

Duqm Liquid Bulk Berths Project

Construction Environmental Management Plan

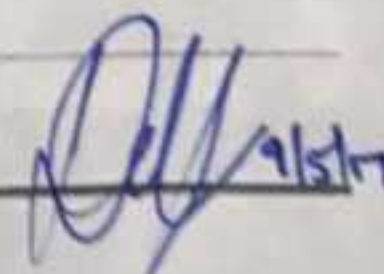
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RESPONSIBILITIES

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Revision Status							
Rev	Issue Date	Reason for Issue	Prepared	Verified	Reviewed	Approved	Owner's Acceptance
A1	29-03-2017	Internal review	Irena Doets		Stefanie Ross	Bart Pröpper	
A2	30-03-2017	IFR	Irena Doets		Stefanie Ross	Bart Pröpper	
B1	13-04-2017	IFA	Irena Doets		Stefanie Ross	Bart Pröpper	
B2	03-05-2017	IFA	Irena Doets	Stefanie Ross	Stefanie Ross	Bart Pröpper	

List of Changes to previous version

Par	Change
B1	
Definition Worker	Changed from 'a Contractor' to 'Contractor'
2.1	Reference Initial Environmental Permit changed. [3] deleted and expiry date deleted.
2.2	2011 deleted for NAAQS
2.3	Added: Socio-Economic Setting and Stakeholder Consultation SEZAD-DPTC-00-WP-EV-REP-2003-B1 (July 2015)
2.4.2	Document numbers changed. Project Environmental Management Plan deleted (is Construction Environmental Management Plan). Local Content Plan deleted (included in Omanisation and SME Content plan), Work Method Reclamation and Ground Improvement Deleted (included in Method Statement Dredging, Reclamation and Ground Improvement), Addendum to IEP added and Interface Management Plan added.
3	KPI 'No inappropriate storage or disposal of non-hazardous and liquid wastes' added. 'solid and liquid hazardous wastes' added
4. Table 4-1	Section 'Turbidity': 'outside the port entrance' changed to 'on the outside from the entrance to the Port.' 'Turbidity limit at ODC RO Plant intake is 10 NTU. If the turbidity level exceed the limit, then the Contractor shall take immediate mitigation measures to reduce the turbidity level or shall bear the cost impact of bringing the ODC RO plant back to normal operation' deleted (double). Section 'Storm water discharge to environment': 'MED' changed to 'MD' Sewage and waste water: 'MD 159/200' changed to 'MD 159/2005' and 'treated water' changed to 'treated waste water'.
4. Table 4-2	EIA references added for each measure
Entire document	'Boskalis/RBW' replaced by 'Contractor'
7.1.3	Date changed to 26 th of March
7.2	Section added.
7.3.	'outside' changed to 'on the outside from'
7.3.3	'from the Lee Breakwater outside the harbour entrance' changed to 'from the entrance of the Lee Breakwater on the outside of the harbour' North sign added to figures. ODC RO Plant intake of turbidity station added ('indicative location, final location to be agreed in discussion with ODC')

7.4.1	Added: 'No correlation will be established in the disposal area as this is the similar material as dredged from the harbour. However, during the pilot study test samples will be taken at the disposal area to verify the relationship from the harbour basin.'
7.4.1.2	'you do not touch the filters' changed to 'are not touched by hand'
7.4.1.5	Added: 'It should be noted that the correlation is not depth depended, but for the purpose of obtaining a wide range of TSS concentrations measurements are taken at different depths.'
7.9.1	Added: 'And all personnel will be asked during induction to report sighting of any marine mammal to the Vessel Master.'
8.2	'SSCs' changed to 'TSS levels'
8.4.2	'plan' deleted
8.4.3	Added: 'Placing the equipment such that it is oriented away from the receptors, where possible.'
8.5.2	'Entry, exit and access routes shall be designated to ensure that disturbed areas are kept to the minimum.' deleted
8.5.3	'Chemicals such as paints are kept in small amounts in suitable and enclosed areas.' added
8.7	'with adequate containment measures in place.' added
8.8.1	'Due to unavailability of recycling facilities.' deleted
8.11.1	Added to last sentence: 'including the mitigation measured adopted to minimise/correct the exceedance.'
11.4	Added: 'Contact person for Third Party Environmental Consultants'
B2	
1.4	<p>Added: 'related to the dredging, offshore disposal, reclamation, dry excavation and dewatering activities in Contractor's Scope of Work'</p> <p>Added: 'Separately, an addendum to the IEP is submitted covering environmental impact assessment, management and monitoring procedures for Contractor's onshore disposal activities, which have currently not been covered in the EIA and IEP. For more detail reference is made to the IEP addendum [103].'</p> <p>Added: 'which will be reviewed periodically and amended based on the experience gained during its implementation as well as changes in the environments'</p>
2.1	RD 116/2001 changed to RD 6/80
4, 7.7 & 9	Monthly seawater and sediment quality requirement of IEP added
5.2.2	OOC changed to: Duqm Port Company (DPC) and Oman Oil Company (OOC) have an agreement with Environment Society of Oman to support marine turtle conservation on Masirah Island.
7.1.1 and 10.5	Noise included
7, Table 7.1	Overview added of monitoring activities, frequency and who conducts the monitoring
7.4	Added: 'During the works, continuous turbidity measurements, as described in section 7.3, will be conducted to assess compliance with the limits'

7.3 to 7.16	Introduction section added to each section
8.2	Deleted: '11. Implementation of a silt screen around the ODC RO Plant intake, should levels reach the turbidity limit at the intake.' Based on discussions with ODC silt screens are not practical as vessel activities are nearby.

File name: Construction Environmental Management Plan

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APPENDICES

APPENDIX 1: SPECIFICATIONS ENVIRONMENTAL MONITORING BUOY

APPENDIX 2: SPECIFICATIONS WATER QUALITY MULTI-PARAMETER SENSOR

APPENDIX 3: EXAMPLE FORTNIGHTLY ENVIRONMENTAL REPORT

APPENDIX 4. SIDE SCAN SONAR SPECIFICATIONS

DEFINITIONS

Owner	Special Economic Zone Authority at Duqm
Contractor	Boskalis Westminster Oman LLC
Owner's Representative	WorleyParsons
Project	Duqm Liquids Bulk Berths Project
Q-Aid	RBW Corporate SHE-Q Management System
Subcontractor	Companies contracted by Contractor to perform a specific portion of the work
Supplier	A company that is requested to supply (temporary) materials or services on behalf of Contractor
Worker	A worker is someone who carries out work for Contractor. A worker includes an employee, labour hire staff, volunteer, apprentice, work experience student, subcontractor, and contractor.

ABBREVIATIONS

ANZECC	Australian and New Zealand Environment Conservation Council
BAT	Best Available Technique
BTEX	Benzene, Toluene, Ethyl benzene and Xylenes
CEMP	Construction Environmental Management Plan
CSD	Cutter Suction Dredger
DLBB	Duqm Liquid Bulk Berths
DO	Dissolved Oxygen
EHS	Environment Health and Safety
EIA	Environmental Impact Assessment
ESO	Environment Society of Oman
FEED	Front-End Engineering Design
IEP	Initial Environmental Permit
IFC	International Finance Corporation
ISM	International Safety Management
ISO	International Organization for Standard
ITT	Invitation to Tender
IUCN	International Union for Conservation of Nature and Natural Resources
JNCC	Joint Nature Conservation Committee
FNU	Formazin Nephelometric Units
KPI	Key Performance Indicator

LBW	Lee Breakwater
MARPOL	International Convention for the Prevention of Pollution from Ships 1973/78
MECA	Ministry of Environment and Climate Affairs
MSDS	Material Safety Datasheet
NAAQS	National Ambient Air Quality Standards
NTU	Nephelometric Turbidity Units
ODC	Oman Drydock Company
ODS	Ozone Depleting Substance
OOC	Oman Oil Company
OSHA	Occupational Safety and Health Administration
PDC	Port of Duqm in Oman
PMS	Plant Management System
PSU	Practical Salinity Units
RBW	Royal Boskalis Westminster
RO	Reverse Osmosis
ROPME	Regional Organisation for the Protection of the Marine Environment
SSC	Suspended Solids Concentrations
SEZAD	Special Economic Zone Authority at Duqm
SEZ	Special Economic Zone
SHE	Safety, Health and Environment
SHE-Q	Safety, Health, Environment and Quality
SO ₂	Sulphur Dioxide
SOW	Scope of Works
TSHD	Trailing Suction Hopper Dredger
TSS	Total Suspended Solids
USEPA	United States Environment Protection Agency
WP	Work Package

1 INTRODUCTION

1.1 PROJECT BACKGROUND

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

The Special Economic Zone Authority at Al Duqm – SEZAD – was established to oversee the planning vision and strategic development of Duqm as a result of Royal Decree No. 119/2011, which was further re-defined through Royal Decree No. 44/2014 and No. 5/2016.

Duqm Refinery & Petrochemical Industries Company – Duqm Refinery – is a major new greenfield industry which will build a new oil refinery at Duqm, as phase 1 of an overall Refining and Petrochemical Complex. The refinery, which is currently being developed, will have a planned capacity of 230,000 BPD.

The Duqm Liquid Bulk Berths Project involves the design and construction of marine structures and dry bulk and tank facilities for the export of finished petroleum products from the Duqm Refinery. The finished liquid products to be handled at the terminal are Naphtha, Jet A1, Diesel Oil, High Sulphur Fuel Oil (HSFO), Pressurized Liquefied Petroleum Gas (PLPG); the finished dry bulk products are Pet Coke and Solid Sulphur Pellets.

Boskalis Westminster Oman LLC was awarded with the EPC 1 Contract comprising the design, dredging and marine infrastructure works for the Project.

1.2 DESCRIPTION OF SITE

The existing Duqm town occupies an area of 10km² and is located in the Sultanate of Oman, at the eastern coast of Al Wusta region, approximately 600km south of Muscat and 480 km north-east of Salalah.

The Port of Duqm is seen as a catalyst for the development of the Al Wusta region. The Port and Dry Dock are being developed to increase the trade. The site enjoys proximity to the busy regional sea-lanes of Oman's coastal waters – Figure 1.1.

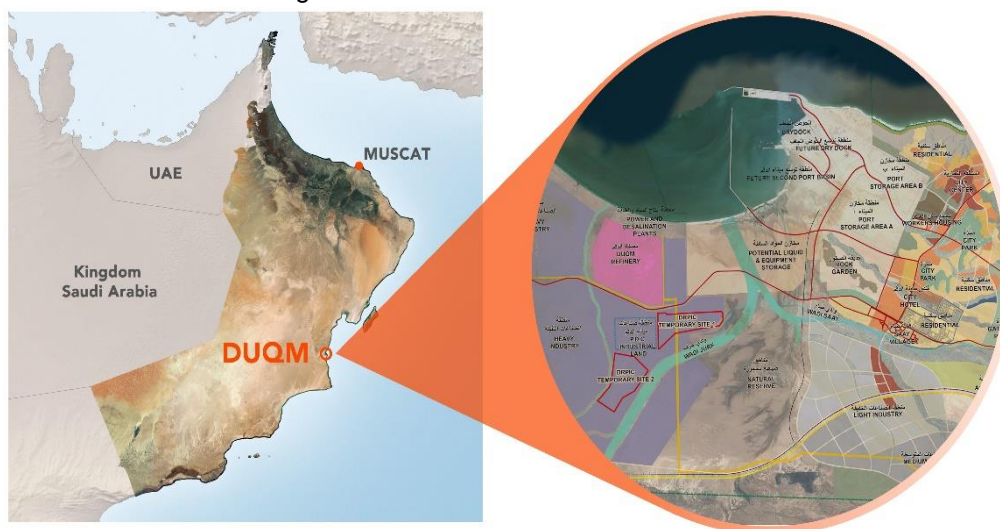


Figure 1.1: Location map and master plan detail

1.3 SCOPE OF WORK

The Scope of Work for the EPC1 Design, Dredging and Marine Infrastructure Contract includes the Detailed Design, Procurement and Construction of the marine structures and associated berths, dredging works and permanent reclamation areas as summarized in Table 1.1. Figure 1.2 presents a schematic overview of the works.

Table 1.1: Summary of the Scope of Work

SUMMARY OF THE SCOPE OF WORK	CONTRACTOR'S WORK PACKAGES
	Project Site
<ul style="list-style-type: none"> • Execution and interpretation of necessary studies • Execution and interpretation of all necessary site surveys and investigations 	Detailed Design and Engineering
<ul style="list-style-type: none"> • Design, procurement and the construction of permanent dredging 	Dredging (Figure 1.2, 1)
<ul style="list-style-type: none"> • Design, procurement and the construction of permanent reclamation and associated ground improvements 	Reclamation and Ground Improvement (Figure 1.2, 2)
<ul style="list-style-type: none"> • Design, procurement and the construction of continuous Quay Berths including associated quay furniture and other required equipment at Berth 900, Berth 901 and Berth 902 • Design, procurement and the construction of the infrastructure required for the oil spill response equipment • Design, procurement and the construction of various seawater intakes and outfalls 	Continuous Quay Wall (Figure 1.2, 5)
<ul style="list-style-type: none"> • Design, procurement and the construction of Double Berth Island Jetty structures including loading platforms, access trestles, dolphins, associated quay furniture and navigation aids at Berth 903, Berth 904, Berth 905 and Berth 906 	Double Berth Island Jetty (Figure 1.2, 4)
<ul style="list-style-type: none"> • Design, procurement and the construction of permanent modifications to the existing Lee Breakwater • Design, procurement and the construction of permanent revetments and scour protection 	Breakwater and Revetment (Figure 1.2, 3)
	Temporary Contractor Facilities and Works

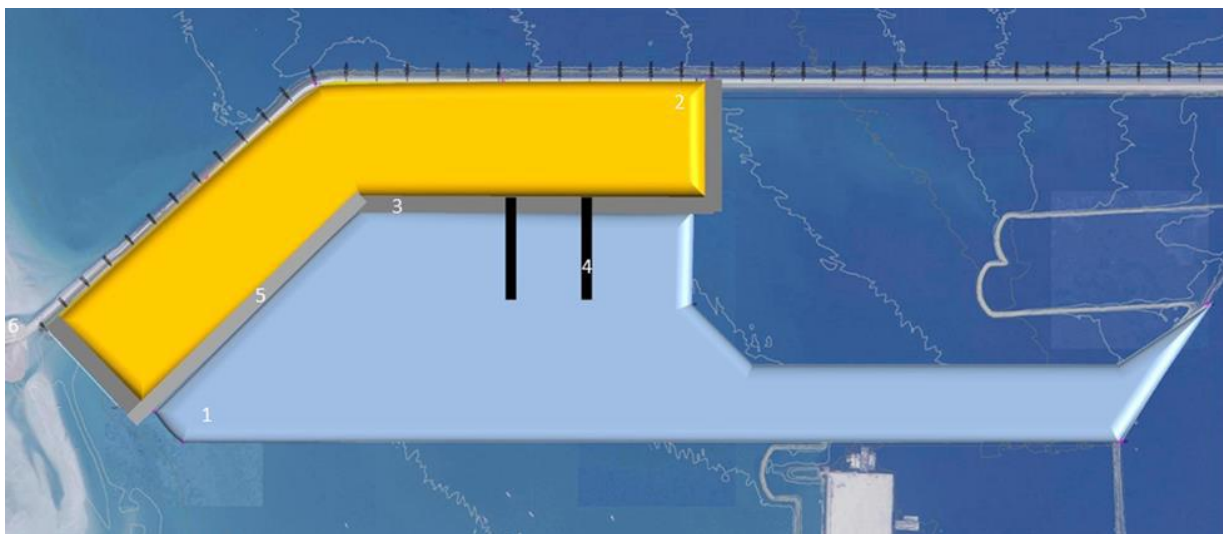


Figure 1.2: Schematization of the Works (1 to 5 indicate dredging, reclamation, revetment, jetties and quaywall, respectively)

1.4 DOCUMENT SCOPE

This Construction Environmental Management and Monitoring Plan (CEMMP) is prepared to comply with the environmental requirements stated in the Environmental Impact Assessment (EIA), the Initial Environmental Permit (IEP), Owner's documents and governmental legislation.

This document provides the environmental management framework and monitoring plan in order to minimize the environmental impact related to the dredging, offshore disposal, reclamation, dry excavation and dewatering activities in Contractor's Scope of Work. The document describes the responsibilities, procedures (including the environmental monitoring plan) and reporting that will be applicable during the execution of the works. Separately, an addendum to the IEP is submitted covering environmental impact assessment, management and monitoring procedures for Contractor's onshore disposal activities, which have currently not been covered in the EIA and IEP. For more detail reference is made to the IEP addendum [103].

This plan is a dynamic document, which will be reviewed periodically and amended based on experience gained during its implementation as well as changes in the project activities. Controlled copies of this plan will be made available to all parties concerned and will be updated/revised whenever the need arises.

1.5 DOCUMENT OUTLINE

This plan presents Contractor's environmental management and monitoring system and follows the following steps:

- Contractor's Project Environmental Philosophy (Chapter 3);
- Overview of environmental requirements applicable to Contractor's Scope of Work (Chapter 4);
- Description of the existing environment and identification of the most environmentally sensitive areas (Chapter 5);
- Contractor's Environmental Management System, Environmental Risk Assessment approach and selection of the most relevant environmental risk for Contractors Scope of Work (Chapter 6);
- Contractor's Environmental Monitoring programme (Chapter 7);
- Contractor's Environmental Control and Mitigation programme (Chapter 8);
- Reporting items and frequencies (Chapter 9);
- Contractor's Environmental Quality Assurance & Control system (Chapter 10); and
- Roles and Responsibilities within the Environmental Management System (Chapter 11).

2 REFERENCES

2.1 LEGISLATION

The following Omani and SEZAD legislation is related to this document:

REFERENCE	DOCUMENT NR	DOCUMENT TITLE
[1]	DUQM/2016/0000231 (28 January 2016)	DLBB EIA Study Approval with Permit Conditions
[2]	1161631	DLBB Initial Environmental Permit
[3]	DUQM/2016/0000330	DLBB Permit Clarification EIA Study Approval (11 February 2016)
[4]		MECA Letter of Approval Subject: 'The Study of the Environmental Impact of the Project of Liquid Bulk Cargo Terminal in the Special Economic Zone at Duqm' (21 January 2016)
[5]	MD 4/87	Regulation on the issuance of quarries and mines licences
[6]	MD 17/93	Regulations for the management of solid non-hazardous wastes
[7]	MD 18/93	Regulations for the management of hazardous wastes
[8]	MD 20/90	Regulations regarding coastal setback
[9]	MD 20/99	Fees for import and handling of chemicals substances
[10]	MD 21/99	Fees for granting permits for the import, transportation, storage and use of radioactive substances
[11]	MD 25/2009	Regulations for organization of handling and use of chemicals
[12]	MD 39/2004	Regulations for the discharge of liquid effluents to the marine environment
[13]	MD 56/2002	Amendment of MD 18/93 Regulations for the management of hazardous wastes
[14]	MD 55/2002	Amendment of MD 145/93 Regulations for wastewater reuse and discharge
[15]	MD 57/2002	Amendment of MD 17/93 Regulations for the management of solid non-hazardous wastes
[16]	MD 68/2004	Amendment to MD 187/2001
[17]	MD 71/2002	Amendment to MD 187/2001
[18]	MD 79/94	Regulations for noise pollution in public environment
[19]	MD 80/94	Regulations for noise pollution in working environment
[20]	MD 101/2002	Ban on hunting, killing or trapping of wild animals and birds
[21]	MD 110/2007	Regulations of the law on nature reserves and wildlife conservation
[22]	MD 118/2004	Regulations for air pollution control from stationary sources

[23]	MD 128/1993	Ammended by MD 169/2000 Ban on Cutting Green Trees
[24]	MD 145/93	Regulations for wastewater reuse and discharge
[25]	MD 187/2001	Issuing regulations for organizing obtaining environmental approvals and final environmental permit
[26]	MD 200/2000	Regulations for stone crushers, stone quarries and transport of sand from coasts, beaches and wadis
[27]	MD 209/95	Obligating industrial and commercial organisations and others to apply environmental regulations as stated in environmental permits
[28]	MD 243/2005	Control and management of climate affairs
[29]	MD 248/97	Regulations for registration of chemicals substances and relevant permits
[30]	MD 249/97	Regulations for control and management of radioactive materials and substances
[31]	MD 281/2003	Amendment of MD 249/97 Regulations for control and management of radioactive materials and substances
[32]	MD 316/2001	Banning the use of some hazardous chemical substances
[33]	MD 317/2001	Regulations for packaging and binding conditions/ stipulations and putting information and labels on the hazardous chemical substances
[34]	MD 421/98	Regulations for septic tanks, soak-away pits and holding tanks
[35]	OS 8/2012	Omani standard for drinking water
[36]	RD 6/2003	Law on nature reserves and wildlife conservation
[37]	RD 8/2003	Law on grazing land and animal resources
[38]	RD 29/2000	Law of protection of water resources
[39]	RD 34/74	Law on marine pollution control
[40]	RD 46/95	Law on handling and use of chemicals
[41]	RD 79/2013	Issuing the regulation of the Special Economic Zone at Duqm
[42]	RD 114/2001	Conservation of the environment and prevention of pollution
[43]	RD 115/2001	Law on protection of potable water sources from pollution
[44]	RD 6/80	Law for Protection of National Heritage
[45]	RD 119/2011	Establishing Special Economic Zone Authority Duqm and issuing its regulations

2.2 CODES OF PRACTICE AND STANDARDS

REFERENCE	DOCUMENT NR	DOCUMENT TITLE
[46]		Australian and New Zealand Recommended Sediment Quality Guidelines, Australian and New Zealand Environment Conservation Council (ANZECC, 2000)
[47]		Dutch intervention and Target Values for soil and groundwater, Netherlands Ministry for the Environment, 2000
[48]		Fresh and Marine Water Quality Standards, Australian and New Zealand Environment Conservation Council (ANZECC), 2000
[49]		Harbour Water Quality, Government of Dubai, 2010
[50]	MARPOL 1973/78	International Convention for the Prevention of Pollution from Ships
[51]		International Finance Corporation – General Environment Health and Safety (EHS) Guidelines
[52]		International Finance Corporation – EHS Guidelines for crude oil and petroleum products terminal
[53]		International Finance Corporation – EHS Guidelines for ports, harbours and terminals
[54]	International Safety Management (ISM) Code: 1998	International Safety Management Code for the Safe Operation of Ships and for Pollution Prevention
[55]	ISO 9001:2015	Quality Management Systems
[56]	ISO 14001:2015	Environmental Management Systems
[57]	NAAQS	National Ambient Air Quality Standards (NAAQS). United States Environment Protection Agency (USEPA)
[58]		Regional Organisation for the Protection of the Marine Environment (ROPME)
[59]	OHSAS 18001:2007	Occupational Health, Safety Management Systems
[60]	BSN EN 872:2005	Water quality. Determination of suspended solids. Method by filtration through glass fibre filters.

2.3 OWNER'S DOCUMENTS

REFERENCE	DOCUMENT NR	DOCUMENT TITLE
[61]	SEZAD-DPTC-00-WP-EV-REP-2002-B1 (September 2015)	Ambient Air Quality, Ambient Noise Level and Terrestrial Ecological Surveys
[62]	SEZAD-DPTC-00-WP-EV-REP-3001-B2 (September 2015)	Environmental Impact Assessment
[63]	SEZAD-DPTC-00-WP-OM-PLN-0003-B1, Rev B1 (January 2017)	Exhibit A – Scope of Work, Contract No. 78-2017, EPC1 – Design, Dredging and Marine Infrastructure Work
[64]	SEZAD-DPTC-00-WP-OM-PLN-0003-B1, Rev B1 (November 2015)	Exhibit C – Coordination Procedures, ITT No. 28-2015, EPC1 – Design, Dredging and Marine Infrastructure Work
[65]	SEZAD-DPTC-11-WP-REP-2006-B1 (September 2015)	Hydrodynamic modelling Study
[66]	SEZAD-DPTC-00-WP-EV-REP-2004-B3 (December 2015)	Marine Environmental Baseline Survey
[67]	SEZAD-DPTC-00-WP-EV-LST-0001-B2 (August 2015)	Environmental Permits List
[68]	SEZAD-DPTC-00-WP-EV-PHL-2002-B2 (October 2015)	Waste Management Philosophy
[69]	SEZAD-DPTC-11-WP-MC-SPC-3001-B2 (October 2016)	Technical Specification Dredging, Excavation, Reclamation and Ground Improvement
[70]	SEZAD-DPTC-00-WP-EV-REP-2003-B1 (July 2015)	Socio-Economic Setting and Stakeholder Consultation

2.4 CONTRACTOR'S DOCUMENTS

2.4.1 General

Reference is made to our Boskalis Management System Q-Aid 2010. The following RBW docs are related to this document:

REFERENCE	DOCUMENT NR	DOCUMENT TITLE
[69]	RBW-002	(Corporate) Policy Statement Safety, Health and Environment
[70]	RBW-308	Audits
[71]	RBW-310	Non-conformities and Corrective Actions
[72]	RBW-311	Preventive Actions
[73]	RBW-313	SHE Risk Assessment procedure
[74]	RBW-504	SHE-Q Management Checklist (model)
[75]	RBW-510	Incident Reporting and Investigation
[76]	RBW-512	Project Environmental Plan
[77]	RBW-513	SHE Risk assessment Matrix
[78]	RBW-514	Job Hazard Analysis
[79]	RBW-515	Permit to Work
[80]	RBW-519	Toolkit project Induction
[81]	RBW-527	Non Conformity Report
[82]	RBW-528	Handover Guidelines
[83]	RBW-532	Inspection & Test Plans
[84]	RBW-540	Weekly Narrative Reporting

2.4.2 Project documents

REFERENCE	DOCUMENT NR	DOCUMENT TITLE
[85]	0020062-EEW00-PM-001	Maintenance Plan
[86]	SEZAD-IP7-BO-PM-00-PLN-4002-00	Project Organization Plan
[87]	SEZAD-IP7-BO-PM-10-PLN-4001-00	Mobilization Plan
[88]	SEZAD-IP7-BO-PM-00-PLN-4001-00	Project Execution Plan
[89]	SEZAD-IP7-BO-PC-00-PLN-4001-00	Project Control Plans
[90]	SEZAD-IP7-BO-PM-00-PLN-4003-00	Stakeholder Management Plan
[91]	SEZAD-IP7-BO-PM-00-PLN-4009-00	Interface Management Plan
[92]	SEZAD-IP7-BO-PM-00-PLN-4004-00	Training Plan
[93]	SEZAD-IP7-BO-RM-00- PLN-4001-00	Risk Management Plan
[94]	SEZAD-IP7-BO-RM-00-PRO-4001-00	Risk Management System
[95]	SEZAD-IP7-BO-PM-00-PLN-4007-00	Omanisation and SME Content Plan
[96]	SEZAD-IP7-BO-QA-00-PLN-4001-00	Project Quality Plan
[97]	SEZAD-IP7-BO-HS-00-PLN-4002-00	HSSE Plan
[98]	SEZAD-IP7-BO-HS00-PRO-4001-00	HSSE System
[99]	SEZAD-IP7-BO-QA-00-PRO-4001-00	Quality Management System
[100]	SEZAD-IP7-BO-EM-CMM-4001-00	Method Statement Dredging and Reclamation
[101]	SEZAD-IP7-BO-EM-CMM-4002-00	Method Statement Excavation and Dewatering
[102]	SEZAD-IP7-BO-HS00-PLN-4006-00-A2	Waste Management Plan
[103]	SEZAD-IP7-00-BO-EV-PCS-4001-00	Addendum to IEP for onshore disposal
[104]	SEZAD-IP7-BO-EV-00-PLN-4001-00	Spill Procedure

Note: These documents are under development at time of writing of this revision of the document

2.4.3 Other

[105] Deltares, December 2016, Delft3D-FLOW User Manual Version 3.15.

3 PROJECT ENVIRONMENTAL PHILOSOPHY

Contractor's environmental philosophy is based on adaptive management. An adaptive management plan seeks to develop strategies to assess the system, predict the impact and cater for uncertainties (Figure 3.1). In general, levels of uncertainty about the construction-related impacts decrease over the course of the project as more accurate information is collected.

By monitoring throughout the construction activities in combination with reviewing the process (for example dredging cycle, production rates, bathymetric surveys etc.) opportunities can be identified and seized to amend the construction productivity. For example, if the measured SSCs (or turbidity) are well below the environmental thresholds and the sensitive receptors appear to remain free from any impacts, it would be possible to increase production or make the operational timeframes more flexible.

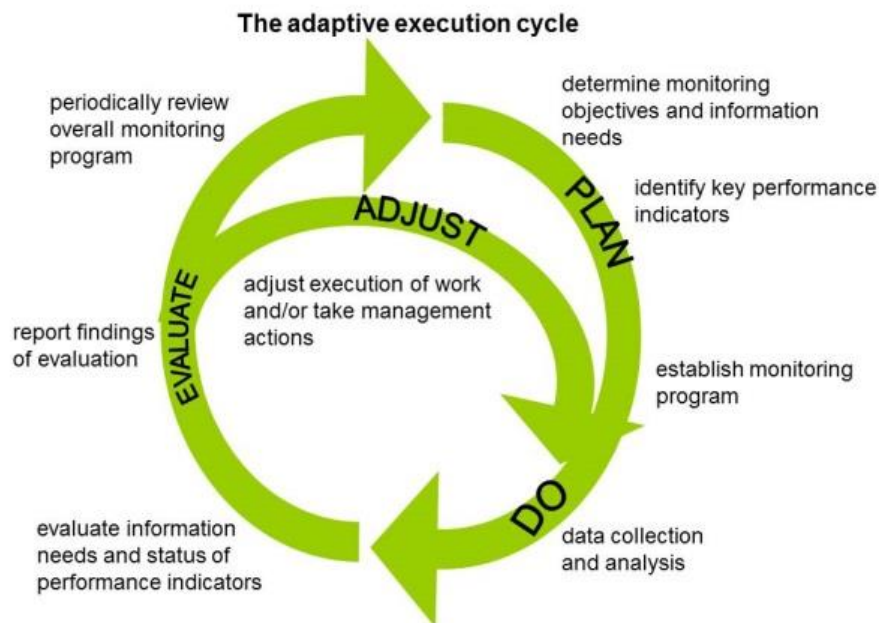


Figure 3.1: Adaptive management

Adaptive management ensures that the activities work within required environmental thresholds; however, adaptive management strategies go beyond merely staying with an environmental boundary condition. Limits set must be adhered to, but they should not become the goal in itself. The main goal is to limit, if not prevent, any negative impacts to the terrestrial and marine ecosystems while meeting the objectives of the planned construction activities, such as timely delivery and maximising productivity. The means to achieving this goal is by adapting the operational plan based upon the monitored ecosystem health, particularly of sensitive receptors which typically will provide early indication of environmental quality issues. This allows limits to be relaxed or tightened depending upon the response from the ecosystem.

Contractor's key performance indicators (KPI) for environmental elements specific to this project are:

- Turbidity:
 - No exceedance of the turbidity thresholds;
 - Corrective actions are taken in a timely manner when exceedances are encountered and reported.
- Marine mammals: no capture and/or injury of (protected) marine mammals;
- Air: implementation of control & mitigation measures for dust and (gaseous) air emission.
- Noise: remain within industrial noise limits.

- Waste:
 - Separate the waste streams;
 - Reduce quantity of waste generated;
 - No inappropriate storage or disposal of non-hazardous and liquid wastes.
- Hazardous waste:
 - No inappropriate storage or disposal of solid and liquid hazardous wastes;
 - No spills into the terrestrial or marine environment.
- Training:
 - Deliver project inductions to all personnel;
 - Identify and provide employees with specific environmental training.
- Compliance to applicable local and international regulations:
 - No regulatory infringements;
 - No formal regulatory warnings;
 - Rectify and investigate incidents and non-conformance in a timely manner.

This CEMP will ensure all reasonable efforts are made to meet the KPI's and comply with applicable local and international environmental regulations. The main objective of the CEMP is to provide:

- Evidence of practical and achievable plans to ensure that the project's environmental requirements are complied with;
- An integrated plan for monitoring, assessing and controlling impacts.

Effective environmental management and monitoring activities will be essential to ensure the environmental objectives of the work are achieved. The CEMP ensures that all activities in all stages of the project, from site preparation through to operations, are carried out in an environmentally acceptable manner. The objective is to minimize any negative impacts of construction, dredging and disposal of dredged materials.

3.1 CORPORATE STATEMENT WITH RESPECT TO ENVIRONMENT

Boskalis often operates in environmentally sensitive areas. We therefore adhere to:

- Complying with the applicable statutory environmental provisions and regulations and, where possible, going further than required;
- Focusing policy on the permanent prevention or limitation, as far as possible, of pollution of soil, water and air, sound creation, creation of waste products and use of dangerous materials;
- Collecting and having waste processed separately, and using water and energy efficiently;
- Translating policy into clear practical guidelines and, furthermore, ensuring that the policy and the guidelines are implemented in practice;
- Permanently ensuring that the environmental awareness and motivation of the employees and others who work on the premises of Boskalis is such that environmental protection - although primarily the management's responsibility - is everybody's concern;
- Optimizing our environmental management system according the ISO 14001 standard, to achieve continuous improvement of our environmental performance SHE-Q structure.

4 ENVIRONMENTAL REQUIREMENTS

The environmental requirements and monitoring requirements applicable to Contractor's Scope of Work as specified in the EIA [62], the EIA study approval and its permit conditions [1] and Owner's documents (Exhibit A [63] and Technical Specifications [69]) are summarized in Table 4.1 below. Mitigation measures proposed in the EIA [62] are summarized in Table 4.2.

Table 4.1: Environmental (monitoring) requirements

ASPECT	REQUIREMENT	MONITORING FREQUENCY	MONITORING LOCATION	REFERENCE DOCUMENTS	OWNER	REFERENCE CONTRACTOR DOCUMENTS
General						
Compliance Audits	<ul style="list-style-type: none"> Waste management practices and adequacy of disposal/recycling methods Adequacy of permits Fuel consumed Emissions to air and water House keeping Management of impacts from ongoing activities Close out of deviations identified during inspections and previous audits (if any) 	Quarterly during construction phase	DLBB Project	EIA Table 8-22 [62]		CEMP section 7.1.1
Inspection	Compliance with the EIA, Permit Conditions, IFC EHS Guidelines, regulations of the Sultanate of Oman	Monthly during construction phase	DLBB Project	EIA Table 8-22 [62]		CEMP section 7.1.2
Permits	The Contractor shall be responsible to obtain all permits/ approvals/ licenses/ consents/ no-objections that are required during the execution of the scope of work. Except for the Initial Environmental Permit (IEP) and offshore dredging and disposal areas.	Prior to commencing an activity		Exhibit A section 6.3.6 [63] and Environmental Permit list [67]		CEMP section 7.1.3
Training of Dredging Crew	Provide Environmental Induction training to the dredging and marine Contractor personnel to create awareness for the marine life and flora and fauna in the area, including specific requirements of marine mammal observation.	Prior to start of construction works		Exhibit A section 6.3.7 [63]		CEMP section 7.9 and Training Plan [92]

ASPECT	REQUIREMENT	MONITORING FREQUENCY	MONITORING LOCATION	REFERENCE DOCUMENTS	OWNER	REFERENCE CONTRACTOR DOCUMENTS
Environmental baseline study	The Contractor shall undertake all pre-construction baseline studies required to obtain the environmental permits and stakeholder approvals. These are likely to require the same scope as the studies undertaken during the project EIA study.	Prior to start of construction	In the extent and footprint of disposal and dredging area	Exhibit A section 6.3.4 & 6.3.5 [63] and EIA Table 8-7 [62]		CEMP section 7.2
Post- construction marine survey	The Contractor shall undertake a post-construction marine survey at the borrow and disposal area following completion of his disposal activities.	Post-construction	At the offshore borrow and disposal area	Exhibit A section 6.3.4 & 6.3.5 [63]		CEMP section 7.12
Water quality						
Turbidity	<ul style="list-style-type: none"> TSS limit 30 mg/l at 500 m from activity location at offshore borrow and offshore disposal area TSS limit 30 mg/l at 500 m on the outside from the entrance to the Port. Overflow of materials from dredging vessel is allowed as long as TSS limit is maintained. 	Continuous	<ul style="list-style-type: none"> 500 m from offshore borrow and disposal area 500 m outside the port entrance 	Exhibit A section 11.7.3 [63], EIA Study Approval Clarification [1], Technical Specifications [69]		CEMP section 7.3
Turbidity – RO plant intake	<ul style="list-style-type: none"> Turbidity limit at ODC RO Plant intake is 10 NTU. If the turbidity level exceed the limit, then the Contractor shall take immediate mitigation measures to reduce the turbidity level or shall bear the cost impact of bringing the ODC RO plant back to normal operation. The Contractor will develop the final limits and procedures jointly with ODC prior to Contract commencement. 	Continuous	<ul style="list-style-type: none"> In the vicinity of ODC RO Plant intake, location shall be advised by ODC. Location as per drawing DPTC/SEZAD/20 15/050 	Exhibit A section 11.7.3 [63]		CEMP section 7.3
Plume dispersion modelling	<ul style="list-style-type: none"> Undertake numerical dredge plume modelling based on the equipment, methods, and any mitigation measures proposed to implement, to demonstrate that the TSS will not exceed the prescribed limits. For all the activities assessed, a pilot test with monitoring shall be conducted to demonstrate that the plume dispersion during dredging 	Prior to undertake any dredging or disposal	<ul style="list-style-type: none"> Desktop activities 500 m from the pilot test location 	Exhibit A section 6.3.6 [63] and EIA Table 8-6 [62]		CEMP section 7.5

ASPECT	REQUIREMENT	MONITORING FREQUENCY	MONITORING LOCATION	REFERENCE DOCUMENTS	OWNER	REFERENCE CONTRACTOR DOCUMENTS
	<p>activities follows a similar pattern as assessed through the numerical dredge plume modelling study and to demonstrate that the TSS levels are lower than the limits. Pilot test shall be conducted at 500 m from the pilot test location.</p> <ul style="list-style-type: none"> Details of the plume dispersion modelling and the pilot test shall be reported to the regulators. 					
Physiochemical analysis of seawater	Physiochemical character of water column for parameters monitored during baseline (Salinity, Dissolved Oxygen, pH and Turbidity)	Weekly	In the area of dredging, reclaiming and/or disposal and at the water quality control points	EIA Table 8-22 [62] and Exhibit A section 11.7.1 [63]		CEMP section 7.6
Storm water discharge to environment	<p>Surface water discharge samples shall be collected for analysis as specified in:</p> <ul style="list-style-type: none"> RD115/2001 and MD145/93 (and its amendment MD 55/2002) MD 159/2005 	<ul style="list-style-type: none"> During selected rainfall events. Should exceedances be noted the frequency of sampling will be increased 		EIA Table 8-22 [62] and Exhibit A section 11.7.2 [63] EIA Study Approval condition 24 [1]		CEMP section 0
Seawater & sediment quality	Seawater and sediment quality monitoring shall be submitted to SEZAD during offshore construction phase	Monthly	Reclamation and disposal area	EIA Study Approval condition 41 [1]		CEMP section 7.7
Marine Ecology						
Marine mammals	<ul style="list-style-type: none"> Carry out marine mammal observation prior to start of any work off-shore. Exclusion zone of 500 m radius shall be scanned around the work area for percussive piling. An exclusion zone of 300 m radius shall be scanned around dredging, borrow and disposal area. 	30 minutes prior to outset of activity during construction		Exhibit A section 11.7.6 [63]		CEMP section 7.9
	<ul style="list-style-type: none"> Conduct marine mammal observation training to dredging and marine Contractor personnel by a qualified internationally recognised institute such as Marine Mammal Observer Association with 	Training: prior to start of construction works. Logs: Daily		Exhibit A section 6.3.7 [63]		CEMP section 7.9

ASPECT	REQUIREMENT	MONITORING FREQUENCY	MONITORING LOCATION	REFERENCE DOCUMENTS	OWNER	REFERENCE CONTRACTOR DOCUMENTS
	<p>training records provided to the Owners Representative as proof of completion.</p> <ul style="list-style-type: none"> Vessel operator shall be given a briefing, alerting them to the possible presence of dolphins, whales and turtles in the area, and guidelines for safe vessel operations in the presence of cetaceans. Daily logs of marine mammals sighted. All vessels shall comply with PDC Port Regulations/PDC ESIA requirements/ PDC environmental permit conditions. 					
	<ul style="list-style-type: none"> A trained crew member must visually monitor, using binoculars, a zone of 300m around the site of the activities prior to start of dredging/borrowing disposal activity for marine mammal. Any marine mammal sighting shall be reported to SEZAD and MECA. On sighting of any marine mammal in the monitoring zone, the activities must be suspended until the mammals are observed to leave the monitoring 	Prior to start of dredging/borrowing/disposal activity	Site of activities	EIA Study approval permit condition 32 & 33 [1]		CEMP section 7.9
Air Quality						
Ambient Air	<ul style="list-style-type: none"> Dust Diffusion tubes for NO_x, SO₂, VOC and O₃ Comply with regulations specifying air pollution control issued under MD 118/2004 	<ul style="list-style-type: none"> Quarterly Increase frequency of dust monitoring during high wind conditions 	DLBB Project fence line (on-shore) at same locations as EIA Baseline study	EIA Table 8-22 [62], Exhibit A section 11.7.4 [63] and EIA study approval condition 7 & 9 [1]		CEMP section 7.11
Emission from vehicles	Verification of road worthiness certificate for all DLBB Project phases	Annually	DLBB Project	EIA Table 8-22 [62] and Exhibit A section 11.7.1 [63]		HSSE plan [97]
Ambient Noise	<ul style="list-style-type: none"> Conduct noise monitoring Comply with noise control in public and working environment promulgated under MD 79/94 and MD 80/94 	Monthly or when high noise activity is undertaken	DLBB Project fence line (on-shore) at same locations as EIA Baseline study and in	EIA Table 8-22 [62] and Exhibit A section 11.7.5 [63]		CEMP section 7.10

ASPECT	REQUIREMENT	MONITORING FREQUENCY	MONITORING LOCATION	REFERENCE DOCUMENTS	OWNER	REFERENCE CONTRACTOR DOCUMENTS
			addition at 3 locations on the site access road			
Waste	<ul style="list-style-type: none"> The Company shall comply with MD 17/93 and its amendments for solid non-hazardous waste handling, storage and disposal methods during all stages of the project phases The Company shall comply with MD 18/93 and its amendments for solid hazardous waste handling, storage and disposal methods during all stages of the project phases; 			EIA Study approval permit condition 10, 11 [1]		CEMP section 7.14, HSSE plan [97], Waste Management Plan [102]
Sewage and waste water	<ul style="list-style-type: none"> Dispose sewage at sewage treatment plants, operated by SEZAD. The Contractor shall communicate with SEZAD prior to commencing disposal of sewage at these sewage treatment plant. Prior approval is required from SEZAD utilities department Design outfall for marine discharge as per MD 159/2005. Quantity of treated water discharge shall not be more than 29 m³/h. 	During construction works	Dispose at sewage treatment plant operated by SEZAD	Exhibit A section 11.6.4 [63] & EIA Study approval permit condition 36 [1] EIA Study Approval permit condition 24 [1]		CEMP section 7.15, HSSE plan [97], Waste Management Plan Table 4.1 [102]
Resource consumption	Records of: power, diesel, hazardous chemical, potable water, ODS (if any)	Compiling and reporting as part of audits and inspections	DLBB Project	EIA Table 8-22 [62] and Exhibit A section 11.7.1 [63]		CEMP section 7.13 and HSSE plan [97]
Ozone depleting substances	Inventory of Ozone depleting substance			Exhibit C 2.6.1 [64]		CEMP section 7.16, HSSE plan [97]
Management of chemicals and fuels	<ul style="list-style-type: none"> The Company shall comply with regulations of registering hazardous chemicals and their licenses issued by MD 248/97 The Company shall comply with MD 25/2009, for obtaining license for storing chemicals from SEZAD, provided that the storehouse conforms to the requirements of storing stated in Article 2 			EIA Study approval permit condition 12, 13 [1]		HSSE plan [97]

ASPECT	REQUIREMENT	MONITORING FREQUENCY	MONITORING LOCATION	REFERENCE DOCUMENTS	OWNER	REFERENCE CONTRACTOR DOCUMENTS
Community and social (in conjunction with Owner)	<ul style="list-style-type: none"> Disclosure of project schedule, mitigation measures & management plans to Wali, Sheikh and other stakeholders Collation of complaints from local community if any 	Compiling and reporting as part of audits and inspections	DLBB Project	EIA Table 8-22 [62] and Exhibit A section 11.7.1 [63]		Stakeholder Management Plan [90], Omanisation and SME Content Plan [95]

Table 4.2: Proposed environmental mitigation measures from the EIA [62]

ASPECT	MITIGATION MEASURES	REFERENCE OWNER DOCUMENTS	REFERENCE CONTRACTOR DOCUMENTS
Turbidity	<ul style="list-style-type: none"> Disposal vessels shall be fitted with tight bottom seals in order to prevent leakage of material during transport. [EIA Ref. MQC6] Barges shall be fitted to a level, which ensures that material does not spill over during transport to the disposal site and that adequate freeboard is maintained to ensure that the decks are not washed by wave action. [EIA Ref. MQC7] After dredging, any excess materials shall be cleaned from decks and exposed fittings before the vessel is moved from the dredging area. [EIA Ref. MQC8] Dredgers should maintain adequate clearance between vessels and the seabed at all states of the tide and reduce operations speed to ensure that excessive turbidity is not generated by turbulence from vessel movement or propeller wash. [EIA Ref. MQC13] 	EIA Table 8-6 [62]	CEMP section 8.2
Storm water discharge to environment	Surface run-off from bunded areas shall pass through oil/water separators prior to discharge to the environment. [EIA Ref. MQC20]	EIA Table 8-6 [62]	Not applicable to EPC1 activities
Marine mammals	<ul style="list-style-type: none"> If dolphins/whales are observed in the exclusion zone for a continuous period of 30 minutes, dredging/ borrowing/ disposal activity shall be delayed until they have left the area. Should dolphins/whales move into the dredging/ borrowing/ disposal area during dredging /borrowing/ disposal activity, it is considered that dolphins/whales shall have acclimatised themselves to the works therefore cessation of dredging is not required. Dolphin and whale sightings shall be reported to PDC and SEZAD. [EIA Ref. MEC8] The vessel operators should be required to use predefined and regular routes, as these will become known to dolphins and whales using these waters. [EIA Ref. MEC3] To reduce underwater sound levels associated with percussive piling, the following steps should be taken: Quieter hydraulic hammers should be used instead of the noisier diesel hammers; Instigate 'ramping-up' of the piling hammer to provide an advance warning system to marine mammals in the vicinity; Acoustic decoupling of noisy equipment on work barges should be undertaken. [EIA Ref. MEC6] 	EIA Table 8-7 [62]	CEMP section 8.3
Terrestrial ecology	<ul style="list-style-type: none"> Where possible, structures should utilise appropriate design to complement the surrounding landscape. Materials and finishes should be considered during detailed design. The major lighting sources shall be pointed inward and downwards where practicable to reduce light spill. [EIA Ref. TEC1] Erect fences along the boundary of the works area before the commencement of works to prevent vehicle movements, and encroachment of personnel, onto adjacent areas. [EIA Ref. TEC2] 	EIA Table 8-8 [61]	CEMP section 8.6

ASPECT	MITIGATION MEASURES	REFERENCE OWNER DOCUMENTS	REFERENCE CONTRACTOR DOCUMENTS
Ambient Air	<ul style="list-style-type: none"> Regularly check the work site boundaries to ensure that they are not breached and that damage does not occur to surrounding areas. [EIA Ref. TEC3] Hunting or trapping of birds or animals by DLBB Project personnel is prohibited. [EIA Ref. TEC5] Good site practices such as regular maintenance and checking of the diesel powered mechanical equipment shall be adopted to avoid any black smoke emissions and to minimize gaseous emissions. [EIA Ref. AQC1] Malfunctioning and breakdown of the process of air pollution control equipment which would cause exceedance of the emission limits or breaches of other air pollution control requirements should be document and reported to DPTC. [EIA Ref. AQC2] The loading, unloading, handling, transfer or storage of other raw materials which may generate airborne dust emissions such as crushed rock, sand, stone aggregate, shall be carried out in such a manner to prevent or minimize dust emissions. Measures such as water spraying and enclosing (with tarpaulin sheets or permanent structures) are to be adopted to minimise dust. [EIA Ref. AQC3] Cement or other equally dusty materials shall be stored in storage silo fitted with audible high level alarms to warn of over-filling. The high-level alarm indicators shall be interlocked with the material filling line such that in the event of the silo approaching an overfilling condition, an audible alarm shall be operate, and after 1 minute or less the material filling line shall be closed. [EIA Ref. AQC4] Vents of all silos shall be fitted with fabric filtering system to meet the emission limit. [EIA Ref. AQC5] Vents of all silos shall be fitted with fabric filtering system. [EIA Ref. AQC6] Seating of pressure relief valves of all silos shall be checked, and the valves re-seated if necessary, before each delivery. [EIA Ref. AQC7] Vehicles shall be periodically washed to reduce dust. [EIA Ref. AQC8] A high standard of housekeeping shall be maintained. All spillages or deposits of materials on ground, support structures or roofs shall be cleaned up promptly by a cleaning method acceptable to the Authority. Any dumping of materials at open area shall be prohibited. [EIA Ref. AQC9] 	EIA Table 8-3 [62]	HSSE plan [97]
Ambient noise	<ul style="list-style-type: none"> Compliance with requirements of MD 79/94 and MD 80/94. [EIA Ref. NC1] High noise activity should be scheduled for the day time. [EIA Ref. NC2] Shielding of equipment and use of enclosures to reduce noise. [EIA Ref. NC3] Regular maintenance of equipment to protect from noise. [EIA Ref. NC4] PPE shall be provided to workers in high noise areas as per MD 80/94. [EIA Ref. NC5] 	EIA Table 8-4 [62]	CEMP section 8.4, Maintenance Plan [85]

ASPECT	MITIGATION MEASURES	REFERENCE OWNER DOCUMENTS	REFERENCE CONTRACTOR DOCUMENTS
Waste	<ul style="list-style-type: none"> • Waste shall be managed in accordance with MD 17/93, MD 18/93, and PDC Port Regulations. [EIA Ref. WC1] • Develop and implement a Waste Management Plan which specifies procedures such as a manifest system, to facilitate tracking of loads and protocols for the maintenance of records of the quantities of wastes generated, recycled and disposed. [EIA Ref. WC2] • The EPC Contractor shall apply for and obtain the appropriate permits/licenses for the disposal of waste, storage/disposal of hazardous waste and effluent discharges. [EIA Ref. WC3] • No waste shall be burnt on site. Wastes shall be collected by licensed waste haulier and be disposed of at licence sites. [EIA Ref. WC4] • Excavated material shall be reused to the extent practical. [EIA Ref. WC5] • The site and surroundings shall be kept tidy and litter free. Waste storage area shall be properly cleaned and shall not cause windblown litter and dust nuisance. [EIA Ref. WC6] • Storage of material on site should be kept to a minimum. Construction materials shall be planed and stocked carefully to reduce amount of waste generated and avoid unnecessary generation of waste. [EIA Ref. WC7] • Suitable hazardous waste storage areas should be formed at the works site for temporary storage pending collection. Hazardous wastes shall be separated for special handling and shall be disposed at appropriate treatment at the hazardous waste landfill (if available) or stored at site until a suitable disposal facility is available. [EIA Ref. WC8] • A licensed Contractor shall be employed to collect waste for delivery to a licensed treatment/disposal facility. [EIA Ref. WC9] • Temporary storage areas for waste should be enclosed or contained to prevent odours, vermin and unauthorised access. [EIA Ref. WC10] • Adequate waste containers and storages should be provided at site. [EIA Ref. WC11] • Recyclable material should be recovered from waste provided adequate avenues for recycling are available. [EIA Ref. WC12] • Waste containers shall be in good condition and fitted with lids or covers to prevent waste from spilling or the ingress of water. [EIA Ref. WC13] • Emergency equipment to deal with any spillage or fire shall be kept on site. [EIA Ref. WC14] • Containers used for storage of hazardous waste shall be maintained in good condition and clearly labelled, suitable for the substance they are holding, resistant to corrosion and securely closed. [EIA Ref. WC15] • Storage areas for waste shall be separate areas for storage of Hazardous Waste and 	EIA Table 8-5 [62]	CEMP section 8.8, HSSE plan [97], Waste Management Plan [102]

ASPECT	MITIGATION MEASURES	REFERENCE OWNER DOCUMENTS	REFERENCE CONTRACTOR DOCUMENTS
	<p>Non-hazardous Waste; clearly labelled and used solely for the storage of waste identified in the labelling; enclosed on at least 3 sides; have adequate ventilation, arranged so that incompatible materials are appropriately separated; have impermeable floor and bunding sufficient to fully retain any spillage or- leakages; ventilated; and covered to prevent rainfall from entering. [EIA Ref. WC16]</p> <ul style="list-style-type: none"> • Training shall be provided to site personnel in proper waste management handling procedures, the concepts of site cleanliness and appropriate waste management procedures, including waste reduction, reuse and recycling. [EIA Ref. WC17] • Regular audits of the waste. [EIA Ref. WC18] 		
Sewage and waste water	<ul style="list-style-type: none"> • Wastewater generated from the washing down of trucks and similar equipment should be recycled wherever practicable. To prevent pollution from wastewater overflow, the pump sump of any wastewater recycling system shall be provided with a standby pump of adequate capacity. [EIA Ref. MQC16] • Sewage and industrial wastewater shall be collected and managed in line with the requirements of MD 145/93 and MD 159/2005. [EIA Ref. MQC18] 	EIA Table 8-6 [62]	CEMP section 8.8, HSSE plan [97], Waste Management Plan [102]
Management of Chemicals and fuel	<ul style="list-style-type: none"> • Transport by licensed contractors. [EIA Ref. CF1] • Personnel involved in the transport, handling and storage of Fuel/Chemicals must be trained. [EIA Ref. CF2] • Storage must be in accordance with MD 25/2009 and the MSDS. [EIA Ref. CF3] • Periodic checking for spills and leaks in the handling area must be done. [EIA Ref. CF4] • Records of chemicals/fuel stored at site must be maintained. [EIA Ref. CF5] • Adequate secondary containment is to be provided. [EIA Ref. CF6] • An emergency management plan is to be prepared which shall define response to spills onsite or offsite. [EIA Ref. CF7] 	EIA Table 8-12 [62]	CEMP section 7.14, HSSE plan [97], Spill Procedure [104]
Community and social (in conjunction with Owner)	<ul style="list-style-type: none"> • Locating the construction camp away from the local community and ensuring self-sufficiency of the camp to minimise interaction between the camp and the local community. [EIA Ref. CSC1] • Movement of workers at the DLBB Project location and labour camps to be properly managed. [EIA Ref. CSC2] • Appropriate awareness on local socio-cultural settings and Omani culture and social practices (especially for new employees) to be provided. [EIA Ref. CSC3] • Identification of suitable jobs for locals, along with identification of need for training and development. [EIA Ref. CSC4] • In line with Government Policy for Omanisation employment of locals shall be encouraged. [EIA Ref. CSC5] 	EIA Table 8-10 [62]	Stakeholder Management Plan [90], Omanisation and SME Content Plan [95]

ASPECT	MITIGATION MEASURES	REFERENCE OWNER DOCUMENTS	REFERENCE CONTRACTOR DOCUMENTS
	<ul style="list-style-type: none"> DPTC and the EPC Contractor shall strive to support local businesses, where possible, by purchasing locally. [EIA Ref. CSC6] Interact with all other construction works and industries in coordinate with SEZAD to develop a unified approach to stakeholder management and community consultation. [EIA Ref. CSC7] Implement a grievance redressed policy and a community engagement plan. [EIA Ref. CSC8] Develop and implement a Corporate Social Responsibility (CSR) program in Duqm. [EIA Ref. CSC9] 		
Land use	<ul style="list-style-type: none"> The land take of the DLBB Project is to be limited and restricted. [EIA Ref. LUC1] Material and equipment is to be stored in designated storage areas. [EIA Ref. LUC2] The DLBB Project site and laydown area is to be fenced to prevent creep outside the fence line. [EIA Ref. LUC3] Temporary land take for construction is to be restored after removal of temporary work. [EIA Ref. LUC4] Focus on optimising land required for temporary works. [EIA Ref. LUC5] Ensure EPC Contractors or suppliers have necessary permits and licenses. [EIA Ref. LUC6] Ensure borrow of fill material and disposal of excess material is only undertaken in designated areas are permitted by the respective authority. [EIA Ref. LUC7] 	EIA Table 8-1 [62]	CEMP section 8.7, HSSE plan [97], Mobilization plan [87]
Archaeological and Cultural Resources	<ul style="list-style-type: none"> Should any archaeological structures be found or suspected in the area the same shall be reported to the Ministry of Heritage and Culture, SEZAD and PDC. [EIA Ref. ACC1] Should any archaeological or culturally significant features be identified work in the area shall be stopped until the same can be investigated by the respective authorities. [EIA Ref. ACC2] 	EIA Table 8-9 [62]	CEMP section 8.10

5 ECOSYSTEM

To understand the impacts of the Project on the environment, it is important to understand the complete system. A clear understanding of the system in which the project is planned is based on three components:

- 1) the marine environmental system (physical and biological);
- 2) the socio-economic system and;
- 3) the governance context.

The first component describes both the a-biotic and biotic system. This includes the prevailing physical and chemical conditions, e.g. currents and water quality, and the ecosystem, i.e. the flora and fauna, as well as the interaction between the two. The second component is the socio-economic aspect. This component describes the economic setting and relevant stakeholders that are integral in the project area and for the envisaged development. The third component is the governance setting. This describes the legal framework, the local and international laws, as well as maritime laws, and regulations related to the environment in which the project is to be executed.

The marine environmental system is described in sections 5.1 and 5.2 below. The socio-economic system is summarized in section 5.3 and the governmental system in section 5.4.

5.1 A-BIOTIC ENVIRONMENT (PHYSICAL)

5.1.1 Climate

Duqm experiences a hot, arid climate with monthly mean temperatures ranging between 22.2 °C and 40.8 °C. Two distinct seasons occur, winter (November to April) and summer (May to October) approximately in line with the winter and summer monsoons. The winter monsoons, also known as 'Shamal', occur late December to April and are characterized by relatively gentle and variable, dry northeast wind. The summer monsoon, also called 'Khareef', occurs between late June and September characterized by high south-westerly wind, light drizzle and mist. In addition, cyclones originating from the Indian Ocean occur at Duqm during May, June and October-November once every 7 to 10 years.

Rainfall is usually sparse and mostly occurring during the monsoons. December is the wettest month with average 4.3 mm of rain. Winds are predominately from South-Southwest and Southwest direction with maximum and average hourly wind speeds of 21.2 m/s and 6.7 m/s, respectively. North east and North-northeast, South and West-Southwest directions are also frequent but have lower wind speeds and percentages of occurrence (see Figure 5.1).

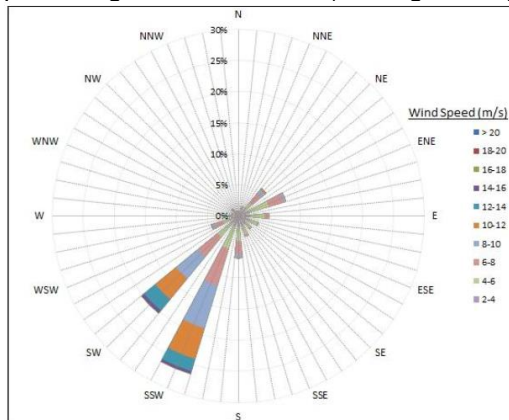


Figure 5.1: Annual wind rose (CFSR at WAVEWATCH Node 52567, 1979-2009 [62])

5.1.2 Geology

The surface geology of the DLBB project area is characterized by low lying and flat salt flats, also called 'sabkha', consisting of mud areas, intertidal sand and mud habitats, tidal and non-tidal lagoons, dunes and sand bars. North of the lee breakwater (LBW) area a series of non-tidal lagoons, also called 'khawrs', are present. Due to the generally high temperatures and low precipitation rates on this wetland area, groundwater is highly saline and unfit for human consumption.

Furthermore, the subsurface geology at the DLBB project consists of Al Huqf's rock, the oldest sedimentary sequence found in Oman and Shuwayr formation, consisting of limestone with corals, debris-flow deposits. The wider Project area is dominated by Ras Duqm headland, a north-south directed limestone ridge with steep sea cliffs on the eastern side and a height of 100 m or more.

Dredged material in the harbour consists of silty sand and rocks consisting of alcaenite, mudstone and siltstone.

5.1.3 Wave conditions

The offshore yearly average significant wave height is approximately 1.5 m with average wave period of 10 seconds (WorldWave database). Maximum significant wave height offshore is around 4 m. Waves can be distinguished between swell and wind sea. The dominant swell direction is from S to SE direction and lower, wind dominated waves are from NE and NW directions.

5.1.4 Currents

Figure 5.2 presents current roses based on historic current measurements near the port of Duqm. This shows that maximum current speed within the port is 0.2 m/s and outside the port in the access channel 0.3 m/s. Hydrodynamic model study report carried out as part of the FEED [65] shows flow conditions during flood and ebb phase of a typical spring tide as presented in Figure 5.3.

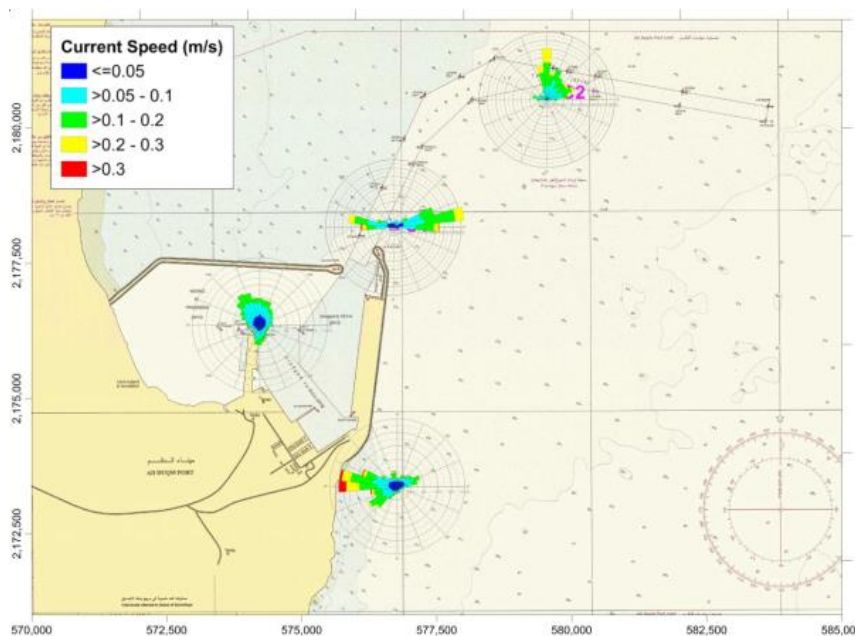


Figure 5.2: Historic current measurements near the Port of Duqm from 9 May 2012 to 9 June 2012 [65]

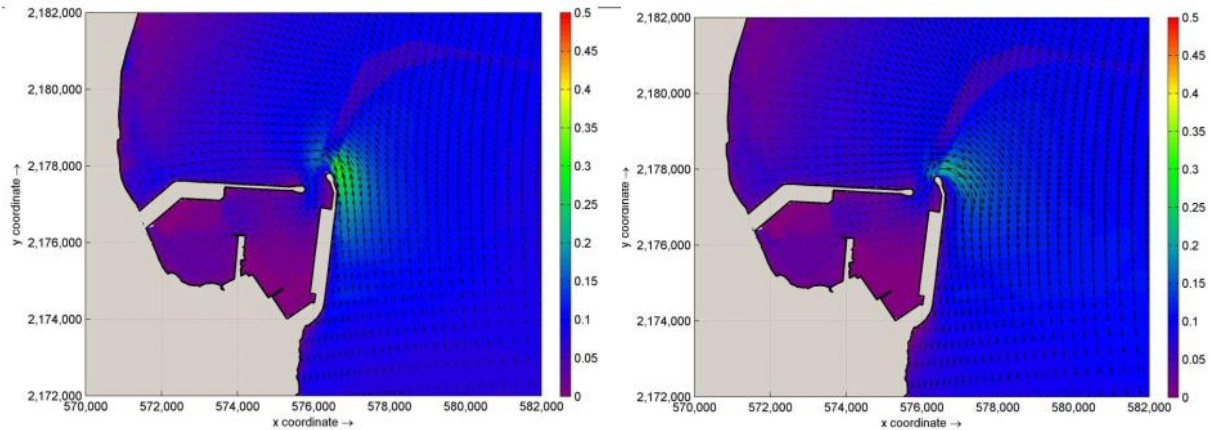


Figure 5.3: Flow conditions during spring tide near port of Duqm, left: flood phase, right: ebb phase [65]

5.1.5 Tide

Tidal levels are in accordance with the hydrodynamic modelling report study [65] and are considered as follows:

- Highest Astronomical Tide (HAT): CD +2.75 m
- MHWS: CD +2.60 m
- MHHW: CD +2.30 m
- MLHW: CD +2.20 m
- MSL: CD +1.64 m
- MHLW: CD +1.60 m
- MLLW: CD +0.80 m
- MLWS: CD +0.50 m
- Lowest Astronomical Tide (LAT): CD +0.00 m

All levels have been reduced to Port of Duqm Chart Datum (CD). Chart Datum coincides with SEZAD/NSA Datum +1.275 m.

5.1.6 Water quality

For the marine environmental baseline study [62] conducted as part of the EIA water samples were taken inside the port, in the nearshore area outside the port and at the offshore borrow and disposal area and analyzed for physiochemical (Temperature, Salinity, pH, Dissolved Oxygen, Turbidity) and chemical (metals, BTEX, hydrocarbons, poly aromatic hydrocarbons, nutrients) water quality. As no water quality guidelines currently exist for Oman, the following guidelines were adopted:

- Saudi Arabian National Environmental Standard Ambient Water Quality Objectives for the Red Sea (Presidency of Meteorology and Environment, 2012);
- Dubai Government, Department of Planning and Development, Ports, Customs and Free Zone Corporation, Water Environment Regulations (EN/002) – Harbour Water Quality Objectives (Government of Dubai, 2010); and
- Australian and New Zealand Guidelines for Fresh and Marine Water Quality Guidelines for slightly to moderately disturbed systems (ANZECC 2000).

Results insight the port showed temperature varied between sites and over depth between 24.5 °C and 25.6 °C, mean turbidity ranged from 2.3 to 9.1 FNU, salinity between 36.4 and 37.3 psu, mean dissolved oxygen (DO) from 97.9% to 59.3% and pH between 7.7 and 7.8. No exceedances of chemical water quality guidelines.

In the nearshore area outside the port temperature varied between sites and over depth between 24 °C and 24.8 °C, mean turbidity ranged from 1.3 to 3.1 FNU, salinity of 37 psu at all sites and depths, dissolved oxygen (DO) from 66.2 % to 85.3 % and pH around 7.7. All metals concentrations were below

laboratory detection limits except for copper and zinc which exceeded the adopted ANZECC guideline but remained below other adopted guidelines.

At the offshore disposal area mean temperature were similar at all sites 23.8 °C, mean turbidity ranged from 0.6 to 2.2 FNU, salinity of 37.4 psu at all sites and depths, mean dissolved oxygen (DO) from 72.2 % to 85.9 % and pH around 7.8. No exceedances of chemical water quality guidelines were measured.

Finally, at the offshore borrow area mean temperature were similar at all sites 25 °C, mean turbidity ranged from 0.1 to 0.3 FNU, salinity of 37.3 psu at all sites and depths, mean dissolved oxygen (DO) from 76.7 % to 90.4 % and pH around 7.8. All metals concentrations were below laboratory detection limits except for copper which exceeded the adopted ANZECC guideline but remained below other adopted guidelines.

5.1.7 Sediment quality

For the marine environmental baseline study [66] conducted as part of the EIA sediment samples were taken inside the port, in the nearshore area outside the port and at the offshore borrow and disposal area and analyzed for metals, BTEX, petroleum hydrocarbons and organics. As no sediment quality guideline currently exist in Oman, the internationally recognized guideline for comparable tropical environments have been adopted: Australian and New Zealand Recommended Sediment Quality Guidelines [66].

Inside the port no exceedances of the adopted guideline were detected. In the nearshore area outside the port and offshore disposal and borrow area minor exceedance of cadmium and nickel were detected, however remaining below upper guideline values.

5.1.8 Air quality

Air quality measurements were undertaken at several locations at the project fence line (see Figure 5.4) between 6 to 26 January 2015 and analyzed for the prime air emission expected from the facility (SO₂, VOC, O₃, NO_x, NO and NO₂). The results are presented in Table 5.1.

The values are within the USEPA NAAQs limits [66], except for O₃ at one location which is marginally above the limit.



Figure 5.4: Ambient Air Quality Monitoring locations during environmental baseline study [66]

Table 5.1: Summary of diffusion tubes analysis results (all units in ppb)

	SO ₂	VOC	O ₃	NO _x	NO	NO ₂
Minimum	0.57	0.20	59	4.44	3.26	1.18
Median	0.67	0.32	68	5.79	3.91	1.63
Maximum	3.02	0.49	78	6.65	4.57	2.18
USEPA	50 (3-hr);	-	75 (8-hr)	-	-	100 (1-hr)
NAAQS	75 (1-hr)	-	-	-	-	53 (Annual)

In addition, dust monitoring was undertaken at the nine ambient air quality monitoring stations and at the Say village at three moments in time (5/6 January 2015, 26/27 January 2015 and 20 August 2015). Dust measurements were higher during August than January, as no truck transporting activities were undertaken in January and wind speed was higher in August. No exceedance of the USEPA NAAQS guideline for PM_{2.5} and PM₁₀ was measured.

5.1.9 Ambient noise

Historic noise monitoring is available through several baseline studies which have been conducted for the Duqm Master Plan EIA (June 2011) and Environmental Baseline Study for Duqm Development and Surroundings (March 2013). Results of measurements along the roads showed values were below the proposed standard (70 dBA for industrial area). Additional measurements were carried out for the EIA [62] at the nine ambient air quality monitoring locations and at Say village. Measured values were below the limits as specified in MD 79/94 for industrial activity.

5.2 BIOTIC ENVIRONMENT (FLORA & FAUNA)

5.2.1 Terrestrial ecology

The terrestrial environment near the project location of Duqm consists of wetland habitat used by migratory and wintering shorebirds as feeding and roosting ground. The area is therefore classified as an Important Bird Area (IBA) by Birdlife International (see Figure 5.5). Examples of birds observed in the project area are presented in Figure 5.6. All birds are listed as Least Concern by IUCN except for the Eurasian Curlew which is listed as Near Threatened.



Figure 5.5: Import Bird Areas and DLBB Project marked red (Birdlife International)



Lesser Sand Plover



Stint Bird



Greater Flamingos



Caspian terns



Eurasian curlew



Heuglin's Gull

Figure 5.6: Birds photographed during baseline study [66]

Reptiles are well represented in the area with high abundance of lizards. Vegetation was mostly found in patches immediately around the LBW. The flora in the study area is dominated by halophyte plant community (see example Figure 5.7).



Figure 5.7: Vegetation observed in project area. Left: Halophytic vegetation, right: *Cistanche chebulosa* [66]

5.2.2 Marine ecology

Numerous cetacean species are observed in the project area. The most commonly recorded nearshore species in Duqm area are the Arabian Sea Humpback Whales and various species of the Delphinidae family such as dolphins, pilot whales and killer whales. The Arabian Sea Humpback Whale is listed 'Endangered' by International Union for Conservation of Nature and Natural Resources (IUCN). Most humpback whales were recorded between August to November and February to April. Furthermore species of the Delphinidae family, such as dolphins, pilot whales and killer whales are found nearshore of Duqm.

The main turtle species in the project area are the green (*Chelonia mydas*) and loggerhead turtles (*Caretta caretta*). There is evidence that turtles nest and feed on the coastline along the Port as shown in Figure 5.8. It should be noted that this map is from 1991, and since then the Green turtle nesting site along the southern beach of Duqm bay (indicated by the red circle) no longer exists as a result of the development of Duqm port that has taken place since. The Green turtle nesting site indicated in green is located approximately 10km north from the entrance to the port and the dredging and reclamation works to be performed inside the port. Nesting season for loggerhead and green turtles is in summer and autumn (July to September).

In addition, in the EIA it is stated that the abundance of turtles in the Duqm area is relatively low compared to the internationally recognized Marine Protected Areas located nearby: Ras Madrasah (located 70km to the southeast), Barr al Hilkam (90km to the northeast) and Masirah Island (approximately 100km northeast).

All turtle species are protected by both Omani national legislation and international agreements to which Oman is a signatory. In addition, Duqm Port Company (DPC) and Oman Oil Company (OOC) have an agreement with Environment Society of Oman (ESO) to support marine turtle conservation on Masirah Island.

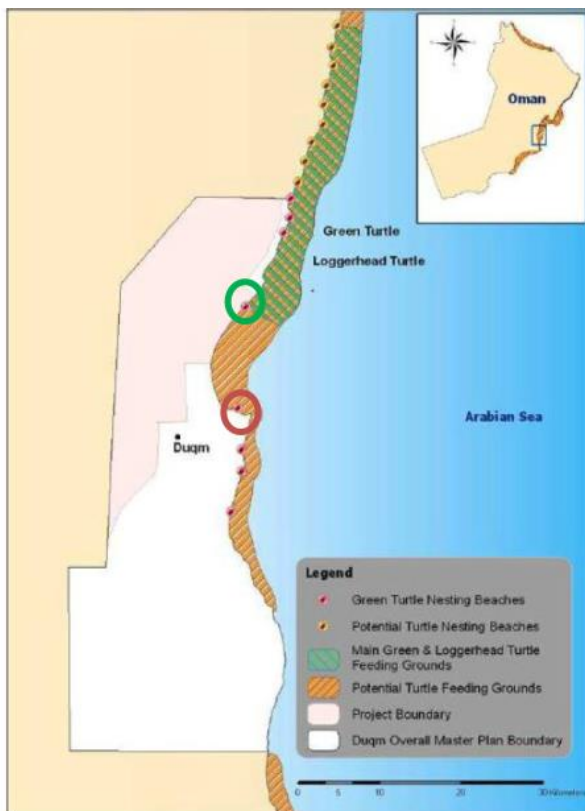


Figure 5.8: (Potential) turtle nesting beaches and feeding grounds in the Duqm area based on Salm, 1991 [62]

Benthic life is sparse in the nearshore area of Duqm (Figure 5.9) as well as in the offshore borrow and disposal area. No coral, seagrass or substantial areas of macroalgae were identified in the area probably due to the absence of hard substrates.

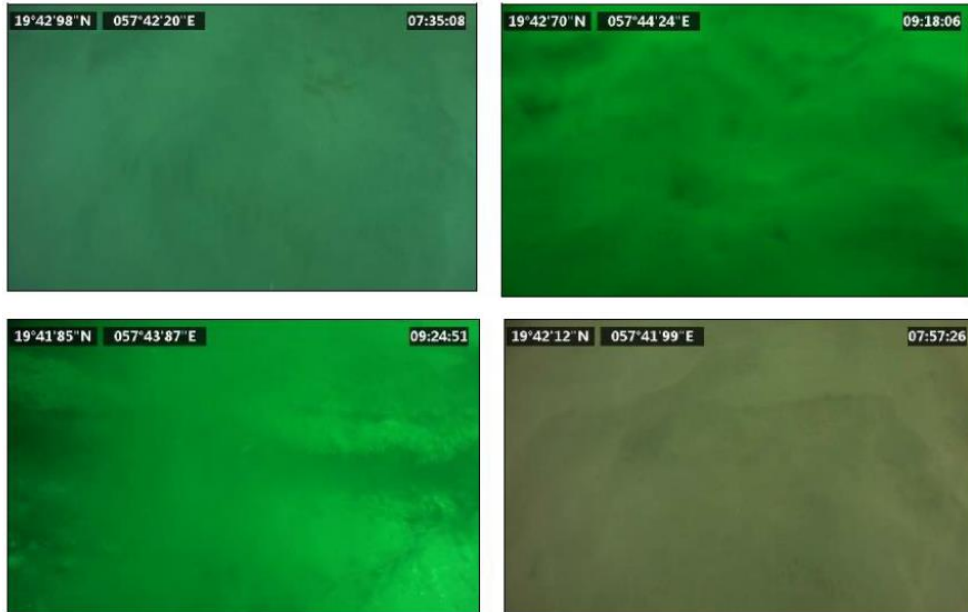


Figure 5.9: Biological cover in nearshore area [66]

5.3 SOCIO-ECONOMY

The majority of the population lives in the coastal zone in small towns or villages, with the nearest inhabited village located about 5.5 km south west. Fishing is an important economic activity, with a fish landing area located 4 km north of the Port. Traditionally, during the monsoon season, when the coastal area along Duqm is too rough for fishing, the local population migrates to villages south of the mountain ranges.

A number of planned initiatives for industrial and tourism developments are expected to supplant the traditional reliance on agriculture and fisheries. Generally, the local population is positive about the project and thinks it will contribute to an improvement of their quality of life as stated in the EIA [62].

5.4 GOVERNANCE

The Port of Duqm is located within the Special Economic Zone Duqm which is administered by the Special Economic Zone Authority at Duqm (SEZAD). SEZAD is responsible for the management, regulation and development of all economic activity in SEZD. SEZAD has the power to issue environmental permits and is responsible for approval of the EIA. The offshore disposal and borrow area are located outside of the SEZD boundary, therefore the Ministry of Environment and Climate Affairs (MECA), the primary environmental regulator in Oman, will be the authority issuing permits for these areas.

Omani environmental law has two main legal instruments: Royal Decrees (RDs) and Ministerial Decisions (MDs). An RD typically provides a general framework relating to a particular area in need of statutory control, while MDs provide specific regulation using the framework provided in the RD. Where Omani environmental regulations and standards are not available, acceptable international environmental regulations and standards apply.

5.5 SUMMARY

The main sensitive receivers in the Duqm project area are the Important Bird Area, which is of specific importance for overwintering and migratory birds, marine mammals, including endangered humpback whale species and turtles. Benthic life is sparse in the nearshore area as well as in the offshore disposal and borrow area. The majority of the population lives in small towns with the nearest at 5.5 km south west of the Port. Fishing is an important economic activity for the local population. It is expected that the construction of the Duqm port will contribute to increased tourism and industrial activity.

6 ENVIRONMENTAL MANAGEMENT FRAMEWORK

6.1 BOSKALIS SHE-Q SYSTEM

Contractor has an integrated SHE-Q system, certified according to the international standards ISO 9001:2008, ISO 14001:2004 and OHSAS 18001:2007. The SHE-Q system of Contractor has been developed to assure a high level of control of safety, health, environmental, security and quality aspects during the preparation and execution of projects. The basic framework of the system is shown in Figure 6.1.



Figure 6.1: Boskalis SHE-Q System

The Contractor applies the same Safety, Health, Environment and Quality (SHE-Q) standards at all its projects around the world and to all its employees and subcontractors. These standards meet Dutch and international OSHA and environmental requirements, and are adjusted if an Employer has more stringent requirements.

All relevant vessels are IMO certified and have to meet international standards for waste, hazardous materials and sewage management, and fire, oil spill and other emergency response and prevention. The SHE-Q system of Boskalis is certified against the standards ISO 9001, ISO 14001 and OHSAS 18001.

6.2 NINA

It is the policy of Boskalis that all employees, including those of subcontractors and suppliers, execute their work safely and under healthy conditions, with appropriate concern for the protection of the environment. The ultimate Safety, Health and Environmental objectives of Boskalis are:

- Zero personal accidents;
- Zero incidents with environmental impact;
- Zero damages to equipment and property.

Boskalis realizes that behaviour of individual employees is a key factor in achieving these objectives.

Our safety program NINA –**No Injuries, No Accidents**– sets clear standards and explains what we expect from our people with regard to their safety behaviour. At the heart of the NINA safety program are five core Values and five Rules. The Values make people aware of their own responsibility regarding safety and encourage them to take action if operations are unsafe and approach others if they are at risk. The Rules provide guidance regarding the management of health and safety risks. NINA is supported by an extensive training and workshop program, and is embedded throughout the organisation.

Safety program NINA (No Injuries No Accidents)

Safety has been a priority within the Boskalis organization for years and this has resulted in a clear improvement of our safety record. To further improve our safety culture and reach our goal of an incident-free working environment, Boskalis has launched the NINA safety program. NINA - No Injuries, No Accidents – is setting clear standards and explaining what we expect from our people with regard to their safety behaviour.

NINA is supported by an extensive training and workshop program so that all our employees understand the NINA principles and how to lead by example. NINA is embedded in our organizational systems and managed by leading indicators.

Our Safety Vision

Our vision statement clearly expresses what we stand for with regard to safety:

“Our people are our most valuable assets, making safety a core value. Our goal is: No Injuries No Accidents. This is embedded in our company’s culture and supported through Values and Rules. All employees, including our sub-contractors, are expected to take these values and rules to heart.”

The vision statement is supported by five Values and five Rules that have been specifically developed to further detail where we stand on safety and to provide guidance to all employees, including those of subcontractors, with regard to both expected behaviour and risk management.



For more information, visit: www.boskalis-nina.com

6.3 PLANT MANAGEMENT SYSTEM

The Plant Management System (PMS) has been implemented in the Boskalis organization to ensure, amongst others, a safe operation of the fleet. The PMS is based on the International Management Code (ISM) for the safe operation of ships and for the prevention of pollution. The PMS is certified according to this ISM-code.

The most important elements of the PMS are:

- Onshore organization, with designated persons for individual vessels;
- On board organization, management of crew and training;
- Communication onshore, on board and ship-shore;
- Standard standing orders and emergency preparedness.

6.4 RISK ASSESSMENT

Risks are the probability that hazards lead to negative impacts i.e. personal injuries, equipment damages or environmental losses. By performing an assessment, risks are identified and categorized in a systematic manner. The execution of a SHE Risk Assessment is obligatory for every Project. Where available, any SHE Risk Assessment resulting from the design stage (prepared by Employer or Engineer) will be taken into account.

The SHE Risk Assessment shall contain the identification of hazards, assessment of hazards and the implementation of control measures. The assessment will include the following:

- All routine and non-routine activities (single, as well as their combinations);
- Activities of all personnel that have access to the workplace (including subcontractors, suppliers and visitors);
- All facilities on the workplace, delivered by RBW or other parties.

The assessment of environmental risks is part of the project risk assessment, and environmental risks will be included in the SHE Risk Assessment Matrix (see next section). The top three environmental risks will be added after an update of the project risk register.

6.4.1 Procedure

The SHE Risk Assessment procedure (RBW-313) gives a detailed explanation on the method to be used with the Risk assessments. The SHE Risk Assessment Matrix (RBW-513) identifies the known hazards that may occur in RBW' projects. For each hazard in the matrix, standard minimum control and mitigation measures are identified to reduce the risk to an acceptable level. Specific hazards and additional control measures are to be evaluated by the Project.

6.4.2 Review and Management of Change

Once prepared, the SHE Risk Assessment shall be reviewed by the Project Manager periodically at least every 3 months or whenever new activities start, operations are modified or legal requirements change. The description of this Management of Change process is included in the SHE Risk Assessment procedure RBW-313.

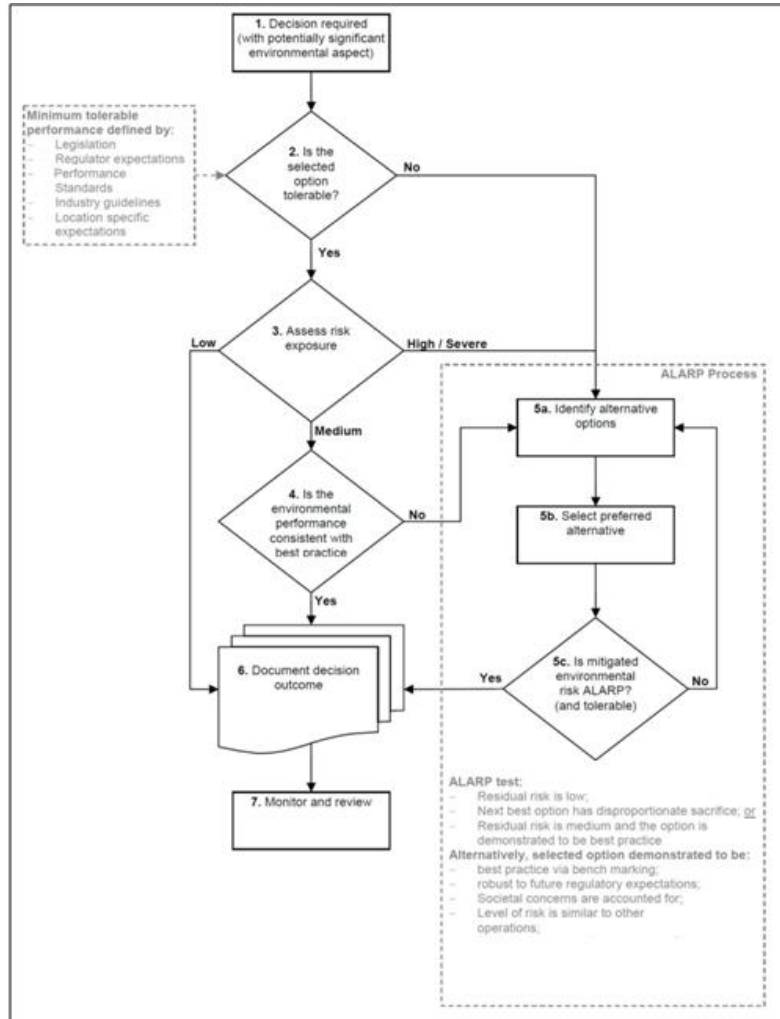


Figure 6.2: Flowchart of Environmental Risk Assessment Procedure (example)

6.4.3 Top environmental risks

The most important environmental risks as defined during tender stage for this project are outlined in Table 6.1. It should be noted that this table will be updated during the course of the works.

Table 6.1: Environmental risks as defined in tender stage

Risk Title	Risk Cause	Risk Consequence	Initial Risk Level	Action(s)	Residual Risk Consequence	Residual Risk Level
Delay start of works due to delayed permits and approvals	The Contractor shall be responsible to obtain the permits and approvals required for the works in the contract price and schedule. Environmental permit	Delay at start for critical milestone 1. Liquidated Damages of 0,28Meuro/day. 0,5 till 1 month delay is 2,5 till 5Meuro.	High	Include permitting plan Assumed it is possible to start 90 days after contract with the execution by using preliminary work methods and preliminary design documents to apply for the permits.	Qualified, residual risk is none. When dropping this qualification the risk will be LDs for 0,5 till 1 month delay is 2,5 till 5 Meuro.	None
Turbidity limit of 30 mg/l above background at 500m outside of lee breakwater and 500m radius from dredging equipment at borrow and disposal site	Technical specifications based on EIA, MECA and SEZAD regulation, IEP	Reduced production/ stop of work in case of exceedance limit. Worst case is a delay of the TSHD for 1 to 3 weeks	Low	Include mitigation measures for borrow and disposal	Delay of the TSHD for 1 to 3 weeks	Low
EIA: Marine mammal observation at 30 min prior to dredging or disposal activity	Requirement from EIA. From May till June no mammals are observed. July till March whales are possible.	Non compliance	Medium	MMO's on board vessels as stated in IEP		Low
Marine Mammal observer training	Addendum 2: Marine mammal observer training by qualified institute prior to start of works to all project personnel.	Non compliance	Low	Marine mammal training plan with in-house qualified MMO's		Low

7 ENVIRONMENTAL MONITORING PROGRAMME

This chapter presents the monitoring plan based on the environmental requirements outlined in Chapter 4. For full details related to resource consumption, waste, waste water and hazardous material management, reference is made to the HSSE plan [97] and Waste Management Plan [102]. An overview of the environmental monitoring activities which will be conducted for Contractor's Scope of Works, the monitoring frequencies and the party conducting the monitoring activities is given in Table 7.1.

Table 7.1: Environmental monitoring activities, frequencies and the party conducting the monitoring

MONITORING ACTIVITY	MONITORING FREQUENCY	MONITORING PARTY
Compliance audits	Quarterly	MECA/SEZAD approved third party Environmental Consultant
Inspections	Monthly	Contractor, witnessed by MECA/SEZAD approved third party Environmental Consultant
Marine environmental baseline study	Once, prior to start of dredging and offshore disposal works	Five Oceans
Turbidity monitoring	Continuously	Contractor
Establishment of TSS-NTU relationship	At start of dredging and reclamation works	Contractor
Plume dispersion modelling	Once, prior to start of dredging, reclamation and offshore disposal works	Contractor
Pilot study for plume dispersion modelling	At start of dredging, reclamation and disposal activities	Contractor
Physiochemical analysis of seawater	Weekly	Contractor
Seawater and sediment quality analysis	Monthly	MECA/SEZAD approved third party Environmental Consultant
Marine mammal	Continuously, during daylight hours only	Contractor and Marine Mammal observers on board the dredge vessels
Ambient noise	Monthly	MECA/SEZAD approved third party Environmental Consultant
Ambient air	Quarterly	MECA/SEZAD approved third party Environmental Consultant
Post-construction marine survey	Once, post offshore dredge and disposal activities	MECA/SEZAD approved third party Environmental Consultant
Resource consumption	Monthly	Contractor
Waste	Monthly	Contractor
Treated waste water	Monthly	Contractor
Inventory of ozone depleting substances	Monthly	Contractor

7.1 GENERAL

7.1.1 Compliance audits

Compliance audits will be carried out on a quarterly frequency during construction phase by a MECA/SEZAD approved Environmental Consultant/Contractor.

The following subjects will be addressed during the audits:

- Waste management practices and adequacy of disposal/recycling methods;
- All relevant permits in place;
- Fuel consumed;
- Emissions to air and water;

- Noise standards;
- House keeping;
- Management of impacts from ongoing activities as per CEMP;
- Close out of items identified during inspections and previous audits (if any).

7.1.2 Inspection

In addition, inspections will be carried out during construction on a monthly frequency. Inspections will be carried out to check proper implementation of the CEMP

The inspections will be carried out by Contractor internally and observed by an independent MECA/SEZAD approved third party as agreed with SEZAD during the environmental meeting on 26th of March 2017. The scope of monthly inspections will include, but not be limited to:

- Implementation of monitoring procedures as described in the CEMP;
- Implementation of control & mitigation measures as described in the CEMP, if necessary;
- Implementation of international standards in the analyses of water samples in laboratory;
- Calibration and/or verification of measurement devices;
- Reporting of incidents and corrective actions taken, if any.

7.1.3 Permits

The Contractor is responsible to obtain all permits/ approvals/ licenses/ consents/ no-objections that are required during the execution of the scope of work prior to commencing any activity, except for the Initial Environmental Permit (IEP) and offshore dredging and disposal area permit.

Currently, the IEP including MECA approval is in place and valid till 7th of February 2018. This permit shall be extended at least one month before expiry, for which responsibility lies with Owner. Contractor will perform their obligations under the CEMP so as not to endanger this extension. The CEMP will be submitted to SEZAD, which will issue a no objection letter once the plan is approved, as agreed during the environmental meeting held 26th of March 2017. In addition, an addendum to the IEP will be submitted for the onshore disposal of the dry excavation material which is currently being prepared.

Investigation of and applications for other required (construction) permits and the required input is currently ongoing. For further detail on the permitting strategy, please refer to the Project Execution Plan [88].

7.2 ENVIRONMENTAL BASELINE STUDY

An update of the environmental baseline study carried out for the EIA (see also [66]) will be conducted to assess environmental conditions prior to start of marine works. Contractor has reviewed the different components of the environmental baseline study based on timeframe of measurements compared to Contractor's expected commencement date and Contractor's work method and discussed with SEZAD and DPTC on 26th of March 2017. It is agreed to carry out side scan sonar of the offshore borrow and disposal area, which allows for large areas to be surveyed in short timeframe. Should results of the side scan sonar indicate anomalies as rough patches which may indicate the presence of marine growth, such as corals or seagrass, spot inspections will be done by video survey.

The environmental baseline study will be carried out by a local MECA/SEZAD approved Environmental Consultant: FiveOceans Environmental Services LLC. As agreed, Owner is invited to observe the side scan sonar survey.

To cover the large area of the Borrow Area (~ 84km²) the area will be divided in sub-sections (of approximately 28km²) allowing the dredging works to start in scanned sub-section before survey of the entire borrow area is complete. Once a sub-section is scanned, this will be reported to SEZAD.

FiveOceans uses the DE3468D model side scan sonar, for detailed specifications see Appendix 4, which emits sound at 340 and 680KHz with a source sound level of approximately 210dB re 1µPa peak. For reference, Mid-frequency military sonar uses 2.8 - 8.2kHz with a source sound level of 223 - 235dB re

1 μ Pa peak, and seismic air gun arrays typically operate at 5Hz-100kHz with a source sound level of 220dB-262dB re 1 μ Pa peak- to-peak.

Cetaceans have a hearing range up to 180kHz, Humpback whales have a hearing range of 7Hz to 22kHz (so-called “low-frequency cetaceans” in Southall’s functional marine hearing groups), which means they cannot hear the much higher frequency emitted by the side scan sonar, but can hear the mid-frequency sonars used by the military and the seismic air gun arrays.

7.3 CONTINUOUS TURBIDITY MONITORING

Contractor will implement this monitoring program, by installing its dedicated autonomous monitoring system, as described in this section. Contractor has developed these monitoring systems over the past 15 years, and has trained Environmental Engineers who collect and report the data, perform maintenance, and follow up any exceedances reported as described section 8.11.

The turbidity limits for the DLBB project are:

- 30 mg/l at 500 m from activity location at offshore borrow and offshore disposal area;
- 30 mg/l at 500 m on the outside from the port entrance;
- 10 NTU at the ODC RO Plant intake (depending on further discussions with ODC).

Contractor assumes these values are above ambient concentrations, as mentioned in Tender clarification 196, except for the ODC RO Plant intake.

7.3.1 Method

As continuous monitoring is required as per Exhibit A [63], Contractor proposes to use monitoring stations equipped with turbidity sensors (example shown in Figure 7.1). These monitoring stations can resist heavy weather conditions, which may occur offshore. A total of seven monitoring stations will be deployed: two at the offshore disposal, two at the offshore borrow area, one outside the port entrance, one station at the ODC plant intake and one for background measurements. All stations are equipped with a turbidity sensor, data logger, GPS, solar panels, battery pack, navigation light and radar reflector.

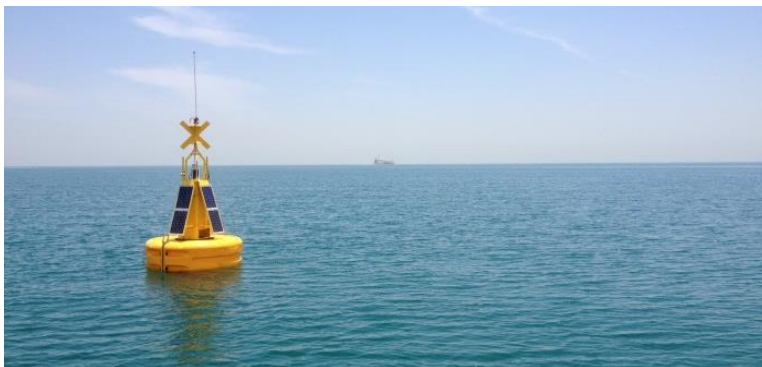


Figure 7.1: Example of Contractor’s environmental monitoring station

Turbidity is measured in Nephelometric Turbidity Units (NTU) which is a measure of the relative clarity of water and is linear correlated to the suspended particles in the water. By taking water samples and determine the SSC (Suspended Sediments Concentration in mg/l) and the turbidity (NTU) a correlation factor can be established. For more detail on the establishment of the relationship reference is made to section 7.4.

7.3.2 Time and frequency

The monitoring buoys will log every second, and every 15 minutes a median is calculated by the data logger to filter outliers caused by organic matter passing the turbidity sensor. Four quarter hour median values will be sent to the data server every hour. The turbidity limit will be assessed for a 24-hours

moving average of the 15 minutes median.

7.3.3 Monitoring location

The turbidity monitoring buoys will be deployed at:

- One buoy 500 m from the from the entrance of the Lee Breakwater on the outside of the harbour and outside the access channel, at a safe distance to the edge of the access channel, as indicated in Figure 7.2.
- Two buoys 500 m outside the offshore borrow and disposal area in line with the main plume directions as found from (initial) plume modelling, indicated in Figure 7.3.
- One station at the ODC RO Plant intake, indicated in Figure 7.2. It should be noted that this is an indicative location, the final location will be agreed in discussion with ODC.
- One buoy located away from the area of influence (approximately 5km away from the port entrance) of the marine works providing constant measurement of background levels in order to define ambient conditions, located at equivalent depth as the station near the Lee Breakwater as indicated in Figure 7.2.

The turbidity sensors will be located at 1.5 m below water surface except at the RO plant intake where it will be located at the same depth as the intake.

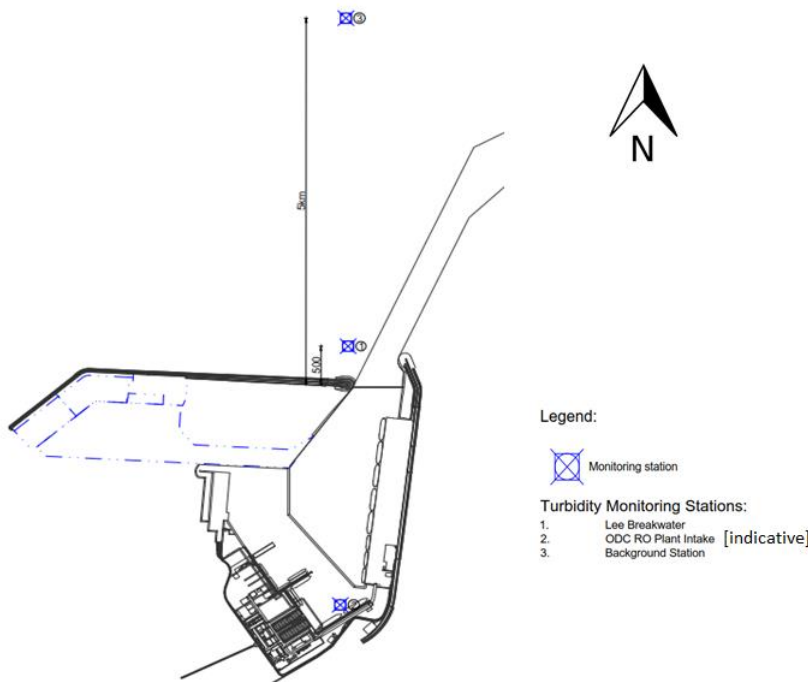


Figure 7.2: Indicative location of turbidity monitoring stations near port basin (1= Lee Breakwater, 2= ODC RO plant intake, 3= background station)

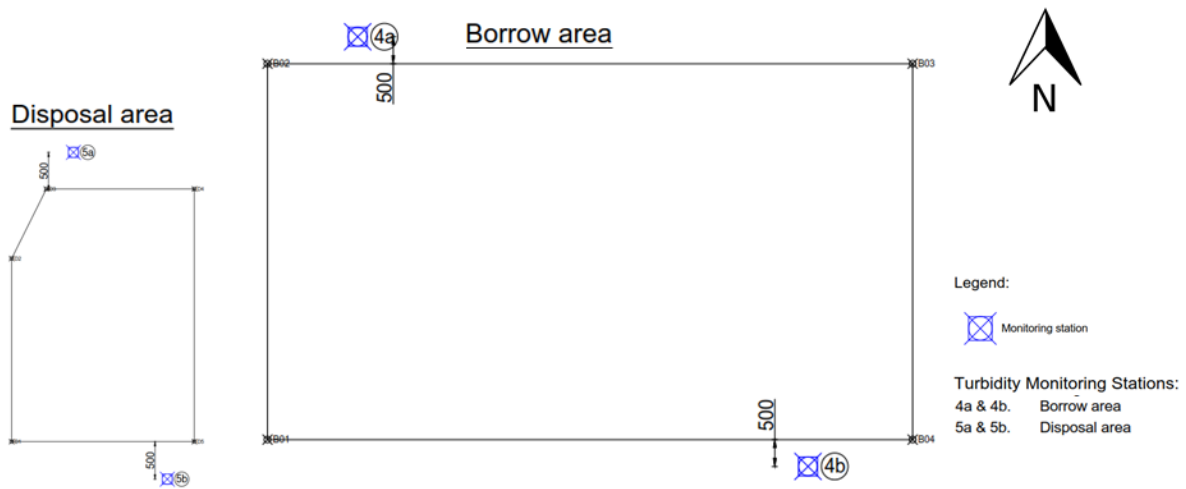


Figure 7.3: Indicative location of turbidity monitoring stations at offshore disposal and borrow area

7.3.4 Equipment

Turbidity monitoring buoys of type DB2000 will be used (for specifications see Appendix 1) and turbidity sensors type Eureka tri-meter (specifications see Appendix 2). The turbidity probe has a wiper to reduce biofouling of the sensor surface. The probes use 90° optics and infrared light in accordance with ISO7027. The probes use a unique modulation technique to ensure almost complete rejection of ambient light conditions.

7.3.5 Quality Assurance & Control

To ensure QA/QC, the following items will be taken into consideration:

- The limit levels should be set over a period of time, to ensure the readings are valid and not a one off. The suggested time period would be 24 hours.
- Spikes in turbidity data can be caused by the sensor malfunctioning, bio fouling or marine life. To avoid these spikes, the median value is taken. The median is the middle value when all values are put in order; therefore it removes spikes that would be included in the average.
- All data is checked by an Environmental Engineer/Surveyor for quality, erroneous data removed and a record kept of the original data, QA data and changes that are made, by who, when and what.
- Regular backups of the data will be made.
- It is noted that turbidity sensors such as the Eureka Manta and Trimeter have an accuracy of approximately 2% of the reading or +/- 0.2 NTU.
- All limits should be considered over background, as background levels usually raise during storms and natural levels may exceed the limits.

7.3.5.1 Calibration of turbidity sensors

The Eureka turbidity probes are factory calibrated, and the calibration is verified monthly per manufacturer specification. Log sheets of calibration verifications are kept by the Environmental Monitoring Engineer for each probe.

7.3.5.2 Buoy Metasheets

Each buoy has a separate Metasheet which shows the main attributes of the buoy, see for an example Figure 7.4. These sheets contain the location information, date and time of deployment / shifting of buoys (if applicable) and maintenance details.

Buoy Metasheet								
Period	Dec 2016 - Jan 2017		Instrument depth:	1	1st deployment			
Name	Buoy 1		Location depth	16	Buoy	07/11/2016		
Buoy Software		BuoyController 1.26						
	No.	Date	No.	Date	No.	Date	No.	Date
NEP5000	409091039	26/12/2016						
Deployment								
Date	KP	Offset	Side	Latitude	Longitude			
20/12/2016	53.500	-1000	East	24° 41.634 N	52° 55.043 E			
21/12/2016	56.500	-1000	East	24° 40.017 N	52° 55.218 E			
22/12/2016	53.500	-1000	East	24° 41.634 N	52° 55.043 E			
24/12/2016	56.500	-1000	East	24° 40.017 N	52° 55.218 E			
28/12/2016	58.750	-1000	East	24° 38.804 N	52° 55.350 E			
01/01/2017	61.000	-1000	East	24° 37.591 N	52° 55.481 E			
10/01/2017	63.250	-1000	East	24° 36.378 N	52° 55.612 E			
12/01/2017	65.500	-1000	East	24° 35.166 N	52° 55.744 E			
Date	Activity							
20/12/2016	Shifted the buoy to new position							
21/12/2016	Shifted the buoy to new position							
22/12/2016	Shifted the buoy to new position							
24/12/2016	Shifted the buoy to new position. Soft cleaning of the sensor							
25/12/2016	Sensor cleaned and checked at 0 and 100NTU							
01/01/2017	Shifted the buoy to new position. Sensor cleaned and checked at 0 and 100NTU							
03/01/2017	Sensor cleaned and checked at 0 and 100NTU							
09/01/2017	Sensor cleaned and checked at 0 and 100NTU							
10/01/2017	Shifted the buoy to new position							
12/01/2017	Shifted the buoy to new position							

Figure 7.4: Example buoy Metasheet

7.3.6 Reporting

Results of the continuous turbidity monitoring will be submitted fortnightly as a separate report and will include the following:

- Location (Northing/Easting);
- Time and Date(dd/mm/yy) and (hh/mm);
- Weather conditions
- Turbidity (graphed and tabled).
- Depth (m);
- Logging frequency;
- Any additional observations – oil slicks, garbage etc.; and
- Comments (QA/QC etc).

For an example of the report see Appendix 3.

7.4 ESTABLISHMENT OF TSS-NTU RELATIONSHIP

As part of the Continuous Turbidity Monitoring and the Pilot Studies, Contractor will take water samples and turbidity readings as described in this section to establish the relationship between TSS (mg/l, used to define the water quality limits for this project) and turbidity (NTU, used by the autonomous turbidity monitoring stations to measure the amount of suspended sediments in-situ). Water samples and field measurements are collected periodically for this program, and are solely collected for the purpose of establishing this relationship, not to check compliance with TSS limits. Contractor's Environmental Engineers are experienced in taking these samples and measurements, and analysing the water samples for TSS (using BN-EN-872) in an on site laboratory, as described in this section.

7.4.1 Method

Turbidity readings are only valid for measuring Total Suspended Solids when they are properly calibrated against Total Suspended Solids values obtained from water samples with suspended matter from the monitoring site. The calibration is site specific, as sediment properties such as particle shape, size and colour affect turbidity readings, and will therefore be carried out in the project area at start of the works.

The calibration is based on membrane filtration which involves taking a number of water samples, passing the water through a pre-weighed filter which is re-weighed after drying the sample in the oven. The difference in weight corresponds to the dry weight of the suspended particles in the water sample. Contractor will use an on site laboratory to analyse the water samples according to BS EN 872:2005 'Determination of suspended solids – method by filtration through glass fibre filters' [60].

Turbidity measurements and water samples are collected simultaneously in the same spot to ensure a proper relation between the two. This is done by tying the Niskin bottle, or similar, to the turbidity sensor. Turbidity readings are logged at the same time that a water sample is taken.

On basis of the analysed samples and the turbidity readings in NTU, a correlation between the two is established and conversion factors are defined. An example of such a correlation is presented in Figure 7.5.

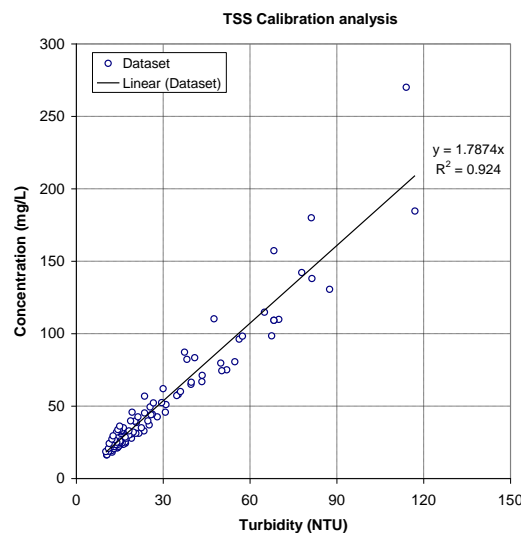


Figure 7.5: Example of a calibration graph between turbidity (NTU) and concentration of suspended sediments obtained from a Total Suspended Solids (TSS) analysis based on membrane filtration.

Contractor proposes to establish a relationship between TSS and NTU at the start of the project, e.g. first weeks of the dredging works, by collecting water samples at various locations, not related to the compliance monitoring. The purpose of these samples is to cover as large a range of NTU and TSS levels as possible, to make the correlation between the two parameters as strong as possible. This will be part of the pilot study of the dredge plume model as described in section 7.5. A correlation will be

established for both the port area and the offshore borrow area, as dredged material will differ in these areas and will therefore result in a different correlations. No correlation will be established in the disposal area as this is the similar material as dredged from the harbour. However, during the pilot study test samples will be taken at the disposal area to verify the relationship from the harbour basin.

A detailed description of the procedure is given in the following sections:

7.4.1.1 Preparation

- Check if samples do NOT contain oil.
- Samples should be analysed within 24hours after sampling.
- Check alignment of the mass balance.
- Place the mass balance away from any air conditioning units.
- Rinse both the measuring cylinder and the funnel well with demineralised water and dry them.
- Ensure all lab equipment is thoroughly cleaned with demineralised water.
- Perform blank test:
 - choose 3 filters from each box at random (top, middle, bottom)
 - test according to the work method with use of 150 ml of distilled water.

7.4.1.2 Work method

Wash filters using demineralised water. Use tweezers and make sure the filters are not touched by hand. Dry in the oven at 105 °C in a glass / ceramic / foil dish for approximately one and a half hours.

Once dried, the filters are cooled in a desiccator with silica gel for 30 minutes and then weighed on the mass balance (m_0). Wait 1 minute or until the balance has stabilised. If the balance has not stabilised, place the samples back in the oven for another 30 minutes. Record the weight of the filter on the TSS analysis work sheet.

Place the filter on the funnel smooth side down, apply vacuum and seal by wetting it with a few drops of demineralised water.

Vigorously shake the sample to ensure it is well mixed and then measure 500 – 1000 ml of sample into a glass measuring cylinder. Record the volume. Less volume is used if the water appears turbid, otherwise the water will not filter through the paper properly. Always record the volume and use as much volume as possible, which will increase the accuracy.

Filter the sample. Rinse the residue from the measuring cylinder, filter and funnel well with distilled water and pour through the filter paper. Repeat several times in order to remove all salt. Apply vacuum until all traces of water are removed.

Carefully remove the filter from the base and dry in the oven at 105°C ±5°C on a metal dish for approximately one hour and a half. Subsequently, let it cool down in the desiccator.

Weigh the filter (m_1).

7.4.1.3 Analysis

Determination of the dried solids retained on the filter will be done by means of:

$$\rho_d = \frac{(m_1 - m_0)}{V}$$

where:

- ρ_d = total suspended solids (mg/l)
- m_0 = weight of filter (mg)
- m_1 = weight of filter + residue (mg)
- V = volume of sample (l)

Results from the analysis will be in terms of milligrams (of dry sediment) per litre of water.

Values showing a difference of less than 0.002g (2mg) between the filter paper before and after the analysis are considered invalid.

The TSS values will be entered into an excel log file which will calculate the concentration. A paper copy of the log file will be stored in the laboratory folder.

7.4.1.4 Sampling

TSS sampling is done at the same time as the NTU measurement; it should be done until a statistically strong relationship is determined between TSS and NTU. The number of samples taken for TSS depends on the hydrodynamic, soil and environmental conditions. Taking water samples continuously takes up too much time, and makes it hard to complete the required monitoring program each day, so it should be kept to a minimum. For accurate TSS analysis a range of NTUs and TSS values are required from high to low.

Twenty to fifty water samples representing various turbidity levels respectively will be collected during the first few weeks of dredging works. The aim is to collect samples in as wide a range of turbidity levels as possible, and spread out as evenly along this range as possible, to establish the strongest relationship possible.

7.4.1.5 Measurement depths

For the purpose of determining the relationship between TSS and NTU, samples will be collected at various water depths, depending on the density of the plume. It should be noted that the correlation is not depth depended, but for the purpose of obtaining a wide range of TSS concentrations measurements are taken at different depths.

7.4.2 Time and frequency

At start of the dredging works (e.g. in the first few weeks) and periodically during the construction period to update the relationship.

7.4.3 Locations

At a safe distance near the dredger, in different areas of the dredge plume to capture a large range of turbidity readings. This will be done in the port area and offshore borrow area and a few verification samples at the disposal area.

7.4.4 Equipment

Water samples for establishment of the TSS-NTU correlation will be done from a monitoring or survey vessel using a turbidity sensor type Eureka Manta+30 (specifications see Appendix 2). This sensor uses the same turbidity probe as the Eureka tri-meter used in the fixed monitoring stations, but allows for additional water quality parameters to be measured in-situ, as used for the weekly physiochemical analysis of the seawater, see section 7.4.6.

The monitoring vessel will be equipped with:

- Global Positioning System (GPS) to determine the exact position of the monitoring locations;
- (VHF) radio;
- Eureka Manta+30 turbidity sensor;
- Laptop computer with Eureka software to download the data from the Eureka sensor.
- Niskin water sampler, or similar; and
- Sampling bottles.

The on-site laboratory (as shown in Figure 7.6) will be equipped with the following equipment to analyse water samples for Total Suspended Solids:

- Analytical Mass Balance capable of weighing with ± 0.1 mg accuracy;
- Dry oven;
- Fibre glass filters meeting specifications of BS EN 872:2005 [60];
- 1000 ml sidearm suction flasks;
- Glass dishes /foil dishes;
- Tweezers;
- Stopwatch;
- 250 ml vacuum filter holders;
- 250 ml glass measuring cylinders;
- 500 ml glass measuring cylinder;
- Desiccator;

- Silica gel or granules;
- Vacuum pump;
- Safety Glasses;
- Distilled water;
- Kitchen paper.



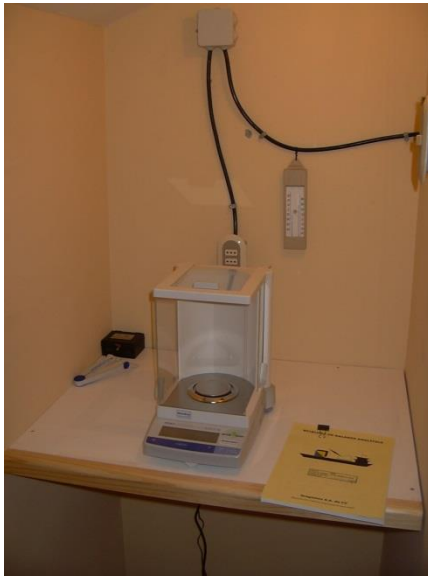


Figure 7.6: Example TSS laboratory and equipment, which was inspected and approved by the local certification authority

7.4.5 Quality Assurance, Quality Control

All data will be analysed by the Environmental Engineer/Environmental Manager. Inspections will be carried out to ensure the water sample analysis is carried out according to BS EN 872:2005. Turbidity sensors will be calibrated and verified periodically as outlined in section 7.3.5.1. Owner will be invited to witness the water sampling and laboratory analyses.

7.4.6 Reporting

During every measuring and sampling event, the following parameters will be recorded:

- Location (Northing/Easting);
- Time and Date (dd/mm/yy) and (hh/mm);
- Weather conditions (wind speed (estimated), direction, rainfall, & estimated visibility);
- Sea conditions;
- Tide (m);
- Turbidity (NTU);
- Depth (m);
- Visual Plume characteristics (colour, direction of movement, estimated distance of dissipation)
- Any additional observations – oil slicks, garbage etc.

The established TSS-NTU correlation for the borrow area and harbour basin (including the approach channel), including graph, formula and samples taken, will be submitted to SEZAD as soon as enough samples have been collected and analysed to establish a statistically sound relationship.

7.5 PLUME DISPERSION MODELLING AND ASSOCIATED PILOT STUDY

Contractor will set up a detailed dredge plume prediction model and calculate various scenarios based on Contractor's foreseen dredging activities. To verify the model results for these scenarios, Contractor will take turbidity measurements in the field, close to the dredge during the first week of any new dredging activity starting (borrow area, dredging the harbour basin, offshore disposal, maintenance dredging). Contractor employs Environmental Engineers who have experience conducting these field measurements for model verification purposes. The field measurements will be compared to the model results.

7.5.1 Method

Plume dispersion modelling will be carried out prior to the start of the dredging activities to assess if turbidity limits will be met. During the works, continuous turbidity measurements, as described in section 7.3, will be conducted to assess compliance with the limits. In addition, a pilot test consisting of turbidity monitoring will be conducted at the start of the dredging works to demonstrate that the plume dispersion during dredging activities follows a similar pattern as assessed through the numerical modelling study. It should be noted that the dredge plume model cannot be calibrated prior to start of dredging, as this requires turbidity measurements during dredge operations. Measured turbidity levels will therefore not be exactly equal to model results, however will allow for verification of the model. In addition, model results are given in TSS (mg/l), while turbidity measurements are carried out in NTU. At start of the works, a relationship between TSS and NTU will be established as described in section 7.3.1, as part of the pilot study. The model results can therefore only be verified with the measurements after establishment of the relationship.

7.5.2 Time and frequency

Prior to construction a dredge plume dispersion model will be set-up and several dredge, disposal and reclamation scenarios will be assessed. At start of the dredging, disposal and reclamation works, e.g. in the first weeks of the works, pilot tests will be conducted to verify model outcomes.

7.5.3 Locations

Pilot tests will be conducted at 500 m, and other locations, from the dredge or disposal location in the direction of the plume with handheld measurements. Measurements will be taken over the entire water column and the depth-average value will be compared with model results, as the model results are also depth averaged.

7.5.4 Instrument/tools

To assess the dredge plume dispersion related to dredging activities, Contractor utilizes the Delft3D modelling package. Delft3D is a state-of-the-art, professional engineering software package designed for 1D, 2D and 3D simulation of coastal areas, rivers and estuarine systems, where in this case a depth-average model will be applied. It can carry out simulations of flow, sediment transport, waves, water quality processes, morphological development and ecological processes. Delft3D is a process-based modelling package, meaning that it is based on a set of mathematical equations based on the first physical principles being conservation of mass, momentum and energy. Reference is made to the Delft3D-FLOW manual for scientific details about the equations and numerical solutions utilized by the software package [105].

For the pilot test handheld turbidity sensors will be used, similar as used for the in-situ measurements as outlined in section 7.4.4. For specifications please refer to Appendix 2.

7.5.5 Quality Assurance, Quality Control

The dredge plume model results will be reviewed by Contractor's experts in the field of plume modelling. The hydrodynamic model used for the plume model will be calibrated, if possible.

Each of the Eureka Manta multi-parameter probe sensors are calibrated following manufacturer instructions, using approved calibration standards. Log sheets of calibrations are kept on file.

7.5.6 Reporting

Prior to start of the works the dredge plume model results will be reported and will include:

- Model set-up;
- Input of the model;
- Dredge, disposal and reclamation scenarios;
- Results;
- Discussion;
- Conclusion.

In addition, results of the pilot study will be reported when carried out.

7.6 PHYSIOCHEMICAL ANALYSIS OF SEAWATER

Contractor will take weekly in-situ water quality measurements as described in this section. Contractor's Environmental Engineers are experienced in taking these water quality measurements, as well as calibrating and maintaining the instruments used to take these measurements.

7.6.1 Method

In-situ water quality measurements for physiochemical analysis are taken from a vessel, using a handheld multi-parameter probe, a laptop, and the vessel's navigation equipment (see Figure 7.7). Parameters which will be measured are:

- Turbidity;
- Salinity;
- Dissolved Oxygen (DO);
- pH; and
- Depth.



Figure 7.7: Manual water quality monitoring

7.6.2 Time and frequency

In-situ water quality measurements are taken weekly, weather permitting and during daylight hours only.

7.6.3 Locations

In-situ water quality measurements are taken at the location of the continuous turbidity monitoring stations over the entire water column.

7.6.4 Equipment

For the in-situ water quality measurements, an Eureka Manta+30 multi-parameter probe is used, capable of measuring the required physiochemical parameters. Refer to Appendix 2 for instrument specifications.

7.6.5 Quality Assurance, Quality Control

Each of the Eureka Manta+30 multi-parameter sensors are calibrated following manufacturer instructions, using manufacturer approved calibration standards. Log sheets of calibrations are kept on file.

7.6.6 Reporting

Results of the in-situ physiochemical analysis of the seawater will be submitted fortnightly together with

the continuous turbidity monitoring results and will include the following:

- Sampling period;
- Sampling location;
- Sampling depth;
- Logging frequency;
- Comments (QA/QC etc.); and
- The results (graph and tabled).

An example of the data format is shown in Appendix 3.

7.7 MONTHLY SEAWATER AND SEDIMENT QUALITY ANALYSIS

Contractor will engage a SEZAD and/or MECA approved third party environmental consultant to conduct monthly seawater and sediment quality analyses.

7.7.1 Method

Seawater and sediment quality analysis of the offshore disposal and reclamation area will be conducted. Seawater analysis will be conducted using a handheld multi-parameter probe, similar as used in the weekly physiochemical analysis of seawater as explained in section 7.6.

Parameters measured for seawater analysis are:

- Temperature;
- pH;
- Conductivity;
- Salinity;
- Dissolved Oxygen; and
- Turbidity.

For sediment quality analysis, samples will be taken using a van-Veen grab, or similar, which will be analysed in the laboratory.

The sediment samples will be analysed for the following parameters:

- Nutrients
- Grainsize distribution
- Heavy metals

7.7.2 Time and frequency

Seawater and sediment quality measurements will be conducted monthly, weather permitting and during daylight hours only.

7.7.3 Locations

Measurements will be taken at 5 locations in the disposal and reclamation area.

7.7.4 Equipment

For seawater quality a handheld multi-parameter probe will be used. For the sediment samples, use will be made of a van-Veen grab, or similar.

7.7.5 Reporting

Results of the seawater and sediment quality analysis will be submitted monthly and will include the following:

- Date and time measurement;
- Location measurements;
- Seawater quality levels;

- Sediment quality levels.

7.8 STORM WATER DISCHARGE

Physiochemical analysis of storm water discharge will not be monitored during EPC1 contract. This will be part of topside contracts, as agreed with SEZAD at 26th of March 2017.

7.9 MARINE MAMMAL MONITORING

Contractor has experience working in areas where cetaceans are present and implementing marine megafauna interaction protocols on its vessels. On the large dredging vessels, Contractor will have dedicated Marine Mammal Observers working with the crew to ensure that when Humpback whales are sighted, their presence is reported to Port of Duqm Company, as required by PDC, and all measures are taken to prevent collisions. On smaller vessels, due to limitations to the amount of people that can be on board, Contractor will train its crew to watch for marine megafauna (including Humpback whales) and follow the same procedures, as described in the following sections, as well as section 8.3.

7.9.1 Method

All relevant vessels have assigned Marine Mammal Observer (MMO) duties to one trained member of each of their crews or a dedicated MMO. The training will be designed and implemented prior to start of works by a certified MMO. In addition, all personnel will be briefed and reminded during Contractor's initial safety induction and tool-box meetings of the presence of marine mammals and particularly the endangered Humpback whales in the project area. And all personnel will be asked during induction to report sighting of any marine mammal to the Vessel Master.

The trained crew member or MMO must visually monitor, using binoculars, a zone of 300m around the site of the activities prior to the start of dredging, borrowing or disposal activities. If marine mammals are observed in the exclusion zone at any moment during period of 30 minutes prior to the start of dredging, borrowing or disposal activities, the start of these activities will be suspended until they have left the area. Should marine mammals move into those areas during the dredging, borrowing, disposal activities, it is considered that they will have acclimatized themselves to the works and therefore cessation of dredging will not be implemented. Should a marine mammal move very close to ongoing dredging activities, measures will be implemented to reduce the risk of collision, taking into consideration vessel safety. Marine mammal sightings will be reported to Port of Duqm Company (PDC) and nearby vessels of Contractor immediately and to SEZAD in the fortnightly reports.

Each vessel has a Marine Mammal Observation log sheet on board. When a marine mammal is sighted this will be reported on the log sheet.

The decision and responsibility chart for personnel involved in the MMO training are presented in Figure 7.8.

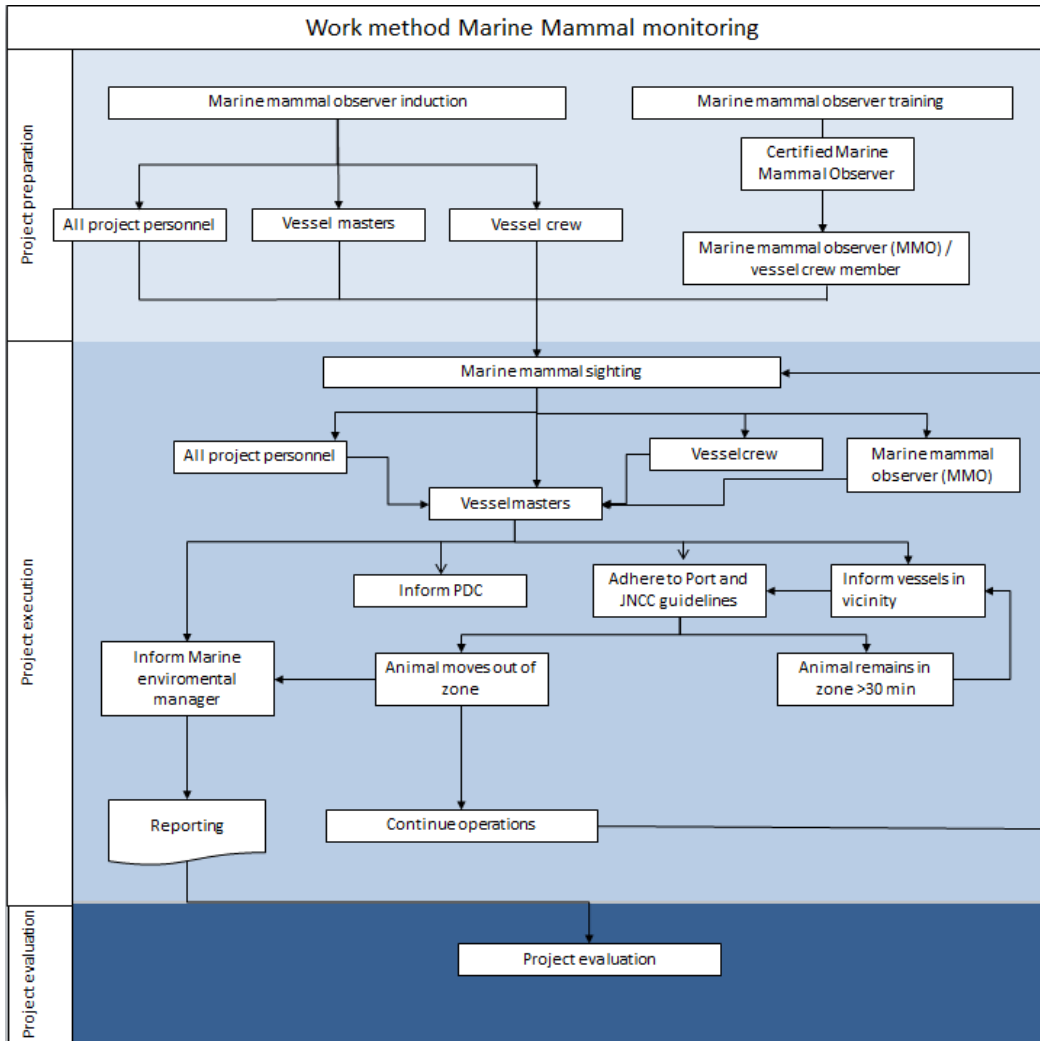


Figure 7.8: Procedure for marine mammal monitoring

7.9.2 Time and frequency

All vessels in the dredging, disposal and borrow area carry out Marine Mammal Observations during daylight hours. Observations are done continuously, crew duties permitting. If no sightings are made, entries will be made on the log sheet daily.

7.9.3 Locations

On all vessels in the work area.

7.9.4 Instruments

Regular binoculars are used.

7.9.5 Quality Assurance, Quality Control

Marine Mammal Observation is a subjective monitoring method for which no QA/QC protocol exists. Regular MMO toolboxes are given to ensure awareness and convey results and new information, if applicable. A check is done by the Environmental Supervisor that the log sheets contain entries for each shift (where applicable).

7.9.6 Reporting

Whenever the Marine Mammal Observer (or another crew member) spots a marine mammal, the sighting will be logged on this sheet with the following information:

- Date and time;
- If observed on dayshift;
- Heading and distance from the vessel;
- Number of animals;
- Type of animal (dolphin, dugong, turtle), species if known;
- Observer name and position.

An example of a marine mammal log sheet is shown in Appendix 3.

7.10 **AMBIENT NOISE**

Contractor will engage a SEZAD and/or MECA approved third party environmental consultant to conduct monthly ambient noise monitoring.

7.10.1 Method

Noise measurements will be carried out along the project fence line monthly or when high noise activity is undertaken as specified in the EIA. MD 79/94 states a limit of 70 dB (A) holds for industrial, plants and public works areas which should be complied with. The impact from noise to residences is considered to be low, as the nearest village is located 5.5 km away from the project site. Noise measurements will be carried out by a local MECA/SEZAD approved Environmental Subcontractor. Measured noise levels will be: equivalent continuous (L_{A-eq}), maximum and minimum sound levels (L_{A-max} and L_{A-min}). Environmental conditions (e.g. wind) and construction activities not related to Contractor's work at time of measurements will be noted.

7.10.2 Time and frequency

Monthly or when high noise activity is undertaken.

7.10.3 Locations

Along the project fence line at same locations as the EIA baseline monitoring (see Figure 7.9) and in addition at 3 locations on the site access road.



Figure 7.9: Locations of Ambient Air and Noise Quality Monitoring Stations of EIA study [62]

7.10.4 Quality assurance & control

The sound meter is factory calibrated and calibration reports will be attached.

7.10.5 Reporting

Reporting will consist of:

- Date and time measurement;
- Measurement locations;
- Sound levels: equivalent continuous (L_{A-eq}), maximum and minimum sound levels (L_{A-max} and L_{A-min});
- Environmental conditions: wind speed and rain;
- Construction activities in surroundings.

7.11 AMBIENT AIR

Contractor will engage a SEZAD and/or MECA approved third party environmental consultant to conduct quarterly ambient noise monitoring.

7.11.1 Ambient air quality

During construction, quarterly air quality measurements will be undertaken for:

- Dust;
- Diffusion tubes for NO_x , SO_2 , VOC, O_3 .

These measurements are compared to baseline monitoring data, conducted in the EIA, to indicate trends as agreed with Owner and Engineer during environmental meeting held 26th of March 2017.

Measurements will be carried out by a local MECA/SEZAD approved Environmental Subcontractor, similar to the Subcontractor conducting monthly noise monitoring (see section 7.10).

In addition, visual observations of dust will be made during daily site inspections. If excessive dust generation is observed, mitigating measures will be implemented. These observations are part of the routine site inspections and will not be reported separately.

7.11.2 Time and frequency

Quarterly or with increasing interval during high wind conditions.

7.11.3 Locations

At the project fence line at similar locations as the noise measurements as shown in Figure 7.9, assuming they are at reasonable distance of other activities that are not part of the EPC 1 contract.

7.11.4 Reporting

Reporting will consist of:

- Date and time measurement;
- Location measurements;
- Dust levels;
- NO_x , SO_2 , VOC, O_3 levels;
- Environmental conditions;
- Construction activities in surroundings.

7.12 POST-CONSTRUCTION MARINE SURVEY

According to Exhibit A section 6.3.4 & 6.3.5 [63] it is required to carry out a post-construction marine survey of the offshore borrow and disposal area after completion of the disposal activities. Contractor will therefore carry out bathymetrical survey.

7.13 RESOURCE CONSUMPTION

Contractor's HSSE department will monitor and report resource consumption for fuel and potable water according to Contractor's HSSE Plan [97].

7.13.1 Potable water

On regular basis (monthly) the purchased amounts of potable water will be registered.

For further detail reference is made to the HSSE plan [97].

7.13.2 Fuel

On regular basis (monthly) the purchased amounts of Fuel will be registered. This will be identified per type of fuel.

For further detail reference is made to the HSSE plan [97].

7.14 WASTE

Contractor's HSSE department will manage, monitor and report waste according to Contractor's HSSE Plan [97] and Waste Management Plan [102].

On regular basis (Monthly) the waste quantities will be registered. This will be registered per type of waste.

For further detail reference is made to the HSSE plan [97] and Waste Management Plan [102].

7.15 TREATED WASTE WATER QUALITY

Contractor's HSSE department will assure treated waste is managed according to Contractor's HSSE Plan [97]. Dredge vessels will adhere to MARPOL regulations.

Treated wastewater quality will be identified and registered on regular (Monthly) basis.

For further detail reference is made to the HSSE plan [97].

7.16 INVENTORY OF OZONE DEPLETING SUBSTANCES ON SITE

Contractor's HSSE department will monitor and register ozone depleting substances are managed according to Contractor's HSSE Plan [97].

On regular basis (monthly) the purchased amounts of ODS containing products will be registered, if ozone creating activities are undertaken. This will be identified per type of product.

For further detail reference is made to the HSSE plan [97].

7.17 COMMUNITY & SOCIAL

For information regarding communication with stakeholders please refer to Contractor's Stakeholder Management Plan [90] and Organisation and SME plan [95].

8 CONTROL & MITIGATION

8.1 GENERAL

The works will be carried out in such a manner as to minimise adverse effects on the water quality during the execution of the works. The method of working will be so arranged as to minimise adverse effects at the site itself, on transport routes, and in the proximity of the dredging and the disposal area.

Measures are taken to ensure that all plant and equipment used will be maintained in good working condition. Care will be taken to ensure that disturbance to any marine mammal, bird or animal life in the vicinity is kept to the minimum, compatible with the nature of the dredging activities.

Potential environmental impacts identified for this project are related to operational issues such as waste management, dredging control, oil spill prevention, etc. These issues are further discussed in the following sections. The following sections are considered as a preliminary version of the control measures which will be taken during the construction phase.

Please refer to the Project HSSE Plan [97] for the following subjects:

- Waste Management;
- Treated Waste Water;
- Chemical and Hazardous Materials Management;
- Resource consumption;
- Land use;
- Emergency Response Plan;
- Oil spill prevention and response;
- Inspections, Audits.

For community and social management reference is made to Contractor's Stakeholder Management Plan [90], Interface Management Plan [91], and Omanisation and SME plan [95].

8.2 TURBIDITY

Dredging activities and work methods will be selected such that suspended sediment has minimal impact on sensitive environmental receivers. Contractor will therefore apply an adaptive management plan to ensure that the dredging activities work within possible required turbidity thresholds as outlined in Chapter 3. By monitoring throughout the dredging activities in combination with reviewing the dredging and disposal process (cycle, production rates, bathymetric surveys etc.) opportunities can be identified and seized to amend the dredging productivity. For example, if the measured TSS levels (or turbidity) are well below the environmental thresholds and the sensitive receptors appear to remain free from any impacts, it would be possible to increase production or make the operational timeframes more flexible.

Preliminary dredge plume results shows that the turbidity limit will be met for reclamation, borrow, dredging in the harbour basin and disposal activities. Maintenance disposal however requires more attention.

In addition to the mitigation measures proposed in the EIA (see Table 4.2) Contractor's proposed adaptive management steps for this project are:

1. Measure turbidity at the designated locations continuously;
2. Well maintained dredging equipment;
3. Well maintained hopper doors on the TSHD to reduce the potential of sediment loss during transport;
4. Raising the level of the overflow to its highest position to reduce potential spillage during sediment transport by the TSHD;
5. In case turbidity monitoring shows levels reach the turbidity limit, limited overflow of TSHD dredging operations can be applied;

6. Use of predictive plume modelling to assess turbidity values caused by dredging and disposal;
7. Verification of the dredge plume model by use of pilot test at the start of dredge, disposal, reclamation operations;
8. Disposal of dredge at non-sequential locations inside the designated disposal site, to avoid localized accumulation of suspended sediments;
9. Prolonging periods between (maintenance) disposal activities by combining disposal activities with borrow area activities;
10. Where possible, dredging in the harbour basin close to the ODC RO plant intake during outgoing tide;

8.3 MARINE MAMMALS

Slow moving marine fauna such as turtles that regularly swim at the water surface, may be impacted by vessels movements. Dolphins and whales are far less likely to get struck by a vessel, but attention needs to be paid regardless, especially to the Humpback whales, as they form a small and unique population along the coast of Oman.

To minimize impact of vessel movement on large marine fauna, a number of operational control procedures for vessels will be implemented. All vessel crew will attend the MMO toolbox, given by the Environmental Supervisor, who will keep the attendance sheets in his records.

Interactions with Marine Mammals require adaptive management on a day-by-day basis. Marine mammal and turtle sightings will be logged and reported immediately to PDC and Contractor's Environmental Manager on site. A trained, qualified and experienced Marine Mammal Observer will give training to relevant project personnel, navigational watch crewmembers on each vessel at the start of the project. Reminders and updated information will be provided in toolboxes throughout the project.



Figure 8.1: Humpback whale



Figure 8.2: Marine mammal observation

On dredging vessels sailing towards or from the disposal and borrow area, a dedicated look out for marine mammals near the vessels. During all phases of the Project, the general principle guiding vessel operations will be to avoid, as far as practicable, any interaction with marine mammals. Therefore, vessels in the vicinity of a cetacean or cetaceans will (with the exception of emergency situations) adhere to the following guidelines. These guidelines are based on guidelines from JNCC for oil & gas industry and piling and blasting activities. As no guidelines exist for dredging, Contractor has adopted applicable guidelines from JNCC which are to be adhered to by dredging vessels.

- Do not intentionally approach within 300 m of marine mammals (Figure 8.3);
- Always operate at a 'no wash' speed when they are within 300 m of a large cetacean;
- Do not approach cetaceans from an angle of less than 60° into or away from the direction of travel of the cetacean(s) as shown in Figure 8.3;
- Do not encourage bow riding by cetaceans. Should any cetacean(s) commence bow riding in front of a vessel, the vessel master will not change course or speed suddenly;
- When operating a stationary or slow-moving dredge, a 300 m safety zone will be enforced around the

dredging unit. If marine mammals are observed within the 300 m 'safety zone' around the operational dredging unit, any non-essential movement of auxiliary vessels will be prohibited. The speeds of any vessels already moving within the safety zone shall be reduced to no wake speed, and avoid the path of the sighted animal(s), until the mammals have moved away;

- Report any marine fauna activity in the area to the Marine Environmental Manager and vessel captain (if applicable);
- Report instantly any observed (possible) danger for marine fauna or related environmental aspects to the Marine Environmental Manager;
- Record any marine mammal sightings on the MMO recording form;
- In case a marine mammal enters the 300 m safety zone around the dredger, communicate to other vessels of Contractor in and near the safety zone to allow compliance with mitigation measures;
- Attend and participate in marine mammal observer toolboxes and environmental meetings relating marine mammal observing, where relevant.

It should be noted, that in confined waters, such as areas within breakwaters, there may be occasions where it may not be possible for vessels to maintain the approach angles or distances without compromising the safety of the vessel and its crew. If such situations should arise, all efforts will be made to minimise vessel interactions with, or disturbance to, cetaceans.

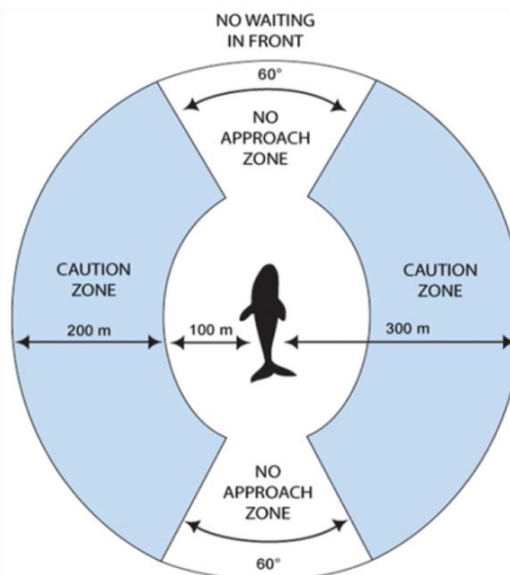


Figure 8.3: Interaction restrictions for marine vessels encountering large marine mega fauna, such as whales

8.4 AMBIENT NOISE

Following the proposed mitigation measures from the EIA the Contractor will minimize (exposure to) high noise activities by:

- Scheduling high noise activity for the day time as much as feasible;
- Shielding of equipment and use of enclosures to reduce noise;
- Regular maintenance of equipment to protect from noise;
- PPE shall be provided to workers in high noise areas as per MD 80/94.

As regulated by the MD 79/94 Noise Pollution, the maximum noise emission allowed in Industrial areas is 70 dBA.

In order to minimise and manage noise and vibration during main construction works the following shall be undertaken:

8.4.1 Scheduling

Where practical, noise generating activities will be scheduled to avoid impacts on noise sensitive receivers. The following are to be considered when planning the schedule of works:

- Construction activities (such as piling and material deposition) to be minimised on windy days, particularly when blowing in the direction of sensitive receptors;
- Avoid simultaneous use/operation of noisy equipment, if possible;
- Erect noise source screening structures (e.g. temporary perimeter fence, mounds, plywood) or purpose build structures where practical to shield the noise sensitive receivers.
- Monitoring measurements during works to be undertaken under the required survey conditions and using appropriate equipment in accordance with relevant guidance and legal requirements.

8.4.2 Equipment and Plant Lay-out

Positioning of land-based equipment away from noise sensitive areas will be considered. The following have to be considered when positioning and installation:

- Inherently quiet equipment to be selected / used, wherever possible.
- Equipment that is fit for the required tasks in terms of power requirements shall be used.
- Inspection and maintenance of machines and vehicles should be undertaken on a regular basis.
- All engines covers shall be kept closed while equipment is operating.
- Machines should be switched off when not in use rather than left idling for prolonged periods.

8.4.3 Construction Methods and Plant

- Careful selection of plant and construction methods. Working methods selected that produce the least amount of noise practicable.
- A register of plant and equipment and statutory certification to be completed.
- Avoid dropping of materials from height (e.g. during materials delivery).
- Noise-producing signals (e.g. horns, whistles, alarms and bells) should be for safety warning purposes only.
- Placing the equipment such that it is oriented away from the receptors, where possible.

8.4.4 Location of Land-based Plant and Barriers

- Temporary noise barriers to be used to reduce noise levels where appropriate and practicable. Such measures can be particularly appropriate for stationary or near-stationary plant such as pile breakers, hydraulic vibrator, pile boring machine and compressors. Barriers to be located as close to the plant as possible and, in order to provide adequate attenuation. The screens may include soil mounds, site offices, site huts, acoustic sheds or partitions.
- Consider the use of at-source noise controls, as much as practicable, so that any noisy equipment is suitably enclosed with an acoustic barrier or other noise reducing method.

8.4.5 Sound and Vibration Reduction Measures

Vibration on site will be generally from pile drilling activities. In order to minimize this impact the following control measures will be considered and implemented as much as practicable:

- Compressors and generators to be “sound reduced” models fitted with properly lined and sealed acoustic covers which will be kept closed during operation.
- Acoustic covers to be fitted on all machine engines that generate excessive noise levels, generators and stationary plant including batch plants, and closed during operation.
- All pneumatic percussive tools to be fitted with mufflers or silencers of the type recommended by the manufacturers.
- If practicable low vibration plant to be used. Have anti-vibration mounts in place on plant.
- If elevated noise / vibration levels are encountered, the source of noise or vibration is to be identified and alternative methods or additional control measures are to be implemented.
- In the event of vibration becoming a concern, an assessment will be undertaken in accordance with local regulations and standards, if applicable.
- In some instances it may be possible to reduce transmitted vibration by cutting a structure to separate site work from sensitive premises. Clearly, it is important to take account of safety and

structural issues before carrying out any work of this nature.

- All vehicles and plant used during the works will be maintained in good working order to ensure optimum performance. A record of maintenance shall be kept.
- If equipment or vehicles are seen to have an excessive amount of vibration, they will be given defect notices and taken out of service until repaired and approved for re-deployment by site supervisor representative.
- Plant and equipment that are idling or being used on an intermittent basis (such as a parked car) will be shut or throttled down when not in use to avoid vibrations.
- Minimize unnecessary operation of construction machinery (which cause vibrations), including efficiency of trip times and reduction of double handling through appropriate placement of stockpiles, haul roads, works depots and work areas.
- Proper and efficient use and operation of construction machinery and vehicles by qualified and skilled personnel (as per manufacturer's instructions).

8.4.6 Traffic Management

Managing the traffic during construction will be considered to help reduce noise problems due to transporting or delivering of materials and equipment on site. The following control measures will be implemented:

- Traffic movement to be minimised outside the site.
- Awareness training to be provided to vehicle drivers.
- Speed limits at the site to be adhered to.
- Tyres and tyre pressure to be maintained to reduce friction between the wheel and surface.
- As far as reasonably practicable, noise from reversing alarms to be managed through the following hierarchy of techniques: site layout designed to limit and where reasonably practicable, avoid the need for the reversing of vehicles; use of banks men to avoid the use of reversing alarms. reversing alarms incorporating a feature for example self-adjusting output sounders; and reversing alarms set to the minimum output noise level required for health and safety compliance.
- Light and heavy vehicle movement will be separated as much as practical possible.

8.5 AMBIENT AIR

This section details the control measures to minimise air emissions (e.g. dust, gaseous pollutants and odours) and impacts from all activities resulting from the works. Each of the measures identifies a number of procedures for routine inspection and maintenance of equipment as well as dust suppression measures to mitigate any perceived impacts.

As part of the implementation of the Air Quality Impacts Mitigation, the Contractor will ensure that weather forecast data and warnings from local Weather Station are monitored on daily basis and communicated to the construction team as alert in case of any bad weather forecast. The data will contribute to the implementation of the management measures and risk management measures as required (e.g. high wind speeds could mean more dust generated during the earthworks). If data from the weather stations indicates high winds, where possible and the programme allows, postpone particularly dust generating activities until wind speeds have reduced.

Further detail on ambient air quality mitigation measures are described in Contractor's HSSE plan [97].

8.5.1 Dust Control

There is a potential for dust to arise during the earthworks (i.e. grading, bulldozing and compaction) material loading and hauling, vehicle movements over unpaved surfaces, excessive vehicle speeds and drop heights during backfilling operations have the potential to generate significant airborne particulates. The use of effective dust mitigation techniques, including good site planning will minimize the potential for dust emissions and impact upon surrounding receptors.

Mitigation measures to reduce dust problems shall include the following:

- All access roads to the site shall be watered as required to minimise dust generation.
- The surrounding roads and sidewalks to be kept free from construction debris and cleaned on a

regular basis.

- Dusty materials (aggregates, bulk earth from excavations) to be stored and handled in ways to minimise nuisance. Materials storage to be kept away from the site boundary and taking under consideration local wind patterns.
- The loading, unloading, handling, transfer or storage of other raw materials which may generate airborne dust emissions such as crushed rock, sand, stone aggregate, shall be carried out in such a manner to prevent or minimize dust emissions. Measures such as water spraying and enclosing (with tarpaulin sheets or permanent structures) are to be adopted to minimise dust
- Footprint of disturbance from construction operations at the working area to be kept to a minimum and movement of vehicles, mobile equipment and machinery to be restricted within the work areas.
- Haul roads to be paved and / or watered (i.e. sprayed) as much as possible. The frequency of watering to be determined by weather conditions.
- The speed of vehicles on haul road will be limited.
- The quantity of dusty materials stored onsite to be reduced or stored materials to be covered to minimise the amount of dust being blown.
- Uncovered stockpiles and the areas other than haul roads if they are a source of dust to be watered. Non-potable water sources to be used as an alternative to potable water use.
- Enclosed chutes and covered skips to be used, where practical in order to minimise dust generation.
- Any soil arising's during the bulk excavations will be reused as much as possible for backfilling and surplus material to be removed and stored at suitable locations for possible future use or disposed onshore, if necessary approvals are obtained.
- Visual inspection to be conducted of dust-generating activities to be maintained on site to ensure that impacts from any dust plumes on neighbouring sites and receptors are acceptable.
- Dust monitoring to be conducted as required by the regulator. Monitoring programme specified in Section 7.11.

8.5.2 Gaseous Emissions

The following measures shall be adopted during the construction works as part of the implementation of the Gaseous Emissions Management:

- All construction vehicles and machinery to have up to date inspection certificates to demonstrate that they are in good working condition before they can be used on site. All maintenance records to be kept in accordance with the Manufacturers' requirements.
- Whenever excessive smoke is identified from any construction vehicle or machinery, it shall be serviced as soon as possible and taken out of use until the maintenance has been satisfactorily completed.
- All activities, related to engine idling (trucks, vehicles, machinery) to be limited as much as practical.
- The burning of any material or waste stream is strictly prohibited on site or in unauthorised/licensed facilities.
- All equipment to be turned off when not in use.
- Driver training to be implemented to minimise fuel consumption and vehicle emissions.

8.5.3 Odour

A limited number of activities during the construction works are likely to generate odours, which could cause a nuisance and affect human health. Odour Management shall be implemented concurrently with the Dust and Gaseous Emission Management measures, described above.

The following measures shall be adopted to minimise any potential odours that could arise on site:

- No burning of any wastes on site, as it is strictly prohibited.
- Chemicals such as paints are kept in small amounts in suitable and enclosed areas.
- The toilet and mess facilities provided to be well maintained and cleaned regularly. They will be positioned away from public areas in order to avoid any odours
- Odour suppressants to be utilized where practicable and deemed necessary.
- No water from vehicle washing areas, toilets, water tanks to be allowed to pool or become stagnant.
- All wastes (especially organic waste which is more likely to biodegrade) to be stored in suitable

covered containers e.g. wheelie bins and be removed from site for disposal at least twice a week by a registered waste Contractor.

8.6 TERRESTRIAL ECOLOGY

Mitigation measures to manage the impact to terrestrial ecology include:

- All reasonably practical measures to minimise injury and disturbance to wildlife or their habitats caused by any work, light, noise, vibration, dust, other air pollution, and pollution incidents to be undertaken and all other management plans to be followed as these provide measures which will also protect wildlife.
- Other measures of particular note include pollution prevention and spillage control, where use of designated refuelling areas, use of drip trays, and availability of spill kits close to works are key, and sediment/ erosion control and stockpile management.
- Deep excavations to be covered or fenced to prevent fauna from falling in and being unable to escape.
- Artificial lighting will be kept to a minimum. The major lighting sources shall be pointed inward and downwards where practicable to reduce light spill
- Erect fences along the boundary of the works area before the commencement of works to prevent vehicle movements, and encroachment of personnel, onto adjacent areas
- Regularly check the work site boundaries to ensure that they are not breached and that damage does not occur to surrounding areas.
- Hunting or trapping of birds or animals by DLBB Project personnel is Prohibited.

8.7 LAND USE

Mitigation measures to be followed during construction works are described below:

- All materials that can contaminate soil will be stored in container or paved surface with adequate containment measures in place.
- High priority on equipment and training to be given in order to reduce the chance of accidental releases. Also training in spill response measures to be provided to relevant staff.
- Equipment inspection and maintenance program shall be implemented.
- Spills response plan and emergency response plan to be developed and implemented as part of Project HSSE Plan during construction and operation to minimise discharges into surface water and groundwater and where accidental spills occur, they are immediately identified and contained.
- The waste water from the site facilities will be regularly collected and disposed in a suitable way by sewage truck to local STP for treatment.
- Drip trays or suitable bunds shall be utilized by Contractor and its Sub-Contractor in conjunction with items of fixed and portable (mobile) plant, such as generators, to prevent contamination of surface soils and run-off. The drip trays shall be positioned away from any watercourse or drains and surrounded by an earth or sand bund with an impervious base of plastic sheet, and inspected daily and emptied as required. Any spillage shall be cleaned up and contaminated soil removed from site for proper disposal.

8.8 WASTE

A separate project specific Waste Management Plan (WMP) [102] has been developed and to be used as a detailed guidance for waste management practices on site. The project WMP provides description of each waste category (waste stream), storage, handling and disposal procedures, manifest system and other relevant details.

However, this Section of the CEMP describes a basic list of control measures that shall be implemented to reduce waste and prevent the inappropriate disposal of waste material and pollution of the environment.

8.8.1 Solid Waste Storage – Non Hazardous and Hazardous

The Contractor plans to maintain a dedicated Waste Storage area within the construction site for the handling and processing of all waste streams. The facility will include the following measures:

- Physically separated facilities to be established for Hazardous and Non-Hazardous Wastes.
- Waste will be safely and securely stored on site, by using covered labelled skips and bins to prevent leaching from bins or windblown materials such as plastics leaving the site. Storage containers will be fit for the purpose (that is, no holes), regularly inspected, and maintained. Each waste container will have clear, water-proof labels with internationally recognisable symbols.
- Waste will be separated at source and a separate, adequate and a sufficient number of containers will be allocated for Hazardous and Non-Hazardous Wastes.
- Separate skips will be provided for Scrap Metal, Food, Concrete, General and Hazardous wastes with appropriate labels on them.
- All food and organic waste to be properly stored in containers with sealed tops to minimise the possibility of vermin infestation or putrescible wastes generating odours.
- Waste bins shall not be overfilled to prevent spills and waste being carried around by scavengers or by the wind.
- Waste will not be allowed to accumulate such that it presents an environmental, health and/or safety hazard. Collections of non-recyclables will be made at least once a week. Littering by site personnel is prohibited.
- When the skip is full, the waste will be emptied and removed to an approved waste disposal area by the approved waste contractor.
- The transfer note and the details of the skip removed from the site will be handled by the stores. All the documentation relating to the management of waste, from the copy of the transport/disposal authorizations to that testifying that disposal has taken place, must always be available on site.
- In addition to the above, for Hazardous Wastes:
 - Flammable substances to be stored under shade and kept away from sources of ignition.
 - They will be stored in a bunded, sealed area with a capacity of 110% of the volume being stored
 - Different types of hazardous waste to be kept separately to avoid adverse chemical reactions and facilitate eventual treatment.
 - Emergency Oil & Chemical Spill Kits and fire-fighting equipment to be located in these areas with specially trained personnel clearly identifiable and available on every shift.
 - Suitable hazardous waste storage areas should be formed at the works site for temporary storage pending collection. Hazardous wastes shall be separated for special handling and shall be disposed at appropriate treatment at the hazardous waste landfill (if available) or stored at site until a suitable disposal facility is available.
 - Containers used for storage of hazardous waste shall be maintained in good condition and clearly labelled and suitable for the substance they are holding, resistant to corrosion and securely closed

8.8.2 Liquid waste management – Waste Water

Mitigation measures related to liquid waste effluents shall be implemented during construction works as detailed below.

- Adequate on site sanitary facilities to be provided for all workers with the septic tanks regularly emptied and disposed of at a licensed facility.
- A dedicated storage tank for sewage waste water (septic tank) shall be constructed as per the facility's operational requirements and relevant regulations.
- Sewage wastewater collects in the sewage tank, for office, site or camp, must be collected regularly to avoid overflowing.
- All equipment washing and cleaning activities, if required, must only be carried out over designated washing area to prevent ground and surface water contamination. All resulting wash fluids and solvents accumulating in the wash tanks to be regularly collected for appropriate off-site disposal or an on-site waste treatment facility, if available.

8.9 CHEMICALS AND HAZARDOUS MATERIAL

The Chemicals and Hazardous Materials Management Measures have been prepared to ensure minimising any potential environmental impacts resulting from chemicals and materials stored or used on site during the construction works. The measures, as detailed below, to be implemented concurrently with all other relevant management, including Waste Management Plan, Land Use management.

In addition to the specifications detailed in other sections, the following measures are to be implemented by the Contractor:

- All chemicals and materials on site to be properly logged and stored in dedicated areas, including bunded areas detailed in this CEMP.
- All chemicals and hazardous materials used on site, to have a Material Safety Datasheet (MSDS) which can be inspected at any time.
- Materials with hazardous components, such as asbestos containing materials, lead based paints and PCBs are not to be used during the Construction Works.
- All accidents and spills to be carefully monitored and were these to happen, immediate clean up and/or remediation shall be carried out and documented.

8.10 ARCHAEOLOGICAL AND CULTURAL RESOURCES

As the Project will be established on reclaimed land within the existing port it is unlikely that archaeological resources will be encountered. However, should any archaeological structures be identified or suspected in the area the same shall be reported to the Ministry of Heritage and Culture, SEZAD and PDC. In addition, should any archaeological or culturally significant features be identified in the area work shall be stopped near the find until the same can be investigated by the respective authorities

8.11 NON-COMPLIANCE AND CORRECTIVE ACTIONS

This section is applicable for all Non Conformities having direct effect on the progress and/or quality of the project works. It is also applicable for the corrective and/or preventive actions taken. Despite of all precautions, non-compliance with specified criteria of products, materials, equipment or work methods may occur. It may occur that production process do not pass in a controlled manner or that situations arise that are not foreseen.

The following procedures from the SHE-Q system of Contractor are applicable in these circumstances:

- RBW-310 Non Conformities & Corrective actions; and
- RBW-311 Preventive actions.

These procedures describe the instructions for dealing with non-conformities when reported to ensure that:

- non-conformities are identified, documented and reported;
- the cause of the non-conformance will be investigated; and
- corrective and/or preventive action is taken to prevent re-occurrence.

8.11.1 Turbidity Non-Compliance Procedure

When an exceedance of turbidity readings is found, the following steps are taken to determine the cause and implement appropriate mitigating actions:

- Determine if the exceedance is a once-off occurrence (spike). If it is a single spike, no further action is taken, as the cause of the increase has disappeared and can no longer be investigated.
- In case the exceedance continues, but the dredging, disposal and/or reclamation activities are not ongoing, then it is likely due to bad weather conditions and the sea will likely be too rough to send the monitoring vessel to confirm the increase in suspended solids. Bad weather is the most likely cause of the exceedance.
- If dredging, disposal, reclamation activities are ongoing, the environmental monitoring engineer will go to the monitoring station reporting the exceedance to check the increase in suspended sediments using the handheld turbidity sensor. This is then done when the weather permits the

monitoring vessel to reach the buoy safely.

- If no exceedance of the suspended solids limit is measured using the handheld turbidity sensor, the most likely cause of the exceedance is biofouling of the sensor.
- If the measurements using the handheld turbidity sensor do confirm an increase in suspended solids, the likely cause of the reported exceedance is the dredging, disposal and/or reclamation activities.

If the cause of exceedance is determined to be biofouling, the mitigating action of performing maintenance on the sensor as soon as the weather allows for the monitoring station to be safely lifted out of the water will be taken.

If the cause of the increase in suspended solids is found to be the dredging, disposal and/or reclamation activities, the following mitigating measures may be implemented:

- Adaptive management measures as presented in section 8.2;
- Introduce adjustments to the dredging equipment and dredging process as necessary (i.e. adjust/modify vessel sailing speed, suction rates, dredging rates, equipment set up, etc.);
- Modify the dredging program to dredge in different non-sequential areas to avoid localized cumulative effects;
- Temporarily stop dredging activities.

If the cause of the turbidity exceedance is found to be the dredging, disposal and/or reclamation activities, the exceedance will be reported to SEZAD as soon as possible, within 24 hrs, including the mitigation measured adopted to minimise/correct the exceedance.

9 REPORTING

Environmental reporting is one of the important parts in the implementation of the CEMP ensuring that the required information is properly communicated to the concerned party or authority. Table 9.1 summarizes the items to be reported and the reporting frequency.

Table 9.1: Environmental items to be reported at specified frequency

ASPECT	REPORTING FREQUENCY
Compliance audits	Quarterly
Inspections	Monthly
Marine environmental baseline study	Once, at start of works
Water quality: continuous turbidity monitoring	Fortnightly
Plume dispersion modelling and associated pilot study	At start of dredging works & after pilot study has been conducted
Water quality: weekly physiochemical analysis of seawater	Fortnightly
Monthly: seawater and sediment quality	Monthly
Marine mammal monitoring	Fortnightly
Ambient noise	Monthly
Ambient air	Quarterly
Resource consumption	As per HSSE Plan
Waste	Monthly, as per Waste Management Plan
Treated waste water	As per Waste Management Plan
Archaeological and cultural resources	Within 24 hours after discovery
Incidents	Depending on level of incident, as per HSSE Plan
Post-construction environmental compliance report	Once, after works have been completed

10 QUALITY ASSURANCE & QUALITY CONTROL

10.1 INTERNAL AUDIT

The aim of internal audits is to identify problems that may exist, so that Contractor/Sub-Contractor improves the standards of HSSE performance. The audits are to judge how HSSE issues are managed and to verify the respect of law and regulations, the responsibilities, risk evaluation and management, respect of environment, safeguarding of health, Sub-Contractor and Suppliers control, competence and training of workforce, implementation of the HSSE training plan, emergency preparedness, accident/incident investigation, HSSE improvement plan. For further detail on the internal audit procedure reference is made to the HSSE plan [97].

10.2 INSPECTION

Monthly inspections will be carried out internally, and observed by an independent MECA/SEZAD approved Environmental Consultant, to check Contractor's performance on implementation of the CEMP:

- Implementation monitoring procedures as described in the CEMP;
- Implementation of control & mitigation measures as described in the CEMP, if necessary;
- Analyses of water samples in laboratory according to international standards;
- Calibration and/or verification of measurement devices;
- Reporting of incidents and corrective actions taken, if any.

10.3 AUDIT

Compliance audits will be carried out on a quarterly frequency during construction phase by a MECA/SEZAD approved Environmental Consultant.

The following subjects will be addressed during the audits:

- Waste management practices and adequacy of disposal/recycling methods;
- All relevant permits in place;
- Fuel consumed;
- Emissions to air and water;
- Noise limits;
- House keeping;
- Management of impacts from ongoing activities as per CEMP;
- Close out of items identified during inspections and previous audits (if any).

10.4 CONTROL & REVIEW OF CEMP

An up to date controlled copy of the CEMP will be maintained on site at all times and it will be available for all parties and available for auditing purposes. The copy of the CEMP will be available to the Owner, Project Consultants and all sub-contracting companies.

All revisions made to the CEMP will be communicated to all parties and the superseded version of the CEMP will be replaced on the online document control system, if any, which is used by employees to access specific documents.

The Environment Manager is responsible for ensuring that all site personnel are informed and aware of any environmental requirements and changes to the CEMP. They will liaise with the Project Management team concerning environmental issues including technical advice. Information will be provided to all applicable site personnel, including subcontractors, in the form of initial inductions and toolbox talks. SHE-Q Manager shall report to the Project Management any non-conformances, incidents and other environmental issues that arise from internal and external inspection and concerns from the Subcontractors, Workers or Site Foreman. Project Management shall administer corrective and

preventive measures on the raised environmental non-conformances, referring to the relevant legislation and technical guidelines.

10.5 DATA-HANDLING

Field logs

Field logs are filed at the end of each monitoring day, and relevant information is included in the fortnightly report.

Data files from instruments

Data files from the logging monitoring instruments are copied onto the computer in the office and onto the project data server where available. Backups of this data will be made at least once a week.

Lab results

Lab results will be logged on paper lab reports in the on-site lab. The results will be included in the fortnightly report.

Backups of electronic data

Backups of electronic data will be made at least once a week.

11 ROLES & RESPONSIBILITIES

This chapter describes the environmental responsibilities of key personnel within the project organisation and the training, induction and toolbox policies that apply to all personnel.

11.1 GENERAL

The responsibility for environment is founded in Contractor's management structure. This accountability is put forward to project sites and vessels via subsequent management levels. Responsibilities per below mentioned function will be supplemented with tasks following from the risk assessment.

The project management / staff will implement the environment plan by:

- setting an example for their colleagues by their own behaviour regarding environmental matters;
- asking corporate SHE-Q department for advice if necessary;
- making sure that the project activities comply with environmental regulations and requirements;
- ensuring that all project employees understand the environmental regulations;
- applying the same instructions to suppliers / sub-contractors; and
- proposing measures to prevent risks for the environment.

11.2 PROJECT MANAGER

Although he is allowed to delegate some of his tasks, the Project Manager is ultimately responsible for all environmental aspects of the Project. This includes amongst others:

- Perform an environmental risk assessment prior to commencement of the works;
- Examine whether the environmental plan meets contractual and legal requirements;
- Ensure the employment of sufficient qualified and trained personnel;
- Make employees aware of the environmental plan and their environmental responsibilities;
- Make sure that the response to environmental incidents is accurate;
- Arrange periodic environmental inspections and meetings;
- Report environmental incidents according the incident reporting procedure (RBW-510);
- Report the environmental actions such as inspections, audits and toolbox meetings; and
- Set environmental targets for project.

Tasks which will be carried out by the Project Manager or Works Manager are:

- Monthly SHE inspection;
- Participation in the investigation and analyses in the event of a serious environmental incident; and
- Chairing the environmental meetings with supervisory personnel when required.

11.3 PROJECT SAFETY, HEALTH, ENVIRONMENTAL AND QUALITY MANAGER

The Project Safety, Health, Environment and Quality Manager is responsible for the environmental management related to the construction site, temporary facilities and the vessels. This includes Waste Management, oil spill prevention and response, resource consumption, and air emission and noise control measures. The Project SHE-Q Manager has the following responsibilities:

- Advise and support management and supervisory personnel on environmental issues;
- Induct and instruct new project personnel, subcontractors and third parties;
- Perform random project spot-checks to verify compliance with the environmental plan;
- Investigate environmental incidents and non-conformities;
- Administrate and review regularly the environmental plan and attached procedures; and
- Record and review the environmental performances achieved on the Project.

11.4 ENVIRONMENTAL MANAGER

The Environmental Manager is responsible for the development, implementation and reporting of the CEMP, together with the Project Manager and the Project Safety, Health, Environment and Quality Manager. The Environmental Manager has a coordinating role, and is assisted by the Environmental Monitoring Engineer for the implementation of monitoring programs in the field. His/her tasks include:

- Contact person for Owner for issues related to ecology;
- Contact person for Third Party Environmental Consultants;
- Liaison and first contact for Owner Representative for issues related to ecology;
- Advising project manager on implementing possible mitigation measures in case exceedance of turbidity levels;
- First contact in case of incidents with marine mammals;
- Investigate environmental, ecology related incidents and non-conformities;
- Reviewing (with the Project Manager) and updating the CEMP; and
- Responsible for reporting.

11.5 ENVIRONMENTAL MONITORING ENGINEER

The Marine Environmental Supervisor will be in charge of the execution of the environmental monitoring. His/her tasks includes amongst others:

- Execution of environmental monitoring;
- Responsible for ecological incident reporting;
- Coordination contact with certified laboratories;
- Liaison with Environmental Manager on Environmental issues.

11.6 SUPERVISORY PERSONNEL

Supervisory project personnel (Superintendent, Captain/ Dredge Master and Foreman) in charge of particular works and project employees, have the responsibility to supervise the environmental aspects accompanying those works. This includes amongst others:

- The Captain or Vessel Master assigns a crewmember on each shift to log visual plume monitoring and marine mammal observations on the appropriate log sheets;
- Report dangerous environmental incidents;
- Correct behaviour that might result in environmental pollution;
- Make sure that during the works, the environment is protected;
- Make sure that emergency preparedness and response tools for environmental incidents will be effective;
- Conduct a weekly environmental inspection of the work and the activities when required; and
- Organize and carry out toolbox meetings.

11.7 PROJECT PERSONNEL

All project personnel are responsible to comply with the environmental policy, Safety Instructions (RBW - 502) and project specific environmental instructions.

They shall:

- Behave and work according the ruling environmental measures and instructions;
- Use equipment, machines, vehicles and tools in environmental friendly manners;
- Use and maintain environmental protection equipment in appropriate manners;
- Report instantly any noticed (possible) danger to supervisory project personnel; and
- Attend and participate in toolbox and environmental meetings.

Prior to employment of project personnel, the Project Management has to verify whether the employees are sufficiently trained for their tasks and duties on the Project. If project circumstances require so, the Project Management shall, in consultation with the SHE-Q and Personnel & Organization departments, arrange specific training.

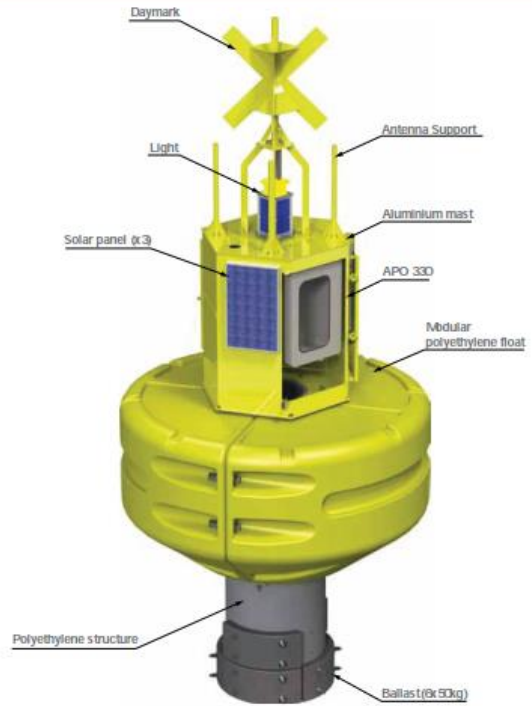
APPENDIX 1: SPECIFICATIONS ENVIRONMENTAL MONITORING BUOY

DB



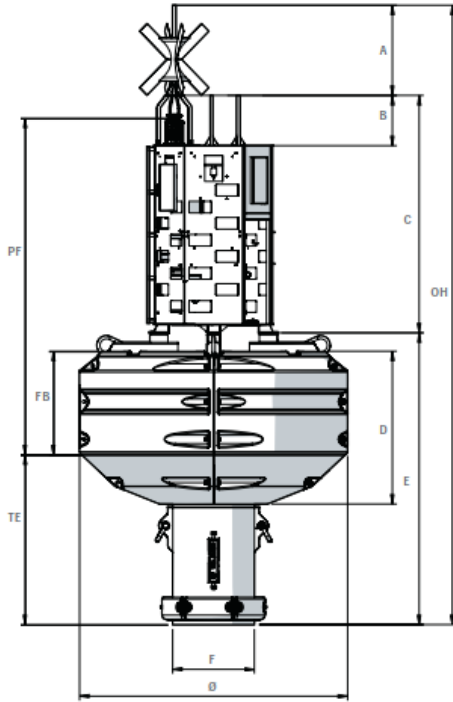
SPECIFICATION	8000 DRAGAGE SURVEY	2000 DRAGAGE SURVEY
WEIGHT WITH BALLAST (t)	2.1	0.7
BUOYANCY (kg/cm)	64	25
VISIBLE SURFACE (m ²)	6.5	2.5

DIMENSIONS (m)	8000 DRAGAGE SURVEY	2000 DRAGAGE SURVEY
Ø : Diameter	3	1.9
PF : Focal Plane	3.7	1.9
TE : Draught	1.8	1.3
FB : Freeboard	1.2	0.6
OH : Overall Height	6.9	4.3
A : Topmark	1	0.7
B : Light support	0.5	0.5
C : Mast	2.6	1
D : Float height	1.7	1.1
E : Structure	3.3	1.9
F : Diameter of structure	0.9	0.6



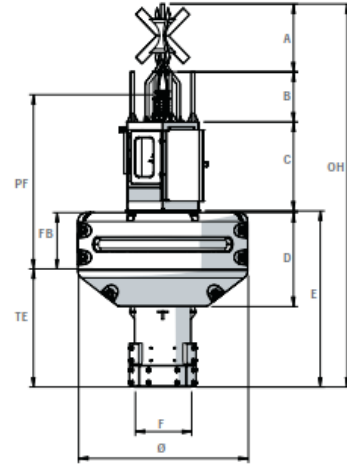
DB 2000 dragage survey
Anchoring elements (shackles, chains, swivels, shackles) are available in mooring accessories section in the catalogue.

DRAGAGE SURVEY



DB 8000 DRAGAGE SURVEY

Non-contractual illustrations and photos



DB 2000 DRAGAGE SURVEY

MOBILIS (IP 4000) (1772) Area-Perimeter Code 3, France
Tel. : +33 (0) 442 371 500 | Fax : +33 (0) 442 371 501
www.mobilis-aa.com



APPENDIX 2: SPECIFICATIONS WATER QUALITY MULTI-PARAMETER SENSOR



Eureka's Hallmark Features

Reliable data is Eureka's Top Priority. We start with the best sensors on the market and finish with our famously simple user-interface.

Using the Manta is really, really easy. Plug the Manta into a USB port and see live Manta data a few seconds later. Most users teach themselves the Manta operating software in about 15 minutes, without reading the manual.

Why pay more to purchase a multiprobe AND pay more to maintain it? The Manta's modular architecture often saves you thousands of dollars in purchase costs, and our rebuildable reference electrode and long-life DO sensor save you as much as \$600 in annual maintenance cost.

Excellent Customer Service is standard equipment. A human is always available to answer you call or email.

New Features in the Manta+

Three-Year Warranty includes the pH sensor, reference electrode, and DO cap.

Event Triggering increases the frequency of data logging when a user-selected parameter changes by a certain amount over a certain time.

Digital Turbidity Sensor has built-in autoranging for excellent performance in near-zero FNU waters, with an upper range to 5000 FNU.

Calibration Stability Indicator tells you when your sensor is stable enough for calibration.

New Sensors include tryptophan/BOD, optical brighteners, bromide, calcium, and sodium ions, fDOM II, chlorophyll red, and transmissivity.

Other new features include: Custom Parameter, Calibration Stability Indicator, Copper-Gauze Antifouling Kit, Expanded Calibration Log, Raw Values, Aquarius™ Compatibility, Battery Voltage Indicator.



Model	Parameters
Trimeter	temperature depth + any other single parameter including fluorimeters
20	temp pH conductivity optical DO (optional depth or ORP)
25	temp pH conductivity turbidity
30	temp pH conductivity optical DO (optional depth or ORP) turbidity
35	temp pH conductivity optical DO + turbidity
40	temp pH conductivity optical DO + turbidity

Option Category	Parameters
small sensor options	sodium ammonium nitrate chloride TDG
medium sensor options	PAR chlorophyll blue-green algae rhodamine crude oil refined oil CDOM/FDOM fluorescein dye optical brighteners tryptophan

standard sensors on 35/40

Products

Trimeter - Three Parameters at the Lowest Possible Cost

Get all the features of a Manta, including top-grade sensors and simple software, in an instrument designed for economy. Each Trimeter employs one of any sensor that Eureka offers, plus optional temperature and depth sensors.



A Data Display for Every Application and Budget

The AmphibianPlus is a waterproof, full-function Windows PDA incorporating the Manta user interface, with GPS and cell phone options.

The Bluetooth Battery powers your Manta, and lets you talk wirelessly to the Manta with any Bluetooth-equipped Android or Windows peripheral. You can save up to \$1500 by using your own phone instead of a limited-purpose data display.



One Job - One Instrument

The Manta family offers up to 12 sensors in one, integrated package.

Available sensors include temperature, optical DO, pH, ORP, conductivity, depth, level, turbidity, fluorometers including chlorophyll a, chlorophyll red, phycocyanin, phycoerythrin, fDOM, fDOM II, rhodamine, fluorescein, crude oil, refined fuels, optical brighteners, and tryptophan/BOD, CO₂, ammonium, nitrate, sodium, calcium, bromide, chloride, TDG, PAR, dual PAR, and transmissivity.



Field-Proven Methods to Minimize Fouling

The Extended Turbidity Brush cleans turbidity and other sensors, such as DO, chlorophyll, and BG algae.

The MiniCleaner is a stand-alone wiper system used when you don't have an Extended Turbidity Brush.

The Copper-Gauze Kit wraps the sensors in copper gauze that slowly dissolves, bathing the sensors with the copper ions that discourage biofouling. Copper gauze is superior to solid copper, which becomes ineffective once oxidized.





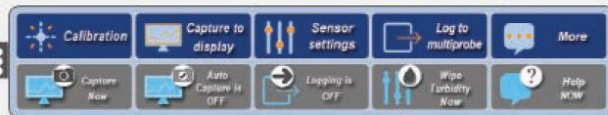
The New Manta Manager

The new Manta Manager retains its predecessors' ease of use and adds new features like event triggering, calibration stability indicator, more QC information options in the permanent calibration log, single-point calibrations, visibility of "raw" sensor values, cut-and-paste of rolling data to MS Office documents, more help screens, a more powerful user-defined-parameter creator, and built-in instruction manual.

Mobile Version



The new Manta Manager also offers a tablet and smartphone version with new "small screen" features like "swipeable" pages and large, high-contrast numbers for easier visibility in sunlight.



DATE	TIME	Temp deg C	pH units	ORP mV	SpCond uS/cm	HK30 mpt	HK30 %sat	pH mV
04/15/16	14:39:55	22.66	5.95	200.3	8.8	4.80	56.4	49.1
04/15/16	14:39:54	22.66	5.95	200.2	8.8	4.80	56.4	48.9
04/15/16	14:39:53	22.66	5.95	200.1	8.8	4.80	56.4	48.9
04/15/16	14:39:52	22.66	5.95	200.0	8.8	4.80	56.5	49.1
04/15/16	14:39:51	22.66	5.95	200.0	8.8	4.80	56.5	48.9
04/15/16	14:39:50	22.66	5.95	199.9	8.8	4.80	56.5	48.9
04/15/16	14:39:49	22.66	5.95	199.8	8.8	4.81	56.6	49.1
04/15/16	14:39:48	22.66	5.95	199.7	8.8	4.81	56.6	48.9
04/15/16	14:39:47	22.66	5.95	199.6	8.8	4.81	56.6	48.9
04/15/16	14:39:46	22.66	5.95	199.6	8.8	4.82	56.6	49.0
04/15/16	14:39:45	22.66	5.95	199.5	8.8	4.82	56.6	49.0
04/15/16	14:39:44	22.66	5.95	199.5	8.8	4.82	56.6	48.9
04/15/16	14:39:43	22.66	5.95	199.4	8.8	4.82	56.6	48.9
04/15/16	14:39:42	22.66	5.95	199.3	8.8	4.82	56.6	48.9
04/15/16	14:39:41	22.66	5.95	199.2	8.8	4.82	56.6	48.9
04/15/16	14:39:40	22.66	5.95	199.2	8.8	4.82	56.7	48.9
04/15/16	14:39:39	22.66	5.95	199.1	8.8	4.82	56.7	48.9
04/15/16	14:39:38	22.65	5.95	199.0	8.8	4.82	56.7	48.9

Accessories for Every Application

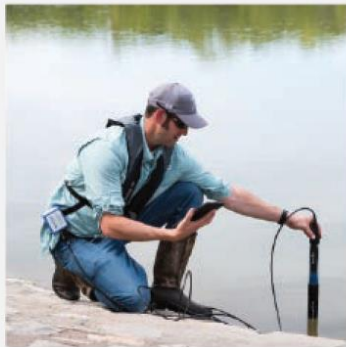
Standard accessories include flow cells, copper-gauze anti-fouling kits, cable reels, SDI-12 converters, hard-sided cases, pipe kits to protect logging units in the field, weather stations, auxiliary batteries, auxiliary batteries with Bluetooth, and a full line of calibration standards including secondary calibration standards for fluorometers.



Applications

lakes, rivers, ground water, storm water, estuaries, streams, ponds, near-shore oceanographic, process waters, waste waters, laboratory research

Site to Site Profiling



Process Monitoring



Unattended Logging



Ground Water

Telemetered Deployments



Buoy Deployments

manta2+™ Multiprobe Specifications								
	Transceiver	Manta+20	Manta+25	Manta+30	Manta+35	Manta+40		
Diameter	1.85"	1.95"	2.45"	2.95"	3.5"	4.00"		
Length - w/o Battery Pack	33.5"	39"	19"	19"	19"	19"		
-Add Internal Battery Pack	23"	27"	27"	27"	27"	27"		
Weight -with IBP	2.8 lbs	2.4 lbs	2.5 lbs	5.8 lbs	9.0 lbs	10.0 lbs		
-without battery	2.2 lbs	-	-	-	-	-		
Number of sensors	Any single sensor plus depth and temp option	Up to 6	Up to 3	Up to 7	Up to 11	Up to 13		
Battery Pack	3 10" cells	2 10"	2 10"	8 1" cells	8 1" cells	8 1" cells		
Operating Temperature	-5 to 50 C							
Depth Rating	200 m							
Communications	RS-232, SDI-12, USB or Bluetooth							
Sample Rate	1 Hz							
Data Memory	>1,000,000 logged readings							
Amphibian2 Handheld Display								
Size	3.6" W x 7.25" L x 1.5" D							
Weight	1.3 lbs							
Operating System	Microsoft® Windows Embedded Handheld 6.5.3							
IP Rating	IP68							
Memory and Data Storage	512MB RAM; 8 GB ash -> 8,900,000 logged readings							
Sensor Specifications								
parameter	range	resolution	accuracy	comments				
temperature	water temperature	-5 to 50 C	0.1	0.1	never needs calibration			
pH/ORP	pH	0 to 14 units	0.1	0.1 within 10 C of calibration, 0.2 otherwise	refillable reference electrode; corrected for temperature; typical sensor life > 4 years			
	ORP	-999 to 999 mV	1	20 mV	platinum ORP sensor is combined with pH sensor			
turbidity	turbidity	0 to 40 FMU	4 digits with maximum of two decimals	2% of reading at 0.2	corrected for temperature; filtered for non-turbidity spikes; includes wiper to clean the optics			
		40-400 FMU		2% of reading at 0.2				
		400-5000 FMU		2% of range				
optical dissolved oxygen	transmissivity	0 to 100% transmission	4 digits	linearity of 0.998 ⁻¹	BET Labs SeaStar; mounts alongside the Manta			
	concentration	0 to 20 mg/l	0.01	0.1				
		20 to 30 mg/l	0.01	0.15				
		30 to 50 mg/l	0.1	5%	corrected for temperature and salinity; EPA approved "lifetime" luminescence method; typical sensor cap life > 4 years			
% saturation	0 to 500% saturation	0.1%		corresponds with the accuracy of the concentration reading				
conductivity	specific conductance, µS/cm	0 to 5000 µS/cm	4 digits with maximum of one decimal	±0.5% of reading ±0.001	corrected for temperature; four easy-to-clean graphite electrodes; optional sensor provides ±0.5% of reading accuracy to 100 mS/cm.			
	specific conductance, mS/cm	0 to 10 mS/cm		±1% of reading ±0.001				
		10 to 100 mS/cm		1% of reading				
		100 to 275 mS/cm		2% of reading				
pressure	salinity	0 to 70 PSS	0.01	0.2	calculated from specific conductance; PSS = Practical Salinity Scale which is roughly equivalent to ppt			
	total dissolved solids (TDS)	0 to 65 g/l	0.1	5% of reading	calculated from specific conductance			
	depth	0 to 25 m	0.01	0.05	corrected for temperature and salinity; 0.05 m out of 25 m is 2" out of 100 feet; 0.4 m out of 200 m is a football length out of two football fields			
	vented depth (level)	0 to 10 m	0.001	0.003m	corrected for temp, salinity, barometric pressure			
	barometric pressure	400 to 900 mm Hg	0.1	1.5	included with depth sensor			
fluorimeters	total dissolved gas (TDG)	400 to 1400 mm Hg	0.1	1	corrected for temperature; maximum depth 15m			
	chlorophyll a - blue	0 to 500 µg/l	6 digits with maximum of two decimals	linearity of 0.998 ²	highest-quality Turner Design fluorometric sensors; fluorometers often require non-trivial calibration; custom optics available upon request			
	chlorophyll a - red	0 to 500 µg/l						
	rhodamine dye	0 to 1000 ppb						
	Phycocyanin (freshwater BG1)	0 to 40,000 ppb						
	Phycocyanin (marine BG1)	0 to 750 ppb						
	CDOM/NDOM	0 to 1250 or 0 to 5000 ppb						
	CDOM/NDOM custom	0 to 1250 or 0 to 5000 ppb						
	optical brightness	0 to 15,000 ppb						
	tryptophan	0 to 20,000 ppb						
	fluorescein dye	0 to 500 ppb						
	retinol oil	0 to 10,000 ppb						
	crude oil	0 to 1500 ppb						
	ion-selective electrodes (ISE's)	ammonium				0 to 100 mg/l as nitrogen	0.1	5% at 2 mg/l
nitrate		0 to 100 mg/l as nitrogen						
chloride		0 to 10,000 mg/l						
sodium		0 to 20,000 mg/l						
calcium		0 to 40,000 mg/l						
PAR	brunide	0 to 80,000 mg/l						
	photosynthetic PAR	10,000 µmol/m2	4 digits	5% of reading	LiCor spherical sensor			
Warranty								
Manta+ Multiprobe	3 years *		Underwater cables		2 years			
Amphibian2 Handheld	2 years		Bluetooth Module		3 years			
Optical DO Cap	3 years							

FOR BEST ACCURACY, ALWAYS CALIBRATE NEAR THE ANTICIPATED FIELD READINGS, AND NEAR THE TEMPERATURE OF THE ANTICIPATED FIELD READINGS.

About Us

Eureka was formed in 2002 by industry veterans who believed there was considerable room in the multiprobe market for improvements in technology and customer service. Eureka, an employee-owned partnership, includes the company's founder along with partners from both Europe and Asia with extensive history in the water quality industry.

Eureka Water Probes continues to provide innovative, reliable multiprobes backed by market-leading customer service. Designing and manufacturing the world's best multiprobes remains our sole focus.

Give us a call – we can make your data-collection easier, better and less expensive.

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For a complete list of our international partners,
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water probes

APPENDIX 3: EXAMPLE FORTNIGHTLY ENVIRONMENTAL REPORT



Duqm Liquid Bulk Berths Project

Environmental Monitoring Results week xx&yy

Doc No.: 0020062-xxxxx-yy-zzz

Document title Environmental Monitoring Results week xx&yy
Document no 0020062-xxxxx-yy-zzz
Revision no A2
CPY Doc:
Date
Author Environmental Manager



0020062-xxxxx-yy-zzz

Page 1 of 23

rev A2



RESPONSIBILITIES

This document is the responsibility of the Project Director and any revision or amendments shall require his approval. The Project Director is responsible for the maintenance of this document and for arranging controlled distribution.

Revision Status						
Rev	Issue Date	Reason for Issue	Prepared	Reviewed	Approved	Owner's Acceptance
A1	dd-mm-yyyy	IDC	Irena Doets	Stefanie Ross	Bart Pröpper	
A2	dd-mm-yyyy	ICR	Irena Doets	Stefanie Ross	Bart Pröpper	
List of Changes to previous version						
Par			Change			

	<p>ENVIRONMENTAL MONITORING RESULTS WEEK XX&YY</p>	 <p>الدقم هيئة المنطقة الاقتصادية الخاصة Special Economic Zone Authority</p>
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File name: Environmental Monitoring Results week xx&yy

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APPENDICES

APPENDIX 1. SPECIFICATIONS WATER QUALITY SENSORS



DEFINITIONS

Owner	Special Economic Zone Authority at Duqm
Contractor	Boskalis Westminster Oman LLC
Owner's Representative	WorleyParsons
Project	Duqm Liquid Bulk Berths Project
Q-Aid	RBW Corporate SHE-Q Management System

ABBREVIATIONS

FEED	Front-End Engineering Design
HOP	Hand Over Package
HSSE-Q	Health, Safety, Security, Environment and Quality
RBW	Royal Boskalis Westminster
SEZ	Special Economic Zone
SEZAD	Special Economic Zone Authority at Duqm
WP	WorleyParsons



1 INTRODUCTION

1.1 PROJECT BACKGROUND

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

The Special Economic Zone Authority at Al Duqm – SEZAD – was established to oversee the planning vision and strategic development of Duqm as a result of Royal Decree No. 119/2011, which was further re-defined through Royal Decree No. 44/2014 and No. 5/2016.

Duqm Refinery & Petrochemical Industries Company – Duqm Refinery – is a major new greenfield industry which will build a new oil refinery at Duqm, as phase 1 of an overall Refining and Petrochemical Complex. The refinery, which is currently being developed, will have a planned capacity of 230,000 BPD.

The Duqm Liquid Bulk Berths Project involves the design and construction of marine structures and dry bulk and tank facilities for the export of finished petroleum products from the Duqm Refinery. The finished liquid products to be handled at the terminal are Naphtha, Jet A1, Diesel Oil, High Sulphur Fuel Oil (HSFO), Pressurized Liquefied Petroleum Gas (PLPG); the finished dry bulk products are Pet Coke and Solid Sulphur Pellets.

Boskalis Westminster Oman LLC was awarded with the EPC 1 Contract comprising the design, dredging and marine infrastructure works for the Port.

1.2 DESCRIPTION OF SITE

The existing Duqm town occupies an area of 10km² and is located in the Sultanate of Oman, at the eastern coast of Al Wusta region, approximately 600km south of Muscat and 480 km north-east of Salalah.

The Port of Duqm is seen as a catalyst for the development of the Al Wusta region. The Port and Dry Dock are being developed to increase the trade. The site enjoys proximity to the busy regional sea-lanes of Oman's coastal waters – Figure 1.1.

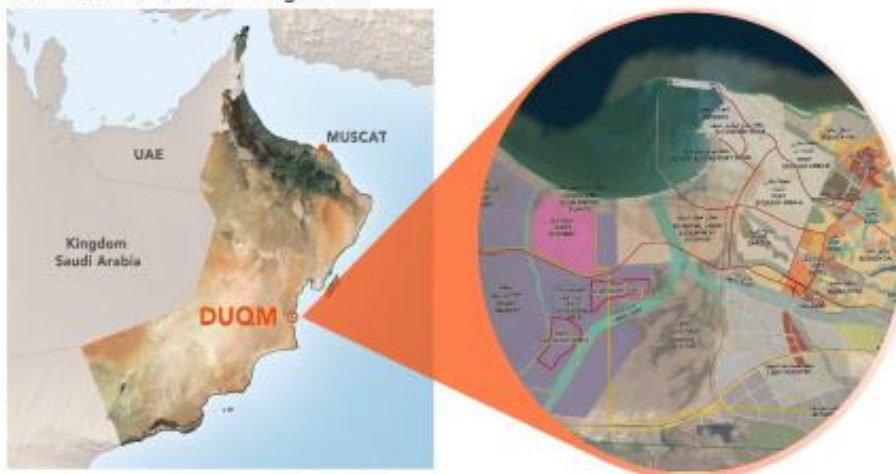


Figure 1.1: Location map and master plan detail



1.3 SCOPE OF WORK

The Scope of Work for the EPC1 Design, Dredging and Marine Infrastructure Contract includes the Detailed Design, Procurement and Construction of the marine structures and associated berths, dredging works and permanent reclamation areas as summarized in Table 1.1.

Figure 1.2 presents a schematic overview of the works.

Table 1.1: Summary of the Scope of Work

SUMMARY OF THE SCOPE OF WORK	CONTRACTOR'S WORK PACKAGES
	Project Site
<ul style="list-style-type: none"> • Execution and Interpretation of necessary studies • Execution and Interpretation of all necessary site surveys and Investigations 	Detailed Design and Engineering
<ul style="list-style-type: none"> • Design, procurement and the construction of permanent dredging 	Dredging (Figure 1.2, 1)
<ul style="list-style-type: none"> • Design, procurement and the construction of permanent reclamation and associated ground improvements 	Reclamation and Ground Improvement (Figure 1.2, 2)
<ul style="list-style-type: none"> • Design, procurement and the construction of continuous Quay Berths including associated quay furniture and other required equipment at Berth 900, Berth 901 and Berth 902 • Design, procurement and the construction of the infrastructure required for the oil spill response equipment • Design, procurement and the construction of various seawater intakes and outfalls 	Continuous Quay Wall (Figure 1.2, 5)
<ul style="list-style-type: none"> • Design, procurement and the construction of Double Berth Island Jetty structures including loading platforms, access trestles, dolphins, associated quay furniture and navigation aids at Berth 903, Berth 904, Berth 905 and Berth 906 	Double Berth Island Jetty (Figure 1.2, 4)
<ul style="list-style-type: none"> • Design, procurement and the construction of permanent modifications to the existing Lee Breakwater • Design, procurement and the construction of permanent revetments and scour protection 	Breakwater and Revetment (Figure 1.2, 3)
	Temporary Contractor Facilities and Works



Figure 1.2: Schematization of the Works (1 to 5 indicate dredging, reclamation, revetment, jetties and quaywall, respectively)



1.4 DOCUMENT SCOPE

This environmental monitoring report of week xx to week yy presents the results of the environmental monitoring conducted during this period. The monitoring conducted during this period are:

- Continuous turbidity monitoring (Chapter 2);
- Physiochemical analysis of seawater (Chapter 3);
- Marine mammal monitoring (Chapter 4);
- Ambient noise (Chapter 5);
- Ambient air quality (Chapter 6);
- Incidents recorded in this period (Chapter 0), if any.

1.5 REFERENCE DOCUMENTS

- [1] Environmental Impact Assessment, SEZAD-DPTC-00-WP-EV-REP-3001-B2, Worley Parsons Oman Engineering LLC, September 22, 2015.
- [2] Marine Environmental Baseline Survey, SEZAD-DPTC-00-WP-EV-REP-2004-B3, Worley Parsons Oman Engineering LLC, December 15, 2015
- [3] DLBB EIA Study Approval with Permit Conditions, DUQM/2016/0000231, SEZAD, January 28, 2016
- [4] DLBB Initial Environmental Permit valid from 7 March 2016 to 7 March 2017, 1161631, March 7, 2016
- [5] DLBB Initial Environmental Permit valid from 8 February 2017 to 8 February 2018, 1161631, February 8, 2017
- [6] DLBB Permit Clarification EIA Study Approval, DUQM/2016/0000330, SEZAD, February 11, 2016
- [7] Exhibit A – Scope of Work, Contract No. 78-2017, EPC1 – Design, Dredging and Marine Infrastructure Work, SEZAD-DPTC-00-WP-OM-PLN-0003-B1, Rev B1, Worley Parsons Oman Engineering LLC, January 31, 2017
- [8] Construction Environmental Management Plan, 020062-MHS00-PM-007, Boskalis, April 2017



2 TURBIDITY MONITORING

2.1 METHOD

Fixed monitoring stations equipped with turbidity sensors. These monitoring stations can resist heavy weather conditions, which may occur offshore. A total of seven monitoring stations will be deployed: two at the offshore disposal, two at the offshore borrow area, one outside the port entrance, one station at the ODC plant intake and one for background measurements. All stations are equipped with a turbidity sensor, data logger, GPS, solar panels, battery pack, navigation light and radar reflector.

Turbidity is measured in Nephelometric Turbidity Units (NTU) which is a measure of the relative clarity of water and is linear correlated to the suspended particles in the water. By taking water samples and determine the SSC (Suspended Sediments Concentration in mg/l) and the turbidity (NTU) a correlation factor can be established. The relationship established at the start of the project respectively the harbour basin and borrow area are:

[include TSS-NTU relationship when available]

2.2 TIME AND FREQUENCY

The monitoring buoys will log every second, and every 15 minutes a median is calculated by the data logger to filter outliers caused by organic matter passing the turbidity sensor. Four quarter hour median values will be sent to the data server every hour. The turbidity limit will be assessed for a 24-hours moving average of the 15 minutes median.

2.3 MONITORING LOCATIONS

The turbidity monitoring buoys are deployed at:

- One buoy 500 m from the Lee Breakwater outside the harbour entrance and outside the access channel, at a safe distance to the edge of the access channel, as indicated in Figure 2.1.
- Two bouys 500 m outside the offshore borrow and disposal area in line with the main plume directions as found from (initial) plume modelling, indicated in Figure 2.2.
- One station at the ODC RO Plant intake, indicated in Figure 2.1.
- One buoy located away from the area of influence of the marine works providing constant measurement of background levels in order to define ambient conditions, located at equivalent depth as the station near the Lee Breakwater as indicated in Figure 2.1.

The turbidity sensors will be located at 1.5 m below water surface except at the RO plant intake where it will be located at the same depth as the intake.

	<p>ENVIRONMENTAL MONITORING RESULTS WEEK XX&YY</p>	
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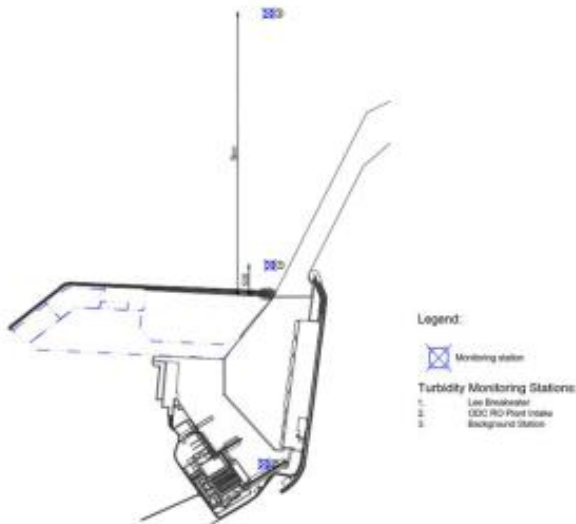


Figure 2.1: Indicative location of turbidity monitoring stations near port basin (1= Lee Breakwater, 2= ODC RO plant intake, 3= background station)

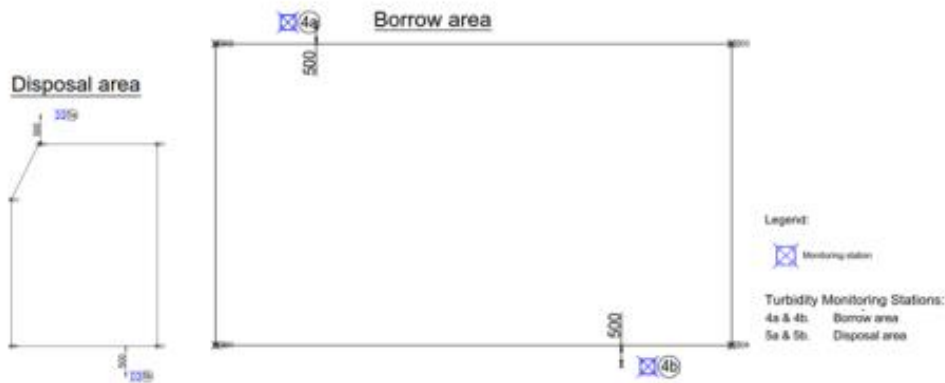


Figure 2.2: Indicative location of turbidity monitoring stations at offshore disposal and borrow area

The location of the buoys and coordinates logged on the Buoy Metasheet that is kept for each buoy. See section 2.6.2.

2.4 INSTRUMENTS

The turbidity sensors deployed on the buoys are Manta Eureka tri-meter (specifications see Appendix 1). The turbidity probe has a wiper to reduce biofouling of the sensor surface. The probes use 90° optics and



infrared light in accordance with ISO7027. The probe uses a unique modulation technique to ensure almost complete rejection of ambient light conditions.

2.5 RESULTS

The table and figures below give a summary of the turbidity log data for the reporting period.

The figures show spikes, i.e. high readings, in turbidity, which can have various causes. These include:

- Other material in the water causing increased readings, such as organic material, air bubbles from prop wash from a passing vessel or even small fish swimming in front of the sensor.
- Biofouling. Due to the high water temperature and oxygen saturation, algae and other microorganisms grow very quickly on any surface that is submerged in the seawater, including the turbidity sensors. The sensors have wipers to keep the sensor surface as clean as possible, but conditions in the Abu Dhabi coastal waters are such that growth of these organisms happens, despite the sensor surface being wiped regularly. Once biofouling affects the sensor surface, turbidity readings can become erratic, until the biofouling has been removed. The buoy metasheets (see section **Error! Reference source not found.**) show when each buoy was lifted out of the water for cleaning and maintenance.
- When a buoy is lifted out of the water, the turbidity sensor is moved from water to air. This can cause high turbidity readings for the period of time that the buoy and sensor are out of the water. Buoys are only lifted out of the water for four reasons: 1) to be moved to their next location; 2) to check the sensor for biofouling and clean it if necessary; 3) to remove the turbidity sensor before an upcoming bad weather period; 4) to replace the turbidity sensor after a bad weather period. The buoy metasheets (see section 3.3.2) show when each buoy was lifted out of the water.

Often turbidity spikes disappear again before the cause can be investigated. In other cases, the sea state is too poor to safely lift a buoy out of the water to check for biofouling (and clean it off), or even to safely sail out to the buoy to take a handheld measurement to verify the high turbidity readings. In most of these cases, trenching and backfilling works are also stopped, but in some cases, backfilling has stopped and the CSD is only pre-cutting seabed material in the trench. This generates no plume, as only the cutter head is rotating to crush seabed material, but no pumping is taking place. The crushed material is removed and used for backfilling later, after the weather has improved enough to restart backfilling operations.

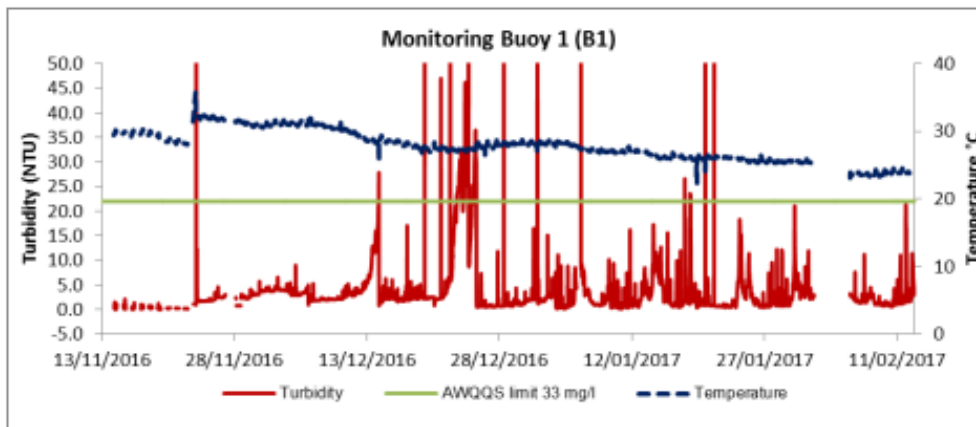


Figure 2.3: Example turbidity timeline, period dd mm yyyy to dd mm yyyy, Monitoring Buoy 1

	<p>ENVIRONMENTAL MONITORING RESULTS WEEK XX&YY</p>	
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Table 2.1: Remarks for Monitoring Buoy 1

Remarks on increases in turbidity				
Buoy	Date	Time	NTU	Remarks
1	23-Nov-16	17:00	172.4	Buoy was being deployed during the spike
1	25-Nov-16	00:00	>20	Elevated turbidity data due to biofouling. Sensor was checked and cleaned on 14-Dec-2016 after the rough sea state.
1	28-Nov-16	13:30	120.41	Single spike, values returned to normal before a check of the increase could be done.
1	30-Nov-16	09:15	29.75	Buoy was being shifted during the spike
1	01-Dec-2016	10:30	172.385	Buoy was being shifted during the spike. Started to show gradual increase in turbidity readings after deployment to new position. Due to rough weather state, it was only resolved on the 25-Dec after checking and cleaning the sensor.
		10:45	163.16	
1	02-Dec-16	12:15	420.26	Single spike, values returned to normal before a check of the increase could be done.
1	07-Dec-16	07:30	265.63	The buoy was under maintenance during the spike.
		07:45	40.27	
		08:00	42.53	

Table 2.2: Example average turbidity values per day for each buoy

Average Turbidity values per day							
Date	B1	B2	B3	B4a	B4b	B5a	B5b
23/11/2016	1.55	0.02	1.19	0.02	0.19	0.20	1.03
24/11/2016	1.75	0.07	1.25	0.02	0.18	0.34	0.23
25/11/2016	1.99	0.54	1.65	0.02	0.33	0.30	0.33
26/11/2016	2.76	1.16	2.32	0.03	0.94	0.72	0.17
27/11/2016	3.00	0.11	1.77	0.03	1.63	29.76	0.19
28/11/2016	1.32	0.28	2.13	0.03	18.77	56.75	0.18
29/11/2016	2.62	0.70	2.87	2.47	19.43	56.75	0.33
30/11/2016	3.21	0.64	2.79	10.50	36.83	56.75	0.94
01/12/2016	3.90	0.37	2.82	52.97	26.38	40.09	1.63
02/12/2016	4.08	0.36	3.25	0.02	0.22	3.10	18.77
03/12/2016	4.00	0.68	3.03	0.02	0.17	0.01	19.43
04/12/2016	3.49	1.97	4.05	0.02	0.34	0.19	36.83
05/12/2016	3.20	1.51	2.07	0.04	0.32	0.20	26.38
06/12/2016	2.64	1.32	1.67	0.04	0.72	0.16	0.22
07/12/2016	1.94	1.78	1.91	0.02	1.30	0.32	0.17



2.6 QUALITY ASSURANCE, QUALITY CONTROL

2.6.1 Calibration of Turbidity sensors

The Eureka Manta tri-meter probes are factory calibrated, and the calibration is verified periodically per manufacturer specification. Log sheets of calibration verifications are kept by the Environmental Supervisor for each probe. Latest calibration/verification has been conducted on dd-mm-yyyy as shown in Figure xx.

2.6.2 Buoy Metasheet

Each buoy has a separate Metasheet which shows the main attributes of the buoy (see tables on the next pages). These sheets contain the location information, date and time of deployment / shifting of buoys, and maintenance details.

Table 2.3: Metasheet buoy 1: Lee Breakwater

Buoy Metasheet							
Period	May 2016 - August 2016		Instrument depth (m)	1.5		1st deployment	
Name	Buoy 1 : Lee Breakwater		Location depth (m)	20		Buoy	12/5/2017
Buoy software	Buoy Controller 1:26						
Turbidity sensor	Serial number	Date	Serial number	Date	Serial number	Date	
	Eureka tri-meter	XXXXXXXX	12/5/2017				
Deployment							
Date	Easting	Northing	Activity				
12/5/2017	XXXXXXXX	YYYYYY	First deployment onsite				
20/5/2017	XXXXXXXX	YYYYYY	Lifting activity for maintenance sensor				
30/5/2017	XXXXXXXX	YYYYYY	Sensor cleaned and checked at 0 and 100 NTU				



3 PHYSIOCHEMICAL ANALYSIS OF SEAWATER

3.1 METHOD

In-situ water quality measurements for physiochemical analysis are taken from a vessel, using a handheld multi-parameter probe, a laptop, and the vessel's navigation equipment.

Parameters which will be measured are:

- Turbidity;
- Salinity;
- Dissolved Oxygen (DO);
- pH; and
- Depth.

3.2 TIME AND FREQUENCY

In-situ water quality measurements are taken weekly, weather permitting and during daylight only.

3.3 LOCATIONS

In-situ water quality measurements are taken at the location of the continuous turbidity monitoring stations over the entire water column and at 500 m from the dredge vessel.

3.4 INSTRUMENTS

For the in-situ water quality measurements, an Eureka Manta+30 multi-parameter probe, capable of measuring the required physiochemical parameters. Refer to Appendix 1 for instrument specifications.

3.5 RESULTS

Results of the in-situ water quality measurements at the locations of the buoys are shown below.

Table 3.1: Depth average results

17-May-17	B1	B2	B3 (background)	B4a	B4b	B5a
Time	10:24	09:48	10:18	11:32	11:20	11:27
Turb NTU	1.4	1.7	1.3	0.9	0.6	0.6
Salinity psu	21.6	21.6	21.6	21.6	21.6	21.6
DO (mg/l)	10	11	12	11	12	11
DO (%)	80	82	82	81	83	81
pH units	8.3	8.3	8.3	8.3	8.3	8.3
Depth m	7.9	10.5	7.3	9.3	10.6	9.3



Table 3.2: Depth average results

25-May-17	B1	B2	B3 (background)	B4a	B4b	B5a
Time	08:50	08:54	09:29	10:11	11:19	10:46
Turb NTU	0.6	1.4	0.7	1.4	0.7	0.8
Salinity psu	21.6	21.6	21.6	21.6	21.6	21.6
DO (mg/l)	10	11	12	11	12	11
DO (%)	80	82	82	81	83	81
pH units	8.3	8.3	8.3	8.3	8.3	8.3
Depth m	8.5	8.9	8.1	9.6	6.5	10.0

3.6 QUALITY ASSURANCE, QUALITY CONTROL

Latest calibration/verification of the sensors has been conducted on dd-mm-yyy, according to manufacturers specifications.



4 MARINE MAMMAL MONITORING

4.1 METHOD

All relevant vessels have assigned MMO duties to one member of each of their crews. Each vessel has a Marine Mammal Observation log sheet on board. Whenever the Marine Mammal Observer (or another crew member) spots a marine mammal, the sighting will be logged on this sheet with the following information:

- Date and time;
- If observed on dayshift/nightshift;
- Heading and distance from the vessel;
- Number of animals;
- Type of animal (dolphin, dugong, turtle), species if known;
- Observer name and position.

4.2 TIME AND FREQUENCY

All vessels in the dredging, disposal and borrow area carry out Marine Mammal Observations during daylight hours. Observations are done continuously, crew duties permitting. If no sightings are made, entries will be made on the log sheet daily.

4.3 LOCATIONS

On all vessels in the work area.

4.4 INSTRUMENTS

Regular binoculars are used during the day.

4.5 RESULTS

- Date and time;
- If observed on dayshift;
- Heading and distance from the vessel;
- Number of animals;
- Type of animal (dolphin, dugong, turtle), species if known;
- Observer name and position.

Example is shown below:

	<p>ENVIRONMENTAL MONITORING RESULTS WEEK XX&YY</p>	
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Marine mammal Observation										
Date	Time	Vessel	Vessel Position		Direction of Animal (s)	Distance of Animal from Vessel(m)	No of Animal(s)	Type of Animal	Observer	
			Latitude	Longitude					Name	Position
14/11/2016	Daytime				SE	185	1	turtle		Master
15/11/2016	Daytime				West	80	1	turtle		Chief Officer
15/11/2016	Daytime				East	100-120	1	turtle		Radio Operator
17/11/2016	Daytime				East	80-100	1	turtle		Radio Operator
	Daytime				West	100	1	turtle		Master
18/11/2016	Daytime				SW	700	2	dolphins		Master
18/11/2016	Daytime				North	600	3	dolphins		Chief Officer
25/11/2016	09:30H				SE	100	2	dolphins		Master
26/11/2016	Daytime				West	10	1	dolphin		Master
27/11/2016	Daytime				S	100	1	dolphin		Master
27/11/2016	12:20H				NW	80 - 100	2	dolphins		Master
29/11/2016	Daytime				East	75	1	turtle		Master
12/Jan/2016	06:30H				NE	60 - 80	2	dolphins		Master
12/Jan/2016	Daytime				N-West	200	4	dolphins		Chief Officer
12/Apr/2016	19:45H				East	100	1	turtle		A/B
12/Apr/2016	09:10H				N	80	3	dolphins		Master
12/May/2016	15:30H				East	80-100	1	dolphin		Env Engr
12/Jun/2016	22:05H				N-East	50	1	turtle		A/B
12/Jul/2016	07:38H				N-West	50	6	dolphins		Master
12/Sep/2016	11:10H				N	80	3	dolphins		Master
					N	200	4	Dolphins		Admin
13/Dec/2016	14:30				E	150	1	Turtle		Captain
14/Dec/2016	12:00				NW	300	5	Dolphins		Captain
14/Dec/2016	12:40				Various	30m	5	Dolphins		Master
21/Dec/2016	11:00				E	100	6	Dolphins		Master
21/Dec/2016	12:30				W	200	1	Turtle		Master
21/Dec/2016	06:40				S	4	1	Turtle		C.Engr.
22/Dec/2016	08:30				W	50	1	Dugong		Master
23/Dec/2016	09:50				S	400	1	Dolphins		Admin
23/Dec/2016	12:30				W	100	1	Dolphin		AB
27/Dec/2016	15:00				N	200	6	Dolphins		AB
28/Dec/2016	08:35				SE	150	1	Dugong		Master
28/Dec/2016	09:40				East	1	1	turtle		Master
11/Jan/2017	19:20				S	800	3	Dolphins		Mate
12/Jan/2017	10:00				S	100	10	Dolphins		Radioman
12/Jan/2017	17:15				S	200	5	Dolphins		Captain
15/Jan/2017	13:00				E	150	10	Dolphins		SHE Supervisor
20/Jan/2017	11:30				E	650	3	Dolphins		Mate
21/Jan/2017	09:00				SW	100	10	Dolphins		Master
25/Jan/2017	14:30				NE	30	3	Dolphins		Admin
26/Jan/2017	09:00				E	300	3	Dolphins		Master
05/Feb/2017	05:35				E	600	3	Dolphins		Mate
06/Feb/2017	06:55				E	70	2	Dolphins		Mate
09/Feb/2017	13:20				E	200	1	turtle		MPCC SHE
	14:55				S	50	5	Dolphins		Master
10/Feb/2017	09:19				W	650	5	Dolphins		Master
12/Feb/2017	07:15				E	100	4	Dolphins		Env Surveyor

4.6 QUALITY ASSURANCE, QUALITY CONTROL

Marine Mammal Observation is a subjective monitoring method for which no QA/QC protocol exists. Regular MMO toolboxes are given to ensure awareness and convey results and new information, if applicable. A check is done by the Environmental Monitoring Engineer that the log sheets contain entries for each shift (where applicable).



5 AMBIENT NOISE

If conducted in this period, attach report of Subcontractor

5.1 METHOD

Noise measurements will be carried out along the project fence line monthly or when high noise activity is undertaken as specified in the EIA. MD 79/94 states a limit of 70 dB (A) holds for industrial, plants and public works areas which should be complied with. The impact from noise to residences is considered to be low, as the nearest village is located 5.5 km away from the project site. Noise measurements will be carried out by a local MECA/SEZAD approved Environmental Subcontractor. Measured noise levels will be: equivalent continuous ($L_{A,eq}$), maximum and minimum sound levels ($L_{A,max}$ and $L_{A,min}$). Environmental conditions (e.g. wind) and construction activities not related to Contractor's work at time of measurements will be noted.

5.2 TIME AND FREQUENCY

Monthly or when high noise activity is undertaken.

5.3 LOCATIONS

Along the project fence line at same locations as the EIA baseline monitoring (see Figure 5.1) and in addition at 3 locations on the site access road.



Figure 5.1: Locations of Ambient Air and Noise Quality Monitoring Stations of EIA study

5.4 INSTRUMENT

Equipment as reported by Subcontractor.

5.5 RESULTS

Example of results graphed and tabled see below.

	ENVIRONMENTAL MONITORING RESULTS WEEK XX&YY	
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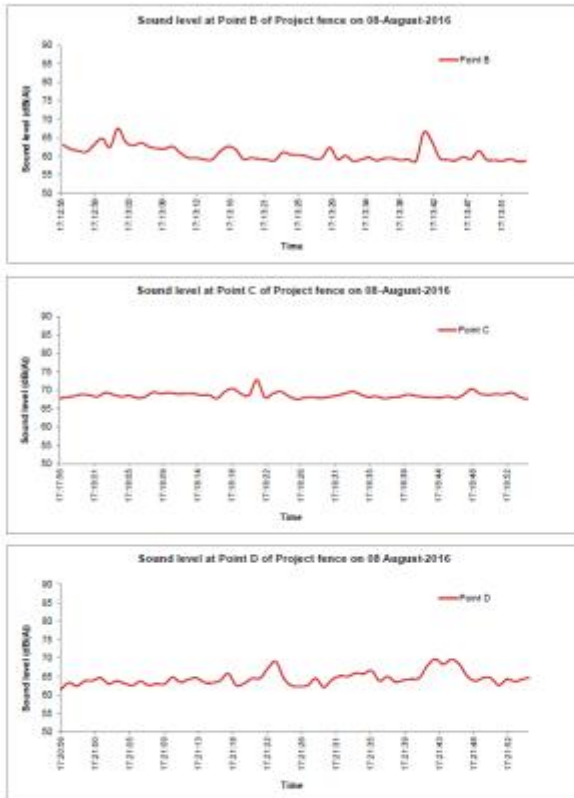


Figure 5.2: Example noise monitoring results

Remarks:

- Environmental conditions: wind speed and rain;
- Construction activities in surrounding.

5.6 QUALITY ASSURANCE, QUALITY CONTROL

Quality assurance as reported by Subcontractor.



6 AMBIENT AIR QUALITY

If conducted in this period, attach report of Subcontractor

6.1 METHOD

During construction, quarterly air quality measurements will be undertaken for:

- Dust;
- Diffusion tubes for NO_x, SO₂, VOC, O₃.

These measurements are compared to baseline monitoring data, conducted in the EIA, to indicate trends as agreed with Owner and Engineer during environmental meeting held 26th of March 2017.

In addition, visual observations of dust will be made during daily site inspections. If excessive dust generation is observed, mitigating measures will be implemented. These observations are part of the routine site inspections and will not be reported separately.

6.2 TIME AND FREQUENCY

Quarterly or with increasing interval during high wind conditions.

6.3 LOCATIONS

At the project fence line at similar locations as the noise measurements as shown in Figure 5.1, assuming they are at reasonable distance of other activities.

6.4 EQUIPMENT

Equipment as reported by Subcontractor.

6.5 RESULTS

Results of dust and diffusion tubes analysis results are shown in Table 6.1.

Table 6.1: Example summary of diffusion tubes analysis results (all units in ppb) and dust monitoring

	DUST (PM2.5)	SO ₂	VOC	O ₃	NO _x	NO	NO ₂
DF1	4	0.57	0.20	59	4.44	3.26	1.18
DF2	6	0.67	0.32	68	5.79	3.91	1.63
DF3	7	3.02	0.49	78	6.65	4.57	2.18
DF4	5	0.57	0.20	59	4.44	3.26	1.18
DF5	4	0.67	0.32	68	5.79	3.91	1.63
DF6	13	3.02	0.49	78	6.65	4.57	2.18
DF7	3	0.57	0.20	59	4.44	3.26	1.18
DF8	4	0.67	0.32	68	5.79	3.91	1.63
DF9	7	3.02	0.49	78	6.65	4.57	2.18



Observations/remarks during measurements:

- Environmental conditions;
- Construction activities in surroundings.

[add graphs with timeline including results baseline survey]

6.6 QUALITY ASSURANCE, QUALITY CONTROL

Quality assurance as reported by Subcontractor.

APPENDIX 1. SPECIFICATIONS WATER QUALITY SENSORS

APPENDIX 4. SIDE SCAN SONAR SPECIFICATIONS

Side Scan Sonars



Portable Side Scan Sonar



Sonar Model	DE3468D	DE340D	DE680D	DE680SAR
Technology	Dual Chirp Digital	Chirp Digital	Chirp Digital	Chirp Digital
Frequency	Dual 340/680 kHz range/resolution optimized	340 kHz Center range/resolution optimized	680kHz Center range/resolution optimized	680 kHz Center range/resolution optimized
Horizontal beamwidth	0.9°/0.5°	0.9°	0.5°	0.9°
Vertical beamwidth	60°/60°	60°	60°	60°
Range	25 to 200 / 10 to 100 m 82 to 656 / 33 to 328 feet	15 to 200 m 49 to 656 feet	10 to 100 m 33 to 328 feet	5 to 50 m 16 to 164 feet
Range resolution	1.5/1 cm 0.59/0.39 inch	1.5 cm 0.59 inch	1 cm 0.39 inch	5 mm 0.2 inch
Max operating depth	100 m 328 feet	100 m 328 feet	100 m 328 feet	100 m 328 feet
Max cable length	200+ m 656 feet	200+ m 656 feet	200+ m 656 feet	200+ m 656 feet
Interface	RS485, GND, Supply, Fischer 103 DEE 4	RS485, GND, Supply, Fischer 103 DEE 4	RS485, GND, Supply, Fischer 103 DEE 4	RS485, GND, Supply, Fischer 103 DEE 4

Length	850 mm 33.5 inch	850 mm 33.5 inch	850 mm 33.5 inch	850 mm 33.5 inch
Diameter	60 mm 2.36 inch	60 mm 2.36 inch	60 mm 2.36 inch	60 mm 2.36 inch
Weight	9 kg 19.8 pounds	9 kg 19.8 pounds	9 kg 19.8 pounds	9 kg 19.8 pounds
Weight in water	6.7 kg 14.8 pounds	6.7 kg 14.8 pounds	6.7 kg 14.8 pounds	6.7 kg 14.8 pounds
Materials	Stainless steel, PVC and Polyurethane	Stainless steel, PVC and Polyurethane	Stainless steel, PVC and Polyurethane	Stainless steel, PVC and Polyurethane