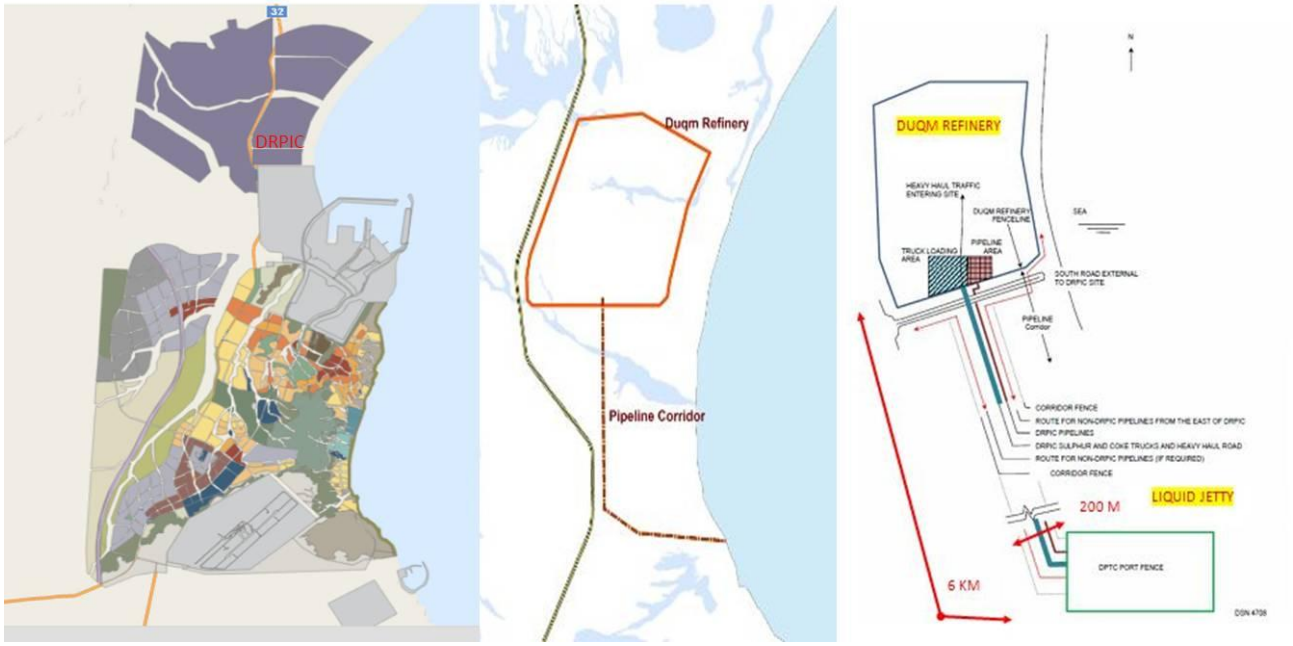
Client:
Special Economic Zone Authority Duqm

EIA for Service Corridor, Duqm

July 2015

Environmental Impact Assessment Report



HMR ENVIRONMENTAL ENGINEERING CONSULTANTS
P.O. Box: 1295, CPO Seeb, Postal Code: 111
Sultanate of Oman
Tel: (968) 21618800 ; Fax: (968) 24618811
Email: oman@hmrenv.com
www.hmrenv.com

EIA for Service Corridor, Duqm

July 2015

Environmental Impact Assessment Report

Project No: HMR #4054

Issue and Revision

Rev	Document No.	Description	Issue	Date	HMR				SEZAD
					Prepared	Checked	Approved		Approved
R0	4054 – EIA - 1	Draft EIA Report	Draft	13 May 2015	ZI	GR	RW	SM	A. Harmain K. Al Hinai
R1	4054 – EIA - 1	Final EIA Report incorporating SEZAD Environmental Department Review Comments	Final	26 July 2015	RW	GR	RW	GR	A. Harmain K. Al Hinai

Table of Contents

List of Figures

List of Tables

ABBREVIATIONS

ALARP	As Low As Reasonably Practicable
AAQMS	Ambient Air Quality Monitoring Station
BOD	Biological Oxygen Demand
AAQMS	Ambient Air Quality Monitoring Station
CAAQMS	Continuous Ambient Air Quality Monitoring Station
CEMP	Construction Environmental Management Plan
CH_4	Methane
CO	Carbon Monoxide
COD	Chemical Oxygen Demand
COPS	Central Oman Paleolithic Survey
CUC	Centralized Utilities Company
dB(A)	Decibels (A Rated)
DGCA	Directorate General of Climate Affairs
DGEA	Directorate General of Environmental Affairs
DO	Dissolved Oxygen
DRPIC	Duqm Refinery and Petroleum Industries Company
EIA	Environmental Impact Assessment
EHS	Environmental, Health and Safety
EMP	Environmental Management Plan
EMS	Environmental Management System
EPC	Engineering Procurement and Construction
ESIA	Environmental and Social Impact Assessment
FEED	Front End Engineering Design
FEP	Final Environmental Permit
GHG	Green House Gases
GRP	Glass Reinforced Pipe
H_2S	Hydrogen sulphide
HC	hydrocarbons
HDPE	High Density Polyethylene
HMR	HMR Environmental Engineering Consultants
IAM	Impact Assessment Matrix
IEP	Initial Environmental Permit

IPCC	Intergovernmental Panel on Climate Change
IPAS	Institute for Prehistory and Archaeological Science
ISLM	Integrated Sound Level Meter
ISO	International Standards Organization
IUCN	International Union for Conservation of Nature
km	kilometre
km^2	Square Kilometre
m	Metre
m^2	Square metres
m^3 / day	Cubic metres per day
m^3 / hr	Cubic metres per hour
m^3 / s	Cubic metres per second
mm	millimetres
mg/m^3	Milli grams per cubic metre
MD	Ministerial Decisions
MECA	Ministry of Environment and Climate Affairs
MoCI	Ministry of Commerce and Industry
MoNE	Ministry of National Economy
MRMWR	Ministry of Regional Municipalities and Water Resources
MSL	Mean Sea Level
MW	Megawatt
N	Nitrogen
NAAQS	US National Ambient Air Quality Standards
NE	North East
NIOSH	US National Institute of Occupational Health and Safety
NO_X	Oxides of Nitrogen
NTU	Nephelometric Turbidity Units
O_3	Ozone
OAAQS	Oman Ambient Air Quality Standards
ODS	Ozone Depleting Substance
OESHCO	Oman Environmental Services Holding Company
OS	Omani Standard
OSHA	Occupational Safety and Health Association
PDO	Petroleum Development Oman

PEP	Preliminary Environmental Permit
pH	pH units
PE	polyethylene
PM	Particulate Matter
PM_{10}	Particles smaller than 10 mm in aerodynamic diameter
PPE	Personal Protective Equipment
ppm	Parts Per Million
RD	Royal Decree
RO	Reverse Osmosis
ROP	Royal Oman Police
S	South
SEZAD	Special Economic Zone Authority Duqm
SCADA	Supervisory control and data acquisition system
SO_2	Sulphur dioxide
SS	Suspended Solids
STP	Sewage Treatment Plant
SW	South West
TDS	Total Dissolved Solids
TSS	Total Suspended Solids
USEPA	United States Environmental Protection Agency
UER	Umm Er Radhuma
VOC	Volatile organic compounds
WWTP	Wastewater Treatment Plant

1 INTRODUCTION

1.1 Overview

The Special Economic Zone Authority at Duqm (SEZAD), the Client, intends to provide a pipeline and utility service corridor within the Special Economic Zone at Duqm [referred to as the Duqm Service Corridor (DSC) or 'the Project'].

Duqm is located approximately 600 km south of Muscat on the Arabian Sea coast, with the SEZAD area incorporating a heavy industrial zone covering approximately 105 km^2. Oman Oil Company (OOC) and International Petroleum Investment Company (IPIC) are jointly planning a grassroots Crude Oil Refinery at Duqm, called Duqm Refinery & Petrochemical Industries Company (Duqm Refinery). Duqm Refinery will be supported by marine jetty facilities which will be operated by the Duqm Petroleum Terminal Company (DPTC). The facilities have to be suitable for importing Crude oil and exporting refined products. Import / Export will be via a dedicated Pipeline Corridor from the Refinery fence to the Marine Jetty Battery Limit. The location plan of the service corridor within Duqm is shown in Figure 1-1 below:

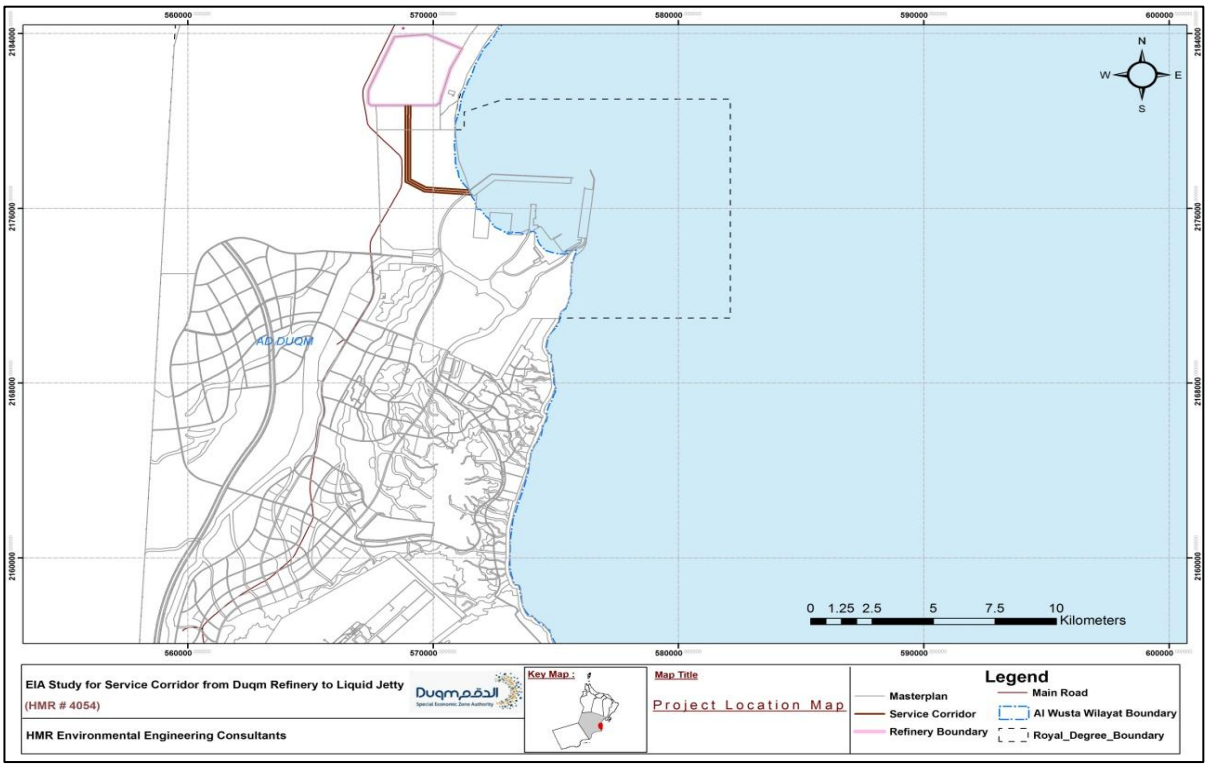


Figure 1-1: Duqm Service Corridor: Project Location Map

The location map of the service corridor with respect to Duqm Refinery and the DPTC is shown below in Figure 1-2.

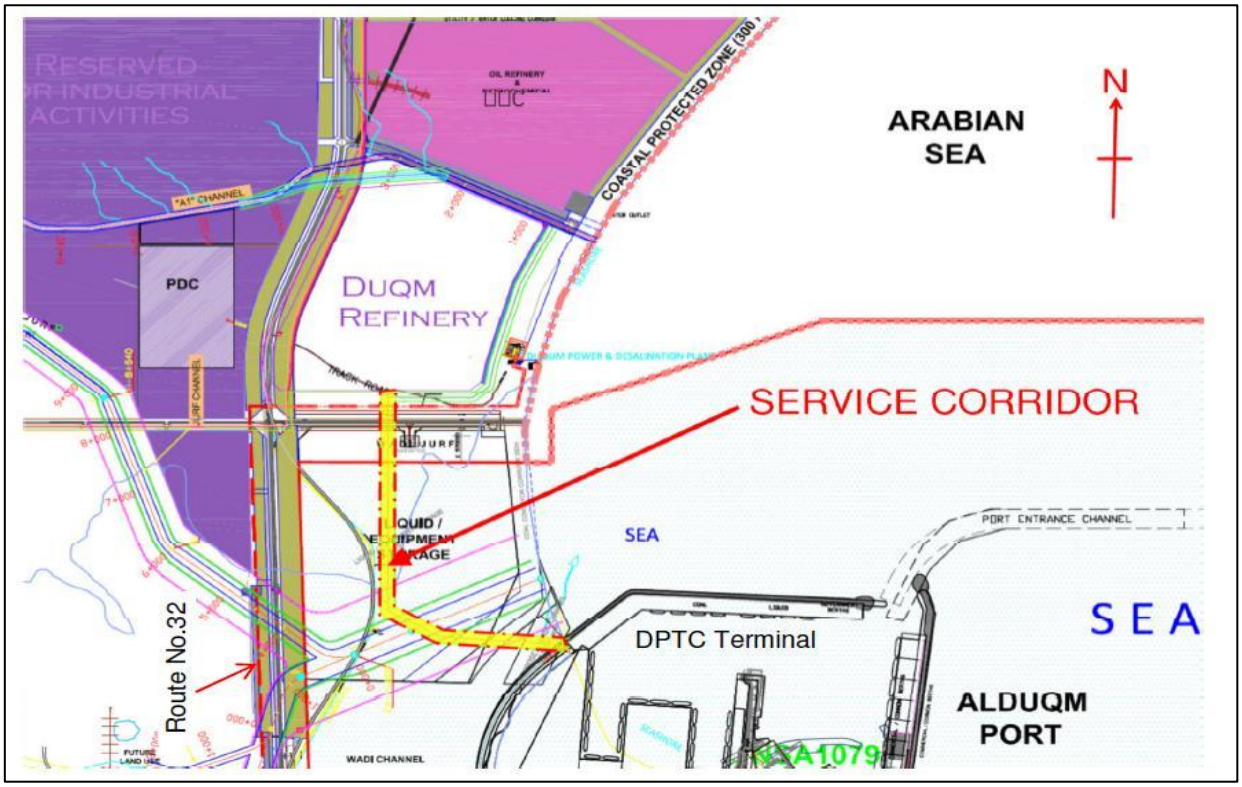


Figure 1-2: Duqm Service Corridor: Locality Map

As per the categorization of projects by the Ministry of Environment and Climate Affairs (MECA), the proposed Project would be categorized under: Group 5, '*Service Projects*'. Therefore, the Project will require an Environmental Impact Assessment (EIA) study with detailed evaluation of the potential environmental impacts, identification of appropriate control measures to mitigate significant impacts, and preparation of a detailed management plan to obtain the Preliminary Environmental Permit (PEP).

The Centralized Utilities Company LLC (CUC) has been appointed by SEZAD as the Project Manager and Client's Representative for the purpose of executing the Project. In future, CUC will also be responsible for operating the utility/pipeline service corridor. Subsequently, SEZAD commissioned HMR Environmental Engineering Consultants (HMR) for Environmental Study Services for the proposed DSC project and primarily to undertake this ESIA study.

1.2 Project Background

The Government of Oman is in the process of developing the Port of Duqm as a strategic dry dock, free trade zone, industrial area and tourism destination. The overall master plan for Duqm Town, which includes the town's own airport, was prepared by Oman's Supreme Council for Town Planning designating land / sites for various components of this ambitious project since 2007. The Royal Decree (RD) 119/2011 established the Special Economic Zone at Duqm, and as a result the Port of Duqm becomes part of this zone and the planning vision will take into consideration the strategic development of the Port and the larger Duqm area as well.

As a consequence of the Royal Decree 79/2013, SEZAD is authorized with the functions of the MECA in relation to issuing environmental permits for the projects coming up in the SEZAD area and take necessary environmental measures. Accordingly, SEZAD is the regulatory authority for this Project. SEZAD shall be the authority for permitting requirements for the onshore and offshore Special Economic Zone limits as specified by RD 44/2014, however any area outside this boundary shall be under the Ministry of Environment and Climate Affairs' jurisdiction.

The proposed Project will comprise works to develop a common utilities and pipelines corridor supporting Duqm Refinery and future industries proposed within the Special Economic Zone at Duqm.

As indicated earlier, to execute the DSC Project, SEZAD has delegated CUC responsible for executing the Project and to carry out the Project Definition, Front End Engineering Design (FEED), tendering for an EPC Contractor, and Construction supervision. Upon completion of construction works, CUC will also be responsible for operating and maintaining the service corridor.

1.3 Scope of the EIA Study

HMR Environmental Consultants (HMR) has been commissioned by SEZAD to perform the required studies to obtain approval from the regulator for the Duqm Services Corridor. HMR is responsible for undertaking the EIA study, preparing the EIA Report, and obtaining the Preliminary Environmental Permit.

As indicated above, in accordance with the authority vested to SEZAD, pursuant to RD 79/2013 - Article (16), the SEZAD Environment Department has indicated that it will assume the environmental regulatory role on this Project. The Duqm Service Corridor Project area is situated within the SEZAD limits as specified by RD 44/2014. However, the SEZAD Environmental Impacts Assessments and

Systems Department have indicated that they will adhere to the assessment process adopted by MECA in evaluating the environmental impacts of the Project and granting the necessary permits.

Accordingly, the EIA will be carried out in accordance with the '*Guidelines on Environmental Impact Assessment*' issued by the DGEA at MECA (Appendix B of the '*Guidelines for Obtaining Environmental Permits*').

Various Project information such as description of the major units of the proposed Project, utility flow schemes, emission / waste details including the proposed methods of their management, details of storage tanks, construction methodology, chemicals and consumables, project schedules, etc., have been obtained from SEZAD and CUC. The above information has been reviewed to conduct the detailed environmental analysis of the Project. Based on the review of the Project information, the applicable environmental regulatory requirements for the Project have been identified.

Further, the secondary data on the environmental baseline of the Project area has been collated from published information and from relevant previous studies for the area along with a limited primary survey for the ecological verification.

SEZAD have also commissioned Swissboring to undertake geotechnical investigation in the Project area to assess general ground conditions at the Project site including laboratory testing to determine the physical and chemical characteristics of the soil, rocks and ground water. The results and findings of Swissboring's investigations will be included as one of the chapters of the Environmental Baseline Report.

1.4 Objective of the Report

The overall objective of this EIA is to identify and evaluate significant impacts on the environment due to Project activities, so that appropriate control and management plans can be developed to mitigate potential adverse impacts. This process will ensure the Project complies with applicable Omani environmental regulations and provide the necessary information and documentation to obtain PEP from the regulator.

As indicated previously, this EIA has been prepared in accordance with Omani regulatory requirements, as specified in the "*Guideline on Environmental Impact Assessment*" issued by the DGEA in MECA. In addition, MECA's recently promulgated guidelines on the '*Information on Climate Affairs to be provided in the EIA study submitted to the Ministry*' have been adopted and followed.

The scope of this EIA includes the following:

- Highlight the environmental legislation and standards pertinent to the Project activities;
- Desktop reviews and field studies for assessing the current status of the environment and socio-economic profile of the Project area and thereby to evaluate the impacts of the proposed Project development;
- Identification and assessment of potential environmental and social impacts of the Project including the impacts on climate change, primarily during the construction stage, and determination of significant impacts of the Project;
- Environmental review of the Project for characterization and quantification of wastes generated, greenhouse gas (GHG) emissions, ozone depleting substances (ODS) used, and energy requirements;
- Environmental analysis of alternatives for the Project location, project design, and approaches associated with the project development;
- Recommend suitable environmental and social management plans including mitigation measures and monitoring programs; and
- Preparation of the ESIA report for review by the regulator to obtain the environmental permit for the Project.

1.5 EIA Approach and Methodology

This EIA was prepared during the period from February 2015 to May 2015. Initially, HMR prepared a Preliminary Environmental Report (ref: 4054–EBR-1) to set out the scope and methodology for the EIA study (HMR, 2015). The Permitting and Preliminary Environmental Report (PER) was based on the available proposed Project components and configuration, contextualized the existing environmental baseline based on previous surveys for the SEZAD area, outlined proposed methods for the EIA study, and highlighted potential environmental impacts for the Project. The Final PER was submitted to SEZAD Environmental Affairs Department on 29 May 2015.

The EIA study involved the following tasks and activities:

- Obtaining and reviewing the Project data and coordinating with SEZAD / CUC for discussions on environmental management requirements;
- Collating the environmental baseline data (secondary data) for the Project based on published information and other available data;

- Conducting the limited onsite surveys for terrestrial, lagoon, and intertidal ecology;
- Characterization and quantification of various environmental releases (waste streams) generated from the Project during construction and operation phases, including the review of proposed control measures for the management of such waste streams;
- Analysis of alternatives considered for the Project with regard to other avenues to move crude and finished petroleum products, project locations, etc. based on an environmental standpoint;
- Identification and assessment of potential environmental impacts from the proposed Project, primarily during the construction and operation phases;
- Determination of GHG emissions, use of ODS, if any, climate change adaptability of the project, energy conservation measures, etc.;
- Developing an Environmental Management Plan (EMP), including mitigation measures and monitoring plan;
- Preparation of the ESIA Report compiling the above information along with the application for the PEP for the project and submission to SEZAD for review; and
- Providing clarifications to SEZAD for their comments (if any) on the ESIA, in order to obtain the PEP for the project.

1.6 Project Proponent and EIA Consultant

As reported previously, the Centralized Utilities Company (CUC) has been appointed as the "Project Manager and Client Representative" for the purpose of executing the Project and therefore is the Project proponent. Contact details for CUC are presented below:

Centralised Utilities Company

P.O. Box 80, Postal Code 102, Sultanate of Oman

Tel: 2208 2000; Fax: 2208 2004

Contact: Mr Mandar Kulkarni (Project Manager)

Email: mandar.kulkarni@almarafiq.net

HMR Environmental Engineering Consultants (HMR) is the Environmental Impact Assessment Consultant for the DSC Project and their contact details are:

HMR Environmental Engineering Consultants

P.O. Box 1295, Postal Code 111, CPO Seeb, Sultanate of Oman

Tel: 2461 8800, 2461 8829; Fax: 2461 8811

Contact: Ms Renelle Watson (Project Manager)

Email: renelle@hmrenv.com

1.7 Structure of this Report

This EIA report is structured as follows:

- Chapter 2: Environmental Regulatory Framework – Presents the applicable environmental legislative regulations relevant to the Duqm Service Corridor Project.
- Chapter 3: Project Description – Describes the various Project components, activities, process units, utilities, facilities based on the Concept Design Report. Further, the construction methodology and resources required during construction phase are described in this chapter.
- Chapter 4: Environmental Releases - Discusses the environmental releases from Project construction and operation phases. The handling, treatment and disposal philosophies proposed for the releases are also presented in this chapter.
- Chapter 5: Climate Affairs - Presents the estimate of emissions of GHG and ODS from the project construction and operation. The chapter also assesses the influence of Project on climate change, and conversely, the vulnerability of the Project to changes in climate.
- Chapter 6: Analysis of Alternatives – Analyses the alternatives for the critical processes, Best Available Techniques, and approaches associated with the project development from the environmental view-point.
- Chapter 7: Environmental Impact Assessment – Identifies and discusses potential impacts on the environment due to the Project construction and operation activities from the Duqm Service Corridor Project.

- Chapter 8: Environmental Monitoring and Management Plan - Provides environmental management plan, compatible with environmental management systems like ISO 14001 for all the phases of the Project.
- Chapter 9: Conclusions - Presents the conclusions of the EIA study for the Project.

The Environmental Baseline Report is written as a separate document and it presents a description of environmental baseline and sensitivities in and around the Duqm Service Corridor site, based on primary data which was collected during baseline investigations carried out as part of this study by HMR and other consultants as part of this Project. The environmental baseline also takes in to account the secondary data from HMR archives and refers to historical information. This Report titled "*EIA for the Service Corridor, Duqm, Environmental Baseline Report for Service Corridor, Industrial Zone, Duqm April 2015*" is referred to as (HMR, 2015b).

2 REGULATORY AND ENVIRONMENTAL LEGISLATIVE FRAMEWORK

2.1 Overview

The Omani legislative framework has two main legal instruments - Royal Decrees (RDs) and Ministerial Decisions (MDs). Typically, a RD provides a general framework relating to a particular area in need of statutory control and is comparable to a law; while MDs provide specific guideline using the framework provided in the RD akin to a regulation.

To identify and assess the impacts resulting from a project, a number of environmental regulatory requirements and guidelines are required to be taken into consideration. The term "environmental" is therefore used in the broadest context and includes standard biophysical components of the environment and also encapsulates social issues related to the general population.

2.2 SEZAD Legislation

The Special Economic Zone Authority at Duqm (SEZAD) is the subject of the Royal Decrees and Decisions listed below:

- RD 119/2011: *Establishing Duqm Special Economic Zone Authority and issuing its regulations*;
- RD 79/2013: *Issuing the regulation of the Special Economic Zone at Duqm*;
- RD 44/2014: *lifting the capacity of a public utility from some of the schemes within the scheme of the Special Economic Zone Authority at Duqm*, as well as amending the location and boundaries of the Special Economic Zone in accordance with the diagram attached to the Decree;
- Decision No. 322/2015 *Issuing the Regulation organizing the urban planning and building permits at the Special Economic Zone at Duqm*; and
- Decision No. 323/2015 Issuing the *Regulation organizing the Investment Environment at the Special Economic Zone at Duqm*. This Decision details the Definitions and General Provisions, Licensing Procedures, Obligations and Prohibitions, Cancellation and Suspension of Licensing, and lists the economic activities subject to inspection by SEZAD before granting the final license and engagement in practicing the economic activity.

With the enactment of the Royal Decree (RD) 119/2011 establishing SEZAD legislative jurisdiction and legal responsibility for this area, SEZAD are charged with overseeing the planning vision and strategic development of Duqm.

2.3 Jurisdictional Authority

In Oman the responsibility for implementation of the environmental legislative framework and laws resides with the Ministry of Environment and Climate Affairs (MECA), and the MECA issue regulations, standards and guidelines through MDs. Within MECA, the authority responsible for environmental permitting, inspection and control in the Sultanate is the Directorate General of Environmental Affairs (DGEA). MECA has also established the Directorate General of Climate Affairs (DGCA), which is the authority to assess the potential aspects relating to climate change.

For the Duqm Service Corridor Project, as detailed in Section 2.2, SEZAD is the jurisdictional authority for the project area as it is located within the Special Economic Zone at Duqm, and therefore the SEZAD Environmental Department handles the responsibilities that usually sit with MECA.

2.4 Omani Environmental Legislation

Omani laws on environmental protection, control and management are covered under two primary laws, viz., the "*Law for the Conservation of the Environment and the Prevention of Pollution*" promulgated in November 2001 as RD 114/2001 (superseding RD 10/82 and its amendments) and the "*Law on Protection of Potable Water Sources from Pollution*" promulgated as RD 115/2001. These two laws provide the framework for all the other laws and regulations concerning environmental conservation and water resources protection.

In addition to the above, the requirements contained in other applicable RDs, MDs were also reviewed during the EIA, and potential environmental impacts from the Project was assessed taking into account the requirements of such regulations.

The Omani environmental laws and regulations applicable to the development, operation, and maintenance activities of the proposed Duqm Service Corridor Project are listed in Table 2-1.

Table 2-1: Applicable Environmental Laws and Regulations

Reference No:	Description	Applicability to Project Activity
Royal Decrees (Environmental Law)		
RD 114/2001	Law for Conservation of the Environment and Prevention of Pollution	Guiding law on pollution prevention and natural resource conservation
RD 115/2001	Law on Protection of Sources of Potable Water from Pollution	Guiding law on preventing pollution of ground water resources
RD 6/2003	Law on Nature Reserves and Wildlife Conservation	Guiding law on protecting wildlife and habitat in the vicinity of the project site
RD 29/2000	Issuing the Law of Water Resources Conservation	Guiding law on sustainable use of water resource
RD 73/1998	Law approving the Ratification by Sultanate of Oman to Vienna Convention for the Protection of Ozone Layer and Montreal Protocol concerning Ozone Depleting Substances	Guiding law for the protection of ozone layer and control and management of Ozone Depleting Substances
RD 46/95	Law on handling and use of chemicals	Use of hazardous chemicals during the construction phase
RD 6/80	Law of Protection of the National Heritage	Protection and conservation of cultural or heritage sites in the project area
RD 46/95	Law of handling and use of chemicals	Raw materials, chemicals, and fuel storage, handling and transport
Ministerial Decisions (Environmental Regulations)		
MD 20/90	Regulations on Coastal Setbacks	Regulations on protection of coastal zones and areas
MD 145/93	Regulations for wastewater reuse and discharge	Prohibits discharge of untreated wastewater to the environment and regulates wastewater treatment
MD 18/93	Regulations for the management of hazardous wastes	Handling, storage and disposal of hazardous wastes generated from project activities
MD 17/93	Regulations for the management of the solid non-hazardous wastes	Handling, storage and disposal of non-hazardous wastes from project activities
MD 79/94	Regulations for noise pollution in public environment	Public noise control
MD 80/94	Regulations for noise pollution in the working environment	Workplace noise control

Reference No:	Description	Applicability to Project Activity
MD 248/97	Issuing the regulation for registration of hazardous chemical substances and the relevant permits	Chemicals management during construction and operation phases and registration of chemicals used
MD 421/98	Regulations for Septic Tanks, Soak away Pits and Holding Tanks	Regulates construction of holding tanks, septic tanks and soak away pits during the construction phase
MD 169/2000	Regulations on cutting of trees	Regulation on protection of trees within the project influence area
MD 200/2000	Regulations for Crushers, Quarries and Transport of Sand from Coasts, Beaches and Wadis	Regulates the use of crushers and quarries at Wadis
MD 264/2000	Regulations for Water abstraction from bore wells	Construction of bore well to abstract water for commercial project purposes
MD 317/2001	Issuance of the regulations for packaging & binding conditions/stipulations and putting information and labels on the hazardous chemical substances	Hazardous chemicals management during construction and operational phases of the project
MD 187/2001	Regulations for organizing obtaining environmental approvals and final environmental permit	Obtaining Preliminary Environment Permit (PEP) and final environmental permit
MD 101/2002	Prohibition of killing, hunting, or capturing of wild animals and birds	Regulation on protection of wildlife
MD 281/2003	Regulations for control and management of radioactive substances	Management of radioactive substances
MD 118/2004	Regulations on controlling air pollutants emanating from stationary sources	Regulates installation and operation of stationary combustion sources
MD 159/2005	Regulations for the discharge of liquid effluents into the marine environment	Discharge of any accidental release of oil products from the service corridor to the sea
MD 243/2005	Regulations for the control and management of Ozone Depleting Substances (ODS)	Prohibits the use of Ozone Depleting Substances
MD 286/2008	Regulations for Occupational Health and Industrial Safety Precautions	Occupational health and safety of employees
OS 8/2012	Omani Standard for drinking water (Issued by the Directorate General of Specializations and Measures and MoCI)	Potable groundwater quality standards

Reference No:	Description	Applicability to Project Activity
Omani (Provisional) Ambient Air Quality Standards (OAAQS)	Provisional Omani standards for ambient air quality	Ambient air quality in the project area
Climate Affairs Guidelines	Guidelines on estimation and reporting of greenhouse gases (GHG) and ODS from project construction and operation phases, outlines the information to be provided towards evaluation of the influence of project activities on climate change, discusses impacts of climate change on projects, and the climate change adaptation and mitigation measures implemented by projects.	Estimation, reporting and control of GHG, ODS, energy consumption, etc., during the construction stage. Statement of mitigation measures for reducing influence of climate change and minimizing vulnerability of the Project area to consequences of climate change

2.5 Regional and International Conventions

Several RDs concerning conventions and protocols to which Oman has acceded have been issued so that these are considered during development of new projects in the country.

Conventions and protocols relevant to the proposed DSC Project are presented in Table 2-2.

Table 2-2: International Conventions and Protocols

#	Convention	Description
1	International convention for the prevention of pollution from ships, London (1973); and Regulations for the prevention of marine pollution by sewage from ships	Concerned with preventing different forms of marine pollution from ships such as: Fuel, Noxious Liquid Substances carried in Bulk, Harmful Substances carried in Packaged Form, Sewage, Garbage, Air Pollution, and Unwanted Aquatic Organism in Ballast Water.
2	International convention relating to intervention on the high seas in cases of oil pollution casualties, Brussels (1969) and its protocol, (London, 1973)	Concerned with affirming the right of a coastal State to take such measures on the high seas as may be necessary to prevent, mitigate or eliminate grave and imminent danger to their coastline or related interests from pollution or threat of pollution of the sea by oil, following upon a maritime casualty or acts related to such a casualty.

#	Convention	Description
3	International convention on civil liability for oil pollution damage, Brussels, (1969) and its protocol, (London, 1973)	Adopted to ensure that adequate compensation would be available where oil pollution damage was caused by maritime casualties involving oil tankers (i.e. ships that carry oil as cargo).
4	International fund for compensation for oil pollution damage, Brussels, (1971)	Fund is obliged to pay victims of pollution when damages exceed the ship owner's liability, when there is no liable ship-owner, or when the ship-owner is unable to pay its liability.
5	Basel Convention on the control of trans-boundary movements of hazardous wastes and their disposal (1989)	To reduce the movements of hazardous waste between nations and specifically to prevent transfer of hazardous waste from developed to less developed countries.
6	United Nations framework convention on climate change (1994)	Related to controlling and stabilizing greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system.
7	Vienna Convention on the protection of the ozone layer (1985)	Acts as a framework for the international efforts to protect the ozone layer.
8	Montreal Protocol on substances that deplete the ozone layer (1987)	This is a protocol to the Vienna Convention for the Protection of the Ozone Layer designed to protect the ozone layer by phasing out the production of numerous substances believed to be responsible for ozone depletion.
9	United Nations Framework Convention on Climate Change (UFCCC) (1992) including Kyoto Protocol (2005)	An international agreement on the reduction of greenhouse gas emissions and on mechanisms aimed at providing monetary and technology benefits for reducing emissions, in order to address possible changes in the climate.
10	Rotterdam Convention on the prior informed consent procedure for certain hazardous chemicals and pesticides in international trade (2004)	It is a multilateral treaty to promote shared responsibilities in relation to importation of hazardous chemicals. The convention promotes open exchange of information and calls on exporters of hazardous chemicals to use proper labeling, including directions on safe handling, and inform purchasers of any known restrictions or bans.

2.6 International Guidelines and Best Practices

To minimize environmental impacts, for areas where Omani environmental regulations / standards do not cover, applicable international guidelines have been used where appropriate.

In addition this EIA study, where relevant, takes into account 'Best Practice' environmental standards / guidelines developed internationally by the World Health Organization, Integrated Pollution Prevention and Control (IPPC), European Union, and United States Environmental Protection Agency (USEPA).

2.7 Applicable Environmental Permits

Based on our knowledge and experience, the DSC Project would typically require the following permits, as applicable for the construction and operation phases:

- Preliminary Environmental Permit (PEP), from SEZAD Environmental Department1;
- Final Environmental Permit (FEP), from SEZAD Environment Department;
- Initial Fire safety approval, from Civil Defence;
- Permit for installing onsite sewage treatment plant (STP) for the construction camp and site office or Approval for discharging sewage to municipal STP, as applicable;
- Wastewater Discharge Permits from SEZAD Environment Department;
- Permit for storage, handling, transportation and disposal of hazardous wastes during construction and operation from SEZAD Environment Department, MECA, be'ah, and Royal Oman Police (ROP);
- Permit for storage, handling and transportation of chemicals and fuel used during construction and operation from SEZAD Environment Department, MECA, and ROP;
- Permit for operating stationary combustion sources from SEZAD Environment Department during the construction phase;
- Permit for import, transportation, usage and storage of radioactive material (if applicable – radioactive sources are located in some geotechnical measurement instrumentation such as the nuclear denosmeter) from MECA, ROP, and SEZAD Environment Department;
- Permit for use of industrial gas cylinders from SEZAD Environment Department;

[1] As per RD 79/2013, the role of MECA can be carried out by SEZAD and SEZAD has advised that it intends to act as the regulator on this Project.

- Temporary environmental approval for construction of labour camp and offices from SEZAD Environment Department;
- Consent for setting up construction camps from the Municipality; and
- Fire regulations and related permits from ROP.

In addition to the above, the contractors transporting /recycling / handling chemicals, fuels, other hazardous materials and non-hazardous wastes will require approvals / permits.

3 PROJECT DESCRIPTION

The government of Oman is in the process of developing the Port of Duqm as a strategic dry dock, free trade zone, and industrial and tourism destination. RD 119/2011 established SEZAD, and the Port of Duqm becomes part of the planning vision of the SEZAD area taking into consideration the overall strategic development of Duqm.

The proposed Project intends to provide centralized utilities and pipeline corridor for the proposed Duqm Refinery and several heavy/petrochemical industries coming within the proposed heavy industrial zone in SEZAD for the planning horizon: 2017 – 2045. As stated, SEZAD has appointed CUC for executing the DSC Project and will be responsible for operating the service corridor.

This section of the report summarizes the Project information that is presently available for the Duqm Service Corridor (DSC) and the description provided is based on information provided by SEZAD to date[2].

3.1 Project Location

The location of the Duqm Service Corridor is shown in Figure 1-1 and Figure 1-2, south of the proposed Duqm Refinery. Figure 3-1 shows the route of the DSC with the DSC alignment crossing a wadi (Wadi-Saay), approximately 3.5 km south of the Duqm Refinery before adjoining the Duqm Petroleum Terminal Company (DPTC). The national road from Duqm to Mahout known and marked as Road 32 in Figure 3-1 flanks the eastern side of the service corridor. The service corridor also lies between 2 proposed roads; i.e. South Access Road and Road No.5 in the South. Road No.5 connects to Road No. 1, which in turn will be connected to existing Route 32 (National Road 32: Duqm-Mahout).

The corridor plan (refer Figure 3-2) shows the services infrastructure extending between the Duqm Refinery site and the DPTC Port fence. The major items in the service corridor will consist of pipelines of various sizes ranging from 12” to 36” dia., heavy haul traffic road, service access road, pipe bridges, and buried power cables. In addition, the corridor would also include suitable provisions to accommodate utility requirements of various industries slated to come up in the heavy industrial zone within SEZAD.

[2] Detailed information about the Project is not available, with the detailed engineering & EPC phases currently in bidding phase.

Table 3-1: Duqm Service Corridor: Set Out Point Coordinates

Set Out Point	Easting	Northing
SP0	569212.05	2180711.46
SP1	568976.71	2180363.54
SP2	568976.12	2179952.32
SP3	568974.60	2178905.09
SP4	568973.09	2177856.99
SP5	568972.25	2177272.64
SP6	569015.61	2177247.76
SP7	569891.77	2176745.01
SP8	569988.49	2176745.01
SP9	571077.46	2176745.01
SP10	571267.69	2176745.01

Figure 3-1: Duqm Service Corridor: Route Alignment

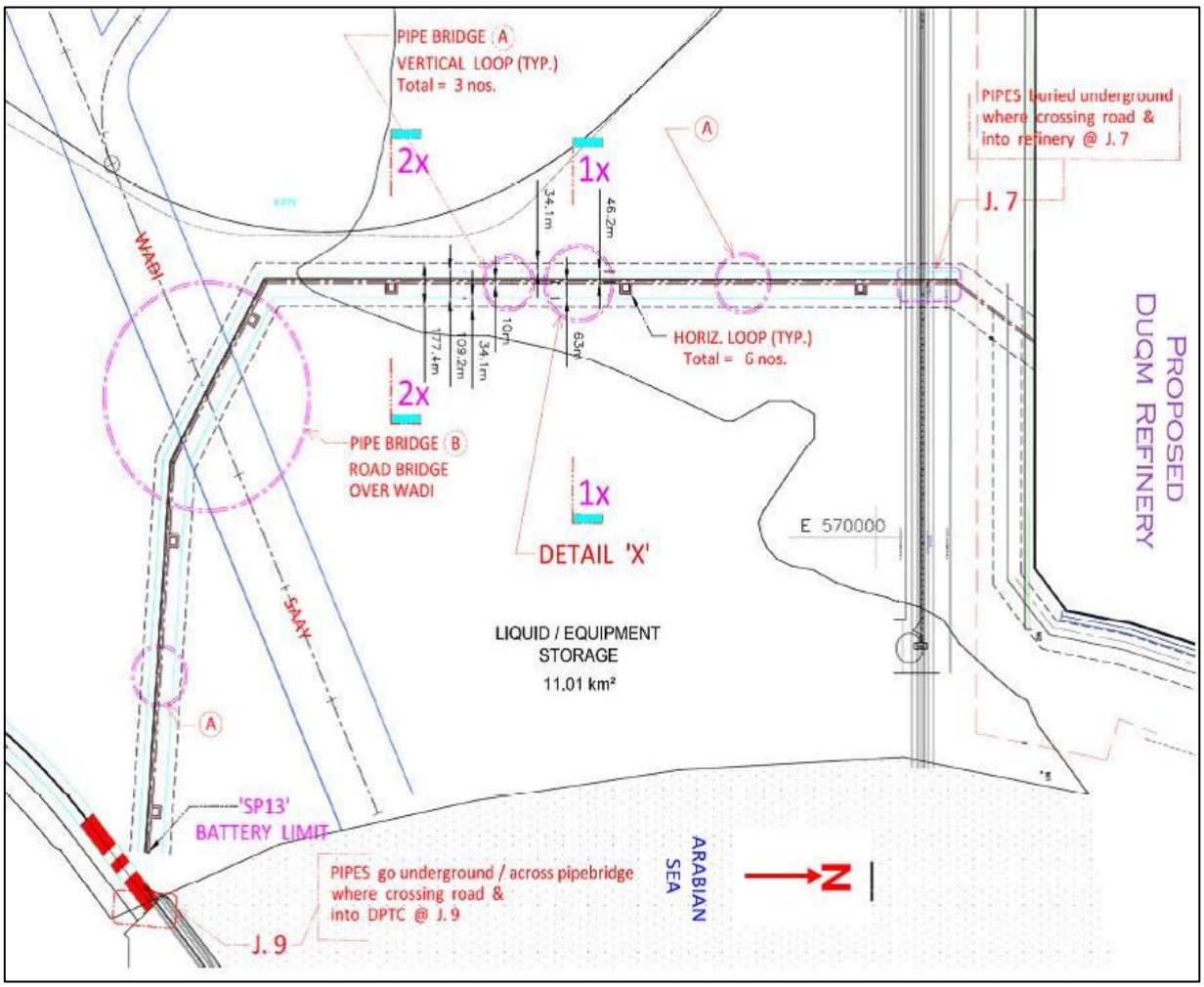


Figure 3-2: Duqm Service Corridor: Arrangement Plan

Source: CUC. (June, 2015) Scope of Work: Pipeline Support Structures for Service Corridor at Duqm SEZAD Oman.

3.2 Conceptual Design

To set out the details of the Service Corridor design the following document has been prepared "*Scope of Work, Pipeline Support Structures for Service Corridor at Duqm Special Economic Zone Oman*", Revision 5, dated 20 June 2015 authored by sembcorp and Takamul, checked by Centralized Utilities Company (CUC), and approved by SEZAD. Information relating to the design of the Service Corridor has been extracted from the Scope of Work document and is detailed in the following sections.

The service infrastructure corridor is proposed to be approximately 200 meters wide and 6 kilometers in length. The service corridor infrastructure will include pipelines, pipe supports, pipe sleepers, pipe bridges, service roads, etc.

The proposed service corridor is arranged in three parallel sections (refer to the Appendix for design drawings of the service corridor), with the Duqm Refinery section in the centre (63 m in width), with space provisions for future pipelines on the eastern and western sides of the central corridor (with corresponding widths of 57 and 80 m respectively).

The service corridor will include:

- Sleepers;
- Pipe Bridges above ground at Wadi Saay;
- Service roads including finished surface grading including lighting, power cables, barriers, bollards and road painting;
- Bunds for Pet Coke/ Sulphur roads;
- Patrol road made good excluding the black top asphalt;
- Fences and security system;
- Corridor drainage;
- Vertical pipe loops – bridges (3 nos.);
- Completion of Corridor at refinery and at the Port (buried section, excluding pipelines and cables);
- Horizontal sleeper bends (6 nos.);
- Road junction profiling;
- Pipeline bedding, haunching & final covering, RC cable troughs, and road crossings at the Refinery South Road; and
- Power Cable trough below ground and C&I cable tray above ground.

3.2.1 Project Exclusions

It is to be noted that the following components are not part of the Duqm Services Corridor project:

- Pet Coke/ Sulphur Road;
- Pipelines for Duqm Refinery and other proposed industries; and
- Instrumentation, leak detection and fire-fighting Systems for the pipelines.

3.3 Reinforced Concrete Sleepers

Reinforced Concrete (RC) sleepers spaced at maximum 15 meters intervals will be provided along the new service corridor, from the Duqm Refinery battery limits to the DPTC fence line. The interval of last 2 pipe sleepers at end of service corridor near DPTC fence line will be less than 15 m to cater for future pipe supports to cross over from the Port fence line. At the northern end of service corridor, near the Duqm Refinery, the pipelines shall be buried to undercrosss the South Access Road.

All pipelines will be supported on RC sleepers in the pipeline corridor. The preferred design of the sleepers is for a precast sleeper design as a single item of approximately 10 to 12 meters in length or width supporting several pipelines simultaneously.

The loading and connection for the future one (1) tier of steel structure extension (total 2 tiers including pipe sleeper) shall be considered in the foundation and sleeper designs. Hot-dipped galvanized embedded plate shall be put on top of pipe sleeper.

3.3.1 Requirements of Duqm Refinery

The Duqm Refinery will be responsible for installation of their pipelines on the sleepers provided by CUC. Currently, Duqm Refinery requires the following pipelines as part of Phase 1:

- 42" dia. Crude Pipeline;
- 30" dia. Naphtha Pipeline;
- 32" dia. Diesel Pipeline;
- 36" dia. JET A1 Pipeline;
- 20" dia. RLPG Pipeline;
- 6" dia. RLPG Return Pipeline; and
- 30" dia. HSFO Pipeline.

Spacing of 7 m above the sleepers shall be catered for future pipelines specified for Phase 2 pipelines. All pipelines will be supported above the water lines due to insulation. No drain lines will be routed in the Corridor, and hence, all drainage of pipeline low points that cannot be removed by scraper traverses etc. will be removed by vacuum trucks.

Where the sleeper system is designed with a single sleeper supporting the Duqm Refinery's pipelines at each bay, the sleepers shall be designed to accept a load of 62 tonnes per day (assuming multiple pipeline hydro-testing simultaneously, and with sleeper spacing of 15 m per bay).

3.3.1 Expansion Loops

Three vertical expansion loops will be provided to allow vehicle access across the service corridor. The size is to be limited to allow the installation of fittings for the 42" dia. crude oil pipeline. The vertical loop is to be minimum 5 m high by 4.5 m wide. These vertical loops shall be in the form of two-tier steel structure pipe rack.

Six horizontal expansion loop bays are anticipated in the Project to accommodate thermal expansion. The size of each of the horizontal expansion loops is provisionally 50 m by 50 m, in order to accommodate the expansion of seven pipelines with an interval space of 2 m plus the future pipelines considered during Phase 2.

3.3.2 Pipe Bridge and Future Tier

Where the terrain is either a wadi crossing or a flooded coastal area, a raised steel bridge structure will be provided. The structure is required to keep the pipelines dry and above the water line. Vehicular access for pipeline installation and maintenance shall be via adjacent proposed Pet Coke/ Sulphur Road, using an Irish crossing.

The loading and connection for future 1-tier steel structure extension (total 2 tiers including sleeper) shall be considered in the designs.

3.3.3 Roads

The road to be provided in the Corridor for the use of the Duqm Refinery shall be designed and constructed to be used for other functions. Access is to allow vehicles into the Corridor including:

- Pipeline Construction vehicles
- Maintenance vehicles (Service Road)
- Patrol vehicles (Patrol Road)
- Construction vehicles (Service road and Pet Coke/Sulphur road)

The roads will be designed and constructed to meet the Primary Road criteria design criteria of:

- DRP001-FED-SPE-C-000-0004-Rev01 - Bituminous Roads and Paving Specification
- DRP001-FED-SPE-C-000-002-Rev01 - Civil Engineering Design Criteria Specification

3.3.4 Wadi Crossings

At the wadi road crossings, an Irish Crossing will be constructed to cater for times of flooding or tidal movement. The design must ensure that vehicles must have safe, dry pipeline corridor access for 350 days per year of operation.

3.3.5 Control & Instrumentation Work

Control cables dedicated to the Duqm Refinery pipelines will be designed and installed by Duqm Refinery. Electrical power cables dedicated to the Duqm Refinery pipelines are to be designed and installed by Duqm Refinery. All civil requirements to be provided in the Corridor cross-section for underground cables (concrete trough) with provision for both a main supply cable and a redundant cable located away from the main cable to maintain the cables independence and isolation.

Currently, no utilities are supplied from the Refinery to the Port via the Corridor. Since road lighting is proposed to be provided by SEZAD, space has been provided for a lighting power cable.

3.3.6 Construction Workforce

The current estimates, in FEED stage, of the construction workforce required for the DSC Project is 300 people.

No onsite labour accommodation camps are proposed, and the workforce is expected to be housed at the existing Accommodation facilities in Duqm (e.g. Renaissance). The labour force will likely work in rotating shifts with 250 employees located in the existing Accommodation facilities, and 50 employees located off camp.

3.3.7 Construction Utilities

Water for construction purposes onsite is estimated at a peak of 150 cubic metres per day, and the water usage for the construction camp are estimated to be 45 cubic metres per day.

Construction power requirements will be minimal, and is estimated to be maximum of 300 KW sourced from the grid if available. It is also likely that generators will be used at the source for activities such as lighting, and for some equipment including power tools and dewatering pumps. A power demand of approximately 50 KW for the camp accommodation is estimated, and it is intended to source this power from the local grid.

3.3.8 Waste Management

For this Project waste handling will be limited as the materials required for construction will largely be procured based on the specific design requirements and fit for purpose components (i.e. pre-cast culverts, and pre-cut lengths of steel).

Domestic waste will be disposed to the nearest waste disposal facility, domestic sewage will be treated by a 'package plant' and effluent disposed to the evaporation area.

As soil excavation for foundations will be required, any surplus excavated material will be re-used where possible in civil earthworks across the Project such as material in road junction profiling, or in shaping for local corridor drainage, or incorporated into Bunds for Pet Coke / Sulphur Roads. The least desirable management option for any surplus excavated material is disposal to landfill and this will be avoided.

3.4 Construction Phasing

The following timelines have been extracted from CUC's Service Corridor Project Schedule (dated June 11, 2015).

3.4.1 Design Life

The project is designed for a lifetime of 50 years.

3.4.2 Project Timelines

The DSC timelines as currently proposed are as follows:

- Completion of Front End Engineering Design: **Quarter 2 of 2015**
- Award to EPC Contractor: **October 29, 2015**
- Detailed Design Works by EPC Contractor: **Quarter 3 of 2015**
- Completion of Detailed Design by EPC Contractor: **December 23, 2015**
- Commencement of Construction: **October 29, 2015**
- Completion of Construction: **March 1, 2017**
- Testing and Commissioning Works: **March 2017**
- Handing Over for Operation: **March 2017**

4 ENVIRONMENTAL RELEASES

This chapter identifies and describes the potential environmental issues that may arise from the Project based on the available information and environmental baseline conditions.

4.1 Overview

In this chapter, the waste streams released into the environment due to the construction and operation of the proposed DSC Project are identified and characterized. The project interaction with the environment during the construction and operation phase will be primarily by way of consumption of resources, release of various waste streams and accidental releases/spills of hazardous materials. These waste streams include air emissions, liquid effluents and solid wastes. In addition, noise generated from various equipment and machines used in construction is also discussed, since no noise generation is anticipated in the operation phase. The nature and quantities of wastes are significantly different for the construction and operation phases of the project. Therefore, they are presented separately.

Note that most of the data presented in this chapter are based on the Project details made available at this stage for conducting the current study. Wherever sufficient information is not available, an attempt is made to estimate the quantities and characteristics using empirical predictions. The recommendations for environmental mitigation and monitoring are presented in Chapters 8 and 9 respectively.

The project lifetime is expected to be 50 years and the environmental impacts during the decommissioning phase, post the project lifetime, cannot be conceived at the present time and hence are not separately discussed.

4.2 Releases during Construction Phase

The releases during construction phase will depend upon the type of construction activities, construction methods, construction equipment, chemicals / materials used, source / amount of utilities and duration of site work, emissions from construction equipment and vehicle, movement of transport vehicles, dust generation from earthworks, sewage generated at site and camp, waste chemicals generated at site, maintenance wastes, construction wastes, and metal, wooden and plastic scraps, etc. These releases are further discussed in the following sections.

4.2.1 Air Emissions

The major sources of air emissions generated during construction will occur from construction plant and equipment such as machinery, diesel generators, transport vehicles, fuel oil storage tanks, and traffic on graded roads. The major pollutants released from these sources include particulate matter (PM10), oxides of nitrogen (NOx), sulphur dioxide (SO_2), carbon monoxide (CO), and un-burnt hydrocarbons (UHC). The air emissions sources and the nature of emissions due to the various construction activities are presented in Table 4-1.

Table 4-1: Air Emissions – Construction Phase

#	Source Name	Source Type	Nature of Emissions and Quantity	Significant Air Pollutants
1	Construction machinery	Stationary point sources[3]	Products of combustion of fuel oils	NO_x; SO_2; CO; HC
2	Diesel generators	Stationary point source	Products of combustion of fuel oils	NO_x; SO_2; CO; HC
3	Transport vehicles	Mobile sources	Products of combustion of fuel oils	NO_x; SO_2; CO; HC
4	Fuel storage tanks	Area sources – fugitive emissions	Vapors generated due to evaporation under storage	NO_x; SO_2; CO; HC
5	Traffic on graded roads and earth work	Area sources – fugitive emissions	Dust generation	PM_{10}
6	Construction materials and aggregate storage yard	Area sources – fugitive emissions	Dust generation	PM_{10}

Based on Table 4-1, emissions to air will be primarily due to combustion of fuel oil for various construction activities. The construction plant, equipment, machinery and vehicles will be designed to the latest standards and will be well maintained, which will minimize emissions to the atmosphere. PM10 in the form of dust will be released during movement of vehicles on graded/un-graded roads and from material handling during construction. The emissions from stationary and mobile

[3] Machinery *considered as stationary point source when operating at any single location within the construction site.*

construction camp equipment, machinery and vehicles has not been estimated as information about number of construction equipment, machinery and vehicles, engine type, engine model, etc. are not available at the time of EIA preparation.

The civil works will mainly include site clearing, levelling and excavation, and these activities will generate dust emissions. The dust generating activities include handling and use of fine material such as aggregates, sand, and construction materials. Dust emissions from these operations are primarily dependent on the quantity and fineness of material, wind speed, and moisture content of the material. Construction materials such as aggregate and sand will be stockpiled in open lay down areas, while the cement will be stored in sheds. Stockpiling of these materials is expected to be for short durations anywhere from a few days to a maximum of a few weeks. Apart from continuous particulate emissions from the storage stockpiles due to wind erosion, the movement of material at stockpiles may generate considerable dust. Stockpile dust emissions due to wind erosion will depend on the stockpile material, area, height of stockpile, and number of loading and unloading operations.

4.2.2 Noise

The construction machinery, mechanical equipment, and vehicles engaged during construction will generate noise during their operation. Construction activities such as bulldozing and site preparation may generate significantly high-level noise. Various equipment like excavators, mixer machines, vibrators, bar cutting and bending machines, air compressors and pumps will all generate noise on this Project. In addition, diesel generators (DG) used for emergency power supply and for powering the site office and the construction camp will produce noise.

Vehicles used for the transport of materials and personnel to site will generate traffic and noise along the route. Typical noise levels expected from construction equipment are presented in Table 4-2.

Table 4-2: Noise Levels – Construction Equipment

Source of Noise	Duration of Operation	Noise Level at 1 m from Source
Excavators, shovels, dumpers etc.	Day and night time	70-80 dB(A)
Vibro-hammers	Day and night time	80 dB(A)
Vibrators and compactors	Day and night time	78 dB(A)
Dredgers	Day and night time	67 dB(A)
Concrete mixers	Day and night time	70-80 dB(A)
Motors and compressors	Day and night time	65-70 dB(A)
Diesel generators	Day and night time	80-85 dB(A)
Trucks	Day and night time	75-80 dB(A)

Construction equipment will be regularly maintained as per manufacturers' specifications to ensure their optimum operations and noise levels are within specified limits. All plant and equipment will be fitted with mufflers to reduce noise levels and comply with the noise standards specified under MD 79/94 and MD 80/94.

4.2.3 Liquid Effluents

The major sources of wastewater likely to be generated during the construction of the service corridor will include dewatered groundwater from excavations for foundations and pier footings, sewage from construction offices and sanitary facilities located on-site and off-site, wash down of construction vehicles, minor amounts of liquids from various construction works, and surface run offs due to rainfall events.

The liquid effluent sources, their nature and their typical characteristics for the construction phase are presented in Table 4-3. With respect to the characteristics of the effluents, it is difficult to estimate the

chemical composition of the various effluent streams. Therefore, first order approximations for the characteristics of these effluent streams (before any treatment) are shown.

Table 4-3: Liquid Effluents - Construction Phase

Liquid Effluent	Source of Generation	Nature of Effluent	Proposed Treatment and Disposal Methods	Expected Quantity/ Composition
Groundwater	Dewatered during excavations for foundation construction and installations of pier footings	Intermittent;	Reuse for dust suppression activities during construction is not considered likely as the groundwater analysis results (HMR, 2015b) do not meet the Standard A or B criteria set out in MD 145/ 1993 Regulations for Wastewater reuse and discharge. However the Wastewater Maximum Quality Limits – for Standard A and Standard B - in MD 145/ 1993 relate to re-use of wastewater for Crops, grasses, and ornamental areas. Therefore, SEZAD may consider allowing short-term re-use of the dewatered groundwater for dust suppression - provided that the volumes are small and the irrigation is in short durations only. Alternatively, the dewatered groundwater will require treatment (due to presence of salts) prior to reuse or discharge into the environment.	Average DSC Groundwater quality results, from the 12 groundwater samples as reported in the Environmental Baseline Report (HMR, 2015b): pH: 7.5 Chloride: 72838 mg/L TDS: 123273 mg/L TSS: 74.26 mg/L BOD: < 2mg/L COD: 129 mg/L For six Groundwater Chemistry parameters: Chloride, TDS, Sulphate, Boron, Magnesium, and Manganese; the calculated average results (HMR, 2015b) exceed the MD145/1993 Standard A and Standard B Maximum Quality Limit for wastewater reuse and discharge.
Sewage – onsite and labour camps	Kitchen, toilets and wash rooms located onsite and labour camps.	Continuous; Contains SS, O&G, BOD and COD	Will be collected and treated by package wastewater treatment plant; and reused where possible.	SS: < 250mg/L O&G: < 100mg/L BOD: < 200mg/L COD: < 500mg/L

Liquid Effluent	Source of Generation	Nature of Effluent	Proposed Treatment and Disposal Methods	Expected Quantity/ Composition
Miscellaneous Liquids such cleaning solutions, paints, chemicals, equipment and vehicle fluids	Maintenance workshops, cleaning.	Intermittent; Hydrocarbon wastes	Some solutions may be able to be neutralised prior to disposal. Construction vehicles and equipment will be serviced offsite therefore waste oil will not be generated onsite. It is expected that the Qualified Mechanic / Servicing Agent will utilise authorised waste oil treatment facilities to recycle wherever feasible.	Difficult to estimate – however likely to be minor quantities.
Surface runoff	Drainage of rain water over areas along DSC.	Rarely; No pollutants expected; Storm water will infiltrate or naturally flow to the nearest wadi	Run offs from storage areas of hazardous materials and chemicals will be prevented.	Free of pollutants unless accidentally contaminated

The sewage generated on-site or off-site (in labour camps) will contain both suspended solids (SS) and dissolved solids (TDS), with relatively high biochemical and chemical oxygen demand (BOD / COD). Sewage generated from the various on-site toilets, kitchens and wash rooms located in the site as well as from labour camps will be collected through underground pipes into a holding tank. Sewage from the construction site will be collected and treated utilizing an onsite wastewater treatment plant (i.e. small package plant). Effluent will be treated to meet the Wastewater reuse and discharge criteria as per MD 145/ 1993, and management options may include: reuse for dust suppression, utilization as construction water (where possible), or use as irrigation water for landscaping purposes (if applicable). The last management option will be disposal to evaporation area, however management option is dependent on effluent quality.

Surface runoffs from stormwater events are likely to be rare, however will be routed via natural overland flow paths to wadi channels.

If a hazardous waste storage area is required to be constructed, it will be designed and constructed in such a way as to prevent infiltration of any runoff into the underlying soils. All hazardous liquid effluents generated onsite will be stored as per MD 18/93 in a protected area with dikes.

4.2.4 Solid Wastes

The project activities will generate both the hazardous and non-hazardous solid wastes during the various construction phases. The solid waste generated during the construction phase may be classified into four groups as non-hazardous non-recyclable wastes, non-hazardous recyclable wastes, hazardous non-recyclable wastes and hazardous recyclable wastes.

Non-hazardous wastes generated at site during construction generally include the following:

- Vegetation;
- Excavated soil and rock material mainly during site preparations, foundation and civil construction works;
- Concrete, various pieces of different material and other construction debris;
- Metal scrap from metal sheets, pipes, frames, rods and other structural components from bridges and guard rails along the DSC;
- Plastic from plastic pipes, joints and off cuts; as well as food and beverage containers from staff canteens and accommodations;
- Various types of packaging material, wooden scraps, and construction wastes; and
- Miscellaneous wastes such as paper, office waste, and kitchen wastes from the construction camps.

Hazardous wastes generated onsite during construction would typically include the following:

- Chemical contaminated material and soils;
- Used oils, lubricants and machine oils;
- Spent batteries and contaminants;
- Electrical equipment wastes;
- Gas cylinders; and
- Used paints and chemicals.

The quantity of waste generated during construction was not available at the time this EIA was prepared. It is difficult to estimate the quantities of non-hazardous and hazardous wastes since the waste generation rates vary with the type, quantity of material used and site specific construction methods. However, the source type and nature of wastes are presented in Table 4-4.

Table 4-4: Solid Waste – Construction Phase

Waste Type	Sources of Generation	Method of On-site Storage and Final Disposal	Estimated Quantity
Non-hazardous Non-recyclable			
Excavated soils and material	Terrestrial construction work	Surplus excavated material will be re-used wherever possible in civil earthworks across the Project such as material in road junction profiling, or in shaping for local corridor drainage, or incorporated into Bunds for Pet Coke / Sulphur Roads	Volumes will be calculated as part of site preparation design component during EPC phase.
General waste - kitchen wastes, and office waste	Construction workers, site canteens, offices and administration buildings	Collected in waste skips and disposed to the nearest approved landfill	Volumes to be estimated and provided during EPC phase. However waste data could be obtained from existing construction camps in Duqm.
Miscellaneous construction waste	Packing wastes, wooden pallets, bulky bags, rubber, cable reels, etc.	Stockpiled and disposed to the nearest approved landfill	Difficult to estimate, but procurement will encourage bulk supply deliveries to reduce packing wastes.
Non-hazardous Recyclable			
Plastic	Plastic pipes, joints and off cuts; food and beverage containers; plastic containers and drums; plastic caps and tape; packaging materials; etc.	Stockpiled and sold to local dealers, Recycled, or disposed to landfill as the last management option	Volumes to be calculated during EPC phase.
Paper and cardboard	Office paper, paper products such as single use satchels, paper cups, labels, newspapers, paper towels, cardboard packaging, etc.	Stockpiled and sold to local waste paper dealers	Volumes to be calculated during EPC phase.

Waste Type	Sources of Generation	Method of On-site Storage and Final Disposal	Estimated Quantity
Metal	Scrap metal and steel, metal containers and drums, piping, reinforced steel bars, metal fittings, frames, wiring, fencing, metal sheeting, panels, roofing, guttering, metal components, servicing machinery parts, etc.	Stockpiled and sold to local scrap metal dealers	Difficult to estimate but procurement will be controlled and waste minimized. Volumes to be estimated and calculated during EPC phase.
Wood	Wooden pallets, wooden crates, wood scrap, furniture and fixtures, etc.	Stockpiled and sent to lumber yard	Volumes to be estimated and calculated during EPC phase.
Hazardous Non-recyclable			
Contaminated soils	Accidental spills and leaks of oils and chemicals	Stored on site in a dedicated area with impervious lining and disposed as per SEZAD or MECA requirements	Depends on accidental leaks but will be avoided by international good work practices.
Waste paints	Unused and off-spec materials and empty containers	Either returned to the supplier or stored on site in a dedicated area with impervious lining and disposed as per SEZAD or MECA requirements	Difficult to estimate but will be controlled and kept to a minimum
Waste chemicals	Unused and off-spec materials and empty containers	Either returned to the supplier or stored on site in a dedicated area with impervious lining and disposed as per MECA / SEZAD Environment Departments' requirements	Difficult to estimate but will be controlled and kept to a minimum. Volumes to be calculated during EPC phase.
Hazardous Recyclable			
Waste oils and oil sludge	Fuel oil storage and lubrication	Stored on site in oil saver drums and sold to local waste contractors as per be'ah requirements	Difficult to estimate but will be controlled and kept to a minimum
Miscellaneous wastes	General activities such as spent batteries, waste tyres, waste cables etc.	Stored on site in a dedicated area with impervious lining and disposed as per SEZAD or MECA requirements	Difficult to estimate but will be controlled and kept to a minimum

4.3 Releases during Operation Phase

4.3.1 Air Emissions

Air emissions are not envisaged in the operations phase under normal operating conditions. However, intermittent air pollutants will be released by transport vehicles used for routine inspection and maintenance. Intermittent release may also occur due to fugitive emissions from the safety relief valves. The air emission details during operation are presented in Table 4-5.

Table 4-5: Air Emissions – Operation Phase

Source Name	Source Type	Nature of Emissions	Significant Air Pollutants
Transport vehicles	Mobile sources	Products of combustion of fuel oils; quantities difficult to estimate	NOx; CO; HC
Traffic on graded roads and earthwork	Area sources - fugitive emissions	Dust risings; quantities difficult to estimate	PM10

As discussed for control of air emissions during operation phase, the engines used for road vehicles will be of standard design and the engine emissions are released into the atmosphere through standard exhaust pipes. Speed limits will be observed to reduce any dust risings. The emission rates of pollutants will be controlled through proper engine tune-up.

It is difficult to estimate the quantity of air pollutants during operations phase as details of potential emission sources (engine type and frequency of use) are not available.

4.3.2 Noise

There won't be any major or continuous source of noise generation during the O&M of the pipelines. The only noise that may be generated will be associated with the movement of vehicles along the pipeline right-of-ways during routine inspections.

4.3.3 Liquid Effluents

Due to routine maintenance activities of the DSC, some small volumes of chemical wastes are envisaged. Wastewater is expected from any accidental spills or any emergency usage like clean-up or fire event. The typical liquid effluents during operation phase are summarised in Table 4-6.

Table 4-6: Liquid Effluents – Operation Phase

Liquid Effluent	Source of Generation	Nature of Effluent	Proposed Treatment and Disposal Methods	Expected Quantity/ Composition
Wastewater	Water from spills, clean-up, fire events, etc.	Wastewater potentially contaminated with traces of chemicals All wastewaters will be sampled and analysed to determine the most appropriate management option.	Pre-treatment and / or neutralisation of liquid effluents from spills, clean ups or emergency usage is likely to be required. A Liquid Waste Disposal Criteria and / or Management Procedure will be defined by SEZAD, such that all operational pipelines have suitable management plans in place for effluent management from maintenance wastes.	Rare occurrence; Difficult to estimate
Surface Runoff	Storm water	Rain water, typically not contaminated	Storm water will flow to the nearest wadi	Free of pollutants; Difficult to estimate

It is expected that in time SEZAD will develop and define, similar to other international industrial zones, a Liquid Waste Disposal Criteria and / or Liquid Waste Management Procedure such that suitable management effluent management plans are implemented for all products within the operational pipelines and any associated maintenance wastes.

Any wastewater generated from accident or emergency events, is the responsibility of the Pipeline owner, will be collected/ stored/ managed as per the requirements of MD 18/93, MD 145/93, and MD 159/2005 and disposed of in approved facilities.

Options of recycling operational liquid effluents, such as products, oils, lubricants and chemicals will be adopted wherever possible.

4.3.4 Solid Wastes

There won't be any major or continuous source of solid waste generation during the O&M of the Service Corridor and its associated pipelines.

5 CLIMATE AFFAIRS

This chapter presents the Green House Gas (GHG) releases from the project activities and discusses the impact on the climate due to the Project.

An estimate of greenhouse gases (GHG) emissions using the emission factors from the Intergovernmental Panel on Climate Change (IPCC) Guideline, and data from the design documents is presented in this chapter. This chapter has been prepared and structured as per the guidelines from the Directorate General of Climate Affairs (DGCA) at the Ministry for Environment and Climate Affairs (MECA), and its subsequent updates.

5.1 Contact Details

The organization and contact details for issues related to climate affairs issues are provided below:

Centralised Utilities Company

P.O. Box 80, Postal Code 102, Sultanate of Oman

Tel: 2208 2000; Fax: 2208 2004

Contact: Mr Mandar Kulkarni (Project Manager)

Email: mandar.kulkarni@almarafiq.net

HMR Environmental Engineering Consultants

P.O. Box 1295, Postal Code 111, CPO Seeb, Sultanate of Oman

Tel: 2461 8800, 2461 8829; Fax: 2461 8811

Contact: Ms Renelle Watson (Project Manager)

Email: renelle@hmrenv.com

5.2 Integration of Climate Affairs Issues to the EIA

5.2.1 Type of Ozone Depleting Substances

The only device likely to contain Ozone Depleting Substances (ODS) during the project activities are potentially the air conditioners that will be used at the site office and living quarters during the construction of the service corridor. Based on the peak manpower estimates of approximately 500 people, it is anticipated that potentially a maximum of up to 200 units of window air conditioners might be installed in the site office and in the construction camp during the construction activities. There will be no need to have air conditioning units during the operation stage of the service corridor.

Hydrochlorofluorocarbons (HCFCs) will be phased out completely by 2015 in line with Montreal Protocol and the construction camps that will be built to house the site workers who will be involved in the construction of the service corridor will comply with this requirement. In fact, based on the design, it is anticipated that no Halons, Chlorofluorocarbons (CFCs), and HCFCs will be used in this project site office and construction camp. However, trace amounts of refrigerants will be used in chiller packages for potable water, and the construction contractor will import chillers that use hydrofluorocarbons (HFCs) rather than HCFCs. The EPC contractor will take into consideration the requirements of Montreal Protocol and ensure compliance to it as well as to the requirements of MD 243/2005[4] and MD 281/2003[5]. The procurement of air conditioning units for the construction phase would also take the above aspects in to account.

It is possible that sulfur hexafluoride (SF6) might be used in high voltage electrical equipment as insulating material.

As this is a Greenfield development, the actual quantity of the global warming potential inducing substances shall be quantified in the forthcoming Climate Affairs Application.

5.2.2 Equipment Containing ODS

The construction camp will not use any ODS and will also not use polychlorinated biphenyl (PCBs), polychlorinated terphenyls (PCTs), and asbestos. No carbon tetrachloride (CCl4) will be used in refrigerants. No new equipment purchased will be allowed to contain any asbestos.

Standard air conditioners that are commercially available in the local market through authorized distributors will be procured. Although it is anticipated that there could be around 200 window air

[4] Regulations for the control and management of Ozone Depleting Substances (ODS)
[5] Regulations for control and management of radioactive substances

conditioners, the exact number and make of these air conditioners will be finalized during the design stage of the project. The air conditioners will be sourced, serviced, and maintained by authorized suppliers and service centers in Oman, which are expected to comply with the requirements of MD 243/2005. Controlled substances listed in MD 243/2005 or equipment, appliances, and products containing such substances will not be used during any stage of the project.

5.2.3 ODS Alternative

The project does not envisage use of any ODS, except for potential trace amounts of SF6. As noted earlier, the EPC contractor will identify and implement processes and procedures to ensure that non-ozone depleting refrigerants will be used during the project. Accordingly, the project will consider all options to use alternatives with less ODS potential.

5.2.4 Plan for Use of ODS Alternative

Regular maintenance of equipment using ozone-depleting refrigerant is the best system for ensuring optimum performance of equipment and minimizing any possible leaks. Recapture and re-use of refrigerants will be employed for all equipment undergoing maintenance or being disposed. No equipment will be disposed from the project site if the refrigerant has not been captured or assigned to a location where it can be assured that recovery will occur.

5.2.5 Adherence with Ministerial Decision 243/2005

Controlled substances listed in MD 243/2005 or equipment, appliances, and products containing such substances will not be used during any stage of project.

5.2.6 Identifying Climate Affairs Issues in the EIA Study

The GHG emissions from various sources such as combustion sources, solid waste, solvent use, gas systems, wastewater treatment, etc. are presented in the following sections.

5.3 GHG Emissions during Construction

5.3.1 Stationary Combustion Sources

One diesel generator of 1 MW rating will be used to meet power requirements for the construction camp and for some of the construction activities (such as concrete batching, pipe cutting, etc.). The type and quantities of the GHG emissions generated in the construction camp and the stationary construction activities is presented in Table 5-1. The detailed GHG emission calculations for stationary combustion sources are given in Table 5-2. The calculations are based on the IPCC6 emission factors. For the purposes of calculation, it has been considered that the activities of the construction camps will be completed within a period of 18 months.

Table 5-1: GHG Emissions from DG sets during Construction

Year	DG capacity	GHG (tons)		
		Carbon Dioxide - CO_2	Methane - CH_4	Nitrous Oxide - N_2O
2015 (6 months)	1 MW	2,569.5	0.104	0.021
2016 (12 months)	1 MW	5,139	0.208	0.042
Total for the DG sets		7,708.5	0.312	0.063

Assumptions made in the above calculations:

- Assuming that an average efficiency of a diesel generator is 45%, it will produce around 16.4 MJ of electrical energy per litre of diesel burnt. Based on the load of 1 MW diesel generator (3,600 MJ/hour), the diesel consumption will be 3,600/16.4 = 220 litres/hour. Assuming that it will be operating all through the month (since it is for the construction activity and construction camp), the monthly diesel consumption will be approximately 160 m^3 per month.
- 160 m^3 per month of diesel consumption results in approximately 428 tonnes/ month of GHG emissions for the 1 MW DG set (refer Table 5-2) which will be used in the construction period. For the construction period of 18 months, the total GHG emissions for the construction camp and other stationary construction activities would be approximately 7,710 tonnes of CO_2 (carbon dioxide).
- Emissions of CH_4 (methane) and N_2O (nitrous oxide) are very negligible.

[6] http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_2_Ch2_Stationary_Combustion.pdf

Table 5-2: Detailed GHG Emission Calculations for Stationary Combustion Sources

DG Capacity	1 MW	Units
Diesel requirement	160	m^3/month
Density of Diesel	0.86	kg/L
LHV of Diesel	42000	KJ/kg
Mobile Combustion (IPCC Table - 3.3.1)[7]		
CO_2 emission factor	74100	kg/TJ
CO_2 emitted from DG set	428.24	tpm
	5,139	tpa
CH_4 emission factor	3	kg/TJ
CH_4 emitted from DG set	0.017	tpm
	0.208	tpa
N_2O emission factor	1	kg/TJ
N_2O emitted from DG set	0.0035	tpm
	0.042	tpa

5.3.2 Mobile Combustion Sources

The GHG emissions summary from mobile combustion source is presented in Table 5-3. It is to be noted that the mobile sources referred in the IPCC guidelines cover off road transportation sources including vehicles and mobile machinery used for construction and maintenance. The detailed GHG emission calculations are given in Table 5-4. It is anticipated that certain construction activities will require diesel fuel for power including construction vehicles and equipment, such as excavators, loaders, hauler cranes, compactors, trucks, water tankers, and crew transport vehicles. It is assumed that the diesel consumption for construction vehicles and equipment will be in the range of 10,000 L/month (i.e. 10 m3/ month).

[7] http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_2_Ch2_Stationary_Combustion.pdf

Table 5-3: GHG Emissions from Mobile Combustion during Construction

Year	Greenhouse Gases - GHGs (tonnes)		
	CO_2	CH_4	N_2O
2015 (6 months)	160.59	0.009	0.062
2016 (12 months)	321.18	0.018	0.124
Total	481.77	0.027	0.186

Assumptions made in the above calculations:

- 10 m^3 per month of diesel consumption results in approximately 27 tonnes per month of GHG emissions in CO_2.
- Emissions of CH_4 (methane) and N_2O (nitrous oxide) are very negligible.

Table 5-4: Detailed GHG Emissions Calculations for Mobile Combustion Sources

Equipment	Value	Unit
Diesel requirement	10	m^3/month
Density of Diesel	0.86	kg/L
LHV of Diesel	42000	KJ/kg
Energy input	0.036	TJ/day
Mobile Combustion (IPCC Table - 3.3.1)[8]		
CO_2 emission factor	74100	kg/TJ
CO_2 emitted from vehicle movement	26.76	tpm
	321.18	tpa
CH_4 emission factor	3.9	kg/TJ
CH_4 emitted from vehicle movement	0.0015	tpm
	0.018	tpa

[8] http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_3_Ch3_Mobile_Combustion.pdf

Equipment	Value	Unit
N_2O emission factor	3.9	kg/TJ
N_2O emitted from vehicle movement	0.0103	tpm
	0.124	tpa

5.3.3 Fugitive Emissions

Fugitive emissions from the project will be limited to fugitive dust emissions during construction and emissions from solvent use. The fugitive gaseous emissions are expected from fuel storage areas and vehicles, and from use of solvents during the construction phase; however significant quantities of emissions are not expected during construction phase.

5.3.4 Land Use and Land Use Change or others

Not Applicable.

5.3.5 GHG Emissions from Industrial Process of the Proposed Plant/Industry

This is not applicable since the industrial processes during construction are only construction of roads, excavation, installation of pipes, etc. and the impacts are quite transient. The GHG calculations have already been carried out.

5.3.6 GHG Emissions from Solid Waste

The recyclable, hazardous, and non-hazardous wastes generated during the construction activities, including the construction camp, will be collected, stored, and disposed in accordance with MD 18/93[9] and MD 17/93[10] regulations. There will not be any biological treatment, incineration, or open burning of waste at the project site during the construction phase. Accordingly, no GHG emissions are expected from the solid waste management.

[9] Regulations for the management of hazardous wastes
[10] Regulations for the management of the solid non-hazardous wastes

5.3.7 GHG Emission from Wastewater Treatment

The sewage generated from the site, during the construction phase from the construction camp and site office, will be collected in holding tanks and will be trucked to the sewage treatment plant (STP) located in Duqm for treatment and disposal. At the peak, the construction activity will have approximately 500 people, and estimating that the wastewater generation will be 100 litres per day of wastewater, the maximum wastewater generation will be around 50 m^3/day. Since they will be treated at the STP, there will be no GHG emissions from wastewater treatment during construction phase.

5.3.8 Reporting Total Amount of GHG Emission during Construction

The details of the GHG emissions calculations from the above tables are presented in Table 5-5.

Table 5-5: Total GHG Emissions during Construction

Type of Activity	Methodology according to IPCC	Emission Factor	Quantity of fuel for Combustion	Total Emissions for 18 months
Stationary Combustion	Emission factors provided in the 2006 guidelines for National Greenhouse Gas Inventories, Volume 2 by IPCC.	CO_2 – 74,100 kg/TJ CH_4 – 3 kg/TJ N_2O –0.6 kg/TJ	160 m^3/ month	CO_2 – 7,708.5 tonnes CH_4 – 0.312 tonnes N_2O – 0.063 tonnes
Mobile Combustion		CO_2 – 74,100 kg/TJ CH_4 – 4.15 kg/TJ N_2O –28.6 kg/TJ	10 m^3/ month	CO_2 – 481.77 tonnes CH_4 – 0.027 tonnes N_2O – 0.186 tonnes
Fugitive Emissions from Oil & Natural Gas System		Not Applicable	-	-
Others		Not Applicable	-	-
Type of Activity		**Methodology according to IPCC**		

The total CO2 emissions are estimated to be 5,460 tpa. Currently, there is no ceiling limit set for CO2 emissions (mass) rates in Oman. According to the UN Statistic Division and the Carbon Dioxide Information Analysis Centre (CDIAC) estimate, Oman generated approximately 57,202,000 tpa during 2010. In comparison with the estimates, the total CO2 emission from camps accounts for approximately 0.00009%, of the total estimated quantity of CO2 emitted by Oman annually.

5.4 GHG Emissions during Operation Phase

5.4.1 GHG Emissions during Operations Phase – Stationary Source

Because of the nature of this project, there will be no need to have diesel generator during the operation stage. Accordingly, there will be no GHG emission from the operation phase stationary source.

5.4.2 GHG Emissions during Operation Phase – Mobile Source

During the operation phase, no GHG emission will be there directly from the service corridor. Accordingly, there will be no GHG emission from the operation phase mobile source.

5.4.3 Details of GHG Emissions from Operation Phase

There will be no GHG emission in the operation phase.

5.4.4 GHG Emissions from Solvent Use

This will not be applicable.

5.4.5 GHG Emissions from Solid Waste Generation

Because of the nature of this project, there will be no solid waste generation during the operation stage. Accordingly, no GHG emissions are expected from the solid waste management.

5.4.6 GHG Emission from Wastewater Treatment

Because of the nature of this project, there will be no wastewater generation during the operation stage. Accordingly, no GHG emissions from wastewater treatment are expected during the operation phase.

5.5 Reporting Total Amount of GHG Emissions

The total GHG emission from the construction and operation is presented below in Table 5-6:

Table 5-6: Total GHG Emissions – Construction and Operation

	Type of Activity	Methodology according to IPCC	Emission Factor	Quantity of fuel for Combustion	Total Emissions for 18 months
Construction	Stationary Combustion	Emission factors provided in the 2006 guidelines for National Greenhouse Gas Inventories, Volume 2 by IPCC.	CO_2 – 74,100 kg/TJ CH_4 – 3 kg/TJ N_2O –0.6 kg/TJ	160 m^3/ month	CO_2 – 7,708.5 tonnes CH_4 – 0.312 tonnes N_2O – 0.063 tonnes
	Mobile Combustion		CO_2 – 74,100 kg/TJ CH_4 – 4.15 kg/TJ N_2O –28.6 kg/TJ	10 m^3/ month	CO_2 – 481.77 tonnes CH_4 – 0.027 tonnes N_2O – 0.186 tonnes
	Fugitive Emissions from Oil & Natural Gas System		Not Applicable	-	-
	Others		Not Applicable	-	-
Operation	Stationary Combustion, Mobile Combustion, Fugitive Emissions, and Others				0

5.6 Assessment of Climate Change Impacts and Vulnerability

The overall vulnerability of the project to climate change is low to medium. Any disruptions in operations that could occur as a result of weather events such as cyclones will be short term in nature. An overall change in climate will not affect the operation of the facilities. A Climate Affairs Risks Matrix is provided in Table 5-7.

Table 5-7: Climate Change Risk Matrix

Type of Risks	Frequency/ degree of Vulnerability[11]	Climate Impacts due to identified Vulnerability[12]	Risk Magnitude
Natural Disasters such as cyclone, earthquake, high waves, landslides, and dust storms	2[13]	2	2
Sea Level Rise	1	1	1
Temperature Increase	1	1	1
Heavy Rains	1	1	1
Flash Flooding	1	1	1

5.7 Climate Change Mitigation and Adaptation

The mitigation options and adaptation measures for climate change is discussed in Table 5-8.

Table 5-8: Mitigation measures

#	Mitigation options	Mitigation Measures
1	Identify the new technologies and measures to minimize the energy consumption and improve the energy efficiency for all stages of the Project.	The energy used in the camp operation will be mainly from the diesel generator; The EPC contractor will be required to include energy efficient designs and equipment during all stages of the construction and for the operation phase of the project, wherever it is applicable. The EPC contractor will be required to use certified energy efficient equipment (where possible) to minimize emissions to the maximum extent possible. The EPC contractor could be asked to adapt and install solar power units at the construction camp as it will then minimize the use of DG set and reduce the diesel consumption. The main sources of GHG emissions are construction vehicles, equipment, and diesel generator, etc. They will be used only during the 18 months of construction period. The vehicles and construction equipment will be maintained properly so that the efficiency of the equipment and vehicles are not compromised.

[11] 1,2,3 indicate low, medium and high frequencies respectively of vulnerability
[12] 1,2,3 indicate low, medium and high impacts respectively due to identified vulnerabilities
[13] The frequency is taken as 2 since Oman had been impacted by cyclones such as Gonu and by dust storms. The other risks in this category such as earthquake, high waves, and landslides are rated as 1.

#	Mitigation options	Mitigation Measures
2	Identify the potential usage of renewable energy for all the stages of the Project and explain the future visions of how to incorporate them into the project activities and how to eliminate the barriers, if exits, which prevents such action.	Already covered above.
3	Explore the benefits of CDM under Kyoto Protocol.	The proposed project currently does not involve opportunities for carbon capture, reduction, or sequestration.
4	Consider planting carbon sinks, which suits to local environment and conditions to reduce GHG.	This project area footprint in the construction and operation phases will be quite small. So, carbon sink will not be possible.
5	Attach the landscaping plan/design of proposed plantation/ green cover.	The entire area is largely barren and being the corridor for movement of vehicles and erected pipelines, there will not be any green cover.

5.7.1 Mitigation

The use of water and energy conservation fixtures at the site office and the construction camp will reduce the resource consumption. It is to be noted that the EPC contractor will utilize energy optimization methods, such as use of efficient and well-tuned equipment and energy efficient generator, for the camp and construction activities which will minimize losses and in turn maximize energy efficiency.

The renewable energies available for use in the project area are wind and solar power. Although the region has high wind speeds, the installation and energy generation from wind power is presently not considered by the Government. Since the construction phase will be over in 18 months, the wind power is not being considered.

The energy from the sun varies from place to place and is entirely dependent on weather conditions. Normally, the available energy from the sun is 1 KW/m^2 per hour in the absence of clouds. Some of the considerations for a solar energy system include the lifespan of the system and the hours of available sunlight. The hours of available sunlight further depends on latitude, climate, and unblocked exposure to the sun, ability to tilt panels towards the sun, seasonality, and temperature, etc. It is to also be noted that solar energy installation requires a large area for the system to be efficient in

providing a source of electricity. The use of water and energy conservation fixtures at the site facilities will reduce the resource consumption. It is anticipated that the EPC contractor will be asked to explore the feasibility of installing solar panels for the construction camp.

5.7.2 Adaptation

The main climate change impacts on the development would be from dust storms and cyclones during extreme weather events. A description of the procedures and tools to adapt and mitigate the impacts of climate change for the project in case of floods, sea level rise, dust storms, Tsunami and increase in temperature are described below:

High waves, Floods, Tsunamis, and Sea level rise

The greatest Tsunami threat facing the Omani coastline is expected to be from the Makran subduction zone in the Gulf of Oman and the Northern Arabian Sea. However, within the Arabian Gulf, it is rather unlikely for large tsunamis to form. Given that the coast is shallow, not prone to landslides, and is without volcanoes, the likelihood for tsunamis is relatively low.

SEZAD has conducted detailed studies on both the onshore and offshore areas to assess the risks and are also currently doing a study on "coastal erosion assessment and preparation of designs to minimize impacts". Therefore, extreme events such as floods, cyclones, Tsunamis, and storms will be considered and protective measures implemented. This will cover the project area as well.

Although the release of GHGs into the atmosphere contributes to global warming and consequently increasing the sea level, it is an on-going phenomenon globally, and historic rates are generally estimated to be in the range of 3.2 mm/year (or 0.16 m over 50 years). According to the study by the Arab Forum for Environment & Development, it is expected that only a fraction of the overall land area of the Sultanate of Oman will be impacted due to a 1 m rise in sea levels. The project will not be impacted as it will be in the higher elevation area.

Landslides

According to World Health Organisation atlas (http://www.who-eatlas.org/eastern-mediterranean/images/map/oman/omn-landslides.pdf), the landslide hazard index for complete Oman is between low and very low. Hence the likelihood of the project being affected by landslides is very unlikely. Figure 5-1 also shows the frequency of landslides from precipitation in Oman is low.

http://www.preventionweb.net/english/maps/index.php?cid=128

Figure 5-1: Risk of Landslides from Precipitation in Oman

Drought and Change in Groundwater Level

The groundwater in the area is highly saline and it is expected that the EPC contractor will prefer using the existing desalination plant supplied potable water to meet the requirements of the camp and the site office. Therefore, the project will not directly contribute to change in groundwater level in the area.

Dust storms

The construction camp and other construction structures will be designed to withstand high winds and have the structural integrity to withstand events such as storms, floods, sea level rise, high dust loading conditions, sandstorms, etc.

Increase in Temperature

The region where the camp is located is prone to high summer temperature for an extended period and therefore the site office and the construction camp will be adequately provisioned with heating, ventilation, and air conditioning (HVAC) systems.

6 ANALYSIS OF ALTERNATIVES

All available alternatives for the major project design decisions are to be discussed with a particular emphasis on environmental considerations. The rationale and the need for the following are discussed in this section:

- Need for the project
- No-Project Alternative
- Routing of Service Corridor
- Laying of pipelines
- Sourcing for utilities for construction phase

6.1 Need for the Project

Once operational, the service corridor will provide centralized utilities and pipeline corridor for the proposed Duqm Refinery and several heavy / petrochemical industries that will be coming up in the Duqm industrial area, which is a part of the overall master plan for developing Duqm Town as per RD 119/2011. This will enable SEZAD to offer multiple customers an integrated supply of energy, water, utilities, logistics, etc. and allowing the companies to focus on their core business and save on investment and operating costs to get access to utilities.

6.2 No-Project Alternative

The No-Project Alternative would require the abandonment, or non-start of the service corridor project. For this alternative option there would be no environmental impact, but proposed developments around Oman would not commence and the economic development of the area would not progress. In addition, if companies do come in, then they will establish their own network for the pipelines and logistics and there will be duplication, and the cumulative impact would be significantly higher.

6.3 Routing of Service Corridor

The routing has been decided based on the best access route for moving the raw material from / to the Duqm Refinery to the Duqm Port considering the developmental constraints in that area. Based on HMR knowledge of the Duqm Refinery Project, two alternate options for the Service Corridor were investigated, a Coastal Route and Road Route. The proposed alignment was chosen as it was

considered optimum based on two main factors: it is the shortest alignment length and most direct route. In addition to these two factors, the current proposed alignment is considered to have a smaller disturbance area / footprint, and hence likely has lower environmental impact than the other proposed alignment options.

6.4 Laying of Pipeline

The laying of pipeline can be carried out in two ways – over ground or buried. The advantages and disadvantages of both the options are presented below:

- Over ground pipelines involve fewer earthworks, whereas buried pipelines involve significant trenching activities.
- Any faults in over-ground pipeline are easy to detect and repair than in buried pipelines.
- Over-ground pipelines need fencing to protect animals getting trapped accidentally, thus restricting their movement, whereas the buried pipeline eliminates any need for fencing.
- Reinstatement of ecologically sensitive species, re-vegetation and restoration of landform contours is possible in case of buried pipeline.
- Surface coating and technical issues are balanced for both the options.

Considering the above factors, buried pipeline is a preferred option as opposed to over-ground pipelines, and where possible the DSC Project involves buried pipelines.

6.5 Sourcing of Utilities

The major utilities required during the construction phase of the Project are power, potable and non-potable water, and fuel.

- Power: The power demand during construction phase is not expected to be significant. The alternatives considered are import from the local grid or the use of on-site diesel generators. Among the two, sourcing of power from grid is a more preferable option than the former due to associated environmental considerations. However, due to the remoteness of the work site, it is not feasible to draw power from the local grid, even if spare capacity is available from the

local grid. Moreover, the power requirement during construction phase is not significant enough to make such arrangements and power requirements during operations phase is only limited to any maintenance activities. Therefore, the power required during the construction phase will be met from on-site diesel generators.

- Non-potable and Potable water: Non-potable water at site can be sourced from local shallow groundwater wells. For drinking water, either bottled mineral water or purified groundwater will be used. Either of these options is acceptable, though the first option is more preferable.
- Fuel: Fuel will be sourced from local resources. As the pipeline construction will be based on a 'moving assembly line' basis, it is preferred to transport the fuel on requirement basis through vehicles as opposed to storage tanks.

7 ENVIRONMENTAL IMPACT ASSESSMENT

7.1 Overview

This section identifies and assesses potential impacts on the environment from the various activities associated with the construction and operation of the Duqm Service Corridor (DSC). Identification and assessment of environmental impacts in general is carried out in accordance with guidelines and requirements of MECA.

The environmental setting of the DSC route and its surroundings are documented in the *Environmental Baseline Report* for Service Corridor (HMR, April 2015b).

The impacts are identified and assessed considering the environmental releases from the construction and operation activities. In general, the impacts that are irreversible or that are expected to take a long period to recover are defined as 'long-term impacts'. Considering the significance of project activities and site sensitivities, it is appropriate to assess potential impacts based on the inherent hazards associated with each activity. This allows for a subsequent assessment of risks and consequences.

The DSC construction activity is scheduled for duration of 18 months (commencement of construction Q3 of 2015 and completion of construction Q4 of 2016) and various associated activities may have potential long term impacts on the existing environment. The mitigation and control measures are presented in the EMP chapter.

7.2 Methodology

The identification and assessment of environmental impacts is based on the guidelines provided in ISO 14001 series of standards and includes the following steps:

- Identification of major activities during the construction and operation phase of DSC based on the discussions on project details provided in Chapter 3;
- Identification of potential environmental aspects from the project activities (identified in the above step) based on discussions in Chapters 3 and 4;

- Identification of environmental releases and potential impacts of the Project considering the environmental aspects identified and various environmental elements / sensitivities (receptors) which are likely to be impacted due to the Project; and
- Assessment of environmental impacts considering the severity of impact and likelihood of its occurrence.

Based on the above, as the first step, each major activities of the project are identified. The associated environmental aspects are identified based on the project description and various releases into the environment. The resulting impacts are identified by combining the above information with the environmental elements / sensitivities. Whenever interactions exist between the identified aspects and sensitivities, they are further analyzed to determine the potential impacts from the project.

For planned activities and resulting aspects, the assessment is carried out considering severity of impacts and the duration of their occurrence; whereas for unplanned activities, the assessment is carried out considering the severity of impacts and the probability of their occurrence.

Impacts may be classified as beneficial / adverse, direct / indirect, reversible / irreversible or short / long term. Using the Impact Assessment Matrix, the impacts have been evaluated using qualitative assessment techniques and rated as 'low', 'medium' or 'high'. An impact assessment matrix, as presented in Figure 7-1 has been used for systematic assessment of impact significance, taking into account of duration and magnitude.

The impact ratings are based on two parameters, i.e., severity of impact and duration or likelihood of occurrence of the aspects. Severity of any impact will depend on the magnitude of the impact, the nature (reversible / irreversible) and the sensitivity of the environmental / social sensitivity. The likelihood of its occurrence depends upon the nature of the aspect / impact and the control measures in place.

For impacts resulting from unplanned and accidental aspects / activities, the assessment is based on consideration of the impact severity and the likelihood of it is occurrence. While the impact severity depends on the nature and size of the activity aspects and the environmental sensitivity, the likelihood depends upon the nature of the activity / aspect and the control measures in place. An impact

assessment matrix, as presented in Figure 7-2, is used for combining the two assessment criteria, i.e., the severity of impact and the likelihood of its occurrence.

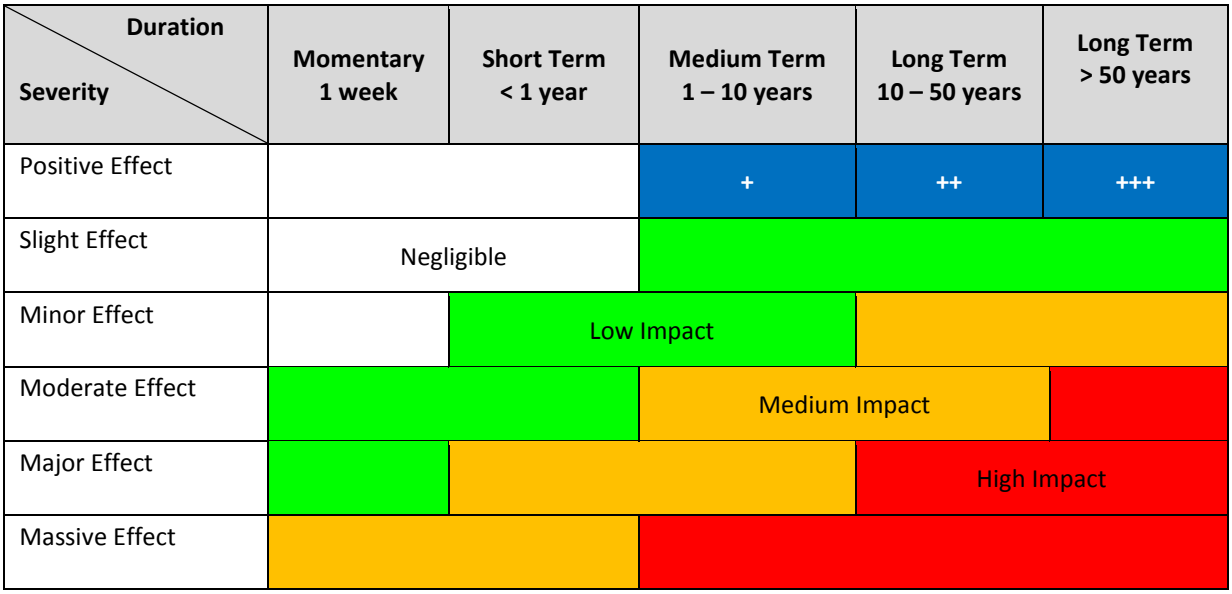


Figure 7-1: Impact Assessment Matrix for Planned Aspects

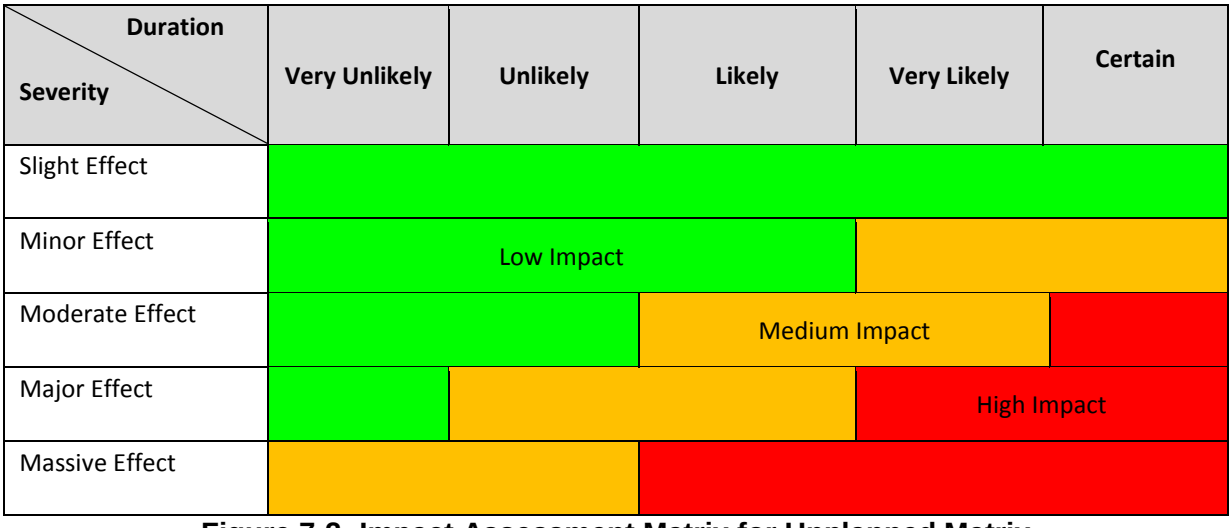


Figure 7-2: Impact Assessment Matrix for Unplanned Matrix

Tabulated below are the definitions of terms used to rate the likelihood of occurrence as presented in Table 7-1 and severity of impact and the duration as shown in Table 7-2.

The resultant impact (consequence) is defined as the multiplication of severity and duration or likelihood. Accordingly, from the assessment matrix, the resultant impacts are classified as low, medium, and high.

These terms are explained as follows:

- **Low impacts** are considered to be acceptable or within ALARP levels. Further control measures are not required to mitigate these impacts;
- **Medium impacts** are those requiring control measures, and management plans need to be implemented so as to mitigate the impacts to ALARP levels; and
- **High Impacts** are those requiring additional studies for such impacts, alternative activities with lower impacts or alternative locations with lower environmental sensitivities or compensatory measures need to be considered during the detailed design stage of the project.

Table 7-1: Likelihood of Occurrence

Likelihood	Definition
Certain	Will occur under normal operating conditions.
Very likely	Very likely to occur under normal operational conditions.
Likely	Likely to occur at some time under normal operating conditions.
Unlikely	Unlikely to but may occur at some time under normal operating conditions.
Very unlikely	Very unlikely to occur under normal operating conditions but may occur in exceptional circumstances.

Table 7-2: Severity of Impact

Severity	Definition
Massive	▪ Persistent severe environmental damage or severe nuisance extending over a large area; ▪ Constant, high exceedance of statutory or prescribed limits (representing a threat to ecosystem in both the long and short term); and ▪ In terms of commercial or recreational use or nature conservancy, a major economic loss for the company.
Major	▪ Severe environmental damage; ▪ Extended exceedance of statutory or prescribed limits; and ▪ The company is required to take extensive measures to restore the contaminated environment to its original state.
Moderate	▪ Release of quantifiable discharges of known toxicity; ▪ Instances exceedance of statutory or prescribed limit; and ▪ Causing localized nuisance both on and off site.
Minor	▪ Contamination; ▪ Damage sufficiently large to attack the environment; ▪ No permanent effects to the environment; ▪ Single exceedance of statutory or prescribed criterion; and ▪ Single complaint.
Slight	▪ Local environmental damage; ▪ Within the fence and within systems; and ▪ Negligible financial consequences.

In assessing the impacts, it is to be noted that the project activities, related environmental aspects and associated impacts are presented together to facilitate subsequent rating. The ratings are primarily based on qualitative assessment of the situation and its interaction with the environmental elements.

The impacts, which are rated as low are considered to be acceptable or within "As Low as Reasonably Practicable (ALARP)" levels. Control measures for further mitigation of these impacts may not be viable. Impacts that are rated as medium and high (significant impacts) will be managed through mitigation measures and implementation of the environmental and social management plan to reduce the residual risks / impacts to ALARP levels.

7.3 Potential Hazards and Impacts by Activity

A summary of the potential impacts of the construction and operation activity is presented in Table 7-3 and Table 7-4.

Table 7-3: Potential Impacts from Construction Phase

Significant Sources of Impact	Potential Environmental Impacts
Land take	
Land take for construction of DSC embankments; construction office/lay down areas for storage of construction materials and wastes etc	▪ Loss of terrestrial habitat; ▪ Conflict with current land use; ▪ Restricted access for community; and ▪ Visual impacts.
Construction works (Direct actions and effects)	
Mobilization of construction equipment and people.	▪ Stress on traffic along the existing roads within Duqm required for transporting men, materials and equipment; ▪ Safety risk to road users; ▪ Influx of large number of people into the project area; and ▪ Health risk to local people.
Construction work	▪ Adverse impact on aesthetics of the site; ▪ Damage to vegetation; ▪ Damage to habitats; ▪ Changes to landscape ▪ Damage to existing surface drainage channels & impacts of flooding ▪ Health and safety for workers & community; ▪ Nuisance to surrounding Community; and ▪ Generation of employment and economic benefit.
Resource use	
Utilization of mineral resources (For construction materials)	▪ Off-site impacts from quarrying for rocks, aggregates, soil. ▪ Off-site impacts on borrow pits (for soil if the excavated soil from site is found insufficient or unsuitable for use).
Utilisation of fuels (For DG sets, construction vehicles and equipment)	▪ Depletion of non-renewable resources; ▪ Loss of fuel due to inappropriate storage and handling
Utilization of groundwater resources (For construction water and domestic / potable water)	▪ Stress on water supply resources

Significant Sources of Impact	Potential Environmental Impacts
Utilization of human resources (Employment of immigrant / expatriate workers for construction)	▪ Generation of employment for local workers; ▪ Public safety and health risks; and ▪ Social conflicts due to workforce influx.
Utilization of local infrastructure facilities (Accommodation, roads, local transport, power supply, water supply, sanitation, hospitals etc.)	▪ Stress on local infrastructure facilities; ▪ Stress on traffic; ▪ Public safety and health risks; and ▪ Local life style and cultural conflicts.
Releases to environment	
Release of air pollutants (Dust from construction activities and road traffic; gaseous emissions from fuel run engines)	▪ Degradation of local air quality ▪ Nuisance and health risks for local communities.
Generation of high level noise (From DG, construction equipment and vehicles)	▪ Increase in ambient noise levels; ▪ Disturbance to local communities, workers; and ▪ Health risk to workers.
Discharges of liquid effluents (Sewage – onsite and labour camps, surface runoff, accidental spillage of hazardous liquid/materials etc.)	▪ Onsite/Offsite soil contamination; ▪ Onsite/Offsite groundwater pollution; and ▪ Health risk to workers and local people.
Management of solid wastes (storage, handling, transport and disposal of non-hazardous construction and domestic wastes and disposal of hazardous wastes from construction site)	▪ Soil contamination onsite/offsite; ▪ Groundwater pollution; ▪ Health risk for community; ▪ Housekeeping issue (restriction on movement due improper waste collection and storage, potential blockage of access to assembly point due storage at undesignated area, tripping or slipping hazards, etc.); ▪ Health risk to workers and local people; and ▪ Stress on landfill for the area.
Handling, storage and transport of hazardous substances (Fuel oils, hazardous chemicals etc.)	▪ Onsite/Offsite soil and groundwater contamination; ▪ Fire, explosion and health risk to workers and local people; and ▪ Public health risk from accidental spillage.

Table 7-4: Potential Impacts from Operation Phase

Significant Sources of Impact	Potential Environmental Impacts
Resources use	
Utilization of human resources (Employment of immigrant / expatriate workers)	▪ Generation of employment for local workers; ▪ Public health risks from use of immigrant workers; ▪ Stress on local healthcare infrastructure; and ▪ Social conflicts due to workforce influx.
Releases to environment	
Vehicle movement along DSC during inspection and maintenance	▪ Degradation of air quality due to dust risings and engine emissions; ▪ Damage to vegetation in case of off-road driving; and ▪ Disturbance to fauna.
Handling, storage and transport of non-hazardous and hazardous substances (Waste oils, pigging wastes and contaminated soils, if any) during Operation and Maintenance,	▪ Land contamination; ▪ Groundwater contamination; ▪ Public health risk from hazardous material transport; and ▪ Disturbance to flora and fauna.
Ecology and wildlife	
Impact to local flora and fauna	▪ Cutting green trees will be prohibited (MD 169/2000) ▪ Hunting or aggravation of wildlife will be strictly prohibited (RD 8/2003 and MD 101/2002) ▪ Disturbance to the domestic animals (camels in particular) moving around or grazing will be kept to a minimum ▪ Accidental injuries or fatalities to these animals will be reported to SEZAD / MECA / or the appropriate Authority.
Soil and groundwater	
Accidental spillage or leakage of products, solvents, chemicals Land and groundwater contamination due to spilled material, storage of Hazardous waste and discharge of contaminated water. Potential flooding / pooling in neighbouring area	▪ Appropriate storage facilities for hazardous materials and wastes, with spill containment ▪ Records of waste generated and waste disposed to be maintained ▪ Spill prevention plan and routine inspection of storage facilities ▪ Any discharge on land to be strictly controlled ▪ Elevation of the Project area will take into consideration of flood risk assessment study ▪ Proper diversion of wadis (if required) will be planned during FEED Stage.

7.4 Assessment of Impacts during Construction Phase

This section presents the evaluation of a potential environmental impacts identified in Table 7-3. It may be noted that for a potential impact, there is more than one source. Therefore, the net impact on each receiving environment due to the various causes is presented in the following sections. It is to be noted that the entire construction activity, from contractor mobilisation to de-mobilisation, will be completed within 18 months.

7.4.1 Natural Resources

During the construction phase, the significant activities that may have potential impacts on natural resources are consumption of aggregates and soil (if required) for civil work; consumption of fuel and electrical power for construction equipment, transport vehicles and in labour camps and consumption of groundwater for construction and domestic use.

The rocks and aggregates that will be used in the civil work will be procured from local quarries. Any fresh/virgin soil required would be procured from local borrow pits, which are approved by SEZAD. These resources are abundantly available, locally, hence no adverse impacts are expected.

Petrol and diesel oil will be used as fuel for DG, construction machinery and vehicles. The quantities of fuel required are not available and it is expected that the local suppliers of refined petroleum products can adequately supply the required quantities, without adversely affecting the local supply. The peak power demand during the construction phase is not known at present, nor is the requirements for DG sets required during the construction phase.

The total water required for the construction activity is proposed to be sourced from approved suppliers or local groundwater wells. If it is found that local groundwater supply wells cannot meet the project water demand, then attempts will be made to source water from the neighboring area / Wilayats. No current data is available on groundwater extraction, aquifer recharge and variations in groundwater table. Adverse impacts on the groundwater required for the project is expected to be low.

The construction workforce is expected to be accommodated in established camps in Duqm etc. These accommodation facilities will have established water and power supplies. No additional resource

consumption is envisaged in this regard. Based on the above, the impacts on Natural Resources are rated as low.

Issue	Severity	Duration	Likelihood	Impact Rating
Fuel supply and demand	Slight	Medium Term	-	Low
Offsite groundwater supply	Minor	-	Likely	Low

7.4.2 Ambient Air Quality

The major sources of potential impact on air quality during construction phase are as listed below:

- Site preparation, earthwork, excavation, and movement of vehicles, which will result in suspension of dust in the air; and
- Operation of construction machineries and vehicles, and DGs (for power generation). These activities will release primary pollutants, such as NOx, SO_2, VOC and PM_{10} into the ambient air.

The dust risings from earthwork and vehicle movement could be significant on the project site particularly during dry weather conditions. Dust clouds due to vehicular movement will be significant on site.

Direct impacts on the physical environment from dust are likely to be limited, even allowing for extensive lateral spread of dust clouds (which is dependent upon number of variables). However the DSC will not be constructed in close proximity to settlements, and as such, significant nuisance from dust is not expected to occur (dependent upon climatic conditions at the time). Though it is difficult at this stage to quantify the impacts on air quality from the aspects listed above during the construction phase, it is reasonable to consider that the impacts will be limited to the nearby environment. Further the impact will not be for more than 18 months considering the nature and project schedule of construction activities.

Based on the above discussions, any adverse impacts on ambient air quality will be low. The necessary mitigation measures that will be implemented in order to minimise the adverse impacts on ambient air quality are discussed in Chapter 8.

Issue	Severity	Duration	Likelihood	Impact Rating
Impacts on ambient air quality	Minor	Short Term	-	Low

7.4.3 Noise

The heavy equipment used in construction work, the diesel generators used for on-site power generation, and the vehicles used for transportation of material and men to site will pose a nuisance on the noise levels in the workplace. In the absence of specific information on the type, number, duration of operation of the major noise generating sources, it is difficult to make any quantitative predictions.

However, it is likely that at times, the noise levels at work site will be in excess of 85 dB (A) requiring the personnel on-site to wear ear protection. With respect to the ambient, noise is attenuated by distance (typically noise levels drop by about 40 dB (A) at 100 m distance from source, based on standard sound wave divergence in homogeneous loss-free environment). It is envisaged that the construction work will be conducted only during the day time during all 7 days of the week. Noise from transport vehicles will be only transient for a given location. However, it can be considered as a nuisance along with the construction noise to the workers.

Based on the above discussions impacts to workplace noise and ambient noise levels are rated as medium. The necessary mitigation measures are presented in Chapter 8.

Issue	Severity	Duration	Likelihood	Impact Rating
Impacts on noise level	Minor	Short Term	-	Low

7.4.4 Soil and Groundwater

During the construction activities, minor quantities of hazardous substances such as fuel, lube oil, chemicals etc. will be handled and used. Further, the construction activities will generate runoffs from the hazardous material / waste storage areas may potentially be contaminated. Improper collection, transportation, storage, treatment and / or disposal of these hazardous materials and wastes may potentially lead to contamination of soil and groundwater. The improper handling may be due to

absence or lack of proper facilities and methods for handling the materials and wastes. The contamination of soil may consequently impact the qualities of soil and groundwater.

Accordingly, the impacts on soil and groundwater are rated as below.

Issue	Severity	Duration	Likelihood	Impact Rating
Impacts to soil and groundwater due to normal management of wastes	Minor	Medium Term	-	Low
Impacts to soil and groundwater due to accidental release	Major	-	Unlikely	Medium

7.4.5 Ecology

The requirement of a 200 m R.O.W. for the DSC can be seen as a significant loss of habitat in the Wadi areas, when considering total area. The area requirement is also increased by the need for temporary office camps and storage yards during the construction phase. However, vegetation can grow within the Open Space Reserve under the Operational phase. After construction, vegetation can re-colonise the area. The areas passed by the DSC are not isolated habitats. They are components of larger habitats and ecosystems and it is considered that the overall impact from land take would be negligible. The DSC R.O.W. should be strictly adhered to because the marine and intertidal environment can only respond very slowly to disturbance and vehicle tracks remain visible for long periods of time. It is therefore considered that the impact from the Project on habitats present within the area is minimal.

Fauna can be disturbed by the noise, dust and the general activity (vehicle movements, lights, vibration etc.) associated with the pipeline construction. Indirect impacts arising from construction include impacts from poor site practices. The presence of putrescible material can attract fauna to scavenge from the construction area. The fuel spillage could in certain instances, poison fauna, or contaminate the area impacting the ecosystem as a whole. The construction activities can also pose a threat to the livestock especially camels and goats in the area.

Issue	Severity	Duration	Likelihood	Impact Rating
Impact on the flora and fauna along the pipeline route	Moderate	Medium Term	-	Medium

7.4.6 Land Use and Local Community

As mentioned in the previous sections, the DSC will be 200 m wide and will be approximately 6 km long. Hence it is envisaged that there will be insignificant or no-land use conflict with the local communities during both construction and operation phase of the Project. The nearby Duqm settlement will not be impacted by site preparation activities and movement of vehicles, especially the heavy vehicles during the construction phase.

The project construction activities are likely to have some impacts on roads, accommodation facilities, etc. The transportation of heavy equipment and vehicles is likely to cause stress on road traffic as well as safety risk to road users. Unsafe driving may cause traffic accidents. Noise and road congestion from vehicle movement is likely to create some nuisance along the DSC route. However, the construction activities will be restricted along the DSC route to daytime and thereby limiting the nuisance during night when the perception of noise is the highest.

Further impacts on the local communities during the construction phase are unlikely from health and safety risk from waste management activities, earthwork such as excavation, dust and gaseous emissions. Except for the fuel oils, none of the substances used during construction pose any significant hazards to safety and health. Fuel oil will be transported in dedicated oil tankers driven by certified drivers. The quantities of hazardous wastes are not expected to be significant during construction. Such wastes will be stored, handled and disposed of in accordance to MD 18/93 and good engineering practice to minimise any safety and health hazards. Based on the above factors the impact rating for Land Use and Local Community is presented below.

Impact	Severity	Duration	Likelihood	Impact Rating
Impact on land use	Slight	Long Term	-	Low
Impact on settlements due to construction activities	Minor	Medium Term	-	Low
Impact on Duqm settlement due to accidental releases	Major	-	Unlikely	Medium
Impact on existing traffic density and safety	Localised	-	Likely	Medium
Stress on infrastructure	Localised	Medium Term	-	Medium

7.4.7 Impact on Local Economy

The construction activities will require significant number of local skilled and unskilled workers. This however, will be only for a limited period of time. However, positive impact on the local livelihood during the construction phase through creating new job opportunity is envisaged.

In addition, local suppliers will also be benefited as they will be contracted for the supply of water, foodstuff etc. Considering the above, beneficial impacts are envisaged from the project on the local employment and economy. Therefore, it can be concluded that the project will be a positive impact on the local Duqm economy.

Issue	Severity	Duration	Likelihood	Impact Rating
Local purchase of goods	Positive	Medium Term	-	Positive
Hiring of local people	Positive	Medium Term	-	Positive

7.4.8 Archaeology, Heritage and Culture

Based on environmental baseline studies for the area in vicinity to the Service Corridor it is envisaged that there are no sites of archaeological or cultural interest along the DSC route and hence there will be no such impacts. However, if any object of cultural / archaeological significance is encountered during excavation, such area will be immediately cordoned off and the construction contractors will inform MHC accordingly to obtain further advice from the Ministry.

Further the expatriate construction workers in the area can have potential impacts on local lifestyle and culture, although with proper implementation of cultural awareness plan for the expatriate labourers the impact can be considerably minimized to a low level.

Issue	Severity	Duration	Likelihood	Impact Rating
Accidental Damage to sensitive sites	Major	-	Very Unlikely	Low
Cultural Conflict	Localised	-	Unlikely	Low

7.4.9 Summary of Impacts during Construction Phase

A summary of the net impacts during the construction phase and their significance is presented in Table 7-5. It is noted that there are no impacts that are rated as high which would have required alternatives to be developed for activities leading to such impacts. Proposals for mitigating the impacts rated as 'Medium' are described in Chapter 8.

Table 7-5: Summary of Impacts – Construction Phase

Impact	Severity	Duration	Likelihood	Impact Rating
Fuel supply and demand	Slight	Medium Term	-	Low
Offsite groundwater supply	Minor	-	Likely	Low
Impacts on ambient air quality	Minor	Short Term	-	Low
Impacts on noise level	Minor	Short Term	-	Low
Impacts to soil and groundwater due to normal management of wastes	Minor	Medium Term	-	Low
Impacts to soil and groundwater due to accidental release	Major	-	Unlikely	Medium
Impact on the flora and fauna along the DSC	Moderate	Medium Term	-	Medium
Impact on land use	Slight	Long Term	-	Low
Impact on Duqm settlement due to construction activities	Minor	Medium Term	-	Low
Impact on Duqm settlement due to accidental releases	Major	-	Unlikely	Medium
Impact on existing traffic density and safety	Localised	-	Likely	Medium
Stress on infrastructure	Localised	Medium Term	-	Medium
Local purchase of goods	Positive	Medium Term	-	Positive
Hiring of local people	Positive	Medium Term	-	Positive
Accidental damage to sensitive sites	Major	-	Very Unlikely	Low
Cultural Conflict	Localised	-	Unlikely	Low

7.5 Assessment of Impacts during Operation Phase

The only activity during the operational phase of the DSC is transport of vehicles and eventually petroleum pipelines. This EIA addresses only the DSC without the petroleum pipelines.

The operation of the DSC will be unmanned. Periodic maintenance will be carried out by a small team of personnel and will be intermittent and for short duration, and is unlikely to result in generation of any significant amount of wastes or wastewater. This would include road and drainage maintenance activities and is not likely to generate hazardous waste. Operation of the DSC will not require any natural resource except for refined petroleum products (fuel) for the inspection and maintenance vehicles. Hence the impact on natural resources is also minimal.

There will be no adverse impact on groundwater resources, since the freshwater required during the operational phase will be negligible.

There will be no risk of soil and groundwater contamination, since no liquid effluents will be discharged on land and no hazardous wastes will be stored on land along the DSC route during the operation phase. However unanticipated events may lead to damage of the road conveying the petroleum products (eventually) resulting in soil and groundwater contamination. Accidental damage, usually by third party encroachment and natural catastrophes (floods, earthquake, land slide, etc.) can lead to contamination of soil and groundwater.

Third party encroachment can be avoided through education, due diligence and a planning for a “call before you dig” program. The DSC will also be designed to minimise damage from natural disasters and events and will meet or exceed the requirements of SEZAD and International Standards.

Thus the likelihood of accidental damage to the DSC and associated environmental release / impacts is very unlikely.

7.6 Cumulative Impact Assessment

The Service Corridor Project is in an area of the SEZAD area where significant development and construction is proposed in approximately the next 3 years.

To assist SEZAD Environment Department as the environmental regulator for these Projects, HMR has prepared the following summary table to document the Project names, project schedules (based on currently available schedules), estimated construction timeframes, and potential environmental impacts for the development projects during the construction phase. It should be noted, that some of this information has been provided to HMR in relation to our current commercial commissions and other is anecdotal information or estimations based on collaboration with other companies.

We acknowledge that SEZAD, as the regulator, may have revised or more detailed information.

The following assessment is not designed to be exhaustive, but rather serve as high level summary and qualitative assessment based on HMR's experience and knowledge of each of the projects listed in Table 7-6.

Table 7-6: Summary of Construction Projects in Heavy Industrial Zone, SEZAD area

Project	Project Owner	Anticipated Start Date	Expected Completion Date	Construction Impacts	Impact Rating
Liquid Jetty Project	Port of Duqm	January 2016	December 2018	▪ Ambient air quality ▪ Ambient noise levels ▪ Flora and fauna ▪ Marine environment ▪ Localized drainage ▪ Traffic density	Low
Duqm Refinery	Duqm Refinery	August 2016	December 2019	▪ Ambient air quality ▪ Ambient noise levels ▪ Flora and fauna ▪ Soil and groundwater due to accidental releases ▪ Localized drainage ▪ Traffic density ▪ Livelihood through employment in refinery construction ▪ Local economy ▪ Potential for cultural conflict due to large expatriate construction workforce	Medium
Duqm Refinery – Labour Camps	Duqm Refinery	June 2016	December 2019	▪ Ambient air quality ▪ Ambient noise levels ▪ Soil and groundwater due to accidental releases ▪ Wastewater management ▪ Waste management ▪ Traffic density ▪ Pressure on Local Infrastructure ▪ Resource Use and Consumption ▪ Local economy ▪ Potential for cultural conflict due to large expatriate construction workforce	Medium

Project	Project Owner	Anticipated Start Date	Expected Completion Date	Construction Impacts	Impact Rating
Sea Water Intake Project	Centralized Utilities Company for SEZAD	April 2016	October 2017	▪ Marine Environment ▪ Ambient air quality ▪ Ambient noise levels ▪ Soil and groundwater due to accidental releases ▪ Livelihood through Project employment ▪ Local economy ▪ Potential for cultural conflict due to large expatriate construction workforce	Medium
Roads 1 and 5	Parsons for SEZAD	June 2016	December 2017	▪ Ambient air quality ▪ Ambient noise levels ▪ Alterations to local drainage ▪ Traffic density	Low
Re-alignment of Road 32	SEZAD	SEZAD to confirm	SEZAD to confirm	▪ Ambient air quality ▪ Ambient noise levels ▪ Alterations to local drainage ▪ Traffic density ▪ Local economy ▪ Inconvenience to residents and businesses of Duqm settlement due to construction activities	Medium
Wadi Engineering Project	Renardet for SEZAD	Project currently in Tendering stage for Civil Engineering Contractor. SEZAD to confirm	SEZAD to confirm	▪ Ambient air quality ▪ Ambient noise levels ▪ Flora and fauna ▪ Marine environment ▪ Alterations to local drainage ▪ Traffic density	Medium

Project	Project Owner	Anticipated Start Date	Expected Completion Date	Construction Impacts	Impact Rating
Port of Duqm Expansion	Port of Duqm	SEZAD to confirm	SEZAD to confirm	▪ Ambient air quality ▪ Ambient noise levels ▪ Marine environment ▪ Flora and fauna ▪ Alterations to local drainage ▪ Traffic density ▪ Potential for cultural conflict due to large expatriate construction workforce	Medium
Upgrade of existing Sewage Treatment Plant	SEZAD	SEZAD to confirm	SEZAD to confirm	▪ Ambient air quality ▪ Potential Odour issues ▪ Ambient noise levels ▪ Marine environment ▪ Alterations to local drainage	Low

8 ENVIRONMENTAL MANAGEMENT AND MONITORING PLANS

The Environment Management Plan (EMP) describes both generic good practice measures and site-specific measures, the implementation of which is aimed at mitigating potential impacts associated with the proposed project operations. The EMP is prepared with a view to facilitate effective environmental management of the project, and implementation of the mitigation measures.

This EMP includes mitigation and control measures proposed to reduce and keep the environmental impacts to below the As Low As Reasonably Practicable (ALARP) level during the construction and operation phases of the project.

The EMP further includes organization structures for implementation of the proposed mitigation and control measures during both phases of the project. Auditing and monitoring programs are also proposed for both phases in order to assess the effectiveness of the implementation of the EMP. EMP for the decommissioning phase is not discussed herein as the project life is expected to be 50 years; and specific data on the decommissioning activities are not available at present.

The ultimate responsibility for environmental management during all phases of the project rests with SEZAD's EPC contractor who will also bear the responsibility for implementing the EMP. Periodic environmental audits will be conducted by SEZAD/EPC contractor during the construction and operational phases to ensure effective implementation of the management plan. Corrective actions will be implemented with due correspondence and consensus with SEZAD.

Any management plan proposed by the EPC Contractor should be revised and approved in line with the recommendations in this EIA Report, and any subsequent EIA updates.

8.1 Construction Phase EMP

The duration of construction activities is anticipated to last for about 18 months excluding mobilization. Approximately 250 to 300 construction workers are envisaged during the peak construction period. It is anticipated that the majority of the construction work would be completed during the hours of 7:00 am to 6:00 pm.

8.1.1 Organisation and Responsibilities

The EPC contractors and their subcontractors will be required to establish an organisation structure for environmental management including health and safety issues to ensure effective implementation of the mitigation measures and to review the environmental management process. An indicative organisation structure is presented in Figure 8-1.

As project developer, SEZAD will be ultimately responsible for the HSE management during the construction phase. SEZAD will appoint a HSE Manager for the construction phase, who with the EPC contractor, will ensure that all the HSE requirements outlined in the sections are followed throughout the project construction period. SEZAD will further ensure that the EPC contractor, and its subcontractors, prepare and implement detailed HSE plans in line with the EMP presented in this chapter for the construction phase and any additional conditions imposed by SEZAD.

The EPC contractor's HSE Manager, reporting to the EPC contractor's Project Manager, will be responsible for the day-to-day HSE management onsite. The HSE Manager will be stationed onsite and will interact daily with the line manager and staff during the construction phase.

EPC contractor's HSE plan and environmental performance will be audited on a quarterly basis to ascertain compliance with Oman's regulations. The audit reports will have to be submitted to SEZAD.

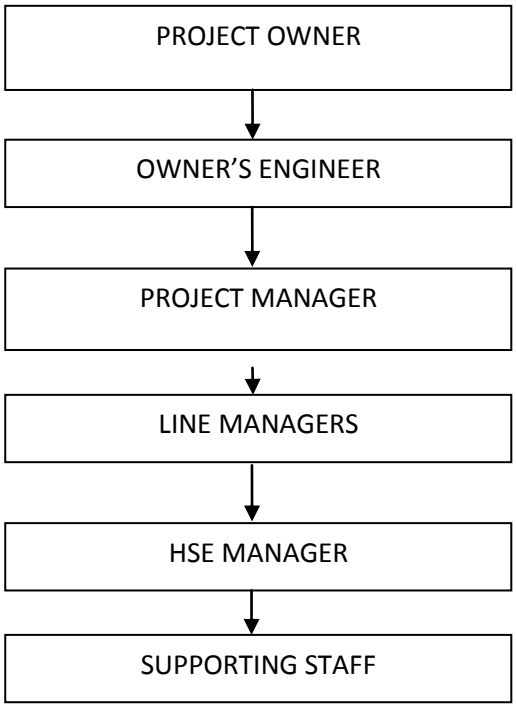


Figure 8-1: HSE Organisation Structure for Construction Phase

8.1.2 Environmental Compliance and Permitting for Construction Phase

The Project will be required to comply with the applicable environmental laws and regulations applicable to infrastructure projects in Oman. In addition to the Preliminary Environmental Permit (PEP) issued by SEZAD, there are few other environmental permits, required to be obtained during the construction phase of the project. SEZAD and the EPC contractor will be responsible for obtaining such permits and other relevant authorities (ROP, etc.). As indicated in Section 2.7, these permits typically include the following:

- Approval for discharging or disposal of sewage to municipal STP, as applicable;
- Permit for storage, handling, transportation and disposal of hazardous wastes during construction and operation from SEZAD and ROP;
- Permit for storage, handling and transportation of chemicals and fuel used at site during construction and operation from SEZAD and ROP;
- Permit for operating stationary combustion sources from SEZAD;
- Permit for import, transportation, usage and storage of radioactive material and explosives, if required (during construction phase) from SEZAD and ROP;
- Permit for use of industrial / laboratory gas cylinders from SEZAD; and
- Temporary environmental approval for construction of labour camp & offices from SEZAD.

The HSE Manager from the EPC contractor will be primarily responsible for ensuring compliance with the permit conditions, obtaining additional approvals as required and coordinating with the regulatory agencies. The EPC Contractor's HSE Manager shall be responsible for environmental compliance during construction stage and shall provide all data/report/compliance information etc., to the Client's HSE Team time to time for review and approval.

8.1.3 Site Preparation

The site preparation will require some small trees and shrubs to be removed along with some major bulk civil earthworks. However, it will be ensured that no vegetation outside the DSC route is damaged during the mobilisation and demobilisation of equipment by utilizing the minimum area to the maximum effort possible. Topsoil onsite will be removed, stockpiled and reapplied upon work

completion on the embankments of the DSC. Grading and soil compaction will be undertaken as part of site preparation. If any dust risings are expected particularly during the dry weather conditions, water will be sprayed for dust suppression.

8.1.4 Mitigation Measures for Construction Phase

The EMP provides a delivery mechanism to address potential adverse impacts and to introduce standards and good practice to be adopted throughout the project works. For each phase, the EMP lists all the requirements to ensure effective mitigation using mitigation measures of every potential biophysical and socio-economic impact identified in the EIA. The mitigation measures for management of various environmental releases and storage, and handling of hazardous and non-hazardous materials during the construction phase are presented in Table 8-1.

Table 8-1: Environmental Management Plan – Construction Phase

Receptor	Aspects and Activity	Mitigation Measures	Responsibility
Natural Resource	Procurement of aggregates and soil	▪ Soil, if required, shall be procured from approved contractors or approved burrow sites.	Party: All contractors Target Date: Construction Period
	Water supply for construction activities	▪ Minimize fresh water consumption by identifying and implementing water conservation and re-use measures wherever feasible; ▪ Identify opportunities for substitution of fresh water with treated wastewater from Municipality for dust suppression and construction activities; and ▪ Maintain daily logs for water consumption and carry out periodic audits to identify conservation measures.	Party: All contractors Target Data: Construction Period
	Fuel consumption	▪ Procure fuel efficient DG and construction equipment and vehicles; ▪ Procure fuel from authorised retailers; and ▪ Minimise idling time of fuel run heavy equipment by adequate planning of construction activity.	Party: All contractors Target Date: Construction Period
Geology, Soil and Groundwater	Waste Management	▪ Solid waste handling, storage and disposal methods shall ensure compliance with MD 17/93; ▪ The handling, storage, transport of any hazardous waste shall be carried out in accordance with MD 18/93; ▪ Oil contaminated waste or soil shall be treated as hazardous waste, and handling, storage and disposal shall be according to MD 18/93; ▪ Hazardous waste such as waste oils and lubes shall be appropriately packed, labelled and accompanied by a waste consignment note when transported to approved recyclers / management centres (MD 18/93); ▪ Hazardous waste storage area shall be established by the EPC Contractor to provide sufficient facility for storage of hazardous wastes until be'ah Integrated Waste Treatment Storage and Disposal Facility in Duqm becomes operational; ▪ Hazardous waste storage facilities will have restricted access; ▪ Hazardous waste will be transported through be'ah licensed transporters and disposed at licensed	Party: All contractors Target Date: Construction Period

Receptor	Aspects and Activity	Mitigation Measures	Responsibility
		treatment or disposal sites in accordance with MD 18/93; ▪ Recyclable waste shall be stored separately onsite and handed over to waste recycling contractors; ▪ In case of accidental spillage, contaminated area will be cleaned; ▪ The EPC Contractor must obtain an Agreement from be'ah to accept all wastes from the construction activity. A copy of this Agreement shall be submitted to SEZAD; ▪ All non-hazardous and hazardous waste shall be handled by be'ah or be'ah approved contractor; ▪ Solid non-hazardous waste will likely be disposed of to the existing landfill site, following approval from be'ah; ▪ Non-recyclable waste shall be stored separately onsite and sent to the landfill. Waste consignment and 'Duty of Care' records shall be maintained; and ▪ No hazardous waste shall be mixed with any other type of waste.	
	Wastewater Management	▪ Dewatered groundwater must be analysed initially to verify the water quality prior to reuse for dust suppression or irrigation for maintenance of landscaping. ▪ Groundwater for reuse or irrigation must meet the requirements and criteria of MD145/1993, or an alternative approval for temporary irrigation of dewatered groundwater granted by SEZAD Environment Department; ▪ Sewage and grey wastewater (wastewater from office) shall be directed to a holding tank; ▪ The holding tanks designated for wastewater streams shall conform to RD 115/2001 and MD 421/98; ▪ Contents of the holding tank shall be diverted to the wastewater treatment plant (i.e. package plant) established by the EPC Contractor to treat sewage; ▪ Sewage effluent may be recycled or reused as per the conditions and criteria listed in MD145/1993; ▪ Approvals from the Local Municipality shall be obtained for transportation of sewage and disposal at STP; and ▪ Design the water spraying application rates specific to atmospheric conditions and the intensity of stockpiling operations. Water spraying is to be done at least once a day and the water application quantity should depend on considerations that the surface is completely wet but that there is no standing water puddles or run-off.	Party: All contractors Target Date: Construction Period
	Accidental spills	▪ Vehicles and their fuel tanks shall be checked regularly for fuel or oil leaks; ▪ SEZAD shall be informed of accidental spillage / leak where vegetation and local community may be impacted;	Party: SEZAD / All contractors

Receptor	Aspects and Activity	Mitigation Measures	Responsibility
		▪ Shovels, plastic bags and absorbent material shall be kept near fuel and oil storage/handling areas to attend spills and leaks; ▪ Emergency response plan to respond to a spill / leak shall be prepared; and ▪ The fuel and other hazardous liquid storage tanks shall be inspected regularly for leaks.	Target Date: Construction Period
Climate	GHG from equipment, machineries and vehicles	▪ Procure standard construction equipment and vehicles; ▪ Planning periodic maintenance schedules including engine tuning, filter cleaning, etc. for construction equipment and vehicle; and ▪ Minimise idling time of fuel run heavy equipment by adequate planning of construction activity.	Party: All contractors Target Date: Construction Period
Ambient Air	Operation of DGs and heavy plant machineries	▪ Maintain and regularly service the diesel fuelled generators and heavy construction machinery so that emissions remain within relevant air quality standards; ▪ Provide stacks or flue pipes on DG sets so that the combustion gases from the generators are emitted at least 3 m above the ground level; ▪ Use of ozone depleting substances shall be prohibited per MD 243/2005; ▪ Dedicated and enclosed painting booths and fabrication yards shall be provided, wherever possible; ▪ Procure diesel fuel from approved refined petroleum product retailers in Oman and ensure sulphur content in diesel fuel is less than 0.05%.; and ▪ Periodically monitor dust levels and source emissions to demonstrate compliance with applicable standards.	Party: All contractors Target Date: Construction Period
	Site Preparation activities	▪ Use water sprays for dust suppression over internal access roadways and work areas. The water application rates to be specific to atmospheric conditions and the intensity of construction operations. Water spraying is to be done at least once a day and the water application quantity should depend on considerations that the surface is completely wet and that there is no water puddles formed; ▪ Stock piles to be periodically sprayed at least once a day using treated wastewater to minimize dust; ▪ Identify opportunities to enclose crushing / grading / screening operations to prevent wind-blown dust emissions; ▪ Cover the vehicles transporting material to and from the site immediately after loading to prevent wind-blown dust emissions and spillages; ▪ Stock piles to be wetted using treated wastewater before loading and unloading the materials to minimize dust;	Party: All contractors Target Date: Construction Period

Receptor	Aspects and Activity	Mitigation Measures	Responsibility
		▪ Minimise the height of dropped material into truck and restrict the drop height to not more than 1m during loading and unloading, to minimise wind-blown dust emissions and spillages; ▪ Install rumble grids at each site exit to remove excess mud and dust accumulated on vehicles and minimise material being transferred onto the public road; ▪ Avoid or minimise dust generating activities (particularly cutting and excavating) during dry and windy conditions. Temporarily suspend dust generating construction works when instantaneous gust wind speeds exceed 25 knots (or 12 m/s); ▪ Provide appropriate PPE like goggles, face / nose mask, safety shoes and helmet to the workers according to their work or the place of their work; and ▪ Ensure proper usage of appropriately issued PPE by all workers on site.	
	Vehicular emissions	▪ Vehicle speed will be controlled onsite to minimise emissions; ▪ Vehicles will be fitted with pollution control to minimise emissions; and ▪ Vehicles and plant not operational will be switched off to minimise emissions.	Party: All contractors Target Date: Construction Period
Background Noise	Operation of DG, and heavy equipment	▪ Avoid night time operation of high noise generating construction machinery; ▪ Plant and equipment to be used appropriately. This includes reasonable work practices with no extended periods of reviving, idling or 'warming up'; ▪ Design suitable noise absorbing enclosures for the generator units, crushers / screening units, where it does not affect access and maintenance; ▪ Provide appropriate silencers or mufflers to reduce noise; ▪ Ensure that the equipment used is provided with suitable noise control systems and source noise levels conform to international standards; ▪ Periodically monitor noise levels in workplace and ambient to check compliance with the standards MD 79/94 and MD 80/94 ; and ▪ Provide PPE (ear plugs or ear muffs) to all workers operating in the vicinity of high noise generating machines.	Party: All contractors Target Date: Construction Period
	Vehicle Movement	▪ Minimize noise from vehicles by reducing speed limits and by using well maintained vehicles; and ▪ Vehicles shall have working noise mufflers installed.	Party: All contractors Target Date: Construction Period

Receptor	Aspects and Activity	Mitigation Measures	Responsibility
Terrestrial ecology and land use	Site preparation and grading	▪ Minimise the DSC impact by clearing vegetation only wherever required along working strip; ▪ Minimise extraneous noise sources and use adequate noise attenuation on engines; ▪ Vehicles and machinery used outside of project area shall be cleaned prior to commencement of work so as to avoid introduction of non-native species into the project area; and ▪ Night time driving and off road driving will be restricted to emergencies only.	Party: All contractors Target Date: Construction Period
Health and Safety	Construction Activity	▪ Site HSE plans shall be prepared and followed; importance shall be given on the usage of PPEs, hygienic conditions etc.; ▪ Proper signage shall be installed; ▪ First aid shall be made available at the site; ▪ Training and awareness programs for staff shall be undertaken; ▪ Staff working at the site shall be made aware of emergency response procedures; and ▪ Fire extinguishers and safety measures shall be made available throughout the work site.	Party: All contractors Target Date: Construction Period
Archaeology and Culture	Construction Activity	▪ Workers shall be made aware about local culture and traditions to avoid socio-cultural issues; ▪ Employees and contractors shall minimize their interaction with local residents and make efforts to minimize their disturbance in the community by timing the operations and transits through local communities to avoid disturbing worship, school, and other community gatherings; ▪ Workers shall receive a briefing on recognizing archaeological artefacts and how to respond when found; ▪ All archaeological sites or finds shall be reported to the Department of Excavations and Archaeological Studies, Ministry of Heritage and Culture; and ▪ A chance finds procedure shall be developed and implemented in areas where there is potential for previously unknown cultural property to be found during construction.	Party: All contractors Target Date: Construction Period

Receptor	Aspects and Activity	Mitigation Measures	Responsibility
Socio Economy and Employment	Construction Phase	▪ Procurement and purchasing shall consider availability and quantity of local supplies and local use of material; ▪ Schedule the site preparation activities to avoid and minimise disturbance to the public/settlements in the area; ▪ Project related community grievances shall be documented and appropriate measures shall be taken by SEZAD and its contractors; ▪ Procurement of scarce or locally sensitive goods shall be conducted outside of the local area; and ▪ Preference shall be given to locals for semi-skilled jobs.	Party: All contractors Target Date: Construction Period
Traffic and Transport	Vehicle Movement	▪ Night time driving and off-road driving will be restricted to emergencies only; ▪ The drivers are to be adequately experienced and are to be provided with training on defensive driving. The drivers transporting hazardous materials are to be provided with adequate awareness on the hazards of the material, emergency measures, contact numbers, etc.; ▪ Appropriate vehicles, in good condition are to be used. The transport vehicles are not to be overloaded; ▪ Maximum speed limits at the work site are to be specified and followed. The speed limit specified on the highway are to be strictly followed; and ▪ Designated access roads are to be used at the work site. Off-road driving is to be avoided as far as possible.	Party: All contractors Target Date: Construction Period

8.1.5 Environmental Monitoring Program

Environmental monitoring recommended for the various environmental components (as highlighted in the above sections) for the entire construction phase are reiterated in Table 8-2. The monitoring data will be compiled and documented. The reports of such audits / monitoring will be provided to SEZAD as required. Corrective actions are to be implemented for any deviations from compliance requirements.

Table 8-2: Environmental Monitoring and Auditing - Construction Phase

Aspects	Scope of Monitoring/Auditing	Method	Frequency of Monitoring/Auditing	
			Internal Compliance	SEZAD Compliance
Air Quality	PM_{10} concentrations at various locations along the DSC route	Using portable dust analyser	Monthly	Quarterly
	NO_X, SO_2, VOC concentrations at various locations along the DSC construction route and nearby receptors	Continuous Ambient Air Quality Monitoring Station (CAAQMS) or deploying diffusion tubes	Quarterly	Quarterly
Noise Levels	Sound pressure levels at several locations along DSC construction route and near the Duqm settlement	Using handheld sound pressure level meter	Monthly	Quarterly
Wastes	Quantity of each category of waste disposed from work sites	Volume / weight calculated based on tanker capacity	Monthly report logging	-
Accidental Spills	Inspection of storage, handling and construction areas	Report the quantities by measurement or reliable estimates.	Monitoring on every incident.	Immediate reporting where it will impact human environment.
Health and Safety	Hygiene, use of PPE, first aid kit, site HSE procedures	-	Monthly report logging and Quarterly audit	-
Environmental auditing	Implementation of the EMP and HSEMS, control measures, waste (hazardous and non-hazardous solid and liquid), hazardous materials management, emergency response measures, applicable permits and status of compliance to the permit requirements, etc.	Site inspection, interviews with concerned EPC contractor personnel and review of documents and records	Weekly and Monthly reporting to Project Manager.	Quarterly audit and reporting

8.2 Operational Phase EMP

The organization structure for HSE management will be developed at a later stage of Project development. The Project Manager (PM) will be responsible for the implementation and effective management of an integrated Health, Safety and Environmental Management System. The HSE manager will be responsible for the routine plant HSE management and for coordination of HSE functions within the line functions. All line managers will be required to implement and ensure compliance with HSE requirements within their functional areas.

8.2.1 Mitigation Measures for O&M Phase

The only activity during the operation phase of the project that needs to be managed will be movement of trucks and equipment during maintenance, and as such the releases to the environment during the operation phase will be minimal. The mitigation measures identified for the operation phase will largely be the responsibility of the maintenance contractor and will mainly consist of exercising good and proper management of the DSC infrastructure (roads and drainage). Major considerations include dealing with pavement failures and periodic clearing of drains; dealing with spills from trucks during routine maintenance; storm damage and general site safety measures.

Control and mitigation measures for reducing the impacts on various environmental elements are proposed through the following sections. The following are the management plans proposed for the operational phase of the project.

1. Ground Patrols – Regular inspection shall be carried out on the DSC by vehicle to check on the condition of the roads and drainage and identify any activities that may have the potential to impact on the integrity of roads and drains (culverts and pipes). These shall include and will not be limited to, a review of:
    - Activity on the DSC and in the vicinity;
    - Road/access track condition and maintenance requirements;
    - Evidence of drainage pipeline exposure;
    - Condition of drains and pipe crossings beneath roadway;
    - Indication of leaks or spills;
    - Damage to fence, gates, signs, markers, etc.; and

- Ground patrol shall be undertaken regularly. Special patrols will be undertaken following events of heavy rain or storm to check for damage to roads and drainage pipelines.

2. Develop and implement an emergency response plan that identifies measures to protect public health and the environment; and
3. Regular monitoring of implementation of the management plans.

8.3 Emergency Preparedness Plan

Emergency preparedness plan refers to the detailed management plan on how to respond, control, recover and mitigate in the event of emergencies. The major hazards associated with the DSC are the accidental releases/spillage of oils and lubricants from vehicle accidents to the road and drainage. SEZAD will prepare a detailed emergency response plan during the detailed design phase. The plan will include consideration of the following:

- Response procedure in the event of fire, leak, equipment failure, bomb threat, natural disasters or any other emergency situations;
- Communication arrangements and contact details;
- Roles and responsibility of responsible person;
- Emergency controls and alarms;
- Evacuation procedure;
- Emergency response equipment;
- Leak detection and control points; and
- Training requirements..

The key principles for the response to a DSC related incident include;

- Continual monitoring of roadway and the DSC;
- Immediate shut down of the pipeline section where an incident is detected;

- Mobilization of crews and equipment to identify nature and severity of the incident, minimize impacts to the surrounding areas and implement actions to manage immediate threats;
- Notification to relevant regulatory authorities and emergency services as required;
- Detailed investigation of the incident and development and implementation of corrective actions; and
- Development and implementation of comprehensive restoration plan.

9 CONCLUSIONS

The Special Economic Zone Authority at Duqm (SEZAD), the Client, intends to provide a pipeline and utility service corridor within the Special Economic Zone at Duqm area. The corridor will extend between the Duqm Refinery site and the DPTC Port fence. This corridor would include suitable provisions to accommodate utility requirements of various industries slated to come up in the heavy industrial zone within SEZAD. The proposed Project covered under the current EIA study involves construction of the foundations of the service corridor; this includes pipelines of various sizes ranging from 12" to 36" dia., heavy haul traffic road, service access road, pipe bridges, and buried power cables. As mentioned in various sections of this report, the Project will implement appropriate control and mitigation measures to minimize the environmental impacts and to ensure compliance with applicable Omani Environmental Regulations.

The Service Corridor will provide centralized utilities and pipeline corridor for the proposed Duqm Refinery and several heavy/petrochemical industries coming within the proposed heavy industrial zone in SEZAD for the planning horizon: 2017 – 2045. The Project is expected to provide employment opportunities for Omani people during construction phase of the project.

Based on discussions in various chapters in the report, it can be noted that upon effective implementation of the proposed mitigation measures and the EMP, the residual impacts can be reduced to ALARP levels making the Project acceptable from an environmental standpoint within the context of local and internationally comparable environmental standards.

10 REFERENCES

5 Oceans. (2011). *Duqm Inustrial and Freezone Masterplan - Final EIA Report.* Sultanate of Oman: 5 Oceans LLC.

Census 1993. (n.d.). *Socio-Economic Atlas (November 1996).* Sultanate of Oman: Ministry of National Economy.

Census 2003. (n.d.). *Socio-Economic Atlas (September 2006).* Sultanate of Oman: Ministry of National Economy.

Census 2010. (n.d.). *Final Results: General Results of Population.* Sultanate of Oman: Minstry of National Economy.

Centralized Utilities Company LLC. (June, 2015) *Scope of Work: Pipeline Support Structures for Service Corridor at Duqm Special Economic Zone Oman.* CUC, Revision 5, dated 20 June 2015 authored by sembcorp and Takamul, checked by Centralized Utilities Company (CUC), and approved by SEZAD.

Eriksen, H., & Eriksen, J. (2010). *Common Birds in Oman: An Identification Guide* (2 ed.). Al Roya Publishing.

Evans, M. I. (1994). *Important Bird Areas in the Middle East: Birdlife Conservation Series No. 2.* Cambridge, UK: Birdlife International.

Halcrow. (1992). *Fishing Harbours at Duqm and Al Ashkhara.*

Haskonig, K&A and Al Baraka. (2004). *New Port and Dry-dock Complex at Duqm: Feasibility Study Report.* Sultanate of Oman: Posford Haskoning, Khatib and Alami and Al Baraka Economic Consultancy.

Hem, J. D. (1985). *Study and Interpretation of the Chemical Characteristics of Natural Water.* US Geological Survey Water-Supply.

HMR. (2013a). *Environmental Impact Assessment Scoping Report, Duqm Refinery.* Muscat: HMR Environmental Engineering Consultants.

HMR. (2013b). *Environmental Baseline for Duqm Development (SEZAD) and Surroundings Q3 Report.* Sultanate of Oman: HMR Environmental Engineering Consultants.

HMR. (2013c). *Environmental Baseline for Duqm Development (SEZAD) and Surroundings Q2 Report.* Sultanate of Oman: HMR Environmental Engineering Consultants.

HMR. (2013d). *Environmental Baseline for Duqm Development (SEZAD) and Surroundings Q4 Report.* Sultanate of Oman: HMR Environmental Engineering Consultants.

HMR. (April, 2015). *Preliminary Environmental Report for Service Corridor, Industrial Zone, Duqm (SEZAD)*. Sultanate of Oman: HMR Environmental Engineering Consultants.

HMR. (April, 2015b). *Environmental Baseline for Duqm Service Corridor Report (SEZAD)*. Sultanate of Oman: HMR Environmental Engineering Consultants.

International Finacne Corporation (IFC). (2012). *Performance Standards on Environmental and Social Sustainability.* World Bank Group.

International Finance Corporation (IFC). (2007). *Environmental, Health, and Safety Guidelines for Petroleum Refining.* World Bank Group.

James Dobbins Associates Inc. (1992). *Draft Regulations for the Prevention of Coastal Erosion in the Sultanate of Oman.* Sultanate of Oman: Ministry of Municipalities and Environment.

Lakes Environmental. (2012). *Wind Speed Data.*

Madany. (1996). *Environmental Levels And Human Exposure - Arsenic .* World Health Organisation.

MNE. (2006-07). *Income-Expenditure Sample Survey.* Sultanate of Oman: Ministry of National Economy.

MNE. (2007). *Statistical Year Book.* Sultanate of Oman: Ministry of National Economy.

MNE. (2010-11). *Income-Expenditure Survey.* Sultanate of Oman: Ministry of National Economy.

MNE. (2011). *Statistical Yearbook.* Sultanate of Oman: Ministry of National Economy.

MoH. (2010). *Annual Health Report.* Sultanate of Oman: Ministry of Health.

Nul, J. D. (2008). *Environmental Baseline Survey Report to Royal Haskoning.*

PAEW. (2012). *Annual Report.* Sultanate of Oman: Public Authority of Electricity and Water.

Parsons. (2014). *Environmental Baseline Studies for Duqm Sea Water Intake Project (SWIP) for CUC/SEZAD.* Duqm: HMR Consultants.

RAECO. (2012). *Annual report.* Sultanate of Oman: Rural Areas Electricity Company.

Reto, J., Al-Sabri, B. A., & Abdullah, S. (2007-08). *Central Oman Palaeolithic Survey - Final Report of Phase I.* University of Basel: Switzerland: Institute of Prehistory and Archaeological Science.

Salm, R. V. (1991). *Turtles in Oman. Status, Threats and Management Options: Manuscript Report of IUCN Coastal Zone Management Project.*

Sargeant, D. E., Eriksen, H., & Eriksen, J. (2008). *Birdwatching Guide to Oman.* Al Roya Publishing.

Sering International. (2012). *Drainage Model Final Results.* Retrieved from http://www.cedd.gov.hk/eng/publications/geo/doc/eg_2_links.pdf

Swissboring & Company LLC (Swissboring). (2015). Service Corridor to the Industrial Zone at Duqm, Draft Site Investigation Report (E-2534-FINAL DRAFT SI-REP), June 30, 2015.

Tatum, F. E. (1940). *A Simplified Method of Routing Flood Flows through Natural Valley Storage.* Rock Island, Illinois: U.S. Engineers Office.

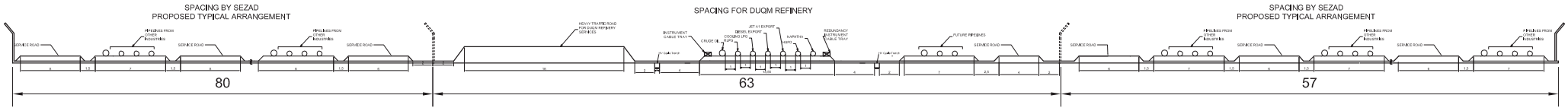
The Equator Principles Association. (2013). *The Equator Principles.*

Appendix - Design Drawings of the Service Corridor

Cross Section Diagram of the Service Corridor

Attachment 2

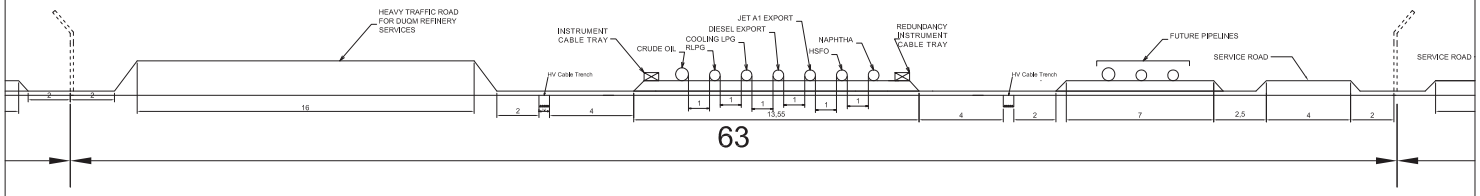
SECTION OF PIPELINE CORRIDOR
PARALLEL PIPELINES ON COMMON SUPPORTS
Sheet 1 of 4



Attachment 2

SECTION OF PIPELINE CORRIDOR
PARALLEL PIPELINES ON COMMON SUPPORTS
Sheet 2 of 4

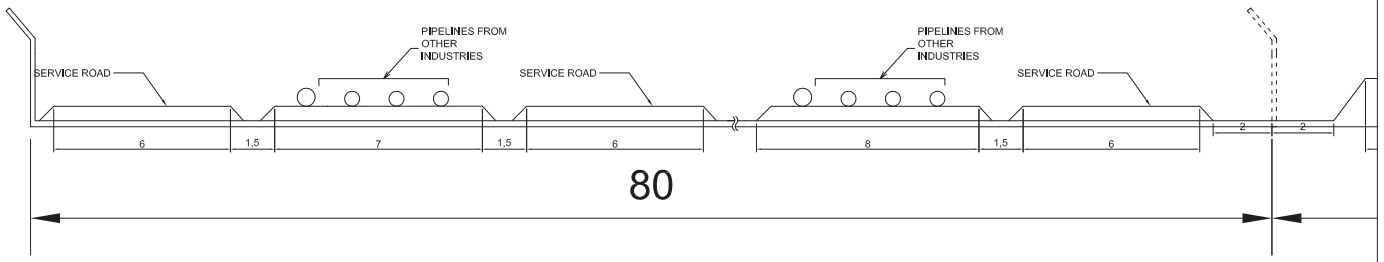
SPACING FOR DUQM REFINERY



Attachment 2

SECTION OF PIPELINE CORRIDOR
PARALLEL PIPELINES ON COMMON SUPPORTS
Sheet 3 of 4

SPACING BY SEZAD
PROPOSED TYPICAL ARRANGEMENT



Attachment 2

SECTION OF PIPELINE CORRIDOR
PARALLEL PIPELINES ON COMMON SUPPORTS
Sheet 4 of 4

SPACING BY SEZAD
PROPOSED TYPICAL ARRANGEMENT