MARINE ENVIRONMENT PROTECTION TECHNICAL NOTE

الدقم
Duqm
هيئة المنطقة الاقتصادية الخاصة
Special Economic Zone Authority

Environment Regulatory Department

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TABLE OF CONTENTS

LIst of Acronyms i

1 Introduction 1

1.1 Objectives of the Marine Environment Protection Technical Note 1

1.2 Project Information 1

2 Applicable Laws, Regulations and Standards 4

2.1 National Regulations 4

2.1.1 Royal Decree 34/74 – Law on Marine Pollution Control 4

2.1.2 Royal Decree 23/1978 – Signing of the Kuwait Regional Convention on the Protection of the Marine Environment from Pollution and its Protocol 5

2.1.3 Royal Decree 8/1979 – Law Sanctioning the Kuwait Regional Convention on Protection of Marine Environment from Pollution 5

2.1.4 Royal Decree 53/1981 - Law of Sea Fishing and the Preservation of Marine Biological Wealth 6

2.1.5 Ministerial Decision 20/1990 - Rules and Regulation and Specifying Coastal Setbacks 6

2.1.6 Royal Decree 90/1991 – Marine Pollution from Land Sources (ROPME) 6

2.1.7 Ministerial Decision 200/2000 – Regulations for Crushers, Quarries, and Transport of Sand from Coasts, Beaches and Wadis ... 7

2.1.8 Royal Decree 114/2001 - Law on Conservation of the Environment and Prevention of Pollution 7

2.1.9 Ministerial Decision 159/2005 – Regulations on Liquid Waste in Maritime Environment 8

2.1.10 RD 44/2014 and RD 5/2016 - Onshore and offshore boundaries of the Special Economic Zone in Duqm 10

2.2 International Standards 10

2.2.1 Sediment quality 10

2.2.2 Marine Water Quality 11

3 Environmental Permitting Requirements 13

3.1 Environmental Regulatory Procedure 13

3.2 Environmental Impact Assessment (EIA) 13

3.3 Construction Environmental Management Plan (CEMP) / Operational Environmental Management Plan (OEMP) / Decommissioning Environmental Management Plan (DEMP) . 14

4 Monitoring and Assessment Methodologies 15

4.1 Monitoring Methodologies 15

4.2 Baseline Monitoring 15

4.2.1 Monitoring Locations 15

4.2.2 Marine Ecology Survey 15

4.2.3 Collection of Samples 16

4.2.4 Analysis of Parameters 16

4.2.5 Water Quality Modelling 17

4.3 Monitoring during Construction 17

4.4 Monitoring during Operation 18

4.4.1 Sampling Locations 18

4.4.2 Marine Ecology and Collection of Marine Water and Sediment Samples 18

4.4.3 Analysis of Parameters 18

4.5 Monitoring during Decommissioning 23

4.6 Assessment Methodology 23

4.6.1 Identification of Exceedance 23

4.6.2 Impact Assessment 23

5 General Pollution Prevention Guidance Notes 24

5.1 Construction and Decommissioning Pollution Prevention Guidelines 24

5.2 Pollution Prevention Guidelines during Operation 24

5.3 Industry-Specific Best Management Practices 24

5.3.1 Petrochemicals 24

5.3.2 Limestone/Cement 25

5.3.3 Silica sand/Glass, Metal Casting and Production 26

5.3.4 Fishery industries 27

5.3.5 Automotive Industry 28

5.3.6 Power Generation Industry 28

5.3.7 Desalination Industry 30

5.3.8 Infrastructure (Port, Harbour and Terminals, Airport, Gas Distribution Network) 31

References 33

List of Figures

Figure 1-1: SEZD Area 3

List of Tables

Table 2-1- Appendix 1 of RD 114/2001 7

Table 2-2 - Appendix 2 of RD 114/2001 8

Table 2-3 - Maximum Discharge Limits for Liquid Effluents into the Marine Environment as per MD 159/2005 9

Table 2-4 - Interim marine sediment quality guidelines (ISQGs) and probable effect levels (PELs; dry weight) 10

Table 2-5 - Marine Water Quality Guidelines for Parameters at Alternative Levels of Protection (ARMCANZ/ANZECC, 2000) 11

Table 4-1: Parameters for Industrial Sources of Pollution Common to the SEZ Area 20

LIST OF ACRONYMS

BMP	Best Management Practices
CEMP	Construction Environmental Management Plan
IDZ	Industrial Development Zone
DEMP	Decommissioning Environmental Management Plan
EDR	Electro dialysis Reversal
EIA	Environmental Impact Assessment
EMS	Enhanced Membrane System
EQS	Environmental Quality Standards
FGD	Flue-Gas Desulphurization
ISQG	Interim Sediment Quality Guidelines
MECA	Ministry of Environment and Climate Affairs
MEP	Marine Environment Protection
OEMP	Operational Environmental Management Plan
PPGN	Pollution Prevention Guidance Notes
QA/QC	Quality Assurance/ Quality Control
SEZ	Special Economic Zone
SEZAD	Special Economic Zone Authority of Duqm
TDS	Total Dissolved Solids
TEL	Threshold Effects Level
VSEP	Vibratory Shear-Enhanced Processing
WWTP	Wastewater Treatment Plant

1 INTRODUCTION

1.1 Objectives of the Marine Environment Protection Technical Note

This Marine Environment Protection (MEP) Technical Note has been developed as part of a set of technical notes for the environmental requirements of the Special Economic Zone (SEZ) at Duqm. The MEP Technical Note includes a description of the relevant national and international marine environment related standards, methodologies for undertaking marine ecology, marine water and sediment quality monitoring and assessments, environmental permit requirements for the SEZ and relevant Pollution Prevention Guidance Notes (PPGN) and Best Management Practices for the protection of the marine environment.

The purpose of this MEP Technical Note is to set forth a comprehensive framework that will ensure compliance with the required standards and legislations and provide guidance to all interested and applicable bodies.

This MEP Technical Note is aimed primarily at applicants where proposed industries may adversely impact the marine environment.

The boundaries of the SEZ are offset by a minimum of 300m from the high water mark. The tenants will have an influence on marine water quality if there is industrial discharges to the marine environment from the project activities. The overall objective of the technical note is to provide guidance for applicants and to ensure there is minimal impact to the marine environment within the SEZ area.

Where a marine impact assessment is required as part of an industrial application, this MEP Technical Note sets out suggested methods of undertaking such an assessment. Environmental assessments could also require a detailed study of the effects of the industry on marine receptors. In such cases, the approach set out in this MEP Technical Note should be followed.

Industries should seek to prevent adverse impacts on marine receptors and ensure that any activities do not result in an exceedance of the objectives detailed within this MEP Technical Note. Applications that give rise to concerns regarding the marine environment will be assessed by the SEZAD Environmental Regulatory Department and specific requirements for compliance will be detailed on a case by case basis.

1.2 Project Information

The SEZ at Duqm is an integrated economic development area that covers 2,000 square kilometers. The SEZ is located in the Wilayat of Duqm on the south-east coast of Oman. The coastline of Wilayat Duqm is approximately 170 km in length, with the northern boundary lying between Nafun and Sidera, and the southern boundary being approximately 120 km south of Ras al Madrakah. Ghubbat Al Hashish and Barr Al Hikman lie to the north of the Al Wusta Region and Ras al Madrakah in the south.

The SEZ is composed of zones that include the Duqm port, the ship dry dock, the oil refinery, the regional airport, the residential, commercial and tourism area, the logistic services area, fisheries area and the industrial area. This MEP Technical Note applies to all industries in the SEZ area. Figure 1-1 specifies the boundaries of the SEZ as per RD 5/2016.

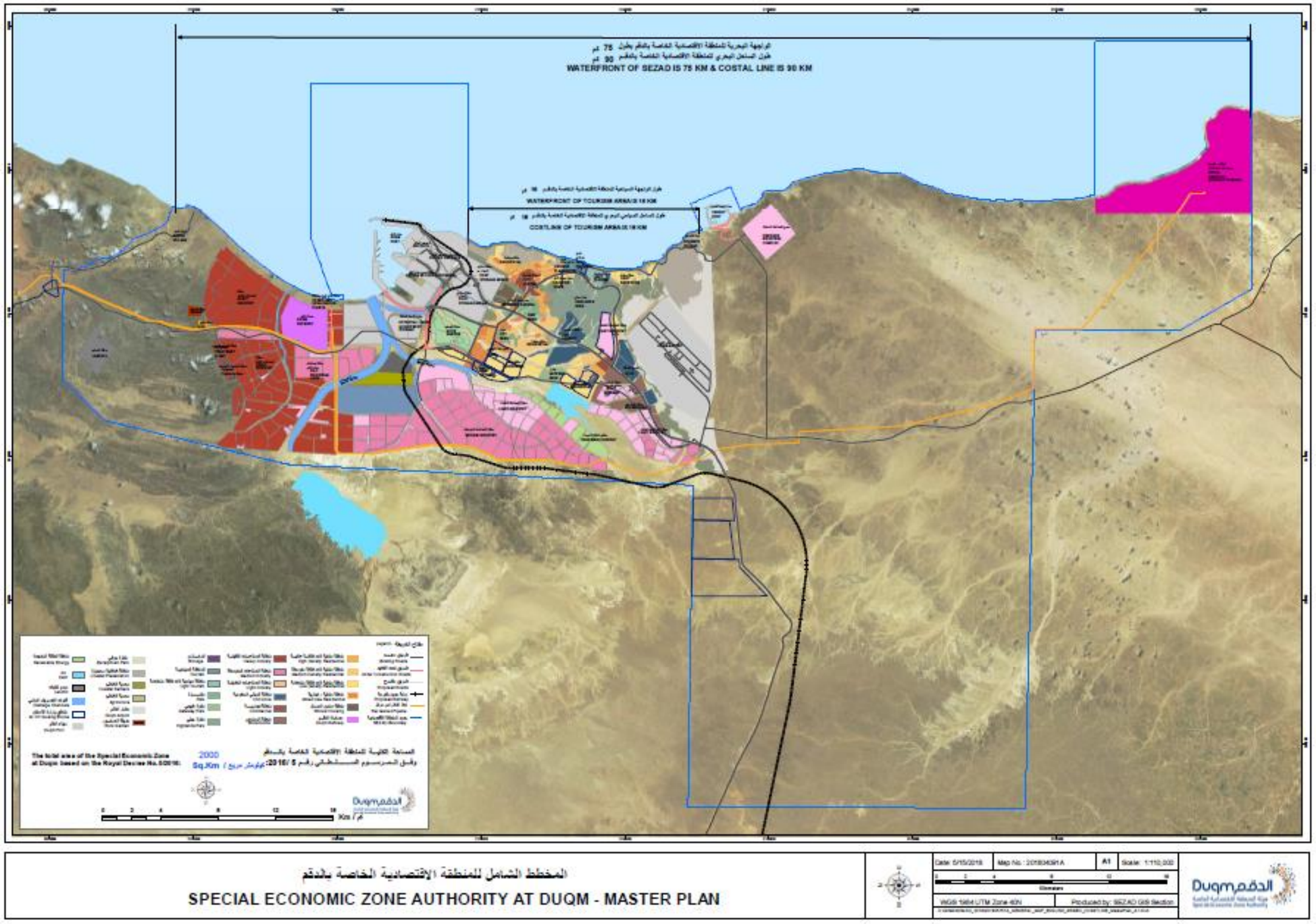

Figure 1-1: SEZD Area

2 APPLICABLE LAWS, REGULATIONS AND STANDARDS

In accordance with RD 79/2013, the Special Economic Zone Authority at Duqm (SEZAD) has the functions of the Ministry of Environment and Climate Affairs (MECA) in relation to issuing environmental permits for projects and implementing environmental regulations within the SEZ. Environmental compliance within the SEZ is governed by the SEZAD Environmental Regulatory Department. At all times local requirements will override international requirements. The international standards are to be complied with, only in the absence of local standards.

*** It shall be noted that within SEZ, SEZAD will have the authority of concerned Ministries mentioned in the below national regulations.**

2.1 National Regulations

Environmental legislation in Oman is present within a series of Royal Decrees (RDs) and Ministerial Decisions (MDs). Those applicable RD and MDs pertaining to marine environment includes the following:

- RD 34/1974 – Law of Marine Pollution Control
- RD 23/1978 – Signing of the Kuwait Regional Convention on the Protection of the Marine Environment from Pollution and its Protocol
- RD 8/1979 – Ratification of the Kuwait Regional Convention on the protection of the Marine Environment and Protocol for Regional Cooperation in Combating pollution caused by Oil and other harmful substances
- RD 53/1981 – Law on Sea Fishing and the Protection of Marine Biological Wealth
- MD 20/1990 - Rules and Regulation and Specifying Coastal Setbacks
- RD 90/1991 - Marine Pollution from Land Sources (ROPME)
- MD 200/2000 – Regulations for Crushers, Quarries, and Transport of Sand from Coasts, Beaches and Wadis
- RD 114/2001 - Law on Conservation of the Environment and Prevention of Pollution
- MD 159/2005 - Regulations on Liquid Waste in Maritime Environment
- RD 44/2014 and RD 5/2016 - Onshore and offshore boundaries of the Special Economic Zone in Duqm

The applicable restrictions implemented by some of these laws and regulations are discussed in more details below.

2.1.1 Royal Decree 34/74 – Law on Marine Pollution Control

The Law on Marine Pollution Control brought to light Oman's early concern for the safety of its marine environment. This law prohibits the discharge or release of any pollutant from a ship, shore location or oil transport facility in the Pollution Free Zone of Oman. This zone is the belt of water around Oman's territorial waters, which

stretched for a distance of 38 miles. Any person violating the provisions of this law is subject to a penalty. Terms such as "operator", "oil transport facility", "pollutant", "pollution control officer", etc, are all defined in this law.

2.1.2 Royal Decree 23/1978 – Signing of the Kuwait Regional Convention on the Protection of the Marine Environment from Pollution and its Protocol

Oman is a member state of the Regional Organization for the Protection of the Marine Environment (ROPME) and signatory to the Kuwait Regional Convention. This Convention consists of thirty Articles broadly dealing with responsibilities of the Contracting States for the protection and preservation of the marine environment which is under constant threat of pollution from offshore and land-based activities as well as marine transport. The Convention was adopted with the objective to ensure that development projects and other human activities do not in any way cause damage to the marine environment, jeopardize its living resources or create hazards to human health.

With a view of strengthening governance in the region ROPME has developed protocols addressing the critical areas of environmental management. This Convention has related protocols that were developed in accordance with the recommendations of the Legal Component of the Kuwait Action Plan. These protocols include:

- Protocol concerning Regional Cooperation in Combating Pollution by Oil and Other Harmful Substances in Cases of Emergency (1978)
- Protocol concerning Marine Pollution resulting from Exploration and Exploitation of the Continental Shelf (1989)
- Protocol for the Protection of the Marine Environment against Pollution from Land-Based Sources (1990)
- Protocol on the Control of Marine Trans-Boundary Movements and Disposal of Hazardous Wastes and Other Wastes (1998)
- Protocol concerning the Conservation of Biological Diversity and the Establishment of Protected Areas.

2.1.3 Royal Decree 8/1979 – Law Sanctioning the Kuwait Regional Convention on Protection of Marine Environment from Pollution

The Kuwait Regional convention is a comprehensive umbrella agreement for protection of the marine environment. It identifies the sources of pollution, which require control, such as pollution from ships, dumping, land- based sources, exploration and exploitation of the seabed, and pollution from other human activities. It also identifies environmental management issues for which co-operative efforts are to be made, such as combating pollution in cases of emergency, EIA and scientific and technological cooperation. There are also provisions dealing with technical

assistance, and liability and compensation in case of pollution of the Sea Area.

2.1.4 Royal Decree 53/1981 - Law of Sea Fishing and the Preservation of Marine Biological Wealth

The above law regulates fishing. The Royal Decree is followed by MD 3/82, which includes executive regulations for law of marine fishing and conservation of aquatic resources. All capture of turtles is prohibited during the nesting season, as determined by the appropriate authority. Law protects specific areas and collection of eggs within them is prohibited within a distance of the coast to be determined by the Ministry. Hunting of turtles on their way to lay egg eggs on the islands and coasts is prohibited during periods, which are determined by the Ministry.

2.1.5 Ministerial Decision 20/1990 - Rules and Regulation and Specifying Coastal Setbacks

MD 20/1990 (Rules Regulation and Specifying Coastal Setbacks) defines mandatory coastal setbacks which limit development within the open coastal zone (defined as the shore area extending one km from the high tide point towards the mainland within which no settlements exist) of the sultanate. Setbacks are to be measured from the maximum end of the high water tidemark. Specific setbacks are delineated for the following scenarios:

- For coastal areas characterized by scenic views including high cliffs and rocky peaks, no projects shall be allowed within a 300m coastal setback.
- For sandy beaches and khwars (tidal lagoons), no projects shall be allowed within a 150m coastal setback.
- For beaches where construction developments have limited impact on the environment, projects shall be required to abide to a minimum coastal setback of 50m.

2.1.6 Royal Decree 90/1991 – Marine Pollution from Land Sources (ROPME)

RD 90/91 ratifies the Sultanate of Oman joining the Regional Organization for the Protection of the Marine Environment (ROPME). The aim of ROPME is to coordinate the Member States efforts towards protection of the water quality in the ROPME Sea Area and protect the environment systems as well as marine living and to abate the pollution caused by the development activities of the Member States. In addition, ROPME requested the Member States to exert their maximum efforts to protect the marine environment and prevent the reasons of pollution. The ROPME Sea Area is the area surrounded by the eight Member States of ROPME: Bahrain, I.R. Iran, Iraq, Kuwait, Oman, Qatar, Saudi Arabia and the United Arab Emirates. ROPME has developed protocols addressing the critical areas of environmental management:

- Protocol concerning Regional Cooperation in Combating Pollution by Oil and Other Harmful Substances in Cases of Emergency (1978);
- Protocol concerning Marine Pollution resulting from Exploration and Exploitation of the Continental Shelf (1989);
- Protocol for the Protection of the Marine Environment against Pollution from Land-Based Sources (1990);
- Protocol on the Control of Marine Trans-boundary Movements and Disposal of Hazardous Wastes and Other Wastes (1998); and
- Protocol concerning the conservation of biological diversity and the establishment of protected areas.

2.1.7 Ministerial Decision 200/2000 – Regulations for Crushers, Quarries, and Transport of Sand from Coasts, Beaches and Wadis

MD 200/2000 (Regulations for Crushers, Quarries, and Transport of Sand from Coasts, Beaches and Wadis) includes regulations regarding the areas from which sand and other geologic material can be sourced. Article 10 of MD 200/2000 has relevance to wadi works. The applicable articles provide information on prohibiting excavation of wadi areas, change to wadi courses and specify that permits are required when undertaking works within wadis. MD 200/2000 states that it is not permitted to make any excavations or remove sand from coasts, beaches or wadis other than specified places. Furthermore, for permitted excavation/sand transport from coasts, beaches and wadis, excavated areas should be re-profiled at the expiry of the excavation permit.

2.1.8 Royal Decree 114/2001 - Law on Conservation of the Environment and Prevention of Pollution

Royal Decree RD 114/2001 (Law on Conservation of the Environment and Prevention of Pollution) outlines regulatory requirements concerning protection of the environment, and includes applicable penalties for offenders.

The articles of RD 114/2001 provide guidance on allowable discharge into the marine environment, and no waste or any other substance of whatever kind, form or state shall be dumped into the marine environment without obtaining appropriate permits.

Furthermore, specific types of mammals and bird species have been afforded protection within the sultanate of Oman via RD 114/2001. The organisms listed in Appendix 1 and Appendix 2 of the RD are given protection from poaching and/or killing and are listed below in Table 2-1 and Table 2-2 respectively. The organisms listed in Appendix 1 are given the highest level of protection, while those in Appendix 2 of the RD are also considered important to protect. Marine and marine-associated animals have been highlighted in red in both tables.

Table 2-1- Appendix 1 of RD 114/2001

S. No.	Scientific Name	Common Name
1	*Oryx leucoryx*	Arabian Oryx

S. No.	Scientific Name	Common Name
2	*Panthera pardus nimr*	Arabian Leopard
3	*Hemitragus jayakari*	Arabian Tahr
4	*Gazella cora*	Arabian Gazelle (Idmi)
5	*Gazella subgutturosa marica*	Sand Gazelle (Reem)
6	*Capra ibex nubiana*	Nubian Ibex
7	*Felis caracal*	Caracal Lynx
8	*Hyena*	Striped Hyena
9	*Felisi sylvestris*	Wild Cat
10	*Canis lupes*	Arabian Wolf
11	*Mellivora capensis*	Honey Badger
12	*Felisi margarita*	Sand Cat
13	*Vulpes reuppelli*	Rueppell's Sand Fox
14	*Lepus capensis*	Cape Hare
15	*Eretmochlys imbricatta*	Hawksbill Turtle
16	*Chalmydotis undulate*	Houbara Bustard

Table 2-2 - Appendix 2 of RD 114/2001

S. No.	Scientific Name	Common Name
1	*Vulpes*	Red Fox
2	*Chelonia mydas*	Green Turtle
3	*Caretta*	Loggerhead Turtle
4	*Lepidochlys olivacea*	Olive Ridley Turtle
5	All falcons, owl, vulture, eagle, flamingo, pelican, gull and tern species	
6	All mammal species not mentioned in Appendix 1, except tamed/domesticated animals	

2.1.9 Ministerial Decision 159/2005 – Regulations on Liquid Waste in Maritime Environment

MD 159/05 in conjunction with RD 114/2001 sets out regulations for discharge of liquid waste into the marine environment. Liquid Waste is defined as any liquid containing environmental pollutants which are discharged into the maritime environment from land or sea sources. MD 159/05 also states:

- No discharge of any liquid waste in the maritime environment shall be allowed, either directly or indirectly, prior to obtaining a license.
- The license applicant should undertake to reuse or recycle the liquid waste or eliminate or reduce the dangerous components of such waste through the use of environmentally friendly technology.
- A detailed description of the liquid to be disposed of shall be an essential prerequisite for consideration of granting the license.
- The end of the discharge pipe should be at a depth of no less than 1m under the minimum tidal height.
- The temperature of liquid waste, at the discharge point, shall not exceed 10°C above the temperature of the sea water surrounding the water discharge point
- The end of the discharge pipe should not impact corals, algae or seagrasses

- An area with a radius of 300m is permitted for primary dilution. Outside of this zone, the following perturbations will be permitted:
    - Temp: 1°C allowable perturbation for an averaging period of 1 week;
    - Dissolved Oxygen: 2% allowable perturbation for an averaging period of 1 week; and
    - Salinity: 10% allowable perturbation for an averaging period of 1 day.

Annex No. 1 of MD 159/05 presents the maximum discharge limits for liquid effluents into the marine environment, which are captured in Table 2-3.

Table 2-3 - Maximum Discharge Limits for Liquid Effluents into the Marine Environment as per MD 159/2005

PARAMETER	Maximum Allowable Limits (mg/L except where otherwise stated)
Temperature	Not exceeding 10 degrees Celsius of receiving seawater temperature.
Biochemical oxygen demand (BOD) (5d@ 20 degrees centigrade)	20.0
Chemical oxygen demand (COD)	200.0
Total Suspended Solids	30.0
Aluminium	5.0
Arsenic	0.100
Barium	2.0
Beryllium	0.300
Boron	1.0
Cadmium	0.010
Chromium	0.050
Cobalt	0.050
Copper	0.200
Cyanide	0.100
Fluoride	2.0
Iron	1.5
Lead	0.08
Lithium	0.070
Mercury	0.001
Molybdenum	0.05
Nickel	0.100
Nitrogen: Ammonia cal	1.0
Nitrogen: Nitrate	15.0
Nitrogen: Organic (Kjeldahl)	5.0
Total – Nitrogen	15.0
Oil & Grease	10.0
Phenols (total)	0.002
Phosphorus	2.0
Selenium	0.020
Silver	0.010
Sophie	0.100
Total chlorine	0.4
Vanadium	0.100
Zinc	1.0
Faecal Coliform Bacteria (per litre)	1,000

PARAMETER	Maximum Allowable Limits (mg/L except where otherwise stated)
Viable Nematode Ova (per litre)	< 1
Organo halogens	< 0.001
Pesticides or their by – products	< 0.001
Organosilicon compounds Organocopper compounds	< 0.001
Organotin compounds	0.00002

2.1.10 RD 44/2014 and RD 5/2016 - Onshore and offshore boundaries of the Special Economic Zone in Duqm

In accordance with RD 44/2014 and RD 5.2016, SEZAD has jurisdiction within the onshore and offshore boundaries of the Special Economic Zone (SEZ). However, any project application that requires the use of offshore facilities outside of the SEZ boundaries will need to obtain a permit from MECA.

2.2 International Standards

2.2.1 Sediment quality

In the absence of Omani guidelines for marine sediment quality, international standards have been sourced in order to formulate a best-practice approach to maintaining marine sediment quality within the SEZ area.

Marine sediment quality standards, intended to be utilized for comparison against marine sediment samples, have been adopted as per the UK Interim Sediment Quality Guidelines (see Table 2-4), which also mirror USA and Canadian guidelines.

Table 2-4 - Interim marine sediment quality guidelines (ISQGs) and probable effect levels (PELs; dry weight)

Substance	ISQG	PEL
Inorganic ($mgkg^{-1}$)		
Arsenic	7.24	41.6
Cadmium	0.7	4.2
Chromium	52.3	160
Copper	18.7	108
Lead	30.2	112
Mercury	0.13	0.70
Zinc	124	271
Organic (μgkg^{-1})		
Acenaphthene	6.71	88.9
Acenaphthylene	5.87	128
Anthracene	46.9	245
Aroclor 1254	63.3	709
Benz(a)anthracene	74.8	693
Benzo(a)pyrene	88.8	763
Chlordane	2.26	4.79
Chrysene	108	846
DDD[2]	1.22	7.81
DDE[2]	2.07	374

Substance	ISQG	PEL
DDT[2]	1.19	4.77
Dibenz(a,h)anthracene	6.22	135
Dieldrin	0.71	4.30
Endrin	2.673	62.4[4]
Fluoranthene	113	1 494
Fluorene	21.2	144
Heptachlor epoxide	0.60[3]	2.74[4]
Lindane	0.32	0.99
2-Methylnaphthalene	20.2	201
Naphthalene	34.6	391
PCBs, Total	21.5	189
Phenanthrene	86.7	544
Pyrene	153	1 398
Toxaphene	1.5[3]	C[5]

[1] ISQGs and PELs presented here have been calculated using a modification of the NSTP approach.
[2] Sum of *p,p´* and *o,p´* isomers.
[3] Provisional; adoption of freshwater ISQG.
[4] Provisional; adoption of freshwater PEL.
[5] No PEL derived.
<http://www.ukmarinesac.org.uk/activities/water-quality/wq4_3_2.htm>
<https://www.pla.co.uk/Environment/Canadian-Sediment-Quality-Guidelines-for-the-Protection-of-Aquatic-Life>

2.2.2 Marine Water Quality

In the absence of Omani guidelines for ambient marine water quality, international standards have been sourced in order to formulate a best-practice approach to maintaining marine water quality within the SEZ area.

Ambient marine water quality standards, intended to be utilized for comparison against marine water samples, have been adopted as per the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ARMCANZ/ANZECC, 2000) (see Table 2-5).

Table 2-5 - Marine Water Quality Guidelines for Parameters at Alternative Levels of Protection (ARMCANZ/ANZECC, 2000)

Chemical	Trigger Values for Marine Water (µg/L) Level of Protection (% Species)			
	99%	95%	90%	80%
Metals and Metalloids				
Cadmium[F]	0.7[B]	5.5[B,C]	14[B,C]	36[B,A]
Chromium (Cr III)[F]	7.7	27.4	48.6	90.6
Chromium (Cr VI)	0.14	4.4	20[C]	85[C]
Cobalt	0.005	1	14	150[C]
Copper[F]	0.3	1.3	3[C]	8[A]
Lead[F]	2.2	4.4	6.6[C]	12[C]
Mercury	0.1	0.4[C]	0.7[C]	1.4[C]
Nickel[F]	7	70[C]	200[A]	560[A]
Silver	0.8	1.4	1.8	2.6[C]
Tributyltin (as µg/L Sn)	0.0004	0.006[C]	0.02[C]	0.05[C]

Chemical	Trigger Values for Marine Water (µg/L) Level of Protection (% Species)			
	99%	95%	90%	80%
Vanadium	50	100	160	280
Zinc[F]	7	15[C]	23[C]	43[C]
Non-Metallic Inorganics				
Ammonia[D]	500	910	1200	1700
Cyanide[E]	2	4	7	14
1,1,2-trichloroethane	140	1900	5800[C]	18000[C]
Anilines				
3,4-dichloroaniline	85	150	190	260
Aromatic Hydrocarbons				
Benzene	500[C]	700[C]	900[C]	1300[C]
Polycyclic Aromatic Hydrocarbons				
Naphthalene	50[C]	70[C]	90[C]	120[C]
Chlorobenzenes and Chloronaphthalenes				
1,2,4-trichlorobenzene[B]	20	80	140	240
Phenols and Xylenols				
Phenol	270	400	520	720
Pentachlorophenol[T,B]	11	22	33	55[A]
Industrial Chemicals				
Poly(acrylonitrile-co-butadiene-co-styrene)	200	250	280	340
Organochlorine Pesticides				
Endosulfan	0.005	0.01	0.02	0.05[A]
Endrin	0.004	0.008	0.01	0.02
Organophosphorus Pesticides				
Chlorpyrifos	0.0005	0.009	0.04[A]	0.3[A]
Temephos	0.0004	0.05	0.4	3.6[A]
Oil Spill Dispersants				
Corexit 9527	230	1100	2200	4400[A]

[A] Figure may not protect key test species from acute toxicity (and chronic). 'A' indicates that trigger value > acute toxicity figure; note that trigger value should be <1/3 of acute figure.

[B] Chemicals for which possible bioaccumulation and secondary poisoning effects should be considered.

[C] Figure may not protect key test species from chronic toxicity (this refers to experimental chronic figures or geometric mean for species).

[D] Ammonia as TOTAL ammonia as (NH_3-N) at pH 8.

[E] Cyanide as un-ionised HCN, measured as (CN).

[F] Chemicals for which algorithms have been provided to account for the effects of hardness. The values have been calculated using a hardness of 30 mg/L $CaCO_3$. These should be adjusted to the site-specific hardness.

[T] Tainting of flavour impairment of fish flesh may possibly occur at concentrations below the trigger value.

3 ENVIRONMENTAL PERMITTING REQUIREMENTS

3.1 Environmental Regulatory Procedure

The environmental permitting requirements within SEZ are governed by SEZAD Environmental Regulatory Department. A summary of the permitting procedure is outlined below:

1. In accordance with SEZAD Decision 326/2015, the SEZAD Environmental Regulatory Department have developed a list of projects within the SEZ that require an Environmental Impact Assessment (EIA).
2. MECA regulation promulgated under MD 48/2017, issued in May 2017, has categorised the projects into three types and has listed the projects, which require EIA study. MD 48/2017 shall also be taken into consideration during the permitting requirement.
3. For projects requiring an EIA study, the development shall undergo the following:
    - Scoping study, identifying the topics and methodology, that need to be included in the EIA. Reviewing of scoping report takes up to 15 days.
    - On approval of scoping study, an EIA study is conducted and submitted to SEZAD. The reviewing of an EIA report shall take 40 days as per SD 326/2015.
4. On approval of the EIA report, a permit application is submitted to SEZAD with required documents.
5. For projects, which do not require an EIA study, the development can directly go for permitting, with the required documents.
6. For projects not listed in SD 326/2015 and/or which falls in Category C of MD 48/2017, a screening exercise is conducted by SEZAD Environmental Regulatory Department, depending on the project application, and a screening opinion,[1] is provided.

3.2 Environmental Impact Assessment (EIA)

The EIA study shall be developed by a MECA registered environmental consultant[2]. SEZAD have the authority to reject environmental reports which are conducted by companies who are not registered with MECA to undertake these studies.

[1] SEZAD reserves the right to request EIA study for projects that are not listed in the regulations. This shall be decided during the screening stage of the project and depending on type of project and likely impacts

[2] A list of the MECA registered environmental consultants can be obtained from MECA.

EIA is a procedure undertaken for those projects with major/significant impacts to the environment. For an industrial project, the EIA generally would assist in determining site suitability as well as the necessary environmental control and mitigation measures.

The objectives of the EIA are summarized as follows:

- To examine and select the best from the project options available;
- To identify, predict and assess significant residual environmental impacts;
- To recommend and incorporate into the project plan, appropriate abatement and mitigating measures; and
- To identify the environmental costs and benefits of the project to the community.

For details on Environmental Impact Assessment, Refer SEZAD Environmental Impact Assessment Guideline.

3.3 Construction Environmental Management Plan (CEMP) / Operational Environmental Management Plan (OEMP) / Decommissioning Environmental Management Plan (DEMP)

A CEMP/OEMP/DEMP is a practical plan of management measures which are designed to minimise environmental impacts from the construction and operation phase of a project. The document will need to outline the below requirements (at a minimum):

- Site specific activities of the development.
- Address the associated environmental and heritage issues.
- Provide planned management strategies to avoid and minimise impacts.
- A CEMP/OEMP/DEMP will also provide a management plan for how wastes generated by the activities will be contained and cleaned-up appropriately.

Refer SEZAD Environmental Impact Assessment Guideline for details on CEMP/OEMP.

4 MONITORING AND ASSESSMENT METHODOLOGIES

To ensure compliance with Omani and international regulations on the protection of the marine environment, the marine environment shall be monitored for all Project phases. This chapter addresses the marine monitoring and assessment methodologies that shall be implemented by the project applicant.

4.1 Monitoring Methodologies

Monitoring methodologies are discussed for the pre-construction phase to develop the baseline marine water quality, sediment quality and marine ecology conditions, and for construction and operation phases to ensure compliance with marine protection criteria.

The suggested monitoring methodologies are considered common for all proposed industries in the SEZ, except for the parameters to be analysed during operation phase, which are industry-specific.

4.2 Baseline Monitoring

Prior to construction, it is typical to undertake baseline studies to understand the existing marine environment and to identify sensitive marine habitats.

Where possible, the Project applicant shall undertake baseline studies during the Environmental Impact Assessment (EIA) phase of the Project and shall include desktop investigations. The baseline studies shall include the following:

- Marine water quality monitoring
- Sediment quality monitoring
- Marine ecology survey including benthic survey where required
- Bathymetric survey
- Metocean survey

4.2.1 Monitoring Locations

The marine water, sediment and ecology monitoring locations shall be selected based on the Project applicant's proposed location of discharge to the marine environment or to project impact area. A targeted sampling approach shall be used that includes monitoring sites located on a concentration gradient from the point of discharge, within the dilution zone and outside the dilution zone. Additional locations based on sensitive marine habitats that may be impacted by the discharge shall also be considered.

4.2.2 Marine Ecology Survey

The monitoring effort for the marine ecological baseline would generally depend on the physical size of the potential impact site, diversity of the habitats, flora and fauna, seasonal variation of the target taxa groups within the area and availability of existing ecological baseline information. The Project applicant shall determine the

appropriate amount of sampling effort to ensure that the marine ecology baseline is representative to address both spatial and temporal variations. The sampling effort (e.g. number and frequency of sampling, locations and timing of surveys, etc.) and methods should be appropriately presented in the Project EIA report.

The survey methods used shall be scientifically robust and appropriate for the habitats and target taxa groups in the area. Standardized survey methods shall be applied wherever appropriate so that results can be compared with those arising from other studies. If the methods used vary from accepted methods in order to meet the specific needs of the baseline survey, the justifications and reliability of the results should be thoroughly presented in the EIA report. The surveys should also be carried out by personnel with adequate knowledge and field experience of the target taxa groups to be surveyed.

4.2.3 Collection of Samples

Sediment Quality Sampling

Sampling of the sediment is often undertaken from boats and, equipment such as grabs are commonly used. The choice and design of the grab contribute to its efficiency in collecting sediment samples at different excavated depths. The sediment samples shall be collected from the grab in dedicated bags/containers (material of container depends on the parameter to be analysed), labelled clearly (with the sampling location codes and the depths at which the samples were taken) and stored in cool boxes at a temperature of approximately 4˚C until delivered to the laboratory.

A submission sheet and chain of custody (CoC) form must accompany all samples submitted to the laboratory to ensure sample traceability.

Marine Water Sampling

Sampling of marine water shall include both in-situ monitoring and marine water samples. The in-situ monitoring shall include measurements of ambient water quality using a multi-parameter probe. The water sampling is typically conducted using Niskin water samplers which are activated at various depths. The water samples shall be collected in appropriate sample jars/bottles (material of container depends on the parameter to be analysed), labelled clearly (with the sampling location codes and the depths at which the samples were taken) and stored in cool boxes at a temperature of approximately 4˚C until delivered to the laboratory.

A submission sheet and chain of custody (CoC) form must accompany all samples submitted to the laboratory to ensure sample traceability.

4.2.4 Analysis of Parameters

The sediment parameters to be analysed are those listed in the UK Interim Sediment Quality Guidelines (Table 2-4). The water quality parameters shall include, but not be limited to, the following:

- Turbidity
- Salinity
- pH
- Temperature

- Dissolved oxygen
- Electrical Conductivity
- Chemical oxygen demand
- Biological oxygen demand
- Total suspended solids
- Nutrients
- Heavy metals
- Total petroleum hydrocarbons
- TBT
- Coliforms

Analysis shall be conducted by laboratories permitted or certified for this purpose and Quality Assurance/Quality Control (QA/QC) plans shall be prepared and implemented. QA/QC documentation shall be included in monitoring reports.

4.2.5 Water Quality Modelling

In accordance with Ministerial Decision No: 159/2005 *Promulgating the bylaws to discharge liquid waste in the marine environment,* the discharge should be characterised in the form of three-dimensional modelling covering one seasonal year and high and low tides cycles. The modelling shall be applied in the worst initial mitigation conditions, i.e. the lowest wind speed concurrent with the diminishing high and low tides, the lowest recorded current speed in the location and the tidal reflection in view of such conditions.

The Project applicant shall ensure the modelling includes the following data and information:

- Meteorology measurements: Wind speed and direction for at least one month during the south-western and north-eastern seasonal winds (winter and summer).
- Marine currents measurements: High and low tide currents and the currents resulting from wind action on the surface, the central and seabed waters covering an area of (1) km on either sides of the discharging point and for (1) km into the sea.
- Seabed topography: Depth contours covering an area of (1) km on either sides of the discharging point and for (1) km into the sea.
- Multi-port diffusers should be used at the pipe-end, provided they allow gradual dispersion and assist in preventing the liquid from reverting to the beach area.

4.3 Monitoring during Construction

The boundaries of the SEZ are offset by a minimum of 300m from the high water mark. In case of any developments having interaction with the marine environment, the project applicant shall include a project specific marine monitoring programme within the Construction Environmental Management Plan (CEMP). The marine monitoring programme shall include the monitoring locations, sampling depths and frequency of monitoring during the construction phase.

Monitoring frequency will be reviewed and approved by SEZAD-Environmental Regulatory Department on a case by case basis. This information will be provided to the industry in the permits or other such official communication by SEZAD Environmental Regulatory Department.

4.4 Monitoring during Operation

If a Project applicant discharges to the marine environment during operations then marine water, sediment and marine ecology should be monitored. The purpose of the monitoring is to maintain adequate marine water quality standards and identify any impacts to sensitive marine receptors.

The Project applicant shall include a project specific marine monitoring programme within the Operational Environmental Management Plan (OEMP). The marine monitoring programme shall include the monitoring locations, sampling depths and frequency of monitoring during the operations phase.

Monitoring frequency will be reviewed and approved by SEZAD-Environmental Regulatory Department on a case by case basis. This information will be provided to the industry in the permits or other such official communication by SEZAD Environmental Regulatory Department.

4.4.1 Sampling Locations

Effluent sampling, sediment sampling and marine ecology locations shall be located at the final discharge point, within the dilution zone and outside of the dilution zone. Process discharges should not be diluted prior to or after treatment with the objective of meeting the marine discharge quality standards.

4.4.2 Marine Ecology and Collection of Marine Water and Sediment Samples

The methodology for conducting the marine ecology survey and collecting discharges and sediment samples is the same as that described in Sections 4.2.2 and 4.2.3.

4.4.3 Analysis of Parameters

Pollutants of concern differ between industries as certain discharge characteristics from the industrial processes should be considered. In reference to the World Meteorological Organization (World Meteorological Organisation, 2013), Table 4-1 lists the parameters for industrial sources of discharges common to the SEZ area.

Analysis shall be conducted by laboratories permitted or certified for this purpose and Quality Assurance/Quality Control (QA/QC) plans shall be prepared and implemented. QA/QC documentation should be included in monitoring reports.

Frequency of monitoring

Monitoring of industrial effluents to the common outfall channel during operations should consider time-dependent variations in discharges. In general, it is recommended that monitoring of industrial effluents takes place on a monthly basis or as determined by the SEZAD Environmental Regulatory Department on a case by case basis.

Additional marine water quality monitoring may be determined necessary with the upgrade of any major infrastructure components.

The marine ecology and sediment monitoring is typically conducted on a less frequent basis than water quality monitoring, depending seasonality and the pollutants of concern. The Project application shall include the monitoring frequency within the Project Operational Environmental Management Plan (OEMP).

Table 4-1: Parameters for Industrial Sources of Pollution Common to the SEZ Area

	Fish Processing Facilities	Vehicles (Machine Production)	Silica sand and Glass (Metallurgy)	Limestone and Cement	Petrochemicals (oil extraction/ refining)	Power Generation	Desalination
Temperature	x	x	x	x	x	x	x
Colour	x	x	x		x		x
Odour	x	x	x		x		
Residues	x	x	x		x		
Dissolved solids				x			x
Suspended solids	x	x	x	x	x	x	x
Conductivity	x	x	x	x	x	x	x
pH	x	x	x	x	x	x	x
Redox potential	x	x	x		x	x	x
DO	x	x	x		x	x	x
Hardness	x	x	x	x	x		x
Ammonia	x	x	x		x		x
Nitrate/nitrite	x		x				x
Organic nitrogen	x						x
Phosphorous compounds	x	x					x
TOC	x	x	x		x		x

	Fish Processing Facilities	Vehicles (Machine Production)	Silica sand and Glass (Metallurgy)	Limestone and Cement	Petrochemicals (oil extraction/ refining)	Power Generation	Desalination
COD	x	x	x		x		
BOD	x	x	x		x		
Sodium	x				x		x
Potassium	x			x	x		
Calcium	x	x	x		x		x
Magnesium	x		x		x		x
Carbonate components	x				x		
Chloride	x	x	x		x	x	x
Sulphate	x	x	x	x	x		x
Sulphide			x		x		
Silica		x			x		x
Fluoride			x				
Boron		x	x		x		
Cyanide		x	x				
Heavy metals		x	x		x	x	x
Arsenic			x			x	x
Selenium		x	x		x		

	Fish Processing Facilities	Vehicles (Machine Production)	Silica sand and Glass (Metallurgy)	Limestone and Cement	Petrochemicals (oil extraction/ refining)	Power Generation	Desalination
Fats	x	x					
Oils and hydrocarbons		x	x		x	x	x
Organic solvents		x					
Phenols	x		x		x		
Pesticides	x						
Other organics			x				
Surfactants	x	x	x		x		
Total Residue Chlorine						x	x
Barium							x

Source: World Meteorological Organization (2013) - Planning of Water Quality Monitoring Systems. Technical Report Series No. 3.; World Bank Environmental, Health, and Safety Guidelines for Thermal Power Plants (2008). California Water Resources Control Board - Management of Brine Discharges to Coastal Waters Recommendations of a Science Advisory Panel Technical Report 694 (2012).

4.5 Monitoring during Decommissioning

Normally, the methodology for monitoring the marine environment during construction is representative of the methodology adopted during decommissioning, as the equipment and procedures employed are similar. Thus, it is unlikely that decommissioning activities will cause a change in the impact on water quality from that experienced during the construction phase. As such no further details are needed for the decommissioning phase.

4.6 Assessment Methodology

This section discusses the preferred assessment methodology to be followed by the Project applicant when assessing the impacts on marine water and sediment quality during all the Project phases. The methodology is considered common for all proposed industries.

4.6.1 Identification of Exceedance

Prior to assessing the impacts on marine water and sediment quality, the results of the sample analysis conducted during monitoring shall be compared against the relevant standards to depict any exceedances in indicators.

All discharges to the common outfall channel shall comply with the Maximum Discharge Limits for Liquid Effluents into the Marine Environment as per MD 159/2005.

Sediment quality results shall be assessed against the UK Interim marine sediment quality guidelines (ISQGs) and probable effect levels.

Ambient marine water quality results shall be compared against the Australian and New Zealand Guidelines for Fresh and Marine Water Quality.

4.6.2 Impact Assessment

If exceedances are identified, the significance of the impact from each project activity shall be determined by comparing the value and sensitivity of the marine environment against the magnitude of impact of the resultant effect. The assessment follows a three-step process:

- Evaluating the value of the marine environment resource and sensitivity of the receptors;
- Assessing the magnitude of the impact of the proposed industry on the marine environment resource, be it adverse or beneficial; and
- Determining the significance of effect resulting from impact (of a certain magnitude) on the resource (of particular value)

Refer SEZAD EIA guideline for generic classifications for environmental value, magnitude of impact and significance of effect.

5 GENERAL POLLUTION PREVENTION GUIDANCE NOTES

This chapter gives an overview of the Pollution Prevention Guidance Notes (PPGN) commonly used during each Project phase and international Best Management Practices for the proposed industries in the SEZ area.

5.1 Construction and Decommissioning Pollution Prevention Guidelines

For any projects proposed within the coastal area and for projects which have marine components, the pollution prevention guidelines to protect the marine environment shall be included in a Marine Management Plan, as part of the Construction Environmental Management Plan (CEMP), which shall be developed and implemented by the construction contractor:

It should be noted that PPGN for the decommissioning phase shall require a Decommissioning Environmental Management Plan (DEMP) which shall include the same management plans as the construction phase. Therefore, this section can be considered applicable to the decommissioning phase.

5.2 Pollution Prevention Guidelines during Operation

During operation there is the potential for industrial discharges of effluent to the marine environment. This can potentially impact marine sensitive receptors if not properly managed and treated. Wastewater effluent generated from industrial operations includes wastewater from utility operations (cooling, demineralisation system, etc.). Since every industry uses different raw materials and processes the wastewater generated will be different in content and quantity and therefore the management approach will be different. Industry-specific best management practices (BMP) are discussed in Section 5.3.

5.3 Industry-Specific Best Management Practices

5.3.1 Petrochemicals

Water is used in large quantities in the petrochemical industry, from extraction activities through to refineries and petrochemicals. The water effluent often becomes contaminated with chemicals and by-products and its discharge could critically impact the water resources if not managed properly. This water results from injection, tank farms, product discharge, processing areas, pipe tracks, cooling water blowdown, flushing/cleaning water and accidental release of raw materials or finished products.

To avoid marine pollution caused by the discharge of liquid effluents, the following BMP are recommended, as a minimum:

- All materials to be used during operation shall be identified and their hazard potential evaluated

- Before any discharge, the liquid effluent shall be analysed to include, at a minimum a review of the critical pollutants described in Table 4.1.
- Effluent parameters shall comply with the relevant Omani standards.
- The liquid effluent shall be monitored and treated (neutralization, filtration, sedimentation, ion exchange, etc.) before discharge if it exceeds limits.
- The elevation of the temperature of the outlet shall comply with the SEZAD discharge permit requirements.
- pH level of effluent discharge shall be maintained between 6.0 and 9.0.
- Sewage shall only be discharged to the dedicated sewage treatment plant for treatment. There shall be no discharge of sewage (either treated or untreated) to the marine environment.

5.3.2 Limestone/Cement

Wastewater from limestone/cement industries is generated mainly from utility operations and the process staging areas. In "dry" process plants, the only effluent is cooling water which can be eliminated through the use of cooling towers or ponds. In the "wet" process, plants may leach collected kiln dust to remove soluble alkali, leading to clarifier overflow which requires neutralization before discharge. Wastewater from this industry has generally high pH, dissolved solids (potassium and sulphate) and suspended solids. Runoff and leaching from material storage and waste disposal areas can be a source of pollution to surface water and groundwater.

To avoid marine pollution caused by the discharge of liquid effluents, the following BMP are recommended, as a minimum:

- All materials to be used during operation shall be identified and their hazard potential evaluated.
- "Wet" process wastewater shall be recycled to kiln and "dry" wastewater effluent shall be recycled to cooling towers and ponds.
- Before any discharge, the liquid effluent shall be analysed to include, at a minimum a review of the critical pollutants described in Table 4.1.
- Effluent parameters shall comply with the relevant Omani standards.
- The liquid effluent shall be monitored and treated (neutralization, filtration, sedimentation, ion exchange, etc.) before discharge if it exceeds limits.
- Cooling water shall be recycled if feasible. If not feasible, the temperature of the discharge shall comply with the SEZAD discharge permit requirements.
- pH level of effluent discharge shall be maintained between 6.0 and 9.0.

- Slurry tank wash or spills shall not be discharged.
- Sewage shall only be discharged to the dedicated sewage treatment plant for treatment. There shall be no discharge of sewage (either treated or untreated) to the marine environment.

5.3.3 Silica sand/Glass, Metal Casting and Production

For glass manufacturing, wastewater will mainly consist of cleaning water, cooling water and surface water runoff. Amounts of liquid effluents discharged from the glass industry are marginal in comparison with other industrial sectors and are limited to particular processes. Discharges may be affected by glass solids, soluble glass-making materials (i.e. sodium sulphate), organic compounds (caused by lubricant oil used in the cutting process), and treatment chemicals (i.e. dissolved salts and water treatment chemicals) for the cooling-water system.

To avoid marine pollution caused by the discharge of liquid effluents, the following BMP are recommended, as a minimum:

- All materials to be used during operation shall be identified and their hazard potential evaluated.
- Before any discharge, the liquid effluent shall be analysed to include, at a minimum a review of the critical pollutants described in Table 4.1.
- Effluent parameters shall comply with the relevant Omani standards.
- The liquid effluent shall be monitored and treated (neutralization, filtration, sedimentation, ion exchange, etc.) before discharge if it exceeds limits.
- pH level of effluent discharge shall be maintained between 6.0 and 9.0.
- The liquid effluent shall be treated (oil water separators, screening, pH adjustment, filtration, sedimentation, etc.) before discharge if it exceeds the limits
- Sewage shall only be discharged to the dedicated sewage treatment plant for treatment. There shall be no discharge of sewage (either treated or untreated) to the marine environment.

In terms of the metal casting and production industry, considerable quantities of wastewater are generated in the course of making iron and steel. This wastewater contains ammonia and other components (phenols, cyanide, thiocyanate, ammonia, sulphide and chloride) released in the coking process.

- To avoid marine pollution caused by the discharge of liquid effluents, the following BMP are recommended, as a minimum:
- All materials to be used during operation shall be identified and their hazard potential evaluated.

- Before any discharge, the liquid effluent shall be analysed to include, at a minimum a review of the critical pollutants described in Table 4.1.
- Effluent parameters shall comply with the relevant Omani standards.
- The liquid effluent shall be monitored and treated (neutralization, filtration, sedimentation, ion exchange, etc.) before discharge if it exceeds limits.
- Cooling water shall be recycled if feasible. If not feasible, the temperature of the discharge shall comply with the SEZAD discharge permit requirements.
- pH level of effluent discharge shall be maintained between 6.0 and 9.0.
- Coagulation and settling facilities shall be required for used water due to the high solids content.
- Production shall be planned to minimise number of processing steps and eliminate unnecessary procedures.
- Where possible, raw material or toxic product products shall be replaced with other materials that produce less waste.
- Good flow management shall be practiced through using cascade blowdowns from compatible non-contact cooling water and water recycle systems
- Sewage shall only be discharged to the dedicated sewage treatment plant for treatment. There shall be no discharge of sewage (either treated or untreated) to the marine environment.

5.3.4 Fishery industries

The process used in the fish industry includes harvesting of the fish, storing, receiving, eviscerating, pre-cooking, cleaning, preserving and packaging.

Due to the different processes, this industry generates large volumes of wastewater mainly from leaks, spills, and equipment washouts. The wastewater generally contains BOD, COD, TSS, oil and grease and may be high or low in pH. Occasionally wastewaters containing high concentrations of sodium chloride may be discharged.

To avoid marine pollution caused by the discharge of liquid effluents, the following BMP are recommended, as a minimum:

- All materials to be used during operation shall be identified and their hazard potential evaluated.
- Before any discharge, the liquid effluent shall be analysed to include, at a minimum a review of critical pollutants (depending on the process), pH, TSS, BOD, oil and grease, faecal coliform and ammonia.
- Effluent parameters shall comply with the relevant Omani standards.

- Corrective actions or applicable treatment techniques shall be employed to the wastewater depending on the quality before discharging.
- pH level of effluent discharge shall be maintained between 6.0 and 9.0.
- Wastewater shall be discharged into a septic tank annexed to a holding tank.
- Sewage shall only be discharged to the dedicated sewage treatment plant for treatment. There shall be no discharge of sewage (either treated or untreated) to the marine environment.

5.3.5 Automotive Industry

The automotive industry is a major consumer of water for various production processes. Major water uses in the automotive manufacturing industry includes surface treatment and coating, paint spray booths, washing, rinsing, hosing, cooling, air-conditioning systems and boilers.

To avoid marine pollution caused by the discharge of liquid effluents, the following BMPs are recommended, as a minimum:

- All materials to be used during operation shall be identified and their hazard potential evaluated.
- Before any discharge, the liquid effluent shall be analysed to include, at a minimum a review of the critical pollutants described in Table 4.1.
- Effluent parameters shall comply with the relevant Omani standards.
- The liquid effluent shall be monitored and treated (neutralization, filtration, sedimentation, ion exchange, etc.) before discharge if it exceeds limits.
- Water shall be reused, treated and recycled, wherever possible.
- Sewage shall only be discharged to the dedicated sewage treatment plant for treatment. There shall be no discharge of sewage (either treated or untreated) to the marine environment.

5.3.6 Power Generation Industry

Power generation facilities can be either large utility plants or industrial combustion plants, providing power (e.g. in the form of electricity or mechanical power), steam, or heat to industrial production processes and are operated according to energy demand and requirement. The facilities can be operated either on a continuous basis to provide a base power load or intermittently to provide power during periods of peak demand.

The wastewater streams in a thermal power plant include cooling tower blowdown; ash handling wastewater; wet flue-gas

desulphurization (FGD) system discharges; material storage runoff; metal cleaning wastewater; and low-volume wastewater, such as air heater and precipitator wash water, boiler blowdown, boiler chemical cleaning waste, floor and yard drains and sumps, laboratory wastes, and backflush from ion exchange boiler water purification units. The characteristics of the wastewaters generated depend on the ways in which the water has been used. Contamination arises from demineralizers; lubricating and auxiliary fuel oils; trace contaminants in the fuel (introduced through the ash-handling wastewater and wet FGD system discharges); and chlorine, biocides, and other chemicals used to manage the quality of water in cooling systems. Cooling tower blowdown tends to be very high in total dissolved solids but is generally classified as non-contact cooling water and, as such, is typically subject to limits for pH, residual chlorine, and toxic chemicals that may be present in cooling tower additives (including corrosion inhibiting chemicals containing chromium and zinc).

To reduce marine pollution caused by the discharge of liquid effluents, the following BMPs are recommended, as a minimum:

- In coal-fired power plants without FGD systems, treatment of process wastewater in conventional physical-chemical treatment systems for pH adjustment and removal of total suspended solids (TSS), and oil / grease (these treatment systems can also be used to remove most heavy metals to part-per-billion (ppb) levels by chemical precipitation as either metal hydroxide or metal organosulfide compounds).
- Collection of fly ash in dry form and bottom ash in drag chain conveyor systems in new coal-fired power plants.
- Use of infiltration and runoff control measures such as compacted soils, protective liners, drainage and sedimentation controls or waste water treatment plant for runoff from coal piles.
- Spraying of coal piles with anionic detergents to inhibit bacterial growth and minimize acidity of leachate.
- Treatment of low-volume wastewater streams that are typically collected in the boiler and turbine room sumps in conventional oil-water separators before discharge.
- Treatment of acidic low-volume wastewater streams, such as those associated with the regeneration of makeup demineralizer and deep-bed condensate polishing systems, by chemical neutralization in-situ before discharge.
- Pre-treatment of cooling tower makeup water, installation of automated bleed/feed controllers, and use of inert construction materials to reduce chemical treatment requirements for cooling towers.
- Use of waste water treatment plant to treat waste water from the wet FGD system to remove heavy metals and to decrease the amount of solid matter. The treatment plant

should also incorporate adjustment of the pH level, precipitation of heavy metals and removal of solid matter.

- Treatment of decanted water from oil storage tanks, storm water from bunded areas and liquid effluents generated during periodic tank cleaning should be drained to a water treatment plant, or directed to an appropriate disposal facility. Water contaminated with oil should pass through oil removal facilities such as partition chambers or plate separators.
- Elimination of metals such as chromium and zinc from chemical additives used to control scaling and corrosion in cooling towers.
- Use the minimum required quantities of chlorinated biocides in place of brominated biocides or alternatively apply intermittent shock dosing of chlorine as opposed to continuous low level feed.
- Consideration should be given to the use of filtration/osmosis or other techniques which allow effluent water to be cleaned for release or, preferably, for return to the process.

5.3.7 Desalination Industry

The main discharge generated by a desalination plant is referred to as concentrate or brine. Seawater desalination plants usually produce brine which is approximately 1.5 to 2 times higher than the salinity of the ambient seawater. In addition to brine, a desalination plant discharge may also include other treatment process side-streams, such as spent pre-treatment filter backwash water, membrane rinsing water, and treated membrane cleaning water.

The desalination brine consists of dissolved compounds (minerals, organics, and metals). Backwash water is generated during the periodic cleaning of the pre-treatment filters and contains particulates and other compounds removed from source water prior to desalination.

Acids and scale inhibitors are often added to the desalination plant source water to facilitate the salt separation process. In addition, pre-treatment often includes introducing chemical additives, such as coagulants and chlorine, to the source seawater. If the desalination plant pre-treatment side-streams are discharged along with the concentrate, the blend may contain elevated turbidity, total suspended solids and biochemical oxygen demand.

The following recommended measures shall be undertaken to reduce pollutants entering the marine environment from desalination plants:

- Consideration of co-allocation with power plants. The power plant thermal discharge is lighter than the ambient ocean water because of its elevated temperature. Consequently, the discharge tends to float on the ocean surface. The heavier saline discharge from the desalination plant draws the lighter cooling water downward and thereby engages the

entire depth of the ocean water column into the heat and salinity dissipation process and accelerates its mixing and blending into the ambient seawater.

- Blending brine discharge with secondary treated effluent from a wastewater treatment plant (WWTP) can be practiced to mitigate the impact of the high total dissolved solids (TDS) (or other solute) concentrate using the blending capacity of a lower-TDS stream.
- Consideration of the use of brine volume reduction processes such as Electro Dialysis Reversal (EDR), Vibratory Shear-Enhanced Processing (VSEP), and Enhanced Membrane System (EMS).
- Consideration of the use of processes capable of reducing the brine discharge to Zero Liquid Discharge (ZLD). These processes include mechanical evaporation, solar evaporation (evaporation ponds), and constructed wetlands.

5.3.8 Infrastructure (Port, Harbour and Terminals, Airport, Gas Distribution Network)

Infrastructure project that are likely to have impact on marine environment is ports, harbour and terminals. The water pollution source from infrastructure project varies depending on the type of project as well as operational activities.

Port Harbour and Terminals

Construction activities (such as dredging, reclamation), and operational activities (such as maintenance dredging, ship maintenance, and ship effluent disposal) can result in increased turbidity via suspension of sediment in the water column. In addition, the introduction of pollutants can have adverse impacts on aquatic flora and fauna (including benthic communities), and excessive nutrient loading leading to eutrophication, oxygen depletion, and toxic algal blooms.

Dredging/reclamation activities and disposal/borrow of material may lead to impacts on water quality from increased turbidity and from release of contaminants to the water column due to re-suspension of sediments and/or changes of certain chemical compounds in the dredged materials when exposed to different level of oxygenation. In addition, marine disposal of dredged material may result in the smothering of benthic habitats, reduced light penetration impacting light sensitive organisms, and impacts on sensitive organisms.

To avoid water pollution during dredging activities in the port/harbour or terminals, the following BMPs are recommended, as a minimum:

- A Dredging Management Plan should be prepared that is tailored to the project defining the dredging methodology, characterizing the chemical and physical composition and behaviour of the sediments to be dredged; modelling of

sensitive ecological receptors (sediment plume propagation modelling) etc;

- The timing of dredging activities should consider areas of high biodiversity value, seasonal factors such as migration periods (e.g., of marine mammals, fish, birds and turtles);
- Inspection and monitoring (such as feedback or adaptive monitoring) of dredging activities should be conducted regularly to evaluate the impact and effectiveness of mitigation measures.

The water effluents generated by ships typically include sewage, tank cleaning water, bilge water, ballast water etc. Water effluents are typically collected and transported using trucks or pipes within the port area.

Ports may collect and treat the wastewater using on-site wastewater treatment systems before discharging to surface water, or municipal sewage treatment plants. Port operators should provide collection, storage, and transfer and/or treatment services, and facilities of sufficient capacity and type for all wastewater generated by vessels at the port in accordance with MARPOL and national regulations, including the following -

- Oily waste and wastewater should be collected in barges, vehicles, or central collection systems and storage tanks (as per MARPOL provisions)
- Wastewater with noxious chemicals from bulk tank cleaning should be collected through appropriate on-site or off-site treatment prior to discharge. Incompatible substances should not be mixed in the collection system. Treatment methods should be established based on the effluent characteristics;
- Ports should provide ship operators with details on the pertaining ballast water management requirements, including the availability, location, and capacities of reception facilities, as well as with information on local areas and situations where ballast water uptake should be avoided;
- Sewage from ships should be collected and treated on-site or off-site, as applicable.

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