Umm Al Houl Power

ESIA for UHP IWPP

Environmental and Social Impact Assessment Report

July 2019

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Table of contents

Table index

Figure index

Appendices

1. Introduction

1.1 Overview

The Umm Al Houl Power Company (UHP), a special purpose company formed between Qatar Electricity and Water Company (QEWC), K1 Energy (a joint venture between Mitsubishi Corporation and JERA JV), Qatar Petroleum and Qatar Foundation, is planning an expansion of the existing Umm Al Houl Independent Water and Power Project (IWPP).

The Umm Al Houl IWPP is located around 2.5 km to the south of Al Wakrah City and 15 km to the south of Doha. The existing Umm Al Houl IWPP was issued an Environmental Permit (Ref: 1-20274-2015) (Appendix A), by the Ministry of Municipality and Environment (MME) in December 2015 following the submission of an Environmental Impact Assessment (EIA) Report prepared by Mott MacDonald. The IWPP consist of the following main components, as per the approved EIA Report:

- 2,520 MW power generation island based on combined cycle gas turbines (CCGT) running on natural gas fuel with no single unit greater than 300 MW
- 136.5 MIGD potable water production block:
  - 60.0 MIGD using reverse osmosis technology
  - 76.5 MIGD using a thermal desalination plant

Expansion of IWPP

UHP is proposing the development of an additional desalination block and associated facilities. The proposed Umm Al Houl IWPP Expansion Project (herein referred to as 'the Project') will augment the existing desalination production capacity with an additional 61.45 MIGD using reverse osmosis (RO) membrane technology.

GHD Global Pty Ltd (GHD) has been engaged by UHP as the Project environmental consultant and has been tasked with undertaking the EIA and preparing documentation to support applications for environmental approval for the proposed Expansion Project from the MME.

The application for environmental clearance is made to the MME; therefore, this EIA report is submitted to the MME for their comments and approval.

1.2 Project proponent

The details of the project proponent is provided n Table 1-1.

Table 1-1: Project proponent details

Project Proponent / Operator	Umm Al Houl Power (UHP) Company
Address	Business Financial Center C-Ring Road Al Emadi Doha
Contact information	Mr. Jamal Al Khalaf Chief Executive Officer (CEO) Phone: (+974) 4 485 8526 Fax: (+974) 4 486 1116

1.3 Project rationale

Qatar's National Vision 2030 sets the long-term objective for transforming the country into an advanced economy, capable of sustaining its own development and providing high standards of living for all people by 2030 (Mott MacDonald, 2016). The population of Qatar continues to grow annually and it dramatically increased from 1.67 million in 2010 to 2.22 million in 2015 (Qatar Statistics Administration, 2015). With the extensive development plans coupled with hosting the Football World Cup in 2022, potential rapid growth in Qatar is anticipated. In order to support Qatar's development plans and meet water supply demands, it is important that the country has sufficient infrastructure to meet this demand.

The Project is proposed for the following reasons:

- *Limited supply of potable water*. Qatar is one of the world with lowest levels of rainfall and short supply of renewable water resources, exacerbated by one of the world's highest per capita water use, Qatar relies heavily on desalinated water (Mott MacDonald, 2016). The World Bank estimates that annual per capita natural water resources in Qatar from 2011 to 2015 is now approximately 27 m^3 (from World Bank indicators -Food and Agriculture Organization, AQUASTAT data), far below the water poverty line of 1,000 m^3 (Mott MacDonald, 2016). This puts Qatar in natural water resource deficit and pushes the country towards heavy reliance on sea water desalination (Mott MacDonald, 2016).
- *Increased water consumption.* Qatar's water consumption has increased from 1995 to 2012 (Mott MacDonald, 2016) as a result of the growth and increasing population. As such, a need to produce sufficient supply of water is necessary to meet the increasing water consumption in the country.

1.4 The Need for an EIA Report

This EIA was developed to identify and assess the potential environmental and social impacts of the proposed Expansion Project and facilitate the Project's compliance with relevant national, regional and international standards, specifically the Equator Principle, International Finance Corporation (IFC) Performance Standards, World Bank Environment Health and Safety (EHS) Guidelines. The requirements of these standards and guidelines are further detailed in Section 3.

This EIA was prepared to support it's approval for an Environmental Permit required by the local authorities (i.e. MME) for the Project. As such, the EIA was developed to meet the following objectives:

- Prepare EIA report in a manner that is consistent with local and international regulatory requirements and guidelines
- Identify potential significant environmental and social impacts (negative and positive) associated with both construction and operation phases of the Project
- Develop mitigation measures to avoid or eliminate, minimise or reduce, manage and offset negative environmental and social impacts and/or enhance benefits (positive impacts)
- Develop an environmental and social management programme that provides a framework for environmental management of the Project's impacts
- Develop monitoring program to evaluate the effectiveness of implementation of identified mitigation measures
- Provides relevant stakeholders with a thorough understanding of the key elements, impacts and mitigation measures of the proposed Project

2. Description of the Project's EIA Process

2.1 EIA scope of work

2.1.1 Technical Requirements

The EIA has been undertaken in accordance with relevant MME guidelines and laws and in consideration of international standards, policies and guidelines. The Project proponent is committed to implement leading industry best practices to manage the environmental and social impacts.

Local requirements

Considering the nature and scale of the proposed Project, it is considered that an EIA is required. As such, this EIA was prepared consistent with the requirements of the following documents:

- Qatari Environmental Impact Assessment Policy and Procedure 1998, which establishes EIA procedures
- Terms of Reference (ToR) for the RO Expansion Project (GHD, 2019b) and the subsequent approval from the MME to commence with the EIA (Appendix B).

International requirements

As the proponent is seeking project funding from international lending institutions, the Project needs to comply with the following:

- Equator Principles 1 to 10 (effective June 2013)
- IFC Performance Standards 1 to 8 (effective January 2012)
- World Bank Group EHS Guidelines (April 2007)

As provided in Principle 8 (Covenants) of the Equator Principles, "*all Category A and Category B Projects shall provide representation of compliance with relevant local, state and host country environmental and social laws, regulations and permits*"; as such, the Projects should comply with the host country standards (detailed in Section 3).

Under the definition provided in Table 2-1, the Project is classified as Category B as it may have potential limited adverse environmental and social risks and/or impacts that are few in number, generally specific, largely reversible and readily addressed through mitigation measures.

Table 2-1: Project categories based on Equator Principle categorization

Category	Description
Category A	Project with potential significant adverse environmental and social risks and/or impacts that are diverse, irreversible and/or unprecedented.
Category B	Project with potential limited adverse environmental and social risks and/or impacts that are few in number, generally site-specific, largely reversible and easily addressed through mitigation measures.
Category C	Projects with minimal or no adverse environmental and social risks and/or impacts.

2.1.2 EIA Scope

The EIA covers:

- The Project description, which includes project information, alternatives and associated activities during all phases of project development
- Environmental aspects that could potentially be affected by the proposed works
- Potential significant environmental and social impacts associated with both construction and operation of the Project
- Environmental and social management and monitoring requirements for the Project

Given the existing site conditions, project nature and scoping undertaken to understand the likely environmental and social impacts of the Project, the EIA focused on the following aspects, which are considered to have the potential to be significantly impacted by the Project or result in significant impacts as a result of the Project if appropriate mitigation measures are not implemented. This is in line with the ToR Report approved by MME (Appendix B).

- Air quality
- Noise and vibration
- Soil and groundwater
- Marine environment
- Waste management
- Socio-economic and health

The proposed Project will be located close to the existing Umm Al Houl Independent Water and Power Plant (IWPP), as such, significant impacts are not considered on the aspects listed below.

- *Terrestrial ecology*. Prior to the development of the existing IWPP, the Project Site, although considered 'greenfield', has been significantly impacted by anthropogenic influences (Mott MacDonald, 2016). The land where the IWPP Expansion Project will be constructed, including its immediate environment, has been extensively disturbed by the construction and operation of the existing IWPP. Therefore, terrestrial ecology assessment will be scoped out in the EIA.
- *Culture, heritage and archaeology*. Cultural heritage assets were not discovered during the construction of the existing IWPP. As such, archaeology and cultural heritage has been scoped out for both construction and operation. In order to mitigate against the loss of any archaeological assets that may be unearthed or discovered, a 'Chance Find' procedure will be incorporated into the construction management plans and will be implemented by the contractor, in the event that a find is made during the construction phase of the Project.
- *Landscape and Visual*. The proposed IWPP Expansion Project is located in a designated industrial area where the existing IWPP is located. The proposed Project and required construction laydown area will be located in an already disturbed area. There are no nearby public roads from which the public can view the future installations. Given the above, landscape and visual impact assessment during the construction and operation phases is proposed to be scoped out in the EIA.
- *Greenhouse Gas*. The aspects of the expansion Project that may result in GHG emissions include (i) construction phase emissions, (ii) energy indirect emissions from power consumption and (iii) emissions from water and/or wastewater treatment. Construction phase emissions will largely consist of fuel combustion emissions from heavy machinery

and other vehicles. However, construction phase emissions are likely to be negligible when divided across the Project's design life of 30 years. As such, there are proposed to be scoped out. Majority of the emissions anticipated to be associated with the additional RO unit will be from energy usage for powering and operation of the plant. However, as the plant will use electricity generated by the existing natural gas-fuelled power station, emissions will have already been accounted for as part of the existing facility, and no additional emissions from power requirements of the expansion Project are expected. Finally, wastewater from the dissolved air flotation (DAF) plant will be sent to the existing wastewater treatment plant (WWTP) prior to final discharge. As pre-treatment at the DAF system involves chemical dosing during pH correction with sulphuric acid and during coagulation, wastewater from the DAF is not expected to contribute to the BOD load at the existing WWTP. As such, no GHG emissions will be attributed to the expansion Project from BOD treatment at the existing WWTP.

2.2 EIA team

2.2.1 Environmental consultant

GHD was appointed as environmental consultant for the Project. This EIA has been undertaken and prepared by GHD on behalf of the proponent. The contact details for GHD are provided in Table 2-2.

Table 2-2: Contact details of environmental consultant

Environmental Consultant	GHD Global Pty Ltd
Address	P.O. Box 14352 Level 23 Al Asmakh Tower, West Bay Doha, Qatar
Contact Details	Sindy Yong Manager – Environment and Infrastructure Tel.: +974-4428-9483 Fax: +974-4444-6127 Email: sindy.yong@ghd.com

2.3 EIA methodology

2.3.1 Overview

In order to identify, assess and minimise impacts of the proposed expansion Project on the surrounding environmental and social receptors, coupled with addressing relevant international and local requirements, the EIA adopted a combination of the following:

- Stakeholder consultation (i.e. liaison with MME and consultation with relevant stakeholders)
- Literature review
- Review of legislative framework
- Baseline data collection
- Qualitative impact assessment and evaluation of findings
- Identification of appropriate mitigation measures
- Establishment of an environmental management programme

Table 2-3 summarises the key approach and methodology for each specific task associated with the development of this EIA.

Table 2-3: EIA approach and methodology

Item	EIA Task Description	Methodology
1	Understanding the requirements of MME	• Review of MME guidelines on EIA and environmental management • Preparation and submission of ToR Report for MME approval (Appendix B)
2	Understanding the international standards and the lender's requirements on EIA, and their relevance to the proposed Project	• Review the Equator Principles 1 to 10 (June 2013) • Review the IFC Performance Standards 1 to 8 (January 2012) • Review the World Band Group EHS) Guidelines (April 2007) and industry-specific guidelines
3	Understanding the Project	• Liaison with the Project proponent including its consultants and contractors • Literature review of Project reports issued by the consultants and contractors
4	Understanding the Project site	• Site walk-over / inspections • Literature review of relevant environmental data • Secondary data collection (desktop research) • Field surveys to collect primary data of the project site
4.1	Ambient air monitoring	• Literature review of publicly available data provided by the MME or available data via the Ministry of Development Planning and Statistics • Desktop review of existing IWPP operational monitoring reports • Ambient air quality monitoring at two locations for 30 minutes for a period of one week • Evaluation of air baseline data against MME ambient air standards
4.2	Baseline noise monitoring	• Desktop review of the existing IWPP operational monitoring reports • Noise measurements at five locations. At each location, noise levels were measured for a period of 30 minutes during day and night for a duration of one week • Evaluation of noise baseline data against MME ambient noise standards

Item	EIA Task Description	Methodology
4.3	Groundwater sampling	• Desktop review of the existing IWPP operational monitoring reports • Collected groundwater samples at five sampling sites within the existing IWPP site. • Evaluation of groundwater quality against Dutch Guideline
4.4	Soil sampling	• Desktop review of the existing IWPP operational monitoring reports • Observed visual signs of contamination and potential sources of contamination during site visit • Evaluation of soil quality against Dutch Guideline
4.5	Marine ecology	• Seawater quality assessment at 12 locations • Seabed temperature assessment at 10 locations • Marine ecology assessment at 13 locations • Plankton analysis at three locations • Sensitive habitat assessment at eight locations
4.6	Social and economic baseline survey	• Site walk over and inspection to identify land use near the project site and sensitive social receptors • Literature review of socio-economic data • Stakeholder Consultation
5	Impact identification and assessment	• Identification of Project activities, equipment and utilities which could potentially cause environmental impacts • Qualitative assessment of impacts • Quantitative assessment / modelling of major environmental impacts including hydrodynamic modelling (refer to item 5.1)
5.1	Marine impacts modelling	• Hydrodynamic modelling
6	Development of environmental mitigation measures	• Review of environmental regulatory standards and requirements applicable to the Project • Identification of mitigation measures based on previous experience, best practise and available options

Item	EIA Task Description	Methodology
7	Environmental Management and Monitoring Programme	• Development of an Environmental Management and Monitoring Program (EMMP) for the construction and operation phase

2.3.2 Sensitive receptors

Sensitive receptors are areas where the occupants are more susceptible to the adverse effects of exposure to toxic chemicals, pesticides and other pollutants (EPA, 2017). The Project is located in the Al Wakrah Municipality, which has an approximate total population of 299,000 (MPDS, 2015). Al Wakrah Town Centre is the nearest sensitive receptor to the Project, which is approximately 3.5 km to the north of the Project site.

There is a public family beach located 1.3 km to the north of the project site. The beach area is used for recreational activities including swimming, quad biking and camping. Figure 2-1 provides an indicative map of nearby sensitive receptors relative to the Project area and Table 2-4 provides the GPS co-ordinates of sensitive receptors.

Table 2-4: GPS coordinates of sensitive receptors

Sensitive receptor	Approximate distance to UHP IWPP	GPS co-ordinates (WGS84)	
		Latitude (N)	Longitude (E)
Al Wakrah Town Centre	3.5 km	Refer to Figure 2-1	
Al Wakrah Family Beach	1.3 km	25° 7'45.00”	51°37'1.74"
Wakrah Coast Guard Station	0.5 km	25° 7'16.23"	51°37'5.63"
Marine environment	<0.1 km	Immediately east of the Project site	

Figure 2-1: Project locations and sensitive receptors

2.3.1 Impact assessment methodology

This EIA assesses the degree of impact associated with the Project both prior to and following the implementation of mitigation measures. Assessment of the level of impact is based on two criteria:

- Likelihood of the impact (Table 2-5): Almost certain, Likely, Possible, Unlikely and Rare
- Consequence level of the impact (Table 2-6): Catastrophic, Major, Moderate, Minor and Insignificant

The impact significance level is based on the following calculation:

Significance of impact = Likelihood Level x Consequence Level

Based on the above calculation, the level of the impact is classified in the following five levels and can be expressed in a matrix, as illustrated in Table 2-7.

- Extreme
- High
- Medium
- Low
- Negligible

Table 2-5: Likelihood of impact

Likelihood Rating	Explanation
5 – Almost Certain	The impact is expected to occur in most circumstances
4 – Likely	The impact will probably occur in most circumstances
3 – Possible	The impact could occur
2 – Unlikely	The impact could occur but is not expected
1 – Rare	The impact may occur only in exceptional circumstances

Table 2-6: Consequence of impact

Consequence rating	Magnitude	Permanence	Reversibility	Example
1 – Insignificant	Only within the project site	No change or Temporary	No change or reversible	• Negligible and short term disruption to flora, fauna, habitats • Minor soil erosion • Temporary nuisances form emission / minor injuries requiring self-administered first aid • No health effect on surrounding communities • Minimal use of energy and natural resources • Generation of non-hazardous wastes • Minor repairable damage to structure
2 – Minor	Only within the project site	Temporary	Reversible	• Minor impact on fauna, flora and habitat at non-ecologically sensitive areas • No significant loss of land / marine resources • Minor emissions with no lasting detrimental effect • No health effect on surrounding communities • Significant use of energy and natural resources • Minor infringement of cultural values • Minor injuries requiring on-site treatment by medical practitioner
3 – Moderate	Effect to areas immediately outside the project site	Permanent	Reversible	• Significant changes in flora and fauna communities (e.g. population, biodiversity), but yet to resulting in eradication of endangered species • Impact on the ecosystem is short-term (less than one year) • Non-persistent but possibly widespread damage to land which could be remediated without long-term loss • Minor health effect on surrounding communities

Consequence rating	Magnitude	Permanence	Reversibility	Example
				• Localised persistent damage • Emission at significant nuisance levels • Generation of hazardous wastes • Significant infringement of cultural values • On-going complaints raised by the surrounding communities • Serious injuries requiring off-site treatment by medical practitioner or immediate evacuation to hospital
4 – Major	Regional or national change or effects	Permanent	Irreversible	• Continuous and serious damage by erosion • Significant impact on ecologically sensitive areas / protected areas (e.g. causing death) • Emission due to uncontained release, fire or explosion • Significant health effect on surrounding communities • Significant damage to the structure, infringement of cultural values
5 – Catastrophic	Regional, national or international change or effects	Permanent	Irreversible	• Long-term and extensive change in the habitats, population of flora and fauna and biodiversity, eradication of endangered species • Depletion of groundwater resources • Extensive chronic discharge of persistent hazardous pollutants / transboundary dispersion of the pollutants • Significant quantities of hazardous wastes generated • Irreparable damage to highly valued buildings / structures / location of cultural significance • Death in surrounding communities • Multiple fatalities

Table 2-7: Significance of environmental impact matrix

Likelihood Rating	Consequence Rating				
	A – Insignificant	B – Minor	C – Moderate	D – Major	E – Catastrophic
5 – Almost Certain	Low (5A)	Medium (5B)	High (5C)	Extreme (5D)	Extreme (5E)
4 – Likely	Low (4A)	Medium (4B)	High (4C)	High (4D)	Extreme (4E)
3 – Possible	Negligible (3A)	Low (3B)	Medium (3C)	High (3D)	High (3E)
2 – Unlikely	Negligible (2A)	Low (2B)	Medium (2C)	Medium (2D)	High (2E)
1 – Rare	Negligible (1A)	Negligible (1B)	Low (1C)	Medium (1D)	Medium (1E)
Note: the above colours are utilised to denote negative impacts. Where an impact is deemed to be positive, it will be represented by a dark grey colour.					Positive

Overall, the following were considered in the evaluation of impacts:

- Direct and indirect impacts
- Adverse and beneficial impacts
- Temporary, short-term or long-term impacts
- Reversible and irreversible impacts
- Cumulative impacts over time (as well as combined impacts of the proposed project with existing developments and other land use activities in the project areas)

2.4 Assumptions and limitations

The EIA report has been prepared on the basis of the following assumptions and considerations:

- The EIA report addresses the expansion Project (i.e. design capacity of 272,760 m^3/day).
- The EIA report will be limited to the Project site footprint and the area of impact immediately around it.
- All information provided by the project proponent, which formed the basis of this EIA, is accurate at the time of issuance.
- All available information relevant to the Project and this EIA has been provided to GHD.
- Other future development around the expansion Project was not assessed as part of the EIA.

3. Policy, Legal and Administrative Framework

3.1 Introduction

This section provides an overview of the key environmental requirements relevant to the Project's construction and operation activities. It should be noted that these are based on GHD's understanding and interpretation of current environmental regulatory standards applicable to the Project, and should not be construed as legal opinion.

Similarly, this is a general analysis based on the facilities and land uses that are currently known to be built as part of the expansion Project. As development progresses, or with the expansion of the processing facilities, any proposed additional activities should be assesses against the relevant policy, legal and administrative frameworks.

The regulatory framework expected to govern the environmental performance of the proposed Project comprises the following:

- Qatar environmental legislation and policy
- Regional conventions and protocols
- International conventions, protocols and guidelines.

3.2 National legal framework

The Qatari environmental laws and regulations that are applicable to the Project are provided in Table 3-1.

Table 3-1: Applicable environmental legislative requirements in Qatar

Aspect	Description	Project relevance
Relevant authority	Law No. 11 of 2000 with regard to establishing the Supreme Council for the Environment and Natural Reserves (SCENR)	The SCENR roles and responsibilities have subsequently been assigned to the MME
Relevant authority	Law No. 12 of 2000 with regard to the transfer of responsibility from the Environmental Department of the Municipal Affairs to Agriculture to SCENR	MME is the sole, competent authority to issue, administer, and enforce environmental standards
Relevant authority	Law No. 4 of 1981 with regard to Establishment of the Environmental Protection Committee	Law establishing of the Environmental Protection Committee
Relevant authority	Law creating the Committee for the Protection of the Marine Environment	Law establishing a Committee for the Protection of the Marine Environment
Relevant authority	Law. No. 13 of 1994 with regard to the establishment of the Environment Department of the Ministry of Municipal Affairs and Agriculture	Law establishing the Environment Department of the Ministry of Municipal Affairs and Agriculture (MMAA)

Aspect	Description	Project relevance
	(MMAA) to replace the Environmental Protection Committee	
EIA Study – permitting requirements	Environmental Protection Law No. 30 of 2002 and its Executive By-Law set the requirements for EIA for projects which are likely to have negative impacts on the environment.	The list of projects under this Law that require EIA includes desalination plants and its associated infrastructure; as such the proposed expansion Project is covered under this law
Overarching environmental assessment	Decree No. 30 of 2002 and its Executive By-Law objectives: • Protecting the environment and preserving its natural balance • Combating pollution in all its forms • Developing the natural resources and preserving the biological diversity, and maximizing exploitation of the same for the benefit of the present and future generations • Protecting the society and human and other living beings' health from all activities and acts which are harmful to the environment or obstructive to the legitimate use of the environment	The expansion Project has the potential to cause impacts on environmental aspects. As such, it will be required to comply with the objectives of this Law.
Overarching environmental assessment	Decree No. 4 of April 2005 consisting of the Executive By-Law, Annexes and Standards for Law No. 30 of 2002 for the Environment Protection Law No 30 of 2002	Regulations for implementation of Law No. 30 of 2002 including: • Objectives for environmental protection and sustainable development • Categorisation of Projects • Application Forms for Authorisations, Permits and Licenses and • Environmental Standards • Requirements for Hazardous Waste Disposal/Treatment
EIA Study	Environmental Impact Assessment Policy and Procedure 1998	Establishes Environmental Impact Assessment procedures
General housekeeping	Law No. 8 of 1974 with regard to General Housekeeping	Law governing the general housekeeping in general areas (e.g. streets, lands, pavement, beaches)

Aspect	Description	Project relevance
Marine environment	Law No. 4 of 1983 with regard to Exploitation and Conservation of Living Aquatic Resources	Law to regulate activities and prevent potential impact aquatic resources
Dredging activities	Law No. 1 of 1993 with regard to the Prevention of Excavation/Dredging of Agricultural Lands and use of Beach Sand	Law that prohibits the excavation of both agricultural land and beaches without obtaining an approval from the relevant authorities
Flora	Law No. 32 of 1995 with regard to Prevention of Damage to Flora	Law that regulate and prevents damage to plants
Environment protection	Decree No 31 of 2002 with regard to Protection from Radiation	Law governing and regulating industries deals with radiating materials or have equipment that emit radiation
Flora and Fauna	Law No 19 of 2004 with regard to the Protection of Wild Life and Natural Reserves	Law for the regulation and protection of wildlife and rehabilitation of natural habitat
Air	Law No. 21 of 2007 with regard to Control of Ozone-Depleting Substances	Law to regulate and control the use of ozone-depleting substances
Health and Safety	Mandate No. 5 of 2005 Establishment of the HSE Regulations and Enforcement Directorate	The Project needs to comply with the requirements of this Mandate in terms of construction and operation health and safety requirements
Labour	Labour Act No. 3 of 1962 Law No. 14 of 2004 The Labour Law: • Vocational training • Individual labour relationships • Disciplinary power of the employer • Wages • Working hours and leave • Employment of juveniles • Employment of women • Safety, vocational health and social care • Work injuries and compensation • Worker's organizations • Joint committees, negotiation and collective agreements • Collective disputes • Inspection or work • Penalties	The Project needs to comply with the provisions stated in this Law in terms of protection of workers' rights.

3.3 Regional and international conventions and treaties

Regional and international conventions and treaties that were considered relevant to the proposed expansion Project are provided in Table 3-2 while International Labour Organization (ILO) conventions ratified by Qatar and should be implemented by the Project is listed in Table 3-3.

Table 3-2: Applicable regional and international conventions and treaties

Aspect	Legislation	Project Relevance
Regional Conventions and Protocols		
Marine environment	Regional Convention for Cooperation on the Protection of the Marine Environment for Pollution	The Project will comply with the provisions in this convention (e.g. no illegal discharge from ships).
Biodiversity	Convention on Conservation of Wildlife and its Natural Resources in the Gulf Corporation Council (GCC) Countries	The Project needs to comply with the provisions of this convention in terms of biodiversity conservation.
International Conventions and Protocols		
Soil and groundwater quality	Dutch Circular on Target Values and Intervention Values for Soil Remediation	This circular will be adopted for the review and assessment soil and groundwater data.
Marine environment	Convention on the Prevention of Pollution from Ships (MARPOL)	The Project will comply with the provisions of this convention, which include the preservation of the marine environment by eliminating pollution by oil and other harmful substances and to minimise accidental spillage of such substance.
Marine environment – waste management	Convention on the Prevention of Marine Pollution by Dumping of Waste and other Matter	The Project will prohibit marine dumping (except for possibly acceptable wastes) in compliance with this convention.
	International Convention for the Control and Management of Ships' Ballast Water and Sediments	The Project will comply with the provisions of this convention in preventing, minimising and ultimately eliminating the risks of introduction of harmful aquatic organisms and pathogens through ships entering the ports.
Sediment quality	Australian and New Zealand Guidelines for Fresh and Marine Water (and Sediment) Quality	This guideline will be adopted for the review and assessment of marine sediment.
GHG Assessment	Montreal Protocol on Substances that Deplete the Ozone Layer of 1987 & Montreal Amendments	Ozone depleting substances listed in the Montreal Protocol will not be used during all phases of the Project.

Aspect	Legislation	Project Relevance
	Kyoto Protocol to the United Nations Framework Convention on Climate Change	The proponent will take into account and consider the targets for the commitment period.
	Vienna Convention for the Protection of the Ozone Layer	The proponent will take into account the mechanisms adopted in this convention. Ozone depleting substances listed in this convention will not be used during the construction and operation of the Project.
Biodiversity	Convention on Biological Diversity	The provisions in this convention will be considered in marine and terrestrial ecology section.

Table 3-3: ILO conventions ratified by Qatar[1]

Convention	Date of ratification	Status
C138 - Minimum Age Convention, 1973 (No. 138) *Minimum age specified: 16 years*	03 Jan 2006	In Force
C182 - Worst Forms of Child Labour Convention, 1999 (No. 182)	30 May 2000	In Force
C111 - Discrimination (Employment and Occupation) Convention, 1958 (No. 111)	18 Aug 1976	In Force
C105 - Abolition of Forced Labour Convention, 1957 (No. 105)	02 Feb 2007	In Force
C029 - Forced Labour Convention, 1930 (No. 29)	12 Mar 1998	In Force
C081 - Labour Inspection Convention, 1947 (No. 81)	18 Aug 1976	In Force

Source: Accessed from the http://www.ilo.org on 20 May 2019

[1] Qatar has not ratified the Federation of Association and Protection of the Rights to Organise Convention, the Right to Organise and Collective Bargaining Convention, the Equal Remuneration Convention, as well as the Employment Policy Convention, Labour Inspection (Agriculture) Convention, and Tripartite Consultation (International Labour Standards) Convention

3.4 International requirements

As the Proponent seeks project funding from international lending institutions, the Project needs to comply with the following:

- Equator Principles, 2013
- IFC Performance Standards, 2012
- IFC-WB EHS Guidelines (general and industry-specific), 2007

3.4.1 Equator Principles

The Equator Principles (EPs) is a risk management framework, adopted by financial institutions, for determining, assessing and managing environmental and social risk in projects and is primarily intended to provide a minimum standard for due diligence to support responsible risk decision-making.

The EPs apply globally, to all industry sectors and to four financial products:

- Project Finance Advisory Services (where total project capital cost is US$10 million or more)
- Project Finance (with total Project capital costs of US$10 million or more)
- Project-Related Corporate Loans (the total aggregated load amount is at least US$100 million)
- Bridge Loans

Equator Principles Financial Institutions (EPFIs) commit to implementing the EPs in their internal environmental and social policies, procedures and standards for financing projects and will not provide Project Finance or Project-Related Corporate Loans to projects where the client will not, or is unable to, comply with the EPs.

The EPs are based on the International Financial Corporation (IFC) Performance Standards on Social and Environmental Sustainability and on the World Bank Group EHS Guidelines. The statement of Equator Principles (June 2013) and the applicability to various project cycles of the proposed Project/borrower are provided in Table 3-4.

Table 3-4: Applicability of Equator Principles to the Project

Principle	Objectives / Requirements	Project Relevance
Principle 1 Review and Categorization	Categorizing the project based on the magnitude of its potential environmental and social risks and impacts in accordance with the IFC categorization criteria.	The Project is categorised as Category B: Projects with potential limited adverse environmental and social risks and/or impacts that are few in number, generally site-specific, largely reversible and readily addressed through mitigation measures.
Principle 2 Environmental and Social Assessment	The borrower to conduct an assessment process to address the relevant environmental and social risk and impacts of the proposed project (which may include the illustrative list of issues found Exhibit II of the Equator Principle).	The EIA report was prepared in line with the approved ToR, which will fulfil this requirement.

Principle	Objectives / Requirements	Project Relevance
Principle 3 Applicable Environmental and Social Standards	The assessment procedure should demonstrate: • Compliance with relevant host country laws, regulations and permits that pertain to environmental and social issues • Applicable IFC Performance Standards on Environmental and Social Sustainability • The World Bank Group EHS Guidelines	The EIA will be undertaken in compliance with Qatar's laws and regulations (refer to Table 3-1), IFC Performance Standards (Section 3.4.2, and World Bank EHS Guidelines (Section 3.4.3)
Principle 4 Environmental and Social Management System and Equator Principle Action Plan	The borrower is required to develop or maintain an Environmental and Social Management System (ESMS). Where the applicable standards are not met to the Equator Principles Financial Institutions (EPFI) satisfaction, the borrower and the EPFI will agree an Equator Principles Action Plan (EPAP) to outline gaps and commitments to meet EPFI requirements in line with the applicable standards.	An ESMS has been developed for the existing IWPP. As such, the proposed IWPP Expansion Project will be undertaken in line with the existing ESMS.
Principle 5 Stakeholder Engagement	The borrower has to demonstrate effective Stakeholder Engagement as an ongoing process in a structured and culturally appropriate manner with affected communities and, where relevant, other stakeholders.	Engagement with relevant stakeholders was undertaken during the preparation of the EIA and will be undertaken throughout the Project.
Principle 6 Grievance Mechanism	As part of the ESMS, the borrower has to establish a grievance mechanism designed to receive and facilitate resolution of concerns and grievances about the Project's environmental and social performance.	A grievance mechanism has been developed as part of the ESMS of the existing IWPP for both, the workforce and for the surrounding neighbourhood. The grievance mechanisms will be implemented for the proposed IWPP Expansion Project.

Principle	Objectives / Requirements	Project Relevance
Principle 7 Independent Review	An Independent Environmental and Social Consultant, not directly associated with the client, should be engaged to carry out an Independent Review of the Assessment Documentation including the Environmental and Social Management Plan, the Environment and Social Management System, and the Stakeholder Engagement process documentation.	GHD was engaged as the environmental consultant to prepare the required environmental studies for the proposed IWPP Expansion Project.
Principle 8 Covenants	The borrower has to provide periodic reports to the EPFI (not less than annually), prepared by in-house staff or third party experts, that: • document compliance with the Environmental and Social Management Plans and Equator Principles Action Plan (where applicable) • provide representation of compliance with relevant local, state and host country environmental and social laws, regulations and permits	Periodic reports to the EPFI will be provided during the construction and operation phases of the Project.
Principle 9 Independent Monitoring and Reporting	The EPFIs will appoint an Independent Environmental and Social Consultant, or require that the borrower retain qualified and experienced external experts to verify its monitoring information, which would be shared with the EPFI.	The Proponent will engage an independent consultant to do periodic environmental monitoring for the Project.
Principle 10 Reporting and Transparency	The borrower will ensure that, at a minimum, a summary of the EIA is accessible and available online.	The EIA will be made accessible and available online.

3.4.2 IFC Sustainability Framework and Performance Standards on Environment and Sustainability

As per Equator Principle 3 (Applicable Environmental and Social Standards), for projects located in Non-Designated Countries[2] (including the UAE), the EPFIs require that the assessment process evaluates compliance with the then applicable IFC Performance Standards on Environmental and Social Sustainability (Performance Standards) and the World Bank Group Environmental, Health and Safety Guidelines (EHS Guidelines) (Exhibit III).

IFC is a member of the World Bank Group and is owned by more than 180 member countries. IFC works in more than 100 developing countries and allows companies and financial institutions in emerging markets to create jobs, generate tax revenues, improve corporate governance and environmental performance, and contribute to their local communities.

IFC's Sustainability Framework articulates the Corporation's strategic commitment to sustainable development, and is an integral part of IFC's approach to risk management. The IFC Sustainability Framework consists of the following:

- Policy on Environmental and Social Sustainability, which defines IFC's commitments to environmental and social sustainability
- Performance Standards, which define clients' (i.e. borrower's) responsibilities for managing their environmental and social risks
- Access to Information Policy, which articulates IFC's commitment to transparency

The first version of IFC's Sustainability Framework was published in 2006. In 2012, an updated version was released, which applies to all investment and advisory clients whose projects go through IFC's initial credit review process after 1 January, 2012.

There are eight performance standards that outline the borrower's environmental and social responsibilities in relation to the project for which they are requesting. The IFC Performance Standards considered in this EIA are provided in Table 3-5.

The Performance Standards provides guidance on how to identify risks and impacts, and are designed to help avoid, mitigate, and manage risks and impacts as a way of doing business in a sustainable way, including stakeholder engagement and disclosure obligations of the client in relation to project level activities. Together, the eight Performance Standards establish standards that the client is to meet throughout the life of an investment (design, construction, commissioning, operation, decommissioning, closure or, where applicable, post-closure) by IFC.

IFC requires the client to establish and maintain a process for identifying the environmental and social risks and impacts of the project. For greenfield developments or large expansions with specifically identified physical elements, aspects, and facilities that are likely to generate potential significant environmental or social impacts, IFC will require the client to conduct a comprehensive EIA, including an examination of alternatives, where appropriate (IFC, 2012b).

It should be noted that the IFC performance standards have been incorporated in the Equator Principles III (June 2013) and an assessment of this in terms of applicability to the Project is identified in Section 3.4.1.

[2] Designated Countries defined by EPFIs: http://equator-principles.com/index.php/ep3/324

Table 3-5: Applicability of IFC Performance Standards to the Project

Standard	Objectives / Requirements	Project Relevance
PS 1 Assessment and Management of Environmental and Social Risks and Impacts	This standard establishes the importance of (i) integrated assessment to identify the environmental and social impacts, risks, and opportunities of the project; (ii) effective community engagement through disclosure of project-related information and consultation with local communities on matters that directly affect them; and (iii) the client's management of environmental and social performance throughout the life of the project.	The provisions in this performance standard were considered in assessing the environmental and social impacts of the Project and in recommending the mitigation measures to prevent any adverse impacts associated with the Project.
PS 2 Labour and Working Conditions	This standard recognizes that the pursuit of economic growth through employment creation and income generation should be accompanied by protection of the fundamental rights of the workers.	The requirements in this standard were taken into consideration in terms of planning for the hiring of workers, providing compensation and benefits, accommodation, and the total health and safety condition of workers. Labour and working condition was assessed and included in the social impact assessment.
PS 3 Resource Efficiency and Pollution Prevention	This standard encourages more efficient and effective resource use, pollution prevention and mitigation with technologies and practices.	The provisions in this performance standard were considered in identifying mitigation measures for use of more efficient and effective resources (where applicable).
PS 4 Community Health, Safety and Security	This standard addresses the client's responsibility to avoid or minimize the risks and impacts of project activities, equipment and infrastructure to community health, safety and security.	The provisions in this performance standard were considered in the assessment of project impacts to the community arising from air emissions, noise generation as well as traffic and security within the Project site.
PS 5 Land Acquisition and Involuntary Resettlement	This standard recognizes that project-related land acquisition and restrictions on land use have adverse impacts on communities and persons that use the land.	Land acquisition and resettlement are not proposed for the Project. The proposed expansion will be located within the existing IWPP Project boundary. As such, this standard is not applicable.

Standard	Objectives / Requirements	Project Relevance
PS 6 Biodiversity Conservation and Sustainable Management of Living Natural Resources	This standard recognized the importance of protecting and conserving biodiversity, maintaining ecosystem services and sustainably managing living natural resources in achieving sustainable development.	The provisions set out in this performance standard will be considered in the assessment of marine and terrestrial ecology.
PS 7 Indigenous Peoples	This standard recognized that Indigenous Peoples (IPs) are often among the most marginalized and vulnerable segments of the population. IPs are vulnerable if their lands and resources are transformed, encroached upon, or significantly degraded.	The rights and heritage values associated with IPs are not expected to be impacted as a result of the Project. The proposed expansion will be located within the existing IWPP Project boundary. As such, this standard is not applicable.
PS 8 Cultural Heritage	This standard recognizes the importance of cultural heritage for current and future generations.	Local heritage is not expected to be impacted as a result of the Project since the proposed expansion will be located within the existing IWPP Project boundary. As such, this standard is not applicable. However, this will apply in the event that important cultural and archaeological sites are identified during construction.

3.4.3 IFC-World Bank Group EHS Guidelines

The IFC-World Bank Group EHS Guidelines are technical reference documents with general and industry-specific examples of good international industrial practice. The IFC uses the World Bank EHS Guidelines as a technical source of information during project appraisals. Table 3-6 summarises the applicable World Bank EHS guidelines to this Project.

Table 3-6: Applicable World Bank EHS Guideline to the Project

Guideline(s)	Objectives / Requirements	Project Relevance
General EHS Guidelines	This guideline contains information on the performance levels and measures that are generally considered to be achievable in new facilities.	The provisions in this guideline will be used together with the relevant industry-specific sector EHS guidelines in assessing the impacts of the proposed expansion. Mitigation measures will also identified based on the recommendations provided in this guideline.

4. Project Description

4.1 Project location

The Project is proposed to be located next to the existing IWPP located 3.5 km to the south of Al Wakrah Town Centre and 15 km to the south of Doha (Figure 4-1). The IWPP is situated at the north eastern boundary of Qatar Economic Zone (QEZ) 3 or Umm Al Houl Special Economic Zone (SEZ) (GPS coordinates: 25.115099, 51.613167).

The proposed expansion is located immediately to the east of IWPP (Figure 4-2).

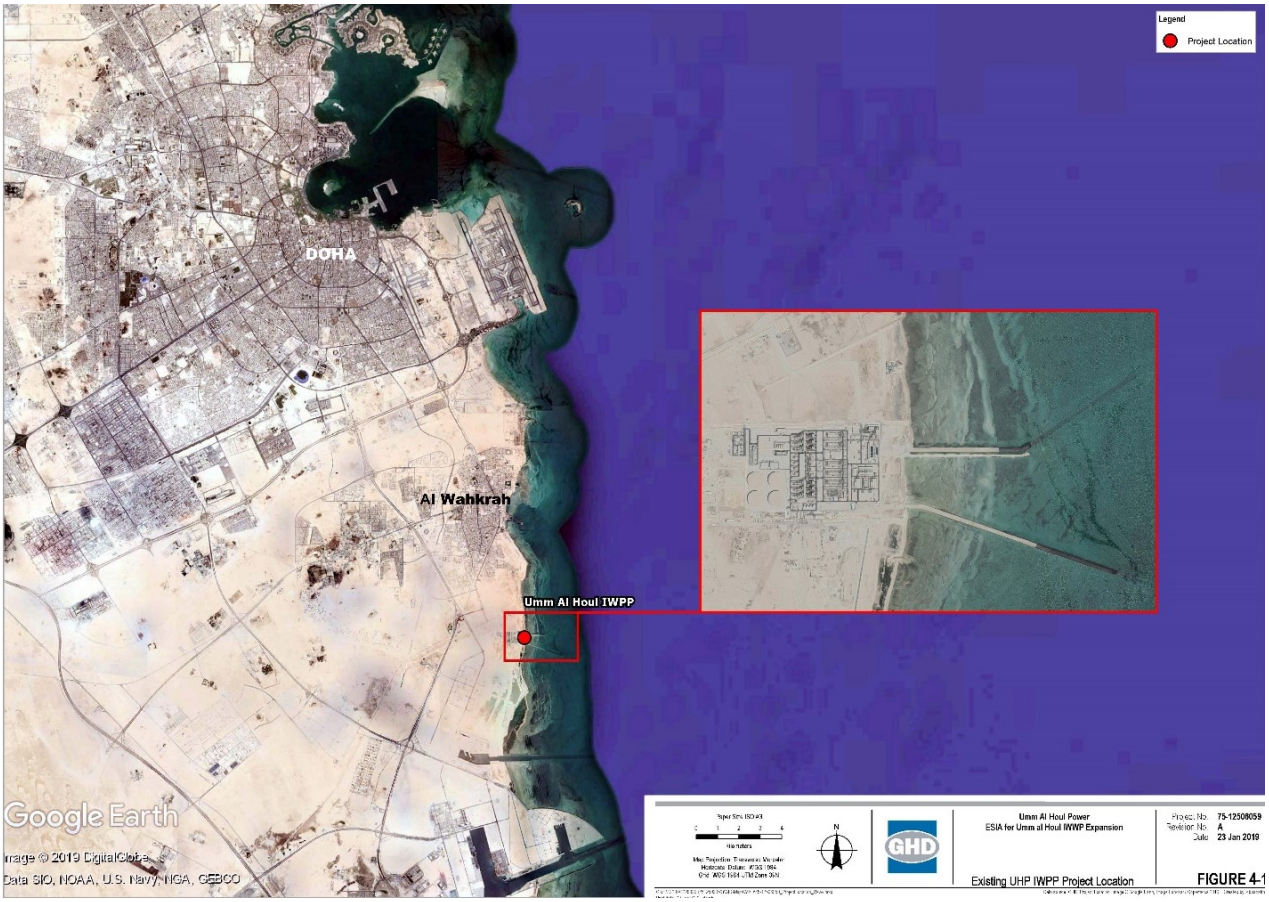

Figure 4-1: Existing Umm AL Houl IWPP

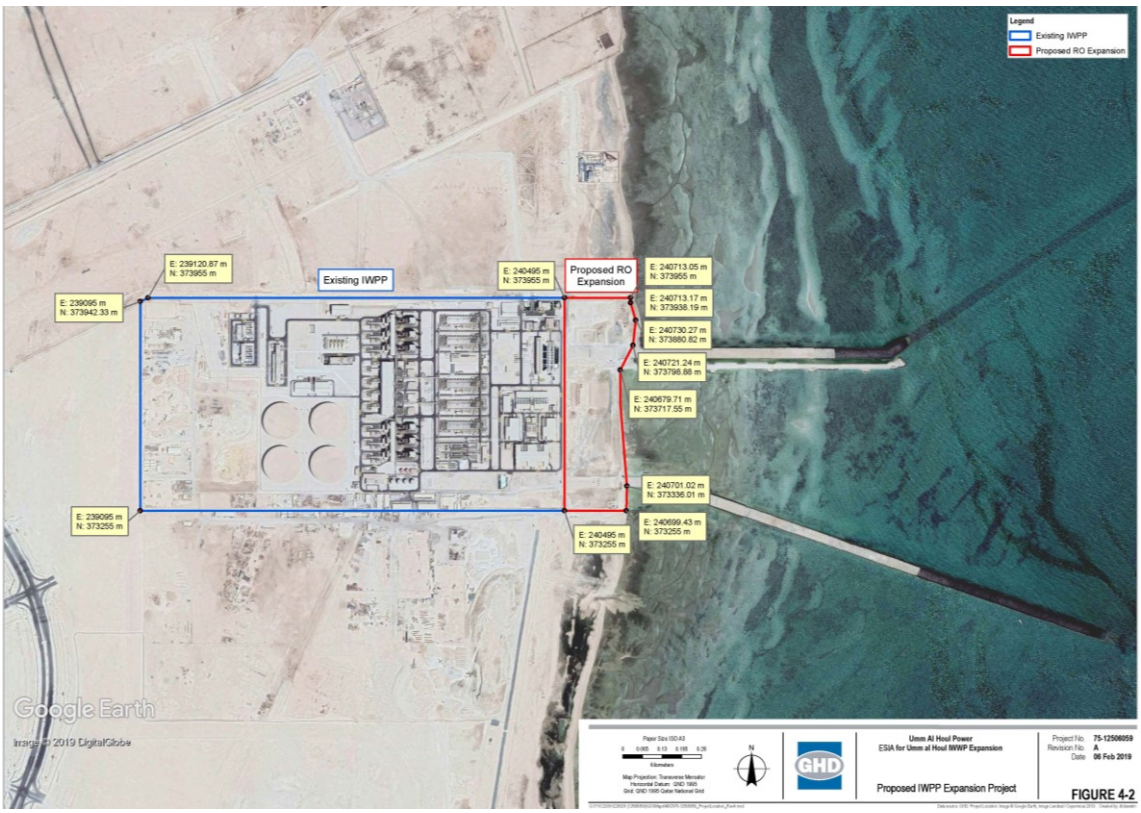

Figure 4-2: Proposed IWPP Expansion Project

4.2 Facility Capacity

The total net product water capacity of the proposed Project will be 61.45 MIGD (272,760 m^3/day; Table 4-1). An additional 2,728 m^3/day is required for the internal water consumption of the plant (i.e. for chemical preparation, clean in place (CIP) for RO membranes and external auxiliary water outside the plant).

Table 4-1: Capacity requirements for the proposed RO Desalination Plant

Description	Unit	Value
Total net capacity	m^3/h	11,365
RO plant net capacity	m^3/day	272,760
Auxiliary water demand		
RO plant auxiliary	m^3/day	2,728
Total gross water capacity		
RO plant gross	m^3/day	275,488

4.3 Plot Layout

The overall layout of the proposed IWPP Expansion Project is provided in Appendix C. As per plot layout provided in Appendix C, the proposed expansion will consist of:

- No. 203 – RO Desalination Plan
- No. 204 – SWGR Building for RO Desalination Plant
- No. 205 – Remineralisation Plant
- No. 206 – SWGR Building for Remineralisation Plant

4.4 Process Description

The process for the proposed RO plant is summarised in the following subsections. Detailed process description is provided in Appendix D while the detailed process flow diagram is provided in Appendix E.

4.4.1 Main Process

4.4.1.1 Seawater Intake

Approximately 31,010 m^3/hour of seawater is required in order to reach the required capacity. The existing seawater intake pipes will be utilised to supply the seawater into the proposed RO plant. Therefore, seawater intake pipes are not proposed for the RO expansion.

4.4.1.2 Pre-treatment

Seawater is known to be warm and rich in organic life, presenting red-tide events from time to time. The DAF system will mitigate the issues originating from red tide events as well as remove solids and algae before reaching the disc filters.

The pre-treatment system will produce an RO feed water with a Silt Density Index (SDI) ≤2.5 75% of the time and SDI ≤3.5 100% of the time, which are enough for the RO membrane requirements.

The adoption of the DAF system is to improve the removal of light pollutant (mainly dissolved hydrocarbons), algae and micro-organism that are feature of the Gulf waters in normal conditions, and a protection against exceptional conditions of black or red tides.

The pre-treatment will primarily consist of:

- *Dissolved Air Floatation (DAF)*. The sludge flows from the DAF system will gravitate from each stream to the floated sludge tank, from where it will be pumped to the sludge storage tank prior to dewatering system. DAF system includes:
  - pH correction (H_2SO_4)
  - Coagulant dosing
  - Dechlorination (sodium metabisulphite dosing)
  - Mixing and flocculation
  - Dissolved Air Flotation
  - Intermediate water pumping station
- *Filtration stage through disc filters*. Disc filters are required to remove coarse solids and avoid them from reaching the ultrafiltration membranes.
- *Filtration stage through ultrafiltration membrane*. Membrane filtration operates inside-out, which means that the feed water flows from the inside to the outside of the capillaries in filtration mode and flows in the reverse direction, i.e. from the inside to the outside of the capillaries, in backwash mode. Therefore, the substances are retained on the inner filtering surface of the ultrafilteration (UF) membranes and will be easily removed, by backwashing or by means of chemical cleaning. One of the main advantages of in-out filtering is that the feed water is not in contact with the outside housing of the membrane, where the solids are retained in the filtering process.

4.4.1.3 Reverse Osmosis (RO) System

The RO system will be designed to produce permeate in compliance with the specification for the range of raw seawater design envelope, whilst maintaining high energy efficiency, operational robustness and flexibility. The RO system treatment will consist of:

- Dechlorination (sodium metabisulphite dosing)
- Antiscalant dosing (1st pass)
- Sulphuric acid shock dosing to each RO rack (1st pass)
- First pass reserve osmosis, including HP pumping, RO membrane racks and energy recovery system
- Antiscalant dosing (2nd pass)
- Second pass reverse osmosis including booster pumps and RO membrane racks
- Cleaning and flushing system

The RO design was developed with the following specifications:

- Inlet salinity vary due to the second pass recirculation
- Additional production has been allowed for internal plant services and membrane displacement
- High energy efficiency
- Energy Recovery Device (ERD), with very high recovery efficiency
- Second pass to reduce chloride, boron and total dissolved solids (TDS) concentration at permeate water

Neutralization Tank

A 100 m^3 tank in GRP will be provided for the neutralization of cleaning chemicals. Once membrane cleaning has been completed, the chemical solutions used will be sent to this tank and other chemicals will be dosed in order to neutralise these solutions before discharge. The neutralization process is fully automatic and the operator will decide if the characterization of the solution is admissible for discharge. pH will be measured at the discharge line in this tank.

Service Water Tanks

Two permeate water storage tanks of 1000 m3 capacity each will be constructed in the RO building. Water will be used for chemical dilution and membranes flushing among other applications. The service water system used to dilute the different chemicals will suction from this tank.

4.4.1.4 Remineralization

The remineralization area is designed to treat the 33% of the permeate flow to be treated through the limestone filters, being the 67% bypassed. The treated water and bypass stream will be blended on line by passing through a static mixer.

Carbon dioxide (CO_2) absorbers and limestone contactors will be used in order to remineralize the water according to the required potable characteristics, which will comply with the latest version of the water quality requirement, "*Water Quality Requirements and Conditions for Drinking Water Producer Companies*" (July 2013).

A summary of the main parameters for the potable water are as follows:

- TDS: 110–250 mg/L
- pH: 7.0–8.3
- Hardness: 65–120 mg $CaCO_3$/L
- Alkalinity: 60–120 mg $CaCO_3$/L

- Turbidity: <1 NTU
- LSI: +0.0 ≤ LSI ≤ +0.3

Remineralization consists of a hardening stage followed by another stage of disinfection. As part of rehardening, CO_2 gas will be injected into part of the permeate water that will be pumped to the CO_2 absorber by the CO_2 absorber booster pumps. This will be around 20% of the 33% side flow. After the CO_2 has been dosed, the acidified permeate water will be mixed with the remaining boosted permeate water in an inline static mixer and subsequently it will enter the limestone filters.

The acidified carbonated water from the limestone filters still contains some excess CO_2 gas, resulting in a too low pH value in the final product water. A Degasser Tower will be used to eliminate the remaining excess of free CO_2 in the Acidified Carbonated Water before the NaOH solution injection.

After the excess of CO_2 has been removed, carbonated water is finally blended with the main permeate by-pass. In order to eliminate the remaining CO_2 in the product water, a solution of NaOH is dosed into the water.

The disinfection will be done by chlorine dioxide dosing. Both the NaOH and chlorine dioxide dosing points will be located just before the potable water tanks into a static mixer in order to enhance the mixing.

4.4.2 Wastewater Treatment

The different process included in the main process line (refer to Section 4.4.1) will have secondary flows. Some of them will be sent directly into the outfall, as their characteristics are similar to the seawater ones and do not have any environmental impact. Others, however, will require a specific treatment in order to reduce the solids concentration before being discharged back into the sea. Secondary flows in the plant consist of:

- Floated sludge from DAF system
- Backwashed water from disc filters and UF[3]

The above flows will be treated in the Wastewater Treatment Building, as follows:

- *Sludge Clarifiers*. Solids will gather together into flocs in the flocculation chambers of the clarifiers. The clarifiers will encourage these flocs (of a large size) to float, from where they are easily removed. Floated sludge will be removed automatically by scrapers and will be floated to the sludge tank.
- *Floated Sludge Tank*. The floated sludge from the sludge clarifier system will be pumped to the floated sludge tank. The tank will encourage the settlement into a certain area, so that the sludge pumps can take the settled material to the thickening stage.
- *Dewatering Centrifuges*. Centrifuges will dewater the sludge from a minimum dryness of 3% to 20% or more. Concentrate from the centrifuge will be pumped to the outfall.

4.5 Chemicals

The anticipated chemical dosing values for the proposed expansion Project is provided in Table 4-2. Based on experience of the Project operator in designing and operating similar plants, the final dosing values will be fixed during the commissioning phase.

[3] Backwashed water from disc filters and UF could be discharged directly to the seal pit if the mixing with other streams into the seal pit complies with environmental regulations.

All chemical tanks will be installed in dedicated bunded areas with capacity for the whole storage volume. All tanks will be equipped with level switches, as a minimum:

- High Level Switch – tank filling stop
  - – Low level: tank filling required
  - – Low alarm: stop dosing pump

Table 4-2: Chemical dosing values

Chemicals	Service	Dosing rate (ppm)	
		Average	Maximum
Pre-treatment			
Sulphuric acid	pH control for coagulant	10	24
Sodium bisulphite	Dechlorination before DAF	2.9	15
Ferric chloride	Coagulation before DAF	0.5	3
Ferric chloride	Coagulation for UF before DAF	1.5	7.3
Sulphuric acid	Shock biological disinfection	--	160
Antiscalant, 1st pass	Avoid salt precipitation	1	1.5
Sodium Bisulphite	Dechlorination before RO	5.9	15
2nd Pass Reverse Osmosis			
Sodium Hydroxide	pH increase	15	35
Antiscalant	Avoid salt precipitation	2	3.5
Wastewater Treatment			
Polyelectrolyte	Dewatering	0.5	1
Ferric chloride	Coagulation before Sludge Clarifier	15	30
Ultrafiltration (CEB)			
Sulfuric acid	UF CEB	1214	--
Sodium Hydroxide	UF CEB	94	--
Sodium hypochlorite	UF CEB	200	--

4.6 Effluents and Wastewater Treatment Plant

Effluents of the RO plant include:

- Backwash water from disc filter and ultrafiltration (UF)
- Floated materials from the DAF system
- Neutralised effluents from UF an RO membranes cleaning

In general, the effluents from the RO plant are discharged to the sea diluted into the brine coming from the MSF and condenser unit. Some of the flows will need treatment prior to

discharge, in order to avoid environmental impact. Table 4-3 shows the expected RO effluent discharge water quality. The effluent water quality is based on the intake requirements and design envelope but is also dependent on ambient/recirculation of seawater concentrations remaining under RFB values as the RO plant process does not add any elements which would affect these values.

Table 4-3: Quality of effluents to discharge culvert

Parameter	Unit	Data
Physical		
Max. rise in surface temperature of seawater at full production	°C	3
Temperature	°C	38 (where seawater is 35°C)
Total Dissolved solids	mg/l	86,750 (where salinity is 45,900)
Suspended solids	mg/l	50 (where seawater is 30 mg/l)
Oil	mg/l	< 10
Chemical		
Ammoniacal nitrogen	mg/l	<3
Arsenic	mg/l	<0.5
Biochemical oxygen demand	mg/l	<50
Cadmium	mg/l	<0.05
Chlorine	mg/l	<1
Chromium total	mg/l	<0.2
Copper	mg/l	<0.5
Chemical Oxygen Demand	mg/l	<100
Cyanide	mg/l	<0.1
Iron total	mg/l	<1
Lead	mg/l	<0.1
Manganese	mg/l	<0.2
Mercury	mg/l	<0.001
Lead	mg/l	<0.01
pH	mg/l	6-9
Phenols	mg/l	<0.5
Phosphate (as total P)	mg/l	<2
Selenium	mg/l	<0.02
Silver	mg/l	<0.005
Sulphide	mg/l	<0.1

Parameter	Unit	Data
Vanadium	mg/l	TBD
Zinc	mg/l	<2
Boron	mg/l	<10.7

Backwash water sourced during UF chemical cleaning will be pumped into its own neutralisation tank, prior to being pumped to the seal pit. Provision to connect the UF chemical enhanced backwash-clean in place (CEB-CIB) neutralised flow with the wastewater treatment (WWT) system has been considered if required to be used during the operation of the Plant.

The CIP system for the RO membranes cleaning includes its own neutralisation tank. Floated materials from the DAF units will be pumped into the wastewater treatment plant.

The wastewater treatment plant will consist of the following elements:

- Sludge clarifiers
- Dewatering centrifuges
- Polyelectrolyte dosing

4.6.1 Brine Pit Discharge

Brine coming from the energy recovery device (ERD) units will have enough remaining pressure to reach the new brine pit.

4.6.2 Outfall Discharge

Drainages, vents, and instrument flows will need to be pumped to reach the seal pit. One duty and one standby pump will be used.

Drainages from the RO plant, will go to the existing seal pit by using the existing RO plant discharge pipe.

4.7 Design Life

The proposed Project has been designed for a minimum service life of 30 years, under normal and various cycling operating conditions with proper maintenance. The Project will be designed to withstand the prevailing ambient conditions to which it will be exposed and to continue to function normally.

The Project will be designed to operate continuously throughout the year. The pre-treatment package and the RO package will be designed to operate for 8,760 hours per year. As such, sufficient spare capacity will be installed to allow for shutdown due to maintenance or plant failure.

4.8 Plant Performance Criteria

The proposed Project will be operated, supervised, and maintained in compliance with the plant performance criteria detailed below.

4.8.1.1 Water Quality Criteria

Seawater Quality

The range of acceptable seawater criteria for the design envelop (i.e. the acceptable water quality at the intake point) are specified in Table 4-4.

Table 4-4: Acceptable seawater criteria for the design envelop

Parameter	Units	Design
Temperature	°C	15–35
Total Dissolved Solids	mg/l	45,900
Ca^{+2}	mg/l	532.91
Mg^{+2}	mg/l	1,695.61
Na^{+}	mg/l	14,068.81
K^{+}	mg/l	506.13
Ba^{+2}	mg/l	0.01
Sr^{+2}	mg/l	13.9
CO_3^{-2}	mg/l	5
HCO_3^{-}	mg/l	146
SO_4^{-2}	mg/l	3,530.18
Cl^{-}	mg/l	25,295.18
NO_3^{-}	mg/l	0
F^{-}	mg/l	1.4
Br^{-}	mg/l	94
B	mg/l	5.3
pH		8.21
Total Suspended Solids	mg/l	<30
DAF Inlet Turbidity	NTU	1.2–15
UF Inlet Turbidity*	NTU	1.2–5*

*UF is designed for 5 NTU feed water on a continuous basis, DAF will be operated above this value.

Potable Water Quality

Potable water after remineralisation will comply with the specification of Water Quality Requirements and Conditions for Drinking Water Producer Companies from July 2013 (LNTP Schedule 25) (Appendix F).

4.8.1.2 Noise Criteria

The proposed Project has been designed with the following noise criteria for sound pressure levels (SPL):

- At 1m distance of each equipment inside the facility: 85 dBA
- At any location within the central control room: 55 dBA

4.9 Project schedule

The key dates for the construction of the proposed expansion Project are as follows:

- Anticipated Start Date: 1 June 2019
- Completion of first 30 MIGD: 1 February 2021
- Completion of second 30 MIGD: 1 April 2021

5. Information Disclosure and Consultation

5.1 Overview

Information disclosure and consultation is an important component of how the Proponent conduct its business and is an integral part of any EIA process. Stakeholder engagement enables project teams and management to identify, monitor and address issues as they pertain to a Project. It also gives opportunities for stakeholders (e.g. regulatory authorities, interest groups, local community and the general public) to provide commentary on the Project and its perceived adverse impacts and benefits. Consultation requires not only dialogical processes but also the use of transparent issues management. It is a two-way process of disseminating and receiving information.

This Chapter describes the stakeholder engagement activities undertaken for the Project to date as well as the planned consultation throughout operation.

5.2 Principles of consultation

Information disclosure and consultation is required to:

- Ensure inclusive process that provides timely, relevant information to project affected people and other stakeholders in a culturally appropriate manner
- Ensure that stakeholders are given opportunity to voice their opinions, concerns and ideas, and that these are considered in Project decisions
- Promote awareness and understanding of the Project, associated time frames and its potential effects and benefits
- Ensure that good engagement practices are implemented, thereby assisting the Proponent in attaining and maintaining a social acceptability of the Project

5.3 Consultation requirements

5.3.1 Qatar requirements

There are no legislative requirements under the Qatar environmental legislation for stakeholder engagement; however, the proponent acknowledges the value of open and transparent engagement and consultation.

5.3.2 Equator Principles

Under the Equator Principles, lenders involved will seek to ensure that the Project is developed in a manner that is socially responsible and reflects sound environmental management practices. The principles state that, "*We believe that adoption and adherence to the Equator Principles offers significant benefits to us, our clients, and local stakeholders through our clients' engagement with locally affected communities*," (Equator Principles, 2013).

There are two information disclosure and consultation-related principles (5 and 6), which are summarised below.

Principle 5: Stakeholder Engagement

The Proponent must consult with Project -affected communities in a structured and culturally appropriate manner. For projects with potentially significant adverse impacts, the Proponent will

conduct an informed Consultation and Participation process as a means to establish whether a project has adequately incorporated affected communities' concerns. The consultation process will be tailored to consider the risks and impacts of the project, the project's phase development, the language preferences of the affected communities, their decision-making processes and the needs of the disadvantaged and vulnerable groups.

Principle 6: Grievance Mechanism

A grievance mechanism will be established for Category A and B projects as part of the ESMS. The grievance mechanism will be designed to receive and facilitate resolution of concerns and grievances about the Project's environmental and social performance.

5.3.3 IFC Performance Standards for information disclosure and consultation

The IFC has published Performance Standards with regard to public consultation and disclosure to ensure that IFC-funded projects are implemented in an environmentally and socially responsible and sustainable manner. In addition, they are cornerstones of Equator Principles that apply to signatory international finance institutions.

The following IFC Performance Standards were taken into consideration:

Performance Standard 1: Assessment and Management of Environmental and Social Risks and Impacts

- Pertains to projects with social and environmental risks and impacts that ought to be managed in the early stages of project development and should be ongoing throughout the life of the project. This approach necessitates the participation of Project Affected Persons (PAPs) in the process.
- Highlights the importance of managing the social and environmental performance throughout the life of a project. A social and environmental management system must be established and maintained and be proportionate with the level of social and environmental risks and impacts. The development of a SEP is recognised as a tool in such a management system.
- Recognises that the pursuit of economic growth through employment creation and income generation should be balanced with the protection of basic rights for workers.
- Acknowledges that constructive worker-management relationships, and safe and healthy working conditions, may enhance the efficiency and productivity of operations.

Performance Standard 4: Community Health, Safety and Security

- Recognises that project activities, equipment and infrastructure bring benefits to communities including employment, services and opportunities for economic development. However, the project can also increase the potential for community exposure to risks from development.
- Where project activities pose risks of adverse impacts on the health and safety of affected communities the developer is required to make available relevant information (including the details of an Action Plan), in an appropriate form, to affected parties and government authorities so that they can fully understand the nature and extent of the risks.

Performance Standard for Grievance Resolution

The IFC Performance Standards (PS) place great emphasis on the establishment of a grievance mechanism and highlights this in the Standards listed below:

- PS1 - Assessment and Management of Environmental and Social Risks and Impacts:
  - "The client will respond to communities' concerns related to the project…will establish a grievance mechanism to receive and facilitate resolution of the affected communities' concerns and grievances about the client's environmental and social performance"
- PS2 - Labour and Working Conditions:
  - "The client will provide a grievance mechanism for workers (and their organisations…) to raise reasonable workplace concerns…use an understandable and transparent process that provides feedback to those concerned"
- PS4 - Community Health, Safety and Security:
  - "A grievance mechanism should allow the affected community to express concerns about the security arrangements and acts of security personnel"

5.4 Project stakeholders

The key stakeholders for the proposed RO expansion as listed below.

- Internal stakeholders:
  - Project owners (Qatar Electricity and Water Corporation (QEWC), K1 Energy (a joint venture between Mitsubishi Corporation and JERA JV), Qatar Petroleum (QP) and Qatar Foundation (QF))
  - Staff and workers
- External stakeholders
  - Government institutions
    - Ministry of Municipality and Environment (MME)
    - Ministry of Energy and Industry
    - Ministry of Labour and Social Affairs
    - Ministry of Transport
    - Ministry of Interior
    - Al Wakrah Municipality Council
  - Community Groups and Organizations (refer to Figure 5-1)
    - Al Wakrah City
    - Al WUkair City
    - Barwa Village
    - Mesaieed City
    - Doha City
  - Non-Government Organizations (NGO)
    - Qatar Environment and Energy Research Institute
    - Mesaieed Industrial City (MIC)
  - Other (general public and wider communities)
    - Emergency services
    - General public
    - Media

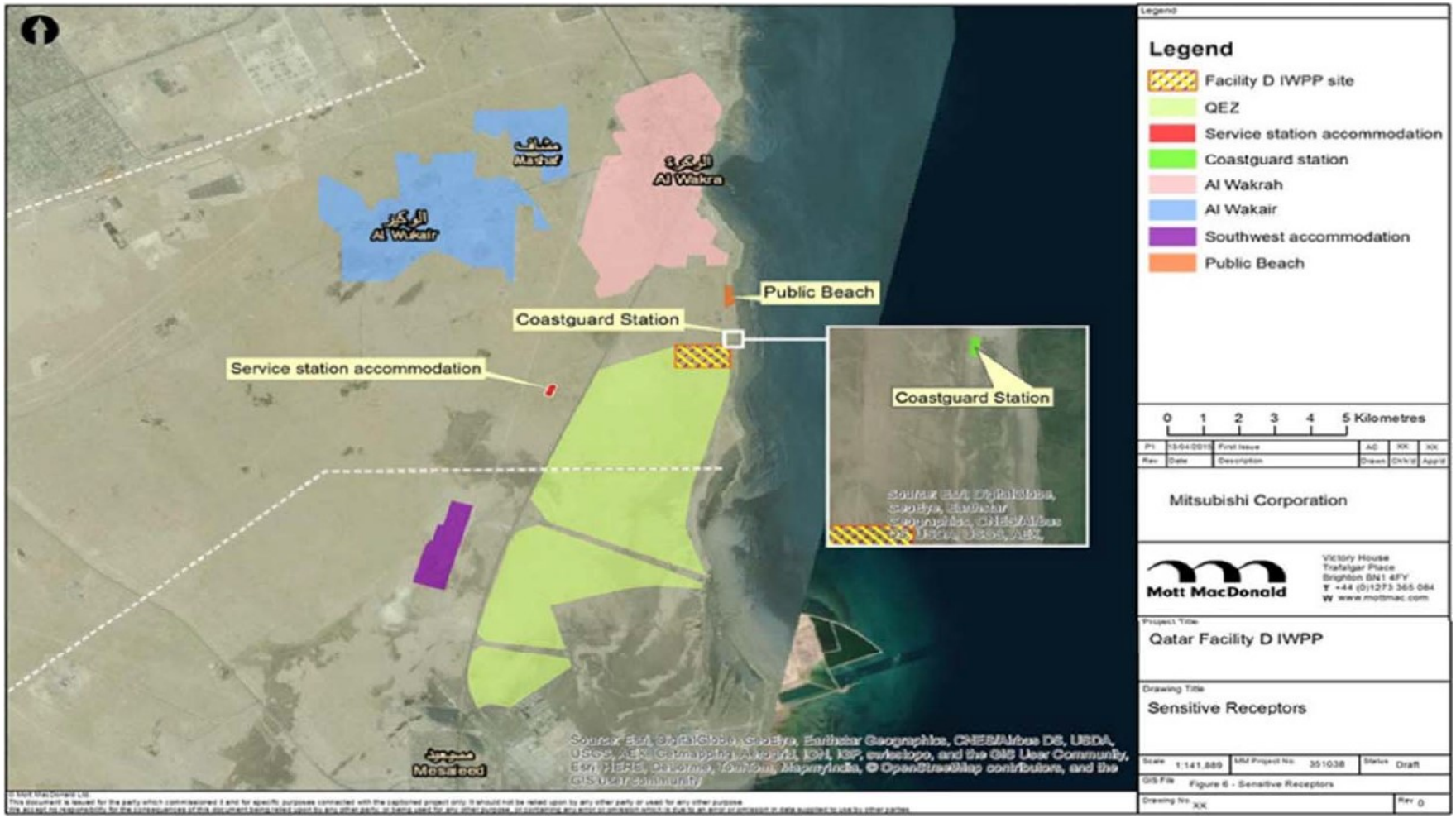

Figure 5-1: Community receptors surrounding the Project site

Source: Umm Al Houl IWPP EIA (Mott MacDonald, 2016)

5.5 Project grievance and redress mechanism

A grievance mechanism is an important aspect of the UHP Company's commitment to environmental and social responsibility and respect to human rights. This mechanism could benefit both the proponent and the stakeholders as they achieve transparency throughout the project.

The UHP Company has an existing grievance and redress mechanism, which will be implemented during the development and operation of the proposed RO expansion project. The overall grievance mechanism is provided in Figure 5-2 and detailed in UHP Company's Stakeholder Engagement Plan (GHD, 2018b).

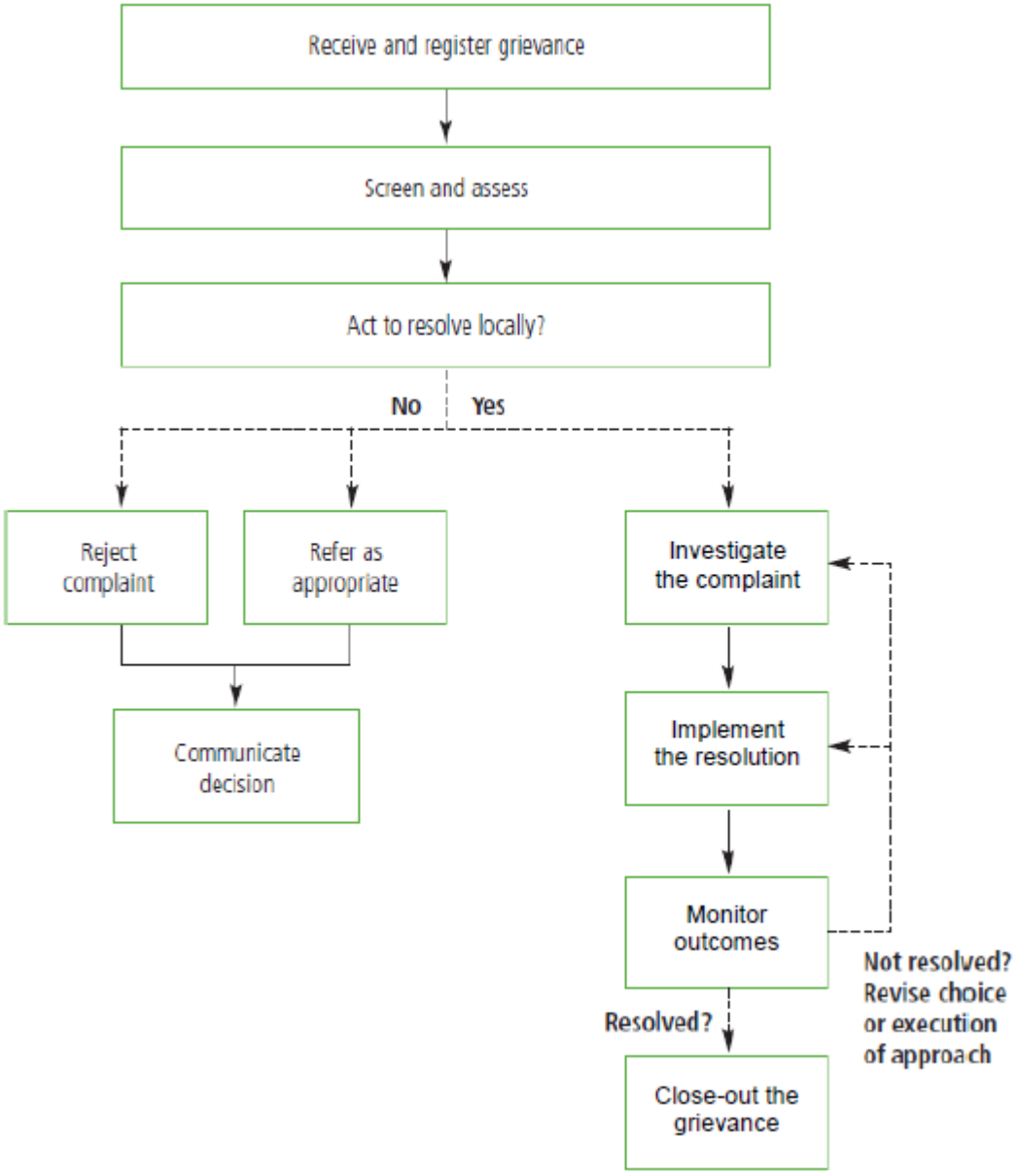

Figure 5-2: Community grievance mechanism procedure

Source: The Office of the Compliance Advisor/Ombudsman, 2008 [Figure 0.1. The Typical Stages of a Grievance Mechanism]

6. Air Quality

6.1 Introduction

This section describes the pre-development and current baseline conditions of the Project area and the impacts and proposed mitigation measures for air quality.

6.2 Assessment methodology

The methodology for air quality assessment at the Project site include:

- Desktop review of the following secondary data:
  - Site specific air quality monitoring survey undertaken by Mott MacDonald (2016) for the Project during the pre-development phase.
  - Air quality monitoring undertaken by GHD as part of the quarterly monitoring for Operational Environmental Management Plan (2019a)
- Identification of the appropriate air quality guidelines applicable to this assessment under legal framework and standards
- Qualitative assessment of the significance of Project construction and operation activities on air quality
- Suggested management procedures and mitigation measures

6.3 Legislative framework and applicable standards

6.3.1 Qatari standards

Air emission limits and ambient air standards were issued by the MME under the Environmental Protection Law. These standards, which was revised in 2005, comprise industry specific emission limit values and national thresholds for the concentration of pollutants in ambient air. NO_x emission limit values for "Thermal Power and Thermal Desalination Plants Greater than 15MW (thermal input)" are summarised in Table 6-1. Relevant ambient air quality standards for NO_2 are provided in Table 6-2.

Table 6-1: Relevant Qatari emission limits values

Pollutant	Unit	Qatari standard
NOx	mg/Nm^3 [(a)]	55

Note: [(a)] Concentrations referenced to 15% O_2, dry, 1 atm, 0°C

Table 6-2: Relevant Qatari ambient air quality standards

Pollutant	Averaging period	Unit	Qatari standard
NO_2	Maximum hourly average	$\mu g/m^3$	400 [(a)]
	Maximum 24-hour average	$\mu g/m^3$	150 [(b)]
	Annual average	$\mu g/m^3$	100
SO_2	Annual average	$\mu g/m^3$	80
O_3	8-hour ambient standard	$\mu g/m^3$	120 [(c)]

Criteria Attainment Key: [(a)]: 99.9th percentile of hourly averages | [(b)]: 99.7th percentile of daily averages | [(c)]: No annual mean standard

6.3.2 World Bank air quality standards

The World Bank introduced an Environmental Assessment (EA) policy as an Operational Directive (OD) 4.01 in 1989. This policy was expanded to Operational Policy (OP) 4.01 in 1999 and most recently updated in February 2011. The World Bank requires environmental assessment of projects proposed for World Bank financing to help ensure that they are environmentally sound and sustainable, and thus to improve decision making.

Item 6 of the OP 4.01 statement refers to the Pollution Prevention and Abatement Handbook (PPAH) (IFC, 2007) for pollution prevention and abatement measures and emission levels that are normally acceptable to the Bank. Section 1.1 (Ambient Air Quality) of the PPAH requires that projects with significant sources of air emissions, and potential for significant impacts to ambient air quality, should prevent or minimise impacts by ensuring that:

- Emissions do not contribute a significant portion to the attainment of relevant ambient air quality guidelines or standards.
- Emissions do not result in pollutant concentrations that reach or exceed relevant ambient quality guidelines and standards by applying national legislated standards, or in their absence, the current World Health Organisation (WHO) Air Quality Guidelines (refer to Table 6-3) or other internationally recognised sources.

Based on the above, the World Bank air quality policy has referred to WHO air quality standards for different key air pollutants. WHO promulgated air quality guidelines for particulate matter, ozone, nitrogen dioxide and sulphur dioxide in the Global Update 2005 (WHO, 2005). However, other pollutants, such as carbon monoxide and lead, were not included in the Global Update 2005 review due to the limited resources available to the project. As a result, the 2000 WHO guidelines (WHO, 2000) will remain in effect for pollutants not considered in the 2005 update. A summary of the WHO's Air Quality Guideline levels is detailed in Table 6-3.

Table 6-3: World Bank / WHO ambient air quality standards

Substance	Symbol	Max. allowable limit (µg/m^3)	Averaging time
Nitrogen dioxide	NO_2	200	1-hour
		40	Annual
Sulphur dioxide	SO_2	500	10-minute
		20[4]	24-hour
Ozone	O_3	100[5]	8-hour
Carbon monoxide	CO	30,000	1-hour
		10,000	8-hour
Particulate matter (10 microns or less in diameter)	PM_{10}	20	Annual
		50[6]	24-hour
Particulate matter (2.5 microns or less in diameter)	$PM_{2.5}$	10	Annual
		25	24-hour
Lead	Pb	0.5	Annual

[4] This denotes the World Bank guideline value for SO_2 Air Quality Standards. Interim target 1 and interim target 2 values for SO_2 are 125 µg/m^3 and 50 µg/m^3 respectively.
[5] This denotes the World Bank guideline value for O_3 Air Quality Standards. Interim target 1 value for O_3 is 160 µg/m^3.
[6] This denotes the World Bank guideline value for PM_{10} 99th percentile Air Quality Standards. Interim target 1, interim target 2 and interim target 3 values for PM_{10} are 150 µg/m^3, 100 µg/m^3, and 75 µg/m^3 respectively.

6.4 Baseline

6.4.1 Air Sensitive Receptors

Sensitive receptors were identified in Section 2.3.2. Air sensitive receptors are described based on the type of receptor and the distance from the construction or decommission activity boundary (Mott MacDonald, 2016).

Based on the criteria provided in Table 6-4, the identified receptors surrounding the proposed Project are considered to be 'low sensitive receptors' as follows:

- Al Wakrah Town Centre – 3.5 km
- Al Wakrah Family Beach – 1.3 km
- Wakrah Coast Guard Station – 0.5 km

Table 6-4: Receptor classification and sensitivity

Receptor	Sensitivity	Distance to activities			
		0–50m	50–100m	100–200m	200–1000m
Hospitals and clinics	High	High	High	Medium	Low
Residential areas Workers' accommodation Beaches Places of work	Medium	Medium	Medium	Low	Low
Farmland Other industry	Low	Medium	Low	Low	Negligible
No receptors	No receptors	Negligible	Negligible	Negligible	Negligible

Source: (Mott MacDonald, 2016)

6.4.2 Current site condition

Stack emissions monitoring is being undertaken at six operational stacks for nitrogen oxides (NOx), sulphur dioxide (SO_2), carbon monoxide (CO) and oxygen (O_2). Results were generally compliant with Project specific guidelines for emissions (GHD, 2019a).

An Air Quality baseline assessment was undertaken at two monitoring locations situated near the Project Site for a duration of one week. An Air Quality baseline report presenting the monitoring methodology and raw data is provided as Appendix G.

The daily average concentrations for PM_{10}, NO_2, SO_2 and CO were found to be compliant with the Qatar Standards for the duration of the baseline survey.

6.5 Environmental impact prediction and evaluation

6.5.1 Construction

Potential air quality impacts during construction and site development will be emissions from heavy vehicle exhausts and dust generation during earthworks as well as wind erosion from disturbed soil surfaces.

Heavy machinery and plant

Emissions from heavy vehicles would consist of products of combustion, including oxides of nitrogen (NOx), SO_2, PM_{10} and volatile organic compounds (VOCs).

Vehicle emissions will arise from diesel powered equipment used during construction. Emissions from heavy equipment will be minimised by ensuring all vehicles on-site are well maintained and operated in an efficient manner.

Emissions from vehicles on-site are not considered to represent a significant source of emissions.

Construction dust

The impacts of dust emissions fall under two distinct categories; health and amenity.

Potential health impacts are attributable to the concentration of respirable particles in ambient air. Respirable particles of dust (PM_{10}) would have maximum impact under light winds and stable atmospheric conditions. These conditions most frequently occur overnight and very early in the morning and therefore, become more significant only if construction operations extend outside typical operating hours.

The presence of total suspended particles (TSP), greater than 35 micron, is likely to affect amenity by way of reducing visibility (whilst in the air column) and by soiling of materials via dust deposition. Amenity impacts are most marked in high wind conditions, when larger particles may be displaced and transported a significant distance before being deposited and so soiling surfaces. Mitigation of amenity related dust impacts would in turn act to reduce health impacts due to dust emissions.

The extent to which these emissions may impact on the surrounding sensitive land uses would depend upon a number of site-specific factors.

Dust emissions will arise during construction of the plant. The following construction activities involve the movement and placement of soil, rock etc. and can be the source of dust emissions:

- Mechanical disturbance: dust emissions resulting from the operation of construction equipment and vehicles
- Wind erosion: dust emissions from exposed and disturbed soil surfaces under high wind speeds during construction

Extensive inventories for PM_{10} and TSP emissions from earth moving machinery are commonly used to characterise the source dust emission rates from activities on-site during the construction phase. At this stage, the reference design has not specified the schedule of operations and the exact type and number of dozers, scrapers, trucks and other earthmoving equipment, so that it is not possible to characterise these sources.

Dust emissions during construction, if properly mitigated are not considered to represent a significant source of emissions.

For the construction phase, a framework which includes a comprehensive range of mitigation measures for the management of dust emissions will be developed as a part of construction dust management measures.

VOC Emissions

The use and storage of waste products and chemicals will result in the emission of volatile organic compounds (VOCs), although appropriate management of the chemicals and waste storage areas will minimise VOCs emissions significantly. Exposure to VOCs without appropriate mitigation measures in place can result in significant health impacts such as respiratory and skin diseases.

Summary of impacts on sensitive receptors

The impact rating of VOC and exhaust gases emissions is described as 'insignificant' for the whole construction period given the appropriate management measures implemented on site. The impact of dust emission on the other hand is conservatively described as 'moderate'. As detailed in Section 6.4.1, the closest sensitive receptor is the Wakrah Coast Guard Station (500 m away from the site), which is described as 'low sensitive receptor' based on receptor sensitivity criteria.

As such, the significance of impacts resulting from VOC and exhaust gas emissions is considered 'negligible' while impacts resulting from the construction phase dust emissions is considered 'minor' adverse.

6.5.2 Operation

Majority of the emissions anticipated to be associated with the additional RO unit will be from energy usage for powering and operation of the plant. However, as the plant will use electricity generated by the existing natural gas-fuelled power station, emissions will have already been accounted for as part of the existing facility. Therefore, no additional emissions from power requirements of the expansion Project are anticipated.

6.6 Mitigation measures

6.6.1 Construction

Impacts on ambient air quality resulting from the construction activities can be controlled through the implementation of the mitigation measures described below. A detailed dust and gaseous emissions control plan will also be developed as part of the construction environmental management plan for the Project.

Dust Control from General Earthmoving and Vehicle Movement

- Erect hoarding of at least 2.5 m along the site boundary and/or areas where dusty activities are performed to minimise off-site dispersion of dust.
- Locate the dust generating activities, haulage routes, stockpiles and dusty materials away from the sensitive receptors (i.e. site offices) as far as possible (taking the predominant wind direction into consideration).
- Provide surfacing and / or compaction of site access roads to minimise dust generated by vehicle movements on-site.
- Provide hard surface and / or compaction of unsurfaced areas as soon as possible once earthworks are complete to minimise areas susceptible to wind erosion.
- Dusty materials on site or being transported (within and outside the site) are to be covered by impervious sheet to prevent wind erosion.
- Impose and signpost a maximum speed limit of 20 km/h to minimise the emission of dust on unsurfaced roads and apply designated traffic routes to reduce traffic on unsurfaced areas.
- Undertake dust suppression through water spraying on unsurfaced areas and areas where dusty work is performed (cutting, grinding and sawing).
- Undertake wheel washing at site exits to minimise dust and soil on wheels being transferred off-site.
- Minimise drop heights from conveyors, loading shovels, hoppers, loading or handling equipment and use water sprays on such equipment / work areas where possible.

- Enclose chutes and conveyors and cover skips to prevent suspension of dust.
- Suspend dusty works during periods of high wind speed, where possible.
- Implement a construction logistic plan and construction traffic management plan to manage the sustainable deliveries of machinery, materials, workers and staff members.

Dust Control from Stockpiles

Should sediment need to be temporarily stockpiled on-site, the following mitigation measures will be implemented:

- Minimize stockpiles onsite (e.g. immediate removal of excavated materials requiring offsite disposal).
- Stabilize stockpiled materials with one of the following:
  - Apply water to at least 80 percent of stockpile surface areas on a daily basis when there is evidence of wind driven fugitive dust.
  - Provide impervious cover to stockpiles of all dusty materials (i.e. sand, cement).
  - Construct a three-sided enclosure around stockpiled material with walls of no more than 50 percent porosity to the height of the stockpile.
- Limit the height and slope of stockpiles and locate away from sensitive receptors.
- Stockpiles will be located away from the Project boundary and will not be located on or near drainage lines.
- Align stockpiles along their main axis in the direction of prevailing winds to ensure minimal cross-section exposure to prevailing winds, whenever possible.
- Stockpiles within 100 meters of buildings/offices must be below two meters in height.
- When stockpiling or unloading dusty/friable material, ensure that the loader bucket is close to the truck so that drop height is below three meters.

Control of Exhaust Gases and Particulate Emissions from Powered Equipment and Site Activities

- Idling of equipment and vehicles will be prohibited, equipment and vehicles to be turned off when not in use to minimise gaseous emissions and fuel consumption[7].
- Use low sulphur diesel, ultra-low sulphur diesel or bio-diesel to minimise the emission of sulphur dioxide, where practical.
- Use equipment fitted with pollution control devices (e.g. diesel particulate matter filter), where possible.
- Maintain equipment and vehicles as per manufacturer recommendations and remove any malfunctioning or sub-standard equipment and vehicles from service, particularly if observed to be emitting black smoke.
- Implement a construction logistic plan and construction traffic management plan to manage the sustainable delivery of machinery, materials, workers and staff members.
- Open burning on site will be prohibited.

Control of VOC Emissions

- Storage of fuel, paints and other volatile materials:
  - Provide a designated and well ventilated storage facilities of volatile organic materials.

[7] USEPA (2010) reports that idling engines waste up to 1 gallon of fuel per hour.

  - The storage area should be located away from on-site and off-site sensitive receptors (with consideration of the predominant wind direction).
  - The quantity of volatile materials to be stored on-site should be kept to minimum and containers holding the volatile materials should be kept closed when not in use.
- An exhaust ventilation system is to be provided where volatile organic materials are stored to protect workers and staff members from exposure.

6.6.2 Operation

Mitigation measures are not required as the project is not anticipated to cause impact on ambient air quality.

6.7 Summary of impacts, mitigation and residual significance

The summary of impacts, mitigation and residual significance of the project on air quality is provided in Table 6-5. Generation of dust is inherent in the construction industry and cannot be completely eliminated especially with the dry climate in the Middle East. With the implementation of appropriate dust control measures during construction, the potential for residual dust impacts will be reduced.

Table 6-5: Summary of impacts and residual significance – Air Quality

Project impact	Initial impact (before implementing mitigation measures			Mitigation measures	Residual impact (after implementing mitigation measures		
	Likelihood	Consequence	Impact rating		Likelihood	Consequence	Impact rating
Construction phase							
Fugitive dust emission from site development/ earthmoving works and wind erosion on unpaved surfaces	Almost certain	Moderate	High	Dust control including erection of hoarding, site planning with dust generating activities/sources located away from sensitive receptors, phasing of earthmoving works, stabilisation/ compaction of unsurfaced areas. Detailed list is provided in Section 6.6.1	Likely	Minor	Medium
Deposition of dust to the marine environment	Almost certain	Minor	Medium	Dust control measures as discussed above	Possible	Minor	Low
Emission of exhaust gases from the operation of equipment, plant, tools and utilities using fuel	Almost certain	Insignificant	Low	Ban open burning onsite Use of cleaner fuel Use of equipment fitted with pollution control devices (e.g. diesel particulate matter filter), where possible Maintain the equipment and vehicles as per the manufacturer's instructions Implement construction logistics plan and construction traffic plan No idling of equipment and vehicles	Almost certain	Insignificant	Low
VOC emissions	Likely	Insignificant	Low	Provision of a well-ventilated storage facility for fuel, paints and other volatile materials	Possible	Insignificant	Negligible

Project impact	Initial impact (before implementing mitigation measures			Mitigation measures	Residual impact (after implementing mitigation measures		
	Likelihood	Consequence	Impact rating		Likelihood	Consequence	Impact rating
Operation phase							
The operation of the RO expansion is not anticipated to cause significant impact on air quality.							

7. Noise and Vibration

7.1 Introduction

This chapter presents the potential noise and vibration impacts associated with the Project during the construction and operation phases. It also assesses the significance of impacts and identify measures to manage these impacts.

7.2 Assessment methodology

The assessment methodology for noise and vibration include the following:

- Desktop review of noise monitoring results undertaken by GHD as part of the quarterly monitoring for Operational Environmental Management Plan (2019). No baseline sampling on vibration has been undertaken in this study; however, potential impacts of the project concerning vibration have been included in the mitigation section.
- Review of applicable standards
- Qualitative assessment of the significance of Project construction and operation impacts on noise and vibration

7.3 Legislative framework and applicable standards

Chapter 3 of this EIA report provides the legislative framework and policy guidance relevant to the Project. The noise legislation and policy applicable to the Project are discussed in the following subsections.

7.3.1 Qatari legislation

Qatari noise standards are provided in Table 7-1. This was issued by the MME under the authority of the Environment Protection Law, which define noise limit standards for residential, commercial and industrial zones.

Table 7-1: Qatari noise standards

Zones	Maximum noise levels at the property line (dB(A)) 15-minute time weighted average	
	Daytime	Night-time
Residential and institutional	55	45
Commercial	65	55
Industrial	75	75

Source: Executive By-Law No. 30 of 2002

Notes:

1. Night time standards would be applicable for the period of 10 p.m. to 4 a.m.
2. A residential zone is an area where more than 50% of the properties are for accommodation, this includes schools, hospitals and mosques
3. A commercial zone is an area where more than 50% of the properties are shops, garages and trading premises
4. An industrial zone is an area where more than 50% of the properties are for manufacturing facilities

7.3.2 International Guidance

IFC/World Bank Guidelines

The International Finance Corporation (IFC), as part of the World Bank (WB) Group, provides guidance on maximum allowable ambient noise levels at sensitive receptors (IFC, 2007).

The guideline also states that noise impacts should not exceed the maximum allowable daytime and night-time noise levels shown in Table 7-2 or result in a maximum increase in background levels of 3 dB at the nearest sensitive receptor location off-site.

A summary of the IFC noise limits is presented in Table 7-2.

Table 7-2 IFC allowable external noise limits

Receptors	Allowable noise limit $L_{Aeq,1hour}$ dB(A)	
	Daytime (7 am to 10 pm)	Night-time (10 pm to 7 am)
Residential; institutional; educational[a]	55	45
Industrial; commercial	70	70
OR		
All sensitive receptors	≤Background levels + 3 dB	

[a] For acceptable indoor noise levels for residential, institutional and educational settings refer to WHO (1999).

World Health Organisation – Guidelines for Community Noise, 1999

The World Health Organisation (WHO) discusses the effects of environmental noise in non-industrial environments in its *Guideline for Community Noise* (WHO, 1999). This guideline examines aspects such as sleep disturbance, annoyance, and speech intelligibility and provides guidance for protecting people from adverse effects induced by excessive noise. Table 7-3 summarises the WHO 1999 Guideline values.

Table 7-3: Summary of WHO guidelines for community noise, 1999

Descriptor	Indoor guideline value	Outdoor guideline value
Speech intelligibility (dwellings indoors)	35 L_{Aeq} dB(A) (steady noise)	Not applicable.
Sleep disturbance (bedrooms)	30 L_{Aeq} dB(A) (steady noise) 45 L_{Amax} dB(A) (intermittent noise)	45 L_{Aeq} dB(A) (steady noise) 60 L_{Amax} dB(A) (intermittent noise)
Annoyance (daytime and evening)	35 L_{Aeq} dB(A)	50 L_{Aeq} dB(A)

World Health Organisation – Night Noise Guidelines for Europe, 2009

The WHO *Night Noise Guidelines (NNG) For Europe* (WHO Europe, 2009) provides detailed discussion of night time noise levels and the effects on sleep and health for residential noise receptors. The NNG is based on noise studies undertaken since the implementation of the WHO 1999 Guideline, which is considered relevant and complementary to the WHO 2009 Guideline.

The summary of the WHO 2009 Guideline recommended night noise targets is presented in Table 7-4.

Table 7-4: Summary of WHO night noise guidelines for Europe, 2009

Descriptor	Outdoor Guideline Value for Europe
Night Noise Guideline (NNG)	40 dB(A) $L_{night, outside}$[a]
Interim Target (IT)[b]	55 dB(A) $L_{night, outside}$

[a] $L_{night, outside}$ is the night time noise indicator defined by EU Directive 2002/49/EC and is the long-term averaged night noise level determined over a year, where night is the eight hour night period (23:00 – 07:00) (refer to Glossary section for definition).

[b] Interim Target is a situation where the achievement of NNG is not feasible in the short run for various reasons.

Based on a comparison of the WHO guidelines shown above, the night time sleep disturbance criterion of 40 dB(A) $L_{night, outside}$ has been adopted for this assessment.

7.3.3 Vibration Criteria

Human Comfort Vibration Criteria

In the absence of local legislation and standards, the British Standard BS 6472:2008 - *Guide to evaluation of human exposure to vibration in buildings - Part 1: Vibration sources other than blasting* (BS 6472, 2008) is commonly recognised as the preferred standard for assessing human comfort criteria for residential receptors. Table 7-5 includes the acceptable values of vibration dose for residential receptors during daytime and night-time periods.

These values represent the best judgement available at the time the standard was published and may be used for both vertical and horizontal vibration, providing that they are correctly weighted. Because there is a range of values for each category, it is clear that the judgement can never be exact.

Table 7-5: Vibration dose value (VDV) ranges and probabilities for adverse comment to intermittent vibration ($m/s^{1.75}$)

Location	Low probability of adverse comment[a]	Adverse comment possible	Adverse comment probable[b]
Residential buildings 16 hours day (7.00 am to 11.00 pm)	0.2 to 0.4	0.4 to 0.8	0.8 to 1.6
Residential buildings 8 hour night (11.00 pm to 7.00 am)	0.1 to 0.2	0.2 to 0.4	0.4 to 0.8

Notes:
[a] Below these ranges adverse comment is not expected.
[b] Above these ranges adverse comment is very likely.

Whilst the assessment of response to vibration in BS 6472-1:2008 is based on VDV and weighted acceleration, for construction and industrial operation related vibration it is considered more appropriate to provide guidance in terms of peak particle velocity (PPV), since this parameter is likely to be more routinely measured based on the more usual concern over potential building damage.

Humans are capable of detecting vibration at levels which are well below those causing risk of damage to a building. The degree of perception for humans is suggested by the vibration level categories given in BS 5228-2:2009 – *Code of practice for noise and vibration control on construction and open sites: Part 2 Vibration* (BS 5228.2, 2009), as shown in Table 7-6.

Table 7-6: Guidance on the effects of vibration levels

Vibration level	Effect
0.14 mm/s	Vibration might be just perceptible in the most sensitive situations for most vibration frequencies associated with construction.
0.30 mm/s	Vibration might be just perceptible in residential environments.
1.0 mm/s	It is likely that vibration at this level in residential environments will cause complaints, but can be tolerated if prior warning and explanation has been given to residents.
10 mm/s	Vibration is likely to be intolerable for any more than a very brief exposure to this level.

Based on Table 7-6 above, human response to vibration could be summarised as below:

- Vibration level in the range between 0.14 mm/s to 0.3 mm/s would generate low probability of adverse comment or complaints.
- Vibration level in the range between 0.3 mm/s to 1 mm/s would generate the possibility of adverse comment or complaints.
- Vibration level greater than 1 mm/s would likely cause adverse comment or complaints.

Structural Damage Vibration Criteria

Guidance on limiting vibration is attained by reference to the German Standard DIN 4150.3:1999 – *Structural vibration – Part 3: Effects of vibration on structures* (DIN 4150.3, 1999) and British Standard BS 7385.2:1993 – *Evaluation and measurement for vibration in buildings – Part 2: Guide to damage levels from ground-borne vibration* (BS 7385.2, 1993). In comparison, DIN 4150.3:1999 provides more stringent vibration criteria as opposed to BS 7385.2:1993.

Table 1 of Section 5 of DIN 4150.3:1999 presents guideline values for the maximum absolute value of the velocity "*at the foundation and in the plane of the highest floor of various types of building. Experience has shown that if these values are compiled with, damage that reduces the serviceability of the building will not occur. If damage nevertheless occurs, it is to be assumed that other causes are responsible.*"

Measured values exceeding those listed in Table 7-7 "*… does not necessarily lead to damage; should they be significantly exceeded, however further investigations are necessary.*"

Table 7-7: Guidance values for short term vibration on structures

Line	Type of structure	Guideline values for velocity v(t)[a] (mm/s)		
		1 Hz to 10 Hz	10 Hz to 50 Hz	50 Hz to 100 Hz[b]
1	Buildings used for commercial purposes, industrial buildings, and buildings of similar design.	20	20 to 40	40 to 50
2	Dwellings and buildings of similar design and/or occupancy	5	5 to 15	15 to 20
3	Structures that, because of their particular sensitivity to vibration, cannot be classified under lines 1 and 2 and are of great intrinsic value (e.g. listed buildings under preservation order)	3	3 to 8	8 to 10

[a] The term vi refers to vibration levels in any of the x, y or z axis..

[b] Where frequencies are above 100 Hz the values given in this column may be used as minimum values.

The vibration criteria presented in German Standard DIN 4150.3:1999 exceed human comfort criteria presented in Table 7-6. Therefore, the human comfort criteria should be the over-riding criteria for the assessment of any vibration.

7.4 Baseline

7.4.1 Noise Sensitive Receptors

With reference to the categories of receptors considered in Qatari National noise standards as well as the IFC limit values as provided in Section 7.3 and the sensitive receptors described in Section 2.3.2, the sensitivity of receptors considered by the assessment is provided in Table 7-8.

Table 7-8: Criteria for determining receptor sensitivity

Category	Description / examples	Project sensitive receptors	Distance
High	Residential, educational, institutional, healthcare, place of worship and high value amenity areas	Al Wakrah Town Centre Al Wakrah Family Beach Wakrah Coast Guard Station	3.5 km 1.3 km 0.5 km
Medium	Public assembly and entertainment	-	-
Low	Commercial and light industrial	-	-
Negligible	Heavy industrial	-	-

Adapted from (Mott MacDonald, 2016)

7.4.2 Methodology

Noise monitoring was undertaken on 26 March 2019 based on the following methodology:

- Monitoring at five locations (Table 7-9 and Figure 7-1) for 30 minutes at both day time and night time periods. Stations NS1, NS2 and were chosen due to the proximity to the Project while NS+2 and NS5 were selected due to their proximity to sensitive receptors:
  - NS1, NS2 and NS3 are adjacent to northern, southern and western boundary fences of the Project site.
  - NS+2 is close to Coastguard Station
  - NS5 is located at the corner of public beach between QP fence and the public beach wall
- Noise levels were recorded at 1.5 m above ground level using the calibrated handheld Type 1 noise meter (i.e. Svantek)
- Noise measurements were not taken during rain or winds stronger than 5 m/s or wind gusts exceeding 10 m/s
- Noise date assessed against Qatar Noise Standards and international requirements for day and night

Table 7-9: Coordinates of noise monitoring locations

Station ID	Longitude	Latitude
NS-1	239792	373959
NS-2	239706	373248
NS-3	239102	373582
NS-4 (NS+2)	240573	374330
NS-2	240322	375164

Note: All coordinates are in Qatar National Datum

7.4.3 Results and discussion

Results of day time and night time measurements on 26 March 2019 at five monitoring stations are presented in Table 7-10. All measured noise levels were recorded below the MME standard as well as IFC/WB EHS Guidelines for industrial site.

Table 7-10: Noise levels during baseline noise monitoring

Station	Day time (dB(A))	Night time (dB(A))
MME Standard* / Consent to operate (CTO)	75	75
IFC/WB EHS Guideline	70	70
NS-1	62.8	51.7
NS-2	50.3	49.6
NS-3	57.8	47.3
NS-4 (NS+2)	61.2	59.8
NS-2	45.1	44.3

*All stations are assessed against Qatar Noise Standards for Industrial site limit of 75 dBA

Figure 7-1: Noise monitoring stations

7.5 Environmental impact prediction and evaluation

7.5.1 Construction

7.5.1.1 Construction noise

The major noise sources during the construction phase will include a range of construction activities, earthmoving and construction equipment as well as construction-related traffic noise. Vehicles accessing the site during delivery of materials and collection of waste, as well as transportation of workers and employees will also generate noise.

The increase in noise levels is anticipated to negatively affect the nearby noise sensitive receptors (NSRs), if appropriate noise abatement and management measures are not implemented. Noise impacts associated with the Project construction were estimated using the following distance attenuation relationship:

$$SPL = SWL - 20\log(d) + 10\log(Q) - 11$$

Where: d = distance between the source and receptor (m)

Q = directivity index (2 for a flat surface)

SPL = sound pressure level at the distance from the source (dB)

SWL = sound power level of the source (dB)

Typical noise levels generated by construction plant anticipated to be used on-site were sourced. Propagation calculations take into account sound intensity losses due to spherical spreading, with additional minor losses such as atmospheric absorption, directivity and ground absorption ignored in the calculations. As a result, predicted received noise levels are expected to slightly overstate actual received levels and thus provide a measure of conservatism.

Noise generated by equipment that are anticipated to be used during construction are shown in Table 7-11 for a variety of distances, with no noise barriers or acoustic shielding in place and with each plant item operating at full power. The sound pressure levels shown are maximum levels produced when machinery is operated under full load.

The magnitude of off-site noise impact associated with construction will be dependent upon a number of factors:

- The intensity and location of construction activities
- The type of equipment used
- Existing local noise sources
- Intervening terrain
- The prevailing weather conditions

Construction machinery will move about the Project site area, altering the directivity of the noise source with respect to individual receptors. During any given period, the machinery items used in the Project area will operate at maximum sound power levels for only brief times. At other times the machinery may produce lower sound levels while carrying out activities not requiring full power. It is unlikely that all construction equipment would be operating at their maximum sound power levels at any one time. Finally, certain types of construction machinery will be present in the Project area for only brief periods during construction.

Table 7-11: Predicted plant activity noise level (dBA)

Equipment [1]	Estimated SWL (dBA) [2]	Estimated SPL (dBA) at distance (m)					
		250	350	500	1000	3000	5000
Backhoe	104	48	45	42	36	26	22
Backhoe (with auger)	106	50	47	44	38	28	24
Bulldozer	108	52	49	46	40	30	26
Compactor	113	57	54	51	45	35	31
Compressor (silenced)	101	45	42	39	33	23	19
Concrete agitator truck	109	53	50	47	41	31	27
Concrete pump truck	108	52	49	46	40	30	26
Concrete saw	117	61	58	55	49	39	35
Concrete vibratory screed	115	59	56	53	47	37	33
Crane (mobile)	104	48	45	42	36	26	22
Excavator	107	51	48	45	39	29	25
Front end loader	113	57	54	51	45	35	31
Generator (diesel)	104	48	45	42	36	26	22
Grader	110	54	51	48	42	32	28
Hand tools (electric)	102	46	43	40	34	24	20
Hand tools (pneumatic)	116	60	57	54	48	38	34
Jack hammers	121	65	62	59	53	43	39
Rock breaker	118	62	59	56	50	40	36
Roller (vibratory)	108	52	49	46	40	30	26
Scraper	116	60	57	54	48	38	34
Truck (>20 tonnes)	107	51	48	45	39	29	25
Truck (dump)	117	61	58	55	49	39	35
Truck (water cart)	107	51	48	45	39	29	25
Vehicle (commercial, 4WD)	106	50	47	44	38	28	24
Welder	105	49	46	43	37	27	23

Notes:

(1) The above equipment are typically used in construction sites and may or may not be used for the Project.

(2) (GHD, 2018a)

The closest noise sensitive receptor to any potential noise source during the construction of the Project is the Wakrah Coast Guard located about 0.5 km from the boundary of the site. From Table 7-11, noise levels exceeding the Qatari standards prescribed noise limit during daytime (55 dBA for residential and institutional) are not expected to impact on the closest sensitive receptor, except when jack hammer and rock breaker are used during construction. The use of jackhammers and rock breakers will be minimised as much as practicable during construction and where required will be used for a short duration. A number of equipment exceeds the night-time limit of 45 dBA. General construction activities will be limited to day time working hours, where feasible and reasonable.

Cumulative impact

All the measured noise levels during the baseline survey were below the MME standard and Consent to Operate (CTO) noise limit of 75 d(BA) as well as IFC/WB EHS Guideline of 70 d(BA). As discussed above, construction activities are not expected to impact the closest sensitive receptor (except when jack hammer and rock breaker are used).

Therefore, it can be concluded that the magnitude of construction impact is assessed as minor at all sensitive receptors and the resulting effects are expected to be low significance.

7.5.1.2 Construction vibration

Vibration impacts essentially focus on potential structural damage to properties in close proximity of the Project area and/or potentially affected by construction activities. It is possible that construction vibration will be perceived at times by local sensitive receptors. However, the level of annoyance will depend on individuals' perceptions of the vibration felt.

Construction activity may result in varying degrees of ground vibration depending on the equipment used and methods employed. Operation of construction equipment causes ground vibration, which spreads through the ground and diminishes in strength with distance. Buildings founded on the soil in the vicinity of the construction site respond to these vibrations with varying outcomes.

Vibration impacts associated with plant construction were estimated using the following equation:

$$PPV_{equipment} = PPV_{Ref} (25/D)^{n}$$ [8]

Where: PPV_{Ref} = reference PPV at 7.6 m

D = distance from equipment to the receiver in meters

n = 1.3 (the value related to the attenuation rate through ground)[9]

Table 7-12: Predicted vibration impacts at nearest receptor

Equipment [(a)]	Reference PPV at 7.6 m (mm/s) [(b)]	Predicted vibration amplitude at nearest receptor (500 m)
Clam shovel drop (slurry wall)	5.1	0.33 mm/s
Hydromill (slurry wall)	0.2 (in soil)	0.01 mm/s
	0.4 (in rock)	0.03 mm/s
Vibratory roller	5.3	0.34 mm/s

[8] (California Department of Transportation, 2013)
[9] The suggested value for "n" is 1.1 because vibration from equipment originates primarily near the ground surface.

Equipment [a]	Reference PPV at 7.6 m (mm/s) [b]	Predicted vibration amplitude at nearest receptor (500 m)
Hoe ram	2.3	0.15 mm/s
Large bulldozer	2.3	0.15 mm/s
Caisson drilling	2.3	0.15 mm/s
Loaded trucks	1.9	0.12 mm/s
Jackhammer	0.9	0.06 mm/s
Small bulldozer	0.1	0.01 mm/s

Notes:
(a) The above equipment are typically used in construction sites and may or may not be used for the Project.
(b) Adapted from Hanson et.al. (2006) as cited by (Cenek, 2012)

From Table 7-12, equipment proposed for site preparation and construction of the project will generate low levels of vibration (between 0.01 to 5.3 mm/s), which are unlikely to cause human discomfort or result vibration risks to structures. Further the predicted amplitude at nearest receptor (500 m) is between 0.01 to 0.34 mm/s, which would generate low probability of adverse comment or complaints based on Guidance on the Effects of Vibration Levels (refer to Section 7.3.3).

7.5.2 Operation

During the operation phase, noise impacts are likely to be associated with noise generated on site from both fixed and mobile plant. It is assumed that there are no additional mechanical equipment proposed during the operation of the proposed Project.

Based on the original EIA, the operational noise from the existing fixed plant is expected to have a negligible magnitude of impact at all nearest sensitive receptors and the resulting effects are assessed to be insignificant (Mott MacDonald, 2016).

7.6 Mitigation measures

7.6.1 Construction

7.6.1.1 Construction noise

- The construction sites should be laid-out in such a way that the primary noise sources are at a maximum distance from sensitives receptors, with solid structures (sheds, containers, etc.) placed between sensitive receptors and noise sources and as close to the noise sources as is possible. This would include items such as the power generator proposed at the construction depot
- Engines and exhaust are typically the dominant noise sources on mobile plant such as compactors, trucks, etc. Residential grade mufflers fitted on this mobile plant would minimise noise emissions from these sources
- All equipment should be selected to minimise noise emissions and maintained in good condition (kept properly serviced). Equipment such as generators, etc., should be fitted with appropriate silencers and acoustic enclosures (where practical) and be in good working order. Machines found to produce excessive noise compared to normal industry expectations should be removed from the site or stood down until repairs or modifications can be made

- Where practical, machines should be operated at low speed or power and be switched off when not being used rather than left idling for prolonged periods
- To reduce the annoyance associated with reversing alarms, broadband alarms (audible movement alarms) should be used for all site equipment and reversing kept to a minimum through improved route choice/layout/dimensions, and operational procedures (reversing beepers are a key complaint issue among residents near construction sites). Loader/dozer manoeuvring using the 'swivel technique' for turning may reduce the frequency of reversing beeper use for this piece of equipment. Satisfactory compliance with occupational health and safety requirements would need to be achieved and a safety risk assessment may need to be undertaken to determine that safety is not compromised
- Optimise the number of deliveries to the site by amalgamating loads where possible and scheduling arrivals within designated hours
- General construction activities should be limited to daytime (7am to 8pm) working hours, where feasible and reasonable
- Where practical, machines should be switched off when not being used rather than left idling for prolonged periods
- All mechanical plant and equipment should be checked regularly to avoid any unnecessary noise caused by lack of maintenance
- Truck drivers should be kept informed of designated vehicle routes, parking locations, operating hours and on-site speed limit
- All engine covers should be kept closed when equipment is operating

7.6.1.2 Construction vibration

- Vibration intensive activities should be implemented during the least sensitive time periods
- Operations should be sequenced so that vibration intensive activities do not occur simultaneously
- Where possible, vibration intensive activities should be located as far away from sensitive areas as possible

7.6.2 Operation

The following mitigation measures are recommended during the operation of the Project:

- Buildings should be located close to the Project site's boundary as much as practicable to provide shielding effects of operational noise emanating from the site
- Plant and equipment considered to be the major noise sources and those located close to the Project site's boundary should, as much as practicable, be enclosed to minimise off-site noise impact
- Selection of quiet equipment/system as early as the design phase should be considered in the development of the Project's operational noise management measures. A 'buy quiet' purchasing policy should be established, where all equipment is purchased to meet the dB(A) standard. This policy would assist in minimising the off-site impact and help in preserving the hearing quality and reducing the Health and Safety risk for on-site employees
- In line with the previous item, the proposed facility should be designed such that the noise levels in the general workplace are as low as possible and meet the relevant Health and Safety regulations as practicable through optimal engineering design

- Machines found to produce excessive noise compared to normal industry expectations should be removed from the site or stood down until repairs or modifications can be made
- All equipment should be selected to minimise noise emissions and maintained in good repair (kept properly serviced). Equipment should be filled with appropriate silencers and be in good working order
- All mechanical plant and equipment should be checked regularly to avoid any unnecessary noise caused by lack of maintenance

7.7 Summary of impacts, mitigation and residual significance

The summary of impacts, mitigation and residual significance of the project relative to noise and vibration is provided in Table 7-13.

Noise is inherent in the construction industry and cannot be completely eliminated. With the consistent implementation of mitigation measures, the construction noise impacts are likely to be localised, intermittent and temporary in nature, with offsite noise impacts reduced to acceptable levels.

Industrial noise is an unavoidable impact of the Project. Given the noise measures and noise monitoring plan, it is anticipated that noise levels are controlled within acceptable levels.

Table 7-13: Summary of impacts and residual significance – Noise and Vibration

Project impact	Initial impact (before implementing mitigation measures			Mitigation measures	Residual impact (after implementing mitigation measures		
	Likelihood	Consequence	Impact rating		Likelihood	Consequence	Impact rating
Construction phase							
Sleep disturbance and annoyance due to construction noise	Almost certain	Minor	Medium	Erection of hoarding/noise barrier along the site boundary and/or noisy areas. Equipment noise control (i) quiet piling methods, (ii) selection of appropriate equipment, (iii) proper equipment operation, (iv) maintain and service equipment at regular intervals, (v) usage of broadband reversing alarms, (vi) installation of acoustic covers and silencers Improve work methods: phasing, scheduling of noisy activities during daytime and minimising consecutive noisy activities	Likely	Insignificant	Low
Sleep disturbance and annoyance due to construction vibration	Possible	Moderate	Medium	Undertaken vibration intensive activities (if any) during least sensitive time periods (i.e. daytime) Sequence operation so that intensive activities do not occur simultaneously	Possible	Minot	Low
Operation phase							

Project impact	Initial impact (before implementing mitigation measures			Mitigation measures	Residual impact (after implementing mitigation measures		
	Likelihood	Consequence	Impact rating		Likelihood	Consequence	Impact rating
Noise from operation of the plant	Possible	Insignificance	Negligible	Regular inspection and maintenance of all mechanical plant and equipment	Unlikely	Insignificant	Negligible

8. Soil and Groundwater

8.1 Introduction

This chapter discusses the baseline soil and groundwater conditions at the Project site. The potential impacts associated with construction, operation and decommissioning of the Project to the soil and groundwater resources were also considered.

8.2 Assessment methodology

The assessment methodology for soil and groundwater resources include the following:

- Site walkovers to identify potential primary or secondary sources of contamination i.e. chemical storage
- Desktop review of available secondary data as follows:
  - Geotechnical ground investigation survey undertaken by Gulf Laboratories Co and presented in EIA for Umm Al Houl IWW prepared by Mott MacDonald (2016)
  - Groundwater quality monitoring results undertaken by GHD as part of the quarterly monitoring for Operational Environmental Management Plan (2019)
- Exposure analysis including analysis of transport mechanism for possible leakages into both soil and groundwater from sources of contamination.
- Qualitative risk assessment using available data

8.3 Legislative framework and applicable standards

8.3.1 Soil quality assessment criteria

No standards have been prescribed by the MME for the assessment of soil quality; as such, international guidelines have been used during the baseline assessment:

- Dutch Intervention Values (DIV) published by the Dutch Ministry for social building, regional planning and environment administration (VROM, 2009)

The environment in Qatar is significantly different to the temperate environment that the DIV have been based on (Mott MacDonald, 2016). Correction factors reported in the Soil Remediation Circular (VROM, 2009) can be applied to the DIV standards to derive standards specific to the type of soil being assessed on the basis of the measured organic matter and clay content, which can then be compared with the measured concentrations in soil (Mott MacDonald, 2016). Where correction is possible, Site Specific Intervention Values (SSIVs) have been calculated for the Project.

8.3.2 Groundwater quality assessment criteria

No standards have been prescribed by the MME for groundwater assessment; as such, the groundwater baseline data and monitoring results were compared with the following standards:

- *Qatari 'Standards for Sea Water Quality'*. The seawater quality standards are considered suitable assessment criteria for assessing groundwater quality due to the proximity of the site to the coast and the elevated salinity of groundwater making it unsuitable for drinking.
- *Local Drinking Water Standards.* In the absence of guidance levels for some parameters in Qatari Standards for Sea Water Quality, the local drinking water standards was also used for comparison.

- *Canadian Environmental Quality Guidelines (CEQG)* – Marine Water Quality Guidelines for the Protection of Aquatic Life – published by the Canadian Council of Ministers of the Environment (CCME, 2013)[10]

Groundwater monitoring was also assessed against the results from previous monitoring quarter, which serves as the baseline values for comparison purposes only (GHD, 2019a).

8.4 Baseline

8.4.1 Sensitive Receptors

Sensitive receptors associated with ground conditions comprise key features, such as designated (regionally, nationally or internationally) important geological sites and/or agriculturally or ecologically valuable soils (Mott MacDonald, 2016). Groundwater receptors on the other hand include aquifers important irrigation, industry or drinking water (Mott MacDonald, 2016).

Based on the study undertaken by Mott MacDonald (2016), groundwater within 500 m of the site is unlikely used for either domestic purposes or drinking, but it may be used for industrial purposes. Further, as per the MME's recommendation on previous projects, soil and groundwater in Qatar are considered sensitive receptors (Mott MacDonald, 2016).

Therefore the soil and groundwater resources at the site are considered to be of moderate sensitivity based on the following considerations:

- There are no geological sites close to the Project site and the soil is not used for agricultural purposes
- There are no known groundwater dependent users at the site, and the beneficial use (i.e. domestic purposes and drinking) is limited by its salinity

8.4.2 Methodology

In 2015, Gulf Laboratories Co (GLL) was commissioned to undertake soil and groundwater quality investigation at targeted locations of the Project site. The survey comprised excavation of five boreholes to 9m below ground level (mbgl) and installation of monitoring wells screened within the bedrock between 4–7 mbgl at the locations provided in Table 8-1 and illustrated in Figure 8-1.

Soil sampling

Prior to the development of the IWPP facility in 2015, soil samples were collected from all the five boreholes at depths between 0–0.1mbgl and 0.1–0.9mbgl. This approach was provided laboratory test data on both surface and near surface. It was deemed unnecessary to undertake contamination testing of deeper soil samples as the site was previously undeveloped (Mott MacDonald, 2016).

Soil sampling aimed to assess the level of heavy metals, hydrocarbons, BTEX and poly-aromatic hydrocarbons (PAHs) in shallow soils (Mott MacDonald, 2016). Additional sampling was undertaken by Gulf Labs in 2015 for boron, magnesium, zinc, sulphur and moisture content (Mott MacDonald, 2016).

Groundwater sampling

Prior to the development of the IWPP facility in 2015, groundwater samples were collected from the five monitoring wells for laboratory analysis. Groundwater samples were tested for a range

[10] Refer to Bullet 1 for justification

of potential contaminants including heavy metals, TPH, BTEX and PAHs (Mott MacDonald, 2016). Additional samples were collected for biological oxygen demand (BOD), chemical oxygen demand (COD), boron, magnesium, zinc, sulphur and bacteriological analysis.

As part of the operational performance monitoring, groundwater sampling is undertaken on a quarterly basis at five locations within the facility premises (Figure 8-2). The study involved monitoring the following parameters:

- Physicochemical parameters:
  - Temperature
  - Dissolved oxygen
  - pH
  - Electrical conductivity
  - Turbidity
  - Oxidation-Reduction Potential
  - Turbidity
- Analytical parameters
  - Inorganics
  - BTEX
  - Petroleum hydrocarbons
  - Polycyclic Aromatic Hydrocarbons (PAHs)
  - Volatile Organic Compounds (VOCs)

Table 8-1: Soil and groundwater stations

Station ID and Description	Easting	Northing
MW-01: at the western end of the facility	239327.8473	373600.0000
MW-02: on the northern edge of the facility	239812.8744	373903.2081
MW-03: at the eastern end of the facility	240328.2119	373686.2982
MW-04: on the southern edge of the facility	239900.8735	373307.2886
MW-05: in the centre of the facility	239788.3565	373618.2409

Source: GLL, 2015 cited by (Mott MacDonald, 2016)

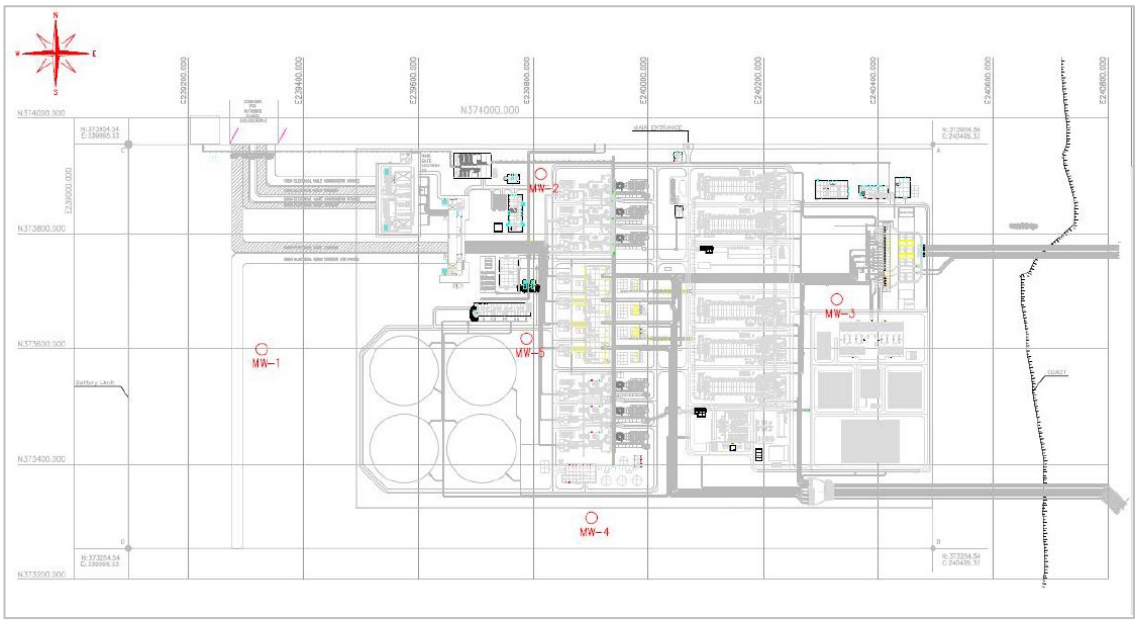

Figure 8-1: Soil and groundwater sampling locations

Source: GLL, 2015 cited by (Mott MacDonald, 2016)

Figure 8-2: Locations of quarterly groundwater monitoring stations

8.4.3 Results and discussion

Soil quality – 2015

A summary of the results of soil testing is provided in Table 8-2 and discussed below:

- Soil content is low (0.9–2.6%)
- High concentration of magnesium in all samples (43,440 and 77,270 mg/kg)
- Low concentration of heavy metals in all samples
- Hydrocarbons, BTEX an PAHs were not detected above the laboratory detection limit

Comparison with international guidance levels for the protection of human health show that contamination levels were all below the site-specific intervention value (SSIV); therefore, within the acceptable levels (Mott MacDonald, 2016).

Table 8-2: Results of chemical soil analysis – 2015

Parameter	Units	Soil concentrations		Site specific intervention value (SSIV)
		Minimum	Maximum	
Aluminium	mg/kg	2747	7398	--
Arsenic	mg/kg	<0.02	<0.02	52
Boron	mg/kg	13.77	27.52	--
Cadmium	mg/kg	<0.5	<0.5	8
Chromium	mg/kg	9.995	22.84	55*
Copper	mg/kg	3.885	8.893	117
Iron	mg/kg	2013	5637	--
Lead	mg/kg	<0.5	4.007	387
Magnesium	mg/kg	43,440	77,270	--
Manganese	mg/kg	78.07	157.7	--
Mercury	mg/kg	<0.0001	<0.0001	3**
Molybdenum	mg/kg	<0.5	<0.5	190
Nickel	mg/kg	5.727	23.19	57
Zinc	mg/kg	4.949	10.16	427
Sulphur	%	0.73	2.36	--
Benzene	mg/kg	<0.1	<0.1	220
Toluene	mg/kg	<0.1	<0.1	6,400
Ethylbenzene	mg/kg	<0.1	<0.1	22,000
Total Xylenes	mg/kg	<0.2	<0.2	22,000
PAH	mg/kg	<1	<1	40,000 (sum of 10)

Parameter	Units	Soil concentrations		Site specific intervention value (SSIV)
		Minimum	Maximum	
Benzo(a)pyrene	mg/kg	<0.1	<0.1	--
Mineral oil	mg/kg	<0.1***/<1****	<0.1***/<1****	1,000,000

Source: (Mott MacDonald, 2016)
Key:
* for Chromium VI
** for organic mercury
*** Gasoline range hydrocarbons
****Diesel range hydrocarbons

Groundwater quality – 2015

A summary of the results of groundwater quality testing is provided in Table 8-3 and discussed below:

- Groundwater is relatively neutral, with a reported with a reported pH between 7.36 and 7.52
- COD was recorded between 15–21 mg/L
- Low concentrations of aluminium, boron, iron, molybdenum, phosphorus and zinc were recorded in all samples
- Low concentration of manganese was recorded in three samples
- High concentration of potassium and magnesium in all samples
- PAHs, TPH and BTEX were not detected above the laboratory MDLs in all samples
- Total coliforms were detected between 7.1 and 17.3 MPN/100 ml in all samples
- Faecal coliforms and egg parasites were not detected in all samples

Comparison with local and international guidance levels for the protection of human health (drinking water quality) and the marine environment show that contamination levels were all well below the guidance levels, with the exception of aluminium and boron, and therefore were within acceptable limits (Mott MacDonald, 2016).

Table 8-3: Results of chemical groundwater analysis - 2015

Parameter	Units	Concentrations		Sea water MPL	Drinking water MPL	WHO drinking water guidelines	CCME water quality CEQG (marine)
		Min	Max				
pH	-	7.36	7.52	6.5-8.3	6.5-8.5	-	-
Total nitrogen	mg/L	0.84	3.4	-	-	-	-
Total phosphorous	mg/L	0.178	0.193	0.03	-	-	-
BOD	mg/L	3.2	3.8	-	-	-	-
COD	mg/L	15	21	-	-	-	-
Total coliforms	Cfu/100	7.1	17.3	-	Absent	-	-
Faecal coliforms	Cfu/100	Absent	Absent	-	Absent	-	-

Parameter	Units	Concentrations		Sea water MPL	Drinking water MPL	WHO drinking water guidelines	CCME water quality CEQG (marine)
		Min	Max				
Egg parasites	-	Absent	Absent	-	Absent	-	-
Metals							
Arsenic	mg/L	<0.0002	<0.0002	-	0.01		0.0125
Aluminium	mg/L	0.069	0.482	-	0.2	-	-
Boron	mg/L	5.382	5.295	-	0.5	-	-
Cadmium	mg/L	<0.005	<0.005	0.7	0.003		0.00012
Chromium	mg/L	<0.005	<0.005	-	0.05		
Copper	mg/L	<0.005	<0.005	15	1		
Iron	mg/L	0.019	0.2424	90	0.3	-	-
Lead	mg/L	<0.005	<0.005	12	0.01		
Magnesium	mg/L	1115	1634	-	-	-	-
Manganese	mg/L	<0.005	0.055	-	0.5	-	-
Mercury	mg/L	<0.00001	<0.00001	0.4	0.001	-	-
Molybdenum	mg/L	0.012	0.02	-	0.07	-	-
Nickel	mg/L	<0.005	<0.005	20	0.02	-	-
Potassium	mg/L	395.9	614	-	-	-	-
Sulphur	mg/L	699.3	1,132	-	-	-	-
Vanadium	mg/L	<0.005	<0.005	10			
Zinc	mg/L	0.022	0.046	-	3	-	-
Total Petroleum Hydrocarbons (TPH)							
Gasoline range	µg/L	<0.1	<0.1	5000	10	-	-
Diesel range organics	µg/L	<1	<1		-	-	-
Heavy fractions	µg/L	<2	<2		-	-	-
BTEX							
Benzene	µg/L	<0.1	<0.1	-	-	-	1110
Toluene	µg/L	<0.1	<0.1	-	700	-	2150
Ethylbenzene	µg/L	<0.1	<0.1	-	300	-	25
m&p Xylene	µg/L	<0.2	<0.2	-	500	-	-
o-xylene	µg/L			-		-	-

Parameter	Units	Concentrations		Sea water MPL	Drinking water MPL	WHO drinking water guidelines	CCME water quality CEQG (marine)
		Min	Max				
Polycyclic aromatic hydrocarbons (PAHs)							
Naphthalene	µg/L	<0.01	<0.01	-	-	-	1.4
Phenanthrene	µg/L	<0.01	<0.01	-	-	-	-
Anthracene	µg/L	<0.01	<0.01	-	-	-	-
Fluoranthene	µg/L	<0.01	<0.01	-	-	-	-
Benzo(a)anthracene	µg/L	<0.01	<0.01	-	-	-	-
Chrysene	µg/L	<0.01	<0.01	-	-	-	-
Benzo(k)fluorathene	µg/L	<0.01	<0.01	-	-	-	-
Benzo(a)pyrene	µg/L	<0.01	<0.01	-	-	-	-
Indeno(123cd)pyrene	µg/L	<0.01	<0.01	-	-	-	-
Benzo(ghi)perylene	µg/L	<0.01	<0.01	-	-	-	-
Acenaphthylene	µg/L	<0.01	<0.01	-	-	-	-
Acenaphthene	µg/L	<0.01	<0.01	-	-	-	-
Pyrene	µg/L	<0.01	<0.01	-	-	-	-
Din-octylpthalate	µg/L	<0.01	<0.01	-	-	-	-
Benzo(b)fluoranthene	µg/L	<0.01	<0.01	-	-	-	-
Dibenz(ah)anthracene	µg/L	<0.01	<0.01	-	-	-	-

Source: (Mott MacDonald, 2016)
Key:
NR – Not Reported
MPL – Maximum Permissible Limit (Environmental Protection Law No. 30 – Annex 3)

Groundwater monitoring

Physicochemical groundwater water quality

Physicochemical parameters measured for Q3-2018 (04 September 2018), Q4-2018 (06 November 2018) and Q1-2019 (31 March 2019) are presented in Table 8-4.

It was observed that salinity levels at stations MW01, MW03 decreased significantly during Q1-2019 compared to Q4- 2018 sampling period, whereas at stations MW05 and MW02 a marginal increase was observed by as much as which minimally increased in levels by as much as 0.61 psu. ORP levels exhibited further reducing conditions in all stations by as much as -24.87 mV. Electrical conductivity and DO varied across stations this quarter in comparison to its previous period ranging from 11.16 to 66.75 mS/cm and 0.64 to 7.07 mg/L, respectively. Temperature levels in all stations decreased marginally in Q1-2019 in contrast to Q4 -2018 by as high as 1.86 °C (MW04). Overall, no significant changes were evident during this quarter compared to the previous monitoring period.

Analytical groundwater quality

No standards has been prescribed by MME for groundwater assessment; however, groundwater monitoring at the site has been completed in line with the MME requirements. The results of the groundwater analysis are therefore compared with the following guidelines:

- Drinking water MPL
- Qatar Seawater (MME 2002)
- CEQG Marine Water Quality Guidelines

Groundwater parameters with concentrations above the detection limit (heavy metals) are summarised in Table 8-5. Other parameters such as total petroleum hydrocarbons (TPH), benzene toluene ethylbenzene and xylene (BTEX), polycyclic aromatic hydrocarbons (PAHs) and volatile organic compounds (VOCs) were below method detection limits.

All groundwater parameters were below the adopted assessment criteria. However, some parameters were detected above the Q3-2018 monitoring results. The high detection of non-metal (e.g. sulphur) and heavy metals (e.g. zinc and iron) compared to the Q3-2018 were unknown due to limited information available for assessment purposes. However, high sulphur concentrations were also detected during the baseline survey (between 699.3 to 1,132 mg/L) which is comparable to the monitoring results.

Table 8-4: Summary of physicochemical results – Q3-2018, Q4-2018 and Q1-2019 groundwater monitoring

Parameters	Units	Q3-2018: 4 September 2018					Q4-2018: 6 November 2018					Q1-2019: March 2019				
		MW01	MW02	MW03	MW04	MW05	MW01	MW02	MW03	MW04	MW05	MW01	MW02	MW03	MW04	MW05
Temperature	°C	28.90	29.70	29.00	30.10	30.00	30.40	29.80	30.30	30.66	30.13	29.7	29.23	28.85	28.8	28.8
Dissolved Oxygen	mg/L	1.38	1.21	3.09	6.43	5.38	1.26	2.15	3.07	6.50	5.52	5.58	3.36	4.43	7.07	0.64
pH	units	7.34	7.48	7.31	7.95	7.22	7.42	7.60	7.47	8.12	7.37	7.80	8.11	7.94	8.55	7.74
EC	mS/cm	69.16	53.04	67.39	11.791	40.21	69.43	55.67	61.82	10.20	39.55	38.83	51.66	32.60	11.16	66.75
Turbidity	NTU	20.80	1.00	3.60	1.90	6.60	1.76	2.00	4.66	6.06	3.43	0.88	0.12	0.83	0.87	0.43
ORP	mV	-30.00	-38.40	-28.20	-66.50	-23.20	-35.0	-45.3	-37.66	-76.36	-32.20	-57.50	-75.68	-65.75	-101.0	-53.48
Salinity	PSU	47.14	34.69	45.74	6.67	25.55	47.3	33.51	44.79	5.69	25.11	24.59	33.84	20.28	6.30	45.27

Source: (GHD, 2019a)

Note: Concentrations highlighted are above the Q3-2018 counterpart monitoring values

Table 8-5: Summary of analytical results – Q3-2018, Q4-2018 and Q1-2019 groundwater monitoring

Parameters	Assessment criteria			Monitoring results																
	Drinking water MPL (mg/L)	Qatar Seawater Maximum Permissible Limits (MME, 2002) (mg/L)	CEQG Marine Water Quality Guidelines (mg/L)	Units	MDL	Q3-2018 (4 September 2018)					Q4-2018 (6 November 2018)					Q-1 (31 March 2019)				
						MW01	MW02	MW03	MW04	MW05	MW01	MW02	MW03	MW04	MW05	MW01	MW02	MW03	MW04	MW05
Aluminium	0.2 (200 µg/L)	--	--	µg/L	1.00	11.5	5.6	4.3	6.4	4.9	15.6	9.1	6.6	12.7	<1.0	<1.0	14.4	<0.1	2	1.1
Arsenic	0.01 (10 µg/L)	--	0.0125 (12.5 µg/L)	µg/L	0.50	0.9	<0.5	1.5	<0.5	<0.5	4.4	<0.5	4.0	<0.5	0.6	0.7	3.2	<0.5	0.6	<0.5
Boron	0.5 (500 µg/L)	--	--	µg/L	1.00	9,130	6,170	7,750	1,610	4,670	9,660	6,950	8,040	1,740	5,610	2,180	3,250	2,560	2,350	768
Cadmium	0.003 (3 µg/L)	0.7 (700 µg/L)	0.00012 (0.12 µg/L)	µg/L	0.10	<0.1	0.1	<0.1	<0.1	<0.1	<0.1	0.3	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Chromium	0.05 (50 µg/L)	--	--	µg/L	0.10	<0.1	1.4	0.5	1.5	3.4	0.4	2.1	1.5	1.9	3.6	1.9	0.2	1.4	2	1.3
Copper	1 (1000 µg/L)	15 (15,000 µg/L)	--	µg/L	0.50	1.1	0.5	2.8	<0.5	<0.5	0.7	1.4	2.1	1.7	<0.5	<0.5	1	<0.5	<0.5	<0.5
Iron	0.3 (300 µg/L)	90 (90,000 µg/L)	--	µg/L	5.00	<5.00	<5.00	<5.00	<5.00	<5.00	9.82	6.08	7.07	7.36	<5.00	<5.00	38.6	<5.00	<5.00	<5.00
Lead	0.01 (10 µg/L)	12 (12,000 µg/L)	--	µg/L	0.10	0.4	0.4	0.5	0.2	0.3	0.3	6.1	0.8	<0.1	0.2	<0.1	<0.1	0.2	0.1	<0.1
Magnesium	--	--	--	mg/L	0.10	2,370	1,360	2,220	206	960	1,490	925	1,240	132	662	-	1.9	1.2	1.0	1.0
Manganese	0.5 (500 µg/L)	--	--	µg/L	0.10	<0.1	1.5	0.4	<0.1	<0.1	1.4	0.4	0.5	<0.1	<0.1	<0.1	9.5	<0.1	<0.1	<0.1
Mercury	0.001 (1 µg/L)	0.4 (400 µg/L)	0.000016 (0.016 µg/L)	µg/L	0.10	<0.1	<0.1	<0.1	<0.1	0.3	<0.1	1.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Nickel	0.02 (20 µg/L)	20 (20,000 µg/L)	--	µg/L	0.10	1.2	8.6	1.5	<0.1	1	2.0	5.1	1.5	<0.1	1.0	0.9	1.5	3.8	0.5	<0.1
Vanadium	--	10 (10,000 µg/L)	--	µg/L	0.10	4.2	9.0	7.5	6.3	9.9	4.9	7.4	11.4	7.1	9.8	6	2.6	6	5.3	3.2
Zinc	3 (3000 µg/L)	--	--	µg/L	10.00	<10	<10	<10	<10	<10	27	39	28	34	26	17	22	454	123	28
Sulphur	--	--	--	µg/L	84.00	1,770,000	1,420,000	1,640,000	269,000	1,310,000	1,920,000	1,960,000	234,000	242,000	224,000	<LOR	<LOR	<LOR	<LOR	<LOR

Source: (GHD, 2019a)

Notes:
1. Numbers highlighted are above the Q3-2018 counterpart monitoring values
2. Numbers highlighted are above the assessment criteria

8.5 Environmental impact prediction and evaluation

8.5.1 Construction

Construction is anticipated to result in the following impacts and/or issues, which are typical of any construction works:

- *Land alteration*: Construction requires a range of site development works including earthmoving, excavation, fill placement, grading and other ground preparation works that will directly impact on landform
- *Soil erosion*: Site topography, soil composition and structure can be altered by:
  - Soil erosion associated with deep excavation works and stockpiling of fill materials on-site
  - Soil erosion caused by movement of construction vehicles
  - Soil erosion caused by runoff from dust suppression water
- *Soil contamination*: The risk of construction activities resulting in soil contamination is associated with the following events:
  - Introduction of contaminants via the use of contaminated fill material on-site (if fill material is used)
  - Accidental spill or leak of fuel, lubricants, paint, solvents and / or other hazardous chemicals and materials resulting from inappropriate storage and handling practices
  - Leak or spill of sewage from temporary septic tanks and portable toilets onsite
  - Inappropriate storage and management of wastes
  - Contaminated water (from water tankers) used for dust suppression and wash down of vehicles, equipment and machinery on site

The risk of soil contamination is generally considered to be low and can readily be controlled via implementation of appropriate mitigation measures. Any soil contamination arising from most of the above-mentioned events will likely be localised issues, readily addressed and remediated. Water supply during construction is not anticipated to be significant and will be delivered to site via tanker or will be sourced from the existing water supply, therefore groundwater will not be used during construction. Impacts to groundwater quality, through pollution, are generally indirect or secondary to soil quality issues. Typically, groundwater contamination occurs where there is sufficient percolation or intrusion of contaminated water / hazardous liquid through the vadose zone (area of aeration above the water table) and into the underlying aquifer.

Dewatering activities, which may be required during excavation, will potentially require settling/filtration to remove suspended solids prior to reuse on-site (e.g. for dust suppression) or off-site disposal. Pumping out of groundwater is likely to have localised impact on surrounding groundwater levels given the temporary nature of the construction phase.

The overall risk associated with groundwater contamination is considered to be low, due to the following:

- The types of activities to be undertaken during the construction phase do not require or generate large volumes of hazardous materials / wastes
- The arid climate condition on-site, wherein there is no significant surface / stormwater flow that will infiltrate any contaminants into the groundwater

8.5.2 Operation

Operation activities that have the potential to cause soil and groundwater contamination include:

- *Use, transport and storage of hazardous materials*. Pollutants associated with project operation include anti-scalant, dechlorination agent, anti-foam, acid for cleaning and treatment, caustic soda, coagulants, chemical for unfiltration, chlorine dioxide, sodium chlorite and hypochlorite disinfectants, corrosion protection, cleaning agents, fuel, lubrication oil and other oils. Improper transport and storage of these hazardous materials may cause leakage or spill that may lead to soil and groundwater contamination.
- *Liquid waste*. Liquid wastes that will be generated during the project operation include sludge from DAF system, backwash water from disc filter and UF as well as neutralised effluents from UF and RO membranes cleaning. Improper handling and storage of these liquid wastes may cause to spill or leak that leads to soil and groundwater contamination.

Soil and groundwater resources at the site are considered to be low sensitivity receptors. Therefore, the potential impacts to soil and groundwater from accidental release or leakage of wastewater and hazardous materials are assessed to be insignificant.

8.6 Mitigation measures

8.6.1 Construction and Decommissioning

The risk for construction activities to generate significant soil and groundwater contamination is considered to be minimal, provided that adequate mitigation measures are adopted and consistently implemented on-site. During the construction phase, the following mitigation measures will be implemented to minimise the potential for adverse soil and groundwater impacts:

- Prepare and implement a grading and/or site clearance plan/s including a cut and fill strategy to minimise area of disturbed and unconsolidated soil
- Prepare and implement an erosion and sediment control plan, including excavation and civil works as well as for stockpiles
- Where possible, excavated spoil material will be reused on site for fill / backfill purposes; where it is necessary to stockpile spoil, appropriate protection measures will be implemented to prevent wind and water erosion
- Progressive compaction (stabilisation) will be undertaken immediately after excavation
- Provision of efficient temporary drainage system on site to prevent loose soil from being scoured off by surface runoff
- Soil stockpiles will be maintained at minimum height and located on flat areas
- Development and implementation of spill preventive and contingency measures
- A program of routine checking of equipment, machinery and vehicles will be implemented to ensure there is no leakage of oil and fuel
- Chemical or fuel spills will be cleaned up as soon as practicable to prevent contaminants from percolating into the soil and groundwater
- Appropriate hazardous waste management practices will be employed, covering storage and handling (i.e. use of 110% bunded storage areas, availability of MSDS, spill kits and emergency equipment, labelling of containers and areas, access restrictions at storage areas and provision of training to relevant staff)
- In the event that new fill materials will be required, a procedure of assessment measures and monitoring will be established to ensure that only clean fill materials are introduced onsite and only fill materials from approved suppliers will be used

- Potentially contaminated soils will be tested and handled appropriately depending on the levels and types of contaminants present

8.6.2 Operation

During the operation phase, the following mitigation measures will be implemented to minimise the potential for adverse soil and groundwater impacts:

- Use best practice in line with local regulations and international guidelines for operation of desalination plant.
- Ensure staff are appropriately trained to use/clean-up/emergency procedures for hazardous materials and wastes.
- Provide appropriate storage and hazardous materials and liquid wastes. Conduct regular inspection and monitoring of hazardous materials storage areas.
- Include soil and groundwater management and remediation plan in Emergency Response Plan (ERP). The ERP should be developed and implemented in accordance with The Environment Protection Law No. 3 and IFC Guidance.
- Maintain existing groundwater monitoring network and conduct routine groundwater monitoring

8.7 Summary of impacts, mitigation and residual significance

The summary of impacts, mitigation and residual significance of the project on soil and groundwater resources is provided in Table 8-6.

No significant residual impacts are envisaged at the proposed RO expansion project given that:

- The Proponent is constructing Wastewater Treatment Facility to treat sludge and backwash water before discharge
- Storage areas for hazardous materials and wastes are appropriately installed (i.e. hardstand cover, bunding and drainage capture) so that likelihood of spill and leakage is limited
- The soil and groundwater resources at the site are considered to of moderate sensitivity receptors
- There are no groundwater dependent users at the site, and the beneficial use of groundwater for protection is limited by its salinity

Table 8-6: Summary of impacts and residual significance – Soil and Groundwater

Project impact	Initial impact (before implementing mitigation measures			Mitigation measures	Residual impact (after implementing mitigation measures		
	Likelihood	Consequence	Impact rating		Likelihood	Consequence	Impact rating
Construction phase							
Land alteration and generation of spoil	Likely	Insignificant	Low	Re-use excavated spoil material on-site Undertake progressive compaction immediately after excavation Maintain soil stockpiles at a minimum height (<2 m) and located on flat areas and away from stormwater paths, water bodies and areas of vegetation	Possible	Insignificant	Negligible
Soil erosion	Possible	Minor	Low	Stage construction works and progressively compact or stabilise ground surfaces Provide drainage within the site so that soil will not be scoured off in the event of high surface water runoff	Possible	Insignificant	Negligible
Soil and groundwater contamination from leaks and spills of hazardous materials and wastes, dewatering activities, and use of fill materials	Unlikely	Minor	Low	Use industry best practice construction techniques Implement comprehensive construction waste management measures, occupational health and safety plan, emergency response plan Provide a purpose-built bunded area for potentially hazardous substances	Unlikely	Insignificant	Negligible

Project impact	Initial impact (before implementing mitigation measures			Mitigation measures	Residual impact (after implementing mitigation measures		
	Likelihood	Consequence	Impact rating		Likelihood	Consequence	Impact rating
				Refuel vehicles at a licensed refuelling stations Develop spill or leakage prevention and contingency measures Where fill materials are required, establish a procedure to ensure that only clean fill materials are introduced onsite			
Operation phase							
Soil and groundwater contamination and potential marine water contamination due to leaks/spills of hazardous materials and liquid wastes	Possible	Minor	Low	Use best practices for operation of desalination plant Provide appropriate training to staff Provide appropriate storage of hazardous materials and liquid wastes Develop and implement Emergency Response Plan Maintain existing groundwater monitoring network and conduct routine monitoring	Rare	Insignificant	Negligible

9. Marine Environment

9.1 Introduction

This Chapter describes the pre-development and current marine environment, and the potential impacts that the Project-related activities may have upon these marine environmental values. Where potential impacts have been identified, appropriate mitigation measures and monitoring programme have been suggested to reduce the likelihood or impact of these hazards to as low as reasonably practicable.

9.2 Assessment methodology

The assessment methodology for marine environment is provided below:

- Desktop review of the following secondary data:
  - Marine environment baseline study undertaken by Mott MacDonald (2016) for the Project during the pre-development phase.
- Baseline Survey of the Marine Environment
- Qualitative assessment of significance of Project construction and operation activities on marine environment
- Suggested management procedures and mitigation measures

9.3 Legislative Framework and Standards

Chapter 3 of this EIA report provides an overview of all the legislative framework and policy guidance relevant to the Project. The marine environmental legislation and policy applicable to the project are discussed in the following subsections.

9.3.1 Qatari Legislation

Qatari National Standards, 2002

The Qatar National Standards 2002 pertaining to seawater and water quality environmental aspects are prescribed. The standards have been used for assessment and comparison as part of this EIA and have been recommended for use for any future monitoring that will be conducted as part of this Project.

Water Quality Guidelines

Discrete and analytical seawater quality measurements were assessed against the Qatar Standards for Seawater Quality (Annex 3/4 of Law 30 of 2002; MME, 2002) to evaluate environmental compliance during this monitoring programme. Where Qatar Standards for Seawater Quality are unavailable, the Qatar Standards for Pollutants Discharged in the Water Environment (Annex 4) is adopted. If no Qatar Standards are available internationally recognised guidelines have been used.

The guidelines for each water quality parameter are also summarised in Table 9-1.

Table 9-1: Local and international standards for water quality

Parameter	Units	Limit of Reporting (LOR)	Consent to Operate (CTO) wastewater quality criteria	Qatar National Standards (MME, 2002) Annex 3/4 Seawater	Qatar National Standards (MME, 2002) Annex 4 Pollutants	Australian and New Zealand Guidelines[11] ANZG
Temperature	°C					
Dissolved oxygen	mg/L			>4		
Salinity	PSU			33-45		
pH	unit		6-9	6.5-8.3		
Turbidity	NTU				50	
Specific Conductivity	mg/L					
Oil and Grease	mg/L		10		15	
Total Suspended Solids (TSS)	mg/L		50	30		
Chemical Oxygen Demand (COD)	mg/L		100		100	
Biochemical Oxygen Demand (BOD)	mg/L		50		50	
Benzene	mg/L		0.05			0.7
Benzo (a) pyrene	mg/L		0.05			
Free Chlorine	mg/L	0.02	0.1			0.4
Ammonia (Nitrogen)	mg/L	0.02		0.015		
TKN (Total Kjeldahl Nitrogen)	mg/L					
Total Dissolved Solids (TDS)	mg/L				1500	
Sulphide	mg/L	0.005	1			
Residual Chlorine	mg/L	0.02	0.1		0.05	
Chlorophyll-*a*	mg/L	1		0.001		
Urea	mg/L	1.2			2	
Nitrate	mg/L	0.04		0.1		
Sulphate	mg/L	5			0.1	400
Nitrite	mg/L	0.016		0.035		
Phosphorus	mg/L	0.01		0.03		
Orthophosphate	mg/L	0.02				
Total Organic Carbon (TOC)	mg/L	0.1				
Phenol	mg/L		0.5			0.27
Total Bacterial Count	MPN/100ml	1.8			100	
E-Coli	MPN/100ml	1.8				

[11] Australian = Australian and New Zealand Guidelines for Fresh and Marine Water Quality Guidelines (95% species protection) (2018)

Parameter	Units	Limit of Reporting (LOR)	Consent to Operate (CTO) wastewater quality criteria	Qatar National Standards (MME, 2002) Annex 3/4 Seawater	Qatar National Standards (MME, 2002) Annex 4 Pollutants	Australian and New Zealand Guidelines[11] ANZG
EPH (C_{10}-C_{40})	mg/L	0.05		5		
GRO (>C4-C12)	mg/L	0.01				
Aluminium (Al)	mg/L	0.001			3	
Barium (Ba)	mg/L	0.01			2	
Beryllium (Be)	mg/L	0.0001				
Cadmium (Cd)	mg/L	0.0001		0.0007		
Chromium (Cr)	mg/L	0.0001	0.2		0.2	
Cobalt (Co)	mg/L	0.0005			2	
Copper (Cu)	mg/L	0.0005	0.5	0.015		
Iron (Fe)	mg/L	0.005		0.09		
Lead (Pb)	mg/L	0.0001	0.1	0.012		
Lithium (Li)	mg/L	0.0001				
Manganese (Mn)	mg/L	0.0001			0.2	
Mercury (Hg)	mg/L	0.0001	0.001	<0.0004		
Nickel (Ni)	mg/L	0.0001		0.02		
Palladium (Pd)	mg/L	0.0003				
Strontium (Sr)	mg/L	0.0005				
Tin (Sn)	mg/L	0.0001				10
Vanadium (V)	mg/L	0.0001		0.01		
Zinc (Zn)	mg/L	0.01			2	

9.3.2 International Guidelines

IFC Performance Standard 6

IFC Performance Standard 6 guidance on ecological impact assessments includes the allocation of a conservation value to the ecological features (protected sites, habitats and species) which are likely to be directly or indirectly impacted by a project within an Area of Influence (AoI). The IFC guidance applies to projects in all habitats, whether or not those habitats have been previously disturbed and whether or not they are legally protected. Where critical or legally protected areas are likely to be affected the developer must employ qualified and experienced external experts to assist in the assessment.

Habitat destruction is recognised as a major threat to the maintenance of biodiversity and to assess likely significance of impacts, PS6 makes the following recommendations depending on habitat status:

- **Modified Habitat:** exercise care to minimise any conversion or degradation of such habitat, depending on scale of project, identify opportunities to enhance habitat and to protect and conserve biodiversity as part of operations
- **Natural Habitat**: developer will not significantly convert or degrade such habitat unless no financially/technically feasible alternatives exist, or overall benefits outweigh cost (including those to biodiversity), and conversion or degradation is suitably mitigated. Mitigation must

achieve no net loss of biodiversity where feasible; offset losses through creation of an ecologically comparable area that is managed for biodiversity, compensation of direct users of biodiversity

- **Critical Habitat:** in areas of critical habitat the developer will not implement project activities unless there are no measurable adverse impacts on the ability of the critical habitat to support established populations of species described or on the functions of the critical habitat; no reduction in population of a recognised critically endangered or endangered species and lesser impacts mitigated as per natural habitats

As defined by IFC PS6, a 'critical' habitat is a subset of both natural and modified habitat that deserves particular attention. Critical habitat includes areas with high biodiversity value, including:

- Habitat required for the survival of endangered and critically endangered species (IUCN)
- Areas having special significance for endemic or restricted-range species
- Sites that are critical for the survival of migratory species
- Areas supporting globally significant concentration or numbers of individuals
- Areas with unique assemblages of species
- Areas having biodiversity of significant social, economic or cultural importance to local communities

9.4 Marine Sensitive Receptors

Sensitive receptors were identified in Section 2.3.2. With respect to marine habitats found in Qatar critical habitats are typically considered to consist of coral reefs, mangroves, seagrass meadows and oyster beds. General and discrete marine sensitive receptors which may be susceptible to impacts, direct or indirect, as a result of the Project include:

- Existing marine habitats, particularly:
  - Seagrass;
  - Oyster beds;
- Ambient marine water quality, including salinity and temperature; and
- Existing IWPP.

9.5 Baseline

9.5.1 Pre-development site condition

A marine environmental baseline survey (MEBS) was conducted prior to the development of the existing IWPP. Five major habitat classifications and different isotopes were recorded and mapped during the survey at the surrounding marine environment (Mott MacDonald, 2016). The five major habitats with their description are provided below:

- ***Intertidal Sand and Mudflats*:** The intertidal zone supports and extensive sand flats which are likely to support infauna assemblages which provide foraging opportunities for migrating birds (5OES, 2015).
- ***Mangroves*:** An intertidal habitat located to the south of the Project area. The mangrove area is known to support a dense mangrove stand, along with associated fauna (5OES, 2015).

- ***Seagrass*:** Seagrass beds are dense and extensive within the project area, and are in a relatively pristine condition given the lack of pre-existing development along the stretch of coastline (5OES, 2015).
- ***Macroalgae*:** Macroalgae habitats were considered to be well developed and abundant in a number of areas, representative of pristine and intact natural habitats (5OES, 2015).
- ***Pearl Oysters*:** Two species of pearl oysters were recorded during the surveys and the concentrations were notable in a number of areas at depths of below 5 m (5OES, 2015).

9.5.2 Current site condition

A baseline survey comprising of a full ecological, sensitive habitat, entrainment, seabed temperature, seawater and marine sediment quality assessment was undertaken. The monitoring locations are illustrated in Figure 9-1 and locations listed in Table 9-2.

Table 9-2: Coordinates of the 13 marine ecology locations sampled (QND 95)

Station	Longitude	Latitude
S-02	242643.16	376650.12
S-06	242651.30	375126.98
S-07	243651.65	375125.37
S-09	241648.53	373628.07
S-10	242648.88	373626.46
S-11	243649.23	373624.84
S-13	241646.11	372127.54
S-14	242646.46	372125.93
S-15	243646.81	372124.32
S-17	241643.69	370627.01
S-18	242644.04	370625.40
C-N	238572.97	421770.92
C-S	248363.30	352850.98

A summary of the MEBS results are presented in the succeeding sections, capturing full seasonal variation of species and processes within the marine environment. This baseline information has been collected over the 2018/19 period throughout the quarterly monitoring schedule represented Table 9-3. The monitoring program outlined in Table 9-3 spans a full year ensuring to capture a full annual cycle to account for any seasonal variation within the marine environment. Results from the Quarter 3 – 2018 report will be used as a representative indication of the surrounding marine environment following a summer season and results from the Quarter 2- 2019 as a representation of the environment following winter.

Table 9-3: Schedule of marine monitoring event

Marine assessment	*Quarter 3 – 2018*	*Quarter 4 - 2018*	*Quarter 1 - 2019*	*Quarter 2 - 2019*
Benthic infauna	✓		✓	
Fish	✓		✓	
Phytoplankton	✓		✓	
Zooplankton	✓		✓	
Sensitive habitats	✓	✓	✓	✓
Entrainment	✓	✓	✓	✓
Seabed temperature	✓	✓	✓	✓
Water quality	✓	✓	✓	✓

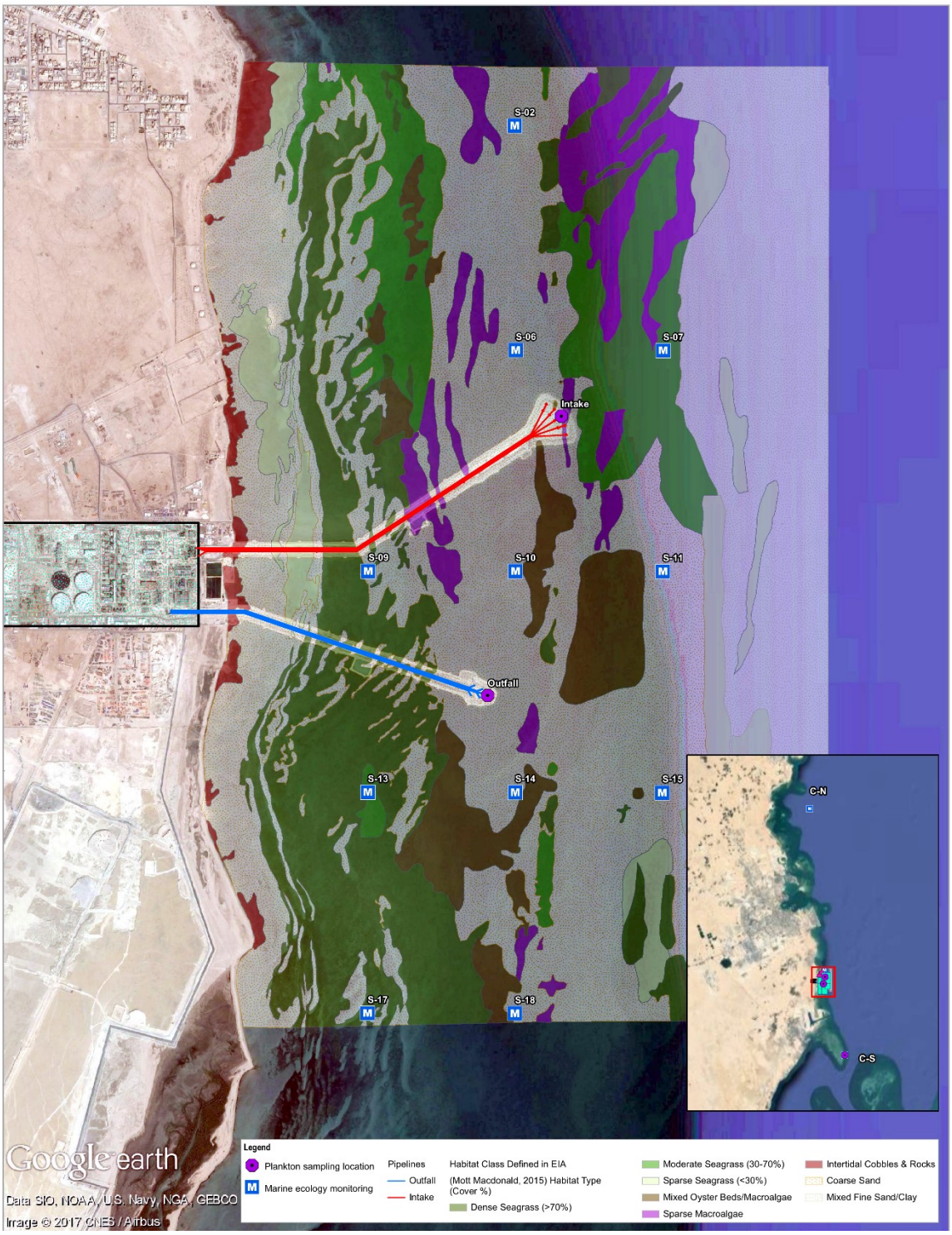

Figure 9-1: Marine ecology monitoring locations

Source: (GHD, 2019a)

9.5.2.1 Benthic infauna

Infauna is the collective name given to the invertebrate fauna that exist within, or are closely associated with, marine sediments (Petersen, 1913).

Faunal Composition

Summer (April – September)

A total of 1019 individuals from 82 species were found in the 13 benthic samples collected during this study. Crustacea accounted for 46% of the individuals and 24% of all species collected. Annelida accounted for 36% of the individuals and 44% of all species collected. Other less common phyla encountered included Echinodermata, Mollusca and Platyhelminthes. Annelida and Crustacea were also the most widely distributed phyla and occurred at 100% (13) of the sampling sites. A further two phyla (Mollusca and Echinodermata) were relatively well distributed, and found at 92% (12) and 77% (10) of the sampling sites, respectively. Platyhelminthes was observed in only one site.

Deposit-feeding organisms (primarily annelids and crustacean) dominated the infauna communities sampled, and accounted for 44% of the total species richness and 49% of the total species abundance. The crustacean *Dimorphostylis* sp. 1, was the most abundant species found during the study. This small (<5 mm), deposit feeding crustacean represented 12% of the total infauna abundance, and was found at all 13 of the sites sampled. The crustacean seed shrimps (Ostracoda 2) was the next most common species and accounted for 9% of the total abundance. The amphipod *Photis* sp. 1 was widely distributed and was collected at 11 (85%) of the sampling stations.

Spatial Patterns in Infauna Richness and Abundance (

Distribution patterns differed for richness and abundance (Figure 9-3a-b). Species richness was highest (35/0.01 m²) at station S-10 (located in between the intake and discharge pipes) and at S-15 (located offshore in the southeast part of the survey area). Stations S-02, S-07, S-11, S-14, and S-13 also had high species richness (>23/0.01 m²), which are located from the north to southwest part of the survey area and forms a perimeter around the two pipes. A low-diversity area across the southernmost stations (S-17 and S-18) and stations near the intake pipe (S-06 and S-09) was observed with station S-09 having the lowest species richness (6/0.01 m²). The highest species abundance (150/0.01 m²) was found at station S-10 followed by S-11 (112/0.01 m²) and S-14 (103/0.01 m²). Abundances were generally higher in the central part of the survey area extending to the southwest stations (S-13 and S-17). Notably, species richness and abundances were higher in the southern control station (CS) than the northern control station (CN).

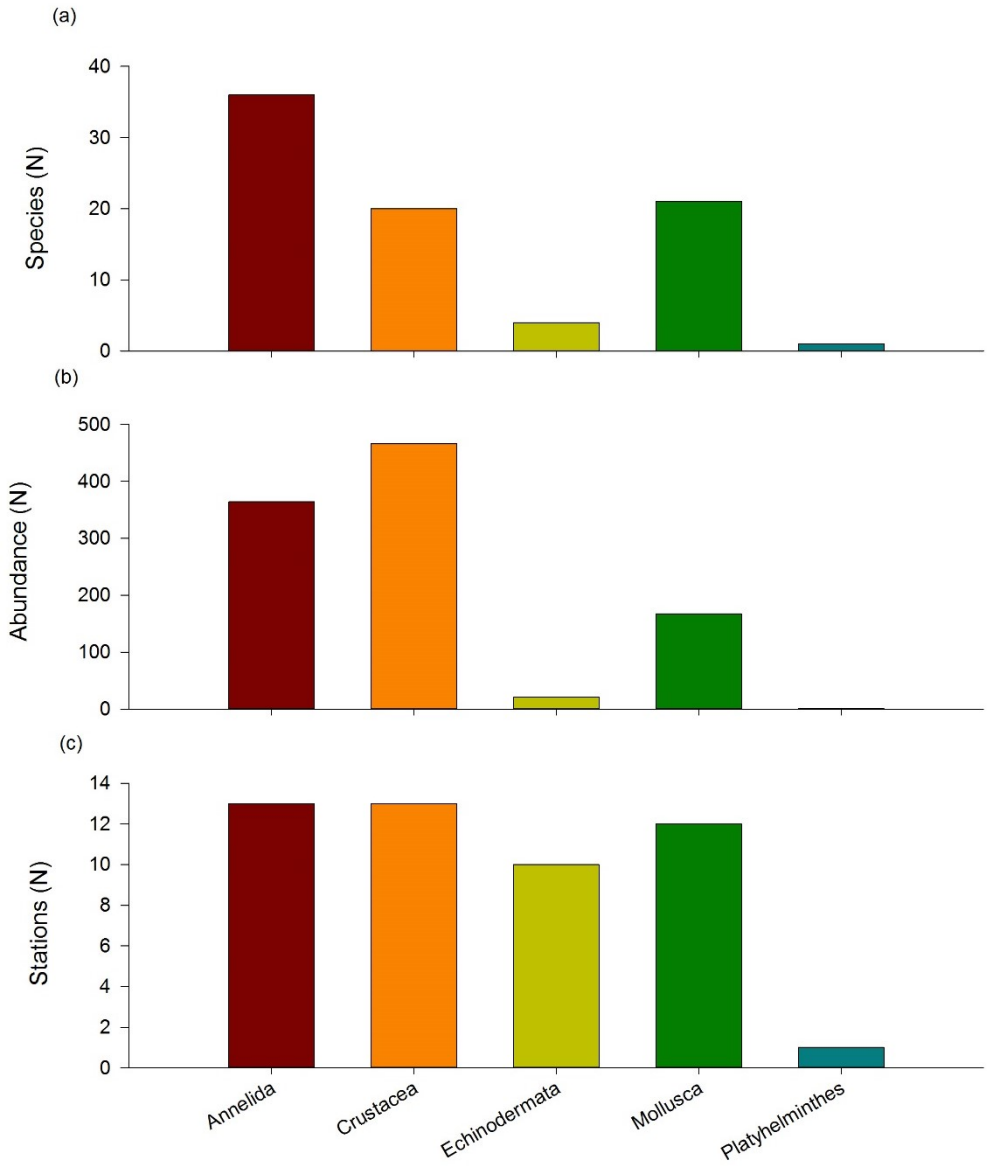

Figure 9-2: Total (a) number of species and (b) individuals of each major phyla collected during the survey, and (c) the total number of sites (out of 13) at which species belonging to each major phyla were collected

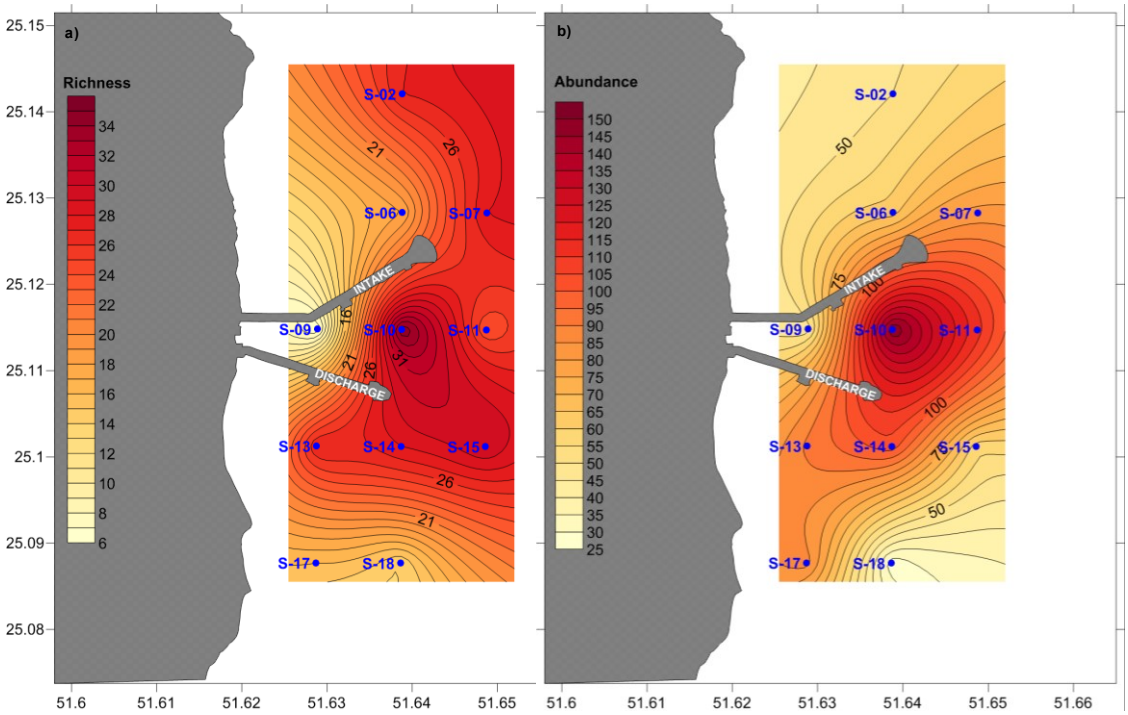

Figure 9-3: Predictive maps of (a) total infaunal richness (number of species) and (b) total infaunal abundance (number of individuals) collected from replicate 0.01 m² grabs at 13 sampling sites off Umm Al Houl IWPP.

Winter (October – March)

A total of 494 individuals from 70 species were found in the 13 benthic samples collected during this study. Crustacea accounted for 48% of the individuals and 33% of all species collected. Mollusca was the next most abundant group comprising 22% of the individuals and 31% of all species collected. Annelids accounted for 20% of the individuals and 29% of all species collected. (Figure 9-4a-b, Table 9-4). Other less common phyla encountered included Cnidaria, Echinodermata, and Sipuncila. Annelida and Mollusca were the most widely distributed phyla and occurred at all 13 sampling sites (Figure 9-4c). Crustacea was the next most widely distributed phyla, which occurred in 12 sites (92% of the sampling sites). Echinodermata and Sipuncula were relatively well distributed, and found at 7 sites (54%) and 3 sites (23%), respectively. Cnidaria was observed in only one site.

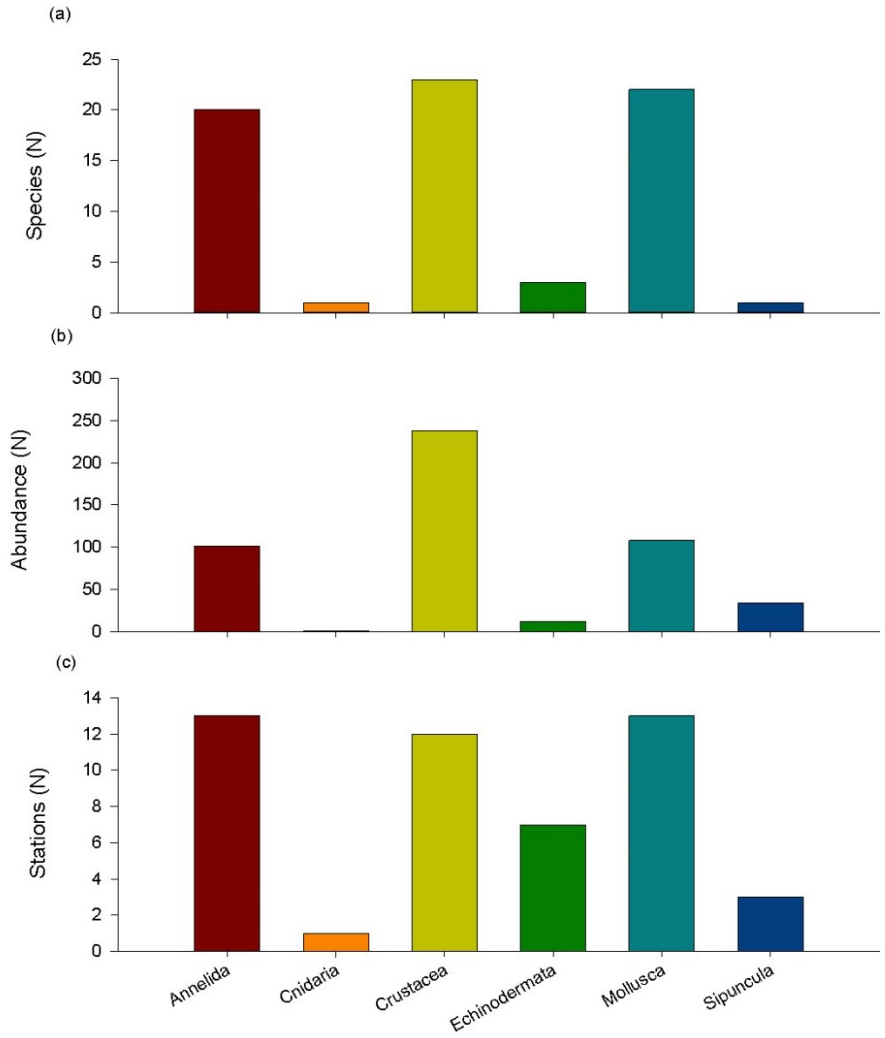

Figure 9-4: Total (a) number of species and (b) individuals of each major phyla collected during the survey, and (c) the total number of sites (out of 13) at which species belonging to each major phyla were collected

Source: (GHD, 2019a)

Table 9-4: Total number of species and individuals of each major phyla collected during the survey, and the total number of sites (out of 13) at which species belonging to each major phyla were collected

Phylum	No. of Species (N)	Abundance (N)	No. of Stations
Annelida	20	101	13
Cnidaria	1	1	1
Crustacea	23	238	12
Echinodermata	3	12	7
Mollusca	22	108	13
Sipuncula	1	34	3
Total	70	494	13

Source: (GHD, 2019a)

Spatial Patterns in Infauna Richness and Abundance

Distribution patterns differed for richness and abundance (Figure 9-5a-b). Species richness was highest (26/0.01 m²) at station S-18 (located at the southernmost region of the sampling area). Species richness was also high at the east stations (S-15 and S-07). A low-diversity area was observed at stations along the coast. The highest species abundance (108/0.01 m²) was found at station S-09, which is located along the coast and in between the intake and discharge pipes. Abundances were generally high at the southern and southeast part of the survey area (stations S-17, S-18, and S-15). Notably, species richness and abundances were low in both the southern control station (CS) and northern control station (CN).

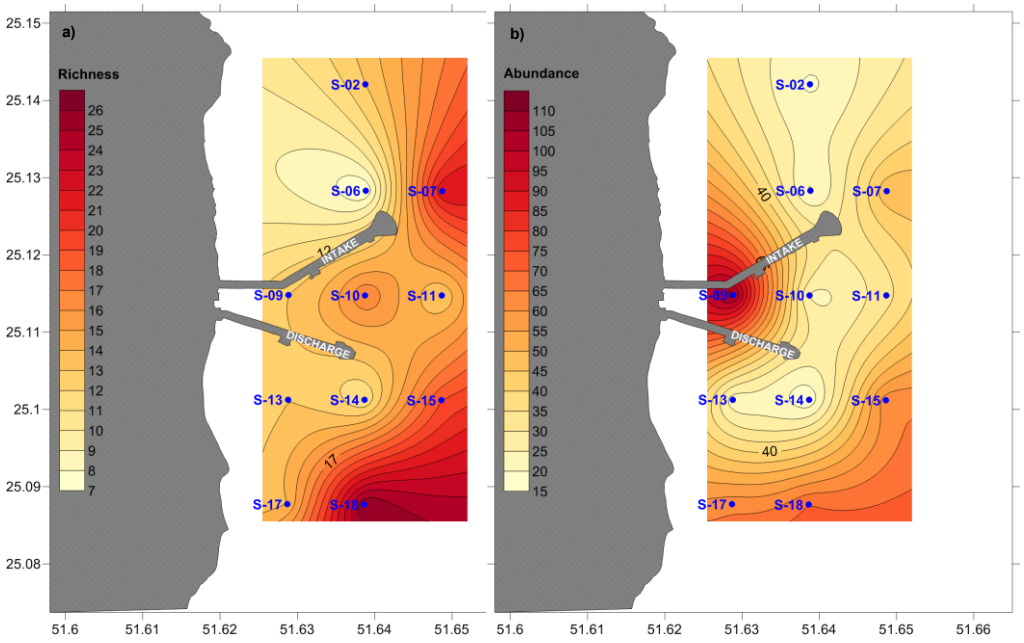

Figure 9-5: Predictive maps of (a) total infaunal richness (number of species) and (b) total infaunal abundance (number of individuals) collected from replicate 0.01 m² grabs at 13 sampling sites off Umm Al Houl IWPP.

Source: (GHD, 2019a)'

Temporal comparison of surveys

Total species richness among the 13 surveyed sites did not significantly differ between the six annual monitoring events (i.e. August 2015, April 2016, March 2017, May 2018, September 2018 and March 2019) with a standard deviation of 6.59 (Table 9-5).

Comparison of infauna abundance spatial distribution over six surveys (August 2015, April 2016, March 2017, May 2018, September 2018 and March 2019) is shown in Figure 9-6. The August 2015 map shows infauna data prior to construction activities; April 2016 is during pre-works phase; March 2017 is during construction phase; May 2018 is during commissioning phase; and September 2018 and March 2019 are during the operations phase.

During the pre-construction phase (August 2015), high infauna abundance was observed nearshore at the south-western station while in the pre-works phase (April 2016), abundance was high at the central nearshore station located between the two pipes. Abundance distribution was similar during the pre-construction and construction (March 2017) phases. In contrast, high infauna abundance was observed in the central part of the survey area, particularly between the two pipes, during the commissioning (May 2018) and operations (September 2018 and

March 2019) phases. The abundance concentration in March 2019 was highest near the coast compared to the September 2018 survey. This distribution pattern may have been influenced by the two pipes wherein water near the intake pipe flows landward while water near the discharge pipe flows seaward creating an eddy within the central part of the survey area.

Table 9-5: Infauna species richness over six annual monitoring periods

Site	August 2015	April 2016	March 2017	May 2018	September 2018	March 2019	Standard Deviation
S-02	10	12	9	12	27	13	6.62
S-06	5	6	7	8	18	7	4.76
S-07	9	12	7	19	28	22	8.18
S-09	4	15	8	6	6	13	4.37
S-10	5	7	6	26	35	17	12.36
S-11	3	10	6	16	24	13	7.51
S-13	6	11	18	16	27	13	7.14
S-14	8	13	10	12	28	11	7.23
S-15	7	10	6	17	30	19	9.11
S-17	17	12	10	10	16	14	2.99
S-18	6	9	4	6	14	26	8.21
C-N	13	14	7	16	22	4	6.44
C-S	8	7	4	22	25	3	9.52
Total	72	70	62	75	82	70	6.59

Source: (GHD, 2019a)

Table 9-6: Infauna abundance over six annual monitoring periods

Site	May 2018	September 2018	March 2019		Standard Deviation
S-02	25	50	19		13.64
S-06	39	63	19		22.17
S-07	54	82	49		28.94
S-09	47	47	108		32.41
S-10	72	150	24		54.89
S-11	98	112	33		48.19
S-13	28	91	22		29.87
S-14	39	103	16		34.59
S-15	25	57	63		22.86
S-17	46	87	63		24.51
S-18	9	27	70		24.97

Site	May 2018	September 2018	March 2019		Standard Deviation
C-N	34	51	5		17.17
C-S	60	99	3		39.01
Total	576	1019	494		316.21

Source: (GHD, 2019a)

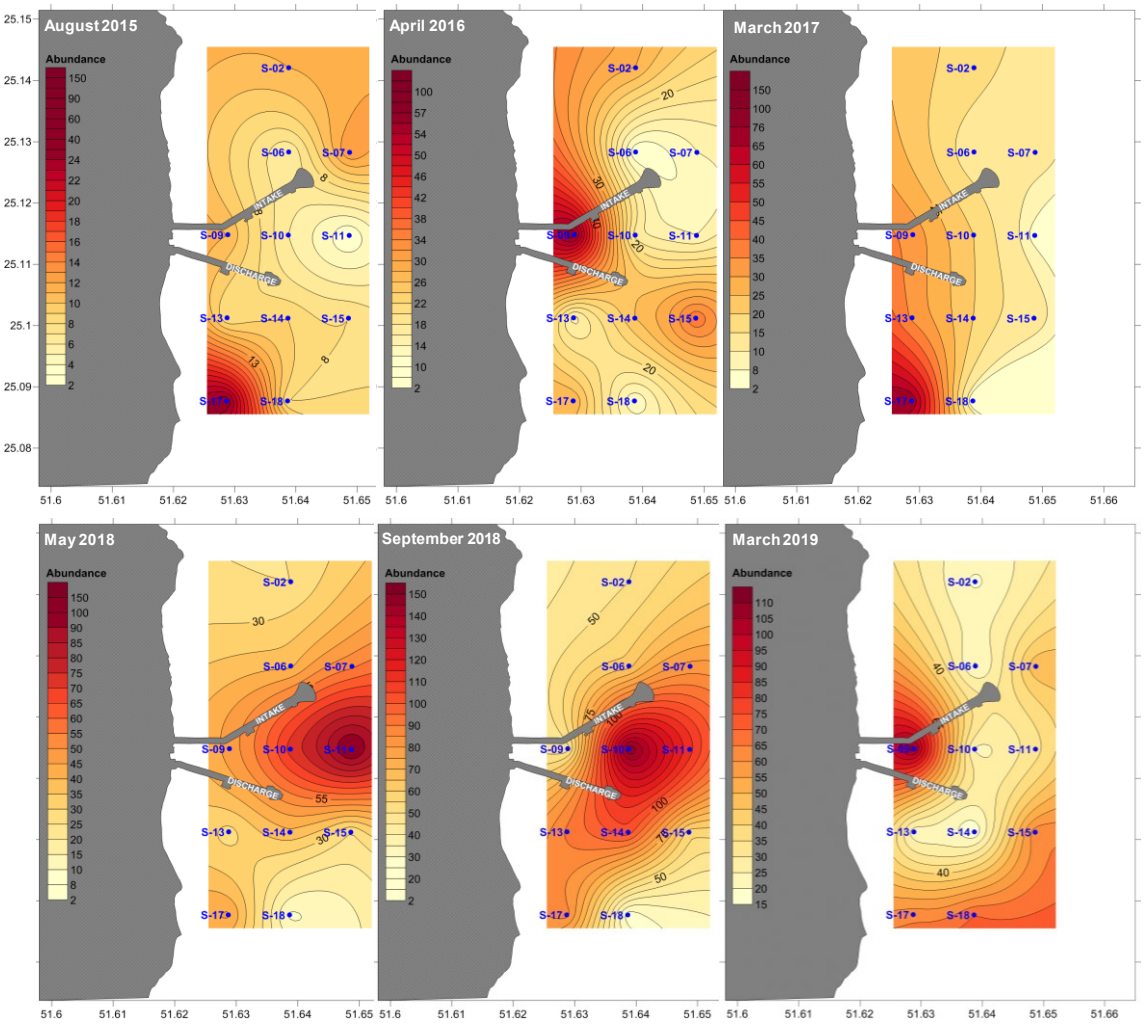

Figure 9-6: Infauna abundance spatial distribution over five annual monitoring period

Source: (GHD, 2019a)

9.5.2.2 Fish

An Underwater Visual Census fish survey was undertaken at each of the 13 monitoring locations (Refer to Figure 9-1). At each station, a single video transect of 200 m was filmed using a high definition 1080-p digital camera. The transects were run parallel to the shoreline in the northerly direction. The videos were used to identify fish in the near vicinity.

Table 9-7: Underwater Visual Census (UVC) fish survey locations and sampling dates

Station	Longitude	Latitude
S-02	242643.16	376650.12
S-06	242651.30	375126.98
S-07	243651.65	375125.37
S-09	241648.53	373628.07
S-10	242648.88	373626.46
S-11	243649.23	373624.84
S-13	241646.11	372127.54
S-14	242646.46	372125.93
S-15	243646.81	372124.32
S-17	241643.69	370627.01
S-18	242644.04	370625.40
C-N	238572.97	421770.92
C-S	248363.30	352850.98

Faunal Composition

Due to its isolation and relatively harsh environmental conditions, the Arabian Gulf supports a relatively low diversity of fish species than that observed in much of the Indian Ocean or Indo-Australasian region. Approximately 200 species are known from the Arabian Gulf (Smith *et al*., 1987), compared with over 3000 in Indonesia and the Philippines (Sale, 1980).

Fish were not commonly recorded within the Umm Al Houl project area during the EIA (Mott MacDonald, 2015). This is attributed to the lack of rock and coral habitats in the area. The cryptic behaviour of many species associated with seagrass, macroalgal and sand habitats is also believed to be a factor in their apparent low abundance. The most commonly recorded species were those that inhabit extensive sand or seagrass areas. These included burrow dwelling blennies and gobies *Amblyeleotris diagonalis, Cryptocentrus lutheri, Valenncia* sp., *Amblygobius albimaculatus,* and goatfish *Parapeneus margaritatus*. Where macroalgae and rock were present other demersal fish species were recorded. These included *Pomacanthus maculosus, Lutjanus ehrenbergii* and *Siganus canaliculatus.* Semi-pelagic species were not prevalent, and limited to single records of *Carangoides bajad* and *Scomberoides* sp.

Summer (April – September)

121 individuals were identified in the 6 out of 13 video tows undertaken during Event No. 0. The highest number of individuals observed was recorded at stations CN (59 individuals) and CS (56 individuals). No fish were recorded at 7 of the 13 stations surveyed (S-07, S-09, S-10, S-11, S-14, S-15 and S-17) (Figure 9-7). The high abundance of fish at stations CN and CS was primarily due to the schools of the blackspot snapper *Lutjanus fulviflamma* and pearly goatfish *Parupenues margaritatus* observed in the area. The Arabian monocle bream *Scolopsis ghanam* was fairly abundant in station CS where individuals were recorded throughout the transect.

A total of 11 fish species were identified in the 13 video. The stations with the most fish species (6 species) observed was the north control station CN while the most common fish observed among the 6 stations was the black streaked monocle bream *Scolopsis taeniata* (3 stations).

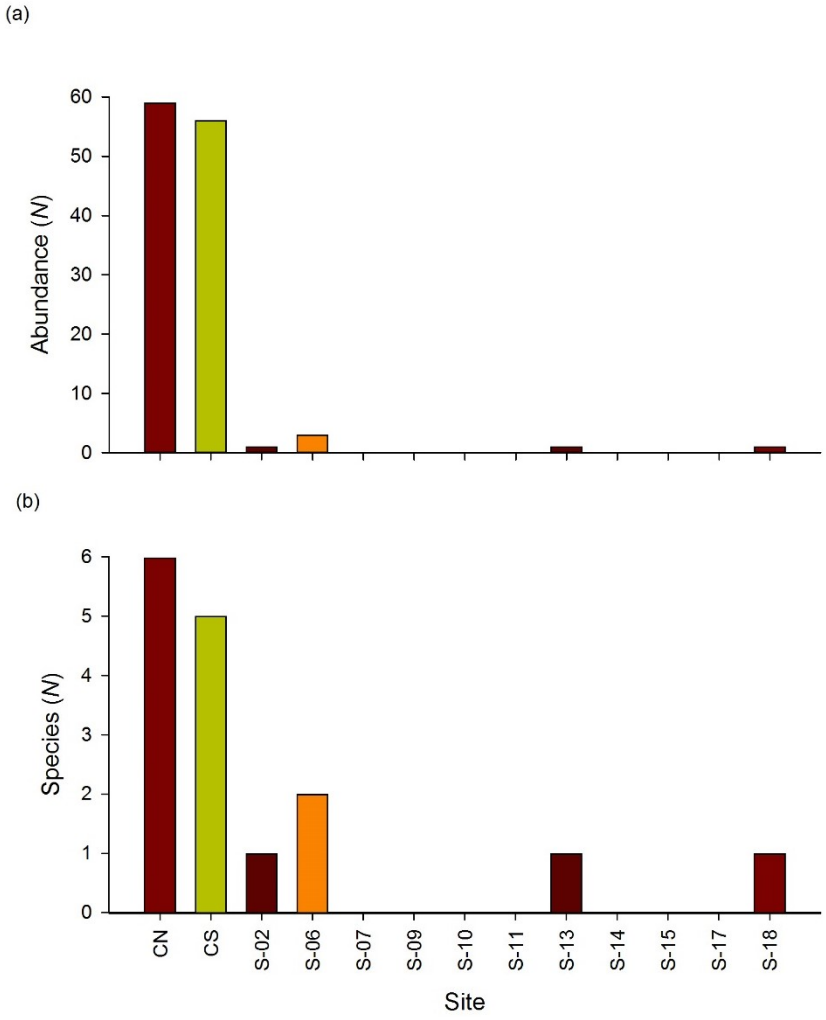

Figure 9-7: Total (a) number of individuals and (b) species richness at 13 video sampling sites off Umm Al Houl IWPP

Winter (October – March)

Six individuals were identified in four out of 13 video tows undertaken during Event No. 1 (March 2019). Stations S-13 and S-14 each had a total of two fish recorded in the survey (Figure 9-8). No fish were recorded at 9 of the 13 stations surveyed (CS, S-02, S-06, S-07, S-09, S-10, S-11, S-15 and S-17). Fish abundance was low at all stations during the recent survey.

Only three fish species were identified in the 4 video tows. The station with the most fish species (2 species) observed was S-13. The bottom dwelling goby *Amblygobius albimaculatus* was the most common and was recorded at 3 of the 4 video tows.

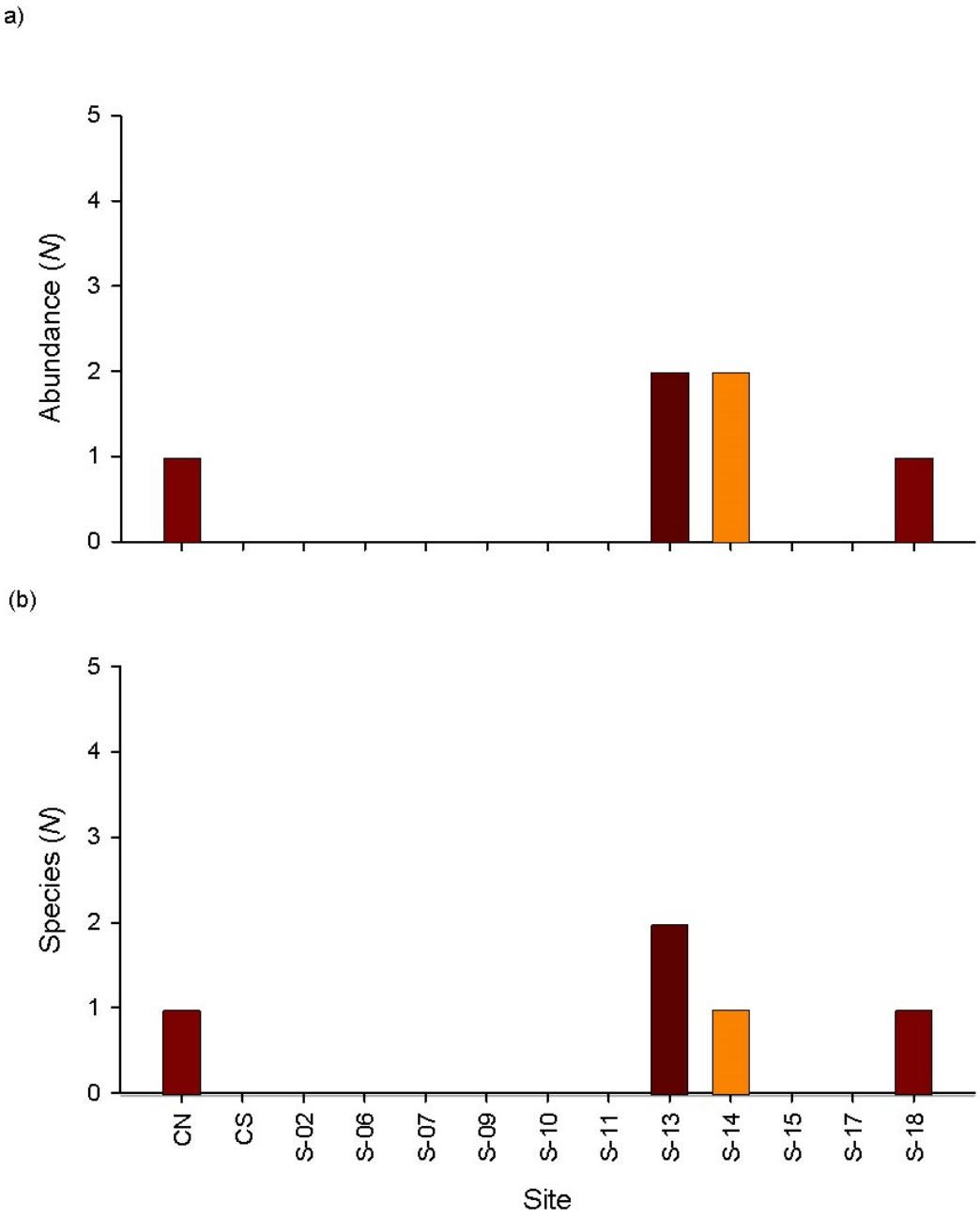

Figure 9-8: Total (a) number of individuals and (b) species richness at 13 video sampling sites off Umm Al Houl IWPP

Source: (GHD, 2019a)

Temporal comparison of surveys

Fish census vary between site and season as well as water condition during sampling. Table 9-8, presents fish species recorded during six annual surveys. Demersal fish species such as *Cryptocentrus lutheri* and *Amblygobius albimaculatus* and reef inhabiting species such as the *Scolopsis* (Monocle bream) and *Lutjanus* (Snapper) were commonly observed in most of the sampling sites and across all survey periods. However, it is notable that the coastal pelagic anchovies (Engraulidae) were the only fish species recorded during the construction phase (March 2017). Vibration and noise disturbance during construction may have been a possible reason as to less bottom dwelling and reef fishes recorded during this phase. Fish could have easily avoided such areas. Though it is essential to note that only three fish species were recorded in the March 2019 survey. This observation is comparable to the March 2017 survey but it is still premature to determine a seasonal pattern. Long term data gathering to compile a robust data would be sufficient to verify this observation.

Table 9-8: List of fish species recorded over six annual monitoring periods

Site	August 2015	April 2016	March 2017	May 2018	September 2018	March 2019
S-02	None	*Amblygobius albimaculatus*	None	*Pseudochromis persicus*	*Pardachirus balius*	None
S-06	None	None	None	None	*Pardachirus balius* *Scolopsis taeniata*	None
S-07	*Cryptocentrus lutheri*	*Amblygobius albimaculatus* *Parupeneus margaritatus*	None	*Unidentified fish* *Selar sp.* *Engraulidae*	None	None
S-09	None	None	None	None	None	None
S-10	*Cryptocentrus lutheri*	Engraulidae	None	*Leognathidae*	None	None
S-11	*Cryptocentrus sp.*	*Amblygobius albimaculatus* *Scolopsis sp*	None	*Bleniidae* *Amblygobius albimaculatus*	None	None
S-13	*Valenciennea sp.* *Parupeneus margaritatus*	None	None	*Lutjanus sp.*	*Terapon puta*	*Lutjanus fulviflamma* *Amblygobius albimaculatus*
S-14	*Cryptocentrus sp.*	None	None	None	None	*Amblygobius albimaculatus*
S-15	*Cryptocentrus sp.*	*Amblygobius albimaculatus*	None	*Terapon puta* *Amblygobius albimaculatus*	None	None
S-17	None	None	Engraulidae	*Lutjanus fulviflama*	None	

Site	August 2015	April 2016	March 2017	May 2018	September 2018	March 2019
S-18	None	*Pomacanthus maculosus* *Lethrinus sp.,* *Scolopsis ghanam*	None	*Lethrinus obsoletus*	*Scolopsis taeniata*	*Amblygobius albimaculatus*
C-N	Amblygobius albimaculatus Amblyeleotris diagonalis	None	None	*Lutjanus fulviflama*	*Acanthopagrus bifasciatus* *Epinephelus coioides* *Lutjanus fulviflamma* *Parupenues margaritatus* *Pomacanthus maculosus* *Unidentified fish*	*Scolopsis taeniata*
C-S	*Dascyllus trimaculatus/Chrysiptera sheila* *Amblygobius albimaculatus* *Pomacanthus maculosus, Lethrinus,* *Scolopsis taeniatus* *Parupeneus sp*	*Pomacanthus maculosus*	*Pomacanthus maculosus*	None	*Lutjanus fulviflamma* *Pomacanthus maculosus* *Pseudochromis persicus* *Scolopsis ghanam* *Scolopsis taeniata*	None

Source: (GHD, 2019a)

9.5.2.3 Phytoplankton

Phytoplankton are aquatic single celled microorganisms that drift along the water currents and form the base of the aquatic food chain. They are relatively plant-like and rely on sunlight and nutrients for growth. They commonly consists of diatoms and dinoflagellates and other marine flagellates such as Chromophyta and Chlorophyta. Phytoplankton are sensitive to changes in water characteristics such as fluctuations in light, nutrient loads, and other pollutants; and have a fast response rate, which makes them good indicators to changes in water quality (Suthers and Rissik, 2008).

Faunal Composition

Plankton samples were collected at 3 monitoring locations (Refer to Table 9-9). Samples were collected by towing a plankton net and samples were transferred to containers and fixed with 70% ethanol. In the laboratory, phytoplankton and zooplankton organisms were classified to the lowest taxonomic level where possible.

Table 9-9: Plankton sampling locations

Station	Longitude	Latitude
Intake	242961	374679
Outfall	242459	372784
C-S	248363.30	352850.98

Summer (April – September)

A total of 2,149 cells per liter, representing 27 taxa, were found in the 3 samples collected during this study. Dinoflagellates accounted for 96% of the abundance and 48% of all species collected (Figure 9-10a-b). Other two groups representing 3% and 1% of the whole abundance were diatoms and cyanobacteria, respectively. Dinoflagellates and diatoms were widely distributed and occurred at all three of the sampling sites (Figure 9-10c). Cyanobacteria had much more restricted distribution and was found only at one sampled site.

The dinoflagellate *Prorocentrum gracile* was the most abundant taxa found during the study. This tropical dinoflagellate represented 33% of the total phytoplankton abundance, and was found at all three samples sites. The bloom forming dinoflagellate *Pyrodinium bahamense* was the next most abundant species and accounted for 25% of the total abundance. This armoured organism was also widely distributed, and was collected at all three sampling stations. The other species which contributed to more than 10% each of the total abundance were the dinoflagellates *Gymnodinium* sp. and *Ceratium furca*.

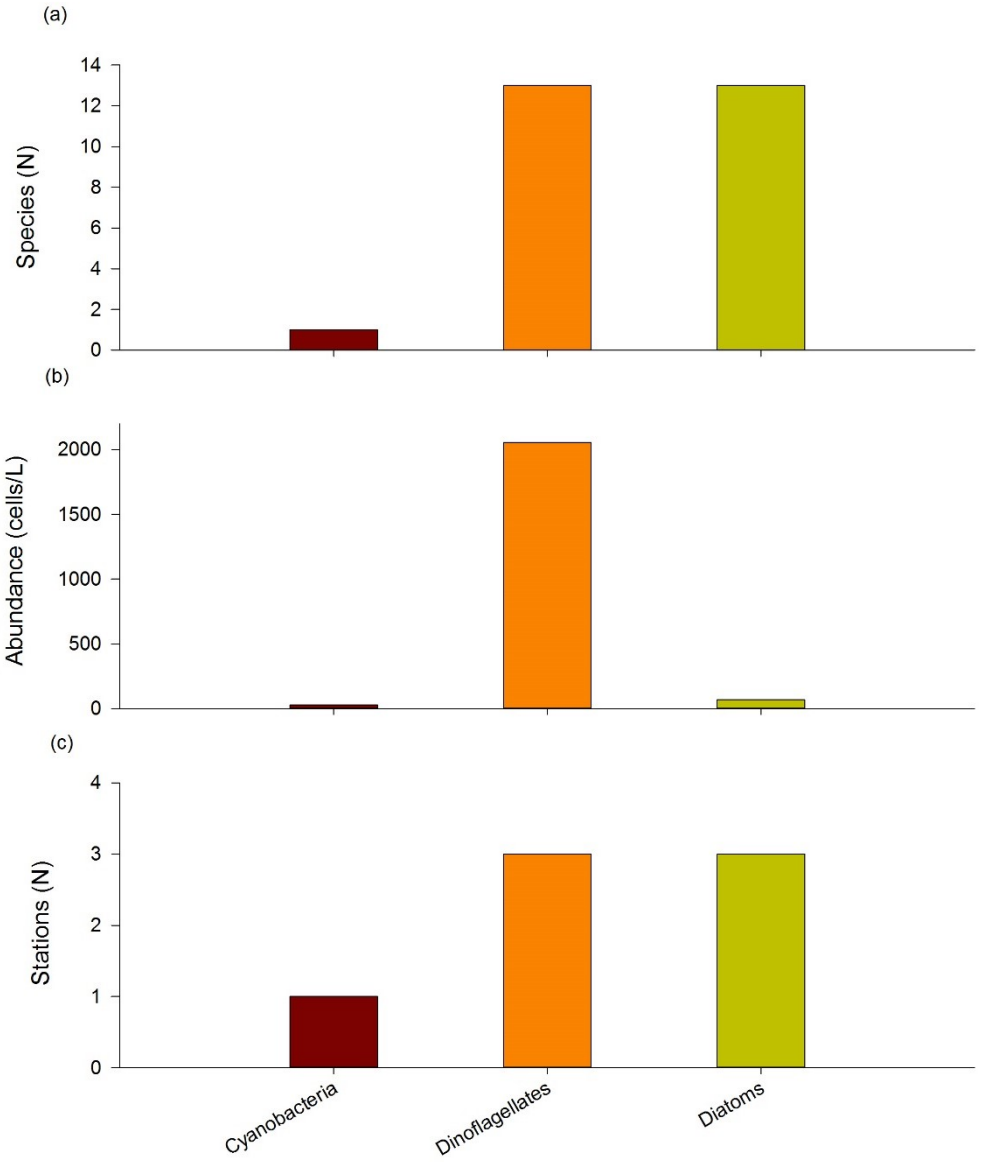

Figure 9-9: Total (a) number of phytoplankton species and (b) cells per litre of each major phyla collected in September 2018, and (c) the total number of sites (out of 3) at which species belonging to each major phyla were collected.

Winter (October – March)

A total of 94 cells per liter, representing 19 taxa, were found in the 3 samples collected during the Q4-2019 monitoring period. Only two phyla were observed during the recent survey. Dinoflagellates accounted for 69% of the abundance and 58% of all species collected (Figure 9-10a-b). Diatoms comprised 31% of the whole abundance and 42% of the species collected. Both dinoflagellates and diatoms were widely distributed and occurred at all three of the sampling sites (Figure 9-10c).

The bloom-forming dinoflagellate *Prorocentrum gracile* was the most abundant taxa found during the study. This tropical dinoflagellate represented 28% of the total phytoplankton abundance, and was found at all three samples sites. The dinoflagellate *Protoperidinium* sp. 1 was the next most abundant species and accounted for 14.7% of the total abundance. This armoured organism was also widely distributed, and was collected at all three sampling stations. Pennate diatoms were fairly abundant and accounted for 11.3% of the total abundance.

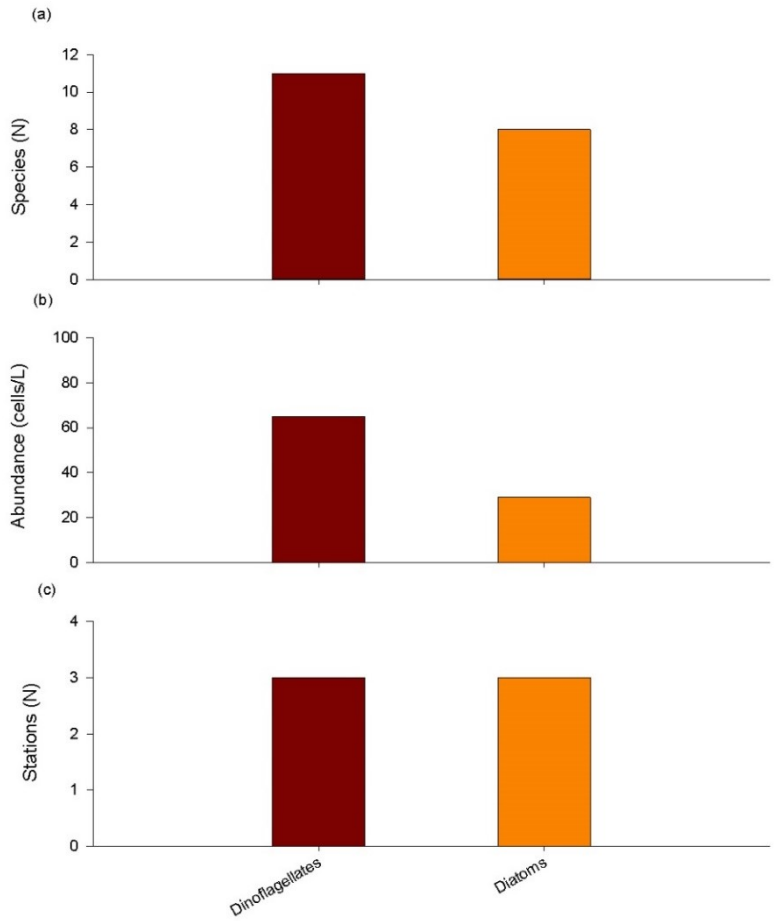

Figure 9-10: Total (a) number of phytoplankton species and (b) cells per litre of each major phyla collected in March 2019, and (c) the total number of sites (out of 3) at which species belonging to each major phyla were collected.

Temporal comparison of surveys

Total species richness among the three phytoplankton groups did not significantly differ between the two monitoring events (i.e. Event 0 and Event 1) with a standard deviation of 5.66 (Table 9-10). Phytoplankton abundance however, differed between years where total abundance significantly decreased from Event 0 (2,149 cells/L) to Event 1 (94 cells/L) (Table 9-11). This significant difference was due to the high abundance of the dinoflagellates *Prorocentrum gracile*, *Pyrodinium bahamense*, and *Gymnodinium* sp. during Event 0. Water temperature in the project area was warmer in Event 1 (34.3°C – 36.4°C) compared to the recent survey (20.7°C – 22.2°C), which may have influenced the phytoplankton abundance during that period. *Prorocentrum gracile* was also the most abundant species in the recent survey (Event 1).

Table 9-10: Phytoplankton species richness over two annual monitoring periods

Site	Event 0 Sept 2018	Event 1 Mar 2019	Standard Deviation
Cyanobacteria	1	0	0.71
Dinoflagellates	13	11	1.41
Diatoms	13	8	3.54
Total	**27**	**19**	**5.66**

Table 9-11: Phytoplankton abundance over two annual monitoring periods

Site	Event 0 Sept 2018	Event 1 Mar 2019	Standard Deviation
Cyanobacteria	25	0	18.01
Dinoflagellates	2057	65	1408.45
Diatoms	66	29	26.51
Total	**2149**	**94**	**1452.97**

9.5.2.4 Zooplankton

Zooplankton cover a diverse range of drifting planktonic animals, some of which spend their entire lives in the plankton (termed holoplankton) and some which are planktonic only in their larval stages (meroplankton).

Faunal Composition

Summer (April – September)

A total of 312 individuals per liter representing 23 taxa were found in the 3 samples collected during this study. Arthropods accounted for 61% of the individuals and 43% of all species collected (Figure 9-11a-b). The ciliates (Ciliophora) were the second most abundant group, which contributed to 26% of the total abundance and 35% of all species collected.

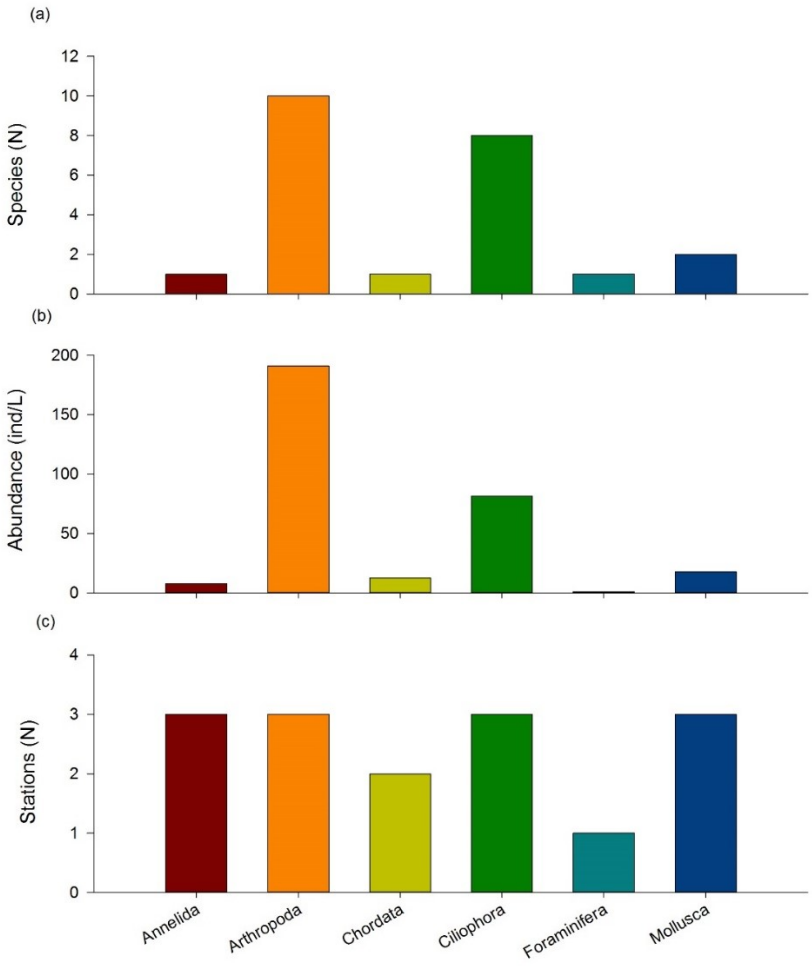

Figure 9-11: Total (a) number of zooplankton species and (b) individuals per litre of each major phyla collected in September 2018, and (c) the total number of sites (out of 3) at which species belonging to each major phyla were collected

Winter (October – March)

A total of 213 individuals per liter, representing 18 taxa, were found in the 3 samples collected during the Q4-2019 monitoring period. Arthropoda accounted for 51% of the abundance and 44% of all species collected (Figure 9-12a-b). Ciliophora was the next most abundant group, which accounted for 33% of the abundance and 33% of all species collected. Mollusca was moderately abundant, accounting for 10% of the abundance and 11% of all species collected. Other two groups representing 6% and 1% of the whole abundance were Chordata and Foraminifera, respectively. Arthropods and cilates were widely distributed and occurred at all three of the sampling sites (Figure 9-12c). Chordates and molluscs occurred in two sampling sites while forminiferans had much more restricted distribution and was found only at one sampled site.

The copepod *nauplii*, was the most abundant taxa found during the survey. This copepod larvae represented 47.2% of the total zooplankton abundance, and was found at all 3 (100%) of the sampling sites. The ciliate *Tintinnopsis gracilis* was the next most abundant species and accounted for 12.8% of the total abundance. It was also relatively common and was found at 2 (67%) of the sampling sites. The other species which contributed to less than 10% each of the total abundance were the molluscs *Limacina* sp., bivalve veliger, *Globigerina* sp. 1, the appendicularian *Oikopleura* sp. 1, the cilates *Metacylis pithos*, *Protorhabdonella* sp., *Favella ehrenbergii*, *Codonellopsis ostenfeldi*, the copepods *Corycaeus* sp., Calanoida 3, *Temora* sp.1, *Triconia minuta*, and the arthropods balanus nauplii, Mysidae 1, and Podonidae 1.

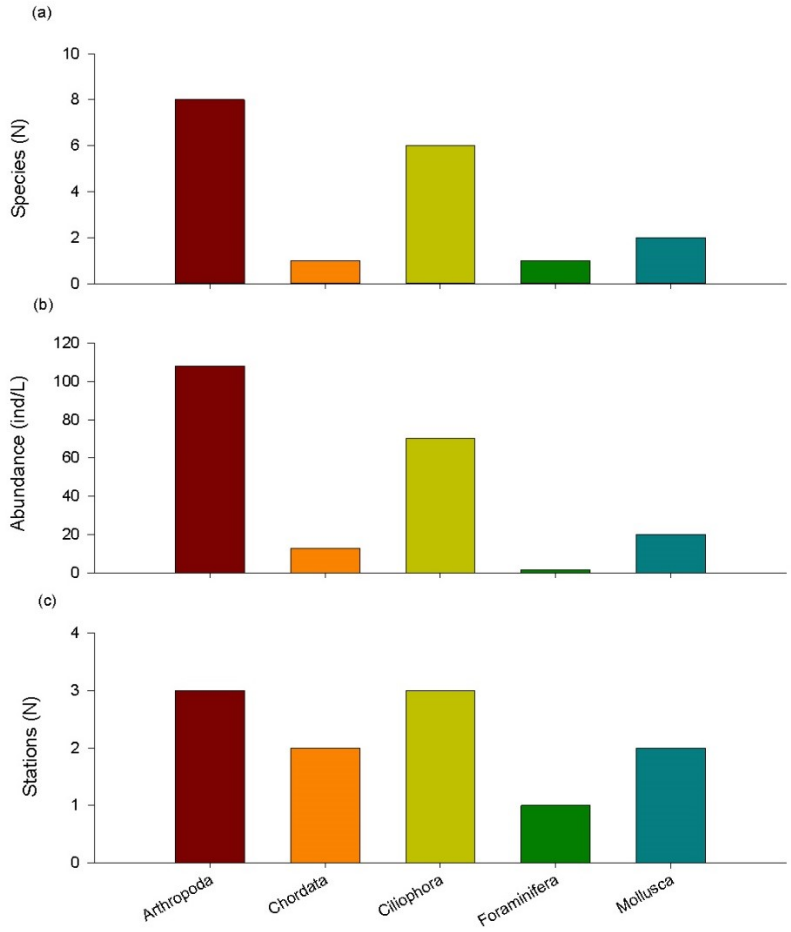

Figure 9-12: Total (a) number of phytoplankton species and (b) cells per litre of each major phyla collected in March 2019, and (c) the total number of sites (out of 3) at which species belonging to each major phyla were collected.

Source: (GHD, 2019a)

Temporal comparison of surveys

Total species richness among the six zooplankton groups did not significantly differ between the two monitoring events (i.e. Event 0 and Event 1) with a standard deviation of 3.54 (Table 9-12). Zooplankton abundance however, differed between years where total abundance slightly decreased from Event 0 (312 ind/L) to Event 1 (213 ind/L) (Table 9-13). The arthropod larvae, copepod nauplii, was the most abundant zooplankton observed in both monitoring events.

Table 9-12: Zooplankton species richness over two annual monitoring periods

Site	Event 0 Sept 2018	Event 1 Mar 2019	Standard Deviation
Annelida	1	0	0.71
Arthropoda	10	8	1.41
Chordata	1	1	0.00
Ciliophora	8	6	1.41
Foraminifera	1	1	0.00
Mollusca	2	2	0.00
Total	23	18	3.54

Source: (GHD, 2019a)

Table 9-13 Zooplankton abundance over two annual monitoring periods

Site	Event 0 Sept 2018	Event 1 Mar 2019	Standard Deviation
Annelida	8	0	5.55
Arthropoda	191	108	58.75
Chordata	12	13	0.30
Ciliophora	82	70	8.18
Foraminifera	1	2	0.60
Mollusca	18	20	1.73
Total	312	213	69.85

Source: (GHD, 2019a)

9.5.2.5 Habitat mapping

Habitat Cover

Epibiota comprise all plants and animals living on the surface of the seabed, either attached to the substrate itself or living freely upon it. These organisms provide structure and shelter, and act as an important source of food for many higher trophic groups, including fish, reptiles and cetaceans (Sheppard *et al*., 1992). The composition and distribution of the seafloor substrate plays a critical role in the distribution of sessile epibiota, as the chemical nature and structural stability of the seabed determine to a large degree which species groups can settle and develop viable populations. Water quality and circulation patterns also have a profound influence on the composition of the epibenthos through modifications in the transport and supply of food resources and new larval recruits (Snelgrove and Butman, 1994). As a consequence of the

dynamic physical nature of most shallow nearshore environments, the associated epibenthic communities are invariably patchy in distribution and constitute a mosaic of biotypes and habitats.

Video transects were undertaken at each of the 13 monitoring locations (Table 9-14). At each station, a single video transect of 200 m was recorded using a high definition 1080 p digital camera. The transects were run parallel to the shoreline in the northerly direction similar to the marine baseline assessment. The videos were analysed and used to detail the habitat map.

Table 9-14: Video transect locations and sampling dates

Station	Longitude	Latitude
S-02	242643.16	376650.12
S-06	242651.30	375126.98
S-07	243651.65	375125.37
S-09	241648.53	373628.07
S-10	242648.88	373626.46
S-11	243649.23	373624.84
S-13	241646.11	372127.54
S-14	242646.46	372125.93
S-15	243646.81	372124.32
S-17	241643.69	370627.01
S-18	242644.04	370625.40
C-N	238572.97	421770.92
C-S	248363.30	352850.98

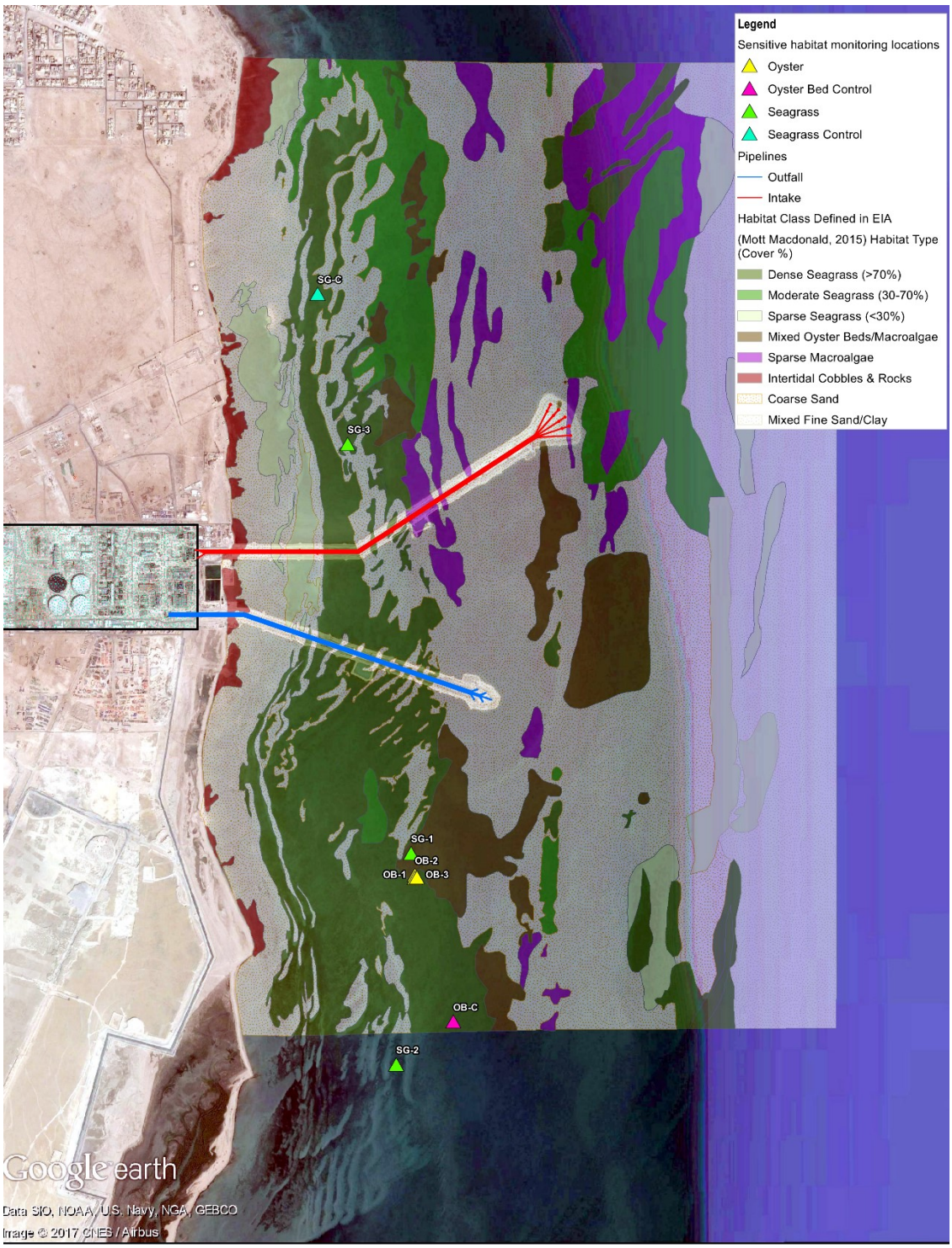

Figure 9-13: Monitoring stations for sensitive habitats (seagrass and oyster beds)

Summer (April – September)

The proportional coverages of each habitat type observed at each of the 13 Umm Al Houl monitoring stations during Event No.0 are summarised in Table 9-15. In addition, a summary map showing the proportional distribution of each habitat type during the Quarter 1 survey is provided in Figure 9-14.

During Event No. 0 bare, unconsolidated, sand was the most common habitat type represented across all sampling sites ($\overline{X}$ = 55.97% of total). Algae and seagrass covered in algae (seagrass

with algae) habitats occupied the remainder of the seafloor, and comprised 22.27% and 11.14% of the total coverage, respectively. A total of 8.51% was composed of seagrass that were not covered in algae. A small percentage of live coral habitat (0.25%) and oyster (0.09%) were also observed.

Seagrass habitats, including those covered with algae, were well distributed during the recent survey, and were represented at 54% (7 out of 13) of the sampling stations surveyed (Table 9-15). Notably, oyster habitat was observed at only one monitoring site (CS), while live coral habitat was observed at three stations (C-S, S-14, and S-18).

Table 9-15: Percentage (%) cover of 7 habitat classes identified during video surveys at 13 monitoring sites off Umm Al Houl IWPP

Survey	Station	Sand	Coral Rubble	Algae	Seagrass	Seagrass with algae	Oyster	Coral
Event 0 (Sept 2018)	CN	38.95%	0%	10.53%	21.05%	29.47%	0%	0%
	CS	19.32%	22.98%	54.52%	0%	0%	1.22%	1.96%
	S02	92.59%	0%	7.41%	0%	0%	0%	0%
	S06	97.11%	0%	2.89%	0%	0%	0%	0%
	S07	59.59%	0%	0%	40.41%	0%	0%	0%
	S09	85.44%	0%	0%	14.56%	0%	0%	0%
	S10	100.00%	0%	0%	0%	0%	0%	0%
	S11	49.10%	0%	44.70%	6.20%	0%	0%	0%
	S13	1.46%	0%	18.58%	15.24%	64.72%	0%	0%
	S14	80.74%	0%	18.21%	0%	0%	0%	1.05%
	S15	53.28%	0%	46.72%	0%	0%	0%	0%
	S17	49.36%	0%	0%	0%	50.64%	0%	0%
	S18	0.70%	0%	85.95%	13.11%	0%	0%	0.23%

Figure 9-14: Pie-charts showing the area coverages (%) of seven habitat classes at 13 monitoring site off Umm Al Houl IWPP

Note: The 2 control sites (C-N and C-S) are omitted as they lay >5 km north and south of the development site.

Winter (October – March)

The proportional coverages of each habitat type observed at each of the 13 Umm Al Houl monitoring stations during Event No. 1 are summarised in Table 9-15. In addition, a summary map showing the proportional distribution of each habitat type during the most recent survey (March 2019) is provided in Figure 9-15.

During Event No. 1 bare, unconsolidated, sand was the most common habitat type represented across all sampling sites ($\overline{X}$ = 58% of total). Seagrass and algae habitats occupied the remainder of the seafloor, and comprised 22.08% and 12.47% of the total coverage, respectively. Coral rubble and coral rubble with algae comprised a total of 6.38% of the total

coverage. A small percentage of live coral habitat (0.55%) and oyster (0.51%) were also observed.

Seagrass habitats were well distributed during the recent survey, and were represented at 46% (6 out of 13) of the sampling stations surveyed (Table 9-15). Notably, oyster habitat was observed at two monitoring sites (CN and S-18), while live coral habitat was observed at six stations (C-S, S-02, S-11, S-13, S-14, and S-18).

Table 9-16: Percentage (%) cover of 7 habitat classes identified during video surveys at 13 monitoring sites off Umm Al Houl IWPP

Survey	Station	Sand	Coral Rubble	Algae	Seagrass	Coral Rubble with Algae	Oyster	Coral
Event 1 (March 2019)	CN	27.42%	0%	8.31%	63.48%	0%	0.79%	0%
	CS	13.62%	18.09%	0.20%	0%	64.84%	0%	3.25%
	S02	98.99%	0%	0%	0%	0%	0%	1.01%
	S06	99.46%	0%	0.54%	0.00%	0%	0%	0%
	S07	41.87%	0%	0%	58.13%	0%	0%	0%
	S09	100%	0%	0%	0%	0%	0%	0%
	S10	100%	0%	0%	0%	0%	0%	0%
	S11	60.95%	0%	28.36%	10.20%	0%	0%	0.50%
	S13	4.90%	0%	41.57%	51.76%	0%	0%	1.76%
	S14	99.10%	0%	0.67%	0%	0%	0%	0.22%
	S15	89.20%	0%	10.80%	0%	0%	0%	0%
	S17	8.95%	0%	0%	91.05%	0%	0%	0%
	S18	9.61%	0%	71.62%	12.45%	0%	5.90%	0.44%

Spatial Patterns in Habitat

A summary map showing the proportional distribution of each habitat type at each epibenthic sampling station off Umm Al Houl is provided in Figure 9-15. This highlights the fact that only 15% (2/13) of the sites surveyed (i.e. S-09 and S-10) was bare and support no observable epibiota. Stations S-02, S-06, S-14 and S-15 were predominantly sand (>80%). Other stations surveyed (i.e. 77%, 10/13) were found to support sessile fauna and flora in contrasting densities and distributions. Notably, seagrass communities comprised 22.08% of the surveyed area and were most prevalent at stations CN, S-07, S-13 and S-17. Algae comprised 12.47% of the surveyed area and was prevalent at station S-18. In comparison, no clear spatial patterns are evident in the summary map for corals and oysters, due to their relative rarity and low density. Corals were encountered at six sites (C-S, S-02, S-11, S-13, S-14, and S-18), with coverages of 0.55%, while oysters were identified at two sites (CN and S-18) during this survey.

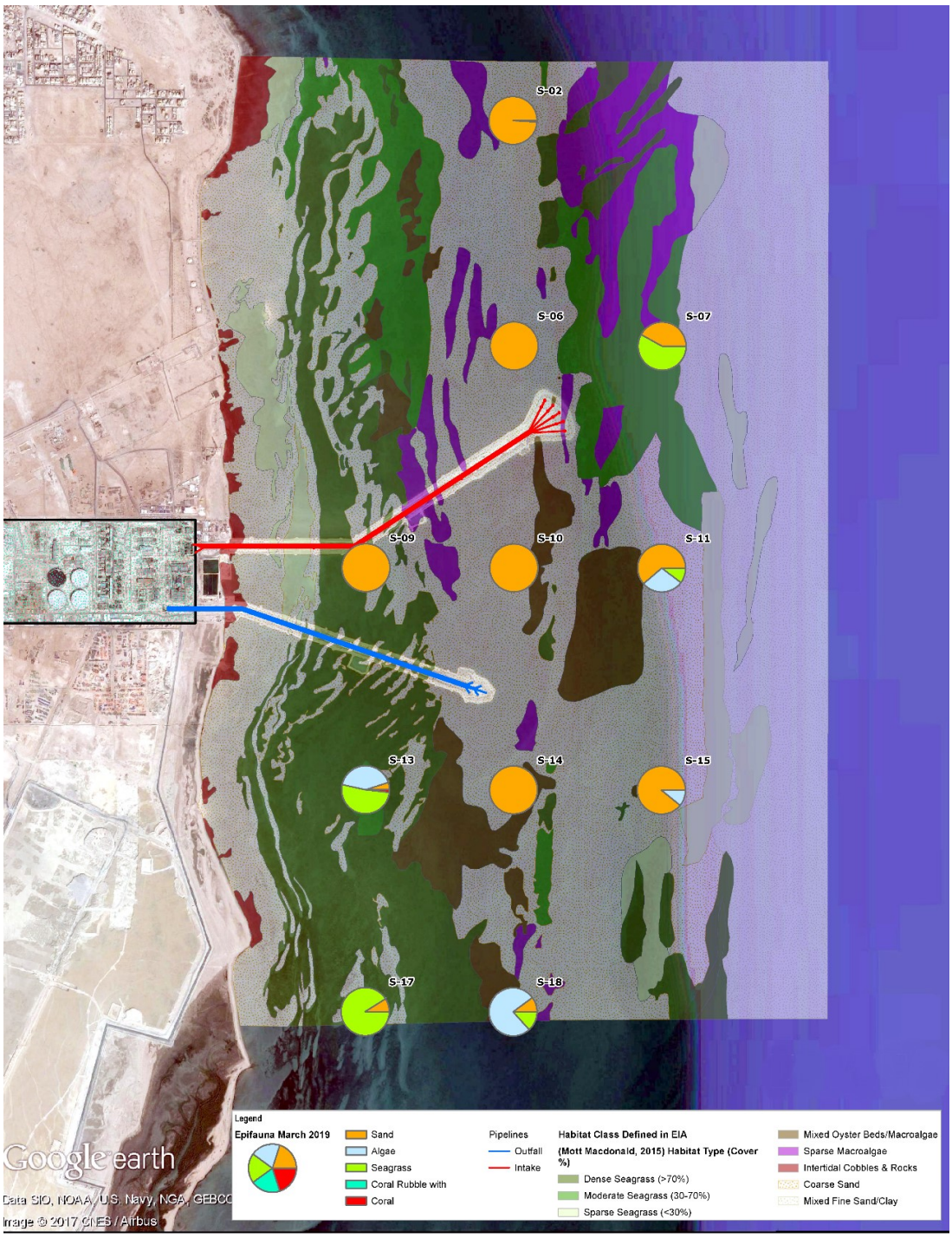

Figure 9-15: Pie-charts showing the area coverages (%) of seven habitat classes at 13 monitoring site off Umm Al Houl IWPP

Note: The 2 control sites (C-N and C-S) are omitted as they lay >5 km north and south of the development site.

Temporal comparison of surveys

While some differences are evident between surveys in the proportional representation of each habitat class at 13 monitoring sites (Table 9-17), most sites have retained similar characteristic over time. Notably, bare sandy substrates have been the principal bedforms at most sites in the study area, while seagrass and algae have been the dominant biotypes.

Since September 2018, overall coverages of seagrass have increased (12.40%) while algae has apparently decreased by -44.02%. Oysters increased from 0.1% in Event 0 to 0.5% in Event 1. Corals also increased from 0.2% in Event 0 to 0.6% in Event 1. These apparent differences between surveys are almost certainly a function of the naturally patchy nature of the seafloor habitats and the proportion of seafloor surveyed.

Table 9-17: Change in percentage cover of 7 habitat classes

Habitat	% Cover		% Δ Cover between Event 0 and Event 1
	Event 0 (Sept 2018)	Event 1 (Mar 2019)	
Sand	56.0	58.0	3.63%
Coral Rubble	1.8	6.4	260.82%
Algae	22.3	12.5	-44.02%
Seagrass	19.6	22.1	12.40%
Oyster	0.1	0.5	446.56%
Coral	0.2	0.6	121.56%

Source: (GHD, 2019a)

9.5.2.6 Sensitive habitats

Seagrass cover

Seagrass cover in the site consists of three species of seagrass (*Halodule uninervis, Halophila stipulacea,* and *Halophila ovalis*) (Figure 9-16). The following section will discuss the seasonsal abundance of these species. Four stations were designated for the monitoring of seagrass cover, height, and shoot density (Table 9-18 and Figure 9-13). Seagrass canopy height and shoot density was assessed in-situ by divers on 3-7 April 2019, while coverage was assessed using photo-quadrats reviewed in the laboratory. Statistical differences between sites were determined using a Kruskal-Wallis test, while a *post-hoc* Dunn's Multiple Comparison test was used to identify differences between groups.

Table 9-18: Coordinates of seagrass sampling stations

Point	Longitude	Latitude
SG-C	241299	375504
SG-1	241924	371754
SG-2	241825	370338
SG-3	241501	374497

Figure 9-16 Commonly occurring seagrasses of the Arabian Gulf: (a) *Halophila ovalis*, (b) *Halodule uninervis*, and (c) *Halophila stipulacea*

Source: (GHD, 2019a)

Summer (April – September)

The Kruskal-Wallis test confirmed that seagrass cover differed significantly between sites ($H_{(3,130)}$ = 48.022, p<0.05), with SG-2 (95.48%) and SG-3 (82.21%) having significantly higher seagrass coverage compared to SG-1 (44.09%) and SG-C (38.79%). A summary of the mean seagrass cover at each monitoring site is presented in Figure 9-17.

All three seagrass species were observed in SG-2, with *H. uninervis* comprising majority of the covered area (90.35% ± 4.31) in the station. *H. uninervis* was observed to be dominant in all sites, except for SG-1, where a larger percentage of seagrass species was identified to be *H. ovalis* (30.00% ± 6.91). Overall, *Halodule uninervis* covered 55.6% of the surveyed area, while *Halophila stipulacea* and *Halophila ovalis* were very sparse by comparison, covering only 1.3% and 7.7% of the surveyed area, respectively.

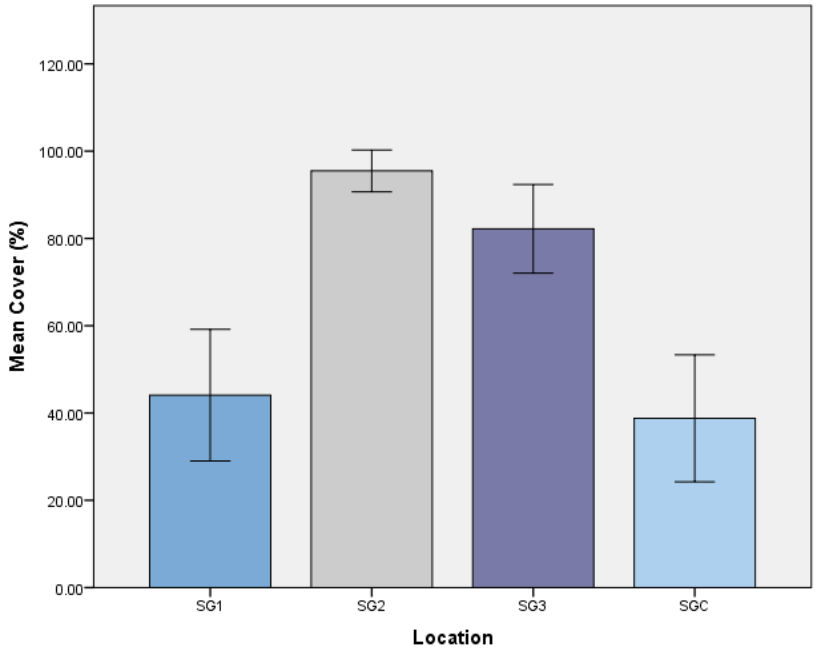

Figure 9-17: Mean percentage cover of seagrass (±0.05 se) recorded at each monitoring station in September 2018

Winter (October – March)

The Kruskal-Wallis test confirmed that seagrass cover differed significantly between sites ($H_{(3,132)}$ = 37.994, p<0.05), with SG-2 (84.33%) having significantly higher seagrass coverage compared to the rest of the sampling sites. A summary of the mean seagrass cover at each monitoring site is presented in Figure 9-18.

All three seagrass species were observed in all four stations (i.e. SG-1, SG-2, SG-3, and SG-C), with *H. uninervis* comprising majority of the covered area (24.94% ± 6.31, 80.39% ± 5.08, 69.58% ± 5.87, and 50.06% ± 6.66 respectively). *H. uninervis* was observed to be dominant in all sites. Overall, *Halodule uninervis* covered 56.24 % of the surveyed area, while *Halophila stipulacea* and *Halophila ovalis* were very sparse by comparison, covering only 1.14% and 0.70% of the surveyed area, respectively.

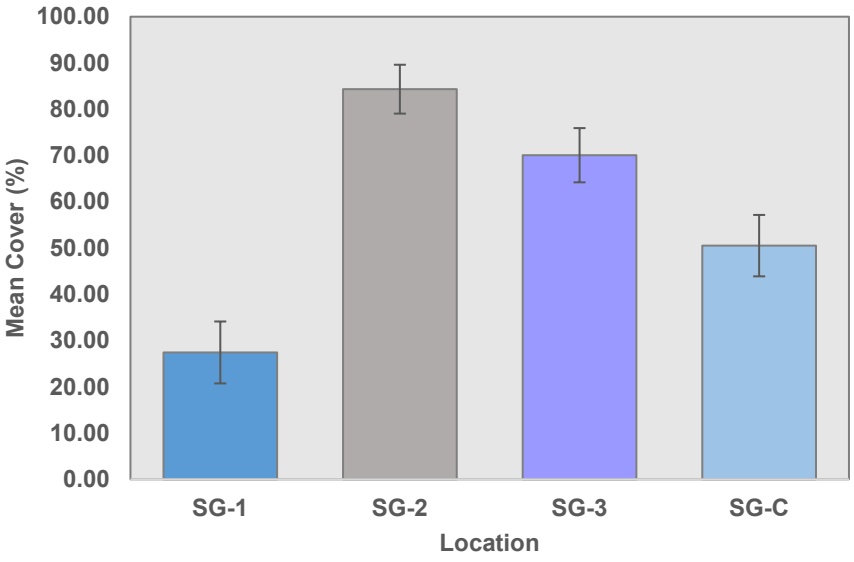

Figure 9-18: Mean percentage cover of seagrass (±0.05 se) recorded at each monitoring station in March 2019

Spatial and Temporal Analysis

Spatial and temporal differences in seagrass cover, height, and density were examined using the Kruskal-Wallis Test (or the One-Way ANOVA on Ranks). This test produces a significance level (otherwise known as a p-value), which when less than 0.05 ($p<0.05$) shows that there is a significant difference between sites or events. Statistically different sites and dates were sorted and grouped together using Dunn's Multiple Comparison Test.

Based on the statistical analysis, there is not any significant difference in seagrass cover, height, and shoot density since the commencement of operational monitoring in-2018 (Table 9-19).

Table 9-19: Temporal patterns in seagrass assessment

Parameter	Q3-2018	Q4-2018	Q1-2019	Q2-2019	*H*	*Sig. (p)*
Seagrass Cover (%)	65.14	64.72	58.08	59.00	0.331	0.954
Canopy Height (cm)	3.62	2.83	2.64	3.05	1.125	0.771
Shoot Density (shoots/0.0025 sq.m.)	3.48	3.52	3.28	2.68	1.845	0.605

Note: Parameters with significant differences ($p<0.05$) between sampling events have significance values highlighted in bold). Cells highlighted in blue are significantly different compared to other sampling events.

Oyster

Bivalves and other benthic organisms have been used in monitoring programmes as bioindicators to assess marine environment health. Bivalves such as the pearl oyster, *Pinctada radiata*, is one of such species (Al-Madfa et at., 1998). However, in the Arabian Gulf, these pearl oysters are also part of the fishing industry which have existed for years and has been part of their culture.

Similar to the seagrass survey, monitoring was conducted along a fixed 50-m transect line, with a 50 by 50 cm quadrat placed next to the transect tape at regular intervals of 10 m. In the recent monitoring (Q2 – June 2019), three 10m^2 transects were placed south of the outfall (OB-1, OB-2 and OB-3) and a control site further south (OB-C) (Figure 9-13).

Results and discussion

The control station (OB-C) consistantly recorded the highest abundance of oysters (*Pinctada* sp.) (218/10m^2), throughout the operational monitoring period. This was followed by station OB-3 with 49/10m^2. Stations OB-1, OB-2 and OB-3 were characterized as predominantly covered in sand and rubble with a few algae (Figure 9-15).

Table 9-20 shows the comparison of pearl oyster abundance in the four sampling stations from the 2018 and 2019 surveys (September 2018, November 2018, March 2019 and June 2019) and represents the overall abundance for oysters at each location. Total abundance appeared to reduce during the winter months October – March (Q4- Q1) before almost reappearing in full numbers in Q2. The overall steadiness of oyster presence was buoyed largely by the large increase at the control location.

Stations OB-1, OB-2 and OB-3 had relatively low declines in oyster abundance with 8%, 9% and 4% change, respectively. The control station, OB-C recorded an increase in abundance from 170 ind/10m^2 to 218 ind/10m^2. As expected, Station OB-C as the control station, had the highest pearl oyster abundance in both the 2018 and 2019 surveys. Another important observation in the recent monitoring (June 2019) was the high abundance of oyster larvae found among the macro algae in station OB-3 and seagrass in station OB-C (Figure 9-20).

Table 9-20: Abundance (individuals/10m2) of pearl oysters recorded in four monitoring transects during Q4-2018 and Q1-2019

Station	Q3-2018 (Sep)	Q4-2018 (Nov)	Q1-2019 (Mar)	Q2-2019 (Jun)	% Change (Q1-2019 vs Q2-2019)
OB-1	41	37	24	16	- 8%
OB-2	34	39	33	24	- 9%
OB-3	38	74	53	49	- 4%
OB-C	198	148	170	218	+ 48%
Total	**311**	**298**	**280**	**307**	**+ 27%**

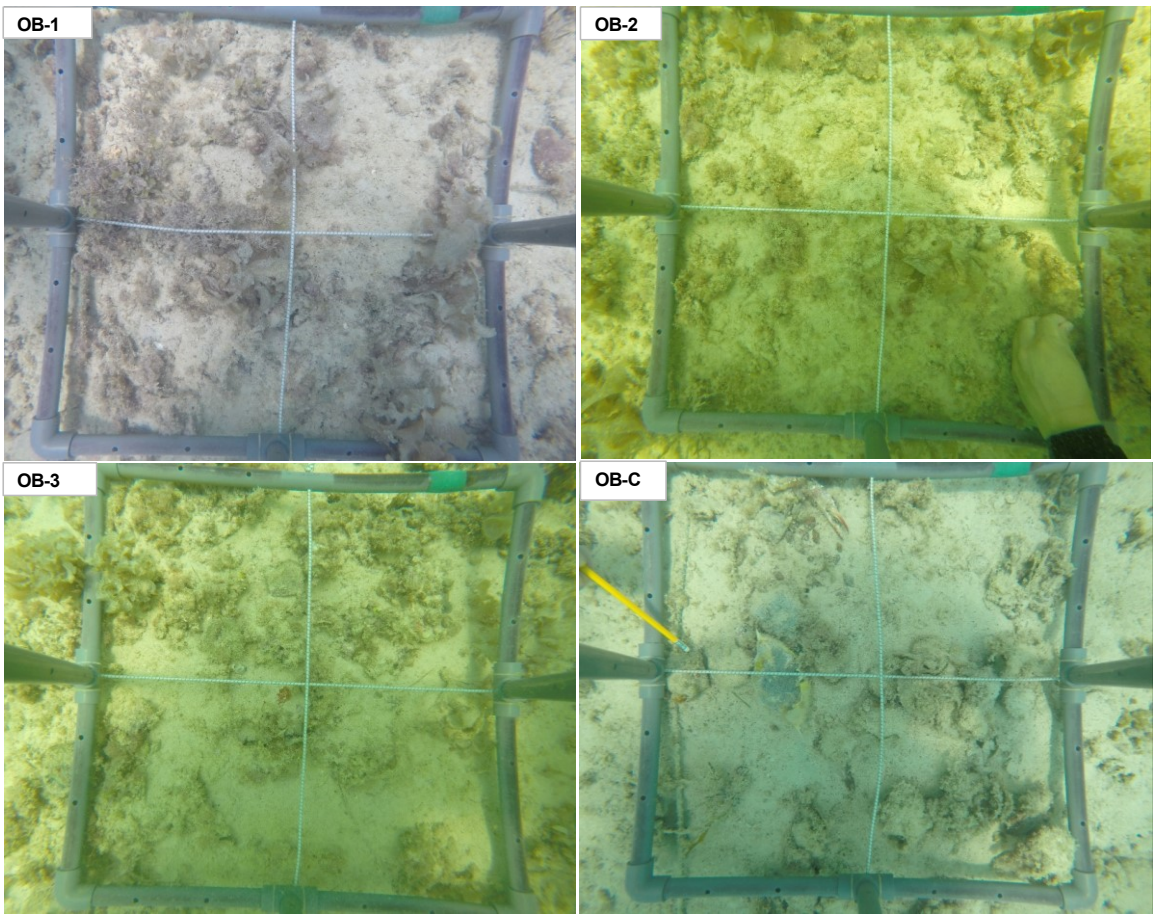

Figure 9-19: Habitat characteristics of the four oyster beds monitoring stations

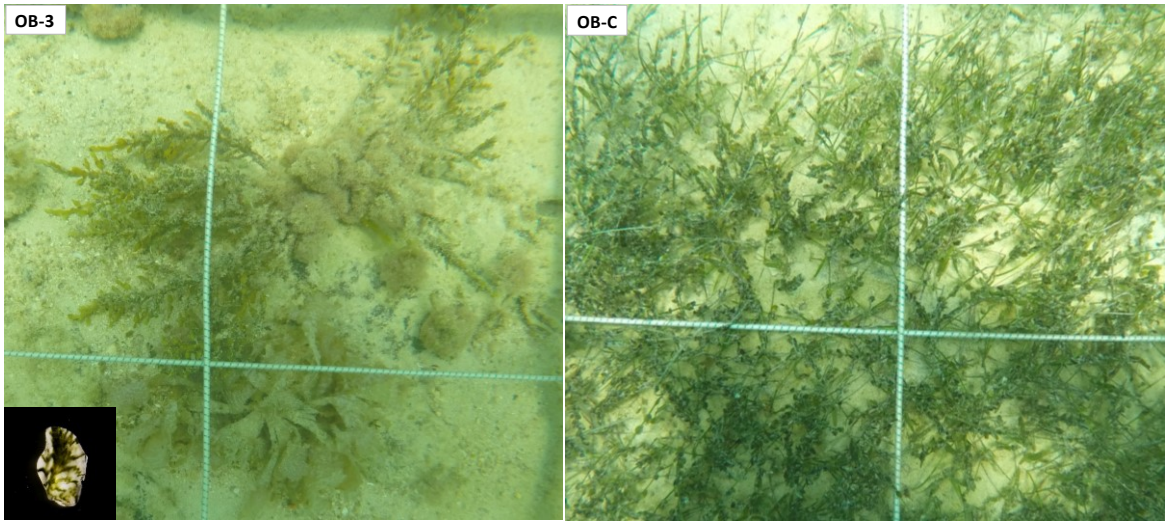

Figure 9-20: Oyster larvae (dark green spots) observed in stations OB-3 and OB-C. (Inset photo: microscopic image of oyster larvae)

The increase (OB-C) and decrease (OB-1, OB-2 and OB-3) in abundance of pearl oysters observed across all stations monitored this period compared to the previous quarter may be a result of the seabed conditions and may not necessarily be an indication of a loss or gain in the number of pearl oysters present. Recurrent underwater disturbances, i.e. motion of sediment/sand waves in and out of the oysterbeds, may either conceal or reveal oysters that are visible during the conduct of the monitoring survey. *Pinctada radiata* has also been studied to show that female gonads mature from February to April before spawning during summer (Karami et al., 2014) and that rising water temperature triggers the onset of reproduction

(Derbali et al., 2009). Thus, seasonal reproductive patterns also contribute to oyster abundance as observed during the recent monitoring period where high abundance of oyster larvae were recorded.

9.5.2.7 Entrainment

Visual monitoring and assessment of the trash baskets at the intake screens will be undertaken during IWPP operations. UHPC field staff, with monthly visits from GHD staff, regularly assessed the contents of the trash baskets prior to disposal. Documentation and assessment included the following monitoring parameters:

- Number, type and species of adult species entrained
- Total biomass weight of each trash basket

Total weight and number of buckets collected throughout the monitoring program is presented in Table 9-21. Total weight collected throughout the complete monitoring period was 32 301 kg. An average weight of 735.9 kg per month was. The bulk of the weight mainly comprised of seagrass, macroinvertebrates and macroalgae (Figure 9-21).

Table 9-21: Number of buckets and weight collected from the entrainment baskets during day and night monitoring in throughout the monitoring period

Month	No. of buckets	Weight (kg)
September	588	2 030
October	3 727	8 340
November	826	2 218
December	136	637
January	111	756
February	168	1 256
March	465	3 644
April	486	5 210
May	77	2 439
June	775	5 771
Total	7 359	32 301

Source: (GHD, 2019a)

Figure 9-21: A mixture of seagrass and macroalgae

Source: (GHD, 2019a)

Figure 9-22: A mixture of seagrass and macroalgae

Source: (GHD, 2019a)

9.5.2.8 Seabed temperature

Shallow waters often have strong seasonal variations in bottom water temperature. Changes in seabed temperature are partly controlled by the diffusive heat flow exchange with the water column and deep layers of sediment.

Seabed temperature was assessed at 10 locations proximate to the Umm Al Houl IWPP (Figure 9-23). Continuous monitoring was conducted at all 10 locations through the measurement of seabed temperatures at 30-minute intervals from 01 April 2019 to 30 June 2019.

Table 9-22: Coordinates of seabed temperature monitoring stations

Location ID	Coordinates (QND95)
Intake	242961 E 374679 N
Outfall	242459 E 372784 N
OB-1	241964 E 371592 N
OB-C	242208 E 370626 N
S-07	243652 E 375125 N
S-09	241649 E 373628 N
S-13	241646 E 372128 N
S-14	242646 E 372126 N
S-17	241644 E 370627 N
S-18	242644 E 370625 N

Note: All coordinates are in Qatar National Datum.
HOBO loggers were reported to be damaged at OB-C and missing at S-13 for this Q2 2019 period.

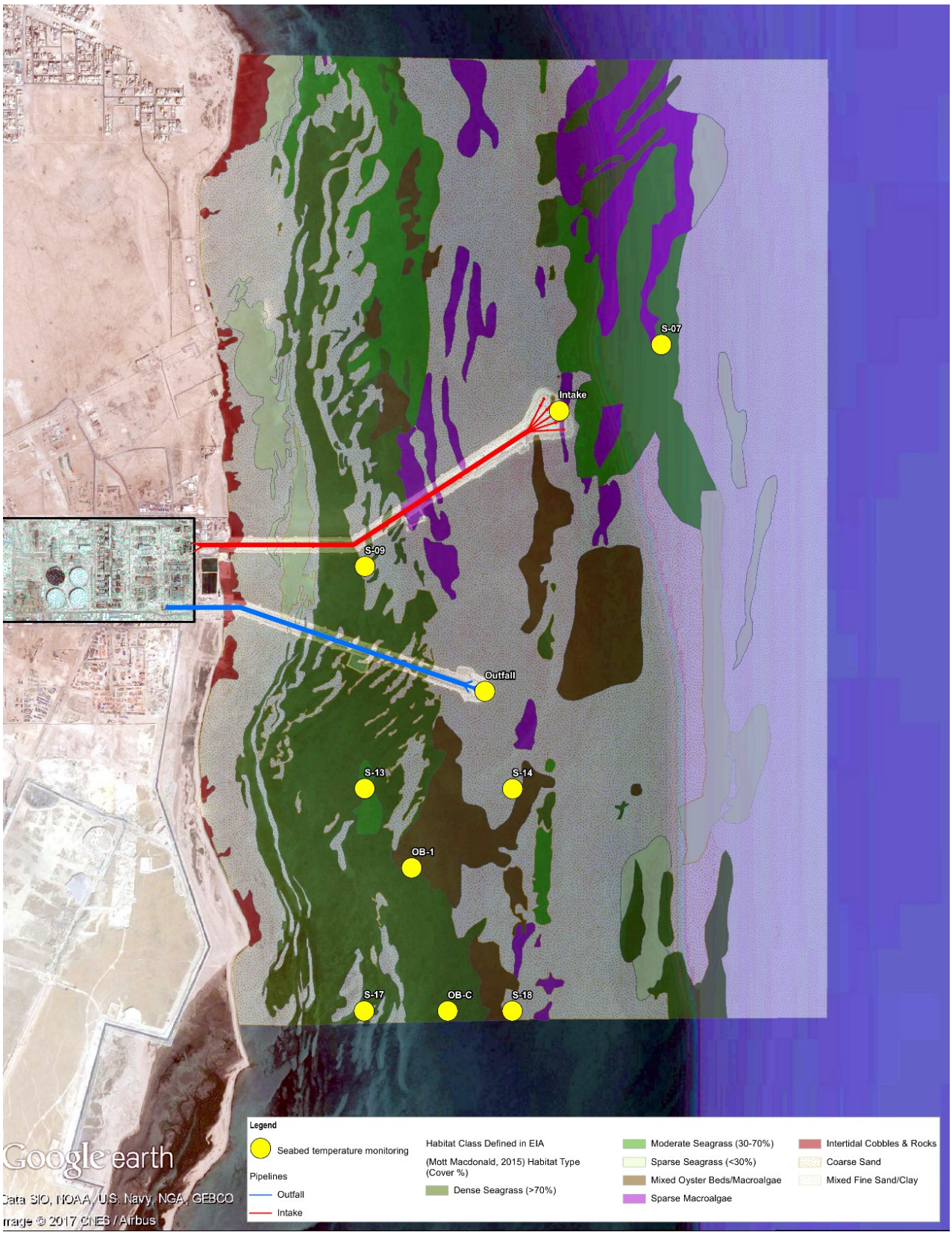

Figure 9-23: Seabed temperature monitoring stations

Seabed temperatures for Q2-2019 were generally higher compared to Q4-2018 and Q1-2019 due to the natural trend of higher temperatures during the transition from spring to summer season. Figure 9-24 and Table 9-23 presents the means of seabed temperature readings at all 10 locations from Q3-2018 to Q2-2019. The fluctuation of seabed temperatures throughout the monitoring program, follows the natural variation of seabed conditions that are expected annually in the gulf.

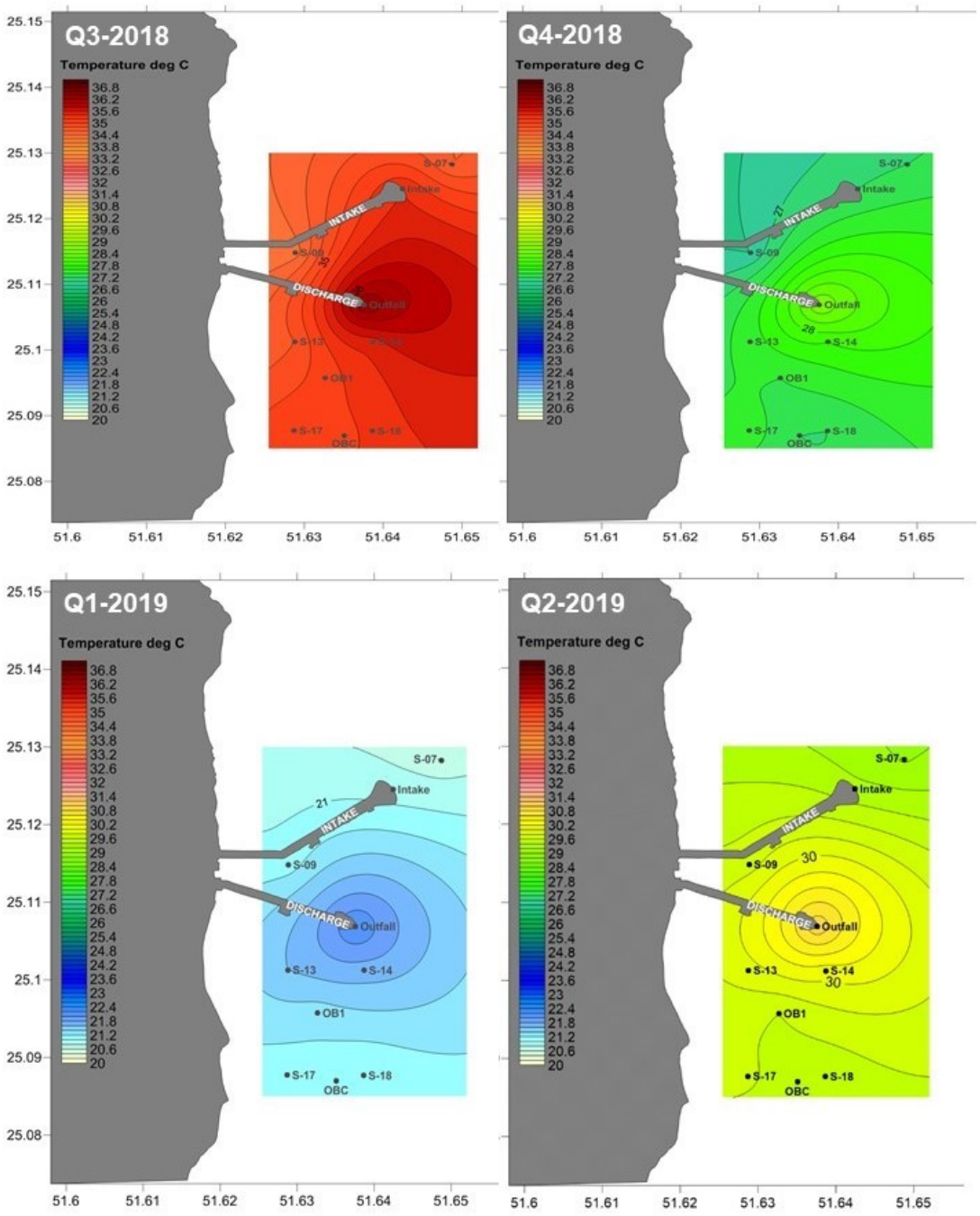

Figure 9-24: Comparison of quarterly averages of seabed temperatures in Umm Al Houl

Table 9-23: Monthly means of seabed temperatures (ºC) in Umm Al Houl

Month	Intake	Outfall	S-07	S-09	S-13	S-14	S-17	S-18	OB-C	OB-1
Sept-18	35.4	36.4	34.6	34.3	34.8	35.5	35.2	35.3	35.1	35.1
Q3-2018	***35.4***	***36.4***	***34.6***	***34.3***	***34.8***	***35.5***	***35.2***	***35.3***	***35.1***	***35.1***
Oct-18	32.1	33.3	32.2	31.3	32.2	32.8	31.9	32.2	32.2	32.4
Nov-18	26.2	27.6	26.2	25.7	26.7	26.9	26.8	26.2	26.2	26.4
Dec-18	23.1	24.9	23.1	23.3	23.6	23.9	*	23.2	23.2	23.3
Q4-2018	***27.2***	***28.6***	***27.2***	***26.8***	***27.5***	***27.8***	***29.8***	***27.2***	***27.2***	***27.4***
Jan-19	20.8	22.0	20.7	20.6	21.4	21.6	20.8	20.9	21.0	21.1
Feb-19	20.3	21.6	20.2	20.6	21.0	21.1	20.7	20.5	20.6	20.8
Mar-19	21.5	23.0	21.3	22.1	22.3	22.5	21.9	21.6	21.8	22.0
Q1-2019	***20.9***	***22.2***	***20.7***	***21.1***	***21.6***	***21.7***	***21.1***	***21.0***	***21.1***	***21.3***
Apr-19	25.0	26.5	24.8	25.4	**	25.9	25.5	25.2	**	25.4
May-19	29.3	31.3	28.9	30.2	**	30.3	30.0	29.6	**	29.8
Jun-19	33.4	35.0	33.3	33.5	**	34.1	33.4	33.6	**	33.6
Q2-2019	***29.3***	***31.0***	***29.0***	***29.7***	**	***30.1***	***29.6***	***29.5***	**	***29.6***

9.5.2.9 Seawater quality

The traditional approach to assessing water quality allows for an identification of contamination sources through comparison of parameters with a local normative or given. The monitoring of organic and inorganic substances dissolved in a body of water are usually monitored for spatial and temporal variations to make appropriate comments on the quality of a specific water body.

Water quality was assessed at 12 coastal sampling sites adjacent to Umm Al Houl IWPP (Table 9-24 and Figure 9-25). This study involved in-situ measurements of five key physicochemical parameters (temperature, salinity, dissolved oxygen, pH and turbidity) and various analytical parameters (inorganics, anions, metals, hydrocarbons, PCBs). These parameters were evaluated for compliance against the Qatar National Standards for Seawater Quality when available.

The following section summarises the water quality results for the entire duration of the monitoring program. This captures a complete 12-month window and outlines any seasonal variability or shifts in the local marine environment and compares the results to national standards.

The monitoring of these physicochemical seawater quality parameters were measured *in-situ* on the following dates:

- 3 September 2018 (Q3-2018)
- 7 November 2018 (Q4-2018)
- 29 January–13 March (Q1-2019)
- 20 May 2019 (Q2-2019)

Table 9-24: Coordinates of water quality sampling locations

Point	Longitude	Latitude
S-06	242651.30	375126.98
S-07	243651.65	375125.37
S-09	241648.53	373628.07
S-10	242648.88	373626.46
S-11	243649.23	373624.84
S-13	241646.11	372127.54
S-14	242646.46	372125.93
S-15	243646.81	372124.32
S-17	241643.69	370627.01
S-18	242644.04	370625.40
Intake	242961.00	374679.00
Outfall	242459.00	372784.00

All coordinates are in Qatar National Datum

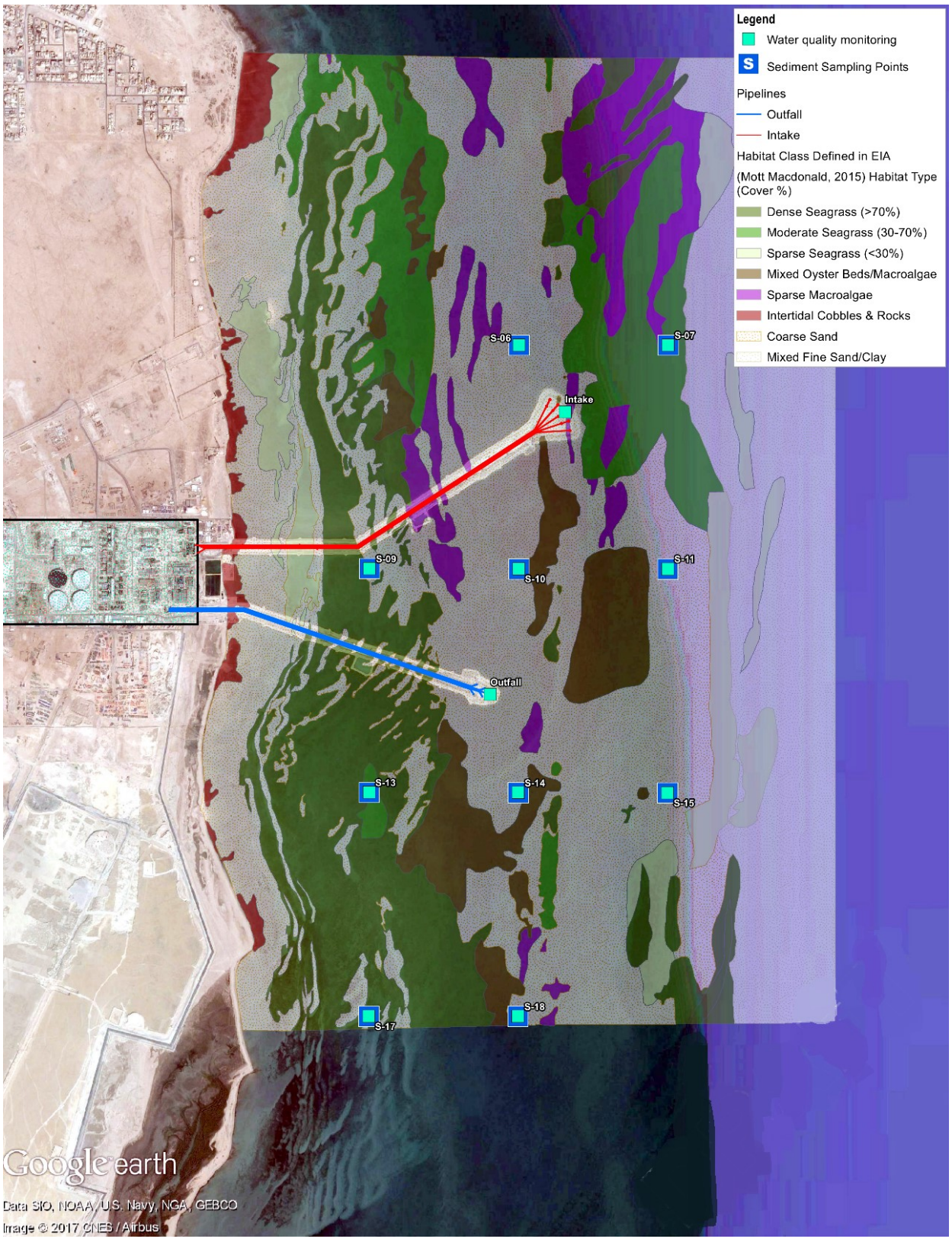

Figure 9-25: Coastal Sampling locations

Temperature

Water temperatures throughout the monitoring program where highest during the Q1 – 2018 and Q4-2019 period. The Q1 – 2019 monitoring period recorded the lowest consistent seawater temperatures throughout the entire monitoring event (Figure 9-26). The average temperatures recorded during the Q1-2019 period, were at least 10°C lower than those recorded during Q3-2018, showing a distinct seasonal variability in the average water temperatures in the region.

Water temperatures were higher in Q3-2018 (>30°C) and lower in Q4-2018 (<30°C) and Q1-2019 (<22°C) compared to Q2-2019. The results were consistent with the natural trend of increasing temperatures during the transition from spring to summer. While no national guidelines are available for assessing water temperature, it is evident that these surface temperatures were consistent with temperatures during the transition of seasons in Qatar.

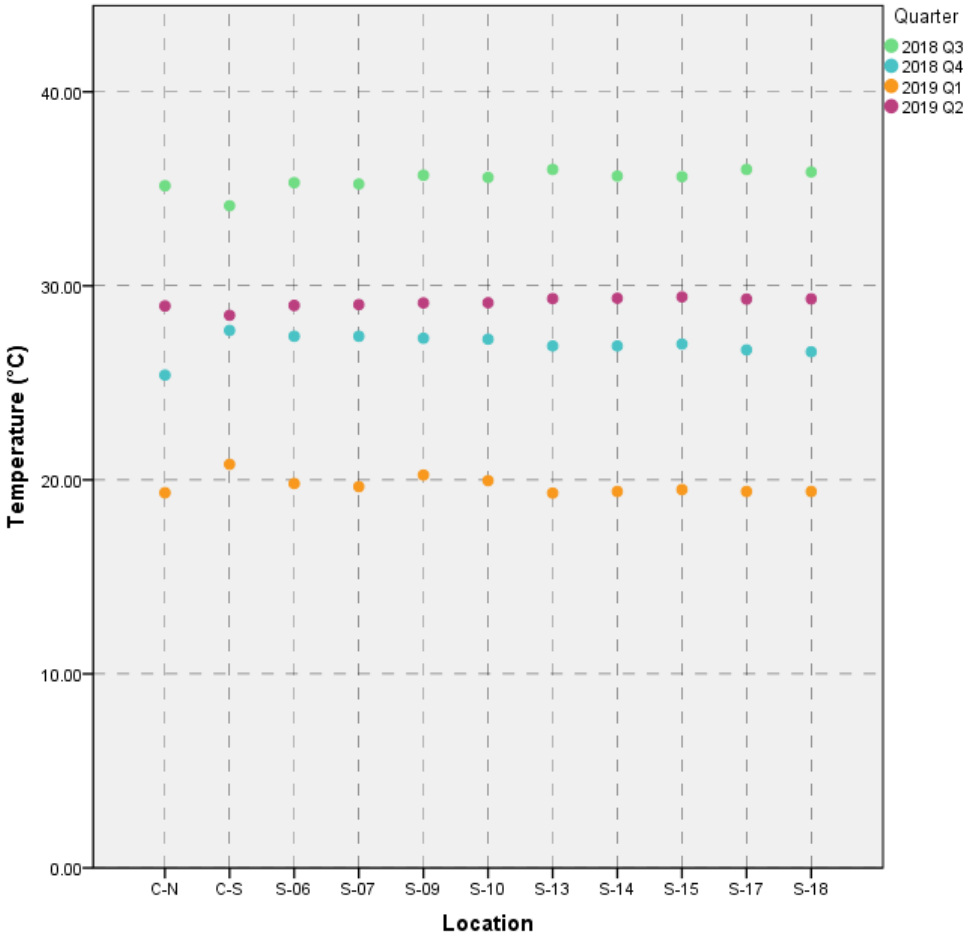

Figure 9-26: Mean water temperature - Q3-2018 (September) to Q2-2019 (May)

Dissolved Oxygen

Surface dissolved oxygen concentrations during the Q2-2019 sampling event ranged from a minimum of 5.28 mg/L (S-06) to a maximum of 5.99 mg/L (S-15) (Figure 9-27). All DO measurements for Q2-2019 were above the Qatar National Standard for Seawater minimum concentration (4 mg/L) and, hence, were indicative of well-oxygenated water.

Dissolved oxygen in Q2-2019 was relatively comparable to the range of values in Q3-2019, which was lower than the other two monitoring periods. DO levels may be affected by a number of variables such as aeration due to meteorological conditions and the metabolism of plants and microorganisms in the water column. The overall trend in Figure 9-27, indicates higher levels of dissolved oxygen in the “cooler” months of the year. This is consistent with biological processes within the marine environment. Biological activity from microorganisms is accelerated with warmer temperatures, and this activity is known to deplete oxygen levels from local marine environments.

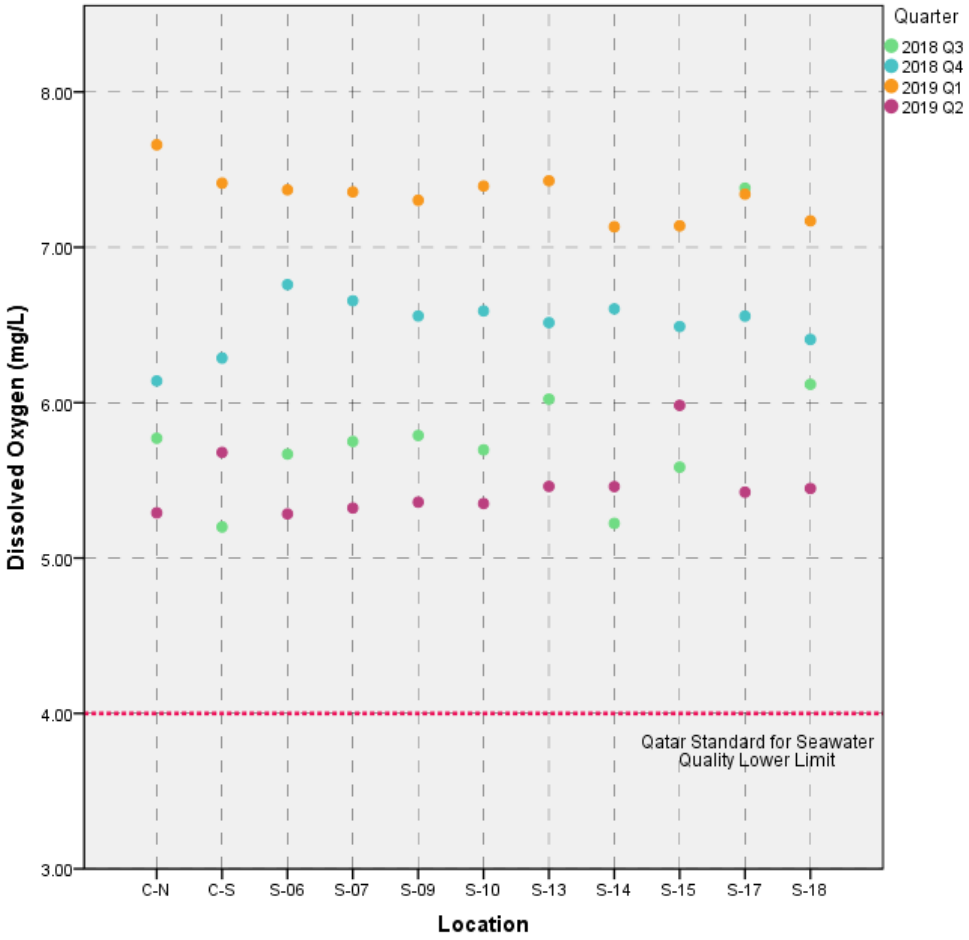

Figure 9-27: Mean dissolved oxygen - Q3-2018 (September) to Q2-2019 (May)

Specific conductivity

Specific conductivity during the Q2-2019 sampling period ranged from a minimum of 68.396 mS/cm (C-S) to a maximum of 70.047 mS/cm (S-15) (Figure 9-28). The average specific conductivity during this period measured 69.093 mS/cm. There are no national guidelines available for assessing specific conductivity.

Specific conductivity levels measured in Q2-2019 were relatively comparable to values from Q1-2019. Both monitoring periods have higher specific conductivity levels compared to the rest of the sampling periods from the last two quarters of the previous year.

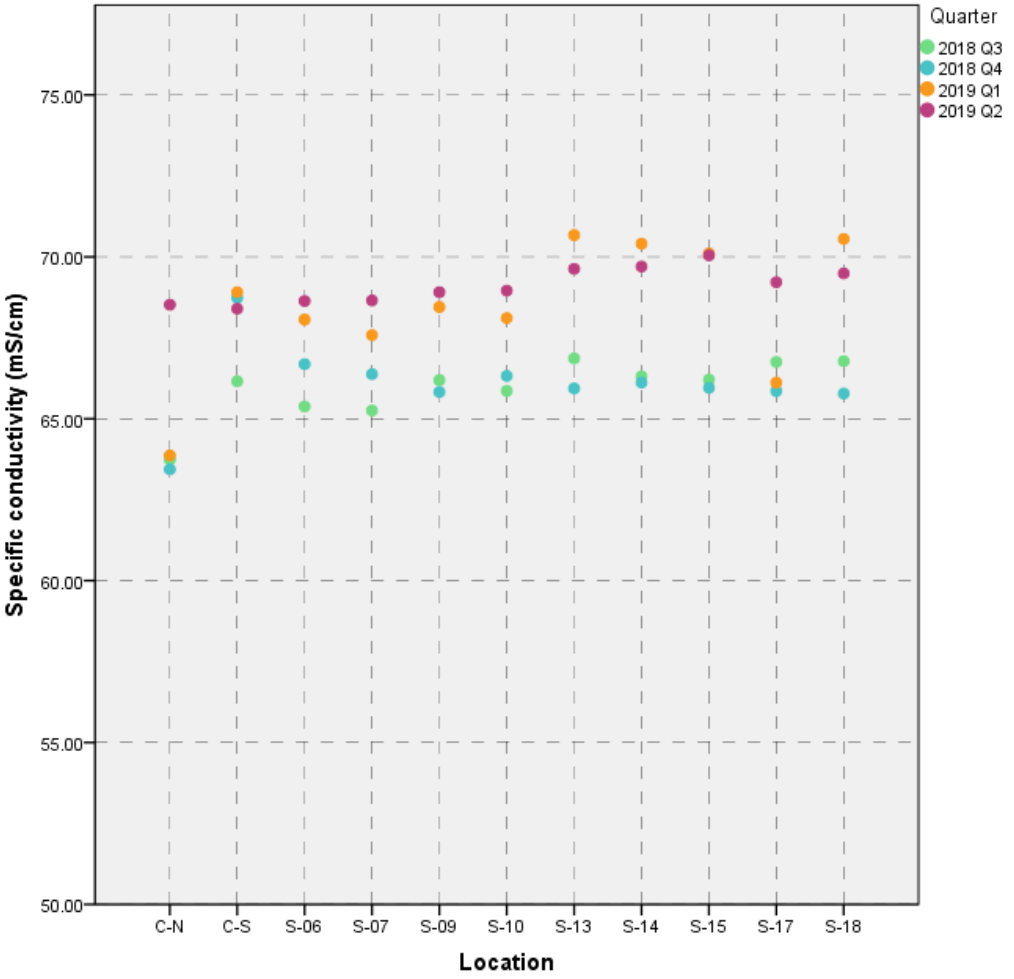

Figure 9-28: Mean specific conductivity - Q3-2018 (September) to Q2-2019 (May 2019)

Salinity

Salinity concentrations during the Q2-2019 sampling event ranged from a minimum of 46.57 PSU (C-S) to a maximum of 48.69 PSU (S-15) (Figure 9-29). All stations exceeded the Qatar National Standard Upper Limit of 45 PSU. It is noteworthy to mention however that salinity levels during the 2015 EIA baseline survey recorded a minimum of 46.25 PSU to a maximum of 49.22 PSU, with an overall mean of 46.88 PSU (Mott Macdonald, 2015). In this case, the recorded “exceedances” are still within the baseline range and the elevated salinity levels are expected off the coast of Umm Al Houl.

Salinity levels this monitoring quarter were comparable to 2019 Q1 concentrations, but generally higher compared to the previous two monitoring periods. This may be due to various factors which might include, but is not limited to, temperature differences induced by seasonality.

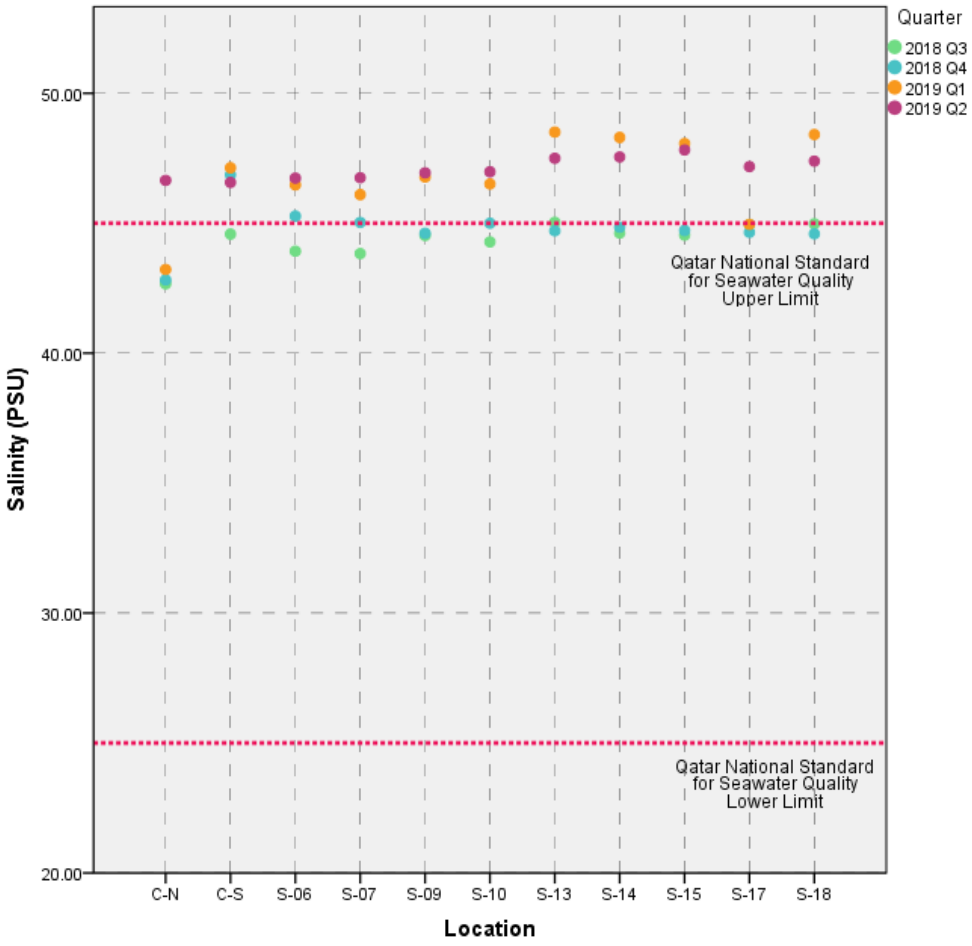

Figure 9-29: Mean salinity - Q3-2018 (September) to Q2-2019 (May)

pH

The pH of surface waters during the Q1-2019 sampling event ranged from a minimum of 8.17 units (C-S) to a maximum of 8.79 units (S10) (Figure 9-30). It was observed that both control stations (C-N and C-S) had lower pH levels compared to the rest of the sampling sites. Apart from C-N and C-S, which were within the Qatar National limits, all pH measurements were above the upper limit of the Qatar National Standard for Seawater Quality. Despite these exceedances, pH levels off the coast of Umm Al Houl have historically been marginally higher than the average Qatar seawater pH. Average pH recorded during a previous sampling event in February 2018 was at 8.64 units, while a maximum pH level of 8.34 was already recorded during the 2015 EIA baseline survey.

As for temporal variation, it was observed that Q1-2019 readings were generally higher than the Q3-2018 and Q4-2018 readings except for C-N and C-S where there was a decrease in pH compared to the previous quarter.

The data for pH of surface waters during the Q2-2019 sampling event was *not processed* due to malfunctioning of the pH meter that was subsequently sent for repair.

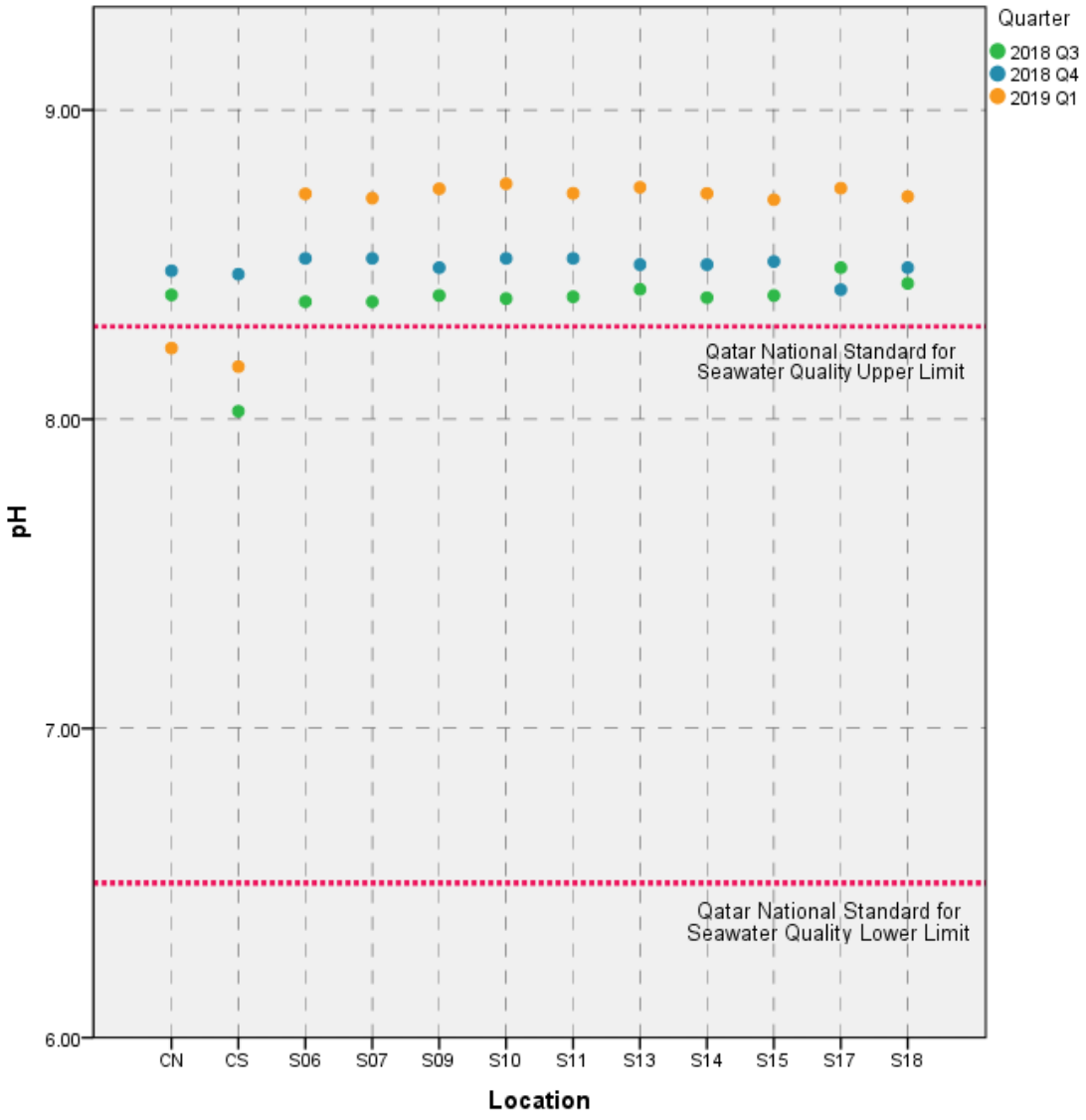

Figure 9-30: Mean pH recorded at 12 sampling sites from Q3-2018 (September) to Q1-2019 (March)

Turbidity

Measurements of turbidity during the Q2-2019 sampling event ranged from a minimum of 0.2 NTU (C-S) to a maximum of 4.7 NTU (S-15) (Figure 9-31). Increases in turbidity within the marine environment can be attributed to extreme weather events, increases in biological activity and human activities which may create sediments to suspend in waters.

There are no Qatar National Standards for turbidity. No specific temporal or spatial trends or patterns were observed for turbidity.

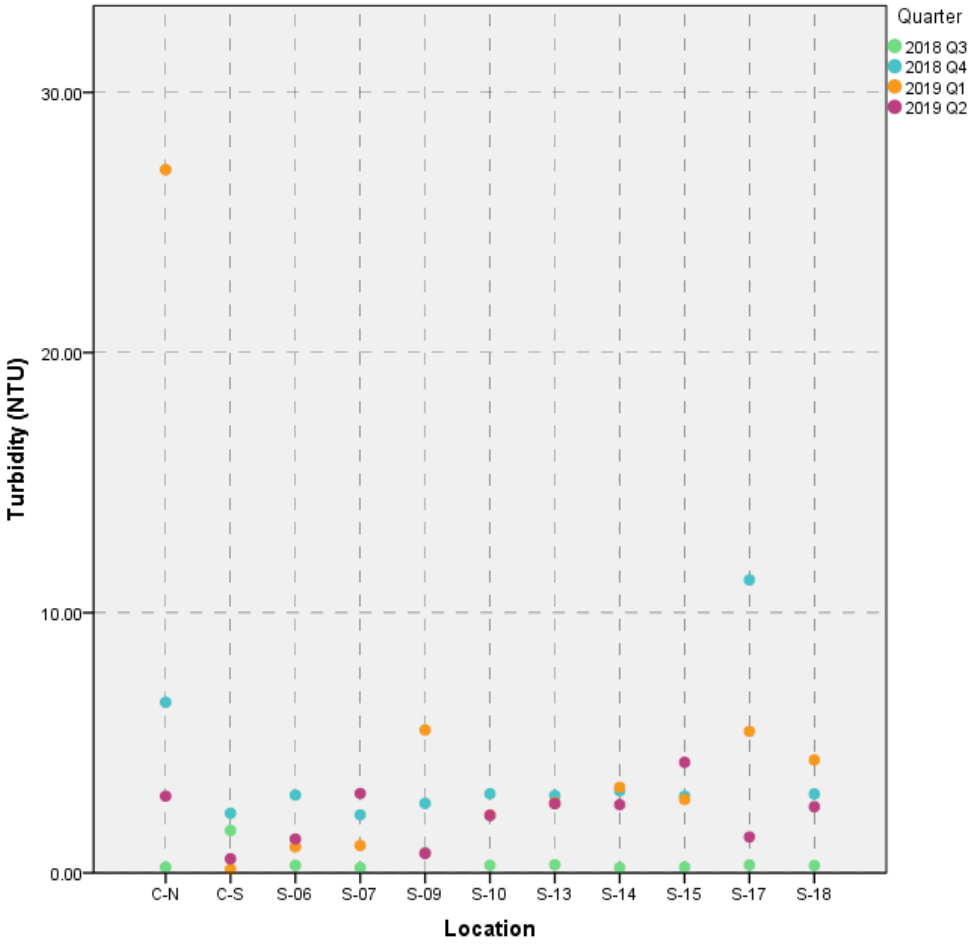

Figure 9-31: Mean turbidity - Q3-2018 (September) to Q2-2019 (May)

9.5.3 Conclusion

In summary, 97.0% compliance was achieved during the monitoring period (Q2-2019), which is comparable and the highest to the previous monitoring compliances of 95.7% (Q4-2018), 96.2% (Q3-2018), and 94.9% (Q1-2019).

The slightly elevated salinity values recorded Q2-2019 is consistent with the previous quarters' high results. The high readings may be correlated to climate and hydrographic conditions. A study comparison between the Arabian Sea and Red Sea, which are two vulnerable areas in the subtropical zone, has shown that sea surface temperatures can influence the distribution patterns of pH and salinity during the winter and summer seasons (Balqadi et al., 2018). The Arabian Gulf is connected to the Gulf of Oman, which is an important branch northwest of the Arabian Sea. During winter, the movement of water is cyclonic and the mixed layer depth extends to the northern Arabian Sea causing weak down-welling near the coast of Oman and upwelling in the central of the Arabian Sea, whereas during summer, an anticyclonic pattern occurs. Sea surface salinity is said to be less than 35 PSU during the rainy season (June to October), while during the dry season (December to April) salinity is greater than 36 PSU due to the sea exhibiting an annual net water loss as a result of evaporation exceeding the combined precipitation and river input (Morrison, 1997).

9.5.3.1 Hydrodynamics

A calibrated TELEMAC-3D model has been set up by HR Wallingford (July 2018) to model the current and potential future scenarios. A TELEMAC finite element modelling system was run for the Project in order to examine the hydrodynamics at the site and model potential changes. TELEMAC-3D is a three dimensional module of the TELEMAC system and allows the simulation of vertical transport and structure of effluent plumes for recirculation assessment.

The model area covers approximately 30 km alongshore by 10 km offshore, using coastline data from international hydrographic offices from the C-Map database. The model mesh is enhanced in the locations of the intake and outfall points, with a mesh resolution of 20 m, rising to 1 km mesh at the model boundaries. The model includes current construction reclamation activities occurring to the south of the site as part of the Doha New Port Project.

The baseline scenario accounts for the already operational IWPP, that is:

- Power plant at 100% capacity;
- Existing RO plant at 100% capacity; and
- MSF at 100% capacity.

The intake flow rate is modelled at 289,043 m^3/h and a discharge rate and effluent characteristics for the baseline case are summarised in Table 9-25 and Table 9-26

Table 9-25: Current discharge flow rates

Source	Discharge rate (m^3/h)
Power plant	159,200
Existing RO	15,601
MSF	81,962
Auxiliary Cooling Water System	6,200
Total	262,963

Table 9-26: Current Seawater and Discharge effluent characteristics

Parameter	Units	Value
Modelled conditions	-	Summer, calm conditions
Ambient salinity	ppt	45.9
Ambient seawater temperature	°C	35
Net ΔS	ppt	4.69
Net salt loads	kg/s	343
Net ΔT	°C	7.64
Net thermal load	°Cm^3/s	558

The baseline scenario model has been run for a spring-neap cycle, with tidal elevations at the intake point shown in Figure 9-32. The smallest neap tides are between days 8-12 and the largest spring tides between days 14 – 17.

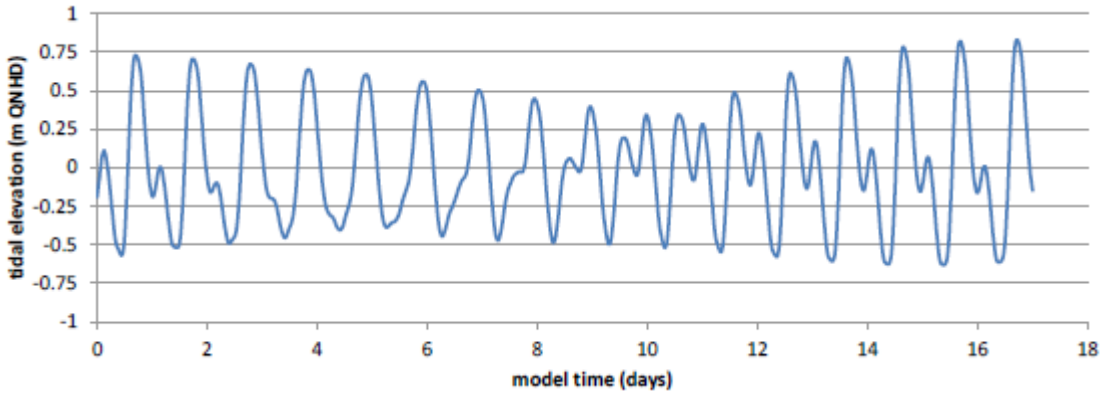

Figure 9-32: Model tidal elevation at intake point

The following hydrodynamic studies were undertaken to support the design and environmental assessment. These reports were used for the environmental assessment in Section 9.6.2 and the detailed reports are provided in Appendix H.

- Recirculation & thermal dispersion study describing the investigation of the recirculation and dispersion of the thermal/saline plume from the UHP IWPP (Report Reference: DKR5430-RT001-R02-00).
- Recirculation & thermal dispersion study describing the investigation of the recirculation and dispersion of the thermal/saline plume from the UHP IWPP for a revised configuration of the intake and outfall structure (Report Reference: DKR5430-RT007-R02-00).
- Assessment of the effects of an additional RO plant on the temperature and salinity footprints. Three potential future operating conditions were tested, along with a baseline case presenting the operational case without the new RO plant (Report Reference: DKR5955-RT001-R06-00).

Temperature

The thermal mixing zone is the area where seawater temperatures measure 3°C above the ambient temperatures (in line with MME requirements) following a typical discharge event. The current operational IWPP's mixing zone covers an area of 54,795 m^2, as shown in Figure 9-33.

As shown from the model contours, an increase in temperature spreads approximately 5 km alongshore from the outfall and 3 km offshore. Maximum differential temperature of up to eight degrees is recorded at both surface and seabed levels.

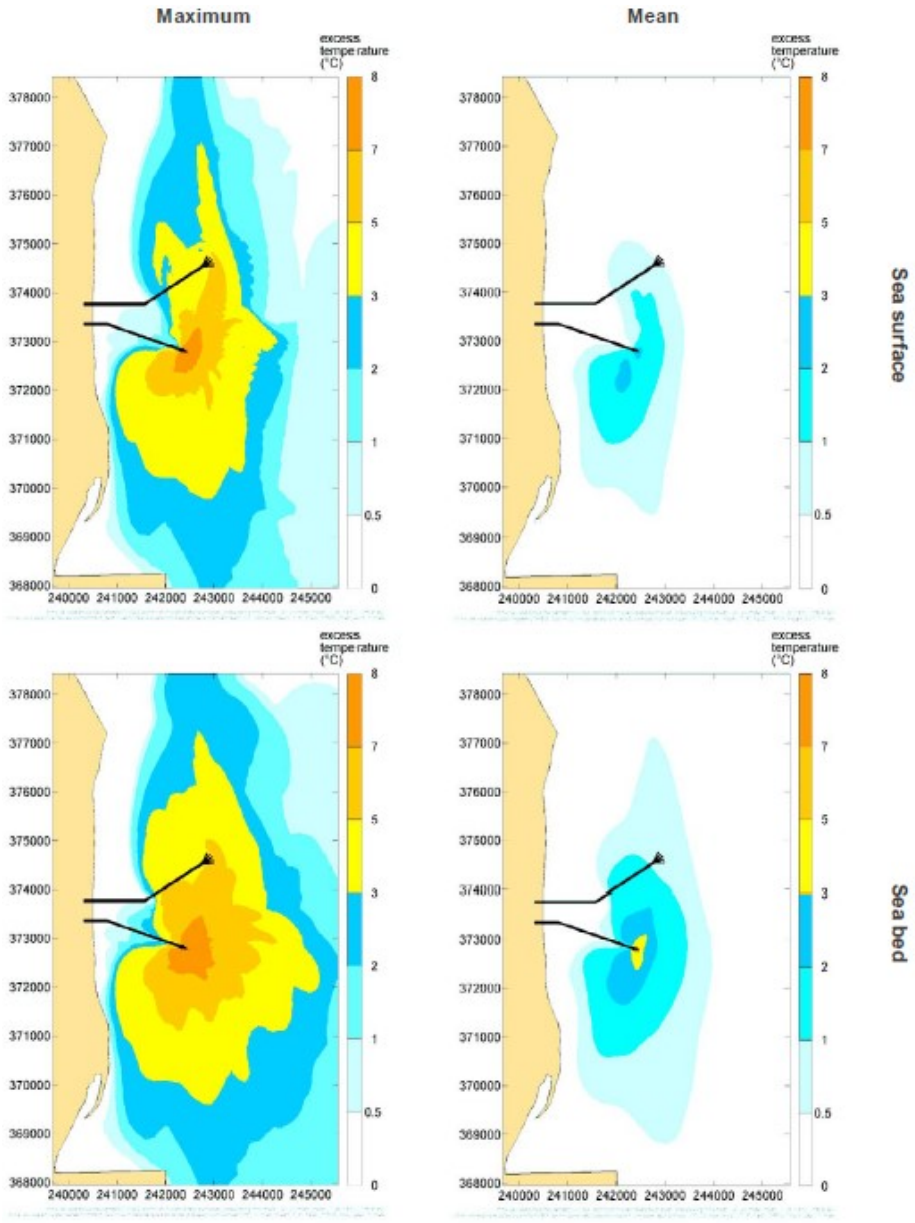

Figure 9-33: Baseline maximum and mean surface and seabed excess temperature – calm, summer conditions

Salinity

The mixing zone for salinity is defined by a 10% deviation from background seawater temperatures at the seabed, equating to approximately +4.69 ppt increase in the seawater measurement following a typical discharge event. The salinity mixing zone for the currently operational IWPP is negligible, as shown in Figure 9-34. A maximum increase in temperature of 5 ppt is observed as a maximum measurement at both surface and seabed, which aligns to the allowed threshold.

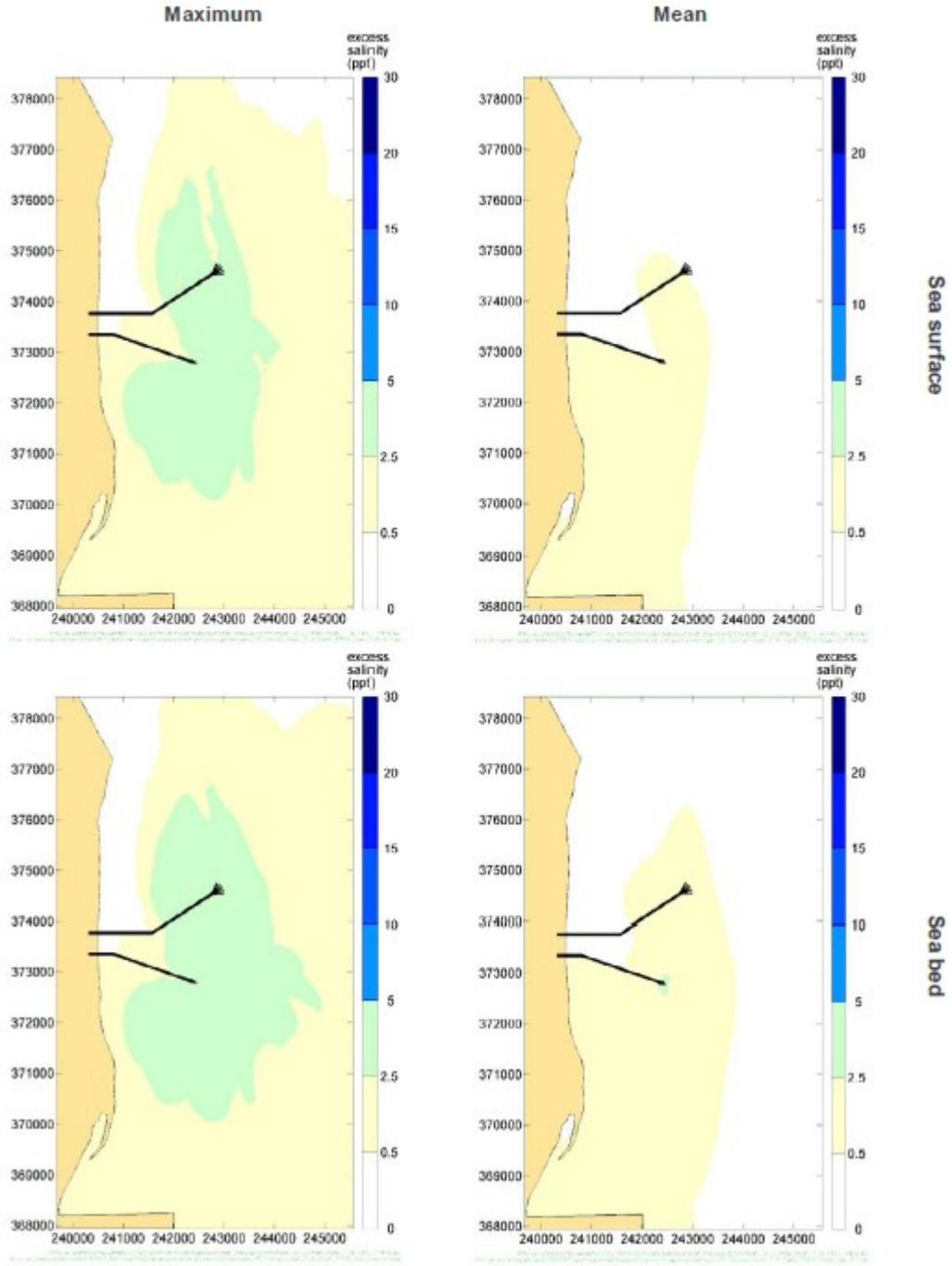

Figure 9-34: Baseline maximum and mean sea surface and seabed excess salinity – calm, summer conditions

9.6 Environmental impact prediction and evaluation

9.6.1 Construction

The proposed expansion will utilise the existing intake and outfall pipelines and therefore marine works are not required as part of the construction phase of this Project. The project's direct marine footprint remains unchanged and the need for marine construction activities, such as dredging and clearing activities and pipe laydown, are completely avoided. Sediment dispersion and additional habitat loss are therefore not anticipated to occur as a direct result of this Project at the construction phase.

9.6.2 Operation

Marine Fauna and Flora

An inevitable impact at the intake point is the entrainment and impingement of marine organisms, including small animals, fish, and plankton at the intake screen. As the intake pipeline is already operational and the intake requirements are not expected to increase, the impact of the entrainment as a result of this Project is **minor**.

Discharged brine has the potential to affect fauna and flora by affecting the ambient water temperature, salinity, and overall water quality. Exposure to the salinity and thermal plumes can affect survivability and distribution of marine organisms and habitats.

Fish populations could be impacted as thermal plumes can act as a barrier to migration, and reduce access to feeding and spawning areas as well as the ability of surrounding habitats to restock themselves via annual spawning activities. This is relevant to fish species that migrate along the coast. However, the potential changes in temperatures, for all future cases, will be **minor** to **moderate** based on the dispersion.

Infauna and sessile organisms are likely to be those mostly affected as these are not able to migrate from the affected areas. In addition, the resulting brine will be of a higher density than the receiving seawater due to the higher concentration in salt and therefore will spread over the sea floor in shallow coastal waters. Benthic communities, such as critical habitat seagrass beds, may consequently be at more risk than pelagic communities and could be affected by high salinity, temperature and chemical residues.

It is considered that pelagic species (including fish, sea turtles and marine mammals) are capable of avoiding the area affected by the brine plume and therefore the impacts are considered to be indirect and associated with the potential decrease in feeding areas for fish and possibly turtles.

Model Results

Three potential cases for the future scenario with the proposed expansion aspects have been modelled. Each modelled case is based on different combinations of operational capacity of the four key facility components and are summarised in Table 9-27.

For all future scenarios, the combined reject brine from the existing IWPP and the new RO facility will be mixed with the power plant's cooling water supply and reused by the power plant before it is discharged. In Case 2b, the 79,600 m^3/h is diverted to the standby STG/condensers without being subjected to any additional heat load or salinity changes.

Table 9-27: Future plant operational cases

Facility Component	Modelled Operational Capacity (%)		
	Case 1	Case 2a	Case 2b
Existing Power Plant	100	100	50
Existing RO Plant	100	67	100
MSF	100	100	60
New RO Plant	100	67	100

For all cases modelled, the intake flow rate is fixed at 289,043 m^3/h. Discharge rates and effluent characteristics are summarised in Table 9-28 and Table 9-29.

Table 9-28: Operational discharge flow rates

Source	Discharge rates (m^3/h)		
	Case 1	Case 2a	Case 2b
Operational IWPP	159,387	159,325	79,787
Standby STG/Condensers	0	0	79,600
Existing RO[12]	(15,601)	(10,400)	(15,601)
Proposed RO	(15,629)	(10,419)	(15,629)
MSF	81,962	81,962	49,177
Auxiliary Cooling Water System	6,200	6,200	6,200
Total	247,552	247,488	214,767

Table 9-29: Operational seawater and discharge effluent characteristics

Source	Units	Values		
		Case 1	Case 2a	Case 2b
Modelled conditions	-	Summer, calm conditions	Summer, calm conditions	Winter, calm conditions
Ambient salinity	ppt	45.9	45.9	45.9
Ambient seawater temperature	°C	35	38	18
Net ΔS	ppt	7.32	5.75	7.24
Net salt loads	kg/s	503	327	432
Net ΔT	°C	8.12	8.12	6.64
Net thermal load	$°Cm^3/s$	558	558	396

[12] Figures in brackets represent a negative contribution to total power plant discharge

Temperature

The thermal mixing zones for each of the future scenarios is summarised in Table 9-30, and the corresponding contour mapping shown in Figure 9-35 to Figure 9-37.

Table 9-30: Future scenario thermal mixing zones

	Case 1	Case 2a	Case 2b
Mixing zone area (m^2)	20,705	43,359	5,510

The mixing zone areas of Case 1 and Case 2b are significantly smaller than the current operational IWPP's thermal mixing zone area (54,795 m^2).

In Case 1, the discharge effluent is denser than the current conditions due to the addition of reject brine into the cooling supply. The denser discharge is distributed and more mixed throughout the water column, as compared to the baseline scenario. This effect of denser discharge is also reflected in the difference at surface and seabed levels.

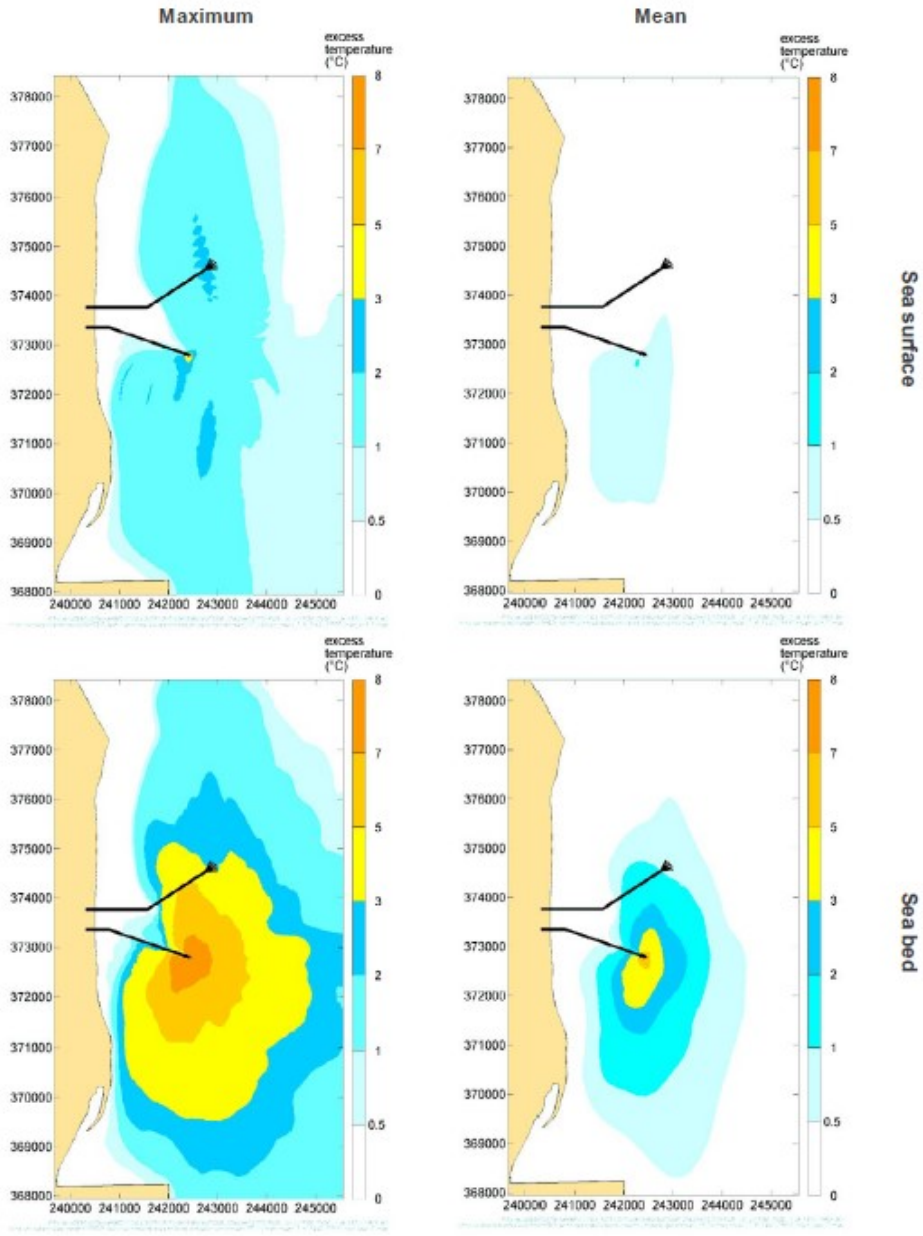

Figure 9-35: Max and mean excess temperatures, Case 1

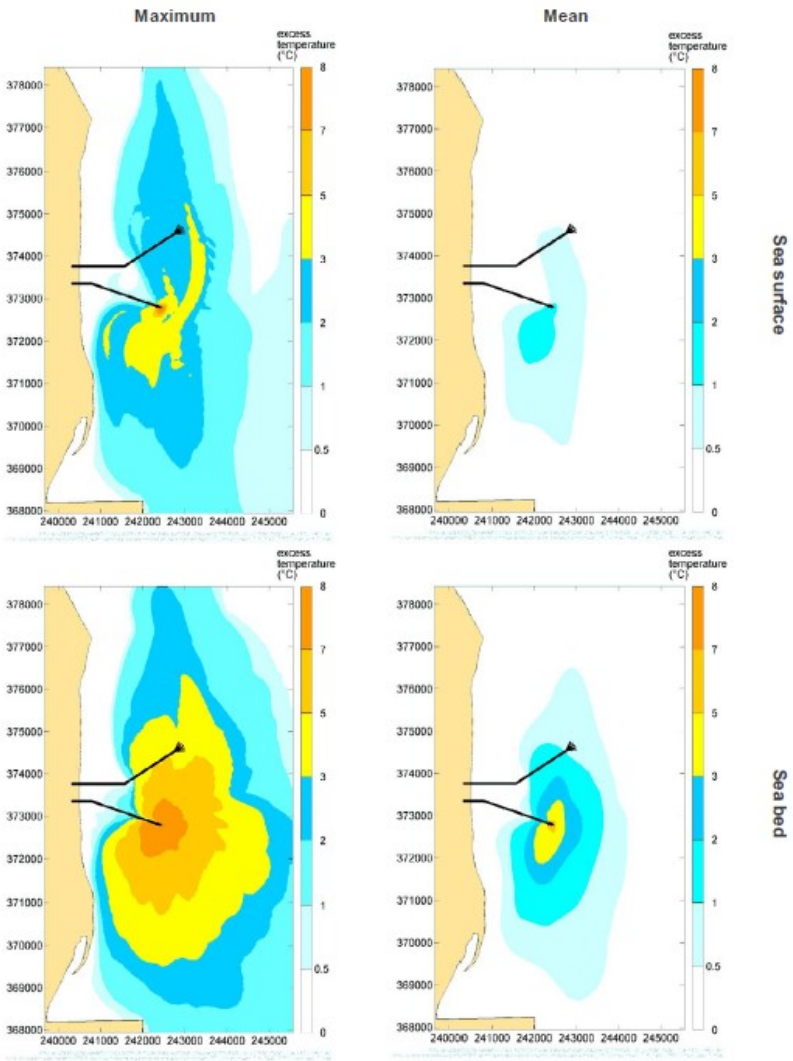

Figure 9-36 : Max and mean excess temperatures, Case 2a

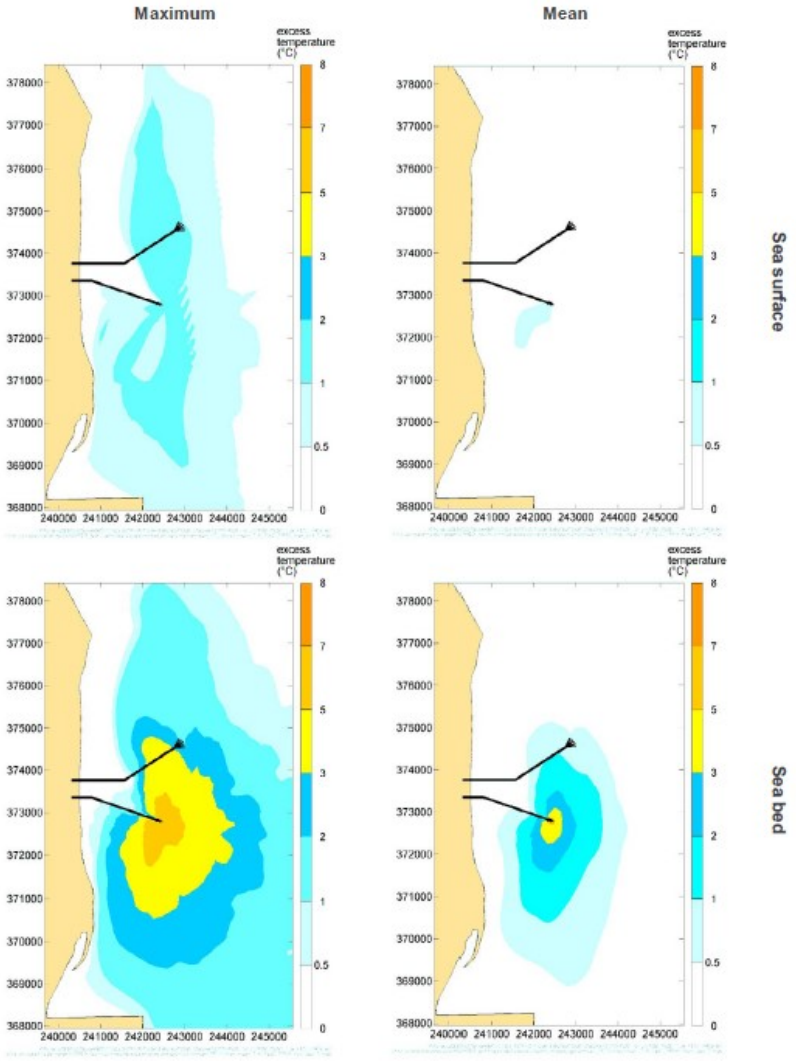

Figure 9-37 : Max and mean excess temperatures, Case 2b

Salinity

The mixing zone in relation to salinity plumes generated by this Project, for each of the future scenarios is summarised in Table 9-31, with corresponding contours shown in Figure 9-38 to Figure 9-40.

Table 9-31: Future scenario salinity mixing zones

	Case 1	Case 2a	Case 2b
Mixing zone area (m^2)	85,589	15,540	68,638

Unlike the thermal plumes, the salinity mixing zones the future cases modelled have larger footprints than the baseline scenario which was negligible in area as discussed in Section 9.5.3.1. However, as shown in the model contours, the salinity does not exceed +10 ppt. Case 2a has the least dense effluent level and therefore the smallest plume footprint. Case 1 and 2b have dense effluent and therefore the plume disperse towards the seabed level.

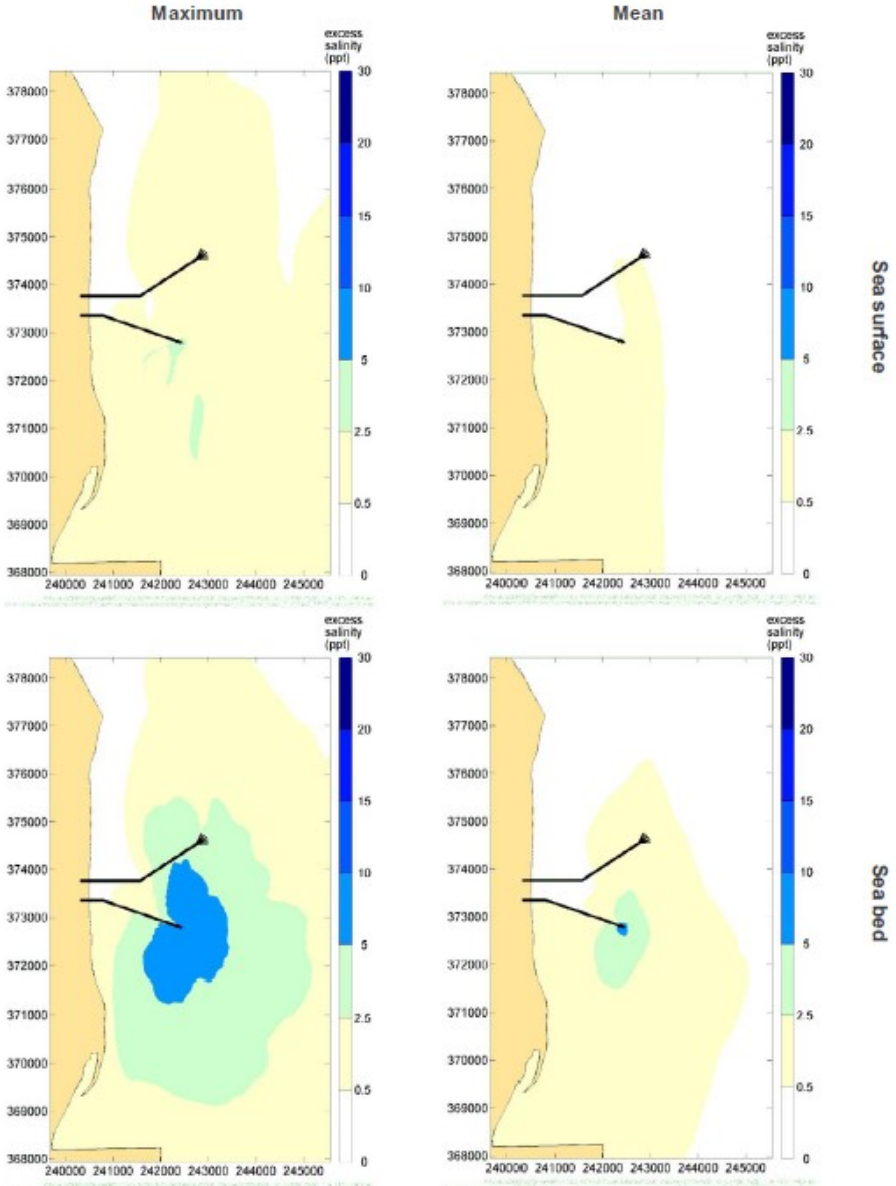

Figure 9-38: Max and mean excess salinity, Case 1

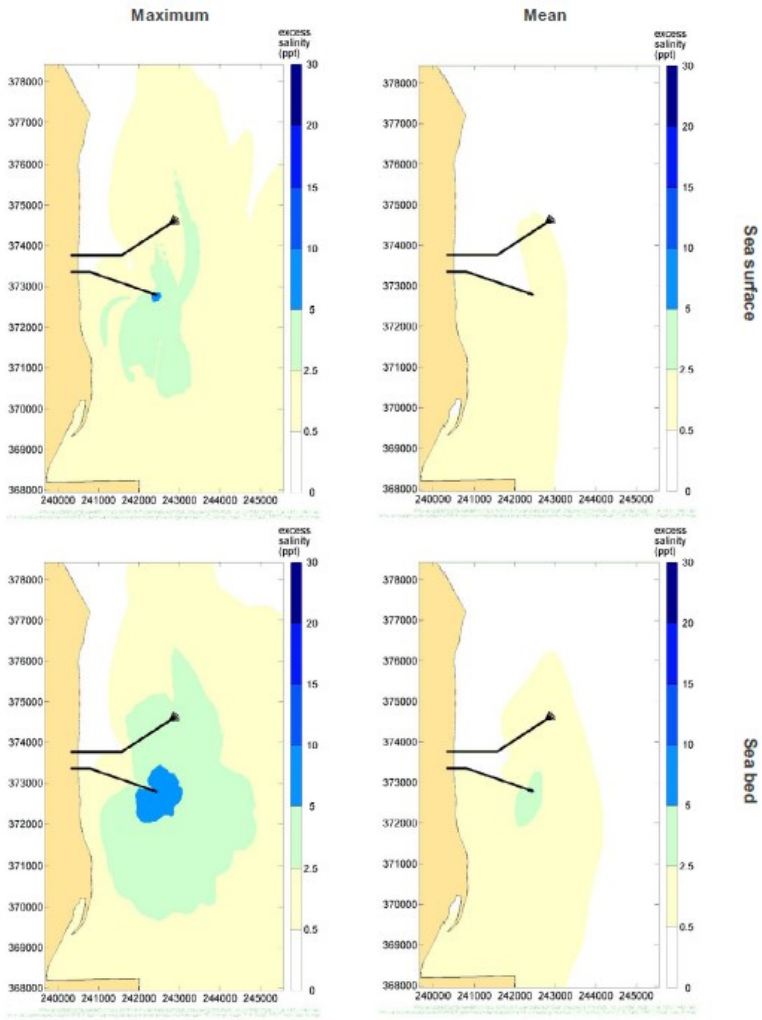

Figure 9-39 : Max and mean excess salinity, Case 2a

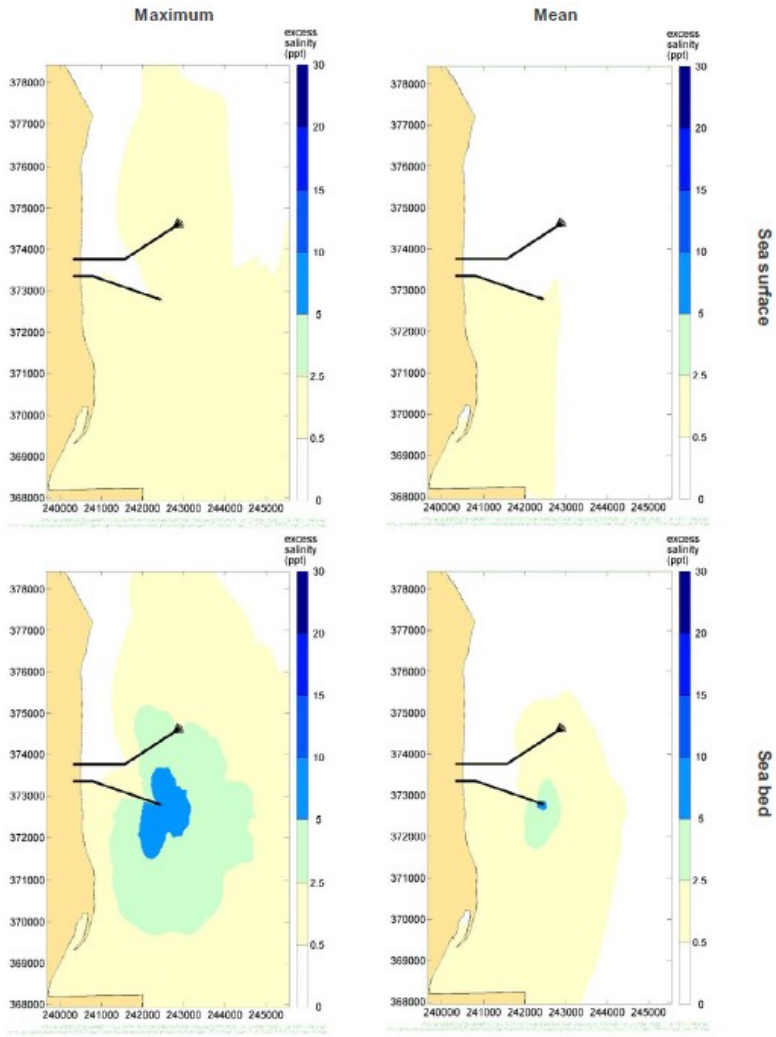

Figure 9-40 : Max and mean excess salinity, Case 2b

9.7 Mitigation measures

9.7.1 Construction

By utilising the existing intake and outfall pipelines, the need for any marine construction works is avoided and none are realised as a direct result of this Project. Therefore no construction phase mitigation measures are considered necessary.

9.7.2 Operation

9.7.2.1 Marine Fauna and Flora

As the intake and outfall pipelines will remain unchanged, it is not expected that additional mitigation measures will be implemented with regards to the design or layout of the existing pipes. Nevertheless, the following measures are recommendations based on the expected impacts:

- The design, existing and future, should incorporate screens and barriers.
- Use of physical barriers, such as barrier nets, Ristroph screens and travelling screens to reduce impinged and entrained organisms
- Impinged fish may suffer lacerations or other mechanical damage to their gills or fins. The Project proponent should ensure that an appropriate monitoring scheme is in place to identify entrainment and impingement organisms and appropriate rehabilitation and release of these.

9.7.2.2 Hydrodynamics

Intake and outfall water should be monitored for hydrocarbons and oil, turbidity, residual chlorine and silt density index, temperature and salinity. Outfall water testing should also include dissolved oxygen.

The use of diffuser systems can significantly reduce concentrate disposal impacts.

The selected Future Case should be selected based on the outcomes of the salinity and thermal dispersion modelling.

9.8 Summary of impacts, mitigation and residual significance

The summary of impacts, mitigation and residual significance of the project on soil and groundwater resources is provided in Table 9-32.

Table 9-32: Summary of impacts and residual significance – Marine Environment

Project impact	Initial impact (before implementing mitigation measures			Mitigation measures	Residual impact (after implementing mitigation measures		
	Likelihood	Consequence	Impact rating		Likelihood	Consequence	Impact rating
Construction phase							
N/A	-	-	-	N/A	-	-	-
Operation phase							
Entrainment and impingement of animals, fish and plankton	Almost certain	Minor	Medium	Design incorporates screens and barriers. A circulation system should be considered which would return any entrained fauna to the sea. Monitoring program to identify and release entrained and impingement	Almost Certain	Moderate	Medium
Temperature increase from discharge effluent – Case 1	Almost certain	Minor	Medium		Almost Certain	Minor	Medium
Temperature increase from discharge effluent – Case 2a	Almost certain	Moderate	High		Almost Certain	Moderate	High
Temperature increase from discharge effluent – Case 2b	Almost certain	Minor	Medium		Almost Certain	Minor	Medium
Salinity increase from discharge effluent – Case 1	Almost certain	Minor	Medium		Almost Certain	Minor	Medium

Project impact	Initial impact (before implementing mitigation measures			Mitigation measures	Residual impact (after implementing mitigation measures		
	Likelihood	Consequence	Impact rating		Likelihood	Consequence	Impact rating
Salinity increase from discharge effluent – Case 2a	Almost certain	Minor	Medium		Almost Certain	Minor	Medium
Salinity increase from discharge effluent – Case 2b	Almost certain	Minor	Medium		Almost Certain	Minor	Medium

10. Waste Management

10.1 Introduction

This Chapter deals with waste generated by the expansion Project during the construction and operation phases. Impacts associated with the project are also discussed including proposed mitigation measures that will be implemented.

10.2 Assessment methodology

Waste assessment has been prepared in accordance with Qatari standards as well as applicable international guidelines, protocols, policies and procedures, which are detailed in Section 10.3 including:

- Qatari standards for waste assessment and management
- IFC Performance Standard 3 – Resource Efficiency and Pollution Prevention (2012)
- World Bank EHS Guidelines including the General Guideline (2007)

The methodology for the waste assessment considered the requirements of the aforementioned legislation and guidelines:

- Describing waste generation and management practices in Qatar based on a review of available data as well as the existing waste management facilities
- Identifying waste types and streams (e.g. solid, liquid; hazardous and non-hazardous) and quantities produced during construction, operation and decommissioning phases
- Assessing impacts associated with waste generation and management (such as health hazards, emissions, soil and groundwater contamination and impacts to existing waste management facilities in Qatar) using impact assessment criteria methodology outlined in Chapter 2 and discussing the benefits of the Project
- Summarising impacts along with the mitigation measures and identifying the residual impacts
- Developing a monitoring program to monitor waste generated and how it is managed

The assessment of waste impacts is typically associated with the impacts on receptors and resources including waste infrastructure. The indirect impacts of waste management are addressed in other environmental components such as air quality (Chapter 6) as well as soil and groundwater (Chapter 8).

10.3 Legislative framework and applicable standards

As described in Chapter 3, this EIA is completed in accordance with the requirements of the Qatari legislation, Equator Principles (and associated IFC Performance Standards) and World Bank EHS Guidelines.

Applicability of national and international standards/guidelines on the proposed RO expansion is presented in Chapter 3. Project's compliance is also discussed in Chapter 3.

10.3.1 Qatari standards

The Environmental Protection Law No. 30 of 2002 requires the preparation of EIA studies for projects that have the potential to cause negative impact on the environment. Water desalination projects and its associated infrastructure are covered by this law. Identification of

waste generated by the project and assessment of its impacts are required as part of the EIA as stated in Article 15 and Article 16 of the Executive By-Law.

10.3.2 International Guidelines

IFC Performance Standard 3

The IFC Performance Standard for Resource Efficiency and Pollution Prevention promotes resource efficiency through implementing measures to improve efficiency in the consumption of energy, water as well as other resources and material inputs. Pollution prevention relates to avoiding the release of pollutants or minimising these releases. The guideline specifically talks about avoiding the generation of hazardous and non-hazardous wastes and adopting the hierarchy where this is not possible i.e. reduce the generation of waste, recover and reuse waste and where this is not possible treat, destroy or dispose of it in an environmentally sound manner. Use of hazardous materials should be avoided where it is possible to use less hazardous substitutes and if not possible then they should be disposed of in an environmentally sound manner by a reputable and legitimate waste contractor.

World Bank EHS Guidelines

The World Bank's EHS General Guideline states that facilities that generate and store wastes should establish waste management priorities at commissioning and establish a waste management hierarchy (prevention, reduction, reuse, recovery, recycling, removal and finally disposal of wastes). This guideline is prescriptive on all elements of waste management including storage, transport and monitoring.

Basel Convention on the Control of Transboundary Movement of Hazardous Wastes and their Disposal

The Basel Convention was established primarily to set up a framework for controlling the "transboundary" movements of hazardous wastes. Hazardous wastes covered by the Convention include toxic, poisonous, explosive, corrosive, flammable, ecotoxic and infectious.

The Convention has developed the criteria for "environmentally sound management", which involves strong controls from the generation of waste to its storage, transport, treatment, reuse, recycling, recovery and final disposal. It also promotes hazardous waste minimisation whenever possible, as well as control of hazardous waste as close to where these are produced as possible.

Under this Convention, transboundary movement of hazardous wastes or other wastes is allowed only under conditions below:

- If the state of export does not have the capability of managing or disposing of the hazardous waste in an environmentally sound manner;
- Upon prior written notification by the state of export to the designated authorities of the state of import and transit, where appropriate; and
- Each country that is a party to the Convention is required to report on its hazardous waste generation and movement. The UAE signed the Basel Convention on September 1989.

Qatar ratified Basel Convention in 1995.

10.4 Baseline

10.4.1 Waste generation

In 2018, BioEnergy Consult reported that Qatar produces more than 2.5 million tons of municipal solid waste per year. Qatar's waste generation rates per day is 1.8 kg, which is considered one of the highest worldwide (Zafar, 2018)). Solid waste stream in the country predominantly comprise of organic materials (60%) and recyclables such glass, paper, metals and plastics.

10.4.2 Waste management

Landfilling is the predominant method of solid waste disposal in Qatar. Wastes are collected and discharged at various transfer stations before it is sent to landfill for final disposal. Qatar has three landfills as follows:

- Umm Al-Afai for bulky domestic waste
- Rawda Rashed for construction and demolition waste
- Al Krana for sewage wastes

Solid Waste Management Strategy

Based on the Qatar National Development Strategy 2011–2016, the country will adopt a multi-faceted strategy to contain the levels of waste generated by households, commercial sites and industry and to promote recycling initiatives (Zafar, 2018)).

In line with this, five waste transfer stations have been set up in South Doha, West Doha, Industrial Area, Dukhan and Al-Khor to reduce the quantity of waste being transferred to Um Al-Afai landfill (Zafar, 2018). The new waste transfer stations are equipped with material recovery facility for separating recyclables from non-recyclables.

10.4.3 Generation and management of Project waste

10.4.3.1 Construction phases

Wastes generated during the construction phase will include by-products that are treated both on-site and off-site. The construction phase will generate recyclable and non-recyclable wastes requiring specific management measures. The wastes will be collected in a centralised recycling area and recycled offsite. Construction of the facility will mainly generate residues, wood, plastics and metals. All construction works will also generate general waste such as office waste and food waste from construction workers.

Solid non-hazardous wastes are generally easy to manage, with a large component that can potentially be reused or recycled. There are existing storage and waste management services at the Project site that can readily be used for managing future construction waste. Site procedures are already established at the site and can effectively manage additional solid waste.

Additional liquid waste or effluent created during construction work will be managed within the existing treatment plan and site infrastructure.

Hazardous waste generated during the construction include:

- Paint
- Oil, fuel and grease
- Batteries

- Light bulbs
- Chemical wastes (e.g. adhesives)
- Containers of hazardous materials

Any materials that are known or suspected to be contaminated by hazardous substances will be treated and managed as hazardous waste. This includes materials used for clean-up of a spill or leakage of hazardous materials. The quantity of hazardous wastes from construction of the RO expansion project will be minimal compared to other construction wastes.

10.4.3.2 Operation phase

Solid waste

Solid waste generated during the operation phase include:

- Food waste
- Office waste
- General waste

Solid wastes that will be generated by the Project consist mainly of domestic wastes such as food, papers and other residual wastes from office operation. Solid wastes generated by the expansion Project will be segregated into hazardous and non-hazardous wastes. Non-hazardous solid wastes will be further classified as compostable, recyclable and residual waste and will be managed as appropriate. The existing waste management services and facilities in the Qatar will be used for managing this waste.

Liquid waste / effluent

Liquid wastes generated during the operation include:

- Domestic sewage from office operation
- Secondary flows from the main process line, which consist of:
  - Floated sludge from DAF system
  - Backwashed water from disc filters
  - Backwashed water from ultrafiltration tank

Some of the secondary flows will be sent directly into the outfall, as their characteristics are similar to the seawater, while others will require a specific treatment in order to reduce the solids concentration before being discharge back to the sea. Backwashed water from disc filters and ultrafiltration could be discharged directly to the seal pit if the mixing with other streams into the seal pit complies with environmental regulations. Secondary flows will be treated in wastewater treatment building (refer to Section 4.4.2).

Hazardous materials

Hazardous materials that are likely to be used during the operational phase of the Project area presented in Table 10-1. All materials during operations will be stored in areas appropriately designed in accordance with the material safety data sheets (MSDS).

Table 10-1: Materials and chemicals that will be used during operation

Material	Activity	Type
Antiscale	Desalination	Hazardous
Antifoam	Desalination	Hazardous
Chemical for acid cleaning (HCL 35%)	Desalination	Hazardous
Chemicals for acid cleaning (NaOH 25%)	Desalination	Hazardous
Sodium Hydroxide (NaOH 50%)	Product water treatment	Hazardous
Limestone ($CaCO_3$)	Product water treatment	Hazardous
Activated Carbon	Product water treatment	Hazardous
Sodium chlorite (NaClO2) 31%	Product water treatment	Hazardous
Hydrochloric acid (HCL) 32%	Product water treatment	Hazardous
Polyelectrolyte	Product water treatment	Hazardous
Oxygen scavenger	Common deaerator	Hazardous
Sodium hypochlorite	Chlorination Unit	Hazardous
Chemicals for acid cleaning (HCL 35%)	Chlorination Unit	Hazardous
Chemicals for acid cleaning (NaOH 25%)	Chlorination Unit	Hazardous

Source: (Mott MacDonald, 2016)

Notes: Hazardous nature are provisionally identified. Material quantities/volumes will be identified

10.4.3.3 Summary of waste generation and management

Wastes produced during the construction and operation including the estimated quantities and proposed management are summarised in Table 10-2.

Table 10-2: Summary of waste generation and management

Waste stream	Proposed management
*Construction phase**	
General wastes (i.e. food wastes)	Collected by licensed contractors for off-site disposal
Recyclable wastes (i.e. metals and steel, timber, concrete, paper, plastic, cardboard, etc.)	Collected by licensed contractors and transferred to recycling centres
Liquid waste / effluent	Collected by licensed contractors for off-site disposal or treated via the on-site Sanitary Wastewater Treatment System, which will then be used for irrigation
Hazardous wastes	Collected by licensed contractors for off-site disposal

Waste stream	Proposed management
Operation phase	
General wastes (including food wastes)	Collected by licensed contractors for off-site disposal
Recyclable wastes generated for maintenance activities (i.e. metals and steel, timber, concrete, plastic, cardboard, etc.)	Collected by licensed contractors and transferred to recycling centres
Recyclable wastes generated in the office (i.e. paper, cardboard)	Collected by licensed contractors and transferred to recycling centres
Liquid waste / effluent from office operation (domestic waste)	Treated via the on-site Sanitary Wastewater Treatment System, which will then be used for irrigation
Hazardous wastes	Collected by a licensed contractor. Where recovery and reuse is not feasible, it will be disposed in a licensed facility.
Secondary flows from the main process line (backwashed water from disc filter and ultrafiltration tank)	Treated via the on-site Wastewater Treatment Plant, which will then be discharged to the sea.
Water treatment sludge / activated carbon	Collected by a licensed contractor. Where recovery and reuse is not feasible, it will be disposed in a licensed facility.

Key: * The anticipated waste during the decommissioning phase is similar with the construction phase

10.5 Environmental impact prediction and evaluation

10.5.1 Construction

Without appropriate management, the generation, storage and disposal of construction waste may lead to the following potential environmental impacts:

- *Potential risk of soil and groundwater contamination*. The risk is primarily associated with storage of sewage, waste oil and chemical waste onsite (and other hazardous materials and substances). Due to the close proximity and interface between the marine environment and groundwater, any groundwater contamination at the Project site may impact the marine environment. It is important that any soil or groundwater contamination at the site is rectified in a timely manner.
- *Stormwater and marine pollution.* Litter and other contaminants (e.g. oil, grease) from the site could enter the marine environment via stormwater or wind dispersion. This is comparable condition as most infrastructure development projects. Although an impact may not be readily apparent at the time of the discharge, some contaminants (e.g. oil, trace metals from waste paints) tend to accumulate over time.
- *Odour from storage of putrescible wastes and sewage storage tanks*. This impact is typically localised and will affect construction workers. Odour may also be a potential indication of contamination (e.g. leak / spill of sewage, chemical or oil)

- *Hazards to fauna*. Construction debris / litter could also pose an injury hazard to fauna. Desert animals could potentially ingest waste or injure themselves from sharp or hazardous waste items
- *Health and safety*. Improper storage and handling of waste has also associated health and safety risks not only to workers involved in managing / handling the waste but also to general workers and visitors to site. Risks include injury due to contact with sharp scrap metals, wood or plastic material; injury or fatality due to fire from improper storage / handling of flammable materials; and ill effects due to exposure to hazardous materials or chemicals.

The above potential environmental impacts and safety issues are predicted to be similar to impacts experienced during decommissioning activities. . The impacts associated with waste generation during the construction/decommissioning phase is considered to be short term and mostly reversible. The potential impacts will be effectively managed through the implementation of the existing Waste Management Plan (WMP) and will be handled by designated contractors. Construction waste from the Project will add to the waste loads of the existing waste management infrastructure and services. It should be noted, however, that current facilities have adequate capacity to accommodate waste generated.

Given the above considerations, the impact rating of waste generated during the construction/decommissioning phase is medium (minor to moderate).

Potential cumulative waste impacts of the Project can be reduced by implementing the proposed mitigation measures provided in Section 10.6. Segregation of wastes during construction will be crucial, with proper signage and disposal containers allotted for separation of different waste streams.

10.5.2 Operation

Operational waste generated by the Project will form additional load to the existing waste infrastructure and utilities. Similar to construction and decommissioning waste, operational waste may result in potential impacts if not properly managed:

- *Soil and groundwater contamination*. The risk is primarily associated with storage of sewage, waste oil and chemical waste onsite. The potential for a human health and ecological impact to occur due to contamination is considered low based on the following:
  - The very low annual rainfall observed in Qatar, the potential for surface water to infiltrate the compacted soil and create leachate is considered to be very low
  - There are no groundwater dependent users and the beneficial use of the groundwater for protection is limited by its high salinity and low recoveries
  - The volume of waste stored will be minimised by regular collection for offsite disposal by authorised contractors
- *Stormwater pollution and marine contamination.* This is considered of low risk from waste as storage will be located away from water bodies. Impacts due to operational spill and leaks (i.e. leaks from wastewater treatment plant, sludge storage, and backwash water storage) are considered further in Chapter 8
- *Risk of injury to staff and visitors*. Waste could potentially cause injury or fatalities to workers or visitors to the site from contact with sharp, flammable or hazardous materials

10.6 Mitigation measures

10.6.1 Construction

10.6.1.1 Solid waste management

The following measures shall be implemented for the management of construction solid waste:

- *Waste minimisation through efficient design, procurement and material management practices*: Construction Work Methods should be developed and corresponding site instruction issued to facilitate the efficient use of construction materials and minimise waste generation.
- *Implementation of procurement policies*: Standard procedures for procurement of construction materials, consumables and equipment / plant should include, where possible:
  - Specifying the actual quantity of materials required for construction
  - Ordering of materials in bulk, where possible, to minimise packaging waste
  - Preference of materials with minimum packaging
  - Arrangements with the suppliers for the return or buy-back of containers and packing materials
  - Preference for pre-fabricated / pre-casted structures or materials
  - Preference for environmentally friendly materials, such as those that are wholly or partly recycled
- *Waste segregation at source*: Waste should be segregated at the minimum, into inert aggregates, metals, timber, dry recyclables and hazardous materials. Waste segregation at source will control the risk of cross-contamination as well as facilitate waste reuse on-site and recycling via approved recycling facilities.
- *Waste reuse and recycling*: Reuse of scrap materials for on-site works shall be considered a priority. The following specific measures should be undertaken, where practical:
  - Re-use of excavated materials for fill purposes during site development or foundation works, ensuring that materials are geo-technically suitable for purpose.
  - Use of scrap materials such as wood and metals for temporary structures on-site. Drip trays could also be made from scrap metal sheets, provided they are water-tight.
  - Recycling of concrete waste and washings. An arrangement where such waste can be sent back to the supplier / concrete batching plant for recycling shall be considered.
  - Where possible, paper, wood, metal and plastic wastes shall be sent to suitable recycling facilities.
- *Provision of appropriate waste bins for different types of waste*: Bins with lids shall be provided for food wastes to avoid vermin infestation. Sharp waste materials should be kept in sturdy waste bins. Skips and bins should also be covered to prevent littering of light-weight materials particularly during strong wind conditions, which could disperse litter off-site including to the marine environment.
- *Labelling of waste bins / containers and collection areas*: The labels should be written in English and other languages understood by the construction workers, and include the name of the waste, hazard and safety precautions. Labelling will assist workers in segregating waste properly and minimise the risk of cross contamination.

- *Strategic location of waste bins / containers*: Areas where waste is generated (e.g. work areas, canteen) shall be provided with suitable waste bins / containers. Waste containers / storage areas shall be located away from the marine environment and stormwater flow paths.

10.6.1.2 Liquid waste management

Similar measures to those discussed in the solid waste management section shall be undertaken for managing the different liquid waste streams generated during the construction phase of the Project. Measures that should be implemented for managing construction liquid waste include the following:

- *Wastewater minimisation*: For washing activities on-site, use high-pressure sprays, where possible. Water efficient portable toilets will also be used, where possible / available.
- *Reuse and recycling*: Where possible, options to reuse washings and dewatered water should be considered. The following are examples of wastewater reuse that should be considered:
  - Dewatered water could be used for dust suppression on haul roads and unsurfaced areas after confirming its appropriate for use through water quality testing
  - Concrete waste and washings can be sent to the concrete supplier / batching plant for recycling
- *Provision of sedimentation / settling tank for dewatering water*: Dewatering effluent typically contains high concentrations of suspended solids which may require removal (e.g. settling) prior to reuse (e.g. for dust suppression) or final discharge into the marine environment. The effluent will also be checked for any other signs of contamination (e.g. oily sheen, foam or odour). When discharge to the marine environment is undertaken, the quality of the dewatering water should comply with the relevant Qatari standards.
- *Designated bunded areas for equipment and vehicle washing*: In the event that equipment, concrete trucks and vehicles washing is undertaken on-site, a suitable and dedicated facility (e.g. a bunded area with impervious surface) should be provided, ensuring that no contaminated washings are discharged into the marine environment or on the ground. Contaminated wash water should be disposed off-site via an approved waste contractor.
- *Provision of suitable temporary sewage holding tanks*: Storage tanks shall be leak proof and of sufficient capacity. An approved service provider should be engaged to collect sewage for off-site disposal. Sewage should be collected on a regular basis such that volume of stored sewage on-site does not exceed 80% of the tank capacity. Sewage storage tanks shall be located away from sensitive receptors and the marine environment.

10.6.1.3 Hazardous waste management

Key measures that should be implemented for managing construction hazardous waste include:

- Provision of suitable bunded storage area (made with impervious material) for hazardous waste storage.
- Copies of MSDS for waste materials shall be maintained at the storage area and kept easily accessible for relevant staff in the event of an emergency (e.g. spill or fire). Handling, storage, and disposal of hazardous materials should be undertaken in accordance with the MSDS requirements.
- Contractors shall establish emergency management procedures at hazardous waste storage areas. Procedures should be developed in accordance with the MSDS

requirements. Spill kits and fire extinguishers suitable to the waste stored at the area should be available where there is a risk of spill and fire, respectively.

- Materials used for containing / cleaning-up spills (e.g. absorbents, sand, hand gloves) should be treated and disposed of as hazardous waste.

10.6.1.4 General waste management

The following are general measures that should be implemented as part of the Project's overall waste management program:

- *Reduce, reuse, recycle*: Establish achievable targets on the quantity of waste minimised, recycled and re-used and establish a programme for implementation and monitoring.
- *Provision of training*: All site workers shall be provided with orientation / site induction training on waste management. The training program shall be developed to provide workers with adequate awareness on the environmental, health and safety issues associated with waste management and to seek commitment in adhering to waste management practices (e.g. minimisation, reuse and segregation) on-site.

  Staff designated to handle or manage construction waste shall be provided with additional training on the proper handling, storage and disposal of waste.
- *Personal protective equipment*: Site staff involved in managing waste should be provided with and trained on the use of suitable personal protective equipment including mask, gloves, coverall and safety boots / shoes.
- *Restriction of access to waste storage areas*: Only authorised personnel shall be allowed access to waste storage areas. Restriction signs and warnings should be posted at these areas.
- *Use of approved service providers*: Only approved service providers shall be engaged for the collection and disposal of construction waste. Recyclable wastes should be sent only to licensed facilities.
- *Waste documentation*: In order to ensure that construction wastes are managed appropriately, relevant documents shall be maintained on-site including but not be limited to:
  - Waste inventory including information on the types and quantity of waste generated
  - Service provider's licence / permit to collect / transport, recycle / process, or treat certain types of waste
  - Waste transfer notes or similar documents showing proof that waste had been collected and disposed of to an appropriate facility, whether a recycling / processing plant or a landfill site.

With consistent implementation of waste management measures discussed in this section, significant adverse environmental impacts are not anticipated during the development of the Project.

10.6.2 Operation

It is recommended that an Operation Waste Management Plan be developed for the Project. The waste management plan will consider the existing Qatari law and regulations as well as international requirements (IFC Performance Standards and WB EHS Guidelines) and international best practices. The waste management plan shall integrate the following key measures:

- *Waste minimisation*: Where possible, operators should be encouraged to develop and undertake a waste minimisation program tailored to their day-to-day activities / operations. Waste management awareness could be enhanced through information campaigns such as seminars, waste collection drive, dissemination of brochures / leaflets.
- *Waste segregation*: Waste segregation should be encouraged among workers, operators and visitors. Suitable and dedicated waste bins shall be allocated to facilitate waste segregation at-source and reduce risk of cross contamination issues.
- *Provision of suitable waste management facility*: Appropriate waste collection bins / skips and storage facilities shall be provided and strategically located such that they are an adequate distance from the marine environment and other on-site sensitive receptor areas (e.g. site offices). The design of the waste management facility shall comply with regulatory / standard design requirements for building waste management facilities. Adequate ventilation and housekeeping should be maintained at the facility.
- *Use of approved service providers*: The collection of waste on a regular basis shall be arranged through licensed service providers.

With consistent implementation of waste management measures discussed above, significant adverse environmental impacts from operational wastes are not anticipated.

10.7 Summary of impacts, mitigation and residual significance

The summary of impacts, mitigation and residual significance of waste generation is provided in Table 10-3. Generation of wastes cannot be wholly avoided, and nor will waste will be entirely recycled or reused. However, with appropriate handling and disposal of wastes, there should be minimal residual impact. Food and other biodegradable waste and non-recyclable waste will be disposed of at an appropriate landfill site while hazardous waste will be treated prior to final disposal.

Table 10-3: Summary of impacts and residual significance – Waste Management

Project impact	Initial impact (before implementing mitigation measures			Mitigation measures	Residual impact (after implementing mitigation measures		
	Likelihood	Consequence	Impact rating		Likelihood	Consequence	Impact rating
Construction and operation phases							
Generation of wastes (hazardous and non-hazardous solid and liquid)	Possible	Moderate	Medium	Develop and implement comprehensive waste management plan consistent with the overall UHP Company's IWPP waste management program as well as regulatory requirements including: •Waste minimisation •Waste segregation •Waste reuse and recycling Use of industry best practice Implement waste awareness programs including training of staff involved in waste handling Regular collection of waste for offsite disposal by approved waste contractors	Likely	Insignificant	Low
Generation of domestic sewage	Possible	Moderate	Medium	Treat sewage using existing onsite treatment plant Reuse treated sewage water	Possible	Insignificant	Negligible
Generation of wastewater	Possible	Moderate	Medium	Identify the source, discharge frequency, characteristics and quantity of liquid effluents	Possible	Insignificant	Negligible

Project impact	Initial impact (before implementing mitigation measures			Mitigation measures	Residual impact (after implementing mitigation measures		
	Likelihood	Consequence	Impact rating		Likelihood	Consequence	Impact rating
				Segregate liquid effluents in order to limit the volume of water requiring specialised treatment Reuse treated effluent where possible			
Generation of hazardous waste	Possible	Moderate	Medium	Maintain a log / inventory of hazardous wastes, and where possible, identify possible strategies to substitute / minimize the product or process of producing the waste	Possible	Insignificant	Negligible
Management of hazardous waste	Possible	Moderate	Medium	Store and handle hazardous waste based on MSDS: •Well identified storage areas (with signage and label) •Well maintained, ventilated and protected from elements •Access is restricted to authorized personnel only •Located away from marine environment •Bunded with drip trays •Capacity to contain at least 110% of the total volume •Provided with spill kits and appropriate firefighting equipment	Possible	Insignificant	Negligible

Project impact	Initial impact (before implementing mitigation measures			Mitigation measures	Residual impact (after implementing mitigation measures		
	Likelihood	Consequence	Impact rating		Likelihood	Consequence	Impact rating
				Regular collection of hazardous waste for offsite disposal by suitably licensed contractors			

11. Traffic

11.1 Introduction

This chapter describes the current baseline conditions of the Project and the impacts, mitigation measures and monitoring programme for traffic.

11.2 Baseline

The network of roads currently leading to the Project Site is underdevelopment. There are sections of road that are paved to a degree with some sections remaining a dirt road (Figure 11-1). This is due to the fact that the Project Site is currently located away from any developed areas. The Project Site does ultimately connect to the main Mesaieed Road which leads to Wakrah and Doha.

Figure 11-1: Road network leading to Project Site

11.3 Environmental impact prediction and evaluation

11.3.1 Construction

Construction activities will lead to a temporary increase in road traffic during the construction period, which can potentially affect road safety at the Project site and nearby road networks if traffic is not properly managed. Transport requirements of the Project during the construction phase will comprise of daily transport of site workers and staff members to the Project site, delivery of construction materials and resources including fuel / oil / water / cement / etc., delivery of site equipment and supporting facilities and collection of waste for off-site disposal.

Potential impacts associated with the construction phase traffic include:

- Increase in traffic congestion
- Increased potential for vehicle accident / incident associated with larger volume of traffic on the road network

- Impact on existing transport infrastructure

It is assumed that the routes leading to the site has previously been used to support construction at the site and is currently used for the day-to-day operation of the existing IWPP facility. As such, the increase in traffic volumes associated with the construction works is not anticipated to cause an unacceptable level of traffic congestion on the surrounding network. Construction work shifts[13] will differ for regular office work shifts (between 8:00 am to 5:00 pm) so that traffic periods will be spread from 6:30 am to 9:00 am and 4:00 pm to 6:00 pm.

Construction transport will include a range of vehicles and equipment, most of which will use the surrounding network. Traffic generated during the construction phase is not anticipated to be significant as the movements would be intermittent and undertaken outside rush hour traffic. Consequently, traffic congestion as a result of the Project is not anticipated. Movement of construction vehicle and equipment will be limited within the construction site only and is not anticipated to affect the surrounding facilities and roads within the site.

It is anticipated that mass/shared transportation (e.g. buses) will be provided to workers to avoid any potential impact on the existing infrastructure.

It is important to note that while the Project's increased traffic impact during construction is likely to be insignificant, road traffic introduced on-site have inherent environmental issues including:

- Potential increased dust levels associated with construction impacts and increased vehicle movements, as discussed in Section 6.5.1
- Noise generated by vehicles as discussed in Section 7.5.1.1

11.3.2 Operation

Traffic impact associated with the Project's normal operations include movement of workers, delivery of materials to the site and transport of waste from the site to off-site disposal. The impact of delivering materials to the site and transporting waste from the site is not considered to cause significant impact. Further, an increase in the workforce is anticipated during the operation phase. As such, the additional number of truck and vehicle movement is minimal and road network is considered sufficient for operational traffic.

11.4 Mitigation measures

11.4.1 Construction

During the construction phase, a construction traffic management plan that complies with the relevant Qatari standards an applicable to the existing site conditions will be prepared to facilitate smooth traffic flow in the vicinity of the construction site. The plan will include, but are not limited to, the following measures:

- Speed limits
- Flagmen and signalling equipment
- Traffic signs and control signals to direct and control traffic flow, to include:
  - Signs that are reflective or adequately illuminated at night
  - Advance warning signs (on approach and departure from work areas)
  - All intermediate advance and positional signs and devices required in advance of the taper or start of work area

[13] Construction work shifts are typically between 7:00 am to 4:00 pm with one-hour break or 7:00 am to 6:00 pm with three hours midday break (12:00 nn to 3:00 pm) during summer

– All delineating devices required to form the taper including the illuminated flashing arrow sign at the end of the taper, where required

– Delineation past the work area

– All other required warning and regulatory sign

The impact of the increased traffic congestion on the road network from the port (or source of construction materials) leading to the Project site will be minimised by implementing logistics plan, which would include the following measures:

- Heavy and oversized vehicles will preferably use the truck road
- Convoys of heavy and oversized vehicles will be used, preferably outside of peak traffic hours
- Where practical, deliveries will be undertaken outside of peak traffic periods in the morning and afternoon
- Construction materials will be delivered in bulk rather than in small quantities to reduce the number of trips
- Coordinate with relevant authorities during delivery of heavy and oversized materials

Mass / shared transportation (e.g. buses) of workers will be arranged to minimise trips and vehicle movement to and from the construction sites. Consistent implementation of the above measures will reduce construction traffic impacts on the Project to acceptable levels.

11.4.2 Operation

In order to minimise impact of operation traffic, a transport management plan will be developed to include the designated route of transport, speed limit as well as emergency spill response / clean-up protocol. Truck operators should also be provided with suitable competency training on traffic safety as well as environmental awareness and spill emergency response.

11.5 Summary of impacts, mitigation and residual significance

The summary of impacts, mitigation and residual significance is provided in Table 11-1. An increase in traffic is an unavoidable impact from the construction and operation activities of the Project. The increase predicted; however, will not impact the overall capacity available for the traffic network.

Table 11-1: Summary of impacts and residual significance – Traffic

Project impact	Initial impact (before implementing mitigation measures			Mitigation measures	Residual impact (after implementing mitigation measures		
	Likelihood	Consequence	Impact rating		Likelihood	Consequence	Impact rating
Construction and operation phases							
Increase in road traffic in the vicinity of the Project site	Likely	Minor	Medium	Develop and implement construction traffic management plan that complies with Qatari requirements and facilitates smooth traffic flow in the vicinity of the construction site. This will include the following measures: • Speed limits (20 km/h) • Flagmen and signalling equipment • Traffic signs and control signals to direct and control traffic flow	Possible	Minor	Low
Increase in commercial vehicles in the vicinity of the Project site	Likely	Minor	Medium	Facilitate convoys of heavy and oversized vehicles outside of peak traffic hours Coordinate delivery with suppliers to be undertaken outside of peak traffic hours Where practical, deliver construction materials in bulk to reduce number of trips	Possible	Minor	Low
Increase in traffic movement by employees	Likely	Minor	Medium	Arrange mass transport of workers (buses) to minimise trips and vehicles to and from the construction sites	Possible	Minor	Low

12. Social Impact Assessment

12.1 Introduction

The social impact assessment of the project is presented in this chapter. The overall objective of this section is to assess the social implications of the proposed RO expansion, which include identifying and assessing the key socio-economic impacts and managing these impacts in a consultative and constructive manner.

12.2 Assessment methodology

The methodology used to assess the social and health impacts of the Project includes review of available data, stakeholder consultation, review of local and international guidelines relevant to the Project, evaluation of impacts and identification of mitigation or enhancement measures.

12.2.1 Desktop review

An assessment of the Project site was conducted through desktop analysis of secondary data from various sources such as client-supplied and publicly-available online information.

12.2.2 Temporal and spatial scope of assessment

Temporal scope

Temporal assessment was undertaken by comparing the existing baseline conditions with the anticipated change as a result of Project construction and operation. The temporal scope of assessment includes the following phases:

- Construction: construction activities is anticipated to start in June 2019 and will be completed in April 2021
- Operations: the Project is expected to be commissioned in April 2021 with a design life of approximately 25 years
- Decommissioning: the RO expansion is anticipated to be rehabilitated after its design life. An assessment of the decommissioning works will be undertaken during this phase

Spatial scope

The Project is located in Al Wakrah Municipality, which has an approximate total population of 299,000 (MPDS, 2015). Al Wakrah is the nearest sensitive receptor to the Project, which is located approximately 3.5 km to the north of the site. There is a public beach located adjacent to the Project site, as well as a gated beach area located 1.3 km to the north of the site developed by the MME. These beach areas are used for recreational activities including swimming, quad biking and camping. The indicative map of nearby sensitive receptors relative to the Project area is illustrated in Figure 5-1 while Table 12-1 provides the GPS coordinates.

The socio-economic conditions of the assessment area is discussed in the succeeding sections.

Table 12-1: GPS co-ordinates of sensitive receptors

Sensitive receptor	Approximate distance to Project site	GPS co-ordinates (WGS84)	
		Latitude (N)	Longitude (E)
Al Wakrah Town	3.5 km	Refer to Figure 5-1	
Al Wakrah Family Beach	1.6 km	25° 7'45.00”	51°37'1.74"

Sensitive receptor	Approximate distance to Project site	GPS co-ordinates (WGS84)	
		Latitude (N)	Longitude (E)
Wakrah coast guard station	0.5 km	25° 7'16.23"	51°37'5.63"

12.2.1 Stakeholder engagement

Social impacts of the proposed RO expansion were verified through consultation with key stakeholders. Issues and concerns of identified sensitive receptors were also considered in the assessment. Stakeholder consultation undertaken for the Project is provided in Chapter 5.

12.2.2 Identification and evaluation of impacts and mitigation/enhancement measures

Potential impacts, both positive and negative, were identified based on the existing conditions prevalent in the area. Mitigation measures were identified to manage adverse impacts while enhancement measures were enumerated to improve Project's benefits.

12.3 Legislative framework and applicable standards

An overview of the socio-economic and labour policies, standards and strategies relevant to the Project is summarised below and detailed in Chapter 3.

Qatar guidelines

Key laws including components of labour as well as health and safety are as follows:

- Labour Act No. 3 of 1962
- Law No. 14 of 2004 the Labour Law
- Law No. (1) of 2015, amending some provisions of the Labour Act No. (14) of the year 2004
- Cabinet Resolution No. 16 of 2011 formed the National Committee of Occupational Health and Safety at the Ministry of Labour
- HSE Regulations and Enforcement Directorate

International Requirements

Equator Principles

The Equator Principles provide an environmental and social policies, procedures and standards for financing projects. The EP identified 10 principles that provide a framework for the assessment of projects and ensure that projects are developed in a socially responsible manner and reflects sound environmental management practices.

Principles relevant to socio-economic and health assessment include the following:

- Assessment of baseline socio-economic conditions
- Identification of socio-economic impacts
- Land acquisition and resettlement (not relevant to the Project)
- Indigenous people and their unique culture and values (not relevant to the Project)
- Cultural heritage and property (scoped out; refer to Section 2.1.2)

- Health, safety and security

IFC Performance Standards

The IFC has published Performance Standards to identify risks and impacts and are designed to help avoid, mitigate and manage risks and impacts. The Performance Standards relevant to the assessment and management of social risks and impacts include:

- Performance Standard 1: Assessment and Management of Environmental and Social Risks
- Performance Standard 2: Labour and Working Conditions
- Performance Standard 4: Community Health, Safety and Security
- Performance Standard 8: Cultural Heritage

World Bank EHS Guidelines

The World Bank Environmental Health and Safety (EHS) Guidelines contain information on the performance levels and measures that are generally considered to be achievable in new facilities. World Bank EHS Guidelines relevant to the Project are the following:

- World Bank General EHS Guidelines (April 2007)
- EHS Sector specific guidelines on Water and Sanitation (December 2007)

International Labour Organization

Qatar has ratified five of the eight fundamental ILO conventions and one governance convention out of four as follows:

- Fundamental Convention
  - C138 - Minimum Age Convention, 1973 (No. 138) (Minimum age specified: 16 years)
  - C182 - Worst Forms of Child Labour Convention, 1999 (No. 182)
  - C111 - Discrimination (Employment and Occupation) Convention, 1958 (No. 111)
  - C105 - Abolition of Forced Labour Convention, 1957 (No. 105)
  - C029 - Forced Labour Convention, 1930 (No. 29)
- Governance Convention
  - C081 - Labour Inspection Convention, 1947 (No. 81)

12.4 Baseline

12.4.1 Population and demography

Qatar has an estimated population of 2.63 million people (July 2018)[14]. Around 88.4% of Qatar's population comprises foreign expatriates with the remaining 11.6% being Qatari nationals[15]. The population growth rate of Qatar is 1.95% (2018 estimate)[16] which is largely attributable to immigration with 11.5 migrants per 1000 population emigrants (2018 estimate)[17].

According to Central Intelligence Agency (2018), the population of Qatar has the following associated demographics:

- The population growth rate is 1.95% (2018 estimate)

[14] (Central Intelligence Agency, 2019)
[15] (Central Intelligence Agency, 2019)
[16] (Central Intelligence Agency, 2019)
[17] (Central Intelligence Agency, 2019)

- Total dependency ratio is 17.5 (2015 estimate), with youth dependency ratio of 16.3 and elderly dependency ratio of 1.3
- The median age is 33.4 years with 34.6 years for males and 28.2 years for females (2018 estimate)
- The proportion of males to females is much greater in the working age population (Table 12-2 and Figure 12-1
- Most of the population is clustered in or around the capital of Doha on the eastern side of the peninsulas with 99.1% of the population living in urban areas. The largest proportion of urban dwellers live in Doha (633,000 – 2018 estimate), which is approximately 10 km north of the Project site.

Table 12-2: Gender ratio of Qatari people

Age group	Ratio of males to females
At birth	1.02
0–14 years	1.02
15–24 years	2.52
25–54 years	4.98
55–64 years	3.35
65 years and over	1.85
Total population	**3.41 (2018 estimate)**

Source: (Central Intelligence Agency, 2019)

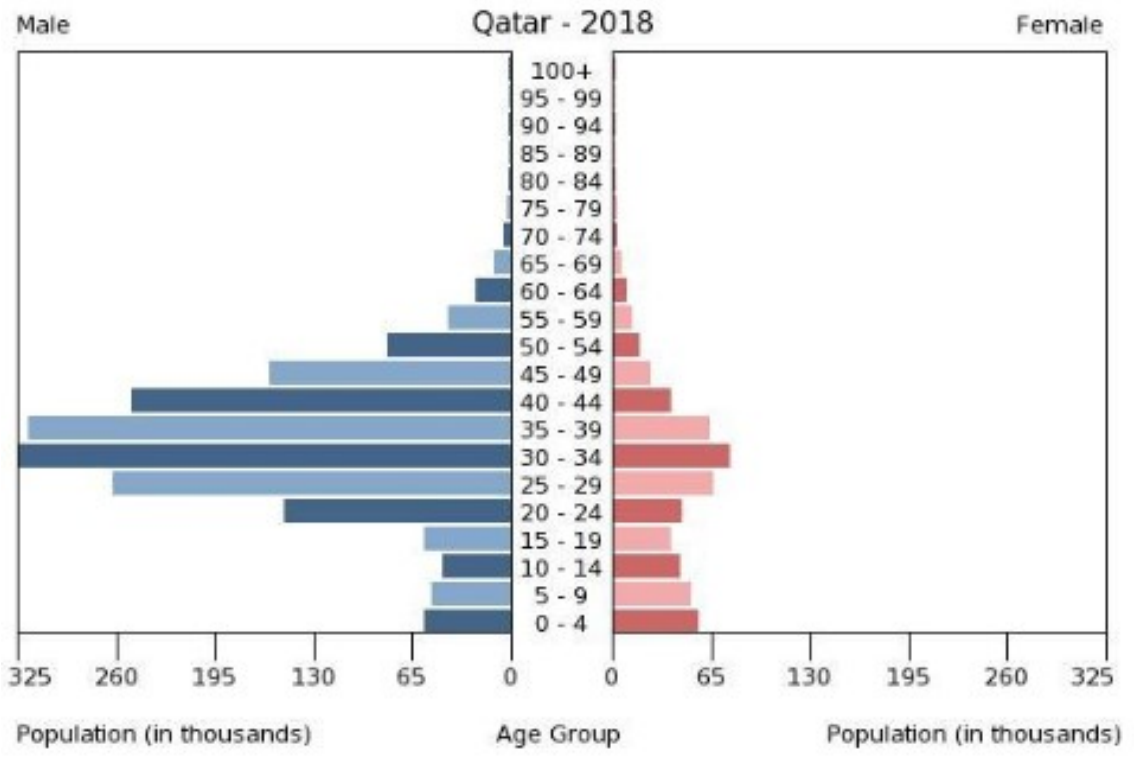

Figure 12-1: Population pyramid of Qatar

Source: (Central Intelligence Agency, 2019)

12.4.2 Economy, employment and labour market

Qatar's main economic engine and government revenue source is its oil and natural gas resources, driving the country's main economic growth and per capita income levels, robust state spending on public entitlements and booming construction spending (Central Intelligence Agency, 2019).

Based on 2017 estimates, Qatar's economy is dominated by industry which constitutes 50.3% of Gross Domestic Product (GDP) followed by services (49.5%), The main industries include liquefied natural gas, crude oil production and refining, ammonia, fertilizer, petrochemicals, steel reinforcing bars, cement and commercial ship repair. The oil and gas industries in Qatar have led the country having the world's second highest GDP (USD124,200) after Leichtenstein (2017 estimates).

Based on 2017 estimates, Qatar has a total labour force of 1.95 million and an unemployment rate of 8.9%, a significant increase from 0.3% in 2015. As with to other countries in the Middle East, migrant workers comprise a significant proportion of the Qatari labour force. Migrant workers have fewer rights under the national legislation than Qatari workers (example, they are not allowed to form or join trade unions independently). As such, the potential for human and labour rights violation is higher for migrant workers as compared to local workers.

12.4.3 Current land use

Immediately southwest of the site is the Umm Al Houl Economic Zone (EZ), which is a 33.52 km2 development immediately adjacent to the new Doha port project and will predominantly focus on petrochemical, building material, maritime. Logistics and food processing industries (Mott MacDonald, 2016).

The proposed RO expansion is located immediately north of the existing Umm Al Houl IWPP, which is government owned land having been allocated to the Qatar General Electric and Water Authority, KAHRAMAA, and IWPP by the Ministry of Municipality and Urban Planning (MMUP). There are no development or livelihood activities in the project affected area (Mott MacDonald, 2016).

12.4.4 Use of natural resources

There is universal access to improved drinking water (100%) and sanitation (98%) in both rural and urban areas in Qatar (Central Intelligence Agency, 2019). About 98% of Qatar's population has access to electricity (2012 estimates).

The total installed capacity (100%) of electricity comes from fossil fuels while a small percentage (1%) comes from renewable resources (Central Intelligence Agency, 2019). The single largest source of water consumed in Qatar comes from desalinated sea water (approximately 50% of water used in 2009) (QNDS, 2011).

12.4.5 Language, ethnicity and religion

Arabic is the official language of Qatar, while English is considered as the second language and understood nationwide. Qataris are considered minority with about 15% and the remaining 85% is comprised of migrants of over hundred different nationalities (Online Qatar, 2019). The ethnic groups in Qatar are Arabs (13%), Indian (24%), Filipino (11%), Nepali (16%), Sri Lankan (5%), Bangladeshi (5%) and others (11%). About 67.7% of the population in Qatar is Muslim, followed by 13.8% Hindu, 13.8% Christians, 3.1% Buddhist, less than 1% Jewish, 0.7% other faiths and 0.9% religiously unaffiliated (Online Qatar, 2019).

12.4.6 Poverty and vulnerable groups

Migrant workers are considered to be the most vulnerable potentially affected people by the proposed RO expansion. Migrant work, which constitutes 95% of Qatar's labour force[18], are vulnerable due to the following factors[19]:

- The Kafala system of sponsorship-based employment which legally binds foreign workers to their employers, restricting all workers' ability to change jobs and still preventing many from leaving the country without their employers' permission
- Late and non-payment of wages, exacerbating high levels of worker debt caused by illegal and unethical recruitment practices
- Barriers to obtaining justice when rights are violated
- Prohibition of workers' organizations
- Failures in the enforcement of Qatar's laws that are supposed to protect workers' rights

In October 2017, the International Trade Union Confederation announced Qatar's agreement with ILO to extensive reforms of current *kafala* (sponsorship) system, institute a non-discriminatory minimum wage, improve payment of wages, end document confiscation or the need for an exit permit for workers wanting to leave the country, enhance labour inspections and occupational safety and health systems, refine the contractual system to improve labour recruitment procedures, and step up efforts to prevent forced labour[20].

Qatari women do not have equal status to men under Sharia Law. Qatar does not allow dual nationality and discriminate against women by not allowing them to pass nationality to their children on the same basis as men[21]. However, women are generally well-educated and, if employed by the Project, would be afforded similar employment rights to men by law[22].

12.4.7 Health and education

Health

The life expectancy in Qatar is 79 years (76.9 years for men and 81.2 years for women), making it 53rd highest in the world[23]. Based on 2017 estimates, Qatar has one of the lowest prevalence rates of HIV/AIDS in the world with 0.1%. Thirty-five percent (35%) of the population is categorised as obese based on 2016 estimates[24].

The World Health Organization (2015)[25] reported that diseases in Qatar in 2012 were attributable to communicable diseases (7.7%), non-communicable diseases (69.0%) and injuries (23.3%). The total expenditure of Qatar on health in 2014 is 2.2% of the total Gross Development Product (GDP).

In 2016, there were 2.78 physicians per 1000 population, a ratio comparable with United Kingdom (2.81) and the United States (2.59)[26]. The ratio of hospital bed density in 2014 is 1.2 beds per 1000 population, a ratio lower than most countries belonging to the Gulf Cooperation

[18] (Amnesty International Ltd, 2019)
[19] (Amnesty International Ltd, 2019)
[20] (Harding, 2018)
[21] (Harding, 2018)
[22] (Mott MacDonald, 2016)
[23] (Central Intelligence Agency, 2019)
[24] (Central Intelligence Agency, 2019)
[25] (World Health Organization, 2016)
[26] (Central Intelligence Agency, 2019)

Council (i.e. Saudi Arabia: 2.7 beds/1000 population and Kuwait: 2 beds/1000 population)[27]. The closest medical facility is the new Al Wakrah Hospital (Al Wakrah City) which is approximately 6 km from the site. Al Wakrah Hospital is one of the largest healthcare facility in Qatar with a combined staff of 3000 including 217 doctors and it provides emergency, general surgery and medicine as well as dental and psychiatric care[28].

Education

Qatar has high literacy rate of 97.3% (2015 estimate) (97.4% for men and 96.8% for women)[29]. Both male and female spend on average 14 years in education (primary, secondary and tertiary). In 2017, the total expenditure of Qatar on education is 2.9% of its GDP.

12.5 Environmental impact prediction and evaluation

12.5.1 Construction

12.5.1.1 Socio-economic impacts

Employment generation

During the construction phase, a significant positive impact of the Project will be the generation of employment and business opportunities. The Project is anticipated to employ approximately 1,873 workers during the peak of construction, which will generally comprise of construction labourers and skilled trades people.

Employment generation will provide income for workers and subsequently maintain and/or improve the standard of living of their respective families. The workers' wages will also contribute to the local economy as a result of multiplier effects. Multiplier effect means that additional money earned locally will be used to purchase goods and services that may add investment in local businesses, which may in turn provide indirect employment opportunities. Local businesses that may positively be benefited include food and beverage as well as accommodation establishments (where accommodation is not provided to labourers by the contractors). If accommodation is provided by contractors to labourers, this would potentially generate income in the goods and services industry such as catering/kitchen staff, laundry services, etc. Business opportunities that are anticipated to contribute to the overall economic growth of Al Wakrah include trading of materials and equipment rental.

12.5.1.2 Health and safety risks

Workforce accommodation and labour conditions

Poor management of labour and working conditions is the greatest risk associated with job creation; which is most relevant for migrant construction workers. The use of worker's accommodation offsite pose potential health, safety and security risks to workers if not managed appropriately. Issues that may arise include sanitation and lack of clean water, inappropriate food, overcrowding, as well as poor ventilation and temperature control which may lead to illnesses.

As per existing policies and practices in Qatar, majority of the construction workforce are provided with accommodation. As such, accommodation facilities will be provided to workers during the construction phase, preventing potential impacts on availability/adequacy of social facilities and infrastructure.

[27] (Central Intelligence Agency, 2019)
[28] (Al Wakrah Hospital, 2019)
[29] (Central Intelligence Agency, 2019)

Existing labour camps used by the Contractors engaged by the Proponent are located in Nass (Camp No. 20) Asian Town and Qatar Real Stated Investment Company 1 & 2 Messaieed. Transportation services from labour accommodations to the Project site will be also provided by the contractor(s). In addition to the labour accommodation, some staff would be permanent employees or contractors living locally or within the vicinity of the Project. Separate arrangements will be put in place for these types of workers to comply with the local and international requirements.

Whether existing labour accommodation will be used or temporary/permanent facilities will be established, it should meet the requirements of the following standards:

- *Qatar Ministerial Decision No. 18 of 2014 Setting the Conditions and Specifications for Workers' Accommodation* (21 November 2014)[30]. Pursuant to this Decision, an employer shall:
  - Equip accommodations with fire extinguishers, smoke detectors and an alarm system
  - Appoint a specialised one health and safety officer
  - Submit a safety emergency plan
  - Appoint a qualified resident nurse or doctor
- Worker Accommodation Planning Regulations (03 March 2016)[31]. This regulation specifically address the following development requirements:
  - Individual, communal and recreational spaces
  - Safe and security
  - Sanitary and laundry facilities
  - Catering facilities and potable water
  - Recreational, leisure, sports and open space facilities
  - Healthcare, first aid and medical services
  - Access to purchase daily goods
  - Religious facilities
  - Emergency and fire safety facilities
  - Transportation

If the above standards are adhered to, then the standard of living for the personnel working on the Project would be deemed acceptable and will not pose adverse impacts.

Occupational Health and Safety

The workers or staff members at the Project site could be exposed to various occupational and safety hazards (OHS) risks (e.g. exposure to heat, noise, electrical hazards, fire and explosion, fall from height, inhalation of toxic chemicals, dangers associated with general construction equipment and materials, etc.) which are inherent to construction works. Contractors will be required to develop safe work methodologies to ensure protection of workers from injuries or ill

[30] (European University Institute & Gulf Research Center, 2019)
[31] (Ministry of Municipality and Environment, 2016)

health effects. The Proponent, through the contractors, will ensure that construction work will meet all Qatar Labour Law and HSE requirements.

Protecting the workforce

It is considered that low or unskilled construction migrants will form the majority of workers employed during the construction phase. Unskilled migrants are poorer and have limited rights than nationals; therefore considered to have high sensitivity.

Child labour and forced labour will not be tolerated at all phases of project development. The Proponent will ensure that safety and protection of workers will be prioritised. A Human Resource Management Plan will be prepared to ensure that employment of juveniles (defined as any person who is 15 years of age or older but has not yet reached 18 years[32]) and forced labour will be avoided. In the event juveniles are employed (e.g. on-the-job training), special permit from the Minister of Labour and Social Affairs must be obtained. Appropriate measures to protect their rights will also be established. Appropriate penalties and disciplinary action will be imposed in case of child labour, forced labour and other forms of workers' right violation.

The Proponent will ensure that its contractors, suppliers and operators will comply with its Human Resource policies and procedures.

Conflict between workers and local residents / occupants

The potential influx of large number of construction workers can be a challenge to the local communities located close to the Project site. Some residents may find behaviour of the workers a nuisance/disturbance (e.g. hanging around and utilising areas in the local communities during rest breaks). Behavioural or cultural differences and misconduct (e.g. littering) by construction workforce may result in public health and safety concerns. The Project site is located approximately 3.5 km from the nearest town, the Al Wakrah Municipality. The nearest receptor are the public beach and gated beach located about 1 km from the site. Considering the location of the site, opportunities for conflict between the workers and local residents to arise is considered limited.

Possible conflict may also arise due to competition with basic resources (e.g. water and sanitation, health and transportation, etc.). To prevent this situation, workers will be provided with proper compensation package including provision of health benefits, accommodation facilities and transportation.

12.5.2 Operation

12.5.2.1 Socio-economic impacts

Employment generation

The Project is anticipated to generate a long term employment opportunities as it requires full time staff to oversee the entire operation of the RO expansion. The works will generally be classified as medium to high skills. As with the current trade in the Gulf Region, employees will likely consist mostly of expatriates although priority will be given to Qataris.

During the operation phase, staff will be permanent employees rather than on short-term contracts providing greater job security.

Production of desalinated water

The proposed Project is anticipated to generate approximately 275,488 m^3/day of desalinated water. Given the limited supply of potable water in the State of Qatar (as discussed in Section

[32] (International Labour Organization , n.d.)

1.3 Project rationale), the Project is anticipated to provide a beneficial impact on Qatar's water supply security and, therefore, the general public, businesses and industry that need water.

12.5.2.2 Health and safety risks

The operation of the RO expansion project have associated OHS risks, which require control measures to ensure protection of workers. The workplace OHS risks during facility operation include personal accident or injury from exposure to noise, use of heavy equipment, trips and hazards; exposure to potentially hazardous chemicals used to desalinate the water as well as working in confined spaces and potential explosions.

During the operation phase, the greatest risk is the potential to contaminate drinking water be it through accidental contact with chemicals or intentional sabotage, which may reduce the quality and/or quantity of water supplied. However, given the safety checks of potable water quality as well as numerous staging areas and guarantee quality, this risk is considered unlikely.

12.6 Mitigation measures

The following measures will be implemented during all phases of the Project (e.g. construction, operation and decommissioning).

12.6.1 Enhancement measures for positive impacts

The enhancement measures will be implemented to optimise the beneficial impacts of the Project.

Priority given to local workforce and companies

As with the current trend in Qatar, workers will most likely consist of expatriates; however, local workers will be prioritised in line with 'Qatarization programme'. This programme of the government aims to increase the number of Qatari citizens employed in public and private sectors and to transfer skills and knowledge from expatriate to local workers. Descriptions of employment and supply chain opportunities during the construction and operation phases of the Project should be advertised via the UHP's website or communicated to the Ministry of Interior (MoI) Human Resources Department of the State of Qatar or via local papers and radio/television. Information to be communicated will include the required skill levels, indicative timeframe of recruitment and likely duration of contracts.

Priority will also be given to local suppliers and service companies, where possible to optimise the economic benefits to the State of Qatar. Initiatives that could be implemented include:

- Provide advanced notice of tenders to local and regional companies for them to be aware of the opportunities
- Simplifying of work packages so the smaller local companies are able to bid for the project

Worker's protection

All forms of forced or compulsory labour will be prohibited. Measures that will be implemented to protect or improve employment conditions for migrant workers should include:

- Develop and implement human resource (HR) policy in line with the requirements of the Qatar Labour Law and which encourages the provision of information to migrant workers prior to their arrival in Qatar. The HR policy should emphasize non-discrimination, equal opportunities and screening of contractors to prevent use of forced, compulsory or child labour.
- Regular construction labour monitoring to ensure that workers' rights are protected

- Provide specialised training and support the professional development of unskilled and/or low skilled workforce in skills required by the Project with the aim of providing longer employment opportunities to workers

12.6.2 Mitigation measures for adverse impacts

Potential adverse impacts of the Project will be mitigated through implementation of the following mitigation measures.

Safeguarding health, safety and wellbeing of workers

- *Provision of health and safety working environment*. Project and site specific Occupational Health and Safety Plan (OHSP) in line with internationally acceptable standards (ISO 14001 and OHSAS 18001), shall be developed and strictly implemented during the construction and operation phases to minimise risk to workers.
- *Human Resource Policy*. The Proponent should develop and implement a human resource policy in line with the requirements of Qatar Labour Law and Equator Principles.
- *Improved Workforce Condition and Living Accommodations*. Regular site welfare and accommodation inspections should be undertaken to ensure that the Project is compliant with Qatari and international standards in terms of working condition and living accommodations.

Safeguarding health, safety and wellbeing of communities

- *Environmental management measures*. With consistent implementation of the environmental management measures described throughout the EIA, potential nuisance/disturbance/adverse impacts (e.g. dust, odour, noise, traffic) to communities can be avoided. The site layout, construction logistics and method will consider the potential environmental, health and safety risk to the local communities. This will include review of procurement and logistics schedules to minimise deliveries as far as practicable; limit deliveries to day time hours to reduce night time noise; limit deliveries and workforce transport outside of peak hours to reduce congestion; and implementation of air and noise control measures to minimise health impacts. The Proponent will also prepare a Community Health and Safety Plan to address potential adverse impacts to the community.
- *Grievance mechanism procedure*. A grievance management procedure should be developed to ensure that all complaints are addressed appropriately and on a timely basis. Any complaints received with regard to the Project should be logged through a Complaints Register. Any feedback, both positive and negative, received will be considered by management, registered, investigated and addressed through appropriate management measures.
- *Appointment of community liaison officer (CLO)*. The Proponent or its contractor should appoint a Community Liaison Officer (or similar) to maintain a good relationship with the local communities or other stakeholder groups who may potentially be affected by construction and operation activities. Where possible, regular project updates should be disseminated to the stakeholders via Proponent's website, newsletter and / or posters onsite.
- *Use of local workforce*. Where possible, the Project should utilise the workforce currently and readily available in Qatar instead of hiring workers outside the country. This measure will subsequently minimise the impacts associated with the influx of additional foreign/expatriate workers; hence, reducing the gap between expatriates and local Qatari population as well as cultural differences.

- *Workers' Code of Conduct and Induction*. Expatriate workers should be provided with appropriate trainings to help them understand and respect culture and religion in Qatar. This should also include rules and practices to be observed to ensure the harmony between community and foreign workers.

12.7 Summary of impacts, mitigation and residual significance

The impacts of the project before and after implementation of mitigation measures are provided in Table 12-3.

It is anticipated that the Project will have a net positive impact from construction and operation activities through the provision of employment and business opportunities as well as simulation of the local and regional economies.

With the completion and operation of the Project, the country will have sufficient supply of water to support Qatar's development plans.

Table 12-3: Summary of impacts and residual significance – Social

Project impact	Initial impact (before implementing mitigation measures			Mitigation measures	Residual impact (after implementing mitigation measures		
	Likelihood	Consequence	Impact rating		Likelihood	Consequence	Impact rating
Construction phase							
Generation of employment	Almost certain	Moderate	High (positive)	Priority given to local workforce and companies Support Qatarization Policy	Almost certain	Moderate	High (positive)
Increased occupational health and safety risks	Almost certain	Moderate	High	Develop and implement Occupational Health and Safety Plan in line with Qater HSE standards and international standards (i.e. ILO, WB EHS Guidelines, OHSAS 18001) Implement environmental management measures	Possible	Moderate	Medium
Poor workforce condition and living accommodation	Possible	Major	High	Develop and implement HR Policy in line with Qatar Labour Law and international standards (i.e. ILO and Equator Principles) Appointment of camp accommodation manager Implement workers' grievance mechanism procedure	Unlikely	Minor	Low
Conflict between local residents and workers	Unlikely	Moderate	Medium	Implement Workers' Code of Conduct and induction program to foreign workers regarding Qatar culture and religion	Unlikely	Minor	Low

Project impact	Initial impact (before implementing mitigation measures			Mitigation measures	Residual impact (after implementing mitigation measures		
	Likelihood	Consequence	Impact rating		Likelihood	Consequence	Impact rating
Operation phase							
Employment generation	Almost certain	Moderate	High (positive)	Priority given to local workforce and companies Support Qatarization Policy	Almost certain	Moderate	High (positive)
Production of desalinated water	Almost certain	Moderate	High (positive)	Compliance with quality control measures to ensure that clean water is delivered to customers	Almost certain	Moderate	High (positive)
Health and safety risks	Almost certain	Moderate	High	Develop and implement Occupational Health and Safety Plan in line with Qater HSE standards and international standards (i.e. ILO, WB EHS Guidelines, OHSAS 18001) Implement environmental management measures	Possible	Moderate	Medium

13. Environmental Management and Monitoring Plan

13.1 Introduction

The framework Environmental Management and Monitoring Programme (EMMP) consist of actions necessary for the monitoring, reporting and auditing of the Project's environmental performance in line with the local and international requirements.

13.2 Objectives

The EMMP provides framework to facilitate the implementation and monitoring of mitigation measures in order to eliminate or minimise adverse environmental impacts of the Project to acceptable levels.

Specific objective of this EMMP are to:

- Provide mechanism for monitoring and reporting of the various environmental undertakings of the Project, which will include routine liaison with MME and other regulatory authorities.
- Define roles, responsibilities and accountabilities of parties and individuals, ensuring that all parties and individuals involved in the Project understand and adhere to the environmental management requirements relevant to their line of work.
- Set the requirements for environmental induction and training programs.

  Facilitate continuous improvement of the Project's overall environmental performance though a regular review of specific environmental management plans (EMP) and audit of the Project's compliance to the requirements.

13.3 Implementation

This framework EMMP should be employed as a guidance for design, construction and operation of the proposed expansion Project. Specific components of this EMMP will be finalised as separate management plans for each stage of construction and operation phases of the Project. Specific management measures will also be incorporated, where relevant, in the Contractors' work method statements.

Managers and supervisors are responsible for providing assurance that their work unit complies with the requirements in this framework EMMP as translated to Construction or Operation EMPs (refer to Section 13.4)

13.4 Environmental Management Plans

A Construction Environmental Management Plan (CEMP) and Operational Environmental Management Plan (OEMP) will be developed prior to the construction and operation phases of the Project to ensure that adverse environmental and social impacts of the Project are addressed. The existing Project CEMP and OEMP may be adopted for the proposed expansion Project.

13.5 Monitoring and record management

Environmental monitoring will be required throughout the Project lifecycle and should be developed according to the following objectives:

- Facilitate consistent implementation of the proposed mitigation measures.

- Assess whether the mitigation measures in place are adequate and identify any requirement for additional measures to confirm that impacts are minimised, where possible, and reduced to acceptable level.
- Assess Project's compliance to the relevant local and international environmental and social regulatory requirements / standards.

Ultimately, the program will facilitate continuous improvement of the Project's overall environmental performance. The environmental monitoring plan is provided in Section 13.7. An Environmental Monitoring Program Register should be maintained to facilitate a well-documented and accurate assessment of the Project's overall environmental performance. The register should include, but not be limited to, the following information / documents:

- Daily site inspection checklist
- Environmental monitoring results (e.g. air, noise, soil, marine, etc.) and compliance status with environmental standards
- Audit reports
- Incident reports including corrective actions
- Non-compliance reports including corrective actions
- Compliant register and management reports

The documents listed above shall prove useful in providing compliance evidence during environmental audits.

13.6 Environmental performance reporting

Reporting of the RO expansion project's environmental performance will be incorporated in the existing environmental reporting requirements (Table 13-1). All records and reports will be provided in digital formats and will be made available upon request.

Table 13-1 Environmental reporting requirements

Item	Report	Frequency of submission
1.0	Monthly Environmental Progress Report which includes monthly environmental compliance monitoring results and inspection results	Monthly
2.0	Quarterly Environmental Monitoring Report which includes: • Monthly environmental compliance monitoring results • Summary of site inspection reports • Environmental incidents / issues (if any)	Quarterly
3.0	Bi-Annual CEMP/OEMP Compliance Audit Report (to be undertaken by third party consultant), which will also include summary of the quarterly reports	Bi-Annual
4.0	Annual Environmental Monitoring Report • Summary of all monthly / quarterly / bi-annual environmental monitoring activities • Summary of annual results for air quality monitoring • Assessment of KPIs	Annual

Source: (GHD, 2018)

13.7 Environmental monitoring plan

The formulation of an environmental monitoring plan will provide assurances that the responsible entity will immediately address any adverse impact on the environmental aspects. Environmental monitoring for the proposed RO expansion will be based on the existing environmental monitoring activities at the site (refer to Table 13-2).

Table 13-2: Existing environmental monitoring programme

Component	Requirements	Key Performance Indicator (KPI)
Full ecological monitoring	Bi-annual surveys. Scope of work: • 200-m video transects with additional verification dives/drop down videos • UVC fish survey • Benthic infauna analyses • Zooplankton and phytoplankton (3 stations) • Water quality profile (continuous reading) • Incidental sightings of marine animals	Quantitative and qualitative habitat maps Diversity and abundance of marine organisms (i.e. fish, benthic infauna, zooplankton and phytoplankton)
Sensitive habitat monitoring	Quarterly surveys at eight (8) locations (3 for oysters, 3 for seagrass and 2 for control) Parameters for seagrass: coverage, height, density Parameter for oyster: abundance	Quantitative monitoring for seagrass and oyster beds
Entrainment monitoring	Daytime and night time visual monitoring Record weight of biomass entrained when cleaning the trash baskets Two sampling events per month Increase visual monitoring during fish spawning season months (March to September) and jellyfish blooming season	-
Seabed temperature monitoring	Real-time continuous temperature monitoring buoy (ΔT<3°C compliance point) at the intake and outfall location (1) Continuous seabed temperature loggers (key marine habitat locations) – 10 locations, bi-annual download	Compliance (number of exceedances, percentage) to Qatar MME standards and Environmental Permit
Seawater quality monitoring	Quarterly at 12 locations (1)	Compliance to Qatar MME seawater quality standards and Environmental Permit

Component	Requirements	Key Performance Indicator (KPI)
Marine sediment quality monitoring	Annual sampling at 12 locations [1]	Compliance to applicable Dutch standards
Cooling water discharges monitoring	Continuous for temperature, conductivity, DO, residual chlorine and TDS [1] Weekly samples to be analysed at the plant's laboratory [1] Monthly samples to be analysed at an external laboratory [1]	Compliance to Qatar MME cooling water discharge standards and Environmental Permit
Treated wastewater effluent monitoring	Continuous for pH [1] Monthly samples to be analysed at internal or external laboratory [1] Monthly samples for irrigation pond [1]	Compliance to Qatar MME water effluent standards and Environmental Permit
Noise monitoring	Quarterly noise sampling for 30 minutes (day and night) a t five locations [1]	Compliance to Qatar MME noise standards
Environmental inspections and audits	Weekly environmental inspections Monthly / quarterly internal audits Annual third party audit	Compliance to C/OEMP commitments Close-out of audit findings
Groundwater monitoring	Quarterly sampling at five locations [1]	Compliance to Qatar MME standards and Environmental Permit
Air emission monitoring	Continuous for in-stack CEMS Annual stack sampling for validation [1]	Compliance to Qatar MME emission standards and Environmental Permit
Ambient air quality monitoring	Continuous online AQMS at two locations Annual ambient air quality sampling at two locations for validation [1]	Compliance to Qatar MME ambient air quality standards and Environmental Permit

Source: (GHD, 2018)

Note: [1]Refer to Operational Environment Management Plan (GHD, 2018) for monitoring parameters and criteria.

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Appendix A – Environmental Permit for the UHP IWPP

State of Qatar
Ministry of Environment

Environment Assessment Department

Ref: 1-20274-2015
Date: 6/12/2015
MoE 700-8

Mr. Abdurrahman Al Nihma
Head of Health, safety and Environment Department
Qatar General Electricity and Water Corporation (KAHRAMAA)
Fax; 44845595
Doha

Greetings,

Subject: Environment Assessment and Permit Procedures - Project Power Plant and Water Desalination South of Wakra – Umm Al Houl (Facility D)

After the technical review of the draft environment impact assessment study submitted on the project, and the remarks and visualization of the Ministry of Environment on them and the exchange of responses and submitted documents with your letters the last was the letter from Umm Al Houl Company ref (UHP/EIA/022) which we received on 26/11/2015 and our replies the last was our letter ref (19959) dated 30/11/2015 and the meeting held between the experts at the Ministry of Environment and the company on 30/11/2015 , kindly find attached the environment permit for the project.

Please give instructions to work according to it and all general and special terms therein and during all the project stages (design , construction, operation etc) and amend the

State of Qatar
Ministry of Environment

environment impact assessment study in accordance with the remarks and visualizations of the Ministry of Environment and our reviews and our approval of the replies and documents submitted then resubmit it to the Ministry of Environment for review and approval in accordance to what have been indicated in the draft of the submitted study.

Thank you

Signature
Ahmad Abdulkarim Al Ibrahim
Deputy Environment Assessment Department Manager

Cc:

- Assistant Undersecretary for Technical Affairs
- Private Engineering Office/ Natural Reservations Sector
- Environment Assessment Department
- Environment Protection Department
- Reservations and Wildlife Department
- Information System Department
- Operations Department

State of Qatar
Ministry of Environment

Environment Permit

Project Name	:	Project Power Plant and Water Desalination South of Wakra – Umm Al Houl (Facility D)
Project Location	:	Umm Al Houl, according to the coordinates and sketches, attached with this permit ((3) maps including geographical coordinates for the project site.)
Owner	:	Umm Al Houl Power Company
Date of Issue	:	03/12/2015
Date of Expiry	:	02/12/2016

General Conditions:

1- All safety precautions must be taken while working in the project.
2- Once the project is completed, the Ministry of Environment must be notified within a period not exceeding 30 days.
3- The Ministry is entitled to omit or change and of the conditions stated in this permit as well as to add any other conditions that the Ministry may find necessary to preserve the environment.
4- The Ministry of Environment has the right to withdraw the permit in case of not conforming to the stated conditions.
5- This permit is considered cancelled if not received within one month from issuance date.
6- The Ministry bears no responsibility for any typing error in the information stated in the permit once received by the authorized person.
7- Any omission or amendment or addition in this permit, it will cancel it and the owner will be legally accountable.

State of Qatar
Ministry of Environment

8- It is necessary to keep this permit of copy thereof in the project site.

9- Coordination must be made with the competent municipality to discharge of the household waste and sewage in the treating stations and as per the applied procedures by the competent municipality.

10- Inform the Ministry of Environment in writing of any changes on the information stated in the application or attached thereto and obtain period approval before implementing any amendments (for example the site, operations, scope of work, characteristics of emissions etc).

Special Terms:

1- This permit was issued for the Project power plant and water desalination South of Wakra – Umm Al Houl (Facility D) , according to the coordinates and sketches attached with this permit (3 maps) and letters of KAHRAMAA and our replies on them among which our letter ref (6042) dated 29/5/2015 and our letter ref (10439) dated 4/8/2013 and the draft environment impact assessment study and the technical revision and the Ministry of Environment remarks and visualization of the Ministry on them and the exchange of responses and submitted documents with your letters the last was the letter from Umm Al Houl Company ref (UHP/EIA/022) which we received on 26/11/2015 and our replies the last was our letter ref (19959) dated 30/11/2015 and the meeting held between the experts at the Ministry of Environment and the company on 30/11/205 .

2- Description of the project: it is located 2.5 km to the south of Wakra city and 15 km to the south of Doha city in Umm Al Houl area. It has power energy production units in addition to water desalination units and all related facilities and units and

State of Qatar
Ministry of Environment

infrastructure that are necessary to operate the facility. The project consists of components / main and auxiliary units and as follows:

- 2,520 MW power generations based on combined cycle gas turbines running on natural gas fuel with no single unit greater than 300MW. No dual fuel capability is required.
- 136.5 MIGD potable water production:
  - 60MIGD Reverse osmosis.
  - 76.5MIGD Thermal desalination plant.
- Power blocks including: Gas Turbines, Heat Recovery Steam generators (HRSG) and Steam Turbines.
- Desalination block including: Reverse Osmosis (RO) and multi- Stage Flash Distiller (MSF).
- Seawater intake [total of 2.75km 90-1 km Dry works and 1.6- 2.75km Wet works)] and outfall [0.2.2km Dry works].
- Wastewater treatment facilities.
- Process and plant drainage systems
- Potable water facilities including: Pumping stations, Reservoirs and connection pipelines.
- Potable water disinfection facilities.
- System control and data acquisition (SCADA) connection between facility,

substations and control centres.

- Administration and support buildings including workshop, laboratory, first aid, security , storage, mosque.

3- The design and implementation of the project mentioned in this permit shall be made in accordance to the specification of the design and implementation approved by the competent authorities among which the Ministry of Municipality and Urban Planning and the Standards and Metric Authority (Qatar Construction Specifications) etc.

4- The design and implementation of the mentioned project in this permit shall be done within the location approved by the Ministry of Municipality & Urban Planning which is approved by the Ministry of Environment and this shall have all the related works and activities directly or indirectly to the project among which for example and not limited to: traffic detours, offices, car parks, collection of reclamation etc.

5- Total commitment with what is indicated in the environment permit application and all attached information and documents and all the correspondents and documents submitted by the employers and the remarks of the Ministry of Environment regarding the environment permit application and in case of contradictions the harsher action and description and text shall be applied.

6- In case of amendments or change to any of the information and /or sketches submitted among which those indicated above, then in this case an application shall be submitted to the Ministry of Environment / Environment Assessment Department for this amendments / changes and in good time to permit review and

taking decision on it and on the requirements of the necessary environment assessment and permit.

7- Due to the volume of shortage and negligence shown in the draft of the submitted study , the project's environment impact assessment study shall be amended as per the remarks and visualization of the Ministry of Environment and the reviews and approval to the replies and documents submitted and the remarks and requirements indicated in the environment permit and resubmit them to the Ministry of Environment (in complete and final form) maximum by 15/1/2016 to be reviewed and approved provided that the sections amended in the study shall be indicated and table of done amendments shall be submitted and all the replies and submitted documents in the stage of reply on the remarks and visualization of the Ministry of Environment in a separate appendix in the study.

8- This permit was issued with regard to the environment side only from the above project and the employer shall obtain all the administrative and technical approvals for the project from the competent parties and authorities in the country and shall fully conform to the indicated requirements and conditions in the entire stages of the project among which the initial, preliminary and detailed design and construction.

9- Approval and no objection shall be obtained from the Natural Reservations sector at the Private Engineering Office before starting any main or preliminary or secondary works relate to the project and any location of the project and shall fully adhere to the requirements and conditions issued by them.

10- Asbestos shall not be used in the temporary or permanent construction related directly or indirectly to the project.