave directions are therefore dominated by these events. Extreme wave heights from offshore of Duqm are shown in Table (4-7):

Table (4. 7): Extreme wave heights from offshore of Duqm

Return Period (years)	Wave Direction (Degrees North)								
	0	30	60	90	120	150	180	210	All
1 :Month	1.49	2.03	1.91	1.62	1.11	1.75	3.74	4.46	5.18
1:1	3.17	3.67	3.35	3.28	2.96	3.75	5.95	7.00	7.28
1:5	4.23	4.72	4.27	4.32	4.12	5.02	7.35	8.43	8.64
1:10	4.68	5.17	4.67	4.77	4.62	5.57	7.96	9.05	9.22

²⁴ JDN (2009): Hydrodynamics and Dredge Plume Modelling Report for the Construction of a New Port at Duqm: Construction of Maritime Works. Prepared by Marine Environmental Department of Jan de Nul Group for MoTC. JDN0926.Per.43.02. Rev01

²⁵ JDN (2009): Hydrodynamics and Dredge Plume Modelling Report for the Construction of a New Port at Duqm: Construction of Maritime Works. Prepared by Marine Environmental Department of Jan de Nul Group for MoTC. JDN0926.Per.43.02. Rev01

1:20	5.14	5.62	5.07	5.21	5.13	6.12	8.56	9.67	9.81
1:50	5.74	6.21	5.59	5.81	5.79	6.84	9.36	10.48	10.58
1:100	6.19	6.66	5.99	6.25	6.29	7.39	9.96	11.10	11.17
1:200	6.64	7.11	6.39	6.70	6.79	7.94	10.56	11.71	11.75
1:1000	7.70	8.16	7.31	7.74	7.96	9.21	11.96	13.14	13.14

The area is affected by cyclones. These generally develop off the western coast of India and travel west over the Arabian Sea. Although infrequent, cyclones have been known to pass near to Duqm, and, notably, have been recorded off the northern tip of Masirah Island in 1977. Numerical modeling of such events has been undertaken and indicates that waves between 5.6 and 5.8 m could have been generated at Duqm under an extreme event making landfall close to the site. Such an event would also be associated with elevated water levels.

4-3-4 Sediment Transport

The main source of sediment at Duqm is the soft eroding cliffs to the south of Ras Duqm. Approximately 94% of the cliff materials degrade to silt (< 63 mm) and the remaining 6% degrades to sand particles (> 63 mm).

These estimates suggest that 40% of the material tends to degrade to fines²⁶. Silt-size particles are likely to remain in suspension in the water column and be carried away by currents. Sand particles are likely to deposit on the beach (seabed) or be available for longshore transport.

The currents at Duqm rarely have speeds sufficient enough to mobilize sediment from the bed and so waves are the process by which this “stirring” occurs. Currents may then facilitate in transporting the material when it is already in motion.

Sand - Waves, which have a prevailing inshore direction of 150° drive nearshore longshore sediment transport of coarser material in a northerly direction, towards the bay. Estimates of potential sand transport are of the order of 650,000 m³/year.

²⁶ **Royal Haskoning, 2007: New Port and Dry Dock Complex, Duqm. Environmental Statement. Final Report 3H6503.**

Fines – Fine material transported in suspension past Ras Duqm is likely to be carried to the north of the headland and to settle out in the sheltered areas of the bays. It is estimated that 600,000 m³/year is potentially available from the cliffs for suspended sediment transport. However, if reasonable assumptions are made about the variations in material in the cliffs and in rate of cliff erosion, this value could be as high as 1,500,00 m³/year or as low as 250,000 m³/year. These calculations take into consideration that suspended sediment is only transported north, and only during the southwest monsoon; during the winter NEM very little suspended sediment volumes have been measured.

4-3-5 Sediment Transport and Morphological Change

Prior to the construction of the breakwaters, coarser sediment being transported north is pushed round into the bay by wave action, forming a sand bar. Finer sediments are carried northwards by the weaker tidal currents and tend to settle out further north where the bay is more sheltered.

The Main Breakwater of Duqm Port creates a small barrier to some of the northerly transported material and a sandy beach is currently accreting where the structure ties in to the Ras Duqm headland. In August 2010 a bathymetric survey suggested that of the order of 150,000 m³ sediment had accumulated at this location since the beginning of construction. The sediment was found to comprise silty sands. The accumulation is likely to reduce (but not cease) during the winter NEM as sediment transport tends to reverse and recommence in the next monsoon season ²⁷.

Effectively, the port has created an artificial headland north of Ras Duqm. This has the effect of temporarily reducing the potential sediment transported to the northern area of the bay, although no significant effect has been measured as of yet. It is anticipated that the construction of the breakwaters will affect the overall plan shape of the crenulate bay.

²⁷ Royal Haskoning, 2010: Siltation at Main Breakwater Study

4-4 Hydrogeology

The EIA study area for soil and groundwater includes the entire area within the port boundary (as illustrated in Figure 4-3). The reason for focusing only within the port boundary is that potential soil and groundwater impacts should be restricted within this zone.

4-4-1 Soil and Ground Water

The soil in the Duqm area is not suitable for agriculture, as the area is mainly comprised of Quaternary sub-recent to recent sabkha deposits, meaning that it is likely to be too saline for commercial crops.

Analysis of the soils, especially at tidal inlets, indicates that soils are generally sandy silts with marine clay content of less than 5%. The beach area consists of sand and recent coastal dunes.

The groundwater in the area is known to be saline, with a salinity ranging between 140-330 ppt. The water table varies from 0.5-1.0 m below the surface and is affected by high tide and heavy rainfall²⁸.

4-4-2 Geology

The study area includes the entire port area (as illustrated in Figure 4-4). The coastal area to the north of the port is considered through the coastal geomorphology study.

The headland of Ras Duqm marks the northern limit of the Shuwayr geological formation. This formation comprises bioclastic reefal limestone with corals, debris flow deposits, dolomitic laminated and green to reddish clay²⁹. These cliffs (Figure 4-5 and Figure 4-6) extend southwards along the coast for approximately 75km (Posford et al., 2004). The material is easily eroded and the cliffs are marked by periodic failure of large sections. It is likely that this process provides a sediment

²⁸ **Oman International Shrimp Company (OISC). 2001:** Environmental Impact Assessment and Environmental Management Plan, Duqm Farm. Private report submitted as part of license application to MRMEWR, Oman.

²⁹ **Schillak, L. Rappenhoner, D., Kessler, H. and Meinig, H. (Date unknown):** Study for Wildlife and Conservation Areas – Master Plan for the Coastal Areas of the Barr Al Hikman and Masirah Island.

source to the area. Offshore of this area, the average sea bed gradient was calculated based on the position of the 10 m contour. This provides a gradient of 1:80.

Approximately 2 km to the northwest of Ras Duqm is a smaller headland, which is linked to Ras Duqm by a shallow sandy bay. North of this headland is the shallow bay of Ghubbat Quwayrat, approximately 12 km long, and backed by extensive sabkha³⁰.

The beach within the crenulate bay comprises a mix of silts and fine sands. An average gradient of 1:250 is calculated based on the location of the 5 mCD contour at 1,200 m from the shoreline. Prior to the construction of the port, the southern end of the bay comprises a flat foreshore interspersed with a small sand bar and spits, which extended from Ras Duqm into the bay.

The Duqm formation is approximately 75 m thick and is described as interbedded green marl, thin bedded laminated gypsum and calcarenite limestone, grey palistrine limestone and conglomerate at base. The formation comprises, at its lower 20-25 m layers, limestone, marls and conglomerates and underlies the majority of the site, including beneath the Shuwayr formation described previously. The conglomerates make up approximately 5 m of this sequence and can contain pebbles and cobbles up to 0.2 m in diameter. 20-60 m of marls (calcareous mudstones) are lain onto this, and are also interspersed with beds of gypsum. This larger layer (approximately 75 m deep) progresses from silty marl at the base to more clay dominated marl towards the top. In addition, as part of the spatial planning for the Duqm region, an area immediately adjacent to the port of approximately 3 km² has been reserved as an area for geological importance. In addition to its geological importance, this area, known as the Rock Garden, is hoped to provide geo-tourism opportunities (Figure 4-6).

³⁰ **Royal Haskoning, 2007:** New Port and Dry Dock Complex, Duqm. Environmental Statement. Final Report 3H6503.

4-5 Hydrology And Surface Water Drainage

The EIA study area for hydrology and surface water drainage includes the entire area within the port boundary (as illustrated in Figure 4-7). The reason for focusing only within the port boundary is that potential impacts to this parameter should be restricted within this zone.

There are seven surface water catchment areas around the Port of Duqm, as illustrated in (Figure 4-8) below. This figure also shows the location of the wadi's that will be re-routed as a result of the Port of Duqm.

The Steering Committee of Town Planning (SCTP) commissioned a hydrology and surface water drainage modeling report to understand this parameter in the Duqm area for the Duqm Masterplan.

▪ Storm Water Drainage

The design of the storm drainage network for Duqm Project was originally based on the (1 in 50 year floods (in accordance with Sultanate of Oman Highway Design Standards) but is now been designed to provide safety against 1 in 500 year flood events, as explained in the Duqm Port Drainage Design Report (RHKA, 2013) ³¹.

The proposed network will collect the storm water through runoff from all around the Port and will discharge into the sea. Originally, the system had two outfalls, one located near the boundaries of the proposed 900 bent Wadi (last reach of Wadi Saay) and the second located near Ras Ad' Duqm and discharged through the wave wall of the main breakwater in the sea. With the most recent revisions, it has been proposed to have a discharge to the west the Lee Breakwater and the other drainage into the Port Basin. The system discharges at the commercial quay and will be designed to flow into conventional oil water separators to minimize the risk of oil entering the sea.

³¹ RHKA, Royal Haskoning and Khatib and Alami Joint Venture (Port Duqm Design Engineers), (2012): Duqm Port – Road Works and Infrastructure. Drainage Design Report. Produced for the Ministry of Transport and Communications. Rev 1.

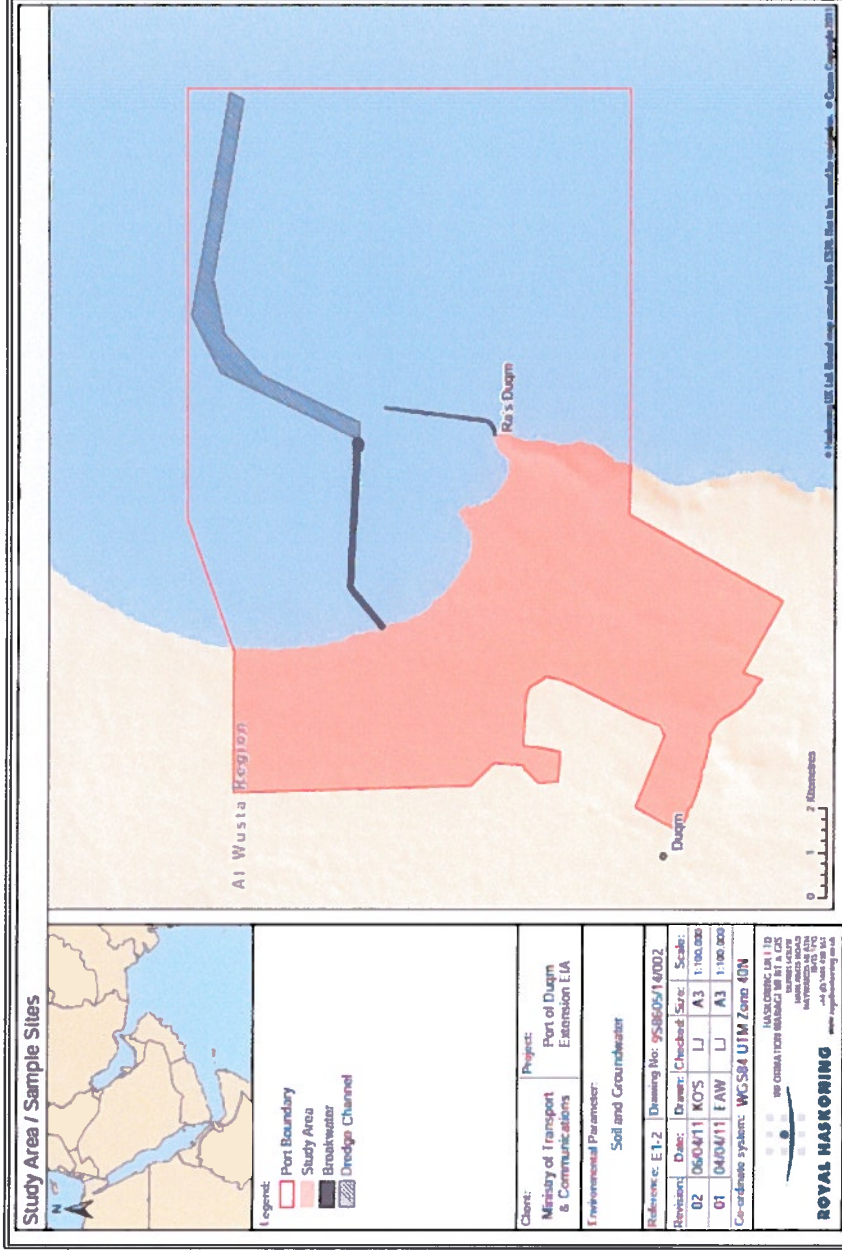


Figure (4. 3) : Environmental parameter (Soil and Groundwater)³²

³² Khatib \$ Alami and Partners, 2012: Port of Duqm Extension, Oman Environmental Scoping Report, Ministry of Transport and Communications, Sultanate of Oman 17 January 2012, Final Report - 9S8605.

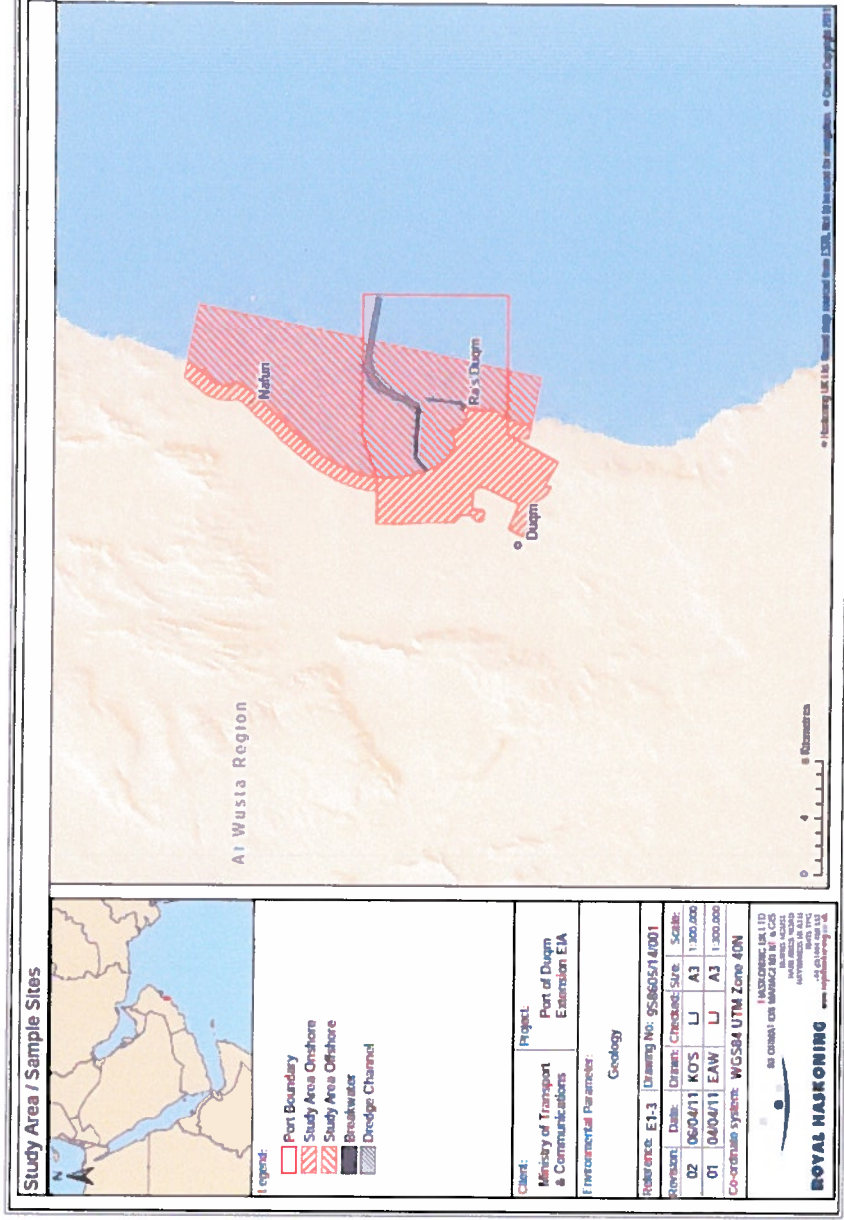


Figure (4. 4) : Environmental parameter (Geology) ³³

³³ **Khatib & Alami and Partners, 2012:** Port of Duqm Extension, Oman Environmental Scoping Report, Ministry of Transport and Communications, Sultanate of Oman 17 January 2012, Final Report - 9S8605.



Figure (4. 5) : Sand and Coastal Dunes in the Study Area (2007)³⁴



Figure (4. 6) : The Rock Garden, located immediately outside the port boundary³⁵

³⁴ Khatib \$ Alami and Partners, 2012: Port of Duqm Extension, Oman Environmental Scoping Report, Ministry of Transport and Communications, Sultanate of Oman 17 January 2012, Final Report - 9S8605.

³⁵ WHS (2009). World Habitat Society (WHS) Journal, Vol. 3, No. 1 Special Edition February 20

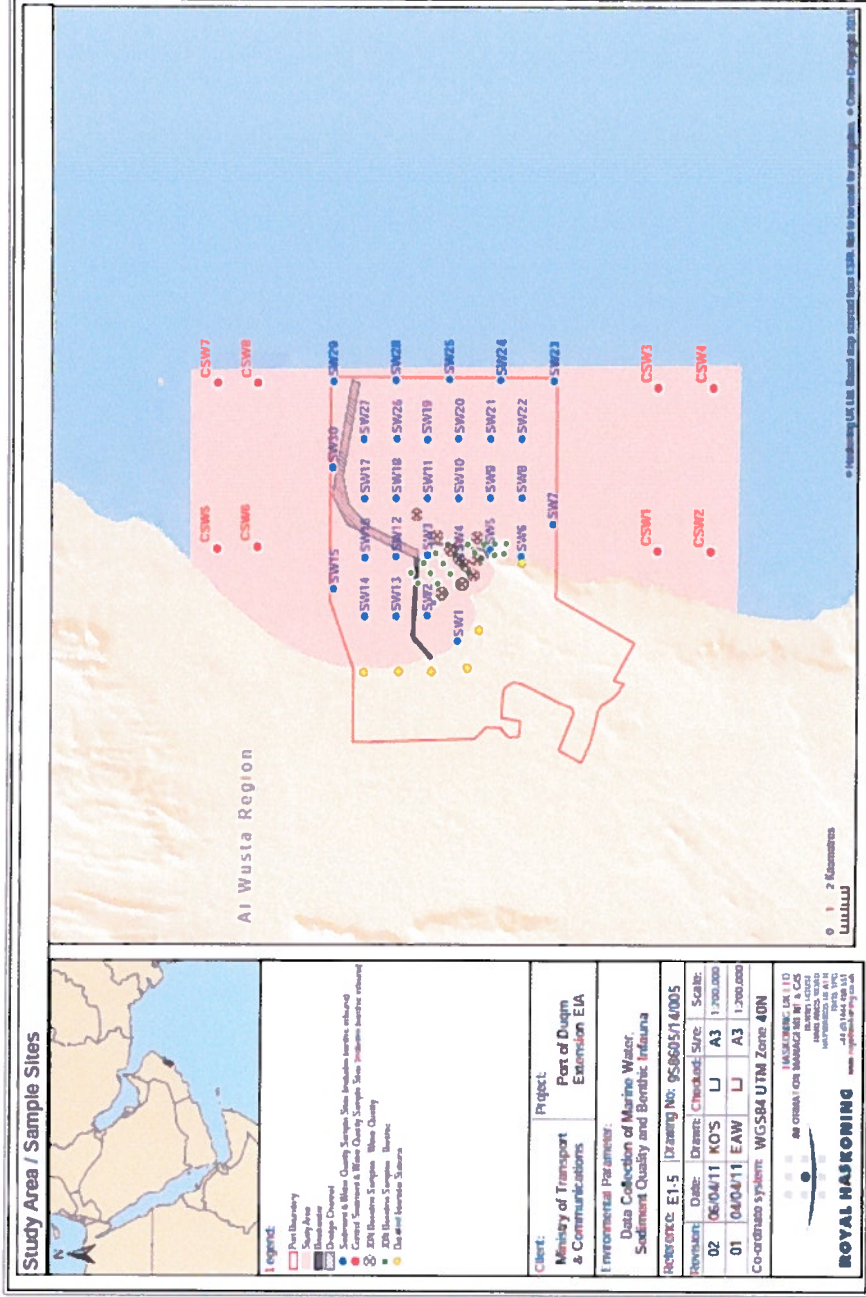


Figure (4. 7) : Data Collection of Marine Water, Sediment Quality and Benthic Infauna³⁶

³⁶ Khatib \$ Alami and Partners, 2012: Port of Duqm Extension, Oman Environmental Scoping Report, Ministry of Transport and Communications, Sultanate of Oman 17 January 2012, Final Report - 9S8605.

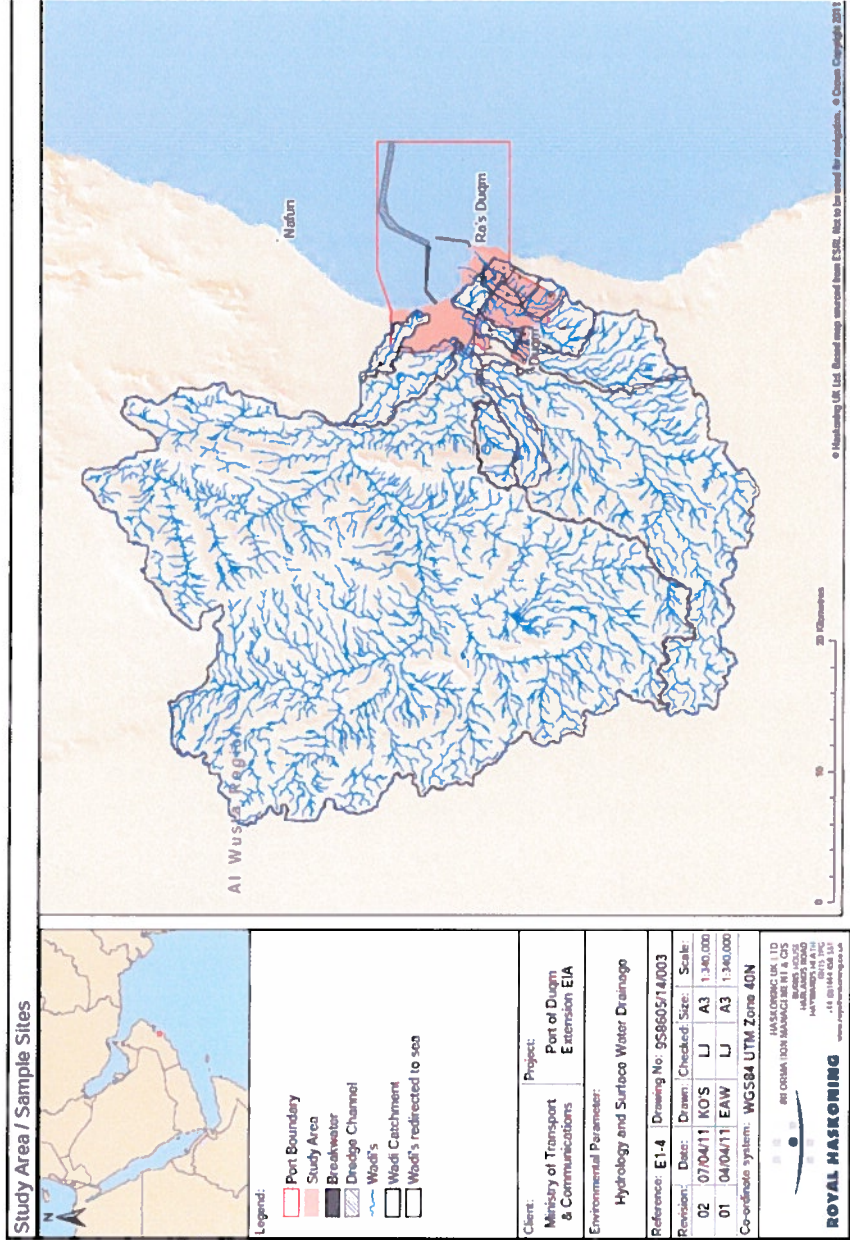


Figure (4. 8) : Environmental Parameter (Hydrology and Surface Water Drainage) ³⁷

³⁷ Khatib \$ Alami and Partners, 2012: Port of Duqm Extension, Oman Environmental Scoping Report, Ministry of Transport and Communications, Sultanate of Oman 17 January 2012, Final Report - 9S8605.

4-6 Marine And Coastal Ecology

The study area covers the entire port area, but also strategic locations outside the port boundary as illustrated in Figures (4-9 and 4-10). In addition, control sites outside the boundary are required to provide data which can be used for comparison during any longer term monitoring.

Environmental baseline surveys in and around the port and approach channel area were carried out by Jan De Nul Dredging Ltd. from 08/11/2007 to 06/12/2007 and in the borrow pit and disposal area from 20/09/2008 to 07/11/2008^(38, 39, 40, 41). The parameters measured, as well as a summary of the findings are provided in Table (4-8) and the sample locations illustrated in Figure (4-11).

During May to September, there is a coastal upwelling of deep, cold water (80 million m³)⁴² that results from the southwest monsoon. This is the dominant environmental influence on the marine life in the region and makes the shallow shelf offshore from Duqm a highly productive environment for all marine organisms and an internationally important habitat for whales and dolphins.

Upwelling is enough to drive marine fauna into shallow waters to take refuge. The Duqm area does not have any formal national or international designations for marine or coastal conservation.

³⁸ Marine Environmental Department Of Jan De Nul Group, 2008: Construction of A New Port At Duqm Construction of Maritime Works. Environmental Baseline Survey Report Jdn0926.

³⁹ Marine Environmental Department Of Jan De Nul Group, 2008: Construction of A New Port At Duqm Construction of Maritime Works. Environmental Baseline Survey Report Borrow Area Jdn0926.Per.81.45

⁴⁰ Marine Environmental Department Of Jan De Nul Group, 2008: Construction of A New Port At Duqm Construction of Maritime Works. Environmental Baseline Survey Report Disposal Area Jdn0926.Per.81.31

⁴¹ Oman Dry Dock Company,,: Oman Dry Dock Company Marine Baseline Survey

⁴² Al Jufaili, S. A. (2001). Oman Marine Environment.

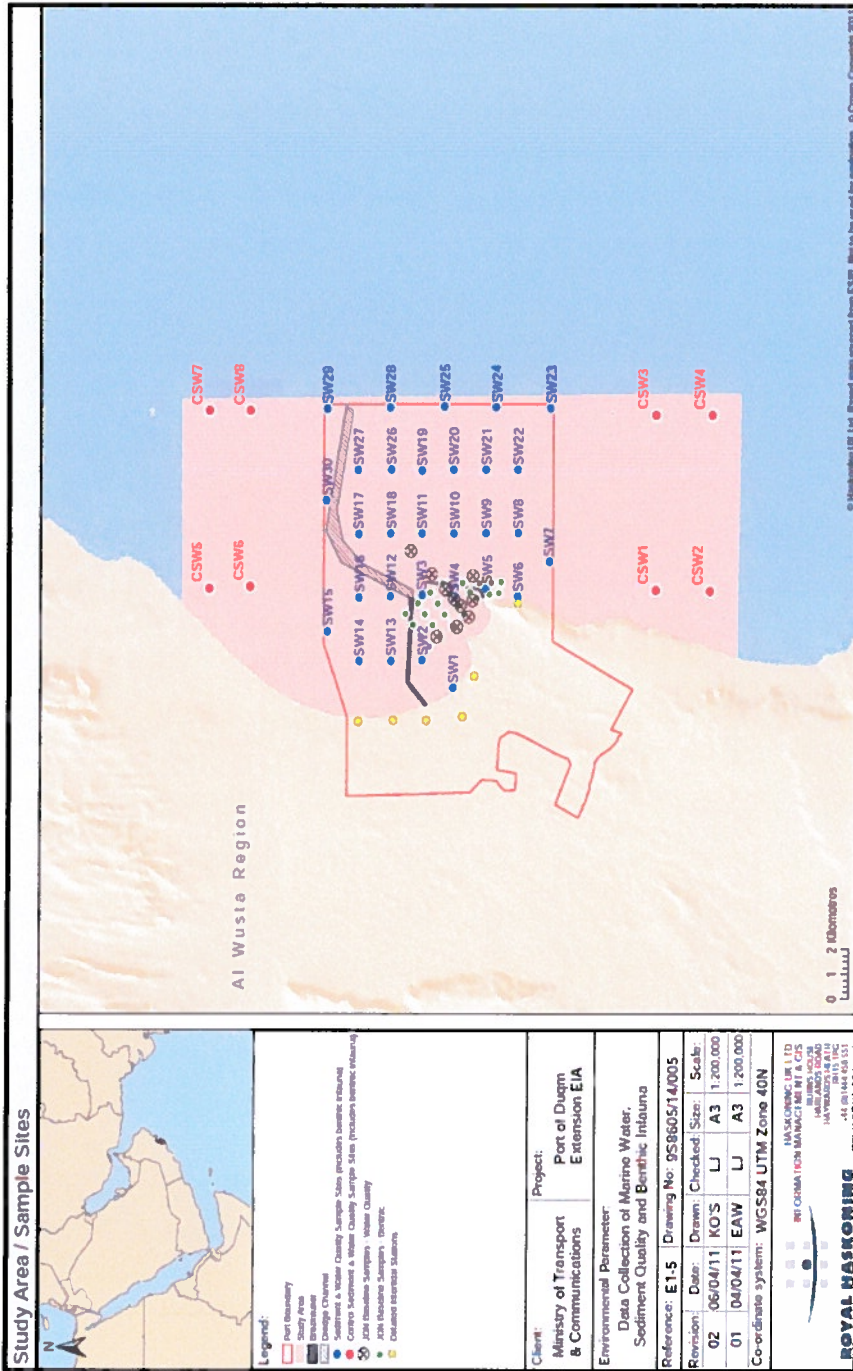


Figure (4. 9) : Data Collection of Marine Water, Sediment Quality and Benthic Infauna⁴³

⁴³ Khatib \$ Alami and Partners, 2012: Port of Duqm Extension, Oman Environmental Scoping Report, Ministry of Transport and Communications, Sultanate of Oman 17 January 2012, Final Report - 9S8605.

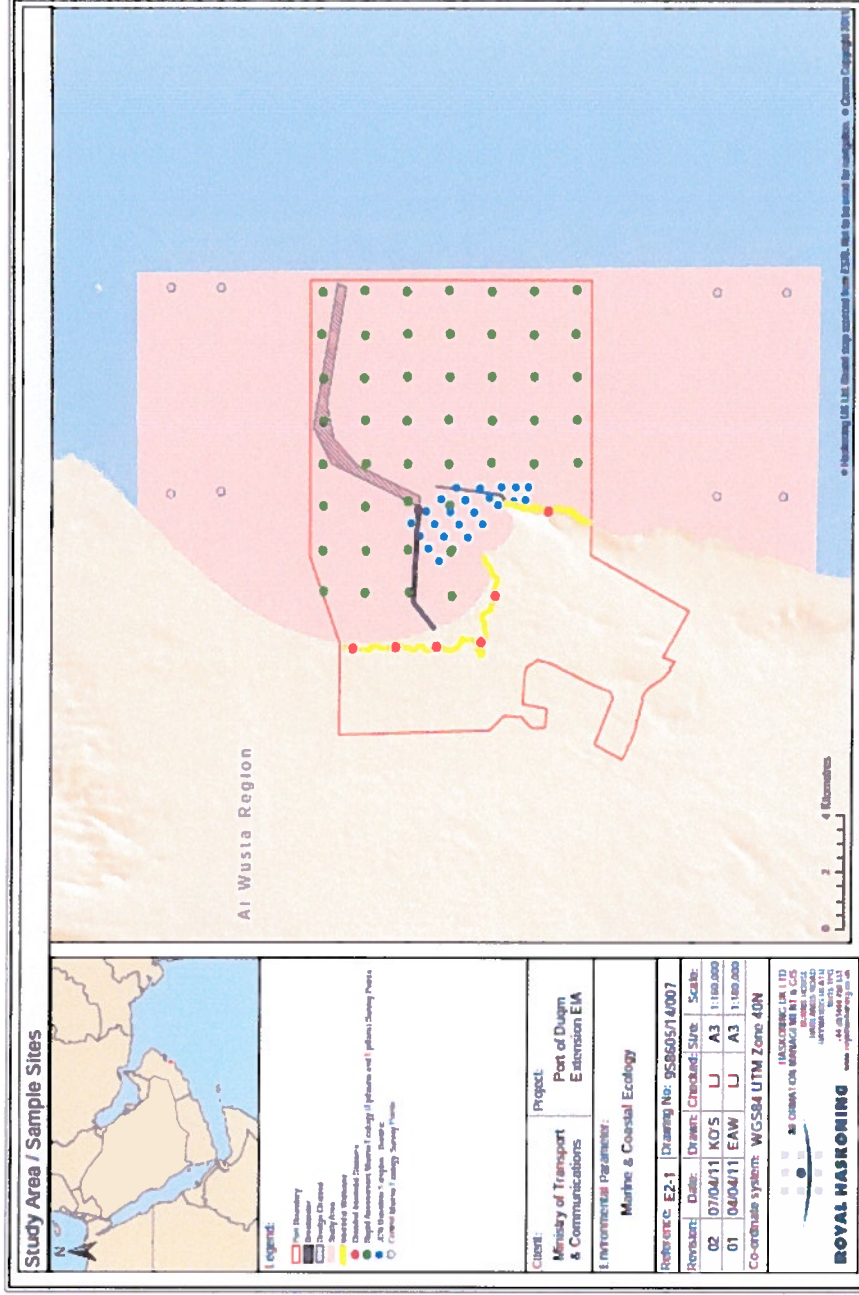


Figure (4. 10) : Marine & Coastal Ecology (Sample locations)⁴⁴

⁴⁴ Khatib & Alami and Partners, 2012: Port of Duqm Extension, Oman Environmental Scoping Report, Ministry of Transport and Communications, Sultanate of Oman 17 January 2012, Final Report - 9S8605.

Table (4. 8) : Physical parameters measured for the Jan de Nul Baseline Environment Surveys (2007-2008)

In Situ Parameters Measured	Laboratory Analysis	Summary of Results
In-situ Baseline Water Quality Surveys & Water Quality Laboratory Tests		
<ul style="list-style-type: none"> • The following parameters were measured using a YSI multi parameter probe: • Temperature • pH • Conductivity • Salinity • Turbidity • Port. 30 in situ sites (measured daily for '1 month) & 10 sites for lab analysis • Borrow area 14 sites 	<ul style="list-style-type: none"> • Total suspended solids (TSS); • Nutrients (K,P, N); • Metals (As, Cd, Cu, Hg, Ni, Zn, Cr, Pb); • COO & BOD: • Coliforms & streptococci; • Total petroleum hydrocarbons; and • Tributyl tin (TBT) 	<p><i>Port</i></p> <ul style="list-style-type: none"> • Tile water quality at the port survey site did not indicate and significant pollution. • There were high levels of nutrients, thought to be linked to the seasonal upwelling. <p><i>Borrow area:</i></p> <ul style="list-style-type: none"> • Water quality was clean, with elevated levels of nitrate (NO₃) and phosphorus (P), above that within tile port, and presumably linked to the deepwater upwelling in the area; <p><i>Disposal site (poor to disposal):</i></p> <ul style="list-style-type: none"> • Water quality was clean, with elevated levels of nitrate (NO₃) and phosphorus (P); • Though unusually high levels of coliforms were recorded.
Sediment Quality		

In Situ Parameters Measured	Laboratory Analysis	Summary of Results
<ul style="list-style-type: none"> • Sediment grab sampling for laboratory analysis using a van veen grab. • Port. 25 sites • Borrow Pit '14 sites 	<ul style="list-style-type: none"> • Metals (As, Cd, Cu, Hg, Ni, Zn, cr, Pb); • Sulfate (total and water soluble); Sulfide; • Total organic material; • Total Petroleum Hydrocarbons; and • Particle size. 	<p>All surveys identified sediments to have high levels of organic matter and various metals (e.q. chromium, zinc and nickel sulphides), which are expected to be naturally occurring.</p> <p><i>Port.</i></p> <ul style="list-style-type: none"> • Approximately 50% sand and 50% fines (silts). • Higher levels of Diesel Range Hydrocarbons (ORH) in the sediments (than at the disposal site, possibly due to oil spillages { leakages from the fishing industry. <p><i>Borrow area:</i></p> <ul style="list-style-type: none"> • Minor pollution, with very low level of ORH <p><i>Disposal site (prior to disposal).</i></p> <ul style="list-style-type: none"> • Approximately 85% sandy particles and 15 % fines. • Minor pollution, with very low level of ORH
Videography of the seabed (disposal area only)		
<ul style="list-style-type: none"> • Sub-surface video of the disposal site • 2 videos (30 minutes and 6 minutes) 		

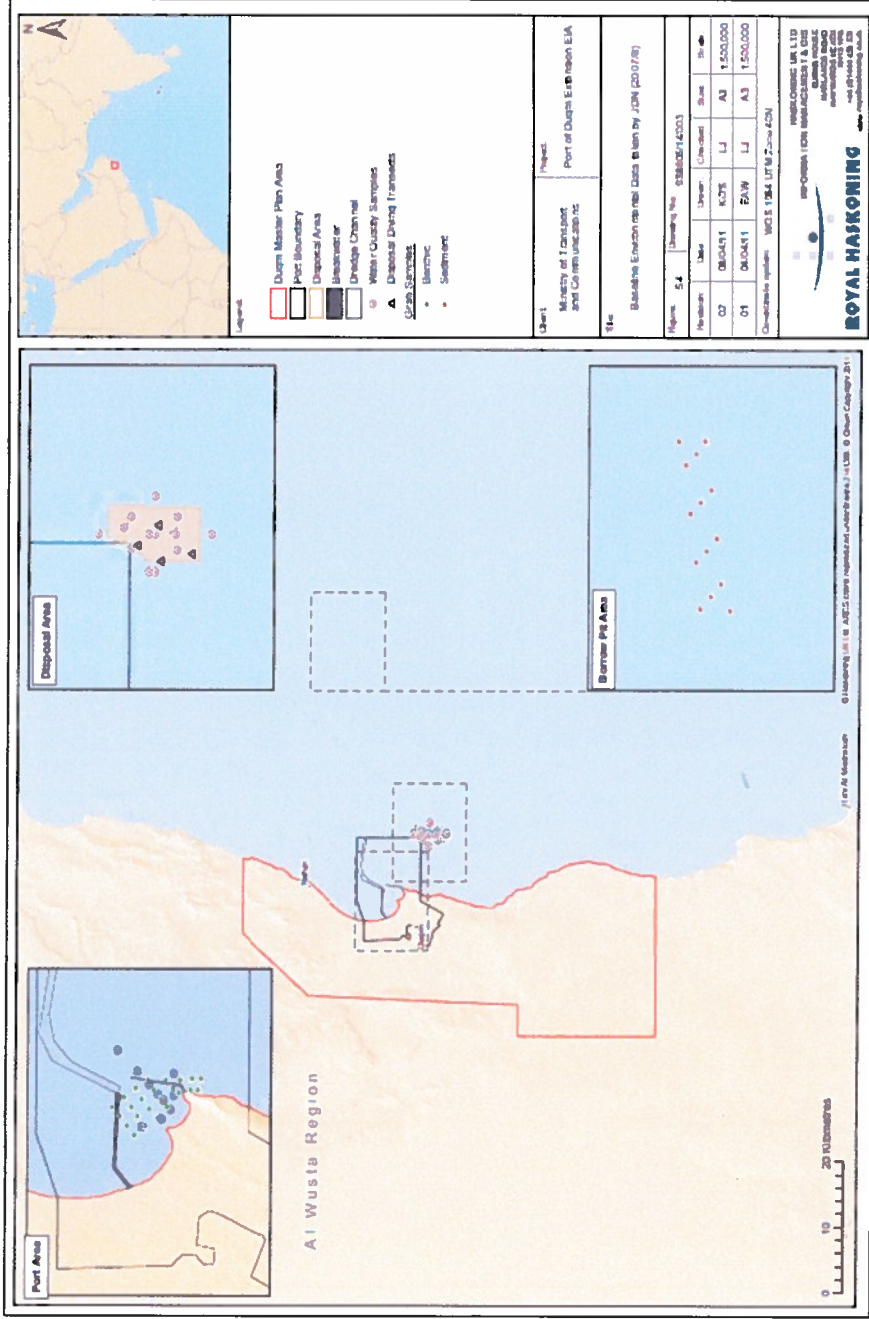


Figure (4. 11) : Baseline environmental data (Sample locations)⁴⁵

⁴⁵ Khatib \$ Alami and Partners, 2012: Port of Duqm Extension, Oman Environmental Scoping Report, Ministry of Transport and Communications, Sultanate of Oman 17 January 2012, Final Report - 9S8605.

Areas further to the north (approximately 200 km) are considered ecologically richer and more diverse due to the range of habitats including mangrove and coral reef. Nevertheless, Duqm has a number of important habitats and species, which are likely to be sensitive to disturbance and development and form part of the regional ecosystem.

As part of the Oman National Oil Spill Contingency Plan (NOSPC), the marine resources were mapped for the whole coastline of Oman. In addition, two sets of coastal zone vulnerability maps were produced on coastal geomorphology and coastal marine resources.

The description assigned to each coastal region indicates the level of vulnerability of the marine resource to oil spills. The bay at Duqm is designated as 'extremely vulnerable' likely due to its classification as an Important Bird Area by Birdlife International. The cliffs to the south of the bay are 'moderately vulnerable' due to the algal turfs on the rocky cliffs. Ghubbat Quwayrat to the north is 'slightly vulnerable'. The study area is understood to comprise the following intertidal and marine habitats:

- Intertidal (sandy beach, rocky shore, Khwars and tidal inlets); and
- Subtidal (sandy sediment, and rocky rubble / sandy habitats).

Environmental baseline surveys in and around the port and approach channel area were carried out by Jan De Nul Dredging Ltd. from 08/11/2007 to 06/12/2007 and in the borrow pit and disposal area from 20/09/2008 to 07/11/2008 ^(46, 47, 48, 49).

The parameters measured for benthic infauna, as well as a summary of the findings are provided in Table (4-9) and the sample locations illustrated in Figure (4-10).

⁴⁶ **Marine Environmental Department Of Jan De Nul Group, 2008:** Construction of A New Port At Duqm Construction of Maritime Works. Environmental Baseline Survey Report Jdn0926.

⁴⁷ **Marine Environmental Department Of Jan De Nul Group, 2008:** Construction of A New Port At Duqm Construction of Maritime Works. Environmental Baseline Survey Report Borrow Area Jdn0926.Per.81.45

⁴⁸ **Marine Environmental Department Of Jan De Nul Group, 2008:** Construction of A New Port At Duqm Construction of Maritime Works. Environmental Baseline Survey Report Disposal Area Jdn0926.Per.81.31

⁴⁹ **Oman Dry Dock Company, Oman Dry Dock Company Marine Baseline Survey**

In summary, the JDN baseline surveys found the species richness of the borrow area and disposal area to be less than the biodiversity in and around the dredging area (refer to Table 4-9). This could be explained by the offshore locations of the borrow area and disposal area.

Table: (4. 9) : Biological parameters measured for the Jan de Nul Baseline Environment Surveys (2007-2008)

In Situ Parameters Measured	Laboratory Analysis	Summary of Results
Benthos/Ecology Determination		
<ul style="list-style-type: none"> • Sediment grab sampling (using a Van Veen grab) and sieving for laboratory analysis • Port: 25 sites (3 replicates at each site) • Borrow area:14 sites (3 replicates at each) 	<ul style="list-style-type: none"> • Primer Univariate & Multivariate statistical analysis of results Ampeliscidae. 	<ul style="list-style-type: none"> • <i>Port</i>: 742 individuals belonging to 56 species, exhibiting a moderate level of invertebrate biomass diversity and abundance. Communities dominated by polychaete worms and crustaceans. • <i>Borrow area</i>: 893 individuals belonging to 16 species. Very low level of biomass, diversity and quality in comparison with the port.

4-7 Marine Mammals And Turtles

Defining the actual study area for highly mobile species with a vast area of habitat is problematic and becomes somewhat arbitrary. Also, the larger the study area, the more complex becomes due to the influence of multiple, synergistic and cumulative effects from different sources. We have therefore based our recommendations for the survey area around the port that is determined by the distance traveled by underwater noise, as well as ship strikes within the port area and approaches.

Cetaceans and turtles are distributed across nearshore and offshore habitats according to their needs for feeding, breeding, migration, and related behavior at different times of the year. Among the habitats that they use, some are more critical than others. For example, there may be specific areas which are essential for certain parts of the breeding cycle, or for certain food resources.

These habitats are known as critical habitats. The area around Duqm is considered critical feeding and breeding habitat for certain cetacean and turtle species as well as being on a migratory pathway.

▪ **Cetaceans**

Marine mammals in Oman include over 19 species of whales and dolphins, the recorded occurrence of which is stored on the Oman Cetacean Database (OMCD), held at the Oman Natural History Museum ⁵⁰ and the Environmental Society of Oman. These include three baleen whales (mysticetes), which prey largely on small fishes and crustaceans in relatively shallow or surface waters. The remainder of the species are toothed whales and dolphins (odontocetes), which are top predators feeding in both deep and shallow waters on a wide range of prey. The majority of species are known to be breeding residents of Oman.

The majority of species known to occur in Oman are either recorded or considered highly likely to occur within 100 kms of Duqm, as this area is known to be very important for cetaceans, with a highly varied habitat and productive waters.

of the larger whales, the Bryde's whale and humpback whales are the most frequently recorded in the area both of which are known to feed and breed here. The same is probably true of the sperm whale. Little is known about the rare blue whales, but there appears to be some seasonality to the sighting records, which suggests a migratory route through the area in winter months.

Figure (4.12) presents sightings data for cetaceans in off the coast of north Oman. This figure shows that most commonly recorded nearshore species in the Duqm area are humpback whales and species of the Delphinidae family (i.e. dolphins, false killer whales, pilot whales, killer whales, etc). The majority of humpback sightings have been seen in water depths of less than 50 m and their coastal habitat is heavily

⁵⁰ **Baldwin, R.M. (1999):** The ecology and conservation status of sea turtles of Oman. In: The Natural History of Oman: A Festschrift for Michael Gallagher. M. Fisher, S.A. Gazanfar and J.A. Spalton (eds), pp89-98. Backhuys publishers, Leiden.

used by local fishermen⁵¹, which results in the accidental entanglement of whales in fishing nets.

Of particular note, the seas around Duqm are known to be important for humpback whales. In Oman, humpback whales have now been confirmed to be a nonmigratory population within the Arabian Sea region, leading the International Whaling Commission (IWC) to formally nominate this population as the Arabian Sea humpback whale population.

The population is genetically and geographically isolated and known to be in decline, with fewer than 100 individuals remaining⁵².

It is listed as Endangered by IUCN⁵³ and is known to be one of the rarest baleen whale populations in the world.

This population is becoming of very high international importance and a high priority for the international research and conservation authorities, such as the International Whaling Commission (IWC)^(54; 55), and it is therefore essential that development considers potential impacts carefully and thoroughly.

Table (4-10) presents the results of surveys for the area adjacent to Duqm. More recent survey work by the Environment Society of Oman (ESO, unpublished data 2010) suggests that construction activities at Duqwm may already be causing an impact to cetaceans, particularly as a result of underwater noise.

Table (4-11) presents data for dead and stranded cetaceans in the Duqm area. This information provides useful comparison data for operational phases of the IDZ and

⁵¹ Baldwin, R. M. (2003): Whales and Dolphins of Arabia. Mazoon Printing Press, Muscat, Sultanate of Oman. Pp 111

⁵² Minton, G. (2004): Ecology and Conservation of Cetaceans in Oman, with particular reference to humpback whales (*Megaptera novaeangliae*). University of London, University Marine Biological Station, Millport.

⁵³ Minton, G., Collins, T.J.Q., Findlay, K.P., Ersts, P.J., Rosenbaum, H.C., Berggren, P. & Baldwin, R.M. (2008): Seasonal distribution, abundance, habitat use and population identity of humpback whales in Oman. Journal of Cetacean Research and Management Special Issue on Southern Hemisphere Humpback Whales.

⁵⁴ IWC (2010): Scientific Committee Report, document IWC/62/Rep 1. 91pp plus annexes.

⁵⁵ Baldwin, R; Collins, T; Minton, G; Findlay, K; Corkeron, P; Willson, A, Van Bresseem, M. (2010): Arabian Sea Humpback Whales: Canaries For the Northern Indian Ocean? Document SC/62/SH20 presented at the IWC Scientific Committee meeting, Agadir, Morocco, June 2010. 5pp.

other components of the overall master plan development. In addition to the ESO data, recent sightings data has been received from HMS Enterprise, a Royal Naval multi-role survey vessel that has been undertaking geophysical surveys off the coast of Duqm. Photographs were taken of two humpback whales on the 26th May 2010 within a few kilometers of Duqm Port area.

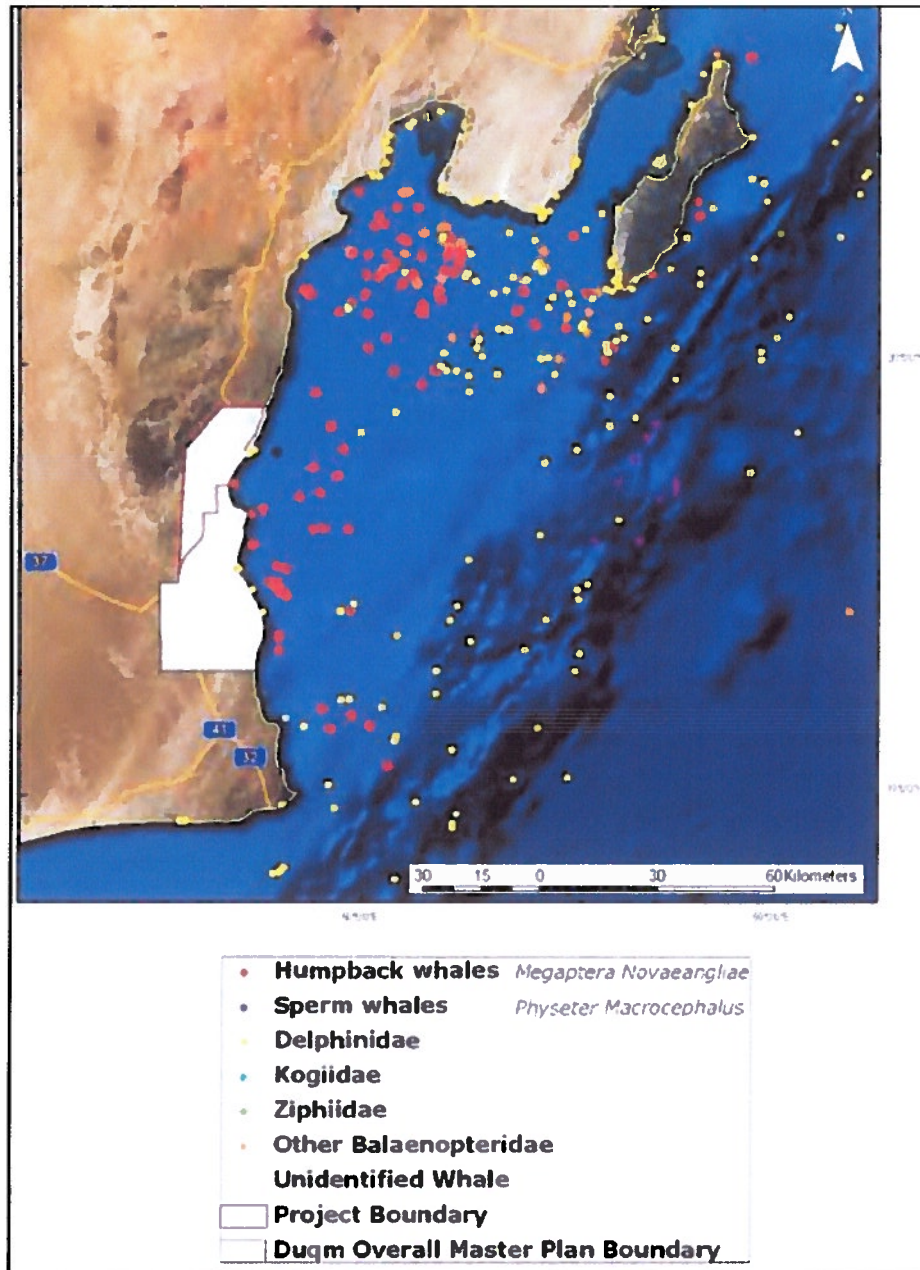


Figure (4. 12) : Live sightings and strandings in proximity to Duqm ⁵⁶

⁵⁶ Environment Society of Oman (2010): Conserving Masirah Island's Turtles. Unpublished report



Table (4. 10) : Live Sightings of Cetaceans near Duqm

Scientific Name	Common Name	Site Details	Best Estimate Number	Sighting Date
<i>Sousa chinensis</i>	Humpback dolphin	N of Duqm	20	24-11-02
<i>Megapteranovaeangliae</i>	Humpback whale	Offshore	3	02-11-02
<i>Megapteranovaeangliae</i>	Humpback whale	Offshore	1	01-11-02
<i>Megapteranovaeangliae</i>	Humpback whale	Offshore	2	01-11-02
<i>Megapteranovaeangliae</i>	Humpback whale	Offshore	1	01-11-02
<i>Megapteranovaeangliae</i>	Humpback whale	Offshore	2	31-10-02
<i>Tursiopsaduncus</i>	Bottlenose dolphin	Offshore	4	31-10-02
<i>Megapteranovaeangliae</i>	Humpback whale	Offshore	1	31-10-01
<i>Tursiopsaduncus</i>	Bottlenose dolphin	Offshore	25	31-10-02
<i>Tursiopsaduncus</i>	Bottlenose dolphin	Offshore	1	31-10-02
<i>Sousa chinensis</i>	Humpback dolphin	N of Duqm	15	22-10-02
Unknown	Unknown whale	20kmSEofDuqm	1	03-11-97
Unknown	Unknown dolphin	75kmESEofDuqm	1	02-11-97
<i>Delphinus tropic alis</i>	Common dolphin	110kmEofDuqm	380	01-06-95

produced by ESO under US Fish and Wildlife Service Cooperative Agreement No. 401818-J520, submitted to the Ministry of Environment and Climate Affairs. 66pp.

Table (4-11) Cont.: Live Sightings of Cetaceans near Duqm

Scientific Name	Common Name	Site Details	Best Estimate Number	Sighting Date
Megaptera novaeangliae	Humpback whale	2kmNofDuqm	1	29-02-00
Megaptera novaeangliae	Humpback whale	Duqm	1	10-06-01
Megaptera novaeangliae	Humpback whale	Duqm	1	12-06-01
Megaptera novaeangliae	Humpback whale	Duqm	2	12-06-02
Megaptera novaeangliae	Humpback whale	Duqm	1	13-06-02
Megaptera novaeangliae	Humpback whale	Duqm	2	13-06-01
Megaptera novaeangliae	Humpback whale	S of Duqm	3	26-10-01
Megaptera novaeangliae	Humpback whale	S of Duqm	1	26-10-01
Megaptera novaeangliae	Humpback whale	E of Duqm	1	27-10-01

Table (4. 12) : OWDRG data for dead stranded cetaceans in the Duqm area

Scientific Name	Common Name	Site Details	Adult] Calf Juvenile	Date Found
Grampus griseus	Risso's dolphin	S of Duqm	Calf	26-09-01
Sousa chinensis	Humpback dolphin	S of Duqm	Juvenile	26-09-01
Tursiops sp.	Bottlenose dolphin	S of Duqm	Unknown	26-09-01
Tursiops sp.	Bottlenose dolphin	S of Duqm	Unknown	12-06-01
Tursiops sp.	Bottlenose dolphin	S of Duqm	Subadult	12-06-01
Tursiops sp.	Bottlenose dolphin	S of Duqm	Unknown	12-06-01
Tursiops sp.	Bottlenose dolphin	S of Duqm	Unknown	12-06-01
Balaenoptera brydei	Bryde's whale	S of Duqm	Unknown	12-06-01
Unknown	Unknown Baleen whale	S of Duqm	Unknown	26-09-01
Unknown	Unknown whale	S of Duqm	Unknown	26-06-01
Balaenoptera brydei	Bryde's whale	Offshore Duqm	Juvenile	31-10-02
Pseudorca crassidens	False killer whale	0.5km N of little headland	Subadult	23-11-02

▪ **Turtles** ⁵⁷

Global turtle populations have reduced drastically since population studies began several decades ago. Of the seven remaining sea turtle species, five occur in the Al Wusta region of Oman - green turtles, loggerheads, hawksbills, olive ridleys and leatherbacks.

The first three are the most commonly occurring. The IUCN (the World Conservation Union) Red List reflects the fact that sea turtles are in danger of

⁵⁷ Khatib \$ Alami and Partners, (2012): Port of Duqm Extension, Oman Environmental Scoping Report, Ministry of Transport and Communications, Sultanate of Oman 17 January 2012, Final Report - 9S8605.

extinction and categorizes all species as either Endangered or Critically Endangered, with the exception of the olive ridley turtle which is classified as Vulnerable.

All turtle species are protected by both national legislation in Oman and through international agreements to which Oman is signatory, such as the Convention on the Conservation of Migratory Species of Wild Animals (also known as CMS or Bonn Convention) and the Memorandum of Understanding on the Conservation and Management of Marine Turtles and their Habitats of the Indian Ocean and South-East Asia region (IOSEA MOU) established in 2001. The current usage of the area adjacent to Duqm by marine turtles is not known in great detail. However, it has been established by several studies that nearshore areas adjacent to Duqm are part of the main feeding grounds for green and loggerhead turtles ^(58; 59; and 60), as illustrated in Figure (4-13).

Feeding also occurs sporadically along much of the length of the Al Wusta coast (Baldwin and Kiyumi, 1996).

Green turtles feed on herbivorous diet of sea grasses and seaweeds. Figure (4-13) shows the main feeding ground which follows the 10 m depth contour. The area may also be a mating ground. Eight nesting sites within the Duqm area were also observed in Salm et al.'s studies (1993) ⁶¹ as presented in Table (4-12). However, it must be noted that the data are from 20 years ago and are in need of updating.

Turtles have also been known to nest at the site (prior to construction), although recent data on this subject are lacking. Records from the late 1980s (Salm et al., 1993) are presented in Table (4-12) below. It is important that these sites are resurveyed to establish the current distribution and abundance of nesting.

⁵⁸ Ross, J. P. (1979): Sea Turtles in the Sultanate of Oman. Manuscript Report of IUCN/WWF Project 1320.

⁵⁹ Salm, R.V., Jensen, R.A.C. & Papastavrou, V.A. (1993): Marine Fauna of Oman: Cetaceans, Turtles, Seabirds and Shallow Water Corals. IUCN, Gland, Switzerland. 66 pp.

⁶⁰ Baldwin, R.M. & Al-Kiyumi, A. (1996): Marine Turtles of the Sultanate of Oman. National Report, Northern Indian Ocean, Sea Turtle Workshop and Strategic Planning Session, January 13-18, 1996. Unpublished Report.

⁶¹ Salm, R.V., Jensen, R.A.C. & Papastavrou, V.A. (1993): Marine Fauna of Oman: Cetaceans, Turtles, Seabirds and Shallow Water Corals. IUCN, Gland, Switzerland. 66 pp.

Marine turtle satellite tracking data from the period 2006 to 2008 (MECA and ESO, unpublished data) has shown migration by hawksbill, green and loggerhead turtles along the coast of Oman, including past nearshore areas around Duqm.

Figure (4-14) presents the migratory routes of loggerhead turtles tracked via satellite studies at Masirah Island. Recently, the Environment Society of Oman, in collaboration with MECA and a team of international scientists funded by the US government, launched a research and conservation programme on Oman's turtles, which includes a focus on loggerhead turtles at Masirah and migratory routes to and from the island ⁶². This research has been on-going since 2007 and has confirmed the importance of Masirah and surrounding waters all the way south into Yemen to loggerhead turtles. The results suggest that Masirah remains one of only two similarly-sized nesting populations in the world (the other being in Florida, USA).

The most important site for turtles in the area is Masirah Island. Four sea turtle species are known to nest on the Island, which is due northeast approximately 111 km from Duqm.

⁶² **Environment Society of Oman (2010):** Conserving Masirah Island's Turtles. Unpublished report produced by ESO under US Fish and Wildlife Service Cooperative Agreement No. 401818-J520, submitted to the Ministry of Environment and Climate Affairs. 66pp.



Figure (4. 13) : Main nesting beaches and feeding grounds for turtles⁶³

⁶³ Salm, R.V. (1991): Turtles in Oman. Status, Threats and Management Options. Manuscript report of IUCN Coastal Zone Management Project CZMP4:F11. 32pp.

Table (4. 13) : Location of Known Sea Turtle Nesting Sites positions shown

Site Name	Map Coordinates*	No. Nests
Ra s Sidarah N	EH801013 - 805000	50
Ra s Sidarah S	EG807982	25
Ra s Sidarah S 1	EG798963	25
Surayr S	EG752873	10
Duqm	EG732747	10
Duqm S	EG746696	50
Duqrn S1	EG733620	20
Shuway'ir N	EG733620	5

Coordinates from maps of the National Survey Authority Series K6611. Source: Salm et al. (1993).

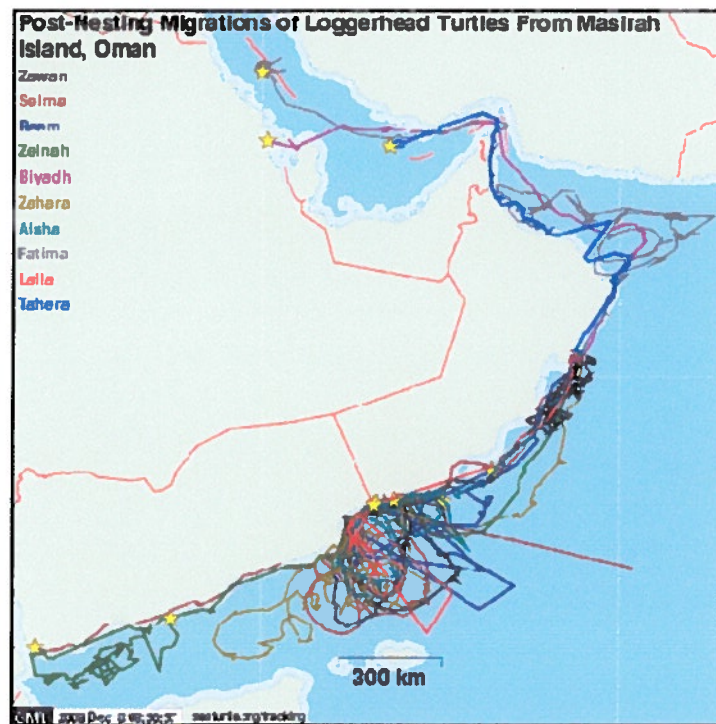


Figure (4. 14) : Migratory routes of loggerhead turtles tracked via satellite studies at Masirah Island (Source: MECA and ESO unpublished data) ⁶⁴

⁶⁴ Khatib \$ Alami and Partners, 2012: Port of Duqm Extension, Oman Environmental Scoping Report, Ministry of Transport and Communications, Sultanate of Oman 17 January 2012, Final Report - 9S8605

Extensive studies, dating back to 1977 by Dr. Perran Ross, have been undertaken on turtle populations on Masirah, notably the sea turtle survey for the WWF and IUCN. This research revealed that Masirah is of global importance and significance to loggerhead populations⁶⁵. This figure was estimated to be around 30,000-45,000 nesting females; the largest population known in the world^(66, 67). This gives Oman an unusually large global responsibility for the protection of this species. Both the populations in Florida and Oman have declined to 50% of their original number over the past decade or more^(68, 69) and a recent global status review of the loggerhead turtle⁷⁰ revealed that all populations of this species are predicted to continue to decline, and most are already showing this trend.

4-8 Terrestrial Ecology And Ornithology

The study area is entirely within the port. The bird surveys focus on the area where most sensitivity is expected, namely the mudflats and habitats within the wadi outflow area.

4-8-1 Terrestrial Ecology - Flora

The terrestrial flora in the area consists mainly of Halophytes (typically covering 15-30% of the substrate) and psammophytes⁷¹. Halophytes are plants that are adapted

⁶⁵ Salm, R.V., Jensen, R.A.C. & Papastavrou, V.A. (1993): Marine Fauna of Oman: Cetaceans, Turtles, Seabirds and Shallow Water Corals. IUCN, Gland, Switzerland. 66 pp.

⁶⁶ Ross, J. P. (1979): Sea Turtles in the Sultanate of Oman. Manuscript Report of IUCN/WWF Project 1320.

⁶⁷ Ross J. P., and M. A. Barwani. (1982): Review of turtles in the Arabian Area. Pages 373-383 in K. A. Bjorndal, editor. Biology and conservation of sea turtles. Smithsonian Institution Press, Washington, D.C.

⁶⁸ Witherington, B., P. Kubilis, B. Brost, and A. Meylan (2009): Decreasing annual nest counts in a globally important loggerhead sea turtle population. Ecological Applications 19(1):30-54.

⁶⁹ Environment Society of Oman (ESO), ESO unpublished data

⁷⁰ Conant, T.A., P.H. Dutton, T. Eguchi, S.P. Epperly, C.C. Fahy, M.H. Godfrey, S.L. MacPherson, E.E. Possardt, B.A. Schroeder, J.A. Seminoff, M.L. Snover, C.M. Upton, and B.E. Witherington (2009): Loggerhead sea turtle (*Caretta caretta*) 2009 status review under the U.S. Endangered Species Act. Report of the Loggerhead Biological Review Team to the National Marine Fisheries Service, August 2009. 222 pages.

⁷¹ Oman International Shrimp Company (OISC). (2001): Environmental Impact Assessment and Environmental Management Plan, Duqm Farm. Private report submitted as part of license application to MRMEWR, Oman.

to saline substrates and species found on the edge of the sabkha and coastline. Psammophytes get their nutrients from dew and calcium carbonate. They are found inland behind sand producing areas such as coastlines that are exposed to monsoon winds. The plants are effective sand binders. Species found on site include the evergreen succulent semi-shrub *Zygophyllum qatarense*. *Salsola rubescens* was also present, which is a common dwarf shrub that is found on rock outcrops.

4-8-2 Terrestrial Ecology - Fauna

The Arabian Oryx (Al Maha) Sanctuary, situated 60km inland from Duqm, is a declared protected area by Royal Decree No. 04/94 and is managed by the DIWAN of the Royal Court (Advisor for Conservation of the Environment) and the MRMEWR Nature Conservation Department. The Sanctuary is a UNESCO World Heritage Site and the official boundaries include the coastline along the Gulf of Masirah.

However, the effective border runs along the coast road. The Sanctuary is divided into three zones according to its sensitivity.

The area further towards the desert to the west is the most sensitive and the area closer to Duqm coast (i.e. the port) in the east is the least sensitive⁷². However, no physical barrier exists to protect the Oryx from outside disturbance.

Gazelles have also been observed in the area and are likely to be occasional visitors to the port, perhaps in the early morning or evening. The gazelles that can be found in the area include the Reem Gazelle and the Arabian Gazelle. The Nubian Ibex occurs in the hills of the coastal plain of Duqm and Arabian wolves may be present on beaches and coastal plains. The red fox was observed in the cliffs of Ras Duqm, and Ruppell's sand fox may be encountered in the area⁷³.

Hares may also be present in the rocky area, whilst other mammals found in the dune belt include the lesser three-toed jerboa. The diversity of fauna at Duqm is

⁷² Al Jufaili, S. A. (2001): Oman Marine Environment.

⁷³ Oman International Shrimp Company (OISC). (2001): Environmental Impact Assessment and Environmental Management Plan, Duqm Farm. Private report submitted as part of license application to MRMEWR, Oman.

valuable and likely to be sensitive to anthropogenic changes. Camels have also been observed grazing in the study area.

Arid ecosystems are inhabited by a large number of insects, most of them with nocturnal activities. No previous information exists regarding terrestrial invertebrates in and round Duqm; however, the site is likely to be dominated by beetles (Coleoptera) with the family Tenebrionidae that inhabit arid/desert ecosystems.

There are no existing survey reports available on the terrestrial ecology of the project area (i.e. within the port boundary). There are however, a number of recent survey reports that exist as a result of the Duqm Masterplan.

4-8-3 Ornithology

The port boundary contains a large area of intertidal sand and mudflats, both within the breakwaters (now only in the area to the north-west of the Government berth) and to the north adjacent to the planned liquid / equipment storage area. The area has historically been known to support hundreds of waterfowl prior to the port development (refer to Figure 4-15). Furthermore, to the north of the port, Ghubbat Quawayrat bay has been recognized as an Important Bird Area by BirdLife International in the Directory of Important Wetlands in the Middle East ⁷⁴. It is an important area for overwintering and passage waterfowl, in terms of it being a staging and feeding ground for them; shorebirds, gulls and terns also feature. Over 31,400 waterfowl of 32 species were recorded in January 1993. The bay is approximately 1,000ha in size and consists of lagoons, intertidal flats and mudflats, and rocky outcrops. Some of the most important historical bird recordings in the area include species of herons, flamingos, shorebirds, gulls and terns. Around 15,000 Socotra Cormorants and a maximum of 49 ospreys have been recorded at the area in winter.

⁷⁴ Scott, D. (1995): A Directory of Wetlands in the Middle East. IUCN. ISBN 2831702704



Figure (4. 15) : Mixed flock of white-eyed or Sooty gulls and Tern species (probably lesser crested), at Duqm⁷⁵

The majority of the overwintering and passage birds pass through Duqm between the end of September and mid-May although exact timings are species dependent. The Omani coastline acts as a bridge between Asia and Africa. Birds tend to avoid flying over the open sea or inland due to limited food sources and therefore move along the coastlines ⁷⁶.

Even following the construction of the marine works of the Port of Duqm, a variety of bird species have been observed both within the port amongst the construction works (e.g. reclamation works and dredging). These mostly consist of gulls, though waders are still observed on the intertidal flats, including flamingos (as observed in Figure 4-16).

⁷⁵ **Khatib \$ Alami and Partners, 2012:** Port of Duqm Extension, Oman Environmental Scoping Report, Ministry of Transport and Communications, Sultanate of Oman 17 January 2012, Final Report - 9S8605.

⁷⁶ **Royal Haskoning (2007):** New Port and Dry Dock Complex, Duqm. Environmental Statement. Final Report 3H6503.



Figure (4. 16) : Birds using the mudflats within the port ⁷⁷

4-9 Fisheries

There are no fishermen actually living within the boundary of the Port of Duqm. However, there is potential for impacts to occur to those living in the Duqm settlements that use the area for artisanal and commercial offshore fishing. The study area is illustrated in Figure (4-17).

4-9-1 Fish

The most important commercial fish in Oman include kingfish, tunas, mackerel, scad, jacks, barracudas and sardine. Commercially important demersal fish (those that live on or near the bottom) include croakers, Sciaenidae, snappers, and emperors. Large numbers of stingray have been found immediately offshore from

⁷⁷ Khatib & Alami and Partners, 2012: Port of Duqm Extension, Oman Environmental Scoping Report, Ministry of Transport and Communications, Sultanate of Oman 17 January 2012, Final Report - 9S8605.

Duqm beach. Molluscs have been recorded in the past at tidal inlets. The tidal channels are also home to rays and juvenile fish such as mullet ⁷⁸.

4-9-2 Fisheries

The main economic activity in the Duqm area is fishing. Fishing activities by local fishermen are carried out for eight months of the year (October to May) and is abandoned during the SW summer Monsoon (June to September). There are two types of fisheries offshore of Duqm: the artisanal fishing and the commercial offshore fishing. The artisanal fishermen mainly fish the shallower areas using long lines or seine nets. The nearshore areas are considered productive fisheries largely as a result of the nutrient upwelling.

Most licensed commercial trawlers are from Korea and are restricted to fishing below the 50m contour or a certain distance from shore. The fishing vessels carry out deep bottom trawling, mid water trawling and long-lining. There has been conflict in the past between the two industries when the commercial trawlers have come too far inshore.

From an appraisal of catch data for the Al Wusta Region, the dominant species are penaeid shrimp and spiny lobster in terms of crustaceans, Indian oil sardines in terms of small pelagics, the emperor and the hammour in terms of demersal fish, and sharks. The most diverse fish assemblages are found where reef corals are present, mainly towards Masirah Island and the Gulf of Oman in the north.

Figures from the Ministry of Agriculture and Fisheries (MOAF) indicated a total of 4,034 fishermen in the Al Wusta Region for the year 2000, with evidence of fishermen numbers having increased from the previous five years. In 2000, the figures showed an estimated number of fishermen at Duqm to be 808 in total, whilst the total fishing boats / vessels at Duqm were 405. In 2008, the number of fishermen had increased to 1196, with 550 fishing boats / vessels ⁷⁹.

⁷⁸ **Oman International Shrimp Company (OISC). (2001):** Environmental Impact Assessment and Environmental Management Plan, Duqm Farm. Private report submitted as part of license application to MRMEWR, Oman.

⁷⁹ **Ministry of Fisheries and Wealth (2009):** Fishery Statistics Book 2009. Fisheries Statistics and Information Department, General Directorate of Fisheries Research.



4-9-3 Fishing Community

A small fishing community previously operated at Ras Duqm, where fishermen used small fiberglass boats and dhows. These fishermen rely on Duqm town, which is 7.0 km away, for accommodation. Due to the incompatibility between an industrial port and a fishing harbor, the fishing community at Duqm will be relocated to a new fishing harbor by the Ministry of Agriculture and Fisheries. The fishing harbor project is currently underway.

It was planned that the harbor would be located at the north end of Ghubbat Quwayrat (just south of Nafun), approximately 20.0 km north of the port. However, due to land quality issues the location has since changed and is now going to be located at Shuw'ayr, which ca. 20.0 km south of the Port Duqm. It is expected that fishermen will continue to reside in Duqm town⁸⁰.

4-10 Noise And Vibration

Noise and vibration can travel several hundred and potentially several thousand meters from a source, depending on the transmission medium (air, ground or water) and the presence of attenuating features such as soft ground and barriers (e.g. buildings). The study area for noise and vibration has been defined as follows (and is illustrated in Figure (4-18)):

Residential and sensitive terrestrial ecosystem receptors within 4km of the Port boundary⁸¹;

Residential and sensitive terrestrial ecosystem receptors within 1km of roads carrying traffic flows greater than 5,000 vehicles per day; and

Industrial sources within 4km of receptors identified above.

⁸⁰ Port Duqm Company S.A.O.C, (2014): Port of Duqm: Phase 1 Operational EIA, Environmental Scoping Report, February 2014, Final Report – Rev 2 (For Issue), PDC/BVB/037/2013-9Y1894/R-2

⁸¹ Based on limiting construction noise to 85dB(A) at the Port boundary to meet a noise criterion of 45dB(A) at the receptor and limiting operational noise to 70dB(A) at the Port boundary to meet a noise criterion of 30dB(A) at the receptor.

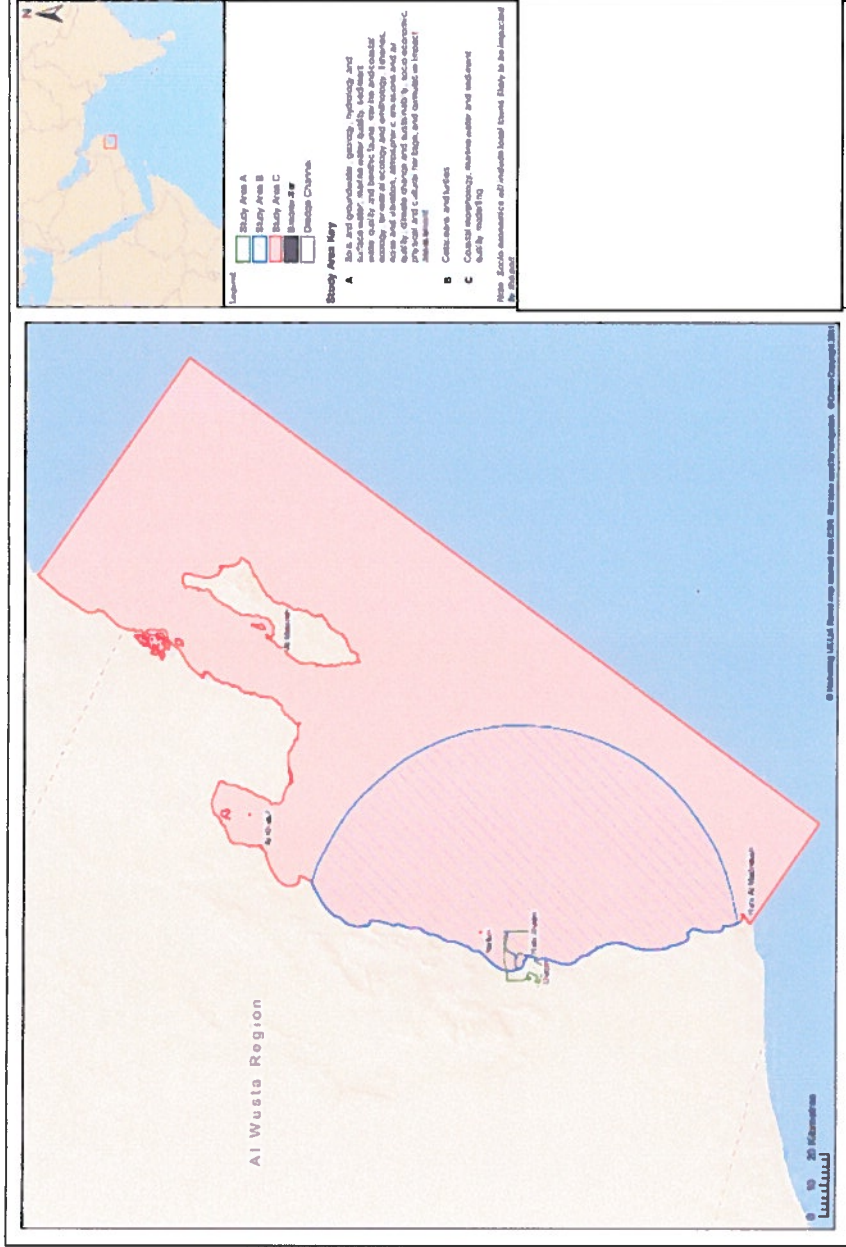


Figure (4. 17) : Human parameters (Fisheries) ⁸²

⁸² Khatib \$ Alami and Partners, 2012: Port of Duqm Extension, Oman Environmental Scoping Report, Ministry of Transport and Communications, Sultanate of Oman 17 January 2012, Final Report - 9S8605.

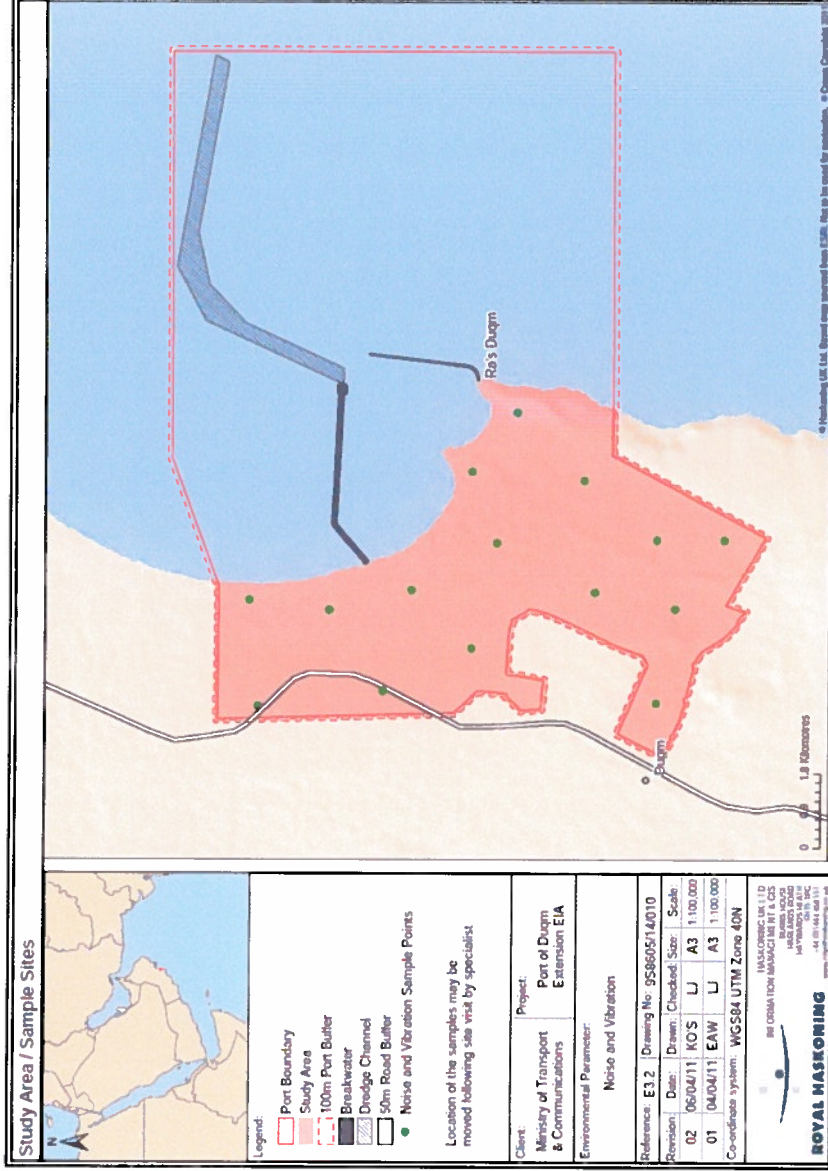


Figure (4. 18) : Environmental parameters (Noise and Vibration) ⁸³

⁸³ **Khatib \$ Alami and Partners, 2012: Port of Duqm Extension, Oman Environmental Scoping Report, Ministry of Transport and Communications, Sultanate of Oman 17 January 2012, Final Report - 9S8605.**

The Port Duqm area is undeveloped with the principal sources of noise and vibration present being the diesel fired Duqm Power Station, the main coastal highway from Muscat to Salalah, local roads and Duqm village itself.

Studies and literature which are applicable to the Duqm area ^(84, 85) indicate that background noise levels are expected to be in the order of 20-30 dB(A) increasing to 30-50dB(A) within close proximity of the highway and Duqm Power station. Noise levels within Duqm village are expected in the range 30-50dB(A). There are no significant sources of ground-borne vibration and vibration levels are expected to be negligible. This information will be gained for input into the EIA, along with a noise survey of the surrounding public environment which will be undertaken and the results included in the EIA.

In addition to the information above, there is information from a noise survey that was conducted within the port and quarry area to comply with HSE requirements, and which is presented in Table (4-13).

The noise survey was conducted during normal daily construction activities (January / February 2011), and does not present background noise levels. These noise levels often exceeded regulatory standards and have therefore required the use of personal protective equipment (PPE).

Table (4-13) indicated that many positions have noise above 85 dB(A) that requires the use of ear defenders or ear plugs, however at the quarry it is required that noise levels above 80 dB(A) requires PPE, resulting in enclosed rooms or areas far from the machines being the only places in the quarry where PPE is not mandatory.

4-11 Air Quality

Air pollution can disperse several kilometers downwind of a source and hence, the study area for atmospheric emissions and air quality has been defined as follows (Figure 4-19):

⁸⁴ Five Oceans, 2011: Noise and air surveys for Oman Drydock Company (ODC)

⁸⁵ Five Oceans, 2010: Baseline noise and air surveys for Duron (Industrial Zone Masterplan)

- Residential and sensitive ecosystem receptors within 5km of the Port boundary ⁸⁶;
- Residential and sensitive ecosystem receptors within 50m of roads carrying traffic flows greater than 5,000 vehicles per day; and
- Industrial sources within 5km of receptors identified above.

Table (4. 14) : Noise Measurements from the port and quarry areas in January and February 2011

Birds	Habitat Use
Seabirds	Various species of shearwaters <i>Puffinus</i> sp. and storm-petrels <i>Oceanites</i> sp. use the offshore waters near Ras Duqm for feeding. These birds are probably under-recorded owing the difficulties of observing them from land, as they tend to stay well offshore.
Red-billed Tropicbird <i>Phaethon aethereus</i>	This species probably breeds in small numbers at Ras Duqm and should be able to co-exist with a new harbour. The species use the waters around Duqm as a feeding ground.
Socotra Cormorant <i>Phalacrocorax nigrogularis</i>	Large numbers (up to an estimated 15,000) of Socotra Cormorants utilise the waters near Duqm and the island of Hamar an Nafur for feeding. The Socotra Cormorant is a declining species with the main breeding grounds in the Arabian Gulf and one colony on the island of Hasikiyah in the Hallaniyat group in Oman. The species is classified as vulnerable by BirdLife International. Any oil spill in the Duqm area could have devastating effects on the Socotra Cormorant population.
Greater Flamingo <i>Phoenicopterus ruber</i>	Up to 3,000 Greater Flamingos use the mud flats just to the west of Ras Duqm for feeding
Waders	The mud flats west of Ras Duqm are an important feeding ground for waders of up to 27 species during migration and in winter.

⁸⁶ 5km is a common distance downwind of an industrial source used to define a study area.

Birds	Habitat Use
Gulls and terns	Massive numbers of gulls and terns are dependent on the Duqm area and adjacent seas for roosting and feeding from October through March. The numbers in midwinter may exceed 50,000 birds. An oil spill in the waters near Ras Duqm could have severe negative effects on these birds.
Passerines	Though several species of small perching birds have been recorded at Duqm, the area is not of particular importance for these species.

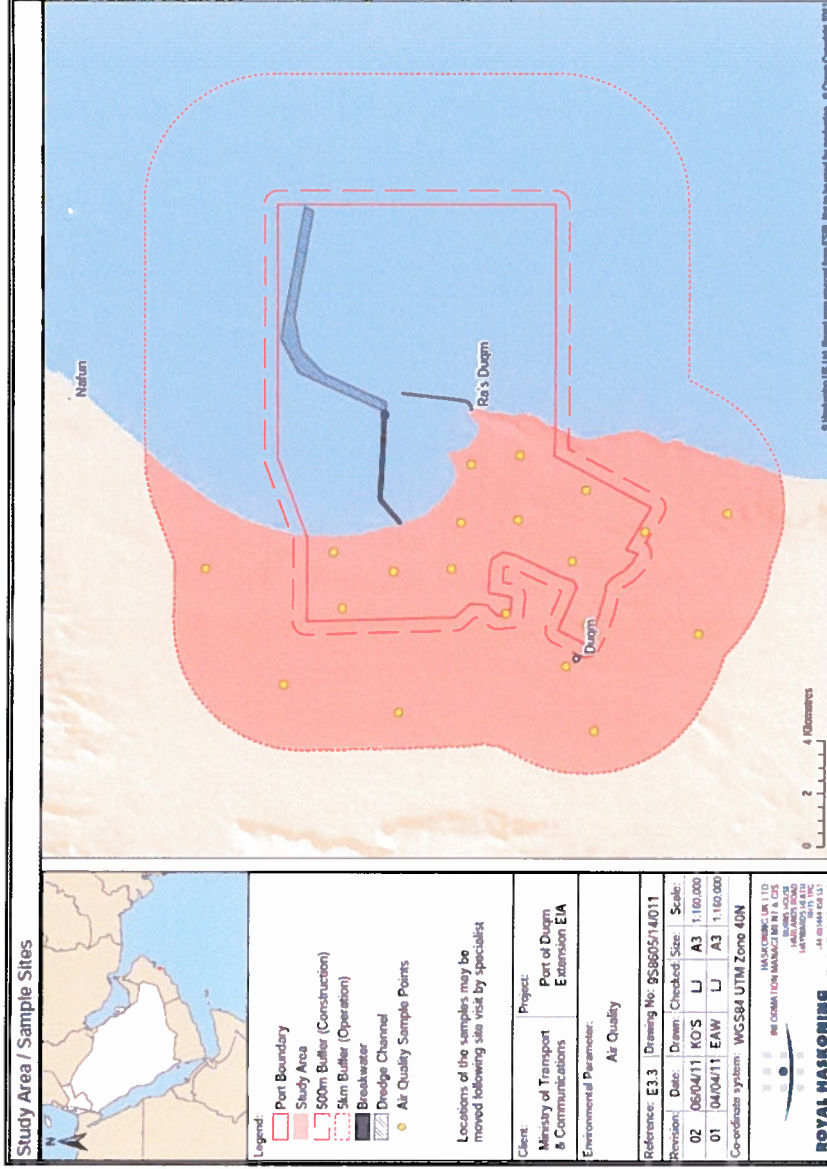


Figure (4.19) : Environmental parameters (Air Quality) ⁸⁷

⁸⁷ Khatib & Alami and Partners, 2012: Port of Duqm Extension, Oman Environmental Scoping Report, Ministry of Transport and Communications, Sultanate of Oman 17 January 2012, Final Report - 9S8605.

The Port Duqm area is undeveloped with the principal sources of air pollution present being the diesel fired Duqm Power Station, the main coastal highway from Muscat to Salalah, local roads and Duqm village itself. Local ambient air quality can be characterized as follows 88, 89:

- Nitrogen dioxide and sulphur dioxide concentrations of these two combustion related pollutants are expected to be in the order of 5 – 15µg/m³ as an annual mean and well below 90 relevant short term and long term air quality standards and guidelines. Concentrations of these pollutants may be elevated near to the principal sources of air pollution identified above but remaining well below air quality criteria.
- Carbon monoxide concentrations, also combustion related, are expected to be in the order of 1mg/m³ as a maximum 8-hour mean; approximately 10% of the relevant air quality standard or guideline.
- Particulate concentrations are also associated with combustion but are dominated by natural levels concomitant with Gulf Region. Both short term and long term air quality standards and guidelines for particulates, either as TSP, PM₁₀ or PM_{2.5} 10, are expected to be breached due to natural levels.
- Acid gases (e.g. hydrogen chloride, hydrogen fluoride and hydrogen sulphide) are all expected to be negligible.
- Heavy metals (e.g. lead, mercury, cadmium, etc.) are all expected to be negligible.
- Dioxins and furans are all expected to be negligible.

4-12 Climate Change And Sustainability

This section considers how the project proposal may affect Climate Change and the Sustainability of the Port of Duqm. For the majority of sources the study area is limited to the Port itself (as illustrated in Figure (4-20)).

⁸⁸ Five Oceans, 2011: Noise and air surveys for Oman Drydock Company (ODC)

⁸⁹ Five Oceans, 2010: Baseline noise and air surveys for Duron (Industrial Zone Masterplan)

⁹⁰ Well below defined as less than 75% of the air quality standard or guideline

The exception is transport related sources (i.e. shipping and road transport) where the change in emissions is reported by considering the use of an alternative (existing) port.

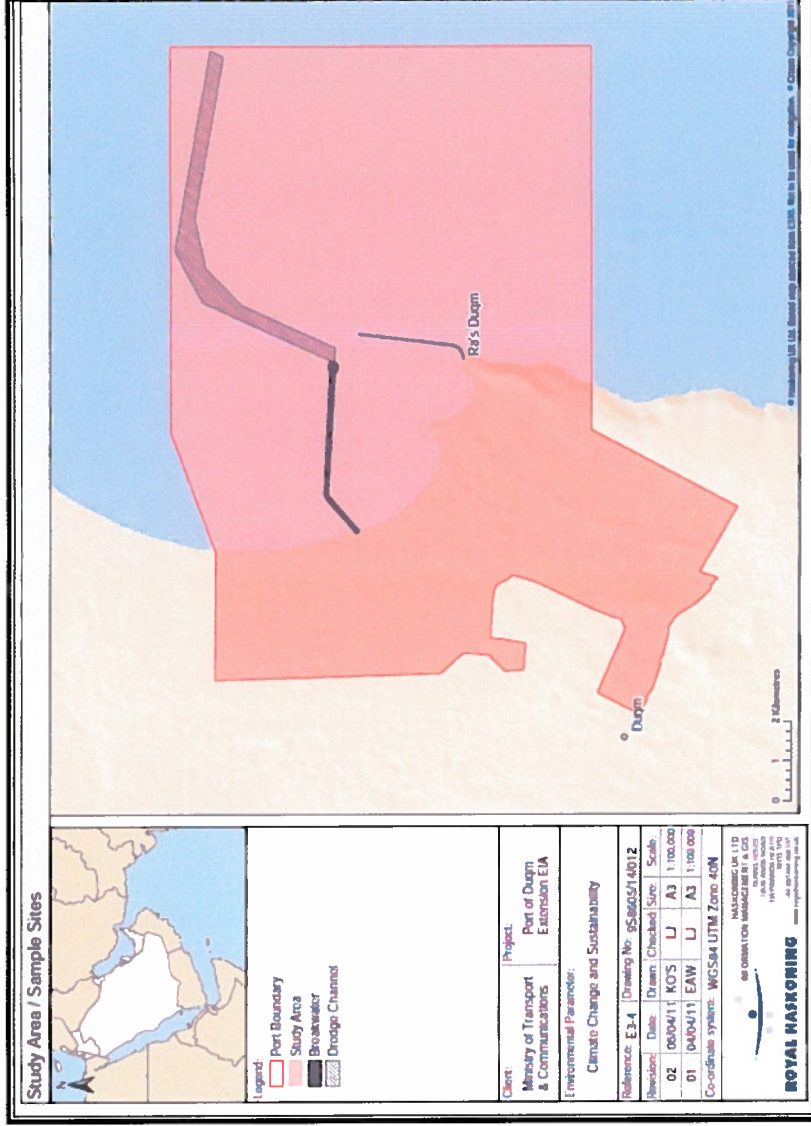


Figure (4. 20) : Environmental parameters (Climate Change and Sustainability)⁹¹

⁹¹ Khatib \$ Alami and Partners, 2012: Port of Duqm Extension, Oman Environmental Scoping Report, Ministry of Transport and Communications, Sultanate of Oman 17 January 2012, Final Report - 958605.

The Port Duqm area is undeveloped with the principal sources of greenhouse gases being the diesel fired Duqm Power Station, the main coastal highway from Muscat to Salalah, local roads and Duqm village itself. All these sources are associated with the release of carbon dioxide as a product of fuel combustion. The existing land use is for nomadic grazing with associated methane emissions. Ozone depleting substances are most likely present, albeit in very small quantities, in the form of paints and solvents with high content of volatile organic compounds.

In 2007 the Sultanate of Oman, with support from the United Nations Development Programme (Global Environment Facility), commenced the collection of energy and non-energy source emissions data for greenhouse gas emissions for the purposes of providing an inventory of greenhouse gas emissions for Oman. This work is due to be completed in 2011⁹².

The Sultanate of Oman is a signatory to the Montreal Protocol and, as such, is committed to the phasing out of the production and consumption of ozone depleting substances (namely, chlorofluorocarbons (CFCs) and hydro chlorofluorocarbons (HCFCs)). There is a permitting system in place for the import and export of CFCs and HCFCs.

4-13 Physical and cultural heritage

The study area for the EIA will be the entire site as enclosed by the port boundary and will not extend outside this boundary (as illustrated in Figure 4-21). The surveys focus on the area where most sensitivity is expected (based on previous work and finds by Jagher, 2009). Sites in the vicinity of the boundary but outside it have already been recorded under Central Oman Palaeolithic Survey (COPS). There is therefore, no need to extend the survey unless a new site is chosen for excavation of aggregates, rock or fill.

Legal protection of Oman's heritage sites was formalized in Royal Decree No 6 of 1980. Since that time no subsidiary legislation has been issued. Amongst its provisions archaeological sites may not be destroyed or damaged without permission from the Ministry of Heritage and Culture: these may include buildings

⁹² <http://www.undp.org/ae/undpuae/oman.html>

or other structures from the Islamic Era and structures including burial mounds from before the advent of Islam, as well as artifacts such as metal or stone tools or pottery. Graves from the Islamic Era are generally the responsibility of the Ministry of Awqaf and Islamic Affairs, whilst administration of modern graveyards is carried out by the Ministry of Regional Municipalities and Water Resources. All Islamic Era burials are recorded as archaeological sites in the first instance.

The study of Oman's archaeology has mainly been through surface survey, with very little excavation carried out, the principle being that remains are safest when buried underground until such time as funds are available for excavation. All pre- Islamic graves are considered significant until excavation has established their importance. Any developer wishing to remove a burial or other archaeological site may apply for permission to do so, on the basis that he will first pay for a full professional excavation to evaluate the site. The Ministry of Heritage and Culture will then decide whether to grant permission for its removal or require it to be preserved. If during mechanical works any archaeological remains are found, work is to halt and the discovery reported immediately to the Ministry of Heritage and Culture.

Archaeological study since 1970 has shown Oman's coastline to be rich in human occupation sites that date from early pre-Islamic times. Excavations in the Ra's al Hadd area, especially those at Ra's al Jinz, have rolled back Oman's history by at least a thousand years to give a clear picture of the Early Bronze Age, around 3,000 BC. An early view that the local inhabitants were primitive hunter-gatherers changed when these excavations revealed a sophisticated population of merchants and seafarers, who traded with India and Sumeria in what is now Iraq. Graves and, later, settlement sites were found some of which have been dated to at least 6,000 BC.

From the earliest times Omanis were able to harvest the rich resources of the Arabian Sea. Apart from graves and remains of a few settlements, the shell middens provide a wealth of evidence of man's activity in early times. Little evidence of settlement sites remains above ground, partly because organic material from prehistoric times has generally decomposed. However under certain conditions, such as anaerobic mud or clay, some organic material may survive and be datable. Near Ra's al Hadd the remains of a reed boat was found and dated to the 3rd

Millennium BC. It had been waterproofed with bitumen extracted from a specific site in Iraq, identified from analysis of the composition of the bitumen.

It has to be assumed that any man-made remains on the ground or found underground during the course of excavation for development will probably contain important historical information. The Ra's al Jinz settlement site appeared to be little more than a faint discolouring of the surface soil, but excavation revealed a complex of quite sophisticated dwellings one of which had a stone drain leading away from its floor. It is therefore important to the conservation of Oman's cultural heritage that where possible early man-made sites are preserved and investigated by professional archaeologists.

A number of archaeological studies have been carried out in the proximity of the port area (refer to ^{93, 94, 95, 96, 97}). The first study was completed by Biagi in 1994, whereby he singled out the bay of Duqm as giving the best evidence of prehistoric occupation between Ra's Halat and Ra's al Aqit. One of the most recent and significant studies was in 2009, when Jagher published results of his 2007-2008 archaeological survey in the Duqm area, which included a number of sites within the expanded Port boundary (refer to Figure (4-21) below).

Sites typical of Al Wusta Region include burials of all kinds, stone structures related to settlement sites, shell middens (waste dumps where shells have been broken open, dating back to prehistoric times), flint implement manufacturing sites, 'murdhafa' (underground storage pits) and triliths. The latter are little understood: excavations at two sites produced ash of ibex bones dated to around the turn of the millennium BC/AD and little else, suggesting they were some kind of religious site related to hunting rituals.

⁹³ Biagi, P. (East and West Journal 38:271- 291), 1988: Surveys along the Oman Coast. Preliminary Report on the 1985-1988 Campaigns.

⁹⁴ Macumber, 1997: Unpublished survey.

⁹⁵ Whelan, 2002: Lower Palaeolithic sites in the Huqf area Jagher, R (Special Compilation of the Central Oman Palaeolithic Survey (COPS)).

⁹⁶ WHS Journal: Volume 3 No 1 Special Edition (www.whs-portal.org), 2009: The Duqm Stone Park.

⁹⁷ Five Oceans Environmental Services LLC, 2010: Archaeological assessment of the Duqm Industrial Development Zone



The earliest sites are the Palaeolithic sites from as far back as 400,000 year BP, where large hand axes and other implements have been found, evidence from man's earliest occupation of Oman. Almost no built heritage exists from the Islamic Era in Al Wusta Region.

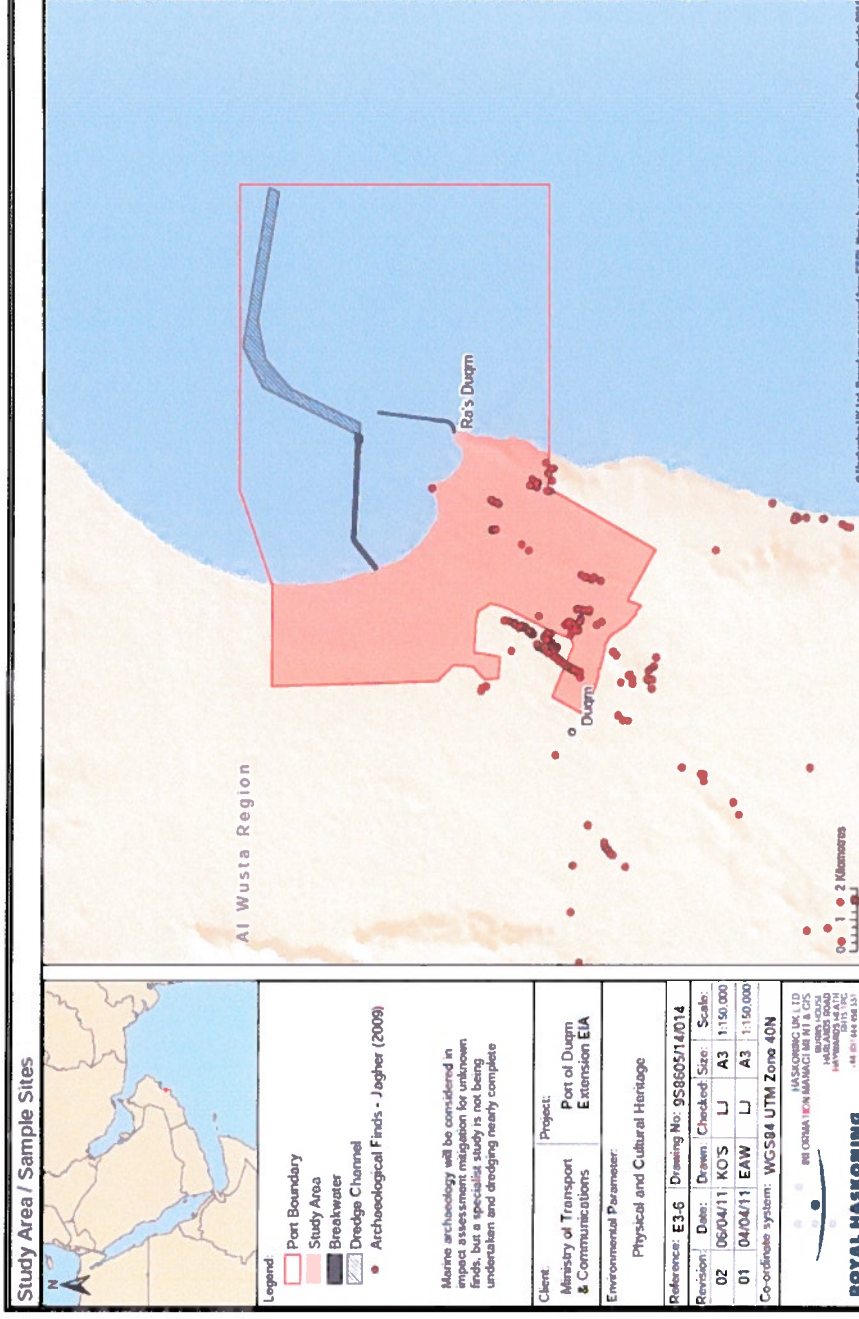


Figure (4. 21) : Study area and locations of archaeological finds by Jagher (2009)⁹⁸

⁹⁸ Khatib \$ Alami and Partners, 2012: Port of Duqm Extension, Oman Environmental Scoping Report, Ministry of Transport and Communications, Sultanate of Oman 17 January 2012, Final Report - 9S8605.

CHAPTER (5)
PRELIMINARY CONSTRUCTION ENVIRONMENTAL IMPACT

5 PRELIMINARY CONSTRUCTION ENVIRONMENTAL IMPACT

5-1 Introduction

5-1-1 Scope

This chapter identifies all the important possible change that might occur because of the proposed infrastructure facilities construction (three Packages of Phase 1), Port of Duqm project. The aim is to make sure that the construction phase is as short as possible reducing impacts and costs. Identification of the potential positive and negative impacts is followed by recommendations for mitigation measures.

The description of the existing conditions (baseline environment) provides a multidisciplinary definition of the ecosystem of the coastal area, the Port of Duqm area and its surrounding. This baseline knowledge will be used to identify the main concerns and issues related to the construction and operation of the proposed infrastructure facilities, forming the basis of this PEIA.

This section provides information on the environmental parameters which are considered to be sensitive to the construction and operational activities, as identified through consultation and based on previous studies undertaken at the site and expert experience based on similar Port projects. Table (5.1) shows the parameters that are covered.

Table (5. 1): Environmental parameters considered within the PEIA

Physical Aspects	Ecological Receptors	Human Receptors
Geology and Geomorphology	Marine benthic ecology	Air Quality
Coastal processes	Fish	Noise
Marine sediment quality	M. mammals / turtles	Culture / heritage
Marine water quality	Plankton	Socio-economics
Soil and groundwater	Intertidal ecology Terrestrial ecology	
	Ornithology	
Climate change		

5-1-2 Data Collection

As part of the EIA scoping exercise, a variety of reports have been collated and reviewed to establish the baseline environment. This task was initially carried out in June 2011⁹⁹, and has been further added to in this report as there have

⁹⁹ Khatib & Alami and Partners, 2012: Port of Duqm Extension, Oman Environmental Scoping Report,

been further significant studies since 2011 that are pertinent to the Port of Duqm and the surrounding area. There may be one or two additional information sources which have not yet been identified, and as such the data search will continue into the following final EIA phase.

A summary of the baseline environment for each environmental parameter has been provided in chapter (4) along with the literature referenced (a list of which is also provided in the references section at the end of this report). Further to this, the boundaries of two pertinent projects are illustrated in Figure (5.1), these are:

- Duqm Town Master Plan Area;
- Duqm Industrial Zone; and
- Duqm Regional Environmental Baseline Study.

5-1-3 Geographic Study Area

The project study area is the geographic area that the PEIA will cover, and it must include areas where direct and indirect effects could occur as a result of port construction or operation, both within and outside of the port boundary. Impacts have been considered that are originating from activities within the proposed three packages and port boundary for accumulation impact. The study areas for each of the physical, biological and human environmental parameters are illustrated in Figure (5.1)¹⁰⁰.

It is important to note that environmental impacts are not contained only within the port boundary, and that for some parameters (noise and emissions impact parameters), effects may extend further. As such, it is important that each parameter has its own geographic study area, dependent on the potential extent of the impact. Marine works were developed before construction works for the proposed packages. The impact is limited mostly to landside works and potentially in some cases could be due accidental spillage and run-off of contaminants.

Ministry of Transport and Communications, Sultanate of Oman 17 January 2012, Final Report - 9S8605.

¹⁰⁰ Khatib & Alami and Partners, 2012: Port of Duqm Extension, Oman Environmental Scoping Report, Ministry of Transport and Communications, Sultanate of Oman 17 January 2012, Final Report - 9S8605.

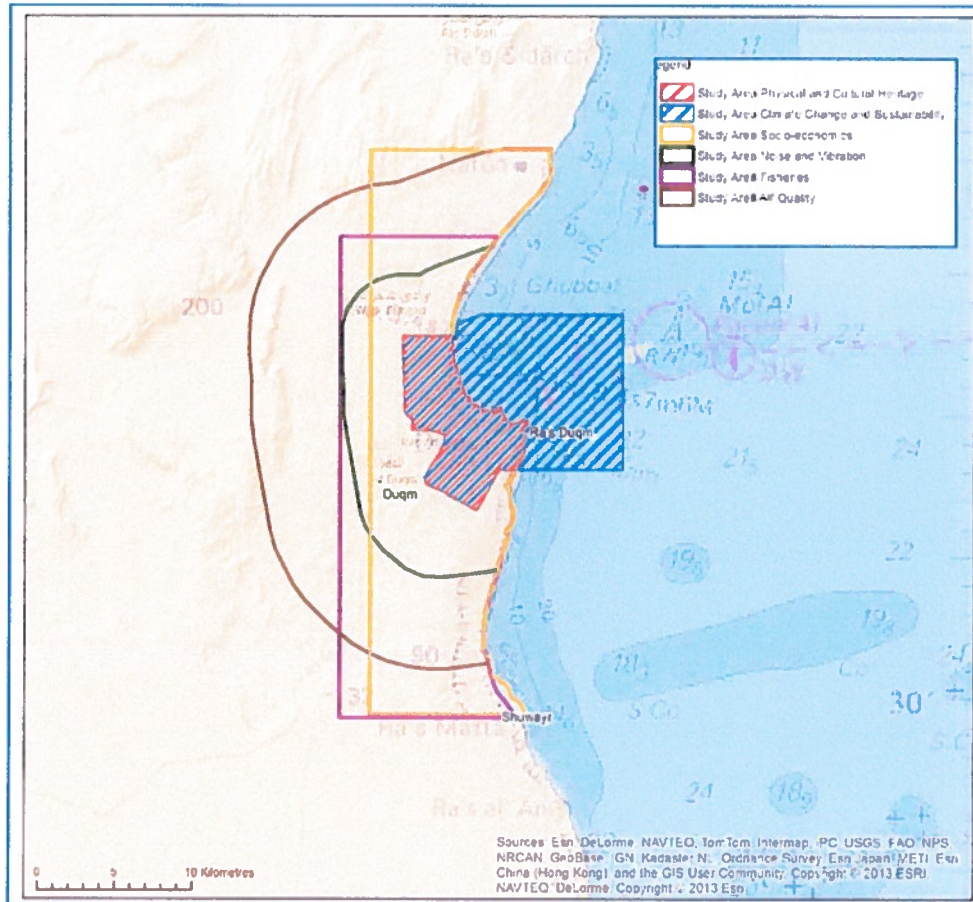


Figure (5. 1): Geographical scope of environmental parameters (accumulation impact)

5-2 Socio-Economic Environment

The impact of the proposed packages and on the socio-economic environment will mainly be on the following aspects:

- Employment opportunities
- Health and safety
- Displacement of residents, farmers, fishermen and other users

The main Duqm town, local settlers and other port users should be fully informed as to upcoming site activities and the associated project issues, prior to the project construction activities. Local sources of labours should be utilized where possible and/or feasible.

5-2-1 Employment opportunities

Positive impacts will be achieved from the project construction in terms of the employment of the local workforce and migrating workers. Temporary employment opportunities around thousand will be available for both skilled and unskilled workers and vessel and equipment hire. Indirectly, the local economy will be enhanced due to the increase in personnel in the area (direct spending potential) and the associated opportunities for businesses and industries in the area (e.g. ship hiring, accommodation). Where possible, personnel should be pooled from the local community and within Duqm area.

5-2-2 Health and safety

The health and safety of the local communities will be affected both during construction depending on the location of the settlements. If they are downwind of the sites, there will be an increase in noise, dust, air pollutions (minor) and traffic congestion until the new roads have been built. This could affect the health of the communities. The effects are described in more detail in the sections 5.5 and 5.6 concerning effects on Atmospheric Environment.

Finally, protective equipment should be made available to all workers and should include: eye protection; full chemical protection for employees dealing with potentially toxic chemicals (including facemask, hand protection and full overalls); steel toe-capped boots, hard hats; and high visibility clothing.

5-2-3 Displacement of residents, farmers, fishermen and other users

Although the chance is relatively small, disturbance and/or displacement of, local residents, farmers and other users of the area may occur as a result of the increased onshore works during construction. When planning the port area, the roads, care has to be taken to minimize the number of displacements. If displacements are needed, compensation in land or financing should be organized. If well organized, this could be turned into a positive effect for the involved stakeholders. Impacts of construction phase on fisheries can be due to loss of shelter for fishermen until new Fisheries Harbour is completed.

5-3 Wastewater and Solid & Hazard Wastes

5-3-1 Wastewater and sludge

The wastewater generated during construction is limited by the contractors' staff and manpower. The total manpower for three packages estimated at 900 to 1000 capita. The estimated generated wastewater is less than 100 m³/day

and dry sludge is about 1.0 tons/day. The generated wastewater during construction will be treated through compact wastewater treatment unit similar to the one for the ongoing construction work as shown in the following Figure (STRABAG contractor).



**Figure (5. 2): Compact STP for manpower during construction (STRABAG contractor)
(Photo taken by K&A, 12-2014)**

The normal sewage effluents will be treated to acceptable standards for reuse for green belt and landscape at the facility's own sewage treatment plant and is not considered to pose an environmental problem.

The choice of a sludge treatment method depends on the volume of sludge generated, and comparison of treatment costs required for available disposal options. Air-drying and composting may be attractive to small communities, while limited land availability may make aerobic digestion and mechanical dewatering preferable for large community.

For construction phase, the generated sludge is limited and it's hard to have visible sludge treatment system. The followings are the proposed scenarios in handling the generated sludge during construction phase:

- The current practice that the STP treats only the wastewater and wet sludge evacuated and transported to be treated in the Duqm STP. This situation is not sure for future by the Duqm STP operator because they cannot manage more sludge for treatment. They can receive dry sludge only (this issue has been raised through the environmental department of (SEZAD). The assigned contractor has to try first if he can keep sending

- the sludge after pre-treatment by thickener to Duqm STP temporary during construction through an agreement.
- The dry dock Company is on operation and using incineration to treat the solid waste. The assigned contractor has to try if he can send the sludge to be treated by incineration temporary during construction through an agreement with Dry Dock Company. The contractor might need sludge pre-treatment.
 - The generated sludge can be treated by sludge thickener & air-drying using drying beds and composting. Mechanical devices to turn over the sludge in the initial stages of the drying process are also available on the market. The position of the drying beds should be downstream the wind and away of any community by at least 2.0 km.
 - The generated sludge can be treated using a variety of digestion techniques, the purpose of which is to reduce the amount of organic matter and the number of disease-causing microorganisms present in the solids. The most common treatment options include anaerobic digestion, aerobic digestion, and composting.

Thee treated sludge can be used for land application to improve the soil characteristics. Other option for disposal of treated sludge is to be sent to Duqm STP where they accept the drying treated sludge.

5-3-2 Solid Waste

Regular non-toxic solid waste generated due construction works will be collected and dispose into dumping site. Other non-hazardous solid waste will be produced in office buildings, canteens and other general facilities for staff working at the site. This waste shall include food residues and other organic material, paper, cardboard etc. and will be collected at regular intervals, brought to an intermediate on-site storage area and from there be transported to the off-site landfill designated for disposal of the solid waste. The project is yet to be awarded; the exact location of dumping yard will be defined by the employer during the mobilization period.

5-3-3 Oil, chemical and toxic wastes

During construction, the only oil sources from leakage from accidental spills collected. The collected and treated oil can be recycled and others collected and stored in oil pit at temporary hazardous waste area with total served area 40,000 m² east of Pre-gate area (IP2). In later stage the disposed oil will be transported to the designed dump fill for the project area.

In case the contractor cannot get approval or no objection for receiving all hazard wastes that would be generated from Duqm Port during construction and operation, treatment facilities should be provided to treat all the toxic wastes or get an approval from Be'ah for having hazard wastes dump site.

5-4 Noise and Vibration

The construction machinery required for road is relatively differing from the machinery required for construction of other infrastructure and building works. So, the noise impacts will presented in two separate sections as follows.

5-4-1 Impact of road construction

The noise level of the heavy construction equipment is high, but is limited to the road surrounding. Table (5.2) summarizes the noise level of equipment commonly used in road construction.

Table (5. 2): Relative noise levels for road construction machinery¹⁰¹

Equipment Type	Name of Equipment	Noise Level (dB) at 15 m
Equipment Powered by Internal Combustion Engines	Compactors (Roller)	72-73
	Front Loaders	71-83
	Backhoes	71-92
	Tractors	77-96
	Scrapers, Graders	80-92
	Pavers	87-88
	Trucks	82-93
	Concrete Mixers	74-88
	Generators	72-82
	Compressors	74-90
	Impact Equipment	Pneumatic Wrenches
Jackhammers & Rock Drills		81-99
Impact Pile Drivers (Peaks)		95-106
Other	Vibrators	70-81
	Saws	73-82

There would be limited impact to workers within the three packages and no impact to other sites out of the three packages zone due to road construction works where:

- For example, assuming a typical tractor of noise level of 90 dB measured at a distance of 50 m, and 200 m, the noise level is in order of 75 dB, and 53 dB, for 5 m/s upwind and downwind cases. The two levels correspond to an average traffic on street corner and typical business office noise levels, respectively.
- There is no sensitive receptor during construction within the project area of the three packages.

5-4-2 Impact of other construction work

There is no sensitive receptors during construction for land side of packages (IP2), (IP3) and (IP4) except for camp sites and offices for supervisors and

¹⁰¹ USA, Environmental Protection Agency, 1995

management staff. Moreover, Marine mammals are located at 1000 m from nearest source of noise and vibration during construction.

The noise level of the heavy construction equipment is high, but is limited to the site surrounding. Table (5.3) summarizes the noise level of equipment commonly used in construction work.

Table (5.3) : Relative noise levels for construction machinery¹⁰²

Equipment Type	Name of Equipment	Noise Level (dB) at 15 m
Equipment Powered by Internal Combustion Engines	Compactors	72-73
	Front Loaders	71-83
	Tractors	77-96
	Trucks	82-93
	Concrete Mixers	74-88
	Concrete Pumps	80-83
	Cranes (Movable)	76-88
	Cranes (Derrick)	88-89
	Pumps	69-71
	Generators	72-82
	Compressors	74-90
Impact Equipment	Pneumatic Wrenches	83-89
	Jackhammers	81-99
	Impact Pile Drivers	95-106
Other	Vibrators	70-81
	Saws	73-82

Source: US EPA

There would be limited impact to workers within the three packages and no impact to other potential sites out of the three packages zone due to construction works where:

- There will be limited number of equipment and trucks needed for construction works (expected less than 50 as described in section 3.6). Such limited number would generate noise level much lower than the allowable limit define by the international guidelines and Omani standards.

¹⁰² USA, Environmental Protection Agency, 1995

- There is no sensitive receptor during construction within the project area of the three packages.

The noise survey was conducted during normal daily construction activities (January / February 2011). These noise levels sometime exceeded regulatory standards and have therefore required the use of personal protective equipment (PPE). It is generally regarded that any noise above 85 dB(A) requires the use of ear defenders or ear plugs.

5-5 Air Quality and Emissions

The potential impact could be due to emissions of nitrogen oxides (NOx) and particulates (PM10 and PM2.5) from:

- Dust and particulate emissions that will result from the movement of site vehicles and mobile plant on unsurfaced ground; and
- Exhaust emissions from mobile plant, including dredging equipment, and vehicles delivering rock and gravel material to the site.

There would be limited impact to workers within the three packages and no impact to other potential sites out of the three packages zone due to road construction works where:

- There will be limited number of equipment and trucks needed for construction works (expected less than 100 as described in section 3.6). Such limited number would generate emission level much lower than the allowable limit define by the international guidelines.
- The land within the three packages is already reclaimed.
- There is no sensitive receptor during construction within the project area of the three packages.

5-6 Cultural Heritage and Recreation Landscape

5-6-1 Cultural heritage

There is no direct impact on cultural heritage sites where the survey and land reclamation activities within the three packages did not lead to any impact on cultural heritage sites. Furthermore, the rock garden site located further north of the three packages protected by fence.

However, there would be very limited impact to other potential sites out the zone of the three packages due to Infrastructure Works for the landside port areas and potentially could be:

- Direct physical impact by mechanical plant or any vehicle movement.

- Removal of rocks or smaller stones for building purposes.
- Casual pedestrians collecting surface material as souvenirs or for identification.
- Reversing heavy vehicles without due care.

There is no site for cultural heritage has been found during land reclamation of the three packages. So, this impact can be classified as minor impact on cultural heritage and recreation landscape sites



**Figure (5. 3): Rock garden protected north of the project area
(SEZAD Website)**

5-6-2 Recreation landscape

During construction activities, the site would not be in a suitable state for recreation. Construction machinery, movements of traffic on land, and the location of office buildings on site will give a different characteristic to the area from an undeveloped, pristine beach to a construction site. Bird watchers will not be able to continue their hobby in the area (at the time of construction) as the birds may temporarily move away to other areas, such as Ghubbat Quwayrat bay to the north. However, as this site is not frequently used by recreational users, the anticipated impact will be of minor adverse significance.



Figure (5. 4): Birds along the beach before Port of Duqm development



(SEZAD Website)

**Figure (5. 5): Birds on land side during land reclamation of Commercial Berths
(Photo taken by K& A, 12- 2014)**

5-7 Hydrogeology and Geology

5-7-1 Soil and groundwater

As part of the 'Environmental Baseline Study for Duqm' soil samples have been collected from nine locations in the Duqm area in order to capture primary information on the surface soil conditions from the Duqm area. Emphasis was given to collect additional samples from the existing waste dump sites considering the potential soil contamination. The majority of the sampling locations were taken from largely undisturbed virgin land without notable anthropogenic activities. The results of the sampling revealed negligible indication of contamination. The soils are alkaline which are commonly found in areas of low rainfall. There was no evidence of hydrocarbon contamination and the small levels of magnesium and iron are likely attributable to the presence of minerals in the region. Four of the samples were found to have elevated arsenic levels as per the USEPA Site Notification Standard 2008 for Industrial Soil Arsenic level, however, they were found to be below the DIVSR 2000 value.

There are reportedly four aquifer systems in the Duqm area. The groundwater in the area is known to be saline, with a salinity ranging between 140-330ppt. The water table varies from 0.5-1.0m below the surface and is affected by high tide and heavy rainfall. The area can be classified into four zones, with the salinity being greatest at the coast and is attributed to saline intrusion through the Sabkha channels¹⁰³.

Site operations during construction phase may lead to impact of soil and or groundwater beneath the site. Potential areas of concern are recognized as follows:

- Fuel and lubricant storage areas;
- Fuel stations;
- Maintenance areas;
- Waste storage areas;
- Plant & equipment holding areas.

The soil in the Duqm area is not suitable for agriculture, as the area is mainly comprised of Quaternary sub-recent to recent Sabkha deposits, meaning that it

¹⁰³ HMR (2012). Environmental Baseline Study for Duqm Development and Surroundings: Secondary Data Gap Analysis and Survey Protocol. Q2 Report – Draft (September 2012). Produced for the Special Economic Zone Authority at Duqm.

is likely to be too saline for commercial crops. In addition, limited sites will be used to support construction activities and measures will be taken by the contractors to minimize leakage to soil and groundwater. So, there would be limited impact to soil and groundwater within the some facilitates within the three packages and no potential impact to other sites out of the three packages zone due to construction works.

5-7-2 Geology

The direct impact on the important geological formations within and surrounding the site (the sea cliffs which consist of ancient marine fossils and the Huqf Formation) will be negligible as construction of the three packages will not interfere with these historical formations.

There is only one geological site (Ras Duqm) nearby the three packages found south of Commercial Berths as presented in the following Figure. Ras Duqm has been protected and care has been taken during land reclamation of the proposed packages.

5-8 Marine and Coastal Ecology

5-8-1 Marine water and sediment quality

Since 2011, there have been a number of studies that have collected sediment and water quality data in and around the port area that now provide a more detailed picture of the baseline environment. For example, in 2012 Jan De Nul, supervised by Royal Haskoning, undertook further water quality sampling and sediment quality sampling in the port area, the borrow area and the disposal site following completion of the dredging activities. In-situ water quality samples and samples for laboratory analysis were collected for water quality at 30 locations in and around the port area, 14 in the borrow area, and nine locations around the disposal site. Sediment quality samples were collected at 25 stations in and around the port area, 14 in the borrow area, and three sites in the disposal area. Results were compared with the baseline surveys undertaken in these locations.

In 2012-2013 SEZAD's primary data collection surveys for the Duqm Regional Baseline Environmental survey commenced, with 13 sediment and water sample locations (ten coastal sites from Nafun to Ras Al Madrasah, one in the port and two 13km offshore reference sites) (HMR, 2013b). Furthermore, ODC have annual monitoring being undertaken within the port for the monitoring of operations (Five Oceans, 2012).

The water quality at the port survey site did not indicate and significant pollution. There were high levels of nutrients, thought to be linked to the seasonal upwelling. All surveys identified sediments to have high levels of organic matter and various metals (e.g. chromium, zinc and nickel sulphides), which are expected to be naturally occurring. At the Port, the sediment samples are approximately 50% sand and 50% fines (silts). It was noticed higher levels of Diesel Range Hydrocarbons (DRH) in the sediments (than at the disposal site, possibly due to oil spillages / leakages from the fishing industry).



Figure (5. 6): Marine works developed before construction works for the proposed packages (SEZAD Website)

The impact is limited to landside works and potentially could be due accidental spillage and run-off of contaminants. The impact can be classified as a minor where mitigation measures will be considered.

5-8-2 Coastal ecology

Marine works were developed before construction works for the proposed packages. The impact is limited to landside works and potentially could be due accidental spillage and run-off of contaminants. The impact can be classified as a minor due to well design and mitigation measures will be considered.

5-9 Aquaculture Ecology (Marine Mammals and Turtles)

There are limited potential pollutant sources during the construction phase, which may impact turtles and cetaceans either directly or via their prey. The impact is limited to landside works and potentially could be due accidental spillage and run-off of contaminants and light pollution on any remaining turtle nesting beaches within the port area. The impact can be classified as minor.

5-10 Terrestrial Ecology and Ornithology

The terrestrial and intertidal sand and mudflat habitats in the project area will be disturbed or removed due to the landside construction infrastructure works (roads, buildings etc) and operation. However, the three packages is contributing to limited impact on landside works and potentially could be due potential for the transfer of pollutants from port construction activities, noise and light disturbance impacts. The impact can be classified as minor in case well design and mitigation measures related to noise and light disturbance are considered.

5-11 Climate Change and Sustainability Assessment

The potential impacts are minor and may arise on the parameters as a result of construction are:

- Inefficient use of energy with implicit carbon dioxide emissions
- Selection of refrigeration plant not using coolants with high global warming potential
- Use of paints and solvents with high volatile organic compound content
- Incomplete treatment of sewage and consequent generation of methane

CHAPTER (6)
PRELIMINARY OPERATIONAL ENVIRONMENTAL IMPACT

6 PRELIMINARY OPERATIONAL ENVIRONMENTAL ASSESSMENT

6-1 Introduction

6-1-1 Scope

This chapter identifies all the important possible change that might occur because of the proposed infrastructure facilities operation (three Packages of Phase 1), Port of Duqm project. The objective of the environmental assessment process is not limited to only prediction of potential negative impacts, but also to identify the benefits that are likely to accrue to the society at large. The PEIA also studies potential socioeconomic impacts that can affect the surrounding people and communities.

6-1-2 Data Collection and Geographic Study Area

As part of the EIA scoping exercise, a variety of reports have been collated and reviewed to establish the baseline environment. The project study area is the geographic area that the PEIA will cover, and it must include areas where direct and indirect effects could occur as a result of port operation, both within and outside of the port boundary. Both subjects; data collection and geographic study area have been covered in the previous sections 5.1.2 and 5.1.3.

6-2 Socio-Economic Environment

The impact of the proposed packages and on the socio-economic environment will mainly be on the following aspects:

- Employment and local economic growth
- National economic growth
- Public facilities
- Development of new housing and infrastructure
- Health and safety
- Displacement of residents, farmers, fishermen and other users
- Heritage
- Recreation and tourism
- Fisheries

The main Duqm town, local settlers and other port users should be fully informed as to upcoming site activities and the associated project issues, prior to the project operation. Local sources of labors should be utilized where possible

and/or feasible. The proposed development of Duqm area is presented in Figure (5.2).

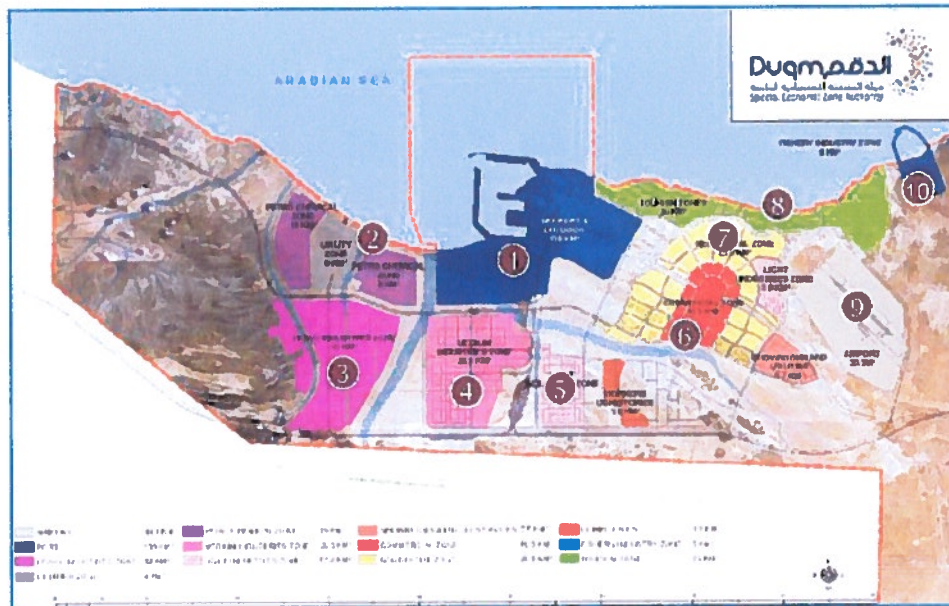


Figure (6. 1) : The proposed development of Duqm area¹⁰⁴

6-2-1 Employment and local economic growth

Positive impacts will be achieved from the project in terms of the employment of the local workforce and migrating workers. Employment opportunities will be available for both skilled and unskilled workers and vessel and equipment hire. Indirectly, the local economy will be enhanced due to the increase in personnel in the area (direct spending potential) and the associated opportunities for businesses and industries in the area (e.g. ship hiring, accommodation). Where possible, personnel should be pooled from the local community and within Duqm area.

Overall the Project site will offer several couple of thousand jobs directly serving the proposed new facilities and several times this amount for jobs indirectly linked to the port and industrial activities. Training will be necessary to prepare the new staff, ensuring that the new skills and techniques are also transferred to the local market. The increase in available jobs will give the local economy a significant boost.

¹⁰⁴ Presentation by SEZAD Authority. 2010

The proposed development will generate significant economic benefits to the region which can be summarized as follows;

- Visitor expenditure in the region is estimated to potentially increase after several years after operation starts;
- Operational employment: Employment is estimated to be generated in the retail, and manufacturing sectors through increased demand for marine industry services and retail spending;
- New business opportunities in the local area due to attraction of industry and commerce to the region as a whole.

6-2-2 National economic growth

The development of the Duqm Port Zone will create benefits for the national Omani economy. The strategic position of the Duqm in Oman will be strengthened as new transshipment hubs and industrial areas are created based on the proposed master plan for Duqm area. Furthermore, the new port area will allow for goods to be transported cheaper to and from Oman as a whole ensuring a decrease in prices paid for consumer and industrial goods.

6-2-3 Public facilities

The new development needs public facilities such as water, electricity, gas, waste treatment etc. The facilities will be modern and efficient with enough capacity to ensure that current needs are met whilst keeping capacity for future expansions. Any old facilities can be closed down if needed and communities can be linked to the improved facilities enhancing the quality of living and working in the area.

6-2-4 Development of new housing and infrastructure

The need for a new workforce to support the port zone activities means that new residential areas will be built. These areas will be connected to existing settlements and also to the national road infrastructure, thus improving the accessibility of the Duqm Port area. The residential area will consist of new housing, built according to the new modern standards and if necessary provided with the latest technology.

6-2-5 Health and safety

The health and safety of the local communities will be affected during operation of the Port Zone depending on the location of the settlements. If they are downwind of the sites, there will be an increase in noise, dust, air pollutions

(minor) and traffic congestion until the new roads have been built. This could affect the health of the communities. The effects are described in more detail in the sections 6.5 and 6.6 concerning effects on Atmospheric Environment.

To ensure that during operation of the port area there are no safety hazards, relatively dangerous port activities such as transport and storage of oil and gas and hazardous chemical industry should be planned in areas as far away from residential areas as possible.

Finally, protective equipment should be made available to all workers and should include: eye protection; full chemical protection for employees dealing with potentially toxic chemicals (including facemask, hand protection and full overalls); steel toe-capped boots, hard hats; and high visibility clothing.

6-2-6 Displacement of residents, farmers, fishermen and other users

Although the chance is relatively small, disturbance and/or displacement of, local residents, farmers and other users of the area may occur as a result of the increased marine traffic and onshore works during operation. If displacements are needed, compensation in land or financing should be organized. If well organized, this could be turned into a positive effect for the involved stakeholders. The old fishery port will be replaced by a modern one as showing in Figure (6.2).

6-2-7 Fisheries

There are no fishermen actually living within the boundary of the Port of Duqm, though they do come inside the Port in their dhows for shelter, this is likely to continue until the new Fisheries Harbour at Shuw'ayr (south of Duqm) is ready after 2016. Therefore, there is potential for impacts to occur to those living in the Duqm settlements that use the area for artisanal and commercial offshore fishing.

The main economic activity in the Duqm area is fishing. Fishing activities by local fishermen are carried out for eight months of the year (October to May) and is abandoned during the SW summer Monsoon (June to September). There are two types of fisheries offshore of Duqm: the artisanal fishing and the commercial offshore fishing. The artisanal fishermen mainly fish the shallower areas using long lines or seine nets. The near shore areas are considered productive fisheries largely as a result of the nutrient upwelling. Most licensed commercial trawlers are from Korea and are restricted to fishing below the 50m

contour or a certain distance from shore. The fishing vessels carry out deep bottom trawling, mid water trawling and long-lining. There has been conflict in the past between the two industries when the commercial trawlers have come too far inshore.

From an appraisal of catch data for the Al Wusta Region, the dominant species are penaeid shrimp and spiny lobster in terms of crustaceans, Indian oil sardines in terms of small pelagics, the emperor and the hammour in terms of demersal fish, and sharks. The most diverse fish assemblages are found where reef corals are present, mainly towards Masirah Island and the Gulf of Oman in the north.

Figures from the Ministry of Agriculture and Fisheries (MOAF) indicated a total of 4,034 fishermen in the Al Wusta Region for the year 2000, with evidence of fishermen numbers having increased from the previous five years. In 2000, the figures showed an estimated number of fishermen at Duqm to be 808 in total, whilst the total fishing boats / vessels at Duqm were 405. In 2008, the number of fishermen had increased to 1196, with 550 fishing boats / vessels¹⁰⁵.

Impacts of operation phases on fisheries can be listed below:

- Loss of shelter for fishermen until new Fisheries Harbour is completed;
- Impact from fishermen on the operations of the Port (e.g. causing obstructions during navigation, fouling the water in the Port when sheltering for long time periods – no sewage facilities on the artisanal boats)
- Permanent displacement of fishermen from the Duqm area to new fishing harbour; restrictions on access to the port
- Disturbance to fish from operational activities such as any decreases in water quality due to spillages

¹⁰⁵ Ministry of Fisheries and Wealth, 2009



**Figure (6. 2): Fishery Port before Port of Duqm development
(SEZAD Website)**



**Figure (6. 3): Fishery factory before Port of Duqm development
(SEZAD Website)**

6-3 Wastewater and Solid & Hazard Wastes

6-3-1 Wastewater and sludge

The wastewater generated during operation is limited by the operation staff and manpower. The generated wastewater during operation will be treated through the following sanitation facilities:

- Package IP2: Sewage left station
- Package IP3: Sewage left station and sewage treatment plant (STP)
- Package IP4: Sewage left station and sewage treatment plant (STP)

The normal sewage effluents will be treated to acceptable standards for reuse at the facility's own sewage treatment plant and is not considered to pose an environmental problem. Normally, sewage from ships will be kept inside the ships but can, if specially requested by the customer, be treated at the on-site treatment plant. The treated sewage effluent (TSE) will be recycled for plantation and green belt.

The choice of a sludge treatment method depends on the volume of sludge generated, and comparison of treatment costs required for available disposal options. Air-drying and composting may be attractive to small communities, while limited land availability may make aerobic digestion and mechanical dewatering preferable for large community.

For operation phase, the followings are the proposed scenarios in handling the generated sludge during:

- The current practice that the STP treats only the wastewater and wet sludge evacuated and transported to be treated in the Duqm STP. This situation is not sure for future by the Duqm STP operator because they cannot manage more sludge for treatment. They can receive dry sludge only (this issue has been raised through the environmental department of (SEZAD). The assigned contractor has to try first if he can keep sending the sludge to Duqm STP during operation through an agreement.
- Other option with Duqm STP, is to expand the sludge treatment facility in the Duqm WTP at the Port Duqm cost.
- The dry dock Company is on operation and using incineration to treat the solid waste. The Port of Duqm can send the sludge to be treated by incineration through an agreement with Dry Dock Company by having sharing cost protocol. The sludge might needs pre-treatment unit.
- The generated sludge can be treated by air-drying using drying beds and composting. Mechanical devices to turn over the sludge in the initial stages of the drying process are also available on the market. The position of the drying beds should be downstream the wind and away of any community by at least 2.0 km.
- The generated sludge is treated using a variety of digestion techniques, the purpose of which is to reduce the amount of organic matter and the number of disease-causing microorganisms present in the solids. The

most common treatment options include anaerobic digestion, aerobic digestion, and composting.

The treated sludge can be recycled or disposed by:

- Land application to improve soil characteristics for landscape and green belt matching with Omani regulation MD 17/93 for nonhazardous waste.
- To be sent to Duqm STP where they accept the drying treated sludge.
- Landfill for restoring excavated areas.

Table (6. 1): Design criteria for sewage treatment plant, capacity less than 1000 m³/day

Item	Unit	Inflow water quality	Design Wastewater Quality	
			Before treatment	Final treated water
pH	-	5.5 - 8.5	5.5-8.5	6.5-7.5
BOD	mg/1	100-200	200	3
SS	Mg/1	100-150	200	3
T-N	mg/1	15-30	30	15
T-P	Mg/1	5-10	10	2

6-3-2 Solid waste

Regular non-toxic solid waste generated due operation works will be collected and dispose into dumping site. Other non-hazardous solid waste will be produced in office buildings, canteens and other general facilities for staff working at the site. This waste shall include food residues and other organic material, paper, cardboard etc. and will be collected at regular intervals, brought to an intermediate on-site storage area and from there be transported to the off-site landfill designated for disposal of the solid waste. The Project is yet to be awarded; the exact location of dumping yard will be defined by the employer during the mobilization period.

6-3-3 Oil and chemical & hazard wastes

The oil water separators along the Commercial and Governmental Berths are mounted downstream the screen chamber and upstream the pump well. The

separator used in the pumping station is underground pre-fabricated GRP separator. The separator is designed to intercept 10% of the storm water flow as the first flush flow, the remaining by-passes to the outlet section to the pumping station wet well which diverted by the pass by chamber to the pump well. The parameters controlling the separator design are oil size droplets, oil size rate, lowest temperature, oil specific gravity, pH level viscosity, and the velocity of the inflow. The separator shall be cleaned periodically to ensure proper separation efficiency. Other oil sources from leakage from workshops and accidental spills collected as well. The collected and treated oil can be recycled and others collected and stored in oil pit at temporary hazardous waste area with total served area 40,000 m² east of Pre-gate area (IP2). In later stage the disposed oil will be transported to the designed dump fill for the project area. Some chemical waste will be treated and recycled and other toxic and disposed chemicals will be collected and stored within the same temporary hazardous waste area to be transported to the designed dump fill for the project area.

In case the contractor cannot get approval or no objection for receiving all hazard wastes that would be generated from Duqm Port during operation, treatment facilities should be provided to treat all the toxic wastes or get an approval from Be'ah for having hazard wastes dump site.

6-4 Traffic and Transport Demand Forecast

It is realized that there will be developed traffic due to the planning and development activities in the port and most generated and developed traffic will be heavy vehicles. This may average the percentage of the heavy trucks in the traffic mix on the proposed road to about 60% while light traffic to about 40% of the total traffic. The average daily traffic volume on the proposed roads at ultimate year (2040) can be projected to be within 12,397 for the Duqm Port⁽¹⁰⁶⁾,⁽¹⁰⁷⁾. Table (6.2) gives the expected traffic volumes on the roads within the three packages (IP2 Commercial Berths, IP3 Commercial Quay and IP4 Governmental Berths) for two way peak-hour and daily trip generations, the ultimate phase, 2040.

¹⁰⁶ Khatib & Alami and Partners and Royal Haskoning 2013 Traffic Impact Study for IP4, April 2013

¹⁰⁷ Khatib & Alami and Partners and Royal Haskoning 2014 Traffic Impact Study for Port of Duqm – Commercial Quay “Zones 1, 2, 3 & 4” October 2014

Table (6. 2): IP2, IP3 and IP4, two way trip generations, ultimate phase

Zone	Peak-hour		Daily	
	Light traffic	Heavy truck	Light traffic	Heavy truck
IP2	210	314	1677	2515
IP3	278	416	2221	3331
IP4	38	56	301	451
Total	525	787	4198	6298

It must be noted that trip generation for the Ultimate Phase has been considered as a worst case scenario. The projected average daily traffic volumes for each package are presented in the following Figures.

The traffic generated by Commercial Berths, IP2 (262 vehicles during the peak-hour in each direction) and equivalent to 4192 two way daily traffic. The traffic generated by Pre-Gate and Commercial Quay, IP3 (347 vehicles during the peak-hour in each direction) and equivalent to 5552 two way daily traffic. The traffic generated by Governmental Berths (IP4) (47 vehicles during the peak-hour in each direction) and equivalent to 752 two way daily traffic.

It is assumed that as a worst case scenario, 100% of the traffic generated by Commercial Berths (262 vehicles during the peak-hour in each direction) and 20% of the traffic generated by Commercial Quay ($347 \times 20\% = 69$ vehicles during the peak-hour in each direction) will travel along Road 02 in both directions. The remaining 80% of the traffic generated by Commercial Quay ($347 \times 80\% = 278$ vehicles during the peak-hour in each direction) will travel along Road 02 in both directions (total daily traffic over 5,000 vehicles).

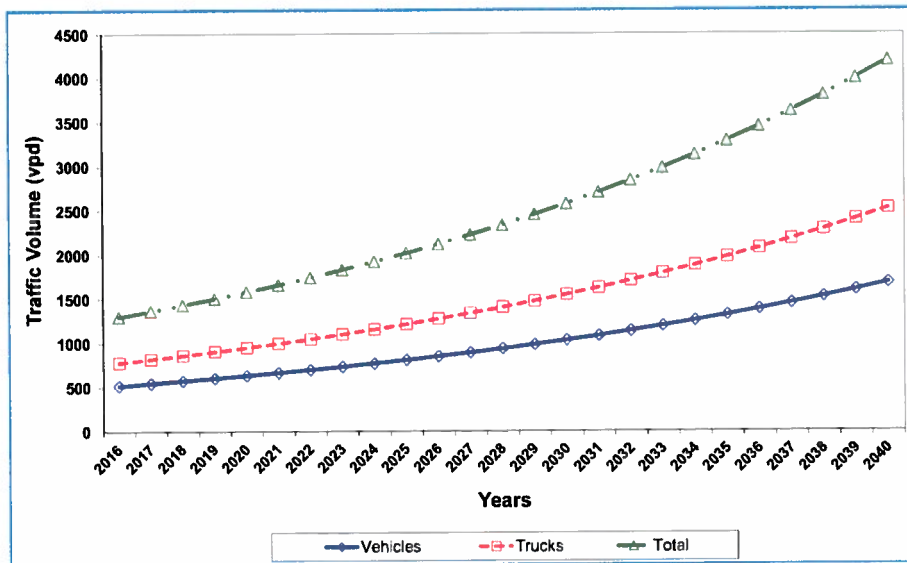


Figure (6.4) : Projected average daily traffic volumes for IP2 Commercial Berths

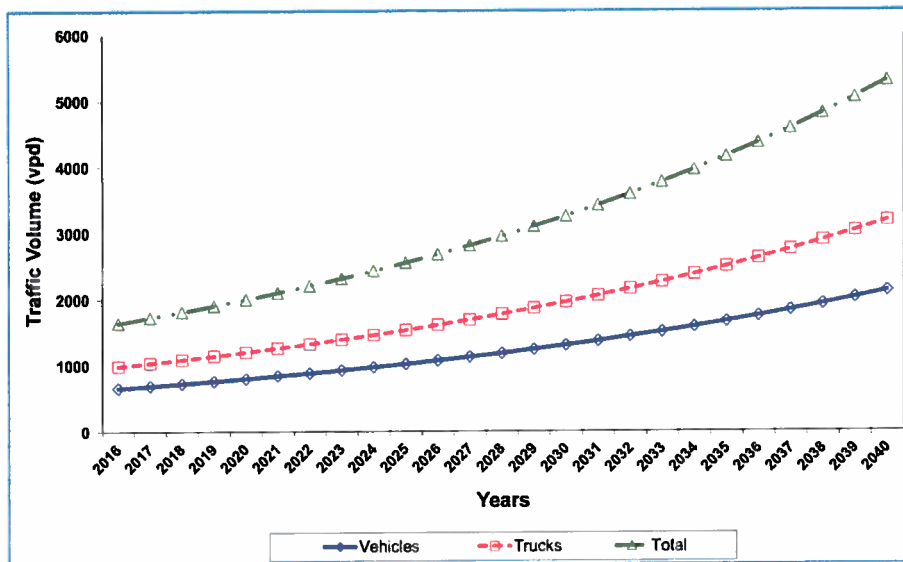


Figure (6.5) : Projected average daily traffic volumes for IP3 (Worst case scenario: 100% of IP2 and 20% of IP3)

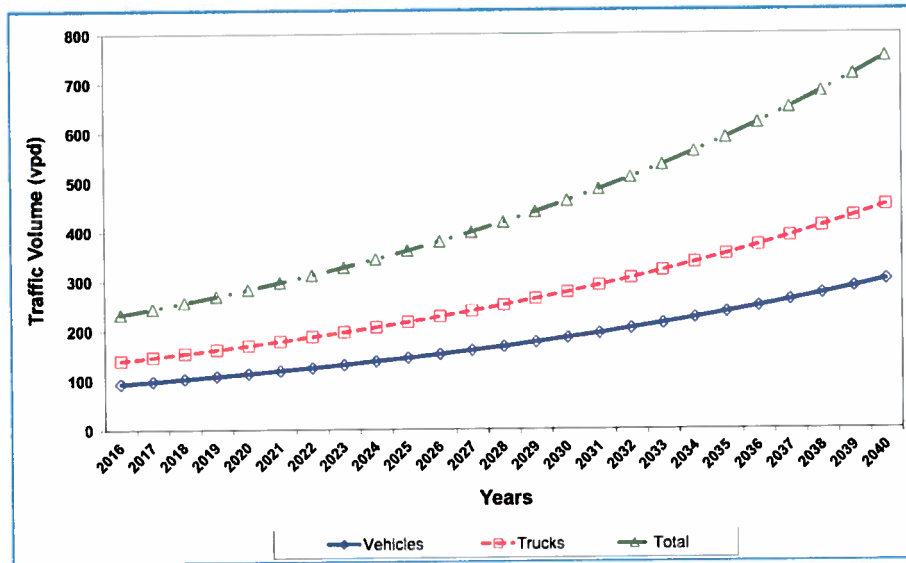


Figure (6.6) : Projected average daily traffic volumes for IP4 Governmental Berths

6-5 Noise and Vibration

6-5-1 Noise allowable limits

According to the regulations of noise control in public environment and workplace noise (MD 79/94) the limits for ambient noise levels from industrial sources are summarized in Table (6.3) .

Table (6.3) : Ambient Noise Standards

Type of District	Maximum Permissible Noise Level [as Leq in dB (A)]		
	Day Time (7 AM – 6 PM) workdays	Evening Time (6 PM – 11 PM) workdays	Night Time (11 PM – 7 AM) on workdays and all times on holidays
Rural residential and recreational	45	40	35
Sub-urban residential	50	45	40
Urban residential	55	50	45
Urban residential with some workshops or business city	60	55	50
Industrial and commercial	70	70	70

MD 80/94 specifies the regulations for noise pollution control in working environment. These regulations state that no employee shall be exposed to noise levels exceeding 85 dB(A). If the workplace noise level exceeds 85 dB(A), suitable ear protection devices shall be provided. The attenuation of such protection devices shall reduce the noise level to 80 dB (A) or lower.

The following Table (6.4) presents the WHO guideline¹⁰⁸ values arranged according to specific environments and critical health effects. The guideline values consider all identified adverse health effects for the specific environment. An adverse effect of noise refers to any temporary or long-term impairment of physical, psychological or social functioning that is associated with noise exposure. Specific noise limits have been set for each health effect, using the lowest noise level that produces an adverse health effect (i.e. the critical health effect). Although the guideline values refer to sound levels impacting the most exposed receiver at the listed environments, they are applicable to the general population. The time base for LAeq for "daytime" and "night-time" is 12–16 hours and 8 hours, respectively. No time base is given for evenings, but typically the guideline value should be 5–10 dB lower than in the daytime. Other time bases are recommended for schools, preschools and playgrounds, depending on activity.

¹⁰⁸ WHO, 1995, Guidelines for community Noise

Table (6. 4) : WHO Guideline values for community noise in specific environments

Specific environment	Critical health effect(s) LAeq [dB(A)]	LAeq [dB(A)]	Time base [hours]	LAmx fast [dB]
Outdoor living area	Serious annoyance, daytime and evening	55	16	-
	Moderate annoyance, daytime and evening	50	16	-
Dwelling, indoors Inside bedrooms	Speech intelligibility & moderate annoyance, daytime & evening	35	16	45
		30	8	
Outside bedrooms	Sleep disturbance, window open (outdoor values)	45	8	60
School class rooms & pre-schools, indoors	Speech intelligibility, disturbance of information extraction, message communication	35	During class	-
Pre-school bedrooms, indoor	Sleep disturbance	30	Sleeping time	45
School, playground outdoor	Annoyance (external source)	55	During play	-
Hospital, ward rooms, indoors	Sleep disturbance, night-time Sleep disturbance, daytime and evenings	30	8	40
		30	16	-
Hospitals, treatment rooms, indoors	Interference with rest and recovery	#1		
Industrial, commercial shopping and traffic areas, indoors and outdoors	Hearing impairment	70	24	110
Ceremonies, festivals and entertainment events	Hearing impairment (patrons:<5 times/year)	100	4	110
Public addresses, indoors and outdoors	Hearing impairment	85	1	110
Music and other sounds through headphones/ earphones	Hearing impairment (free field value)	85#4	1	110
Impulse sounds from toys, fireworks and firearms	Hearing impairment (adults) Hearing impairment (children)	-	-	140 #2
		-	-	120 #2
Outdoors in parkland and conservations areas	Disruption of tranquility	#3		

#1: As low as possible.

#2: Peak sound pressure (not LAF, max) measured 100 mm from the ear.

#3: Existing quiet outdoor areas should be preserved and the ratio of intruding noise to natural background sound should be kept low.

#4: Under headphones, adapted to free-field values.

6-5-2 Noise and vibration baseline

The Port Duqm area is undeveloped with the principal sources of noise and vibration present being the diesel fired Duqm Power Station, Dry Dock of Port Duqm which is recently in operation, the main coastal highway from Muscat to Salalah, local roads and Duqm village itself.

Studies and literature which are applicable to the Duqm area indicate that background noise levels are expected to be in the order of 20-30 dB(A) increasing to 30-50dB(A) within close proximity of the highway and Duqm Power station. Noise levels within Duqm village are expected in the range 30-50 dB(A). There are no significant sources of ground-borne vibration and vibration levels are expected to be negligible. This information will be gained for input into the PEIA.



Figure (6.7): Project area of Commercial & Governmental Berths and Commercial Quay undeveloped except the Dry Dock (Photo taken by SEZAD)

6-5-3 General sensitive receptors at Duqm area

Noise and vibration can travel several hundred meters from a source, depending on the transmission medium (air, ground or water) and the presence of attenuating features such as soft ground and barriers (e.g. buildings). The study area for noise and vibration has been defined as follows:

- Residential and sensitive terrestrial ecosystem receptors within 4km of the Port boundary;

- Residential and sensitive terrestrial ecosystem receptors within 1km of Roads carrying traffic flows greater than 5,000 vehicles per day (traffic volumes forecast presented in the previous section (6.4).
- Industrial sources within 4km of receptors identified above.

It's important to define the sensitive receptors within each package zone as well to define the impact on the local area. This will be identified for each package level in the following sections.

6-5-4 Impact analysis process

To define the impact of operation phase of the proposed three packages would require identifying three elements as follows:

- Sensitive receptors: the land use mapping data and local surveys to establish existing land and maritime use and the expected land and maritime use as dictated by the Duqm Master Plan. Receptors sensitive to noise and vibration include: residential properties; mosques; hotels and hospitals and marine mammals.
- Noise and vibration sources: these would include industrial activity if any, pumping stations, electrical switch station and workshop & maintenance building.
- Noise and vibration impact: this can be predicted through identify levels of noise indoor & outdoor and modeling technique.

6-5-5 Sensitive receptors and noise sources

I. Package (IP2): Commercial Berths

Sensitive receptors: There are no sensitive receptors within the Commercial Berths however, there are limited facilities for operation staff and manpower within the commercial berths can be identified as follows:

- Terminal administration building
- Training & amenities center
- Terminal (1) administration building
- Terminal (2) administration building
- Administration future extension

Noise and vibration sources

- Road network traffic:

- Impacts have predicted traffic volume for ultimate phase in section 6.4 and considered in modeling for accumulation impact, in case design speed 60 km/hr, noise level 10 m from main road is about 68.4 (L10, dB).
- Infrastructure Works:
 - Potable Water and Fire Fighting Network (Combined pump station)
 - Storm Water Drainage and Sewerage Network (pump stations)
 - Electrical works (11KV switch station)
- Building Works:
 - Workshop & maintenance building: Terminal (1) and Terminal (2)
 - Workshop & maintenance building: Container Terminal (2)
 - Workshop & maintenance building: Dry Bulk Terminal Area
- Crane Beam and Track Works
 - Terminal (1) and Terminal (2)

II. Package (IP3): Commercial Pre-Gate, Gates & Inspection Zone

Sensitive receptors: There are no sensitive receptors within the Commercial Pre-Gate however, there are limited facilities for operation staff and manpower within the commercial berths can be identified as follows:

- Inspection Zone: Administration inspection building, Ministry of Health Administration & Inspection Building and Clinic
- Gate and Pre-Gate Area: Mosque

Noise and vibration sources

- Road network traffic:
 - Impacts have predicted traffic volume for ultimate phase in section 6.4 and will be considered in modeling for accumulation impact, in case allowable speed 60 km/hr, noise level 10 m from the main road is about 72 (L10, dB).
- Infrastructure Works:
 - Potable Water and Fire Fighting Network (Combined pump stations)
 - Storm Water Drainage and Sewerage Network (pump stations)
 - Electrical works (11KV switch station)
- Building Works:
 - Workshop & maintenance building: Terminal (1) and Terminal (2)
 - Workshop & maintenance building: Container Terminal (2)
 - Workshop & maintenance building: Dry Bulk Terminal Area

- Crane Beam and Track Works
 - Terminal (1) and Terminal (2)

III. Package (IP4): Governmental Berths

Sensitive receptors: There are no sensitive receptors within the Governmental Berths however, there are limited facilities for Royal Oman Navy, police, operation staff and manpower within the commercial berths can be identified as follows:

- Royal Oman Yacht Compound (Zone 1): VIP Majlis, staff accommodation and administration building.
- Royal Oman Navy and Police Compounds (Zone 2 and 3): staff accommodation & dining and administration building.
- Sultan's Special Force (Zone 4): staff accommodation & dining and administration building
- Fast Ferry Terminal: Terminal building, staff accommodation and administration building.

Noise and vibration sources

- Road network traffic:
 - Impacts have predicted for traffic volume ultimate phase in section 6.4 and will be considered in modeling for accumulation impact, in case allowable speed 60 km/hr, noise level 10 m from the main road is about 61.2 (L10, dB).
- Infrastructure Works:
 - Potable Water and firefighting network (Combined pump station)
 - Fuel pumps
 - Storm water drainage and Sewerage network (pump stations)
 - Electrical works (11KV switch station) and Electrical Service Building

6-5-6 Noise modeling

Prediction of noise propagation for typical operation has been performed for noise from the main source of noise which is in this case the road network (two cases around 5000 vehicle per day at ultimate stage) and the other sources as well in the accumulation impact section (6.5.9).

The Federal Highway Administration (FHWA) of USA, Office of Natural and Human Environment, released the FHWA Traffic Noise Model (TNM 2.5, 2003), a state-of-the-art computer model for highway traffic noise prediction and analysis has been applied to three packages (IP2, IP3 and IP4) road network.

The Federal Highway Administration Traffic Noise Model (FHWA TNM®), computes a predicted noise level through a series of adjustments to a reference sound level. In the TNM, the reference level is the Vehicle Noise Emission Level, which refers to the maximum sound level emitted by a vehicle pas-by at a reference distance of 15 meters (50 feet). Adjustments are then made to the emission level to account for traffic flow, distance, and shielding. These factors are related by the following equation:

$$L_{Aeq1h} = EL_i + A_{\text{traff}(i)} + A_d + A_s, (1)$$

where EL_i represents the vehicle noise emission level for the i th vehicle type, $A_{\text{traff}(i)}$ represents the adjustment for traffic flow, the vehicle volume and speed for the i th vehicle type, A_d represents the adjustment for distance between the roadway and receiver and for the length of the roadway, and A_s represents the adjustment for all shielding and ground effects between the roadway and the receiver. The TNM is based on a three-dimensional coordinate system and detail is presented in Appendix (B).

The noise levels have been calculated for as presented in the following three Tables for the following speed and distance from the road network:

- Distances: 10, 20, 50 and 100 m from the main road
- Design Speed: 60, 80, and 100 km/hr

The equivalent A-weighted sound pressure level L_{Aeq} in dB(A) has been calculated for each package 1.5 meters above ground level. The activities are constant during normal operation and 12-hour daytime noise level has been calculated.

If the scheme operated at nighttime, the activities are equivalent to the daytime operation and noise level will be of the same magnitude. The design speed for roads network, as recommended by the Master Plan for the Ultimate Phase which is related to roadway classifications is 60 km/hr and posted speed is 40 km/hr.

6-5-7 Noise impact of road network operation

The operational noise level may be estimated by using the predicted traffic volume for worst case scenario described in the previous section and predicted rush hour volume. Using The Federal Highway Administration (FHWA) of USA, Office of Natural and Human Environment, released the FHWA Traffic Noise

Model (TNM 2.5, 2003)¹⁰⁹, Tables (6.5) to (6.7) summarizes the predicted noise levels (L10) along three proposed packages as follows:

- The traffic generated by Commercial Berths, IP2 equivalent to 4192 vehicles two way daily traffic.
- The traffic generated by Pre Gate and Commercial Quay, IP3 equivalent to 5552 vehicles two way daily traffic.
- The traffic generated by Governmental Berths (IP4) equivalent to 752 vehicles two way daily traffic.

¹⁰⁹ The Federal Highway Administration (FHWA) of USA, Office of Natural and Human Environment, released the FHWA Traffic Noise Model, TNM 2.5, 2003

Table (6. 5) : Predicted noise level (L10 , dB) along Commercial Berths Road

Year	2016	2020	2025	2030	2035	2040
Speed 60 km/h						
Dc = 10 meter	63.65	64.6	65.55	66.5	67.4	68.4
= 20 meter	60.8	61.5	62.4	63.1	63.6	64.6
= 50 meter	54.1	54.8	55.5	56.2	57.0	57.9
= 100 meter	49.4	49.8	51.0	51.7	52.4	53.2
Speed 80 km/h						
Dc = 10 meter	66.5	67.4	68.4	69.3	70.3	71.2
= 20 meter	62.7	63.6	64.6	65.5	66.5	67.4
= 50 meter	57.0	57.9	58.9	59.8	60.8	61.7
= 100 meter	50.3	51.3	52.2	53.2	54.1	55.1
Speed 100 km/h						
Dc = 10 meter	69.3	70.3	71.2	72.2	73.1	74.1
= 20 meter	64.6	65.5	66.5	67.4	68.4	69.3
= 50 meter	58.9	59.8	60.8	61.7	62.7	63.6
= 100 meter	54.1	55.1	56.0	57.0	57.9	58.9

Table (6. 6) : Predicted noise level (L10 , dB) for IP3, worst case scenario(100% of traffic generated by Commercial Berths and 20% of Commercial Quay)

Year	2016	2020	2025	2030	2035	2040
Speed 60 km/h						
Dc = 10 meter	67	68	69	70	71	72
= 20 meter	64	64.8	65.7	66.5	67	68
= 50 meter	57	57.7	58.5	59.2	60	61
= 100 meter	52	52.5	53.7	54.5	55.2	56
Speed 80 km/h						
Dc = 10 meter	70	71	72	73	74	75
= 20 meter	66	67	68	69	70	71
= 50 meter	60	61	62	63	64	65
= 100 meter	53	54	55	56	57	58
Speed 100 km/h						
Dc = 10 meter	73	74	75	76	77	78
= 20 meter	68	69	70	71	72	73
= 50 meter	62	63	64	65	66	67
= 100 meter	57	58	59	60	61	62

Table (6. 7): Predicted noise level (L10 , dB) along Governmental Berths Road

Year	2016	2020	2025	2030	2035	2040
Speed 60 km/h						
Dc = 10 meter	57.0	57.8	58.7	59.5	60.4	61.2
= 20 meter	54.4	55.1	55.8	56.5	57.0	57.8
= 50 meter	48.5	49.0	49.7	50.3	51.0	51.9
= 100 meter	44.2	44.6	45.6	46.3	46.9	47.6
Speed 80 km/h						
Dc = 10 meter	59.5	60.4	61.2	62.1	62.9	63.8
= 20 meter	56.1	57.0	57.8	58.7	59.5	60.4
= 50 meter	51.0	51.9	52.7	53.6	54.4	55.3
= 100 meter	45.1	45.9	46.8	47.6	48.5	49.3
Speed 100 km/h						
Dc = 10 meter	62.1	62.9	63.8	64.6	65.5	66.3
= 20 meter	57.8	58.7	59.5	60.4	61.2	62.1
= 50 meter	52.7	53.6	54.4	55.3	56.1	57.0
= 100 meter	48.5	49.3	50.2	51.0	51.9	52.7

Summary of maximum noise impact of the three packages at ultimate limit stage 2040 (Maximum traffic volume) for design speed 60 km/hr is as follows:

- Commercial Berths, IP2: 64.6, 57.9 and 53.2 (L10 , dB) at distance of 20, 50, 100 m respectively:
- Commercial Quay, IP3 (worst scenario): 68, 61 and 56 (L10 , dB) at distance of 20, 50, 100 m respectively:
- Governmental Berths, IP4: 57.8, 51.9 and 47.6 (L10 , dB) at distance of 20, 50, 100 m respectively:

The results of the noise prediction presented in the previous tables and briefed above show that noise generated by the operation of the facility will not have any impact on the noise levels at the nearest industrial, commercial, residential areas or within the proposed facilities of three packages where:

- The Noise level at distance 100 m and design speed 60 km/hr from the road network is less than 55 (L10 , dB) while the noise level at distance 200 m and posted speed 40 km/hr from the road network is less than 45 (L10 , dB).
- For example, assuming a typical tractor of noise level of 61 and 45 dB measured at a distance of 50 m, and 200 m, for 5 ni/s upwind and downwind cases. The two levels correspond to an average traffic on street corner and typical business office noise levels, respectively.

- There is no sensitive receptor during operation outside the project area of the three packages within 4.0 km
- There is no sensitive receptor during operation within the project area of the three packages within 200 m.

6-5-8 Noise and vibration impact of other facilities operation

The sensitive local receptors and potential sources of noise within the proposed facilities of the three packages are listed in section (6.5.3). The sources and noise levels are used for basis for assessment of environmental noise and its impact on the surrounding limited to the followings:

- Infrastructure Works:
 - Potable Water Network and Fire Fighting Network
 - Storm Water Drainage and Sewerage Network (pump stations)
 - Electrical works (11KV switch station) and Fuel station

The expected noise level inside the facilities is within 80 dB at distance 1.5 m and braked to less than 60 dB just outside the facilities.

- Building Works:
 - Workshop & maintenance building
 - Crane Beam and Track Works
 - Building Works: Electrical Service Building

The expected noise level inside the facilities is within 80 to 100 dB at distance 1.5 and braked to less than 70 dB just outside the facilities and to less than 50 dB after 100 to 200 m. Addition to ad hoc and for limited time is noise from ship movements and subsequent impact on marine mammals. The accumulation impacts will be predicted and presented in the following section (6.5.9).

No potential vibration impacts from operational activities and subsequent impact on local buildings are envisaged as any sensitive receptors are significantly and the activities themselves are expected to generate less vibration than construction activities.

Moreover, noise generated by the operation of the facility will not have any impact on the noise levels at the nearest industrial, commercial, residential areas or within the proposed facilities of three packages.

6-5-9 Noise accumulation impacts

The noise accumulation impacts of the roads networks, facilities within the three packages and from activities from surrounding environment (mainly the Dry Dock) will be predicted by noise simulation model. The resulting noise contour lines have been created by interpolation of the calculations.



Figure (6. 8) : Surrounding environment, Dry Dock facility impacting on the proposed packages, (Photo taken by SEZAD)

The noise accumulation impacts results presented in the following Figures (6.9) and (6.10) shows that:

- The noise level from operations are expected to be below 50 dB(A) at each package scheme boundary during operation.
- The impact of noise is very local to some operation facilities and doesn't impacting sensitive receptors. Workers in the immediate proximity of noisy tools and machinery to be protected from damage to their hearing by the use of PPE in accordance with Oman regulation.
- There is no potential impact to other sites environment out of the three packages zone including the nearest industrial, commercial or residential areas due to operation work.
- There is no impact on three packages; Commercial Berths (IP2), Commercial Pre-Gate, Gates & Inspection Zone (IP3) and Governmental Berths (IP4) from the surrounding environment (the only facility on operation is the Dry Dock¹¹⁰):

¹¹⁰ COWI, 2010, Ship Repair Yard and Dry Dock Complex in Duqm, Environmental Impact Assessment of the operation Phase

To preserve the outdoor land-use noise levels, it's recommended:

- Keep the maximum design speed at 60 km/hr within the commercial Berths and inception zone Commercial Quay and posted speed at 40 km/hr.
- Minimum distance to be kept, if possible, between the road and the nearest building is 20 meter for road speed of commercial Berths, inception zone & Commercial Quay and Governmental Berths.

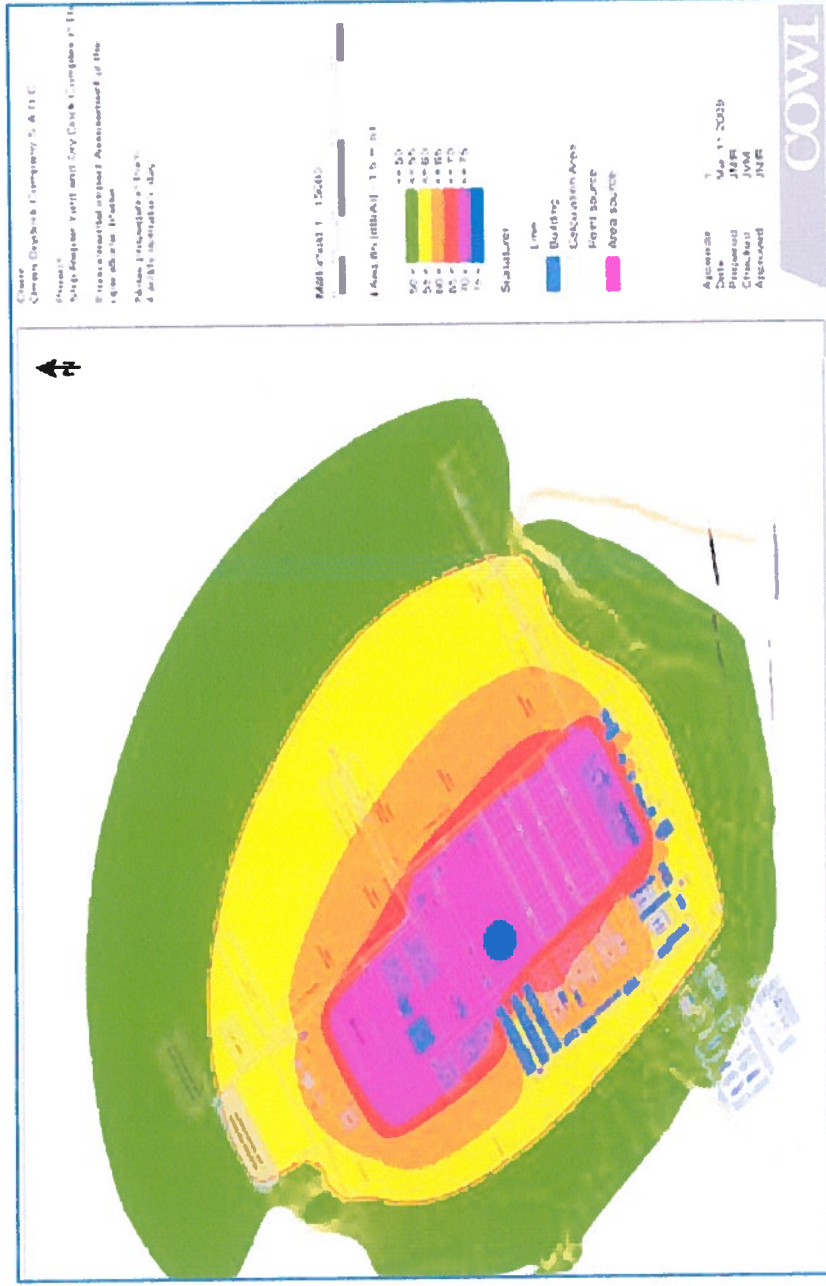


Figure (6.9): Prediction of Dry Dock impact on the proposed packages, COWI 2010

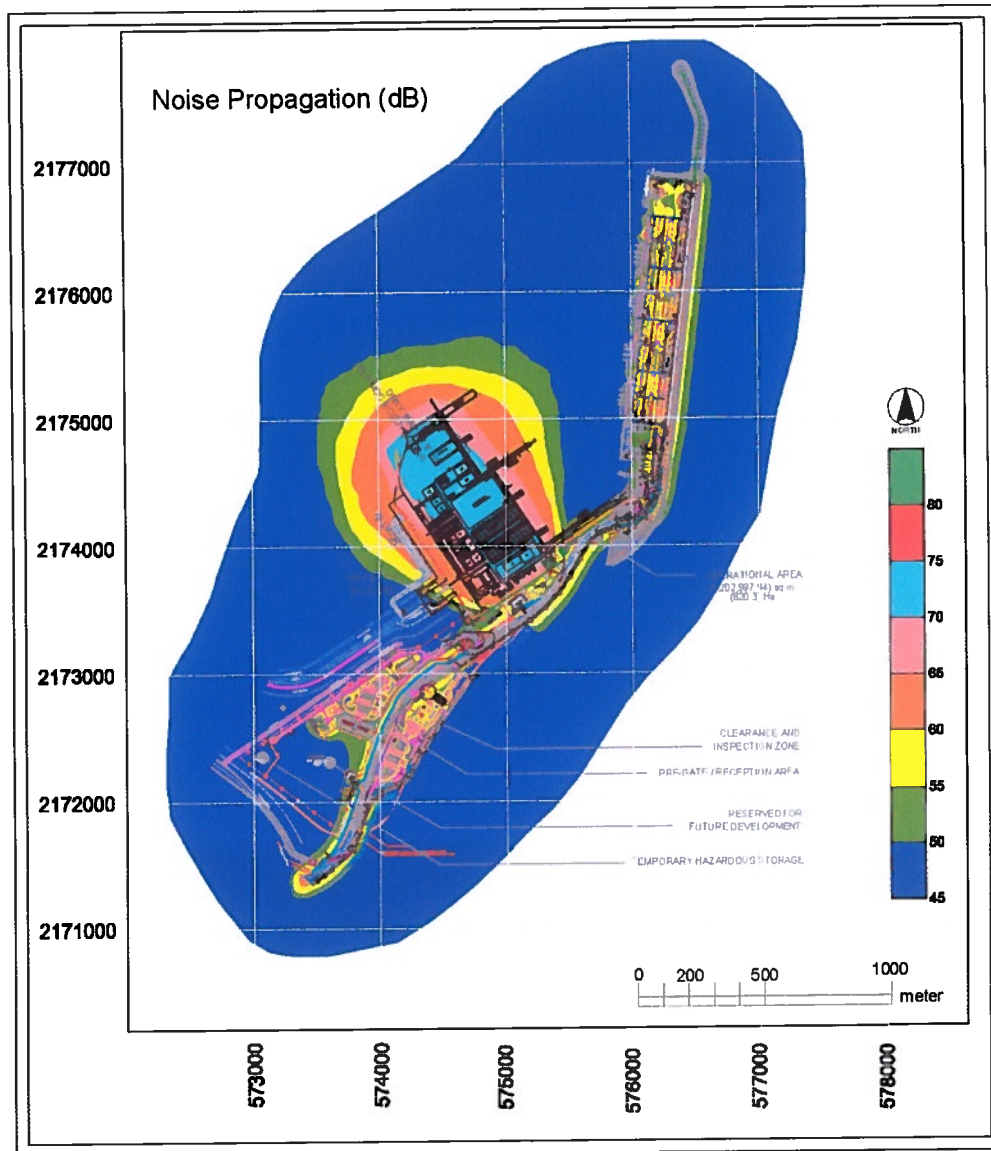


Figure (6. 10) : Prediction of accumulation impact of project area

6-6 Air Quality and Emissions

6-6-1 Air quality and emissions allowable limits

Omani regulations include MD 118/2004 air pollution from stationary sources regulation on controlling air pollutants (MD118/2004) issued by Ministry of Regional Municipalities, Environment & Water Resources, and Sultanate of Oman on August 7, 2004. In the table below the EU and the US standards for ambient air quality are listed. Oman has no air quality standard for ambient air within their legal framework.

Table (6. 8): EU and US EPA quality standards for ambient air

Pollutant	Unit	Averaging Period	EU Standard	USEPA standard
Sulphur Dioxide (SO ₂)	ug/m ³	1 hr	350 (5)	400 (1) 86
		24 hr	125 (6)	
		Annual	20	
Particulate Matter « 10 microns diameter)	ug/m ³	24 hr	50 (3)	150 (3)
		Annual	40	
Particulate matter <2.5 microns diameter)	ug/m ³	24 hr		35 (5)
		Annual	25	15 (4)
Nitrogen Oxides, as Nitrogen dioxide (NO ₂)	ug/m ³	1 hr	200 (4)	100
		Annual	40	
Photochemical Oxidants, as ozone (O ₃)	ug/m ³	1 hr	180 (1)	510 ug/m ³ (7)
		8hr	120 (2)	320 ug/m ³ (6)
Carbon Monoxide (CO)	mg/m ³	1 hr		40 (I)
		8hr	10	10 (I)
Hydrocarbons	ug/m ³			160

EU standard

Reference conditions are: temperature 293 K and 101.3 kPa

(1) Limit for information

(2) Target value

(3) Cannot be exceeded more than 35 times pr. year

(4) Cannot be exceeded more than 18 times pr. year

(5) Cannot be exceeded more than 24 times pr. year

(6) Cannot be exceeded more than 3 times pr. year

US EPA standard

Reference conditions are: temperature 298 K and pressure 101.3 kPa

(1) Not to be exceeded more than once per year.

(2) Final rule signed October 15, 2008.

(3) Not to be exceeded more than once per year on average over 3 years.

(4) To attain this standard, the 3-year average of the weighted annual mean PM_{2.5} concentrations from single or multiple community-oriented monitors must not exceed 15.0 ug/m³.

(5) To attain this standard, the 3-year average of the 98th percentile of 24-hour concentrations at each population-oriented monitor within an area must not exceed 35 ug/m³ (effective December 17, 2006).

(6) To attain this standard, the 3-year average of the fourth-highest daily maximum 8-hour average ozone concentrations measured at each monitor within an area over each year must not exceed 0.075 ppm. (effective as of May 27, 2008)

(7) (a) The standard is attained when the expected number of days per calendar year with maximum hourly average concentrations above 0.12 ppm is < 1. (b) As of June 15, 2005 EPA revoked the 1- hour ozone standard in all areas except the 8-hour ozone nonattainment Early Action Compact (EAC) Areas.

6-6-2 Air quality baseline

The Duqm area is still relatively undeveloped with the principal sources of air pollution present being the diesel fired Duqm Power Station, dry dock, the main coastal highway from Muscat to Salalah, local roads and Duqm village itself. There is significant ship and tanker traffic around the Arabic peninsula. The use of high sulphur marine fuel oil is a source of SO₂ emissions, as well as NO₂. The effect on the coastline is expected to be insignificant as most of the traffic will take place at considerable distance from the coastline. From a study of existing land use¹¹¹, local ambient air quality can be characterized as follows:

- Nitrogen dioxide and sulphur dioxide concentrations of these two combustion related pollutants are expected to be in the order of 5 – 15 µg/m³ as an annual mean and well below relevant short term and long term air quality standards and guidelines. Concentrations of these pollutants may be elevated near to the principal sources of air pollution identified above but remaining well below air quality criteria.

¹¹¹ Khatib & Alami and Partners, 2012: Port of Duqm Extension, Oman Environmental Scoping Report, Ministry of Transport and Communications, Sultanate of Oman 17 January 2012, Final Report - 9S8605

- Carbon monoxide concentrations, also combustion related, are expected to be in the order of 1.0 mg/m³ as a maximum 8-hour mean;
- Particulate concentrations are also associated with combustion but are dominated by natural levels concomitant with Gulf Region. Both short term and long term air quality standards and guidelines for particulates, either as TSP, PM₁₀, are expected to be breached due to natural levels.
- Acid gases (e.g. hydrogen chloride, hydrogen fluoride and hydrogen sulphide) are all expected to be negligible.
- Heavy metals (e.g. lead, mercury, cadmium, etc.) are all expected to be negligible.
- Dioxins and furans are all expected to be negligible.

6-6-3 Air quality modeling

The source of air pollution during operation of the proposed facilities of the three packages are roads carrying traffic flows greater than 5,000 vehicles per day (traffic volumes forecast presented in the previous section (6.4) in-addition to number of small capacity pumps. The impact of the activities is estimated using the US-EPA AERMOD dispersion model.

Output from the model includes ambient HC, CO and NO_x concentrations for the ultimate stage (2040) which are the most important parameters related to main source of air pollution within the three packages. The model accounts in this case for partial retention of emissions within the pit by calculating an escape fraction for each particle size category. The variations in escape fractions across particle sizes result in a modified distribution of mass escaping from the pit.

6-6-4 Emission impact of road network operation

The operational emission levels were estimated by using the predicted traffic volume for worst case scenario described in the previous section and predicted rush hour volume. The impact of the activities is estimated using the US-EPA AERMOD dispersion model. Figures (6.11) to (6.16) and Appendix (C) illustrate the predicted emission (CO, NO_x and HC) along three proposed packages.

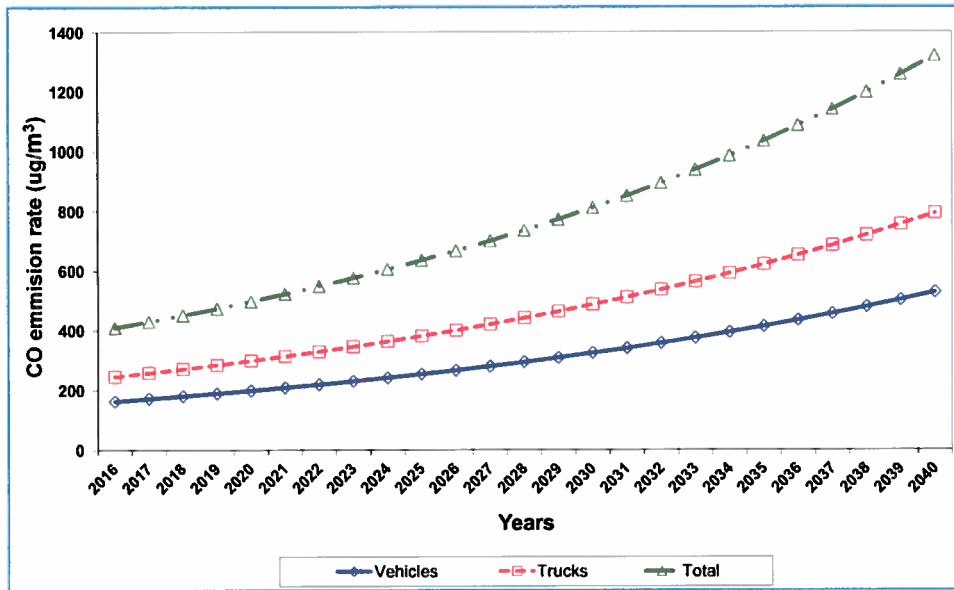


Figure (6. 11): Predicted CO traffic emission rate for Commercial Berths

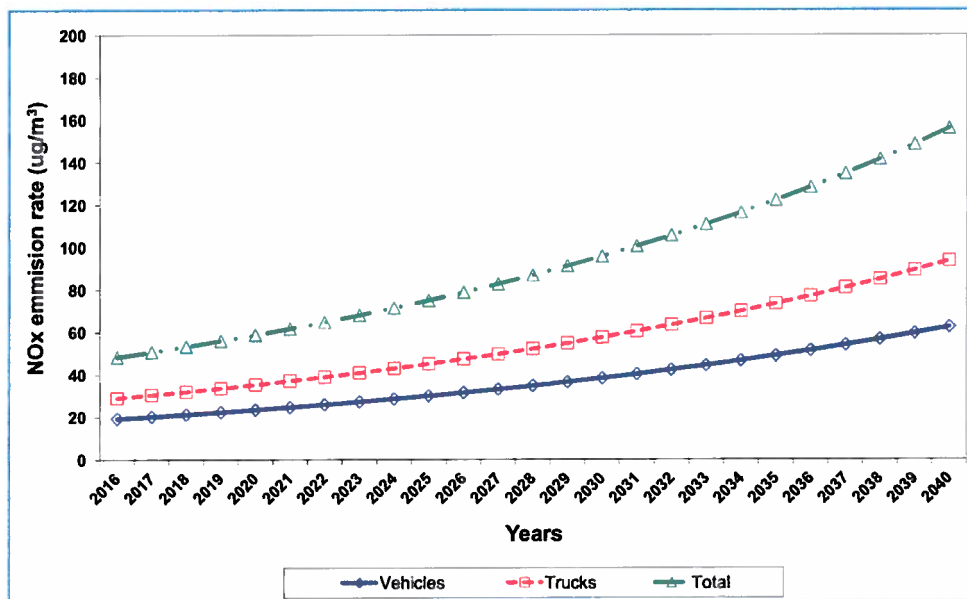


Figure (6. 12): Predicted NO_x traffic emission rate for Commercial Berths

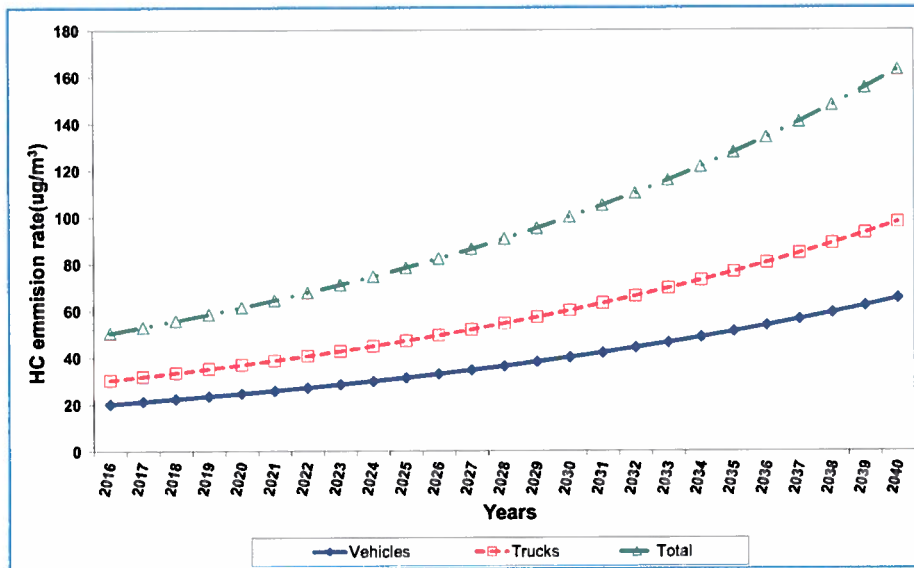


Figure (6. 13): Predicted HC traffic emission rate for Commercial Berths

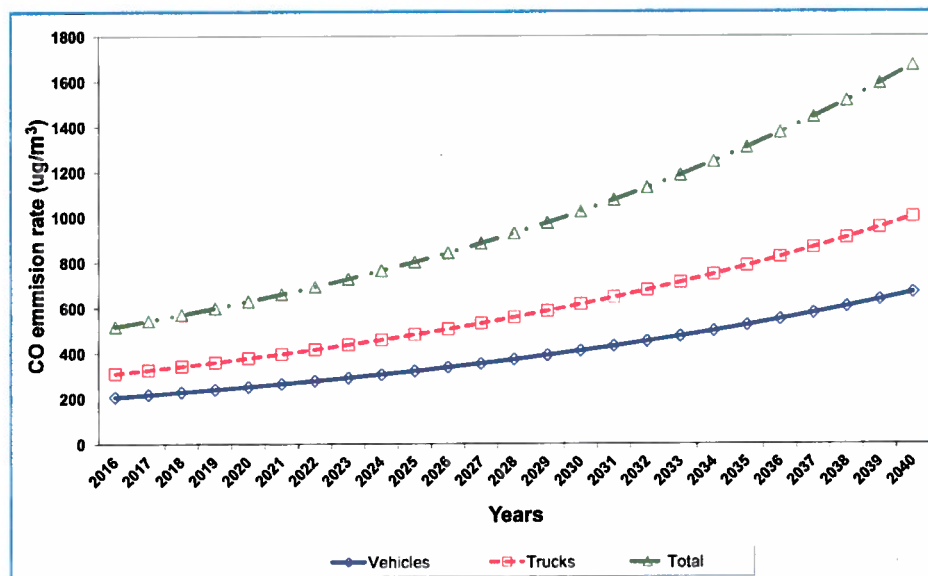


Figure (6. 14): Predicted CO traffic emission rate for IP3, worst case scenario (100% of traffic generated by Commercial Berths and 20% of Commercial Quay)

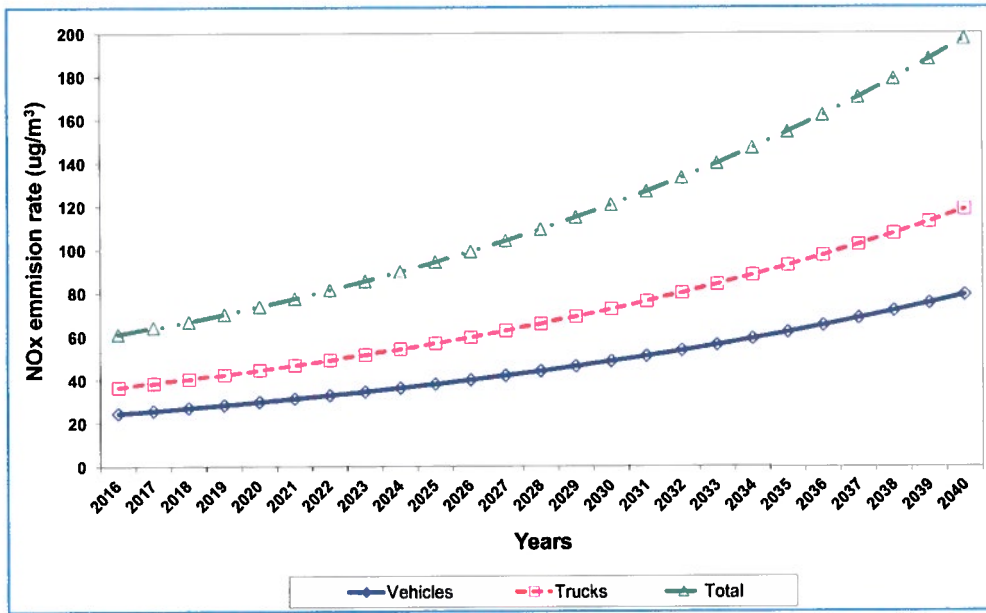


Figure (6. 15): Predicted NO_x traffic emission rate for IP3, worst case scenario (100% of traffic generated by Commercial Berths and 20% of Commercial Quay)

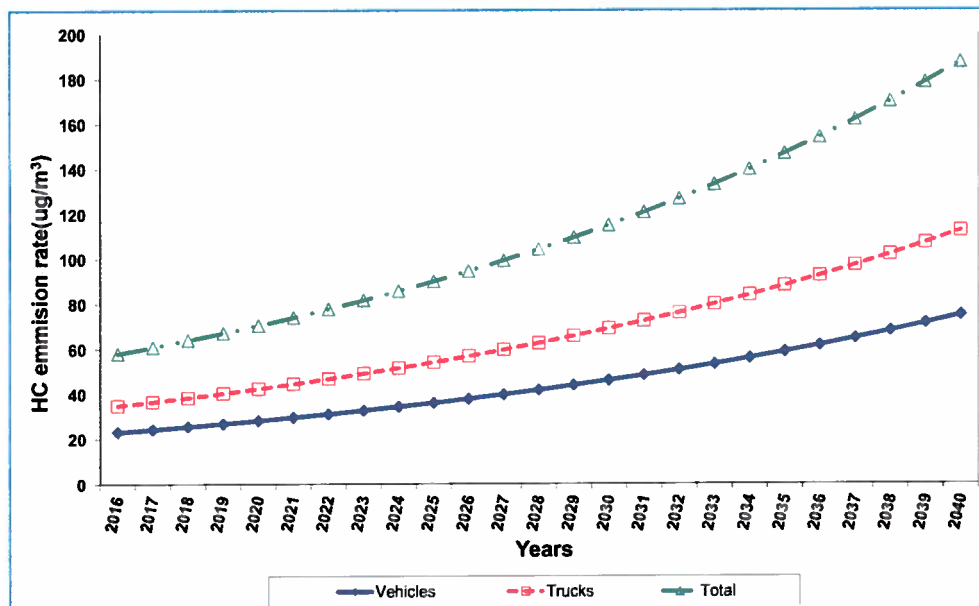


Figure (6. 16): Predicted HC traffic emission rate for IP3, worst case scenario (100% of traffic generated by Commercial Berths and 20% of Commercial Quay)

To predict the CO, NO_x, and HC levels surrounding the roads, the following assumptions have been adopted:

- the automotive emissions have been treated as ground-level source with a mixing height of 2.5 m.
- a wind speed of 1 m/s has been used to simulate a low wind episode;
- a moderately stable Pasquill atmospheric condition has been used to simulate low values of horizontal and vertical mixing.

From the figures above, the emissions levels at a distance of 50-m off the roads (all packages) up to 2040 are less than and sometimes approaching the allowed levels where:

- The Carbon Monoxide levels (1800 ug/m³) are much less than the standards (40 mg/m³) for both directions.
- The NO_x levels (190 ug/m³) are approaching the 1.0 hr standards (200 ug/m³) for both directions.
- The Hydro Carbon levels are approaching the 3.0 hr standards (160 ug/m³) for both directions. It is worth mentioning that the concentrations are decreasing exponentially as function of the distance from the road centerline.

There would no impact to other potential sites out of the three packages zone and within the proposed packages due to roads operation. There is minor impact at a distance up to 50-m off the road (very local impact) regarding Hydro Carbon starting from 2037 for the worst scenario.

6-6-5 Emissions impact of other facilities operation

The sensitive local receptors and potential sources of emissions within the proposed facilities of the three packages are listed in section (6.5.3). Table (6.9) including the pumps distribution downstream the oil water separators as well.

Table (6.9) : Oil water separators pumps distribution within the three packages

Label	Max. Flow (25 yr)(l/s)	Area Name	Pumps Numbers & Configuration	Pump Req. Each	Power Demand Consumption
CB1	630	ROY	4 pumps (3 duty+ 1 standby)	210l/s @16 m head	165 kw
CB2	572	ROY	3 pumps (2 duty+ 1 standby)	286 l/s @15 m head	160 kw
CB3	864	RON	4 pumps (3 duty+ 1 standby)	288 l/s @18 m head	270 kw
CB4	410	ROP	3 pumps (2 duty+ 1 standby)	210 l/s @18 m head	110 kw
CB5	480	ROP	3 pumps (2 duty+1 standby)	240 l/s @18 m head	150 kw
CB6	404	SSF	3 pumps (2 duty+ 1 standby)	210 l/s @18 m head	110 kw
CB7	466	FFT	3 pumps (2 duty+ 1 standby)	240 l/s @18 m head	150 kw
CB8	1692	FFT	4 pumps (3 duty+ 1 standby)	565/s @16 m head	375 kw

The emission generated by the operation of the infrastructure (pumps and electrical switch) and buildings (workshops) facility will not have any impact on the emission levels at the nearest industrial, commercial, residential areas or within the proposed facilities of three packages where:

- For the general air pollutants (HC, NO_x and CO) it is found that the emissions are limited and do not result in violations of international criteria for ambient air quality outside the perimeter of and for dioxins the emissions are considered to be negligible.
- Dust and particulate emissions (PM₁₀) that will result from the movement of site vehicles and mobile plant will be negligible where all road will be well paved;
- Addition to ad hoc and for limited time is emissions from ship movements.
- No sources of other emission pollutants are expected where no real industrial activities within the three packages facilities which are limited by small capacity pumps with limited fuel consumption as presented in the previous table (6.9) and small workshops for maintenances.

6-6-6 Emissions accumulation impacts

The emissions accumulation impacts of the roads networks, facilities within the three packages; mainly pump stations and activities from surrounding environment (mainly the blasting of Dry Dock) will be predicted by simulation

model. There is number of pumps serving wastewater and water supply in addition to submersible pumps used in a wet well to dispose the water to designated outfalls. The resulting contour lines have been created by interpolation of the calculations.



Figure (6. 17): Potential impact of Dry Dock facility on the proposed packages
(Photo taken K&A, 12- 2014)

The emissions impact from Dry Dock and the emissions accumulation impact results presented in the following Figures (6.18) and (6.19) for the project area respectively show that:

- **Surrounding environment impacts¹¹²**
 - The impacts of the repair and maintenance activities on ambient air quality out- side the perimeter of the dry dock and shipyard premises have been assessed for dust resulting from blasting activities, organic solvents (represented by xylene) from hull painting processes, general air pollutants from stacks and exhausts (NO_x and SO₂) and dioxins (from the incineration plant).
 - For the general air pollutants it is found that the emissions are limited and do not result in violations of international criteria for

¹¹² COWI, 2010, Ship Repair Yard and Dry Dock Complex in Duqm, Environmental Impact Assessment of the operation Phase

ambient air quality outside the perimeter of the dry dock/shipyard and for dioxins the emissions are considered to be negligible.

- With regard to dust, the standards for PM10 will be exceeded up to 300 meters outside the perimeter in the worst case, i.e. if NIX blasting is carried out with- out any measure to mitigate the influence of wind.
- For organic solvents (xylene) no Omani or internationally recognized (e.g. EU or US EPA) standards exist for ambient air and as such no limits or regulations are violated. However, if comparing with standards from Denmark and Ontario (Canada) the xylene levels are found to exceed

the (Danish) standard for annual average concentrations at a distance up to 4.5 km from the source

▪ **Proposed Packages Impacts**

- The main source of emission due to operation of the three proposed packages is the Roads carrying traffic flows greater than 5,000 vehicles per day (IP2 and IP3: Commercial Berths and Quay).
- There would no impact to other potential sites out of the three packages zone and within the proposed packages due to roads operation. There is minor impact at a distance up to 50-m off the road (very local impact) regarding Hydro Carbon starting from 2037 for the worst scenario.
- For the general air pollutants (HC, NO_x and CO) it is found that the emissions are limited and do not result in violations of international criteria for ambient air quality outside the perimeter of and for dioxins the emissions are considered to be negligible.
- Dust and particulate emissions (PM10) that will result from the movement of site vehicles and mobile plant will be negligible where all roads will be well paved;
- No sources of other emission pollutants are expected where no real industrial activities within the three packages facilities which are limited by small capacity pumps with limited fuel consumption
- There is no potential impact to other sites environment out of the three packages zone including the nearest industrial, commercial or residential areas due to operation work.

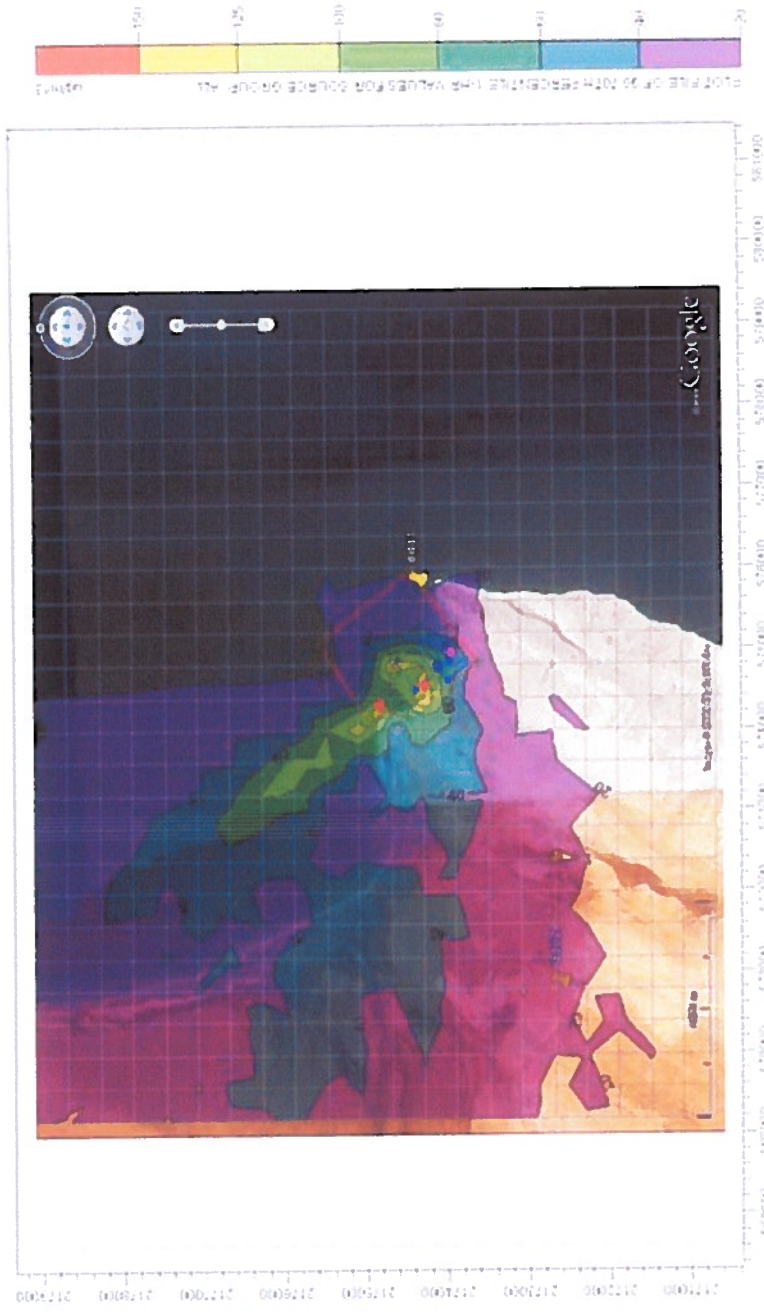


Figure (6. 18) : Prediction of potential impact of NO_x from Dry Dock on the project area, COWI 2010

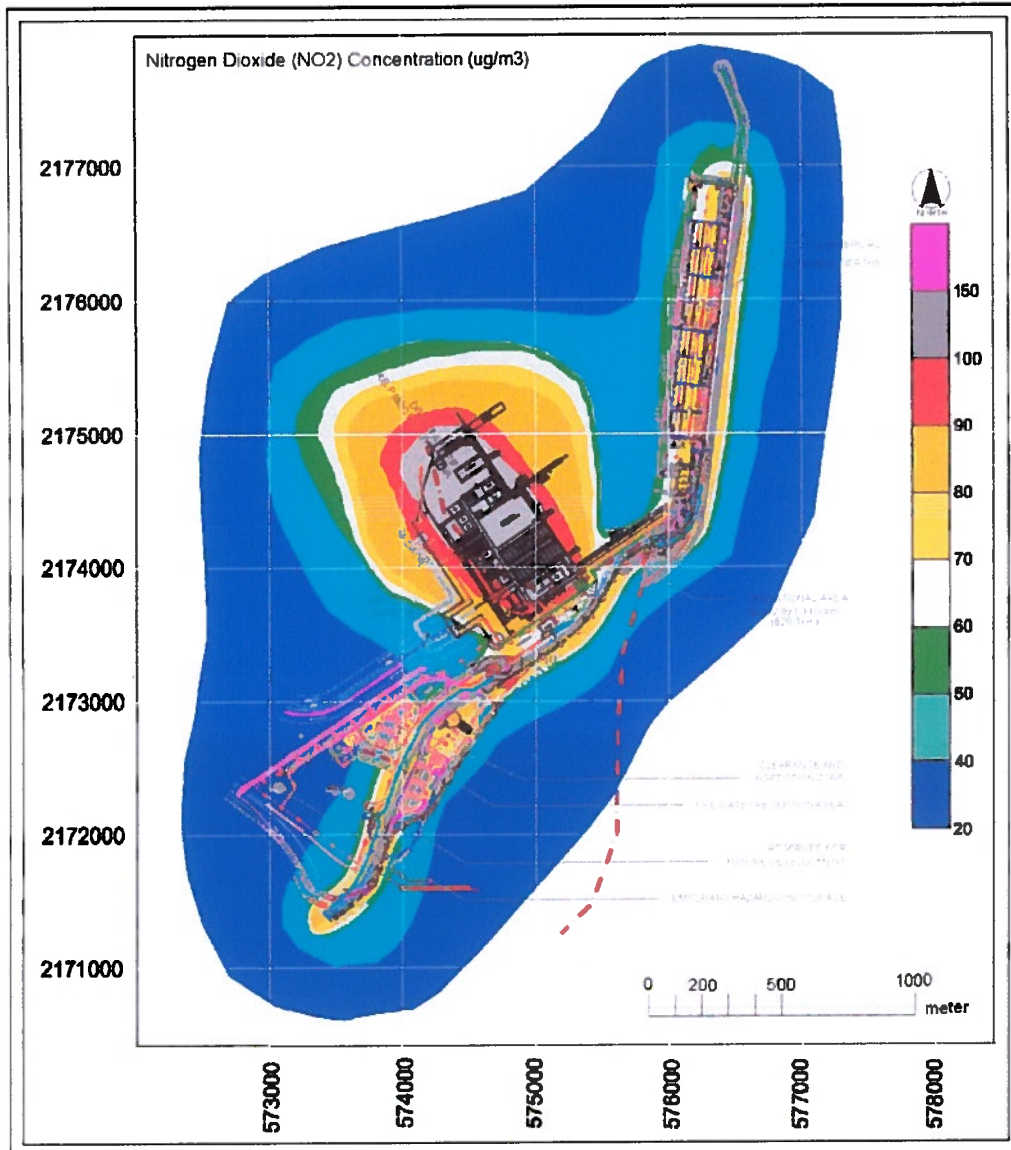


Figure (6. 19): Prediction of emissions (NO_x) accumulation impact of project area

6-7 Cultural Heritage and Recreation Landscape

6-7-1 Cultural heritage

The impact is limited to vehicle movements, personnel and tourists in the landside port areas out of the three packages zone. All sites remain vulnerable until mitigation measures have been implemented. Ideally pre-Islamic burial cairns can be built into landscaping works, that include appropriate barriers, notices etc. but with some interpretative material to explain to people the importance of each site and its local context.

There is no site for cultural heritage has been found during land reclamation of the three packages. So, this impact can be classified as minor impact on cultural heritage sites



**Figure (6. 20): Rock garden protected north of the project area
(SEZAD Website)**

6-7-2 Recreation landscape

The Duqm area, especially the coastal region, is used for informal camping by visitors to the area (sometimes these visits include swimming, exploration, bird watching, and fossil hunting). The Duqm area is not presently used as a stopover destination, as it is situated 180km from Haima, which is on the more heavily trafficked Muscat to Salalah road. The road from Duqm to Haima was recently tarmacked. There are no hotels or formal camping facilities in Duqm Port. Outside the port to the south there is Crowne Plaza hotel serving mostly the touristic and recreation activities. Developing the Duqm area would lead to more development of recreation, touristic activities and hotels which induces more tourists.



Figure (6. 21): Birds along the beach before Port of Duqm development



(SEZAD Website)

**Figure (6. 22): Birds on land side during land reclamation of Commercial Berths
(Photo taken by K& A, 12- 2014)**

This impact during operation phase can be classified as minor to moderate positive impact on recreation landscape sites. Depending on the availability of space, the plans can incorporate development of recreational areas and tourist attractions for all age groups. For example:

- Educational and recreational tours can be organized in the Port area for locals and tourists for bird watching, fishing, walking and generally enjoying nature;
- The construction of a water-related theme park;
- Facilities for sailing and fishing in the coastal area;
- Organized tours of the harbour area (e.g. Port of Rotterdam)
- Developing a waterfront aimed at looking at ship passages and maneuvering

6-8 Hydrogeology and Geology

6-8-1 Soil and groundwater

The PEIA study area for soil and groundwater includes three packages area (IP2, IP3 and IP4) within the port boundary. Analysis of the soils, especially at tidal inlets,

indicates that soils are generally sandy silts with marine clay content of less than 5%. The beach area consists of sand and recent coastal dunes.

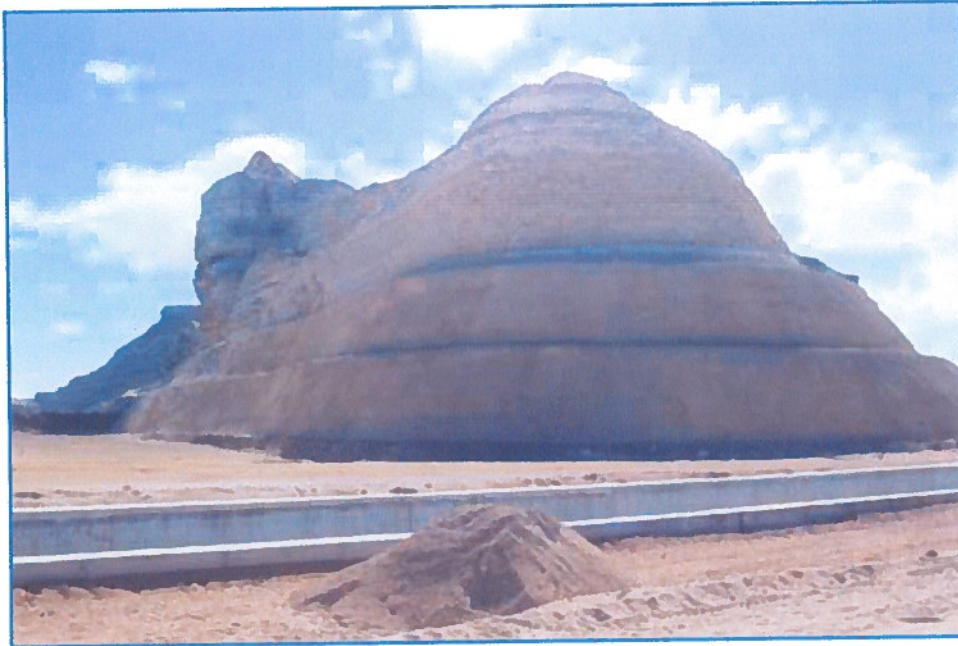
Future site operation may lead to impacts to soil and or groundwater beneath the site. Activities such as chemical handling, loading of products, and liquid bulk storage etc have potential for affecting the environment and specifically soil and or groundwater beneath the site.

Many measures have been considered in the design to protect soil and groundwater and minimizing leakages So, there would be minor potential impact to soil and groundwater within the some facilitates within the three packages and no potential impact to other sites out of the three packages zone due to operation works.

6-8-2 Geology

The direct impact on the important geological formations within and surrounding the site (the sea cliffs which consist of ancient marine fossils and the Huqf Formation) will be negligible as construction of the three packages will not interfere with these historical formations.

There is only one geological site (Ras Duqm) nearby the three packages found south of Commercial Berths as presented in the following Figure. Ras Duqm has been protected and care has been taken during land reclamation of the proposed packages.



**Figure (6. 23): Ras Duqm south boundary of the Commercial Berths
(Photo taken by K& A, 12- 2014)**

Nevertheless, in order to avoid damage to the proposed facilities from natural slumping of cliff materials, a safety fence will be constructed. It should be recognized that the formations represent a very interesting natural resource in that fossils and remains from the former seabed can be observed amongst the cliffs. This resource interest has the potential to attract geologists, archaeologists and ecotourists.

6-8-3 Hydrogeology

The wadis channel and the rerouting path within the port area is not part of the proposed packages as seen in the following Figure, however, uncontrolled wadis flow can cause slight to moderate damage to geological site and soil due to erosion. Moreover, it would impact the existing road network and any the development scheme to be implemented within the project area. Drainage hydraulic structures have been designed to allow smooth flow of water during the peak flow of the wadis as shown in Figure (6.25). So, the proposed project will have major positive impacts in terms of wadis flow movement within project area.

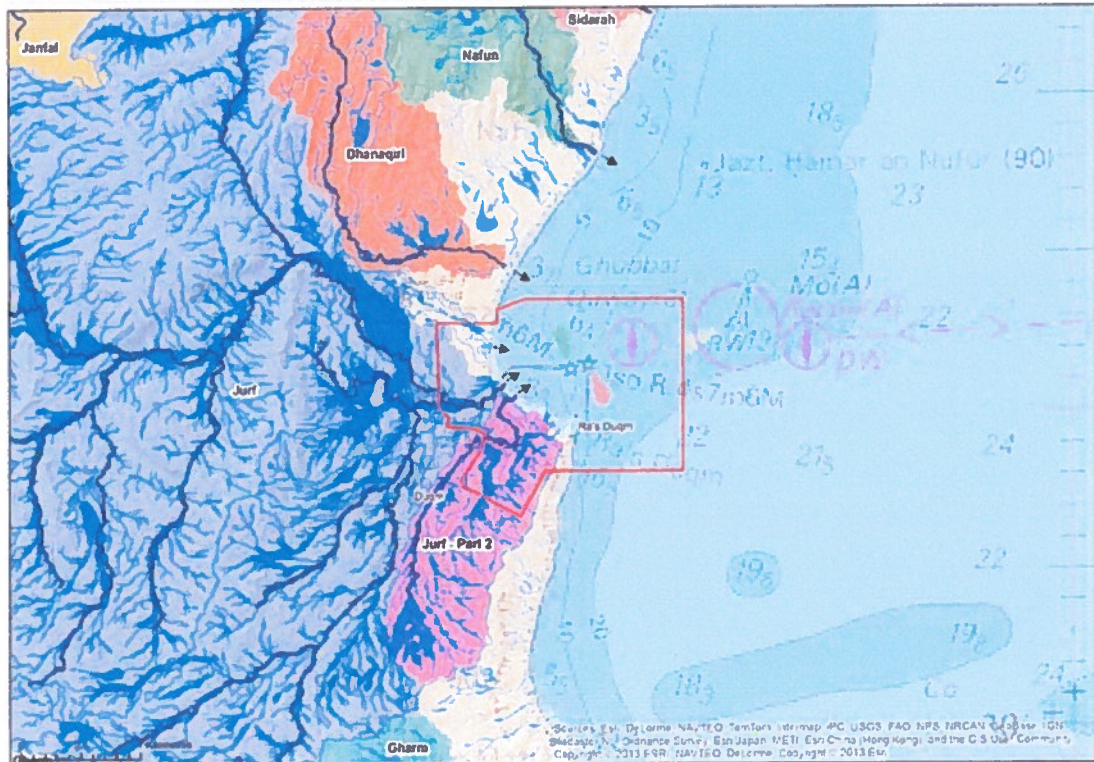


Figure (6. 24) : Main wadis within Duqm area outside the proposed packages zone



**Figure (6. 25): One of drainage hydraulic structures at Wadi crossing road
(Photo taken by K& A, 12- 2014)**

6-9 Marine and Coastal Ecology

6-9-1 Marine water and sediment quality

The impact is limited to landside works and potentially could be due effect of surface water run-off from the proposed development on water quality and accidental spillage and run-off of contaminants from onshore activities and ships during transit to the Port and inside the Port. The impact can be classified as a minor due to well design and mitigation measures will be considered.

6-9-2 Coastal ecology

The Duqm area does not have any formal national or international designations for marine or coastal conservation. Areas further to the north (approximately 200km) are considered ecologically richer and more diverse due to the range of habitats including mangrove and coral reef. Nevertheless, Duqm has a number of important habitats and species, which are likely to be sensitive to disturbance and development and form part of the regional ecosystem.

As part of the Oman National Oil Spill Contingency Plan (NOSPC), the marine resources have been mapped for the whole coastline of Oman. In addition, two sets of coastal zone vulnerability maps have been produced on coastal geomorphology and coastal marine resources. The description assigned to each coastal region indicates the level of vulnerability of the marine resource to oil spills. The bay at Duqm is designated as 'extremely vulnerable' likely due to its classification as an Important Bird Area by Birdlife International because of the number and variety of bird species it supports. The cliffs to the south of the bay are 'moderately vulnerable' due to the algal turfs on the rocky cliffs. Ghubbat Quwayrat to the north is 'slightly vulnerable'. The study area is understood to comprise the following intertidal and marine habitats; intertidal (sandy beach, rocky shore, Khwars and tidal inlets); and subtidal (sandy sediment, and rocky rubble / sandy habitats).

The impact is limited to landside works and potentially could be due effect of surface water run-off from the proposed development on water quality and accidental spillage and run-off of contaminants from onshore activities and ships during transit to the Port and inside the Port. The impact can be classified as minor due to well design and mitigation measures will be considered.

6-10 Aquaculture Ecology (Marine Mammals and Turtles)

Marine mammals in Oman include over 19 species of whales and dolphins, the recorded occurrence of which is stored on the Oman Cetacean Database (OMCD), held at the Oman Natural History Museum (Baldwin et al., 1999) and with ESO. These include three species of baleen whales (mysticetes), which prey largely on small fishes and crustaceans in relatively shallow or surface waters. The remainder of the species are toothed whales and dolphins (odontocetes), which are top predators feeding in both deep and shallow waters on a wide range of prey. The majority of species are known to be breeding residents of Oman. The species known to occur in Oman are either recorded or considered highly likely to occur within a 100km of Duqm, as this area is known to be very important for cetaceans, with a highly varied habitat and productive waters.

Of the larger whales, the Bryde's whale and humpback whales are the most frequently recorded in the area both of which are known to feed and breed. The same is probably true of the sperm whale. Little is known about the rare blue whales, but there appears to be some seasonality to the sighting records, which suggests a migratory route through the area in winter months¹¹³.

Of particular note, the seas around Duqm are known to be important for humpback whales. In Oman, humpback whales have now been confirmed to be a non-migratory population within the Arabian Sea region (Minton, 2004), leading the International Whaling Commission (IWC) to formally nominate this population as the Arabian Sea humpback whale population. The population has been identified as being genetically and geographically isolated and known to be in decline, with fewer than 100 individuals remaining (Minton, 2004). It is listed as Endangered by IUCN (Minton et al., 2008) and is known to be one of the rarest baleen whale populations in the world. This population is becoming of very high international importance and a high priority for the international research and conservation authorities, such as the IWC (IWC, 2010; Baldwin et al., 2010), and it is therefore essential that Port development considers potential impacts carefully and thoroughly. ESO recently commenced some acoustic research and monitoring, and vessel-based surveys offshore from the Duqm Port area in 2012 and 2013. Survey work is still on-going, though the data will not be analyzed as yet.

The current usage of the area adjacent to Duqm by marine turtles is not known in great detail. However, it has been established by several studies that nearshore areas adjacent to Duqm are part of the main feeding grounds for green and loggerhead turtles¹¹⁴. Feeding also occurs sporadically along much of the length of the Al Wusta coast.

¹¹³ Baldwin, R. M. (2003). Whales and Dolphins of Arabia. Mazoon Printing Press, Muscat, Sultanate of Oman. Pp 111

¹¹⁴ Ross J. P. (1998). Estimations of the nesting population size of loggerhead sea turtles, *Caretta caretta*, Masirah Island, Sultanate of Oman. Pages 84-87 in Epperly, S. P. ,Braun, J. Compilers, Proceedings of the Seventeenth Annual Sea Turtle Symposium. NOAA Technical Memorandum NMFS-SEFSC-415.

The cetacean and turtle populations that are known to occur around Duqm are internationally-recognized as being globally important in terms of their conservation and scientific value. This perceived value has made them the subject of significant national and international media attention. Among current international media teams with a focus on cetaceans and turtles in Oman are well known organizations such as the BBC Natural History Unit, National Geographic magazine and Al Jazeera. Within Oman, all of the major English and Arabic media have covered stories on cetaceans and turtles in Oman this year.

There are some potential pollutant sources during the operation phase, which may result in chronic pollution of the environment. Cetaceans are particularly susceptible to accumulation of pollutants through bio-magnification along the food chain and certain pollutants (e.g. hydrocarbons) accumulate in the high lipid content of cetacean bodies and can be passed from mothers to suckling offspring.

Port facilities include those to encourage increased fishing effort in the region which may result in increased by-catch and changes to trophic dynamics of prey species of cetaceans and turtles. There is a potential for light pollution impact on any remaining turtle nesting beaches within the area. The impact can be classified as minor to moderate.

6-11 Terrestrial Ecology and Ornithology

6-11-1 Terrestrial ecology - flora

The terrestrial flora in the area consists mainly of Halophytes (typically covering 15-30% of the substrate) and psammophytes. Halophytes are plants that are adapted to saline substrates and species found on the edge of the sabkha and coastline. Psammophytes get their nutrients from dew and calcium carbonate. They are found inland behind sand producing areas such as coastlines that are exposed to monsoon winds. The plants are effective sand binders. Species found on site include the evergreen succulent semi-shrub *Zygophyllum qatarense*. *Salsola rubescens* was also present, which is a common dwarf shrub that is found on rock outcrops.



Figure (6. 26): View of flora covering undeveloped area within Duqm port
(Photo taken by K& A, 12- 2014)

6-11-2 Terrestrial Ecology - Fauna

The Arabian Oryx (Al Maha) Sanctuary formally listed as an UNESCO world heritage site, situated 60km inland from Duqm, is a declared protected area by Royal Decree No. 04/94 and is managed by the DIWAN of the Royal Court (Advisor for Conservation of the Environment) and the MRMWR Nature Conservation Department. The Sanctuary is divided into three zones according to its sensitivity. The area further towards the desert to the west is the most sensitive and the area closer to Duqm coast in the east is the least sensitive¹¹⁵, and it is therefore not deemed of relevance to this development and therefore does not need any further study.

Gazelles have also been observed in the area and would once have been likely to be occasional visitors to the port area, perhaps in the early morning or evening, though not so much now with all the human disturbance. The gazelles that can be found in the area include the Reem Gazelle and the Arabian Gazelle. The Nubian Ibex occurs in the hills of the coastal plain of Duqm and Arabian wolves may be present on beaches and coastal plains. The red fox was observed in the cliffs of Ras Duqm, and

¹¹⁵ IWC (2010). Scientific Committee Report, document IWC/62/Rep 1. 91pp plus annexes.

Ruppell's sand fox may be encountered in the area. Hares may also be present in the rocky area, whilst other mammals found in the dune belt include the lesser three-toed jerboa. The diversity of fauna at Duqm is valuable and likely to be sensitive to anthropogenic changes. Arid ecosystems are inhabited by a large number of insects, most of them with nocturnal activities. The site is likely to be dominated by beetles (Coleoptera) with the family Tenebrionidae that inhabit arid/desert ecosystems.

6-11-3 Ornithology

The port boundary contains a large area of intertidal sand and mudflats (comprising of sabkha), both within the breakwaters (now only in the area to the north-west of the Government berth) and to the north adjacent to the planned liquid storage area. The area has historically been known to support hundreds of waterfowl prior to the port development. This is still the case even with the Port development so far, since much of the development has been on harder ground near Ras Duqm where the area was not as productive in terms of feeding grounds.

Surveys of the Duqm site have indicated that the maximum numbers of avifauna were observed in the coastal regions where over-wintering birds dominate the beaches. The beaches in the study area are primarily inhabited by Siberian gull and the Caspian gull, along with the great

black-headed gull, sooty gull, flamingos and five species of tern. These species arrive during winter from sub-polar regions to escape the extreme cold weather and food scarcity. Other smaller gulls and terns are local migratory or resident birds which cover much smaller distances to reach the Duqm area. In the summer these birds all migrate back to their respective breeding grounds.

The majority of the overwintering and passage birds pass through Duqm between the end of September and mid-May although exact timings are species dependent. The Omani coastline acts as a bridge between Asia and Africa. Birds tend to avoid flying over the open sea or inland due to limited food sources and therefore move

along the coastlines¹¹⁶. The two most significant beaches within the study area are Ras Markaz and the beach from Duqm Port stretching up to Nafun. Other shorebirds like gullwits, sanderlings, plovers, dunlins, oystercatchers, herons, egrets and cormorants also frequent the area in large numbers. Flamingoes are also spotted on both beaches. Table (6.10) below summarizes the use of habitat at Ras Duqm.

Table (6. 10): Notes on the Important Bird Groups in Duqm Area¹¹⁷

Birds	Habitat Use
Seabirds	Various species of shearwaters Puffinus sp. and storm-petrels Oceanites sp. use the offshore waters near Ras Duqm for feeding. These birds are probably under-recorded owing the difficulties of observing them from land, as they tend to stay well offshore.
Red-billed Tropicbird Phaethon aethereus	This species probably breeds in small numbers at Ras Duqm and should be able to co-exist with a new harbour. The species use the waters around Duqm as a feeding ground.
Socotra Cormorant Phalacrocorax nigrogularis	Large numbers (up to an estimated 15,000) of Socotra Cormorants utilise the waters near Duqm and the island of Hamar an Nafur for feeding. The Socotra Cormorant is a declining species with the main breeding grounds in the Arabian Gulf and one colony on the island of Hasikiyah in the Hallaniyat group in Oman. The species is classified as vulnerable by BirdLife International. Any oil spill in the Duqm area could have devastating effects on the Socotra Cormorant population.
Greater Flamingo Phoenicopterus ruber	Up to 3,000 Greater Flamingos use the mud flats just to the west of Ras Duqm for feeding.
Waders	The mud flats west of Ras Duqm are an important feeding ground for waders of up to 27 species during migration and in winter.

¹¹⁶ Royal Haskoning (2007). New Port and Dry Dock Complex, Duqm. Environmental Statement. Final Report 3H6503. Produced for the Ministry of Transport and Communications.

¹¹⁷ Royal Haskoning, 2007: New Port and Dry Dock Complex, Duqm. Environmental Statement. Final Report 3H6503.

Gulls and terns	Massive numbers of gulls and terns are dependent on the Duqm area and adjacent seas for roosting and feeding from October through March. The numbers in midwinter may exceed 50,000 birds. The development of the future basin will have major impact on these bird species due to the loss of their feeding and roosting areas. Furthermore, an oil spill in the waters near Ras Duqm could have severe negative effects on these birds.
Passerines	Though several species of small perching birds have been recorded at Duqm, the area is not of particular importance for these species.

The terrestrial and intertidal sand and mudflat habitats in the project area will be disturbed or removed due to the landside infrastructure works (roads, buildings etc) operation. However, the three packages is contributing to limited impact on landside works and potentially could be due potential for the transfer of pollutants from port operation activities, noise and light disturbance impacts. The impact can be classified as minor to moderate in case well design and mitigation measures related to noise and light disturbance are considered.

6-12 Climate Change and Sustainability Assessment

The proposed packages operations may affect Climate Change and the Sustainability of the Port of Duqm in accordance with MECA's 2013 'Guidelines for the Preparation of Climate Affairs Chapter in the Environmental Impact Assessment (EIA) Study for the projects'. For the majority of sources the study area is limited to the facilities itself.

The Port Duqm area is undeveloped with the principal sources of greenhouse gases being the diesel fired Duqm Power Station, the main coastal highway from Muscat to Salalah, local roads and Duqm village itself. All these sources are associated with the release of carbon dioxide as a product of fuel combustion. The existing land use is for nomadic grazing with associated methane emissions. Ozone depleting substances are most likely present, albeit in very small quantities, in the form of paints and solvents with high content of volatile organic compounds.

In 2007 the Sultanate of Oman, with support from the United Nations Development Programme (Global Environment Facility), commenced the collection of energy and non-energy source emissions data for greenhouse gas emissions for the purposes of providing an inventory of greenhouse gas emissions for Oman. This work is due to be completed in 2011¹¹⁸.

The Sultanate of Oman is a signatory to the Montreal Protocol and, as such, is committed to the phasing out of the production and consumption of ozone depleting substances (namely, chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs)). There is a permitting system in place for the import and export of CFCs and HCFCs.

The potential impacts they may arise on the parameter as a result of construction and / or operational activities are

- Inefficient use of energy with implicit carbon dioxide emissions
- Selection of refrigeration plant not using coolants with high global warming potential
- Use of paints and solvents with high volatile organic compound content
- Incomplete treatment of sewage and consequent generation of methane

The potential impact can be classified as minor impact and the following measures and adaptation can reduce the impact further:

- Mitigation actions and monitoring of emissions from the combustion process (for CO₂, NO_x, SO₂, hydrocarbons and particulates PM_{2.5} and PM₁₀) of ships and industrial processes (furnace and heat treatment facilities and boilers and the incinerator etc.);
- New technologies and measures to minimize energy consumption and improve energy efficiency (all project stages);
- Potential usage of renewable energy (all project stages) and how these could be incorporated and any barriers that could prevent this from occurring;
- Explore benefits of Clean Development Mechanism (CDM) under Kyoto Protocol;

¹¹⁸ <http://www.undp.org/ae/undpuae/oman.html>



- Describe plantations, green cover, trees, which suit local environment and conditions to increase are of GHG sinks; and
- Determine percentage of GHG sinks and compare to total area of the project.



CHAPTER (7)

IMPACT MITIGATION MEASURES

7 Impact Mitigation Measures

The proposed mitigation measures mentioned below are recommended to be included as a part of the Contractor tender documents, condition of an environmental permit and the following final Environmental Impact Assessment study for the same project. The proposed measures will be presented in two sections covering both construction and operation phases.

7-1 Mitigation Measures for Construction Phase

7-1-1 Local Development

- Pedestrian crossing with speed limitation will be realized in the villages areas ;
- A comprehensive sustainable development plan should be prepared with the participation of all the partners, especially local population; this plan will focus on the increase of local employment and limitation of rural depopulation with respect for the local traditional ways of life.

7-1-2 Roads Network

- Concrete should be pigmented with natural colors in order to minimize the visual impact of the infrastructures, especially near touristic areas. Use of natural stone may also have a similar effect.
- When building the road, the sub-base will be abundantly watered prior to compaction. In the project, water will be pumped from wells. Sometimes this water may be brackish, or even salty. Salty water should be avoided whenever possible to compact the road because of the risk of Salinization of the soil. Whenever fresh water is not available, and alternation of brackish water and fresh water brought from further wells should be used.

7-1-3 Rock quarries, borrow pits and crushers

The Ministerial Decision 298/93 clearly states the requirements for such infrastructure to be apply:

- To have a 3 km minimum distance from the road means that these structures would be in some cases in the heart of the mountains.
- It would create an important dust pollution which would be detrimental to the ecological stability.

- It is recommended to use the cut material extracted, if adequate, should be used as fill material for building the road dike or sub-base material prior to materials extracted from pits,.

7-1-4 Camp sites

The contractor's campsites should follow the following basic rules:

- A strict list of recommendations, instructions and restrictions will have to be prepared to minimize the negative ecological impact of the camp and the restoration of the site after the works.
- The contractor will minimize the number of sites in order to minimize the negative impact as well as the restoration costs
- Former camp sites could be used to set up new facilities such as camping sites, parking and picnic space, petrol stations, etc.

7-1-5 Restoration of the environment

The construction works will perturb seriously the environment immediately around the project area, and along the access roads to the borrow pits and quarries. The major effects will be the following:

- Compaction of the soil
- Destruction of trees and seedlings
- Disturbance of the wadi beds
- Deviation of minor wadi beds
- Pollution in the contractor's camp sites
- Opening of quarries and borrow pits

A program of restoration will have to be organized. Ministerial Decision 298/93 clearly describes the condition for restoration and reinstatement of the quarries, borrow pits and crushers sites. The following recommendations wish to insist on a few points:

- Every service road and track created by the project's vehicles will be scarified and their access blocked.
- The wadi beds will be cleaned from any broken equipment, garbage, concrete leftovers, etc. left by the contractor

- Vegetation will be restored by seed dispersion in the most forested areas and eventually by seedling plantation only if an adequate follow-up can be organized.
- The camp sites will be cleaned, every garbage removed and taken away from the area. Sewerage water will be used for irrigation. Solid waste will be removed. The whole area will be graded and seeded.

7-1-6 Noise

To preserve the outdoor land-use noise levels, it's recommended:

- Workers in the immediate proximity of noisy tools and machinery have to be protected from damage to their hearing by the use of PPE in accordance with Oman regulation.

7-1-7 Solid and hazardous waste

The analysis of waste streams undertaken in the chapters 5 and 6 of this report indicates that a secure landfill will be required for storage of hazardous waste (Only, temporary hazardous waste area with total served area 40,000 m² is allocated at IP2).

The Project is yet to be awarded; the exact location of dumping yard will be defined by the employer during the mobilization period.



7-2 Mitigation Measures for Operation Phase

7-2-1 Local Development

- The traffic volume generated up to ultimate stage will be over vehicles 5000 per day for two the commercial Berths and Pre-gate and Commercial quay. Such high volume of traffic would need regulations to be taken to limit the speed of the vehicles when the road crosses villages within Duqm area during approaching the project area. The recommended maximum speed would be 60 km/hr.
- Pedestrian crossing with speed limitation will be realized in the villages areas ;
- Special help should be given to local populations to develop "bed and breakfast" type accommodation and marine fishery as a recreational resource;
- The development areas for touristic projects and activities will be located near the villages to give work opportunities to local population ;
- The committee on fishing, who will initiate its work to address the issue of over-fishing and control of regulations, will find a solution to procure extension services to the fishermen ;
- A comprehensive sustainable development plan should be prepared with the participation of all the partners, especially local population; this plan will focus on the increase of local employment and limitation of rural depopulation with respect for the local traditional ways of life.

7-2-2 Roads Network

- It's highly recommended to keep the design speed for roads network, as recommended by the Master Plan for the Ultimate Phase which is related to roadway classifications is 60 km/hr and posted speed is 40 km/hr.
- Blocks preventing cars from leaving the road should be placed when the road wadi beds, etc.

7-2-3 Recreation landscape

Depending on the availability of space, the plans can incorporate development of recreational areas and tourist attractions for all age groups. For example:

- Educational and recreational tours can be organized in the Port area for locals and tourists for bird watching, fishing, walking and generally enjoying nature;
- The construction of a water-related theme park;
- Facilities for sailing and fishing in the coastal area;
- Organized tours of the harbour area (e.g. Port of Rotterdam)
- Developing a waterfront aimed at looking at ship passages and maneuvering

7-2-4 Noise

There is no noise potential impact to other sites environment out of the three packages zone including the nearest industrial, commercial or residential areas due to operation work. To preserve the outdoor land-use noise levels, it's recommended:

- Keep the maximum design speed at 60 km/hr within the commercial Berths and inception zone Commercial Quay and posted speed at 40 km/hr.
- Minimum distance to be kept, if possible, between the road and the nearest building is 20 meter for road speed of commercial Berths, inception zone & Commercial Quay and Governmental Berths.
- Workers in the immediate proximity of noisy tools and machinery have to be protected from damage to their hearing by the use of PPE in accordance with Oman regulation.

7-2-5 Air Quality

No sources of other emission pollutants are expected where no real industrial activities within the three packages facilities which are limited by small capacity pumps with limited fuel consumption. There is no potential impact to other sites environment out of the three packages zone including the nearest industrial, commercial or residential areas due to operation work.

However, the Dry Dock would cause some impact on the proposed project. With regard to dust, the standards for PM10 will be exceeded up to 300 meters outside the perimeter in the worst case, i.e. if NIX blasting is carried out without any measure to mitigate the influence of wind.

Dust from the abrasive NIX blasting is an issue that needs to be addressed as from time to time episodes will take place where elevated levels of dust outside the shipyard perimeter will occur.

It is proposed to reduce the wind drift of dust created by dry abrasive blasting of hulls by establishing section-wise covering (e.g. in the form of a canopy) of the ship hull to be blasted as it will not be feasible to cover the whole dry dock due to its huge dimensions. Further, blasting operations should be suspended under unfavorable wind conditions. Blasting of smaller items will take place inside the workshops under controlled conditions. Fabric filters are typically used to control emissions from enclosed abrasive blasting operations with reported control efficiencies in excess of 95 percent¹¹⁹.

Evaporation of organic solvents from the painting of hulls etc. will in some cases result in elevated concentrations of e.g. xylene (considered to be the most widely used solvent in paints) at a considerable distance from the shipyard. However, neither Omani nor international standards exist for the contents of xylene in ambient air. A number of different methods can be used to VOC emissions from painting and priming processes. These methods include:

To the extent possible cleaning of surfaces by blasting and painting operations will take place indoor where emissions can be controlled. However, this will not be possible for operations on hulls of large vessels, and while some mitigation of impacts of dust from the use of abrasives is possible, this is, with the exception of use of solvent free paints for certain applications, not the case for organic solvents evaporating from a newly painted hull surface.

The stack from the incinerator will be equipped with a fabric filter as well as a scrubber system to trap particulates as well as gaseous contaminants being emitted from the combustion chamber. As demonstrated, the design specifications for the installation will secure a very low level of such contaminants in the emissions, which is considered safe for humans as well as the environment.

¹¹⁹ COWI, 2010, Ship Repair Yard and Dry Dock Complex in Duqm, Environmental Impact Assessment of the operation Phase

Other emissions to air are marginal and do not require further mitigation.

7-2-6 Solid and hazardous waste

The analysis of waste streams undertaken in the chapter 6 of this report indicates that a secure landfill will be required for storage of hazardous waste (Only, temporary hazardous waste area with total served area 40,000 m² is allocated at IP2).

The Project is yet to be awarded; the exact location of dumping yard will be defined by the employer during the mobilization period. Consequently it is necessary to prepare a provisional environmental assessment of the impact of a hazardous waste landfill facility on the basis of local knowledge and international best practice.

In this assessment it is assumed that separate landfill facilities will be required for municipal solid waste and hazardous solid waste, because of different operating, safety and security requirements.

The principle elements to be considered in planning, design and operation of landfills are:

- Design life (and hence size) of the landfill.
- Landfill location, layout and design.
- Landfill operations and management.
- Reactions occurring in landfills.
- Management of landfill gases and leachate.
- Environmental monitoring.
- Landfill closure and post closure care

7-2-7 Releases to the marine environment

Releases of sewage and industrial wastewater effluents to the marine environment are not allowed so it's not considered to require further mitigation than the treatment facilities already being considered in the proposed packages and the treated effluents will be reuse for green belt and landscape.

The occasional storm water runoff can contribute to release of various contaminants including possible oil spills to the harbor and therefore the drainage system should be designed to minimize such releases.

7-2-8 Climate Change and Sustainability

- Mitigation actions and monitoring of emissions from the combustion process (for CO₂, NO_x, SO₂, hydrocarbons and particulates PM_{2.5} and PM₁₀) of ships and industrial processes (furnace and heat treatment facilities and boilers and the incinerator etc.);
- New technologies and measures to minimize energy consumption and improve energy efficiency (all project stages);
- Potential usage of renewable energy (all project stages) and how these could be incorporated and any barriers that could prevent this from occurring;
- Explore benefits of Clean Development Mechanism (CDM) under Kyoto Protocol;
- Describe plantations, green cover, trees, which suit local environment and conditions to increase are of GHG sinks; and
- Determine percentage of GHG sinks and compare to total area of the project

CHAPTER (8)
SCOPING ENVIRONMENTAL MANAGEMENT PLAN

8 Scoping Environmental Management Plan

8-1 Introduction

8-1-1 Background and context

The outline Scoping Environmental Management Plan (SEMP) has been prepared based on the environmental impacts described in the previous sections of this PEIA report. More detailed EMP shall be developed and agreed with MECA during preparation of following Environmental Impact Assessment Report. The legal requirements relevant to the preparation of the SEMP are found in:

- Royal Decree No. (114/2001): The Law on Conservation of the Environment and Prevention of Pollution. Ministry of Regional Municipalities, Environment and Water Resources, Sultanate of Oman.
- Ministerial Decision No. (/87/2001) for Organizing the Issuance of Environmental Approvals and the Final Environmental Permit. Ministry of Regional Municipalities and Environment, Sultanate of Oman.
- Ministerial Decision 79/94 Dated 20 March 1994: Issuing Regulations for Noise Pollution Control in Public Environment. Ministry of Regional Municipalities and Environment, Sultanate of Oman.
- Ministerial Decision 80/94 Dated 20 March 1994: Issuing Regulations for Noise Pollution Control in Working Environment. Ministry of Regional Municipalities and Environment, Sultanate of Oman.
- Ministerial Decision No. (118/2004): Issuing Regulations for Air Pollution Control from Stationary Sources. Ministry of Regional Municipalities, Environment and Water Resources, Sultanate of Oman.
- Omani Standard for Drinking Water. O.S. 8/1998. Ministry of Commerce and Industry, Directorate General for Specifications and Measurements, Sultanate of Oman.
- Ministerial Decision 145/93 Dated 13 June 1993: Issuing Regulations for Wastewater Re-use and Discharge. Ministry of Regional Municipalities and Environment, Sultanate of Oman.
- Ministerial Decision No. 17/93 Dated 2 February 1993: Regulations for the Management of Solid Non-hazardous Waste. Ministry of Regional Municipalities and Environment, Sultanate of Oman.

- Ministerial Decision No. 18/93 Dated 2 February 1993:
- Regulations for the Management of Solid Hazardous Waste. Ministry of Regional Municipalities and Environment, Sultanate of Oman.

8-1-2 Objective of the Scoping Environmental Management Plan

The objective of the SEMP is to describe the measures that will be implemented to mitigate the impacts of the construction and operation of the proposed infrastructure (Three packages) in Duqm Port as identified in the impact assessment (Chapter 5), describe the organization that will be responsible for the implementation of the identified mitigation measures and describe an appropriate environmental monitoring programme. The SEMP includes guidelines and regulations describing:

- The setup of a strong and efficient organization able to monitor all environmental and social issues related to construction activities and to enforce mitigation measures;
- A solid legal background for the enforcement of all the environmental obligations relevant to contractor responsibility including a clear line through which breaches can be reported to designated institutions to establish accountability;
- Measures for the rehabilitation of sites degraded during works (camps, storage and borrow areas);
- A monitoring program to control the effect of the measures and to make sure no breaches of the rules and regulations are made;

8-1-3 Environmental policy and Strategy

8-1-3-1 Environmental policy

Environmental policy is a statement describing top management's intentions and principles. It is the driver for implementing and improving the company's Environmental Management System and provides a framework for action and for setting of environmental objectives and targets. The environmental policy should:

- Be appropriate to the nature, scale and environmental impacts of its activities, products or services.
- Include a commitment to continual improvement and prevention of pollution.

- Include a commitment to comply with relevant environmental legislation, and with other requirement.
- Be documented, implemented and maintained.
- Be available to interested parties.
- Provide the framework for setting and reviewing environmental objectives and targets.

8-1-3-2 Port Environmental Strategy

The Port of Duqm Authority has set up a comprehensive Environmental Strategy indicating adherence to national and international environmental legislation. Port Authority abides to International conventions related to marine environment protection:

- Oman is a member state for (inter)national conventions (e.g. MARPOL, rule 4/1994 regarding protecting the Marine Environment and its bylaws), which seeks to enforce the rules and regulations, applicable to ships and tankers calling the ports of PSPA, to protect marine environment from oil pollution and others, such as:
 - International Convention for prevention of marine pollution from ships and modifying protocols.
 - International Convention for Preparedness, Prevention and cooperation to prevent oil pollution.
 - International Convention for Prevention of marine pollution from dumping wastes and other substances.
- The procedures pertinent to Ozone layers-depletion goods, as per Montréal Convention 1988, are applied.

Facilities and supplies available at the port for preventing and controlling environmental hazards:

- The port is equipped with radioactivity pollution detection devices to inspect containers, in and out goods, and transshipment goods.
- Dangerous Goods regulations enforcement and handling security;
- The port is equipped with reception facilities and equipment to receive solid wastes, used fuels/ oils wastes from ships;
- Mechanism adopted for getting rid of damaged goods inside the port

8-2 Organization

8-2-1 Overview

The responsibility of the overall management of environmental issues at the proposed facilities of Duqm Port lies within the PDC. An organization will be established which is targeted and staffed to be able to handle the future environmental tasks and obligations described in this SEMP outline and followed detailed EMP.

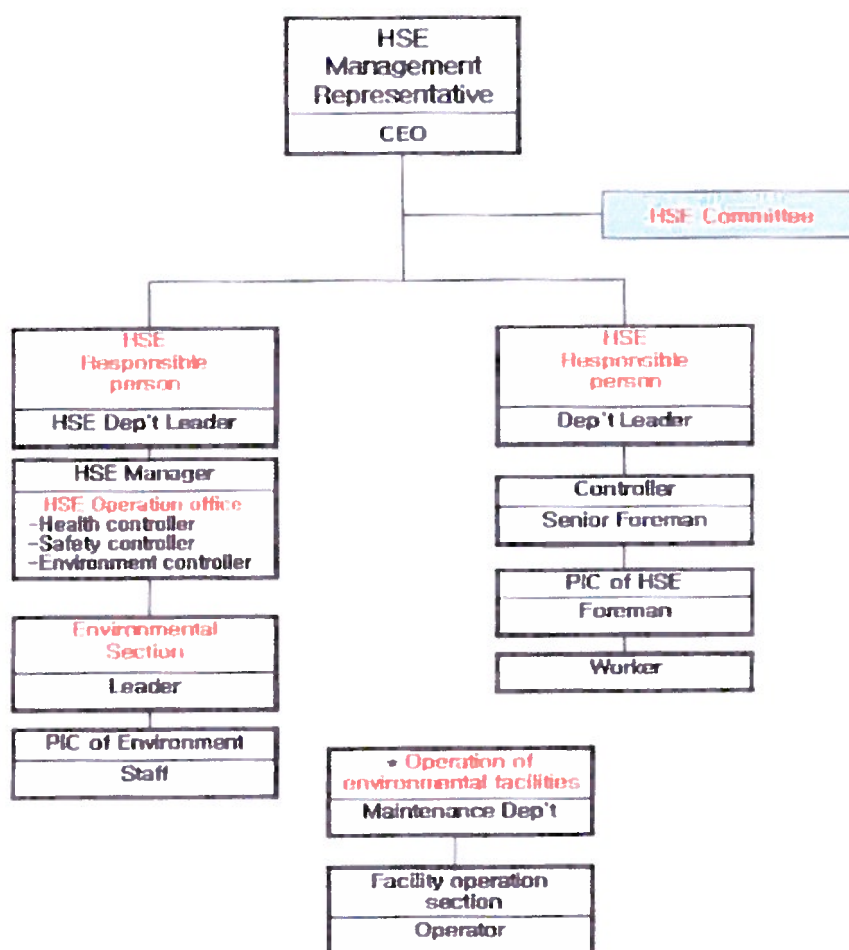


Figure (8.1) : Organization of environmental management



8-2-2 Roles and responsibilities

Representative of the company (CEO)

- as the representative of the company, shall declare internally and externally his strong will for the "leveling-up" (incremental improvement) of the HSE practices
- participate in the execution of the HSE Management System as the chairman of the HSE steering committee.
- establish and approve the company's HSE policies and shall provide the necessary human, material and financial resources to maintain and control the HSE Management System.
- approve the company's HSE objectives and goals.
- nominate and announce a Management Representative for the HSE Management System.
- conduct a management review to ensure the continuation of the adequacy and effectiveness of the HSE Management System.

The HSE Steering Committee

- The CEO shall appointed as the chairman, the Management Representative shall be appointed as the chief secretary and the director of the HSE Operation Office shall be appointed as the secretary of the committee
- The committee shall evaluate and decide the company's HSE policy and goals and examine the operational status of the HSE management
- The committee shall evaluate and decide the direction of policy concerned with HSE: problems, solutions and reasonable investments.

Management Representative (COO)

- The management representative shall be authorized and be responsible for the establishment, maintenance and control of the HSE Management System as per the Company's HSE Policy.
- The management representative shall be authorized and responsible for the formulation, execution, and maintenance of the company's HSE management System to conform to the requirements stipulated in OHSAS 18001 ISO 14001



- The management representative shall prepare regular reports and special reports for Management's review, concerning the adequateness and effectiveness of the HSE Management System.
- The management representative shall stop work, in case of emergencies having adverse influences on health, safety and environment, and shall report to the CEO, if necessary.

The Chief of the HSE Operation Office

- The Chief of the HSE Operation Office shall monitor and control the establishment and implementation of the company's HSE management System as per the requirements stipulated in OHSAS 18001 ISO 14001
- The Chief of the HSE Operation Office shall initiate the internal audit to ensure the adequacy and effectiveness of the HSE Management System.

8-3 Contractual for Environmental Management

8-3-1 Contractual dispositions

It has been observed that obtaining any specific task from a contractor requires first that the task is specified in the contract documents and then, that a specific payment is allocated to that task. This is the basis for any construction contract, which relies on detailed technical specifications and their related bills of quantities.

To be effective, the environmental and social obligations of a contractor must be comprehensively specified and individually payable through the contract documents. Both actions work together because the payment system will influence the way specifications are displayed and prepared. Most of the international construction contracts follow standards established by the Federation of Consulting Engineers (FIDIC). A contract is generally constituted of several documents, which receive an order of priority in case uncertainties or inconsistency are observed between them:

- Memorandum of Contract Negotiation,
- Technical Specifications,
- Supplementary Information and Annexes, and
- Contract Conditions.

For an efficient implementation of the environmental mitigation measures, these measures must be particularly detailed in the Technical specifications. Thus, the preparation of detailed environmental and social specifications for the Contractor is proposed prior to the bidding process, with the objective to have eventually a legal document which establishes clearly the obligations of the contractor, the quantities of work involved and the related cost of measures.

8-3-2 Decommissioning: reclamation of temporary used sites

Decommissioning refers to the dismantling, decontamination and removal of process equipment and facility structures, at the end of the construction stage, and to re-contouring the land and planting vegetation to prevent soil erosion as appropriate. Assuming there is no other use for field facilities, all structures and related infrastructure facilities are to be dismantled by the contractor.

The entire sites used temporary by the contractor installations will be fully rehabilitated at the end of the construction stage and shall be returned to their initial use. These concern areas for borrowing earth, for temporary access roads, for workers camps and facilities, for material storage and for machinery parking and maintenance.

8-3-3 Preparation of contractual documents

From experience, it has been observed that enforcing contractors to comply with their environmental obligations is often difficult. Obtaining any work from a contractor requires first that the work be specified in the contract documents and then, that payment (or withdrawal of payment) be allocated to the task.

To be effective, contractor environmental and social obligations absolutely need to be comprehensively specified and payable through the contract documents. Both actions work together because the payment system will influence the way specifications are displayed and prepared. Too many separate documents are dealing with environmental mitigation measures with some contractual links. It is recommended to centralize all mitigation measures within the Technical Specifications document under a section Environmental Specifications.

This step is important because the specifications described in the contract for the work to be carried out and paid for by the Developer is to cover all contract works, whether construction related or carried out for environmental reasons. The level of detail concerning specifications related to the workers' health, safety and welfare needs to be similar to those concerning the specifications related to concreting, grouting, and so on.

For several reasons (lack of time during preparation of contracts documents specifications, lack of knowledge for specific types of issue) it might be impossible for the Developer to specify in detail a solution to a particular potential problem. In such case, the contractor should be requested to propose a methodology in his tender and to price it. This method, if appropriate, would then be included in the Technical Specifications of the final contract documents.

For the present scheme, it is recommended that the developer prepares in details the environmental specifications in accordance with the following four sections:

- section A : Environment Protection Management
- section B : Labour Camps and Worker Health Management
- section C : Safety Management
- section D : Social Management

Section A : Environment Protection Management

The section A will specify the Contractor's obligation with regards to the preparation of an Environmental Management Program (EMP) aiming at protecting the work site and its vicinities against unacceptable adverse impacts.

The Contractor's EMP will include the facilities and procedures for the management of solid wastes; the soil conservation and all rehabilitation works once the construction ends; the measures aiming at protecting the local fauna and flora; the preventive measures against water pollution; and the contractor monitoring program as Presented in the following Table.

Table (8.1): Waste management for and protection works

Location	Waste	Collecting / Evacuation	Observations
Construction site	Domestic waste	The contractor shall provide collecting points with containers, like garbage cans. Periodically (at least once a week) they must be emptied in a trailer, and the waste will be transported to the communal waste platform indicated by the local administration authorized within the Environmental Accord	Strict evidence must be kept, recording the dates, the eliminated quantities and the transport means identification.
	Construction materials waste	As concerns their contamination potential, this waste does not involve special problems (they are mainly concrete, mortar leftovers). As concerns their recycling and removal, several methods exist: 1. Local reuse, for service roads pavement 2. Store in borrow pits, in their final phase of exploitation 3. Use as contact covering material in the communal waste deposits used in the area.	
Construction site	Oil residue	This waste is generally generated during maintenance of plants and equipment. Considering its dangerous character (flammable and toxic for organism). It should be collected in metal airtight recipients (200 l sheet metal barrels) to be transported in safe conditions. This waste shall be obligatorily delivered to the SNP PETROM Units, keeping records of the materials movement.	
	Exhausted batteries	These are materials with dangerous potential both for the environment and users. They shall be adequately stored, in locked places, for recycling. Strict evidence must be kept.	To be delivered to specialized recovery units.

Location	Waste	Collecting / Evacuation	Observations
	Used tires	The storage space for separate waste categories must include a space for tires. The Technical Specifications must recommend the Contractor's obligation to present at least one solution to transport this waste to a recovery unit.	This is typical waste of site organizations. The Environmental Accord must recommended strict interdiction of burning such materials.
Construction site	Mud collected in settling tanks	Organic mud (from septic tanks serving sanitary purposes) shall be obligatorily transported, by a shovel, to purification stations.	It is very important to prevent the risk of accidental outflow of the shovel in the marine or on fields (including the communal waste deposits in the area).
	Paper and office specific waste	Paper shall be collected and stored separately from the other waste, for recycling.	
Borrow pits	Domestic waste	Waste collecting points must be installed provided with containers type garbage cans. Periodically (at least weekly) the waste shall be emptied in a trailer, to be transported to the communal waste area accepted by the local administration and approved by the Environment Accord.	
	Metallic waste	As far as they arise, it shall be transported to specific enterprises to be obligatorily recycled.	

Section B : Labor Camps and Worker Health Management

The section B will address the minimum standards to be implemented in the labor camps and facilities. They will focus on accommodation, food supply and canteen, waste management; water supply; treatment of sewage and sanitary conditions on site. They will cover the following topics:

- Maximization of employment of locally based labor who will be transported to the sites by bus;



- Mechanisms to ensure contractors provide their work force and camps with adequate quantities and standards of the following:
- Accommodation, Water supply
- Recreational facilities (TV, radio, organized sports, bar)
- Sanitation and solid waste disposal
- Health checks and disease pathogen and vector control
- Access to medicines, soap, toiletries, foods, consumer goods,
- Security and lighting & Fire extinguishers and fire drills
- Sleeping arrangements (beds, mattresses, and mosquito nets)
- Communication facilities (public phones and a letter box service)
- Training for specific tasks, particularly safety training
- Catering and canteen & Personal Protective Equipment
- Transport to public transport nodes
- Worker participation in camp management

Section C: Safety Management

For the safety issues, the Environmental specifications will have to address two distinct aspects:

- on site Safety, PPE, and Medical issues
- of site Safety, Medical and Road traffic issues

The on site Safety, PPE, and Medical aspects will have to address all measures the Contractor need to implement to ensure an international standard for the safety and proper medical evacuation of its workforce.

For most off-site safety accident and medicinal issues, the Environmental Specifications will fix the objectives. In its offer, the Contractor will detail what are the measures its Site Management intends to apply for achieving these objectives. Aspects to be covered under this off-site safety accident and medicinal issues are related to:

- Project related signs
- Project implementation accidents
- Project traffic regulations including Night stop regulations, Truck parking, Truck cleaning, washing and cargo transfers, Use of headlights at all times,



Carriage of unofficial persons and goods, Education of project drivers in safety matters, Regular inspections of vehicle condition, Registration numbers for each truck, Compulsory first aid kits, fire extinguishers, Use of vehicle log books, Seat belts.

- First aid and emergency medical facilities;
- Third party, livestock and property accident insurance cover;
- Roadside recreational facilities (Drinking);
- Hazardous cargo movement and accident procedures;
- Exceptional load movement procedures;
- Accident reporting procedures;
- Off-site damage / injury claim procedures;
- Village liaison and discussion arrangements;
- Parking fees and payments;
- Repairs of local roads and bridges damaged by project traffic;
- Load shedding and spillage accidents, including damage to other non-project vehicles;
- Cargo dumping

Protective measures must be taken by the general contractor and subcontractors, respecting the Egyptian laws for work protection, security against fire, civil protection and security and others. Also the prescriptions of the design and norms referring to quality in constructions must be respected. These measures include:

- Strict control of working personnel concerning discipline on the site: periodical instruction, wearing protection equipment, control of alcohol or even drugs consumption, presence only at the assigned working place;
- Verify, before starting operations, the site plants, transport means, cranes, equipment, devices and tools, for integrity and adequate functioning;
- Verify, at standardized frequency, the electric installations, compressed air, oxygen bottles or other containers containing explosive, inflammable, toxic or dangerous materials;
- Verify, before starting the work, especially at the weekly restart, the supports, scaffolds or other abutments – especially for bridges;

- Verify the indicators for access interdiction in certain areas, and the warning sign panels;
- Carry out fencing, signing and other warnings to delimit the working areas;
- Control the people access to the site;
- Execute the works in strict compliance with the design documents and the technical specifications, and assure the technical and geometric elements of the Channel.

These preventive measures are intended to avoid or to diminish substantially the risk of site accidents, which, even if they do not usually affect the environment, still might produce significant damage and fatalities.

Section D : Social Management

The Section D will fix the minimum condition to be applied by the Contractor while managing all social aspects related to construction activities. Most of them will focus on how to reduce nuisance to residents.

The Developer will arrange meetings between the contractors and the residential area chiefs likely to experience nuisance events.

As a result of the meetings the contractors will prepare a nuisance reduction program which will be translated into local language for posting in public places in affected villages. This program will include measures to deal with at least the following issues:

- **Transportation (Cargo)**
 - A possible by-pass route
 - Speed bumps near schools, hospitals
 - Crossing places
 - Prohibition of working at night
 - Site watering
- **Noise**
 - Regulations about working hours in the residential area
 - Adequate maintenance of equipment and installations during construction in order to reduces the noise level in their area of influence.

- Regulations about use of klaxons in the residential area
- Fumes, dust, etc.
 - Regulations about passage of noxious, or unpleasant smelling cargoes
 - Prohibition on refueling, fly ash and cement transfer etc in or near the residential area
 - Effective covering of loads such as sand or gravel
- Obstruction of local traffic.
 - Designated short term parking areas
 - National routes to be kept open at all times, even during upgrading work or during movement of exceptional loads.
- Antisocial behavior.
 - Designated overnight parking areas and recreational zones
 - Monthly meeting between contractor and residential area committees to receive complaints and solve problems

The contractors' nuisance reduction program will be paid for by the contractor, who should be informed during the contract negotiation stage that EMC will require such a program. The contractor will be expected to specify a sensible budget for such a program which is included in the final amount. EMC will advise village chiefs and individual villagers to

use the monthly contractor meetings to ensure the nuisance reduction program continues to serve their interests.

The contractor will be required to register with EMC any transactions made between them and the residential area chiefs, which might affect the efficacy of the nuisance reduction program.

8-4 Monitoring of Construction Phase

8-4-1 Importance of monitoring construction activities

Past experience has shown that many construction contractors do not fully understand their obligations with respect to environmental mitigation measures. Most of the time, they do not make adequate provision for the work to be done during bid preparation and they find themselves without sufficient funds to fully

implement the mitigation measures. This is unfortunately frequent for the works which come at the end of a project construction and which often concern the rehabilitation of construction or disposal sites.

It is thus of utmost importance that the construction contract includes provisions to ensure:

- The contractor understands clearly environmental mitigation measures and its obligations,
- The mitigation measures are specified in sufficient detail that the contractor can make reasonable estimates of actual costs in its tender document,
- The project management has the legal and financial power to enforce the application of mitigation measures through the contractor.
- The project management has the capability to monitor the contractor's performance in this regard,

8-4-2 Content and implementation of the monitoring

The environmental monitoring of construction activities is at the heart of the effective implementation of the EMP. The objective is to carry a regular and comprehensive review of the actual status of the environmental obligations of the Contractor. This monitoring aims at ensuring compliance of Contractor activities with its contractual commitments and the environmental regulations.

In accordance with the Environmental specifications, the ES will monitor all aspects relevant to the four sections of the specifications:

Environmental Protection Measures Section, Labor camps and Worker Health Management Section, Safety Management Section and Social Management Section.

For each section, a Standard Review Sheet (SRS) will be prepared at the early beginning of the project, by the Central ESD assisted by an international consultant.

8-4-3 Execution of the environmental supervision

For the four sectoral sections, the Developer will have to specify what are the indicators that will be monitored during the execution of the environmental supervision.

Measurable items

Most of contractor environmental and social obligations are actually measurable. For these obligations, the indicator to be monitored will be a quantity and the Contractor will be paid only if this quantity is observed on site.

An example is given below for section B "Labour Camps and Worker Health Management" with regards to Restrooms and Ablution Blocks:

- Description of the Contractor's obligations with regards to Restrooms and Ablution Blocks:

"Contractor shall provide washrooms and other facilities, as necessary, to satisfy the religious needs and customs of its workforce. Washrooms shall be located and sized based upon camp population and shall include adequate lighting and appropriate number of facilities. Separate facilities shall be provided for men and women. Washrooms shall be constructed in well-ventilate areas, and supplied with an adequate amount of hot and cold water (potable) and other ancillaries."

- Description of indicators that will be monitored every month for payment or withdrawal of payment:

As a minimum, the following shall be provided:

- toilets : 1 unit per 15 persons. Each unit being supplied with toilet paper and holders, waste receptacle, and deodorant ;
- urinals : 1 unit per 25 men ;
- shower stalls (stainless steel) : 1 per 10 persons ;
- washbasins and mirrors : 1 per 4 persons.

Non-measurable items

Some contractor environmental and social obligations remain difficult to quantify. A typical example is the protection of areas adjacent to

construction areas: It is not sensible to specify a penalty according to the number of trees cut at the wrong place or to measure and withdraw payment for any cubic meter of material.

But it is sensible to specify methods aiming at limiting adverse impacts and to specify what would constitute a non-payment situation.

8-5 Operational Environmental Protection Procedures

The proponent has developed an Environmental Management Manual, based on the requirements of the following international management system specifications:

- BS 8800 "Occupational Health and Safety Management System"(1996)
- OHSAS 18001 "Occupational Health & Safety Assessment Series"(October 1999)
- ISO 14001 "Environmental Management System" (October 1996)

The Manual ("Health, Safety and Environment (HSE) Manual") contains procedures for management of Environmental, Safety and Health issues to be provided in the EMP of final EIA report.

8-5-1 Control of air emissions and dust

The emission generated by generated traffic and the operation of the infrastructure (pumps and electrical switch) and buildings (workshops) facility will not have any impact on the emission levels at the nearest industrial, commercial, residential areas or within the proposed facilities of three packages. The air emission and dust control activities and measures will be recorded and stored.

8-5-2 Noise control

The noise level from operations are expected to be below 50 dB(A) at each package scheme boundary during operation. The impact of noise is very local to some operation facilities and doesn't impacting sensitive receptors. Workers in the immediate proximity of noisy tools and machinery should be protected from damage to their hearing by the use of PPE in accordance with Oman regulation. To preserve the outdoor land-use noise levels, it's recommended:

- Keep the maximum design speed at 60 km/hr within the commercial Berths and inception zone Commercial Quay and posted speed at 40 km/hr.
- Minimum distance to be kept, if possible, between the road and the nearest building is 20 meter for road speed of commercial Berths, inception zone & Commercial Quay and Governmental Berths.

Environmental noise is a measure of sound levels immediately "outside the boundary fence". Standards for environmental noise are based on the premise that

there are tolerable levels of noise that can be defined, which do not present a hazard to human health or harm the environment.

The Environmental Manager will be responsible for ensuring that environmental noise control is managed in accordance with the requirements. Sources of noise that have the potential to impact on local communities and wildlife shall be:

- Identified and analyzed
- quantified (either by direct measurement or using appropriate methods of estimation) and recorded, as appropriate

8-5-3 Management of chemicals

Chemicals and chemical substances used in the proposed facilities will be registered with the Ministry of Environmental and Climate Affairs. The Material Safety Data Sheets (MSDS) for each chemical or chemical substance will be forwarded to the Ministry of Environmental and Climate Affairs as part of the registration procedure.

Chemicals and chemical substances will be stored according to the Hazardous Chemicals Storage Regulations from the Ministry of Environmental and Climate Affairs, and storage and transport will be approved by the Civil Defense Administration of the Rap. Handling and use of chemicals and chemical substances will be in compliance with the requirements of Royal Decree No. 46/95, Law on handling and use of chemicals. The consumption and use of chemicals will be recorded and stored.

8-5-4 Waste management

Waste treatment: The normal sewage effluents, and any industrial & chemical will be treated to acceptable standards for reuse at the facility's own sewage treatment plant and is not considered to pose an environmental problem.

Sludge treatment: The generated sludge should be treatment to the acceptable level. Sludge treatment scenarios are proposed in sections 5.3.1 and 6.3.1.

Treated wastewater and sludge reuse & disposal:

The treated sewage effluent (TSE) will be recycled for plantation and green belt or road watering.

The treated sludge can be recycled or disposed by:



- Land application to improve soil characteristics for landscape and green belt matching with Omani regulation MD 17/93 for nonhazardous waste.
- To be sent to Duqm STP where they accept the drying treated sludge.
- Landfill for restoring excavated areas.

Hazardous waste: The operation company will describe their system for identification of hazardous waste and for collecting, packaging, labeling and transporting the waste to the designated Hazardous Waste station. The plan for hazardous waste will also include detail of mitigating measures and actual control.

In case the contractor cannot get approval or no objection for receiving all hazard wastes that would be generated from Duqm Port during construction and operation, treatment facilities should be provided to treat all the toxic wastes or get an approval from Be'ah for having hazard wastes dump site.

Non-hazardous waste: Non-hazardous Solid Waste as defined in "Regulation for the Management of Solid Non-hazardous Waste", Ministerial Decision No. 17/93, will on a daily basis be collected and transported to the designated waste stations inside the working areas of the Main Contractor.

Waste types will be segregated, clearly identified and kept in such a manner as to not pose a risk to Health, Safety or the Environment. All waste will be contained to ensure that the blowing of debris or pest infestation are not risks. Special consideration must be taken for local wind prevailing strengths and direction to avoid risk of endangering and causing nuisance to the neighbors.

The designated waste stations will be established, operated and maintained in compliance with the requirements in "Regulation for the Management of Solid Non-hazardous Waste".

Recording: A Waste Log-book will be established to ensure that wastes (hazardous and nonhazardous waste) are placed at the approved location(s) and treated and/or disposed of as required.

Discrete chemicals identified as 'waste chemicals' will be recorded in a separate log book. The Environmental Manager shall approve how the waste can be disposed

before it can be moved. Signed acceptance sheets from waste management facilities will be required and stored appropriately.

8-5-5 Maintenance of equipment and installations

Activities and procedures will be developed to ensure that equipment and installations perform according to standards and meeting environmental requirements will be elaborated in due time.

8-5-6 Storm water drainage during construction

Storm water drainage during construction can cause erosion and sedimentation impacts that need management. For effective erosion & sedimentation management the measures must be:

- Appropriate for the purpose
- Installed correctly
- Maintained

The following sections discuss the range of measures that can be used on construction sites to manage these two scenarios.

- Principles of erosion management
Staging works, retaining existing vegetation, Drainage management techniques (catch drains, earth banks, down slope water diversions, energy dissipaters), Stabilization matting
- Sediment management measures
Silt fences, Straw bales, synthetic straw bale replacements and logs, Rock log-check dams, Sediment basins, in-stream structures. More detailed can found at ([http://www.melbournewater.com.au/Planning-and-building/Standards-and-specifications/site-management/Stormwater management during construction/Pages/Stormwater-management-during-construction.aspx](http://www.melbournewater.com.au/Planning-and-building/Standards-and-specifications/site-management/Stormwater%20management%20during%20construction/Pages/Stormwater-management-during-construction.aspx))

8-5-7 Traffic management

Traffic rules etc. at the site to ensure staff safety and minimization of environmental impact of (road) traffic will be updated established in the EIA.

8-6 Environmental Monitoring for Operation Phase

8-6-1 Air quality

To determine the level of dust and air pollutants resulting from the project operations and document compliance with (international) air quality standards to the MECA a survey will be conducted when the new facilities have been put into operation and daily routines have been established. The survey will be conducted at a few selected points within the premises of the Commercial and Governmental Berths and Quay as well as at a few selected stations at the perimeter and 1 or 2 stations at some distance in the prevailing winds directions (one station in direction of Duqm town). A background location should also be sampled.

The survey should comprise sampling and analysis of general air pollutants such as CO, HC and NOx as well as particulates (dust), i.e. PM10. Following the initial survey, a monitoring programme for air quality and dust will be established and monitored at regular intervals (campaigns) at appropriate positions along the perimeter fence.

8-6-2 Noise

To ensure that the noise level is below the limit value an initial survey at various points will be conducted when the new facilities have been put into operation and daily routines have been established.

Following the initial survey, and to keep a record of the noise emissions from the proposed packages, a limited number of permanent monitoring stations are going to be established. The monitoring stations will be constantly operating and the records will be checked on a regular basis. If the noise level exceeds the expected level the environmental management organization will take action to investigate the reasons and if possible introduce preventive measures to avoid reoccurrence. Its recommended to have two sites along the border between the Pre-gate area (IP3) and Dry Dock.



8-6-3 Marine environment

A monitoring programme of possible impacts on the quality of the marine environment should be established for the port as a whole and not only the commercial and Governmental Berths as it will hardly be possible to distinguish between pressures from the general ship traffic and other port activities and the Berths activities. The monitoring should include stations both inside and outside the port and comprise chemical monitoring (water and sediment quality) as well as monitoring of ecological parameters. An annual survey is proposed.

8-6-4 Waste generation and disposal

The waste management plan will include a system to record the amount of waste collected and disposed. The recording system will include non-hazardous waste as well as hazardous waste. In addition, Operation Company will developed a Waste Management Procedure Manual which sets out responsibilities, objectives and standards for storage and disposal

8-7 Contingency Plan

To ensure an efficient mitigation of the environmental impacts of contingency situations an environmental emergency plan will be developed. The emergency plan will include procedures for handling of identified emergency situations including alarm numbers for responsible persons and authorities, allocation of responsibilities in relation to handling of the emergencies and description of the equipment needed to enclose and remove the risk of serious environmental im- pacts such as oil spill from the dry dock to the port etc.

8-8 Training

In relation to the assessment of HSE awareness and the development of the competence of the employees related to HSE practices, the Operation Company will establish and maintain procedures, educational programs and training which shall be applicable to whole organizations and employees, including sub-contractors.

The procedures of the HSE education and training will be established and implemented suitable to the responsibilities, the capabilities, the identified risks and HSE influences relative to each organization and/or group.

8-9 Emergency Situations

The company will establish and maintain program for preparation and treatment of emergency situations, which involve serious injury, or safety /health /environmental impact by unexpected accidents.

The probable emergency situations that always exist within the HSE management system shall include the following situations:

- Natural Disasters: typhoons, storms, surges, floods, earthquakes, etc.
- Operational Activities Disasters: fires, explosions, leakage of oil, accidents involving poisonous materials, etc.

The HSE operation office will establish and maintain procedures for the treatment of incidents, fires/explosions, environmental accidents or other emergency situations and for preventing and mitigating human life, property, damage and environmental impact caused by the emergency situations. Moreover, Operation Company will develop an "Emergency Response Plan for Oil Pollution Accident" which sets out aims, communication system, education and combating organization.

Operation Procedures in Ordinary Situations: The HSE operation office shall establish and maintain scenarios, including treatment methods and procedures, for emergency situations. In preparation for emergency situation, the HSE operation office shall periodically train and educate the first aid treatment and the reporting procedure to the person in charge and the relevant staff. Through simulation training, the effectiveness of treatment of the emergency situation shall be evaluated and the operation procedure and the scenario shall be improved, if necessary.

Operation Procedure for Emergency Situations: Organization in charge of each emergency situation will be as follows:

- Industrial Disasters: HSE Operations Office
- Nature Disasters: Anti-Calamity Headquarters

The first finder shall immediately inform the HSE operation office of the emergency situation, and he shall perform first aid treatment.

In the case of environmental accidents, the HSE operation office shall check the situation and perform treatment on the emergency, and shall inform the management representative and government institutes, if necessary.

In that a second treatment is required, the organization involved in the situation shall first treat the situation or request a relevant organization to cooperate.

After the emergency situation is over, the HSE managing department shall review the cause from its own perspective and report the result to the management representative. The departments shall establish and execute countermeasures to prevent recurrence. The HSE operation office shall evaluate and report the HSE cause and influence of the emergency. In case any change and supplement of the treatment system is required according to the result of evaluation, the relevant procedure and organization system shall be changed. Training and education shall be carried out according to the modified system.

Emergency Situation (Night time): The emergency at night shall be dealt with according to the "Performance of Night Duty Procedures".

8-10 Reporting and other Communication

Environmental reports covering the environmental management activities and results as well as the results of the described monitoring programme will be prepared and submitted to MECA at intervals to be negotiated. Yearly reports are suggested as some of the monitoring campaigns are proposed to take place only 1-2 times per year.

8-11 A Sustainable "Green Port of Duqm"

Many investors nowadays take their own responsibility in sustainable development of our world. Public opinion helps by forcing them to safeguard the natural environment during production, transportation and storage of their products. After all, a sustainable development ensures that future generations can still enjoy the Port and the areas surrounding the ports. It is a subject that is enjoying a lot of attention in through worldwide news coverage and distribution of environmental news through Internet.

For the development of a world-class distribution and industrial hub area between Asia/Middle east and Europe attention should be given to the sustainable

development of the area. This has the potential to become one of the strong points of the Port of Duqm development and can become a unique selling point on the long-term “Green Port” following a trend set by global ports worldwide. The basis of a sustainable development is in the infrastructure network, location of different functions and integration of industrial development with residence and recreation / nature. Also the smart port concept, with electronic transfer and availability of information is an aspect of sustainable development, as it reduces internal transport of goods.

However, there are many more ways to make a port sustainable. In the long run, investing in the Green Port concept can be beneficial as the chance of the implementation of more stringent international environmental laws and regulations is realistic. MARPOL, IMO and the Green and Blue Policy Papers in the EU are examples of these changing policies.



Figure (8. 2): Port of Amsterdam: combination of oil tanks, dry bulk, cars and to the right water treatment, nature area and wind turbines for sustainable energy (Photo copyright D. Rijks).

Examples of sustainable solutions to make a Green Port with minimal impact on the surrounding natural environment:

- Create green zones within and around the port and industrial areas that also act as buffer zones for the surrounding residential communities and agricultural lands for dust, noise, view, lights etc. These green zones can be used as public space to enhance the quality of the working environment;
- Adjust lighting so that it is aimed downwards and inwards to minimize effect of light on surrounding areas. Also, use special lights that only emit a selective part of the light spectrum (mostly blue and green) and thus minimize effect on migrating birds. This is currently being used on oil platforms in the North Sea to not confuse migrating birds. The light still allows for safe working conditions;
- Use treated waste water for irrigation to create green zones and small parks for the workers
- Create a permit system that awards environmentally friendly companies and Green Flag ships ("Clean ships") instead of a system that fines ships and companies that don't adhere to the rules. This stimulates the transition to environmentally friendly and sustainable working methods.
- Examples of sustainable solutions for improving Air Quality are:
 - Use electricity from shore when ships are berthed. This will lower emissions of NO_x, SO_x etc in the Port area improving air quality. Many ports all over the world already have this system, the EU and ESPO already recommend the promotion of shore-side electricity;
 - Use electrical equipment or LNG where possible instead of diesel fuel;
 - Use tractors or small rails in the Industrial Zone to transport goods to and from the port area;
 - Create permit system that only allows 'clean' trucks to enter the compound i.e. trucks that use clean fuel or have filters.
- Examples of sustainable solutions to lower energy consumption need are:
 - Look at possibilities to attract series of companies and industry (Supply Chain Management) that are interdependent and thus use each other's products. On



a global scale, this will diminish the transport kilometres which is both beneficial for environment and economy. E.g. Oil -> Petrochemical Industry -> Plastic industry -> Company making plastic products, or Agricultural products (e.g. fish) -> canning or freezing factory -> packaging -> transport.

- Place solar panels on the flat roofs of the industrial buildings. If necessary use tinted glass roofs allowing sunlight to enter the buildings as alternatives to minimize use of electricity during the day time;
- In the construction of buildings and residents use isolation material (warmth and cooling), energy saving lamps, dual water system for drinking water and sanitation and irrigation water, etc.
- Use roads and paving as sources of energy;
- During construction and operation reuse materials as much as possible or use recycled material.

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Appendix A

Climatic Conditions

Climatic conditions

Project area, mean temperatures (1956-2003) range from 22 0C in January to 30 0C in May. The average annual rainfall is 64 mm, however with significant variation. The rain is relatively evenly distributed throughout the year, however with lowest amounts occurring in May and August-October.

The wind climate is dominated by the northeast (Nov.-Jan.) and southwest (April-Oct.) monsoons with very little energy from other directions. The monsoon wind velocities are typically 4 m/s (northeast) and 7 m/s (southwest). The average annual wind rose for the five year period 2003 to 2007 is shown for the Duqm area in Figure (A-1). The wind rose is derived from meteorological datasets prepared for the dispersion modeling by Lakes Environmental.

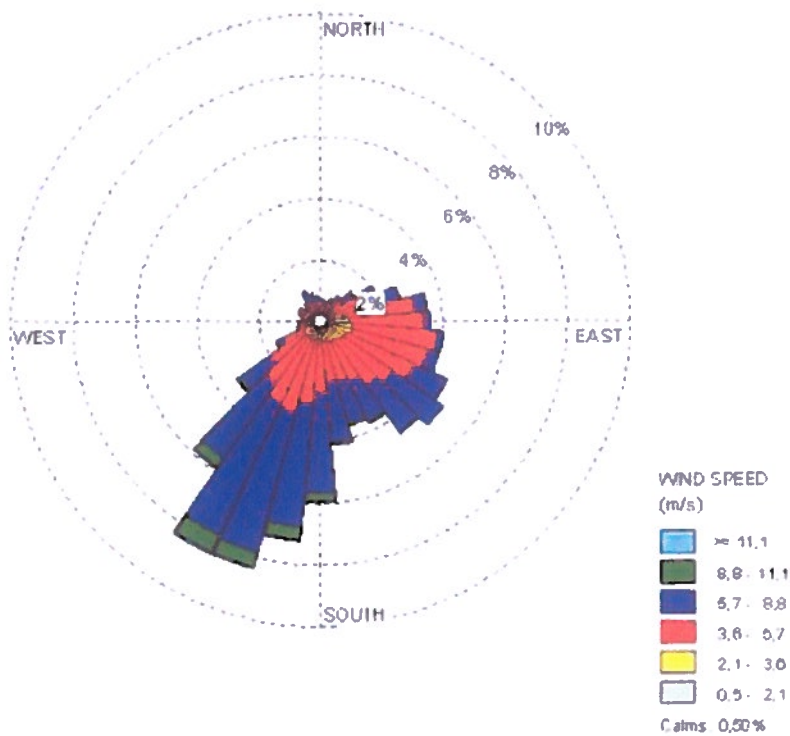


Figure (A-1): Wind rose for the Duqm area for the period 2003-2007

The wind rose clearly illustrates the predominantly southwesterly and south-easterly wind direction averaging over five years. Figures (A-1) and (A-2) show the seasonal variation over a year. As can be seen from there is quite a variation in the wind pattern over the year. During the winter the wind is mainly from easterly directions, whereas during the summer months the wind is mainly from south westerly directions. The wind speed is furthermore stronger during the summer period.

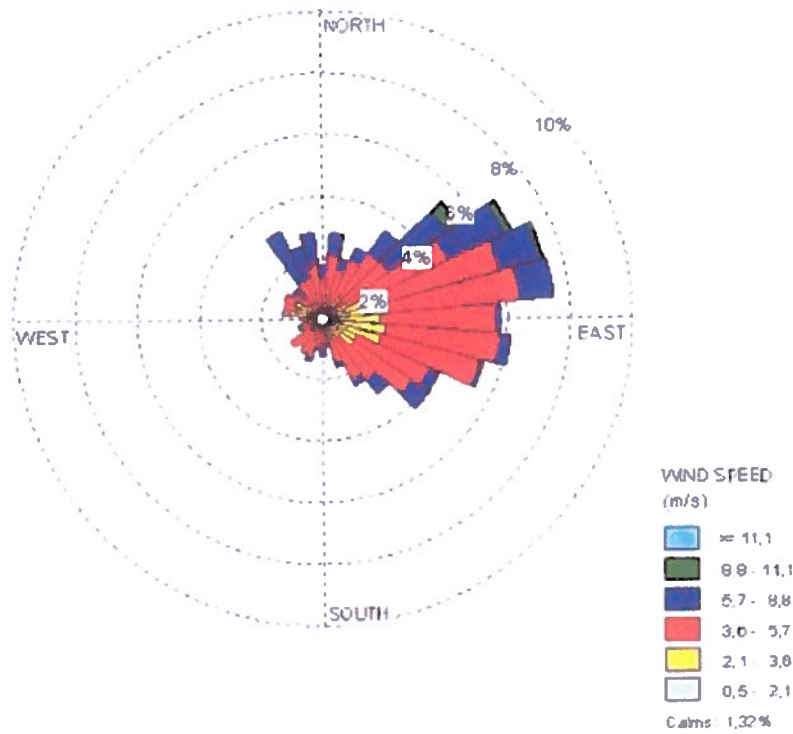


Figure (A-2): Wind rose for the Duqm area for the period January, February, November and December 2007

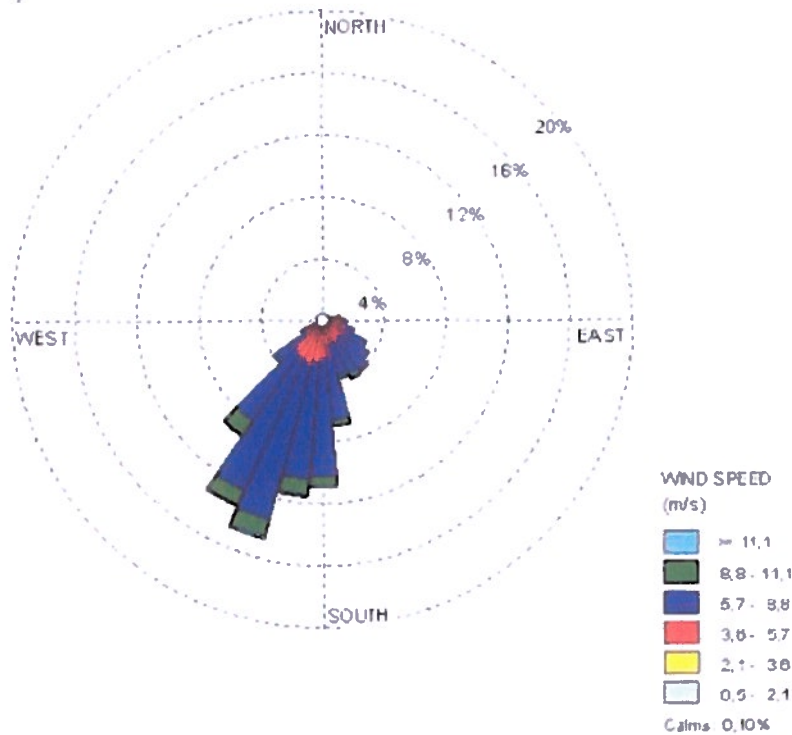


Figure (A-3): Wind rose for the Duqm area for the period May, June, July and August 2007

The daily variation is determined by the sea and land breeze circulation. Sea and land breeze circulations are prevalent throughout the Middle East region (Eager et al., 2007). Heating of the land surface during the day causes rising air over the land to draw air in from the sea (sea breeze). At night, the land cools more quickly than the sea, and the relative cooling cause's air to sink over land and flow out toward the sea (land breeze).

Over mainland areas such as the Saudi, UAE and Oman coasts, the sea breeze circulation can reach up to 150 km inland, depending on topography, and involve a similar distance out over the water.

The sea breeze wind may not be apparent on days with relatively stronger regional wind, but it is superimposed on the overall wind pattern. On days with light winds, the sea breeze becomes more significant, and can also become a factor in dispersion of local air pollution



Appendix B
Noise Level Modeling

Noise level modeling

In March 1998, the Federal Highway Administration (FHWA) of USA, Office of Natural and Human Environment, released the FHWA Traffic Noise Model (TNM), Version 1.0, a state-of-the-art computer model for highway traffic noise prediction and analysis. Since then, the FHWA, with assistance from the Volpe Center Acoustics Facility (Volpe Center) and Foliage Software Systems (FSS), have released updates of TNM (Versions 1.0a and 1.0b) in March 1999 and August 1999, respectively. In support of the FHWA and the California Department of Transportation, the Volpe Center and FSS released Version 1.1 in September 2000. Two additional updates were released (i.e., TNM 2.0 in May 2002 and TNM 2.1 in March 2003). TNM 2.5 is the latest version of TNM.

The Federal Highway Administration Traffic Noise Model (FHWA TNM[®]), like many other noise prediction models, computes a predicted noise level through a series of adjustments to a reference sound level. In the TNM, the reference level is the Vehicle Noise Emission Level, which refers to the maximum sound level emitted by a vehicle pas-by at a reference distance of 15 meters (50 feet). Adjustments are then made to the emission level to account for traffic flow, distance, and shielding. These factors are related by the following equation:

$$L_{Aeq1h} = EL_i + A_{\text{traffic}(i)} + A_d + A_s, \quad (1)$$

where EL_i represents the vehicle noise emission level for the i^{th} vehicle type, $A_{\text{traffic}(i)}$ represents the adjustment for traffic flow, the vehicle volume and speed for the i^{th} vehicle type, A_d represents the adjustment for distance between the roadway and receiver and for the length of the roadway, and A_s represents the adjustment for all shielding and ground effects between the roadway and the receiver.

The TNM is based on a three-dimensional coordinate system and is designed to run on a personal computer (PC).

Vehicle Emission Levels

The TNM incorporates a database of vehicle noise emission levels, based on measurements conducted throughout the U.S. in 1994 and 1995 [Fleming 1995].

Components of those data include:

- Slow-speed and accelerating vehicles



- Bus and motorcycle data
- Vehicles on grade
- Vehicles on different pavement types, including dense-graded asphaltic concrete (DGAC), open-graded asphaltic concrete (OGAC), and Portland cement concrete (PCC).

Other aspects of the noise emission data are:

- Energy apportioned to two source heights: one at the pavement level and one at 1.5 meters (5 feet) above the pavement, except for heavy trucks, where the upper height is 3.66 meters (12 feet) above the pavement
- Data stored in 1/3-octave bands.

Free Field Levels

Characteristics of the free-field noise level computations include:

- TNM computes three different sound-level descriptors, depending on user selection: the energy-equivalent sound level over a one-hour time period (1HEQ, represented by the symbol, LAeq1h), the average day-night sound level (DNL, represented by the symbol, Ldn), or the average day-evening-night sound level, designated as the Community Noise Equivalent Level (CNEL, represented by the symbol, Lden)..2
- Traffic control devices can be inserted, and the TNM computes vehicle speeds and emission levels accordingly. Such devices include traffic signals, stop signs, toll booths, and on-ramp start points.
- Computations are performed in a-octave bands for increased accuracy; this aspect is not visible to users.
- The TNM computes noise contours if specified; the NMPLOT Version 3.05 contouring program is used for compatibility with the Federal Aviation Administration's Integrated Noise Model (INM) Version 5.0 and higher [Olmstead 1996], and the U.S. Air Force's NOISEMAP program [Moulton 1990].

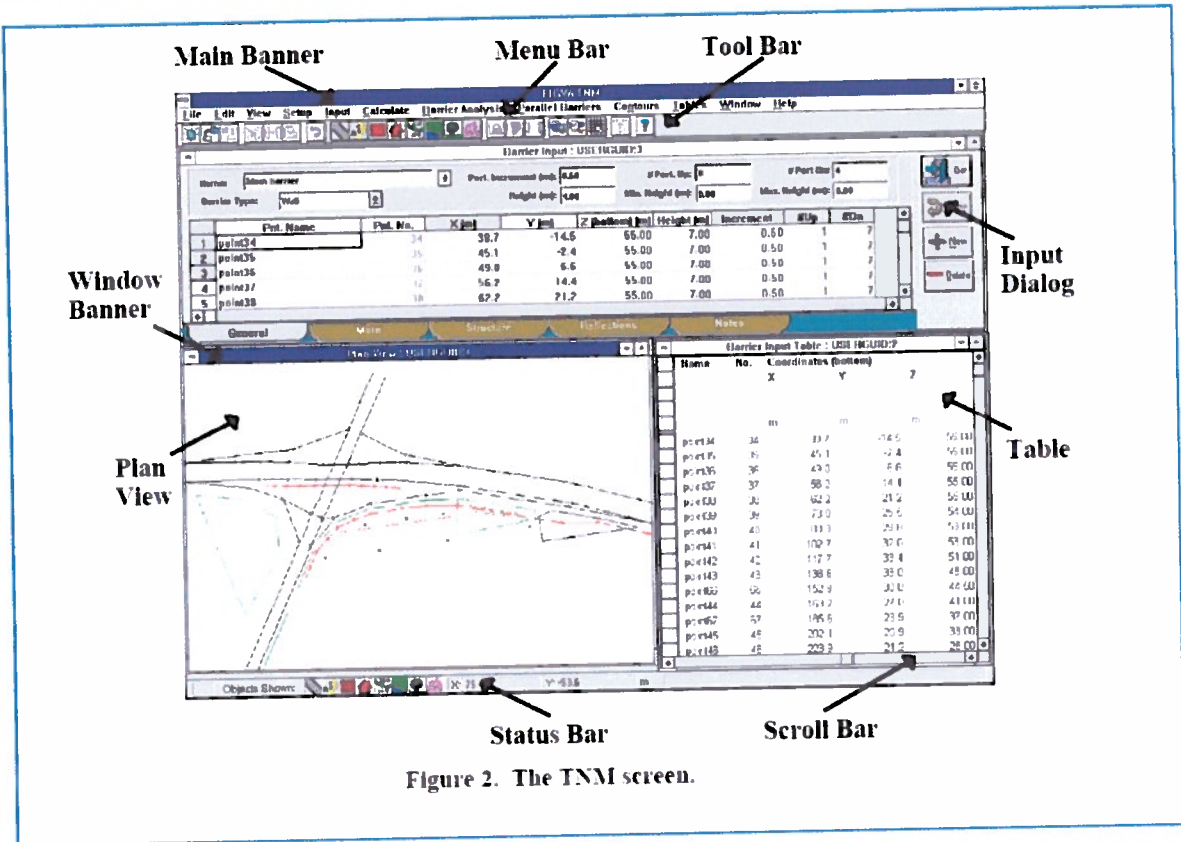


Figure 2. The TNM screen.



Appendix C

Predicted traffic emission rate up to Ultimate stage (2040) for the Governmental Berths

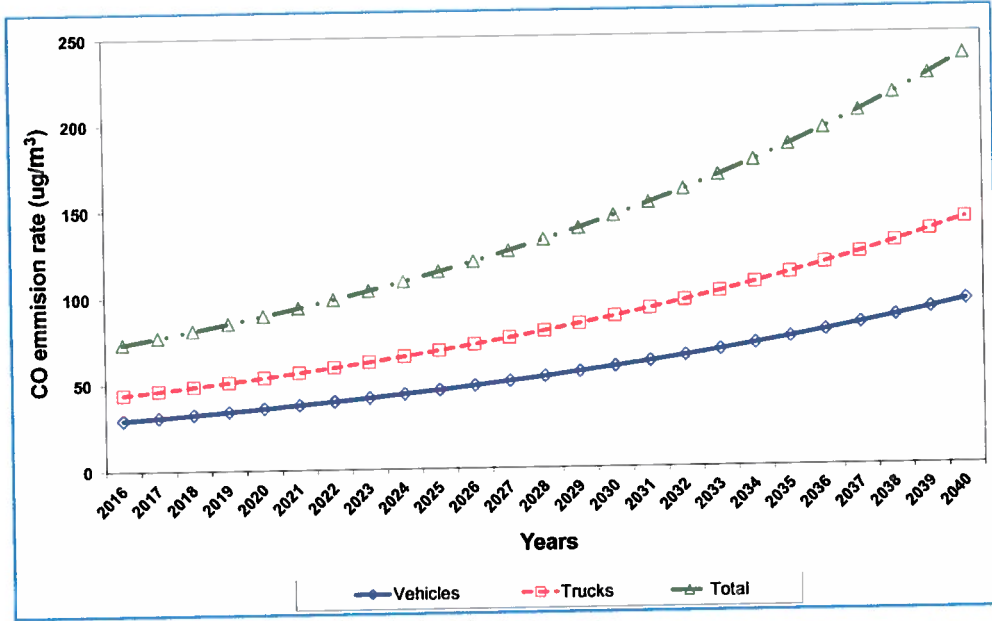


Figure (C.1): Predicted CO traffic emission rate for Commercial Berths

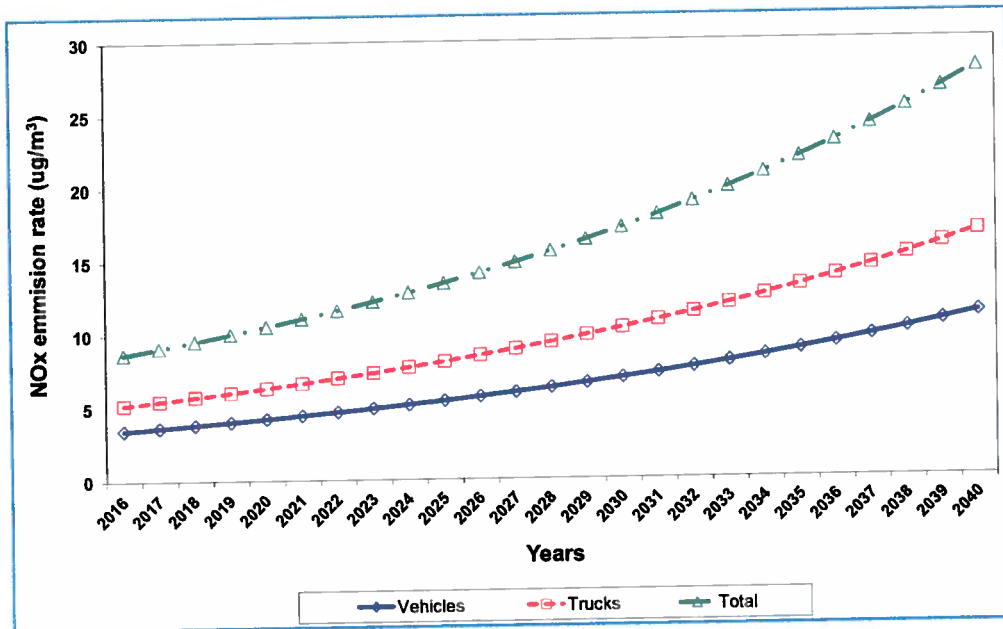


Figure (C.2): Predicted NO_x traffic emission rate for Governmental Berths

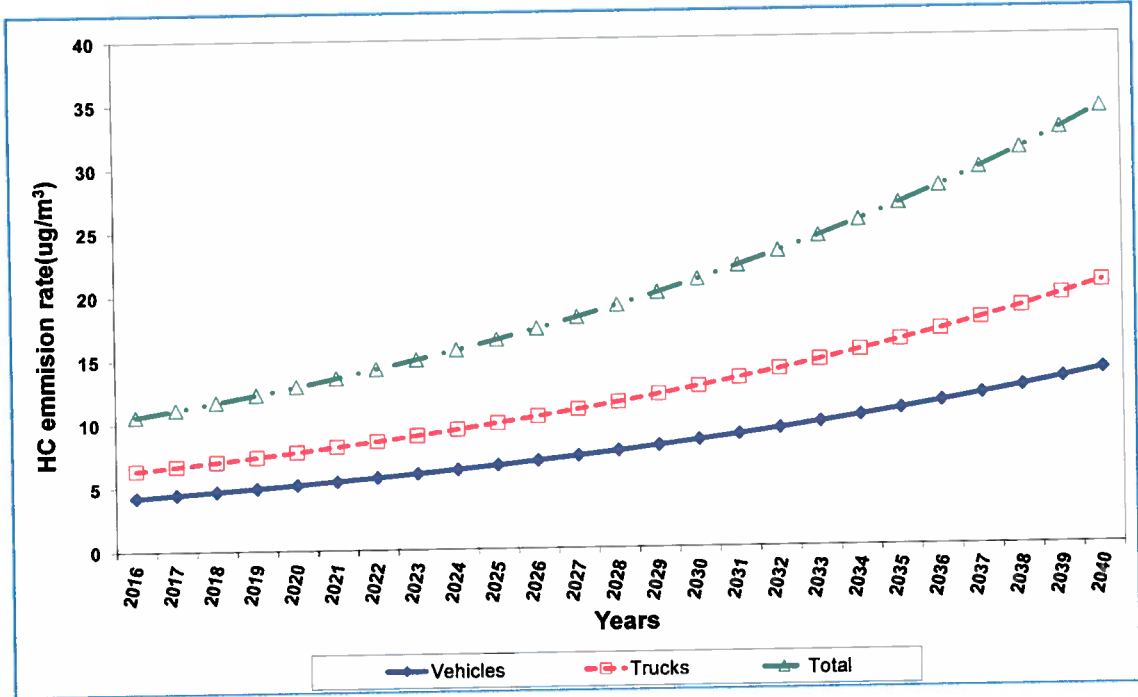


Figure (C3): Predicted HC traffic emission rate for Governmental Berths

Appendix D
Air Quality Modeling

Air quality modeling

The impact assessment is done by modeling the resulting concentrations CO, HO and NOx inside and outside the plant boundary in a distance of approximately 2 km from IP2 and IP4 where the impact from IP4 is negligible.

The impact of the activities is estimated using the US-EPA AERMOD dispersion model, version 6.0

Output from the model includes grids of ambient concentration statistics, which are plotted as trend up to the ultimate year (20140) and as isoline maps to show the pattern of concentrations around the site for illustration (NOx).

Significant limitations of the AERMOD dispersion model are that the model in most cases does not take into account removal of dust from the air by deposition and it only considers effects from buildings when the sources are modeled as point sources.

In addition the AERMOD model calculations can lead to overestimation of pollutant concentrations near the source especially at very low wind speed (This can be noticed for road network operation activities).

The model only includes the effect on the dispersion from nearby buildings if the emission sources are modeled as point sources.

A meteorological dataset for the port development site has been obtained from Lakes Environmental. The data covers the five year period 2003- 2007. The data is obtained through processing of model output from the MM5 meso-scale meteorological forecast model, using surface and upper-air measurements from stations throughout the region. The MM5 model takes into account the regional terrain and coastal location.