Hamriyah Independent Power Project

Environmental and Social Impact Assessment

October 2018

GE Energy Financial Services / Sumitomo Corporation

Mott MacDonald
Al Ghaith Tower
Hamdan Street
PO Box 47094, Abu Dhabi
United Arab Emirates

T +971 (0)2 401 5333
F +971 (0)2 627 0734
mottmac.com

GE Energy Financial Services / Sumitomo Corporation

Hamriyah Independent Power Project

Environmental and Social Impact Assessment

October 2018

Issue and revision record

Revision	Date	Originator	Checker	Approver	Description
A	15/07/18	Project team	R. Abou-Atieh	G. Clamp	First draft for client review
B	22/07/2018	Project team	R. Abou-Atieh	G. Clamp	Submission to EPAA
C	25/10/2018	Project team	R. Abou-Atieh	G. Clamp	Final - Amended with final marine survey results and responded to the EPAA and lender's advisor comments

Document reference: 395137 | 010 | C

Information class: Standard

Contents

Tables

Figures

Executive summary

A consortium of GE Energy Financial Services Inc, a subsidiary of General Electric Company (GE), and Sumitomo Corporation (the developer or consortium) submitted a proposal to Sharjah Electricity and Water Authority (SEWA) to design, build, own and transfer a new 1,800MW independent power project (IPP, the project) within the Hamriyah power and water plant (HWPP/Hamriyah Power and Desalination complex) in the Emirate of Sharjah, United Arab Emirates (UAE).

The proposed new combine cycle power plant is designed with flexibility to accommodate gas (natural gas or imported LNG) and liquid (distillate) fuels. The proposed plant will consist of three identical power blocks and each will consist of the following key components:

- H-class gas turbine
- Heat recovery steam generators (HRSGs)
- Steam turbine

The gas turbines will operate on both natural gas/imported LNG as the main fuel or distillate oil as a back-up fuel in the event of unavailability of gas.

The project will be developed within the Hamriyah Power and Desalination complex and will be adjacent to the existing power plant, 600m south of Hamriyah Port, adjacent to and west of Hamriyah Free Zone (HFZ) about 1.2km north of Al Zahwra power and desalination plant located in the emirate of Ajman. The site location is shown in Figure 1.

Figure 1: Location of the 1,800MW Hamriyah IPP

Google Earth, Mott MacDoanld, July 2018

No marine structures will be built as part of the project. The project will use the existing intake and outfall facilities that were built to accommodate production of approximately 2500MW and 140MIGD of power and desalination water, respectively.

Environmental baseline

The project site is located on levelled reclaimed land which was used as a laydown area during construction of the intake and outfall structures. The site is currently cleared with no significant land features or drainage lines and no signs of potential ground or groundwater contamination. Sparse vegetations/shrubs exist on site.

The proposed project laydown area will be located 150m north-east of the project site. Currently the site contains stockpiled sand. The source of the sand is unknown but may be dredged material generated during construction of the intake and outfall facilities or excavated or surplus materials from construction of the complex.

Based on available data, ambient PM_{10} concentrations exceed the respective UAE daily average standard of 150µg/m^3. Although there are no applicable annual mean national standards for PM_{10} and $PM_{2.5}$, the monitored ambient values exceed the WHO guideline values. Exceedances of the PM_{10} and $PM_{2.5}$ standards are not unexpected due to the arid environment, the proximity to the sea and associated contribution of marine salts to the atmosphere and the presence of nearby industrial sources.

Exceedances were not recorded for any of the gaseous pollutants monitored (i.e. SO_2, NO_2, and CO). Considering the monitored ambient annual mean NO_2 concentrations it can be concluded that there are unlikely to be exceedances of the national ambient air quality standards which are set for one hour and 24-hour averaging periods. In addition, the annual average is well below the WHO standard which is applicable in the absence of an equivalent national standard.

The project is located within Hamriyah Power and Desalination complex and within an industrial area. The site is adjacent to the Hamriyah Port and Hamriyah Free Zone Authority (HFZA) which hosts a significant number of industries, including oil and gas processing and storage facilities.

The predominant marine habitat recorded in the survey area is hard bottom covered in sand, as would be expected in the Arabian Gulf due to it being a relatively shallow sea. Moreover, this ecological system is subject to natural pressures of high temperatures and high salinity. From the data recorded it can be extrapolated that pockets of exposed hard substrate provide 'islands' of habitat. In some areas off to the left of the existing power station inflow, there is an area of sparsely populated coral and hard bottom and hard substrate populated with pearl oysters to the right of the power station.

Key sensitive human receptors identified within the project area and its vicinity include:

- Users of the beach area adjacent to the project site
- The Oberoi Beach Resort Al Zorah in Ajman approximately 2.5km to the south of the site
- Al Zorah mangrove area approximately 2.5-3km south-east of the site
- Al Zorah villa complex and golf club approximately 2.5-3km south-east of the site
- Ajman residential area approximately 4km south-east of the site
- Rest area 40m from south-west boundary
- Residential and fishing community of Al Hamriyah to the north east of project area (approximately 3km away)

Stakeholder consultation

Stakeholder consultation was undertaken through a series of meetings and formal communications to disclose project information and record the feedback or concerns. These stakeholders include Environment Protected Area Authority (EPAA), Ajman Municipality, Sharjah Municipality, Hamriyah Free Zone Authority (HFZA), Hamriyah Municipality and EWS-WWF. No significant concerns have been raised during the meetings or communications with stakeholders.

It is noted that direct consultation with local communities is not culturally acceptable in the UAE and government or municipality departments and agencies have communicated to the Project that they will adequately represent the interests of these communities.

Construction phase key impacts

Air quality

Air quality impacts are anticipated to result from fugitive dust emissions during construction. The impact magnitude of construction activities is conservatively described as major for the whole construction period, however, not all construction activities have a high dust-raising potential and it can be considered that potential dust episodes may only occur over short periods and not throughout the whole construction phase. The assessment identified one residential receptor (the beach campers camping area) and several adjacent industrial receptors within 500m of the project boundary. The beach campers' receptor is classified as having low sensitivity as they are located approximately 230 metres from the project boundary. Adjacent industries sensitivities range from medium to negligible as they are located from directly adjacent to the project boundary to well beyond the 500m buffer to the east and north of the project boundary.

Greenhouse gases emissions (GHGs)

Sources of GHGs emissions during construction are based on current project data, methodology and emission factors taken from the plant technical specifications and World Bank guidance. Construction emissions may be in the order of 1.0MtCO2e. This is a significant impact; however, it is noted that the construction emissions are around 21% of one year's operational emissions. Therefore, in an operating period of around three months, emissions associated with gas combustion are likely to exceed total construction emissions.

Marine ecology and water quality

Dewatering activities and secondary impacts of leakages or spills of hazardous materials or sewage have been assessed to present a potential for minor impacts to marine ecology without appropriate mitigation. The project aims to avoid dewatering during construction, but in the event that dewatering is required a permit will be obtained from the competent authorities (e.g. EPAA and SM) in order to discharge dewatering effluent to the existing stormwater network or to the marine environment. Through the application of dewatering control measures such as flow control through sedimentation tanks with visual monitoring and regular water quality testing against applicable UAE standards by an approved service provider, the residual impacts are expected to be minor.

Soil, groundwater and land contamination

Soil and groundwater quality could be impacted during construction of the project, particularly site preparation activities, considering the shallow depth of the water table (1.55 to 4m bgl). Although the EPC contractor has confirmed that dry excavation will be carried out during construction, in the event dewatering activities are necessary during construction, they could lead to potential soil contamination and the need to manage significant quantities of contaminated waters. The ESIA includes mitigation measures within the marine ecology and water quality chapter and the environmental and social management and monitoring plan (ESMMP) to reduce potential impacts associated with dewatering.

Following the results of the subsurface investigation at the site, there is not expected to be significant contamination within the soils or groundwater. There remains a potential for subsurface contamination to be discovered during construction activities, but any such contamination will be managed and addressed by the EPC contractor in accordance with the CESMMP.

Earthworks may potentially include piling and excavations associated with new structures as well as trenches for service interconnections. Piling presents a potential pathway for any currently unknown existing soil contamination to impact groundwater.

Construction activities will involve the use of potentially hazardous substances would be used, such as oils, lubricants and fuels. In addition, sewage will be generated by the the construction workforce. Accidental spills or leakages of hazardous substances may result in local contamination of soils, with potential implications for groundwater, surface water and human health.

Waste management and material use

The environmental impacts of generated wastes associated with the construction phase of the project will be short-term and mostly reversible impacts. These potential impacts will be effectively managed through a construction waste management plan that will be developed by the EPC contractor as part of the detailed CESMMP.

While quantities of hazardous materials and wastes onsite are anticipated to be relatively low, the assessment has identified potential for minor adverse impacts to soils, groundwater and secondary impacts on the marine environment should leakages or accidental spills occur. This potential impact has been classified as minor to insignificant based on the expected implementation of an environmental incident and spill response procedure as part of the CESMMP.

Excavated spoil from construction will be reused on site wherever practicable. Consequently, volumes of waste spoil are predicted to be low in comparison to the volumes of waste generated in the Emirate of Sharjah overall and the significance of impacts of materials used and waste generated at the construction phase prior to mitigation is assessed to be minor.

Noise and vibration

Results indicate that noise levels from the construction works at the closest noise sensitive receptor (rest area located approximately 40m south of the site perimeter) are not expected to exceed the 60 dB(A) noise level limit of the UAE Federal Environment Agency for daytime impacts during all stages of the work. The impacts would be lower at all other, more remote, receptors. The overall assessment concluded that construction noise is expected to result in minor adverse impacts at the rest area receptor location during site clearance and preparation, excavation and ground works and site road, paving and hard standings phases and negligible impacts during all other project stages. The assessment additionally demonstrated negligible impacts during all stages of construction at all other residential receptors, including Hamriyah Town (<36 dB(A)), Oberol Beach Resort (<36 dB(A)) and Al Zorah Golf Club noise sensitive receptors (<35 dB(A)).

It should also be noted that noise level limits of the UAE Federal Environment Agency's '*Requirements for the Reduction of Construction and Demolition Noise*' are expected to be met if the receptor area is classified as '*Residential Areas with Some Workshops & Commercial or near Highways*'. This is because the upper limit is 60 dB(A) for daytime impacts.

Terrestrial ecology

The site is reclaimed land that has been cleared and levelled with no significant land features or drainage lines. The site comprises low vegetation cover, with limited number of common species, dominated by *Tetraena qatarense*. No trees were observed, and no signs of small mammals or reptiles were noticed. Overall the impact to terrestrial ecology during the construction phase has been assessed to be not significant.

Wastewater management

The environmental impacts associated with wastewater management during the construction phase of the project will be short-term and mostly reversible impacts. These are related to the generation, storage, handling and final disposal of wastewater streams from the discharge of dewatering water, washdown water from construction facilities, vehicles, and concrete batch plants, as well as any sewage generated by the workforce. These potential impacts will be effectively managed through a construction wastewater management plan developed by the EPC contractor as part of the CESMMP.

Socio-economic issues

Construction of the project has been assessed to provide a minor beneficial socio-economic impact to migrant labourers through employment generation.

It is estimated that at peak construction there will be 1,150 workers on site with a total of 1,550 during the full construction period and all are likely to be migrant workers. Migrant workers pose social risks with respect to human rights and health disparities UAE nationals are afforded better health care than is likely to be available to the migrant workers used on this project, although all workers will be provided with health insurance at least to a basic standard. These risks are most relevant for migrant subcontracted construction workers, as oversight of labour issues can be more difficult for the project company to manage among subcontractors. Typical risks in the region can include poor accommodation provision, retention of workers' passports, payment of exorbitant fees by workers to recruitment agents, workplace accidents and injuries and health-related issues related to working in extreme temperatures. Risks to workers' rights will be carefully managed and mitigated through the adoption and implementation of appropriate measure as defined within the environmental and social management and monitoring plan (ESMMP) framework of this ESIA study.

Impact on biodiversity, in particular reduction of fish stocks due to entrainment of plankton, eggs or fish larvae, may reduce fisheries' stocks, which would potentially impact the livelihood of traditional fishermen from Al Hamriyah. The Ajman Municipality has indicated that they will provide an alternative site and relocate the local fishermen belonging to the Al Hamriyah Cooperative Association for Fisherman. Based on information available at this time, we do not consider that the fishermen will experience adverse impact from relocation to an alternative site, as they are highly likely to be Emiratis who receive appropriate protection and social welfare provisions from the state. Thus, combining low sensitivity and minor magnitude, this impact is considered to be minor adverse.

Construction works to take place on the project site may disrupt access to the amenities available on the adjacent beach, which is used by recreational campers and tourists. Given that the disruptions will likely affect a small number of local residences and there are several alternative beaches with amenities in the Emirate of Sharjah and neighbouring emirates, combining low sensitivity and minor magnitude, this adverse impact is considered to be minor.

Traffic and transport

The number of anticipated additional vehicle movements during the construction phase is assessed to be low in comparison to existing traffic volumes and capacity of the road network in Sharjah and surrounding areas. Overall the significance of impacts with respect to traffic and transport at the construction stage prior to mitigation is assessed to be insignificant. A traffic management plan (TMP) will be required as part of the site management plan.

Cultural heritage

As the construction work will take place within the boundaries of the existing SEWA complex, the impact on archaeology and cultural heritage is anticipated to be not significant. A ‘chance finds procedure’ will be developed by the EPC contractor and included within the CESMMP.

Landscape and visual impacts

Given the existing extent of industrial development in the immediate surrounding area, the significance of impacts on the surrounding landscape prior to mitigation is assessed to be not significant.

Operational phase key impacts

Air quality

Nitrogen dioxide (NO_2) is the only significant pollutant emission from gas fired power plants and advanced air dispersion modelling has been undertaken to assess the potential for impacts on air quality.

The proposed main stack height of 60m will provide adequate dispersion of NOx from the plant when operating on natural gas. Across the range of normal gas-fired operational scenarios, the modelling demonstrates that the maximum predicted NO_2 process contribution based on five years of meteorological data is 127.0µg/m^3. This is approximately 32% of the national standard and results in a predicted environmental concentration of 176.0µg/m^3 which, is below 50% of the national standard. The results show that the 1-hour 99.79th percentile process contribution is 64.1µg/m^3 which, is approximately 16% of the national standard and results in a predicted environmental concentration of 113.1µg/m^3. This indicates that the highest predicted one-hour impacts would be limited to a small number of hours a year. The maximum 24-hour process contribution concentration is approximately 22% of the daily average standard. No exceedances of the annual WHO guidelines are expected as the annual process contributions are less than 10% of guideline and located within the industrial area. In accordance with the significance criterial adopted for the assessment the predicted impacts for all averaging periods are considered insignificant.

The proposed bypass stack height of 45m will provide adequate dispersion of NOx from the plant when operating on natural gas. In general, the modelling shows that air quality impacts will be lower with the proposed project operating on open cycle mode using the bypass stack, compared to combined cycle mode using the main stack. This is due to the increased exhaust gas temperature as there is no heat recovery operating in open cycle mode. The modelling results if the 1-hour 99.79th percentile is considered is significantly lower, with a process contribution of 8.4µg/m^3. This demonstrates that the highest one-hour contribution is not expected to occur frequently. The maximum 24-hour process contribution concentration is approximately 9.4% of the daily average standard. In accordance with the significance criterial adopted for the assessment the predicted impacts for all averaging periods are considered insignificant.

Under abnormal operational scenarios, firing on fuel oil may be necessary in emergency cases and not on a permanent basis. Modelling demonstrates that the maximum process contribution predicted based on five years of meteorological data is 280.1µg/m^3 which, is approximately 70% of the national standard and results in a predicted environmental concentration of 329.1µg/m^3 which is within the national standards. The 1-hour 99.79th percentile is considerably lower, with a process contribution of 134.2µg/m^3. This demonstrates that the highest one-hour contributions are not expected to occur frequently and therefore the likelihood of fuel oil operation coinciding with the worst case meteorological conditions which would result in the highest process contributions occurring is unlikely. The maximum 24-hour process contribution concentration is approximately 47% of the daily average standard although it is unlikely that the proposed project would operate for 24 consecutive hours of fuel oil firing unless there was an emergency with gas supply. In accordance with the significance criterial adopted for the assessment the predicted impacts for all averaging periods are considered insignificant.

Cumulative impacts have been assessed through consideration of existing ambient air quality baseline within the project area. Air quality monitoring data provided by HFZA for one year (2017) is considered sufficient for the overall assessment.

Greenhouse gases

Sources of greenhouse gas emissions that have been considered are from natural gas combustion during the operational phase of the project. The calculations were based on current project data, and the methodology and emission factors taken from the plant technical specifications and World Bank guidance. This assessment quantified the emissions associated with the plant running under design conditions. The calculated emission can be summarised as:

- The overall GHG emissions from the operational phase are estimated to be 4.84MtCO_2e per year
- The potential GHG emissions from electricity production by the project are 4.78MtCO_2 per year less than if the electricity was generated according to the current national grid average emissions factor.
- The project is expected to produce around 324gCO_2 per kWh, which is in line with the typical performance from a new gas fired thermal power plant. This is at the lower end of the typical ranges presented in Table 4 of the IFC Environmental, Health and Safety Guidelines for Thermal Power Plants (325-439g CO2/kWh for CCGT).

A best available technique (BAT) study that was undertaken as part of this ESIA (see full study in Appendix B) demonstrated that given the efficiency of the proposed CCGT is best available technology for this plant.

Marine ecology and water quality

Expected impacts during the operation of the power plant include:

- Entrainment at the pumping station intake - Abstraction of water has the potential to draw fish into the water pumping system to either be trapped on the intake screens or to pass through these into the water circuit
- Changes to water quality due to discharge of cooling water with consequent temperature rise and a potential increase in contaminant concentrations which is likely to impact on marine habitats and associated benthos, mammals and fish

The proposed Hamriyah power station and existing 20 MIGD desalination plant will result in a maximum worst-case combined discharge of water approximately 0.5 - 1ppt above existing salinity which is well within the 5% threshold outlined in Abu Dhabi's marine water quality standards, resulting in maximum mixing areas of 0 ha. While surface temperatures are increased over a maximum mixing zone area of 235.7ha, it will be cooled as it mixes with the seawater and the sea bed mixing zone area is therefore 2 ha, that is likely be contained within the outfall channel. The average surface water temperatures which have a mixing zone area of 81.4 ha, is likely to be contained within the port area, which is approximately 100 ha.

There is a possibility that marine fauna could become entrained at the intake structure. The design includes screens, barriers/fenders and other structures to prevent marine fauna from being trapped in the pipelines. A procedure for returning any live entrained fauna to the sea will be developed as part of the OESMP. Dead organisms will be required to be disposed of in approved landfills.

Soil, groundwater and land contamination

The main potential land quality impacts for the project during the operation phase are associated with the use, transport and storage of hazardous materials and liquid waste disposal. Impacts to soil and groundwater may result from leaks and spills from the dedicated chemical stores, wastewater collection basins/sumps, dedicated waste management areas and uncontrolled drainage of contaminated run-off from hard surfaced areas due to poor maintenance of drainage system and waste management system.

Impacts may result from the use of pesticides and fertilisers on landscaped areas. Excess usage of chemicals, or usage at inappropriate times (such as prior to heavy rainfall) can result in leaching to underlying soils.

Impacts may also result from incidents such as firefighting, including the infiltration of contaminated waters into the subsurface and dispersion of airborne contaminated material to surrounding areas, with the potential to impact both human health, land and water quality.

Best practice management procedures will minimise potential impacts

Waste management and material use

Environmental impacts of generated wastes associated with the operational phase of the project are associated with the production, management and handling of a number of waste streams, hazardous and non-hazardous. Potential impacts will be effectively managed through a detailed waste management plan (WMP) that will be developed as part of the operational environmental and social management and monitoring plan (OESMMP). The production of a detailed WMP for all operations at the project will be fundamental to ensuring best practice waste management is undertaken and embedded into the operational philosophy of the project.

While quantities of hazardous materials and wastes onsite are anticipated to be relatively low, the assessment has identified potential for minor adverse impacts to soils, groundwater and secondary impacts on the marine environment should leakages or accidental spills occur.

The operational phase overall potential impact is expected to be minor to not significant based on the implementation of an environmental incident and spill response procedure as part of the CESMMP.

Noise and vibration

The main noise impacts during operation are expected to arise due to the continuous operation of the plant and equipment to be installed on the site.

Adverse noise impacts from operation of the plant and equipment associated with the project have been assessed through noise modelling. The results of predicted noise levels show that the combined noise levels from all plant to be installed is expected to be no greater than 36.9dB(A) at Hamriyah Town, Oberol Beach Resort and Al Zorah Golf Club noise sensitive receptors. This is below the day and night-time noise limit values and contributes to a negligible increase to existing ambient noise levels. The day and night-time noise impacts at these receptors are therefore assessed as negligible.

Noise levels at the rest area, which is located approximately 40m south of the southern site boundary, are predicted to be 60.8 dB(A) which marginally exceeds both the 60dB(A) limit for the daytime period. For the night time period the existing baseline noise already exceeds the 50dB(A) limit in Article 42 of Local Order No. 61. The addition of the IPP is predicted to increase night time noise levels by 3.8dB(A). The change in ambient noise level is marginally above 3dB during the day time periods. The day and night-time noise impacts at the rest area location is assessed as moderate.

It should be noted that the classification of this receptor is unclear due to the uncertainty of its use. It is understood that security staff use the area periodically when working in the HFZA area. It is also noted that this assessment is based on a conceptual design using the assumptions stated above. It is recommended that the calculation of operational noise impacts at this location is revised as design details become more certain. If moderate impacts are confirmed consideration should be given to relocating these buildings or providing additional noise attenuation to the existing structures

Terrestrial ecology

No impacts on terrestrial ecology have been identified in the operational phase.

Waste water management

Potential impacts will be effectively managed through a wastewater management plan that will be developed as part of the operational environmental and social management and monitoring plan (OESMMP) or the environmental management system. As a result any impacts related to wastewater are expected to be minor.

Socio-economic

Operational phase employment and increase in availability of electricity generation in Sharjah have been assessed as not significant to minor beneficial impacts. Through development and compliance with health and safety management system requirements and procedures including incident, emergency and fire preparedness and response, the potential for occupational health and safety risks to operational staff has been assessed from moderate to minor adverse. The operational phase presents opportunities for beneficial impacts through Emiratisation, which is a UAE government initiative to preferentially give suitable employment opportunities to Emiratis. Given the low number of additional operational staff or trainee positions likely to be associated with the project post-construction, the significance of the beneficial impact has been assessed to be not significant.

Traffic and transport

Additional land-based vehicle movements in the operational phase have been assessed to be negligible and where feasible, waste collection, will be incorporated within the existing trips required by the existing SEWA power and desalination station’s operation. The residual impact has subsequently been assessed to be not significant.

Cultural heritage

No impacts to cultural heritage have been identified in the operational phase.

Landscape and visual impacts

Given the existing extent of industrial development in the immediate surrounding area, the significance of impacts on the surrounding landscape prior to mitigation is assessed to be not significant.

Table 1 provides a brief assessment against the IFC Performance standards and provides cross references to mitigation measures in the body of the report and the ESMMP.

Table 1: Summary of mitigation measures to comply with IFC Performance standards

Performance standard	Background information	Compliant[1]	Mitigation measure		
PS 1 Assessment and Management of Environmental and Social Risk and Impacts	An environmental and social impact assessment (ESIA) has been undertaken for national permitting purposes and to demonstrate compliance with IFC PS requirements A framework environmental and social management plan (ESMP) is included in the ESIA report	Yes	Cross references to mitigation measures are detailed in the relevant rows below		
PS2 Labor and Working Conditions	A social impact assessment was undertaken as part of the ESIA process. Labour and working conditions formed part of the assessment	Yes	Refer to section 13.8 and Table 11 of the framework ESMMP for mitigation measures		
PS3 Resource Efficiency and Pollution Prevention	The ESIA report and ESMP framework set out management and monitoring approaches to be adopted to ensure pollution control and efficiency	Yes	Mitigation measures are provided as follows		
				ESIA report section	ESMMP
			Air quality	5.7	Table 4
			Greenhouse gases	6.5.4	-
			Soil and groundwater	8.7	Table 7
			Solid waste management	9.6	Table 6
			Noise	10.7	Table 8
			Waste water	12.8	Table 10
			Landscape and visual impacts	15.5	Table 12
			Transport and traffic	17.5	Table 14
PS4 Community Health, Safety, and Security	Community health and safety is addressed in the relevant sections of the ESIA report and ESMP	Yes	Refer to section 13.8 and Table 11 of the framework ESMMP for mitigation measures		

[1] The project is considered compliant with relevant IFC PS provided the mitigation measures in the ESIA report and the ESMMP and all conditions applied by the environmental regulator (Sharjah EPAA) in the environmental permit are complied with by the project company and the EPC contractor as appropriate.

Performance standard	Background information	Compliant[1]	Mitigation measure		
PS5 Land Acquisition and Involuntary Resettlement	Not applicable	Not applicable			
PS6 Biodiversity Conservation and Involuntary Resettlement	Potential impacts on the marine environment from construction and operation of the project have been assessed to be minor at worst There are no significant impacts on terrestrial ecology	Yes	Mitigation measures are provided as follows		
				ESIA report section	ESMMP
			Marine environment	7.9	Table 5
			Terrestrial ecology	11.7	Table 9
PS7 Indigenous Peoples	Not applicable	Not applicable			
PS8 Cultural Heritage	The risk of adverse impacts on cultural heritage is very low given that the project site is reclaimed land	Yes	Refer to section 16.6 and Table 13 of the framework ESMMP for mitigation measures		

Source: Mott MacDonald.
Notes: [1] The project is considered compliant with relevant IFC PS provided the mitigation measures in the ESIA report and the ESMMP and all conditions applied by the environmental regulator (Sharjah EPAA) in the environmental permit are complied with by the project company and the EPC contractor as appropriate.

1 Introduction

A consortium of GE Energy Financial Services Inc, a subsidiary of General Electric Company (GE), and Sumitomo Corporation (the developer or consortium) submitted a proposal to Sharjah Electricity and Water Authority (SEWA) to design, build, own and transfer a new 1,800MW independent power project (IPP, the project) within the Hamriyah power and water plant (HWPP) in the Emirate of Sharjah, United Arab Emirates (UAE). The consortium was awarded the project on 28/12/2017. The proposed IPP will be located on the Arabian Gulf coastline near the Hamriyah Free Zone.

In accordance with UAE Federal Law No.24 of 1999 for the Protection and Development of the Environment, an environmental and Social impact assessment (ESIA) of the project is required for the project to acquire its environmental permit prior to commencement of construction. This ESIA assesses the anticipated environmental and social impacts associated with the project and details of measures that are required to be implemented by the plant to meet both national and applicable international requirements.

1.1 Overview

The HWPP was planned to be developed in phases and designed for total power generation capacity of 2500MW and water production of 140 million imperial gallons per day (MIGD) to meet present and predicted future demand for power and water in the Emirate of Sharjah.

The existing phase of the Hamriyah station consists of a 400-500MW open-cycle power plant and a 20MIGD reverse osmosis (RO) plant. The existing Hamriyah station was developed in phases with an initial 250MW of power generated in 2006, followed by another 250MW in 2007 and a 20MIGD desalination plant which became operational in 2014.

Given the increasing demand for electricity generation in the Emirate of Sharjah, SEWA is committed to expand the generation capacity of the HWPP. The developer submitted a proposal to SEWA to build, own, transfer a 1,800MW combined-cycle power plant. The proposed project will be developed adjacent to the existing power and desalination plant and will consist of three combined cycle units.

The existing station receives its natural gas from the Zora gas field and Dolphin pipeline. The gas is currently pumped 25km via pipeline from an onshore gas processing plant at the Hamriyah Free Zone to the Hamriyah station.

It is understood that SEWA signed a gas sales agreement with Sharjah National Oil Corporation (SNOC) in 2017, guaranteeing the supply of natural gas to three SEWA power stations, including HWPP. SNOC, in a joint venture with Uniper, will import liquefied natural gas (LNG) into the port of Hamriyah, commencing supply in 2019. It is understood that the project will comprise an offshore floating storage regasification unit (FSRU) at Hamriyah Port with approximately 180,000m^2 of LNG storage volume and gas send-out capacity of up to 1 billion cubic feet per day (bcfd).

It is intended that some of the gas will flow from the Hamriyah port receiving jetty directly into the HWPP, but there are other markets for the gas; the viability of the FRSU/LNG storage project is not reliant on the Hamriyah IPP project.

In accordance with UAE Federal Law No.24 of 1999 for the Protection and Development of the Environment, all projects constructed and operated in the UAE require an environmental permit or no objection certificate prior to commencement of site activities. To obtain an environmental permit, the 1800MW IPP project will first need to conduct an EIA that meets national requirements.

The project will be largely financed by international lenders and private financing institutions (e.g. JBIC and NEXI), many of whom are signatories to or follow the Equator Principles (EPs), or require projects to which they provide financing to comply with IFC Performance Standards and World Bank Guidelines. The EP, IFC Performance Standards and World Bank Guidelines will require the project to perform an environmental and social impact assessment (ESIA) study to adequately identify and mitigate potential impacts.

1.2 Project proponent

Table 2 presents the Hamriyah IPP project proponents.

Table 2: Project proponents

Project title	
Hamriyah Independent Power Project (IPP)	
Project proponent	**Contact**
Sharjah Electricity and Water Authority (SEWA)	To be provided (TBP)
A consortium of GE Capital and Sumitomo Corporation	Ahmed Y. Bahei-Eldin Vice President, EFS Global Markets M +971 52 639 8842 abahei@ge.com Eugene Vogel Business Development Director Summit Global Power Office 2002, 20th Floor Nation Towers 2 Corniche Road Abu Dhabi Tel +971 02 695 -1900 eugene.vogel@sumitomocorp.com
Environmental consultant	
Mott MacDonald Limited Al Gaith Towers Hamdan Street PO Box 47094, Abu Dhabi United Arab Emirates T +971 (0)2 401 5333 F +971 (0)2 627 0734 mottmac.com	Rouba Abou-Atieh Tel: +971 (0)4 206 9180 Mob: +971 (0)50 305 9206 Email: rouba.abou-atieh@mottmac.com

1.3 ESIA objectives

The key objectives of the ESIA study are:

- To ensure that the IPP project complies with the national and international (e.g. Equator Principles (EPs) and International Finance Corporation (IFC)/World Bank) requirements for environmental and social assessment
- To ensure that the key impacts which may be associated with the construction and operation of the Hamriyah IPP are identified, assessed and appropriate mitigation measures are specified

- To ensure that the baseline environment is adequately assessed to sufficiently identify potential sensitive receptors and resultant impacts and ensure they can be properly mitigated within the design of the plant and subsequent construction/operational phases
- To ensure that consultation with project stakeholders is relevant, prior and informed and that feedback from these parties is input into the design and assessment process
- To summarise and outline the mitigation and management measures for environmental and social aspects within a framework environmental and social management and monitoring plan (ESMMP) which will need to be subsequently elaborated upon by the engineering procurement and construction (EPC) contractor and operator of the IPP.

1.4 ESIA report structure

The ESIA report is structured as per Table 3:

Table 3: Structure of the ESIA report

No.	Chapter	Description of content
	Executive summary	Provide a non-technical summary of the overall projects and associated potential environmental and social impacts
1	Introduction	Presents a brief overview of the project, description of the developer stage of project preparation, extent of ESIA study, brief outline of contents of the report
2	Project description	Describes the project, its main elements and activities for construction and operation
3	Legal and institutional framework	Defines key national legislation and international Lender guidelines applicable to the project
4	Environmental and social impact assessment	Provides a summary of the methodology for evaluation of significance of environmental and social issues
5	Baseline conditions	Provides an overview of the physical, biological, and socio-economic characteristics of the study area. Specific baseline observations are also noted in the relevant specialist chapters
6-17	Environmental and social aspects: • Air quality • Marine environment • Soil, groundwater and land contamination • Solid waste and material use management • Noise and vibration • Terrestrial ecology • Wastewater management • Socio-economic issues • Stakeholder engagement • Landscape and visual impacts • Cultural heritage and archaeology • Transportation and traffic assessment	Individual sections assess the potential impacts of the proposed IPP project and identify mitigation measures
	Appendices	Relevant appendices referred to within ESIA including air dispersion modelling report
A	Appendix	Plant layout
B	Appendix	Best available techniques (BAT) study
C	Appendix	Summary of air dispersion modelling
D	Appendix	Marine survey report
E	Appendix	Hydrodynamic modelling report
F	Appendix	Environmental contamination survey report

No.	Chapter	Description of content
G	Appendix	Environmental and social management and monitoring plan (ESMMP) framework. It summarises the minimum environmental and social management requirements and lists the appropriate measures to mitigate the potential environmental and social impacts associated with the project and requirements for environmental and social monitoring campaign
H	Appendix	Stakeholder engagement plan (SEP)
I	Appendix	Stakeholders engagement records
J	Appendix	Stack height determination report

1.5 Climate change assessment and adaptation

In line with the EPs requirements (Exhibit II of EP), the viability of the project operation in view of reasonably foreseeable changing weather patterns/climatic conditions, together with adaptation opportunities shall be assessed within the ESIA.

Our review of the available information suggests that there will be no significant impacts associated with potential climatic changes/patterns on the viability of the project based on the following:

- The plant design is based on a maximum ambient temp of 55°C (in the shade) and maximum relative humidity of 96%. The site elevation is approximately 4-5m above sea-level
- As per the UAE Ministry of Climate Change and Environment, the current temperature in summer months in the UAE rises to about 48°C in coastal cities. Projected average temperature increase is 2-3˚C during summer months by 2060-2079
- Average historical sea level rise over the past decade in the Arabian Gulf is between 0.18-0.23cm per year. The Ministry states that coastal areas in the UAE will experience increasing mean high tides leading to inundation in low lying areas, current generation ocean models are unable to model future sea levels

Given the above and given the life-span of the project (<25 years), potential climate changes are not expected to impact the viability of the project.

2 Project description

This section provides an overarching description of the project which includes a summary of the IPP generation process. The project description and plant equipment details are based on the EPC Contractor's proposal and provide an overview of the plant. While the detailed design may ultimately change slightly once construction starts, the project, once it reaches commercial operation, will meet the environmental and social requirements of UAE legislation and IFC guidelines as outlined within this ESIA and in conjunction with the appropriate implementation of proposed management/mitigation measures.

2.1 Project requirements and justification

According to UAE State of Energy Report (2015), residents in the country use approximately 550 litres of water and 20-30kilowatt-hours of electricity per day. As the economy grows, it is predicted that the energy demand in the UAE will increase by 9% annually. Electricity demand in the UAE had reached 105 billion kilowatt-hours in 2013, placing the UAE among the highest electricity consumers per capita in the world.

The Emirate of Sharjah's current population stands at 1.4m and is expected to grow to almost 2m by 2020, making it the second-most populated emirate. SEWA plans to improve its power generation capacity by at least 1.5GW to reach self-sufficiency by 2021. It is understood that Sharjah is currently importing energy ranging from 700MW to1,200MW depending on the season, from the national grid.

The project is expected to meet the current and future energy demand growth in Sharjah and facilitate future development and projected industrial investment in Sharjah and the northern Emirates.

2.2 Project site selection and alternatives

As indicated previously, the site will be located within the HWPP complex which SEWA initially planned to develop as 2,500MW and 140MIGD phased power and water plants.

Building the power plant within SEWA's complex will allow the plant to use some of the existing infrastructure, including gas pipelines, intake and outfall facilities, back-up fuel loading facilities, roads and other site infrastructure. This will reduce costs, increase efficiencies and reduce the overall size and impact of the project development.

Given the industrial nature of the overall area and surrounding facilities including locations of existing power and desalination plants, the shared facilities and proximity to the HFZA industrial area, the selected site is considered to be appropriate. The site selection process is further discussed during the ESIA process as part of the project alternatives section.

2.3 Technology alternatives

The ESIA process requires an analysis of alternatives to determine that the proposed development represents the best practicable option, taking account of economic, technical, environmental and social issues. At present, most electricity used in the UAE is generated via thermal power (firing gas or fuel oil), though with increased emphasis on diversifying the sector to include renewable technologies. This section is intended to provide a high-level assessment of available generating technologies and determine which of these technologies represents the best practicable option for future power generation in Sharjah in the short and longer term.

A review of available technologies can essentially be considered under two generic headings; fossil-fuelled and renewables. Exploiting the benefits of renewable technology for UAE has some attractions in terms of improving the diversification of supply and increasing energy production self-reliance, thus reducing dependency on imports of fossil fuels. As noted, the relative intermittence of renewable energy generation, combined with size of plant required for equivalent supply, when compared to fossil fuel generation, is an important factor to be considered. A range of technologies is shown below and considered with headline advantages/disadvantages in Table 4.

Fossil fuelled

- Diesel engine plant
- Conventional boiler plant
- Combined cycle gas turbine (CCGT)
- Coal-fired plant

Renewables

- Wind
- Solar (thermal or photovoltaic solar panels)
- Hydroelectric
- Biomass and waste-to-energy

The UAE is diversifying its energy generation to include nuclear power, with the development of Barakah Nuclear Power Plant which is expected to be operational in 2020.

Technologies such as wave power have not been commercially scaled and have not been considered further within the ESIA technology assessment. Similarly, geothermal potential has not been explored in significant detail in the UAE and is not considered further.

Table 4: Technology alternatives- key advantages/disadvantages

Technology	Advantages	Disadvantages
Diesel engine plant;	• Well established technology • More robust, well established small-scale generating technology compared to other thermal generating technologies • Relatively high level of plant efficiency (~40%) • Can install several small engines to create flexible plant able to respond rapidly to changes in demand- suitable for peaking power generation • Require fewer operations and maintenance staff than compared to other thermal generating processes • Diesel engines operate at lower temperatures than other thermal generating processes generally resulting in longer maintenance intervals.	• Typically, relatively small scale and not ideally suited for large baseload power generation with lower efficiencies and fuel type cost than turbines • Fuel use – particularly with use of HFO, does have associated environmental problems associated with high sulphur content causing elevated emissions of sulphur dioxide. LFO can be used but is significantly more expensive than HFO
Conventional boiler plant	• Well established and understood technology • Cheapest projected cost per MWh • Range of potential providers for coal increasing security of supply	• Higher CO_2 emissions than gas • Lower plant efficiency than closed cycle gas generating technologies • Can be high maintenance costs throughout lifetime of plant • Large quantities of water needed for cooling/steam
Combined cycle gas turbine (CCGT)	• Lower emissions to air depending upon fuel used and pollution abatement techniques employed when compared to other thermal generating technologies • Combined cycle gas turbines are one of the most efficient generating technologies; H-class turbines, which are the most efficient GE manufactured turbines, are going to be installed • Guaranteed availability of gas for the operation of the plant • Existing infrastructure facilities such as intake and outfall	• Can be large quantities of water needed for cooling/steam purposes • Can be relatively high maintenance costs throughout the lifetime of plant
Coal-fired plant	• Higher emissions to air depending upon fuel used and pollution abatement techniques employed when compared to other thermal generating technologies • Range of potential providers for coal increasing security of supply	• Highest CO_2 emissions of all thermal technologies • Can be large quantities of water needed for cooling/steam purposes • Feedstock- coal- still needs to be imported into the UAE • Can be relatively high maintenance costs throughout the lifetime of plant
Wind	• Renewable technology- free fuel- with CO_2 emissions only considered with lifecycle assessment of equipment manufacture- no CO_2 emissions from general operations	• Only suitable for areas with high wind intensity/regularity • Dependent on wind allowing little scope for increasing power generation if needed: generally, not seen as suitable for baseload power given inconsistencies in generation • Typically needs large areas of land • Wind turbines sometimes considered as visually detrimental to the surrounding landscape
Solar (thermal or photovoltaic solar panels)	• Renewable technology- free fuel- with CO_2 emissions only considered with lifecycle assessment of equipment manufacture- no CO_2 emissions from general operations	• Only suitable for large scale within particular areas with high solar irradiation

Technology	Advantages	Disadvantages
		• Power only possible during sunlight hours (or limited energy storage through use of molten salts for thermal solar power) • Relative inefficiency /square meter compared to combustion- large areas required • Generally, not seen as suitable for baseload power given inconsistencies in generation • Typically, fewer employment opportunities during operations than combustion technologies • Panel efficiencies reduce over time (though typically manufacturers offer maximum degradation guarantees)
Biomass and waste-to-energy	• Typically seen as ‘carbon neutral’ emissions whereby fuel has absorbed carbon during its lifetime	• Typically, not large scale with relatively little experience globally of >100MW plants • Limited suitable feedstock/biomass fuel within UAE
Hydropower	• Renewable technology- free fuel- with CO_2 emissions only considered with lifecycle assessment of equipment manufacture- no CO_2 emissions from general operations • Energy storage possible with dam use • Run of river schemes typically minimise impacts to river users	• Relatively limited available water resources within UAE suitable for hydro schemes • Can often significantly impact on communities upstream and downstream • Dam construction for largescale projects can be costly • Can be significant impacts on the hydrological profile/ river ecologies

Source: Mott MacDonald, 2018

As Table 4 indicates, consideration of the most appropriate technology, fossil-fuelled or renewable, must include review of the requirements of secure reliability of supply (intermittent generation) and indigenous knowledge of technology.

As noted previously, while the UAE is increasingly diversifying their electricity generation supply, encouraging mixed power generation resources, with commendable focus on renewable technologies, there remains a requirement to increase the existing power supply, particularly baseload generation. Increasing energy demand from a growing population means that a ‘no project’ scenario cannot match the demand requirements of UAE and in particular Sharjah, based on government predictions.

Wind and solar technologies are all subject to interruptions in generation. During calm conditions or when wind speeds are too strong, wind turbines cannot operate. Predicting the occurrence and frequency of periods with no wind power is inherently difficult. Although the prediction of solar powered generation is more certain, there are significant periods when generation will not occur. Battery storage is becoming a more reliable technology to sport renewables but is yet to be trailed in the UAE.The use of such technologies requires careful management of the electricity grid with sufficient reliable supply available to meet demand when these technologies are not operating. While the UAE is also exploring these options, with recent project awards using these technologies, there still remains a requirement for reliable capacity to be installed regardless to meet total peak demand.

While coal-fired plants offer an efficient method of power generation, coal will be required to be imported into the UAE and CO_2 emissions from coal fired plans are more than gas-fired plant.

Energy from waste and biomass are technologies which can provide a reliable electricity supply but both represent new technologies for UAE. The need for technology transfer, training of staff and the provision of additional facilities for operation and maintenance needs to be considered and these technologies have typically not been to the scale required of a nationally reliant baseload plant, with limited experience globally of the size of plant which would be required for the power demand. Periods of maintenance for such plants are likely to be extended due to these reasons. Additionally, the sourcing of a reliable supply of waste and/or biomass within UAE would need to be carefully considered as it is not clear where such a supply of biomass could be sustainably provided from, particularly given the generally arid climate.

Hydropower resources in the UAE are limited and therefore cannot be investigated further for power generation at a national level.

With current gas availability within the UAE and the LNG project that is proposed to be developed by SNOC, the gas-fired combined cycle plant is considered the cheapest and most cost-efficient way of the UAE increasing its power generation baseload. While the UAE has identified long term policies to introduce more renewables into its energy mix- with a target of 44% of total generation by renewables by 2050[2]- the gas-fired combined cycle plant will ensure security of supply during this transition. Modern emission abatement technologies which will be employed at the plant where required and efficiency improvements mean that the proposed plant will minimise air emissions, which combined with the marked advantage of the project cost per megawatt hour and existing experience of gas within the UAE, have resulted in the proposed plant being the preferred technical option.

---

2 UAE State of Green Economy Report 2017

2.4 Site location

The project will be developed within the Hamriyah Power and Desalination Station complex and will be adjacent to the existing plant, 600m south of Hamriyah port, adjacent to and west of Hamriyah Free Zone Area (HFZA) about 1.2km north of Al Zahwra power and desalination plant located in the emirate of Ajman (see Figure 2).

Figure 2: Proposed site location for Hamriyah IPP

Source: Google earth (2018), Mott MacDonald

The HFZA is a highly industrialised area with heavy industries which include steel mills, hydrocarbon processing facilities and shipyards, among other industries, occupying more than 1000ha. There are two industrial ports and one recreational port located north of the HFZA, which provides support to Al Hamriyah population and traditional fishermen.

2.4.1 Site condition, land use, and ownership

The proposed Hamriyah IPP will be located within the SEWA's Hamriyah Power and Desalination Station complex on the coast of the Arabian Gulf (Figure 3). The project site is levelled and appears to be reclaimed land which has not been used for industry previously. The site is accessible via the Al Etihad road (E11). The site will be accessed through the existing power and desalination station main gate.

Figure 3: Location for the IPP and proposed layout

Source: Google earth (2018), Mott MacDonald

The site is currently cleared with no significant land features or drainage lines and no signs of potential ground or groundwater contamination. Sparse vegetations/shrubs exist on site (Figure 4 and Figure 5).

Figure 4: Project site

Source: Mott MacDonald, 22/02/2018

Figure 5: Shrubs on site

Source: Mott MacDonald, 22/02/2018

The proposed project laydown area will be located 150m north-east of the project site (Figure 6). Currently the site contains stockpiled sand (Figure 7). The source of the sand is unknown but may be dredged material generated during construction of the intake and outfall facilities or excavated or surplus materials from construction of the complex.

Figure 6: Location of laydown area

Source: Google Earth, 2018

Figure 7: Sand stockpile at laydown area

Source: Mott MacDonald, 22/02/2018

Google Earth's historical images show that the site was previously used as a material and machinery laydown area during the construction of the intake and discharge channels and was cleared afterwards (Figure 8).

Figure 8: Historical use of the proposed IPP site

Source: Google Earth, 2013

Potential sources of contamination are shown in Figure 9 and can be summarised as follows:

- The site appears to have been reclaimed between 2005 and 2007. The source of material/sand used onsite is unknown
- The Google Earth aerial photo for 2009 shows an irregular area of liquid/effluent in the northern part of the proposed 1,800MW GCCT IPP laydown area. This may be water but could be discharge/leakage from unknown source of contamination
- Google Earth aerial photos for 2013 show the presence of containers, potential earthworks and construction materials laydown at the proposed location of the 1,800MW GCCT IPP. This appears to be associated with construction activities to the north of the site indicating that the site may have been used as a construction laydown area. There are a few suspect areas of discoloured soil on the aerial photos. These may have been stockpiles of aggregate or construction materials (they have disappeared on later photos) but contamination cannot be discounted
- At the same time the stockpiles of soil/sand/material in the proposed 1,800MW GCCT IPP laydown area have appeared. These appear to be associated with the construction works to the north where it is evident that significant excavation or dredging and removal of soils has taken place. It is also possible that other materials may have been buried at this location during the construction works
- During this period and up until 2015, there is a small building located in the south of the proposed 1,800MW GCCT IPP construction site. This building had been demolished by 2016.

Figure 9: Potential historical areas of contamination onsite

Source: Mott MacDonald, March 2018

A geotechnical investigation was undertaken for the site and laydown area which included environmental sampling and analysis of soil and groundwater. A summary of the geotechnical and environmental report and existing soil and groundwater baseline on the project site and laydown area is provided in Chapter 0.

2.4.2 Geology, soil, and topography

The UAE is situated on the Arabian platform which consists of a body of continental rock covered by unconsolidated ancient sediment deposits. The land surface of the area is predominantly desert plain sands and coastal sediments (sabkha). From reviewing historical aerial photography, it is seen that the area was reclaimed from the sea between the period 2000 and 2010. For the purpose of this assessment, it is not known where the material used to raise the land was sourced, although it is assumed to be local unconsolidated ancient sediment deposits.

A geotechnical investigation was undertaken on site by Tecnicas Reunidas in June 2018, involving 30 boreholes. This exploration revealed a 10.50 to 16.50m thick brownish layer of overburden material consisting of medium dense to dense locally loose silty gravelly fine sand with interlayers of gravels. This is underlain by a very dense sand layer of 0.21 to 9.02m thickness. The very dense sand layer is underlain by the distinctly weathered to unweathered, locally destructured calcarenite/sandstone up to the drilled depths of 20.0 to 30.0m.

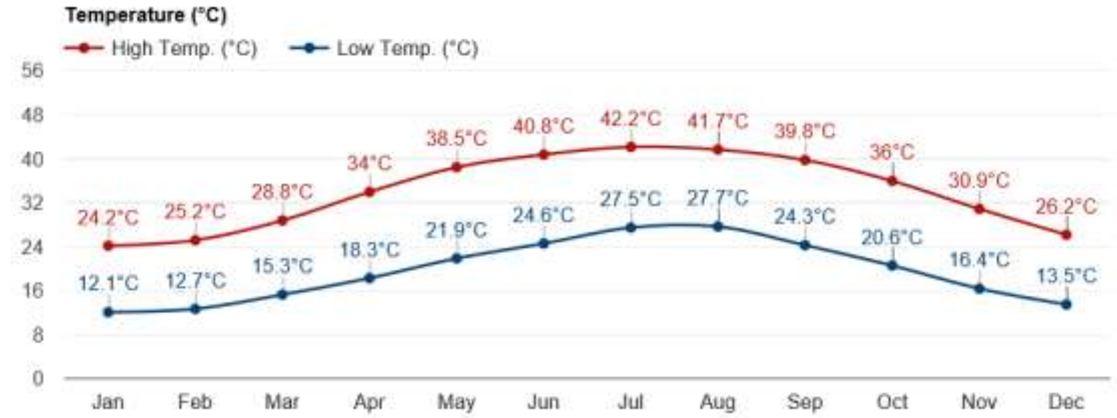
At the time of investigation, groundwater was encountered at depths ranging from 1.55 to 4.0m below ground level. Groundwater levels are subject to tidal and seasonal variations and by artificially induced effects.

The site topography is uneven. The site level ranges between approximately +3.359 to +16.32m SHMD (Sharjah Halcrow Municipality Datum).

2.4.3 Climate

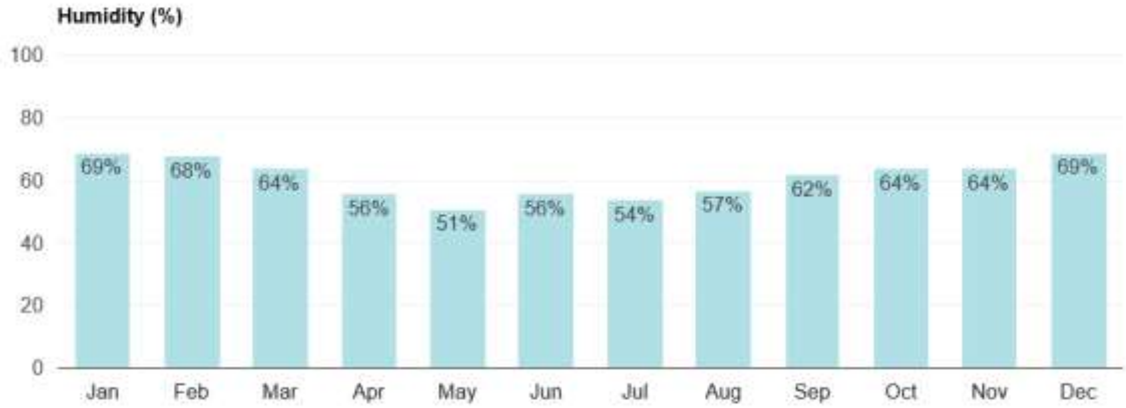
The UAE lies in the arid subtropical climate zone extending across Asia and North Africa. High temperatures are expected most of the year and sporadic rainfall occurs mainly during the winter season between November and March. Rainfall occurs on average 12.7 days per year with a total average annual rainfall of 106.9mm. Temperatures range from a low of approximately 12.1ºC during winter to a high of 42.2ºC during summer. Figure 10 to Figure 13 below illustrate the climate data of Sharjah.

Figure 10: Average temperature Sharjah, United Arab Emirates



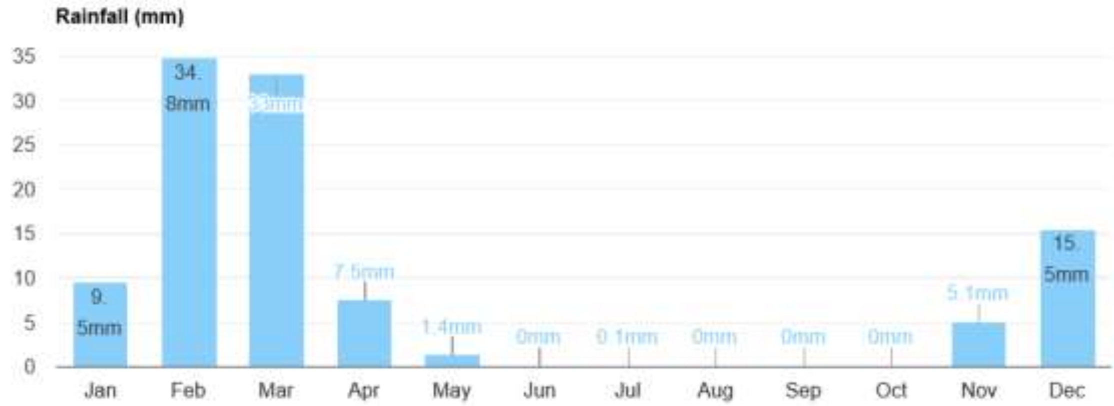
Source: Weather-Are.com

Figure 11: Average humidity Sharjah, United Arab Emirates



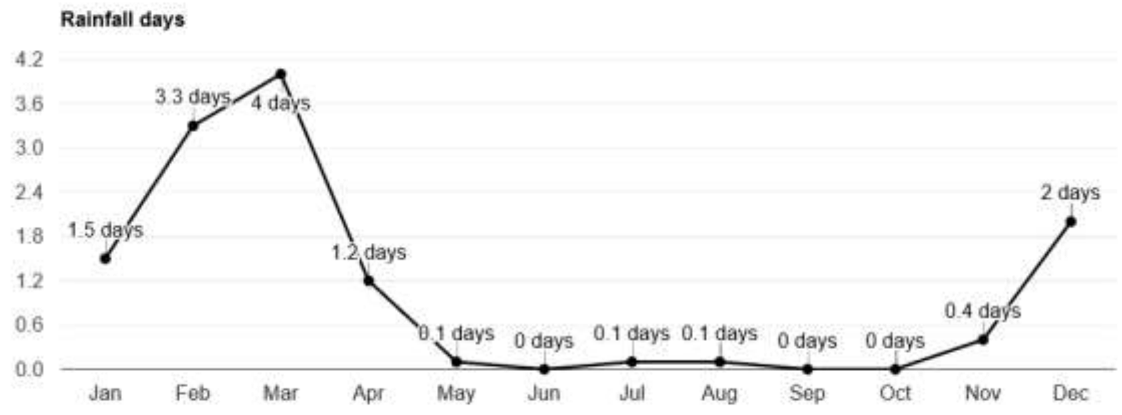
Source: Weather-Are.com

Figure 12: Average Rainfall Sharjah, United Arab Emirates



Source: Weather-Are.com

Figure 13: Average rainfall days Sharjah, United Arab Emirates



Source: Weather-Are.com

During certain periods of the winter, night and early morning fog is common. This may persist from two hours after sunset until two hours after dawn when it lifts out to sea. Heavy dew can be expected most mornings all year round, particularly in the coastal areas.

2.5 Key project components

2.5.1 Overview

Project description

The proposed new combine cycle power plant will have a nominal capacity of 1,800MW and is designed to accommodate gas (natural gas or imported LNG) and in the unlikely event natural gas and LNG is not available, liquid (distillate) fuels. The proposed plant will consist of three identical power blocks and each will consist of the following key equipment (see Appendix A for plot plan):

- GE 9HA.01 gas turbine
- Hydrogen cooled generator directly cooled to the gas turbine
- Triple pressure reheat heat recovery steam generator (HRSG) dedicated to the gas turbine. HRSG is equipped with both main and bypass stacks
- Triple pressure reheat steam turbine
- Air cooled generator directly cooled to the steam turbine
- Direct cooled condenser to condense steam from the steam turbine

Usual balance of plant equipment such as pumps and pipes.

Each 9HA.01 heavy-duty industrial gas turbine will be equipped with dry low NOx (DLN) combustion system, coupled to a hydrogen cooled generator. The exhaust gas from the gas turbines will be fed to a heat recovery steam generator (HRSG) linked to a floor-mounted triple pressure steam turbine.

The gas turbines are designed to run on dual fuel, natural gas/LNG or distillate oil. For natural gas operation, no water injection will be required for the plant to meet the applicable emission standards. When firing distillate oil (expected to be limited), demineralised water will be injected into the combustion chamber for the plant to meet the relevant national/international emission levels.

The 9HA.01 gas turbine will be connected to the HRSG via a bypass damper. The bypass exhaust stack provides a high operationally flexible power plant, which allows simple cycle and combined cycle operation.

The water/steam cycle represents a state of the art triple pressure cycle with naturally circulated evaporator sections.

Project concept

The concept chosen for the combined cycle power plant has the main characteristics summarised in Table 5.

Table 5: Key characteristic of project concept

Description
Flexibility
The plant is capable of running at base load as well as part load. Start-up of the gas turbine and HRSG is independent from the steam turbine through steam bypasses resulting in short start-up times.
Capability
Gas turbine capable of ramping very quickly at 8.3%/min (based on ISO base-load) with record breaking efficiency to deliver most cost-effective conversion of fuel to electricity. Optimized water/steam cycle and HRSG.
Environmental consideration
Low emission level throughout a large load range
High reliability and availability:
Simplicity in design and operation, thus minimising O&M requirements and increasing reliability and availability.
Low operation costs:
Resulting from the points above the proposed plant will result in minimum project specific operational costs.

Source: EPC proposal, 2018

Gas and fuel oil supply system

The gas turbines will use natural gas/imported LNG as the main fuel and distillate oil as a back-up fuel should natural gas/LNG not be available. .

Gas will be supplied directly to the plant by the Sharjah National Oil Corporation (SNCO) through a single gas pipeline, the terminal point for the plant will be at the site boundary.

The Hamriyah facility already has an existing tank for distillate oil. The IPP will connect to the existing tanks. As a result, , no new large-scale oil storage tanks will be required. Small day tanks may be required for emergency generators.

2.5.2 Cooling water system

Existing intake and outfall facilities

Seawater to feed the plants cooling and auxiliary systems including main condensers will be abstracted through the existing Hamriyah facility’s intake structure. New screens and pumps will be installed to reduce entrapment and entrainment.

Cooling water will be discharged to the existing site outfall. Other waste water streams will be discharged to the outfall after suitable treatment to render the effluent in compliance with the required environmental standards.

It should be noted that the existing intake and outfall structure was designed for 2500MW of power generation and 140MIGD of water production. The existing plant has an installed capacity of 400MW (simple cycle gas turbines, i.e. no heat load to the seawater) and 20MIGD of reverse osmosis (RO) desalination.

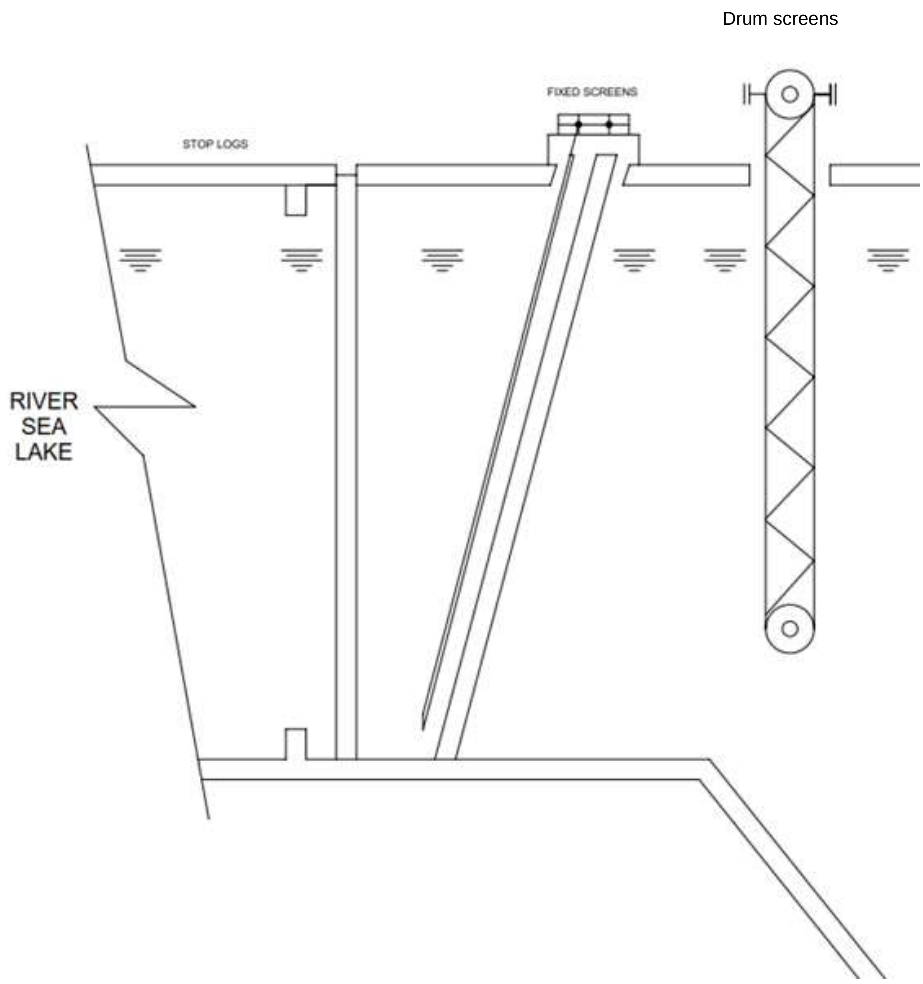
Main cooling water system

Cold water will be withdrawn from the sea at a nominal flow rate of 16.7m^3/s via the existing onshore intake structure. Abstracted water would first pass through a fixed bar screen (50mm gap between bars) that will remove the larger debris. The screen will be mechanically raked at 4m/min periodically to remove collected debris. The debris will be discharged at the top of the screen into a flushed channel leading to a trash basket for collection and disposal. Collected marine organisms that are alive will be released back into the sea.

Debris that passes through the fixed screen will be collected by drum screens with aperture screen size of 3mm x 3mm. Water flow rate at this stage will be 0.2m/s. Collected debris will also be discharged to the trash basket.

The physical filtration system is shown in Figure 14.

Figure 14: Diagrammatic cross-section of the filtration systems of the intake structure



Source: SEW-0-PA_MDD.TR.100

Stop logs will precede the filtration system to allow isolation and dewatering of the system for cleaning and maintenance.

Seawater pumps downstream of the filters will pump the filtered cooling water to the condensers and auxiliary systems, including common services cooling systems, electric chlorination plant and water treatment plant.

The steam exhausted from the steam turbine is condensed in the surface condenser, which is cooled by the cooling water (CW) system. The main cooling water system (MCWS) operates by direct cooling. The hot water return from the condenser and the auxiliary common services cooling systems shall be fed to the seal pit (transition pit); from the seal pit the water goes to the existing outfall channel for discharge.

Incoming cooling water will be chlorinated at the sea water intake station by sodium hypochlorite to prevent biofouling of the plants cooling system. The sodium hypochlorite will be generated by the electro chlorination system, which uses seawater as a feedstock to make the sodium hypochlorite. Dosing will involve continuous release of 1ppm sodium hypochlorite solution with intermittent shock dosing of 5ppm three times a day.

Closed cooling water system

The closed cooling water (CCW) system is a closed system filled with conditioned demineralised water supplying various consumers throughout the plant with clean and non-corrosive cold water. For CCW recirculation, pumps are provided. The warm water for each block is cooled by means of water/water coolers fed from the auxiliary common services cooling system which is delivered from the MCWS by means of booster pumps. The warm water for equipment common to the three blocks is cooled by the common services cooling system which is delivered from seawater pumps located in the pump basin.

2.5.3 Water supply system

Demineralisation water

Raw water (seawater) is taken from the seawater intake and is fed to the water treatment plant where demineralised water is produced by two-pass reverse osmosis, and mix bed exchangers.

The demineralised water is fed to the demineralised water tanks.

From the demineralised water tanks the respective consumers and the water steam cycle are supplied with water through the transfer pumps.

Potable water

An independent potable water system will be provided. Potable water shall be obtained from the water treatment plant and distributed to manned buildings, toilets and safety showers. Potable water from existing network shall also be utilised to meet requirement of service water for the CCPP.

Fire water

An independent fire water system will be provided for fire protection and detection of the plant.

Plant drainage system

The plant drainage system is designed to collect the different waste streams produced by power plant operation and to convey them (except for those collected separately) to the waste water collection basin.

2.5.4 Chemical dosing systems

Chemicals are fed into the condensate line and boiler drums to maintain desired quality of condensate. Chemicals are also fed into closed cooling water to avoid corrosion of pipes. The circulating water chemical dosing system is based on an electro-chlorination system.

2.5.5 Compressed air system

Compressed air required for tools, instruments, control valves and other plant auxiliary systems and maintenance is generated in a centralised compressor station from where the air is distributed to the point of use.

2.5.6 Continuous emission monitoring system

Exhaust gas samples are extracted at the main stack and the bypass stack. They are then conditioned and analysed in an instrument cabinet. $NOx/CO/O_2/SO_2/CO_2$ emissions are continuously monitored and recorded. Exhaust dust concentrations (as PM_{10} measurement) are also monitored.

The continuous emission monitoring system incorporates a data acquisition and emission evaluation computer system. The measured values are transferred to the power plant distributed control system (DCS).

2.5.7 Power evacuation facilities

The power generated by the plant will be evacuated to the Hamriyah 220kV substation. The substation is located within the facility boundary. The substation will be expanded as part of the IPP contract. The existing gas insulated switchgear (GIS) building is oversized and as such the new 220kV expansion will be located within the existing building (Figure 15). Cables will run from the IPP plant to the substation in concrete trenches.

Figure 15: GIS building

Source: Mott MacDonald, February 2018

2.5.8 Infrastructure facilities

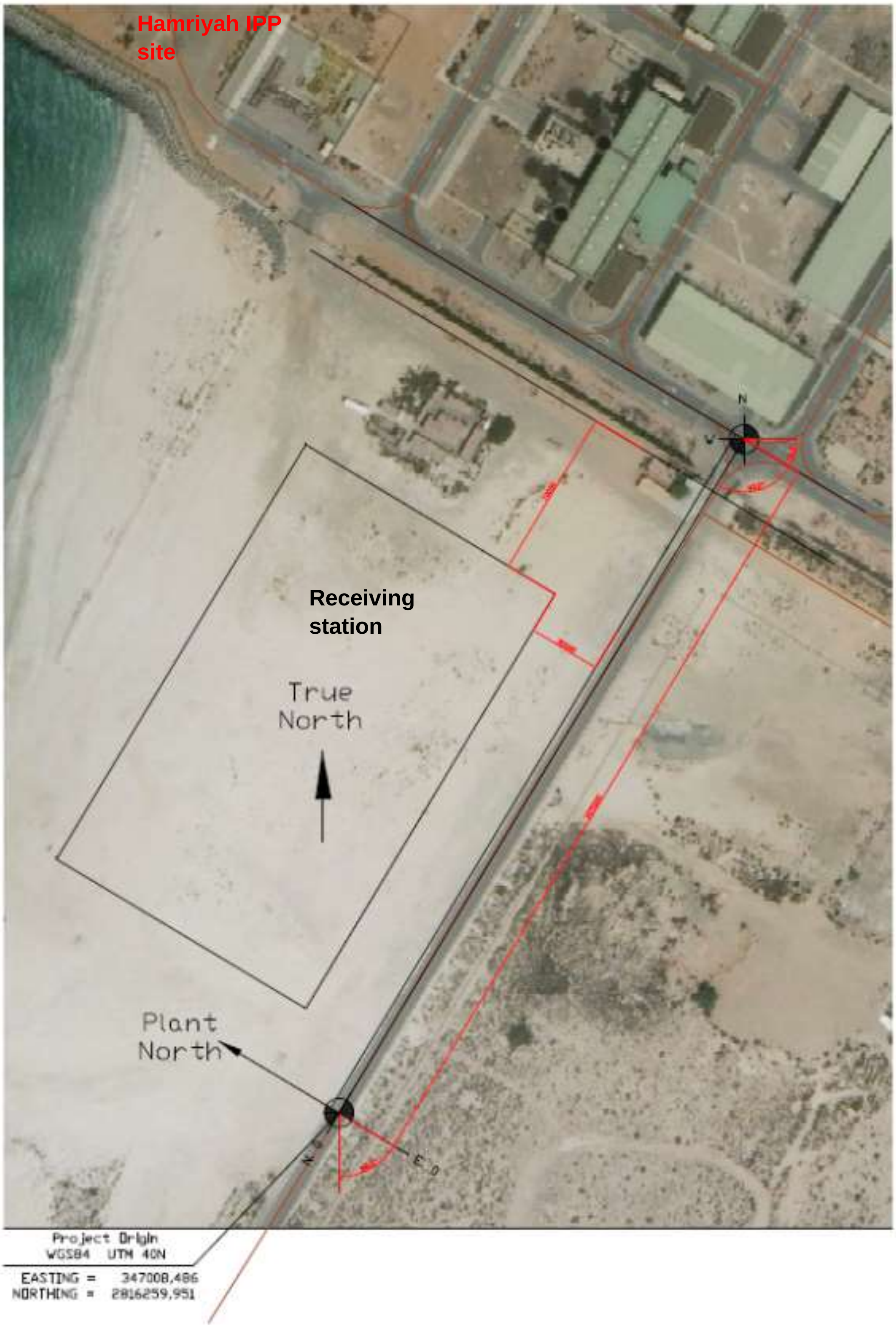
Gas supply

A gas receiving station will be built adjacent to the site and gas pipeline will connect the receiving station to the terminal point within the Hamriyah IPP fence. SNOC hasn’t finalised its design or the routing for the gas pipeline, but it is understood that it will run from the receiving station to the boundary of the site then along the inside of the boundary to the terminal point for the IPP. Design, construction and operation of the receiving station and the gas pipeline up to the terminal point within the IPP boundary will be the responsibility of SNOC and falls out of the scope of the project company.

The project company will be responsible for building the gas facilities within the fence line of the IPP plant only except for a data cable to the gas receiving facility on the beach adjacent to the site which will follow the route of the new gas pipeline.

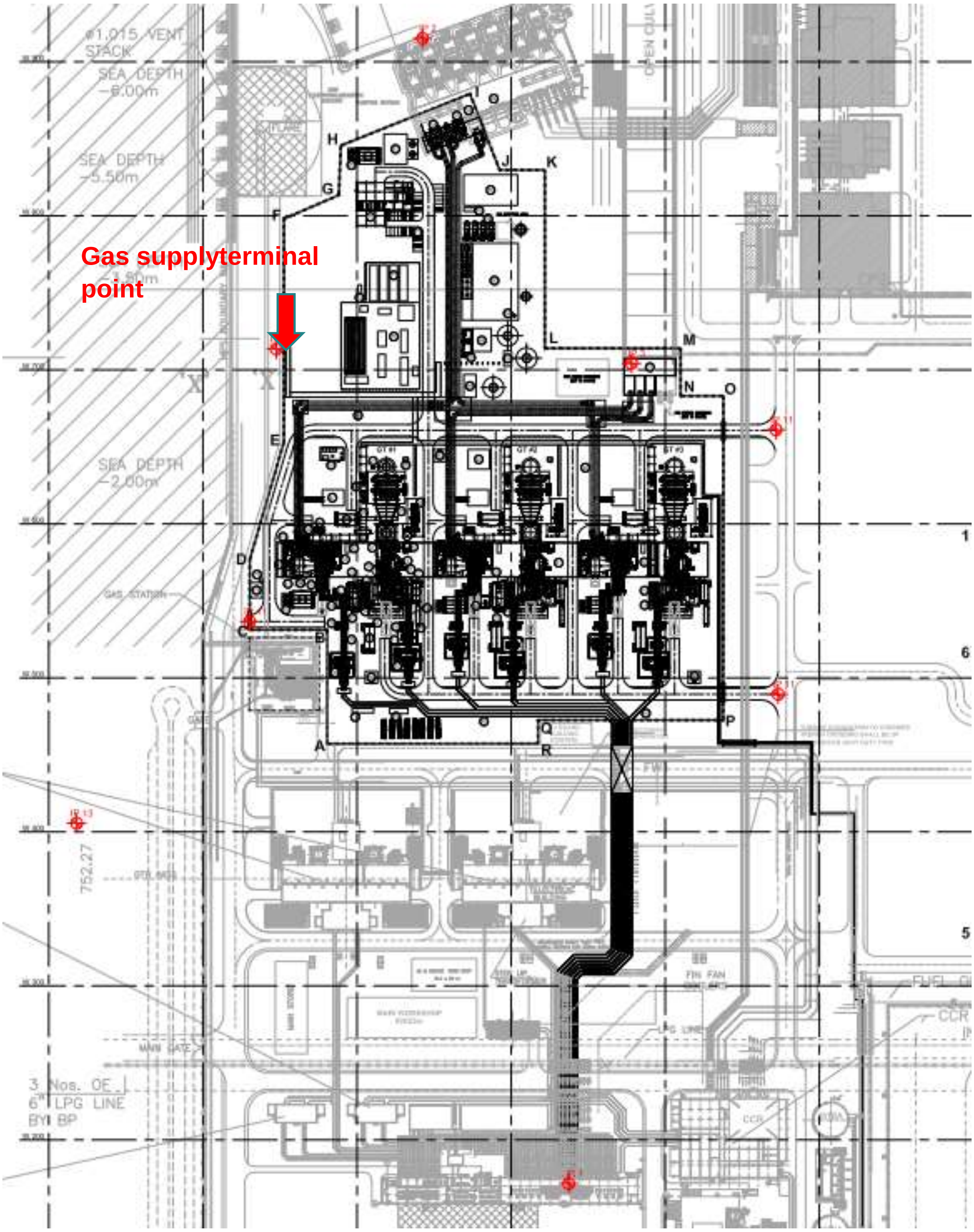
Figure 16 shows the location of the LNG receiving station, Figure 17 shows the terminal point for the gas supply.

Figure 16: Location of the LNG receiving station



Source: Sumitomo, 08//07/2018

Figure 17: Terminal point on site



Source: Sumitomo, 08/07/2018

2.6 Project schedule

Table 6 presents the indicative project development schedule.

Table 6: Indicative project schedule

Milestone	Date
LNTP (limited notice to proceed) - Start of engineering, soil investigation and site survey and potential ground work commencing at later stages	30/04/2018
NTP (notice to proceed) - Full construction commences	December 2018
Financial close (targeted)	December 2018
ECOD (early commercial operation date) – unit 1 in service	01/05/2021
ECOD – unit 2 in service	01/05/2022
COD - All units (full IPP) in service	01/05/2023

Source: GE/Sumitomo, 22/06/2018, Appendix 9.4 Project implementation schedule (EPC proposal)

2.7 Decommissioning

It should be noted that decommissioning is not within the scope of the consortium. The project is being developed under a BOOT (Build, Own, Operate and Transfer) model and, as such, after the 23.5 years of operation (term of the power purchase agreement), the consortium will transfer ownership of the plant to SEWA – which will solely decide on and be responsible for decommissioning. It is anticipated that decommissioning will be required to comply with relevant legislation in place at the time.

2.8 Sensitive receptors

Sensitive receptors can be described as any receptors which are notable in some way- whether due to their local or national importance or if they are especially sensitive to changes. Assigning sensitivity is variable and dependent upon a number of aspects including the project type/area. Sharjah Municipality does not have its own classification of the sensitivity of receptors. Typically, sensitive receptors relate to ecological or human receptors (e.g. habitats, species, population centres) as well as geographical phenomenon or structures.

Initial assessment and site visit undertaken in February 2018 has identified a number of receptors which can be considered sensitive in the project vicinity:

- The Oberoi Beach Resort Al Zorah in Ajman approximately 2.5km to the south of the site
- Al Zorah mangrove area approximately 2.5-3km south-east of the site
- Al Zorah villa complex and golf club approximately 2.5-3km south-east of the site
- Ajman residential area approximately 4km south-east of the site
- Recreational campers and fishermen at the beach adjacent to the boundary of the overall power and desalination complex (150-200m to the south of the IPP site)
- Rest area 40m to the south west of the site
- Users of the beach area adjacent to the project site
- Residential and fishing community of Al Hamriyah to the north east of project area (approximately 3km away)

Figure 20 shows locations of nearest potential sensitive receptors to the site.

During the ESIA phase, Mott MacDonald's project manager visited the vicinity of the site on numerous occasions as part of undertaking environmental surveys and consultations. During these visits, we have visited the beach adjacent to the Hamriyah power plant to undertake informal discussion with the campers/fishermen but they were not on site. The visits were undertaken at different times of the days (night and day time) while we were undertaking the noise surveys. Therefore, the planned information discussion with them haven't been undertaken by Mott MacDonald's team.

Ajman Municipality have been consulted on the fishermen issue. We understood that there are fishermen who use the beaches in the areas and the municipality have been trying to relocate them to a dedicated fishing area within Ajman. The reason for this was given as visual impacts on residents and tourist attractions.

Hamriyah Municipality was consulted on 13/08/2018 with regard to the project and adjacent beach users. The Municipality confirmed that beach users were evacuated in February-March 2018 and this beach is not publicly open for fishing and recreational activities. The Municipality confirmed that there was one user who used to visit the beach on a regular basis who has been informed that using this beach area is illegal. Signboards from both Hamriyah Municipality and SEWA were seen on the beach area which announce the beach as a government area and prohibit using the beach, taking photos, fishing and swimming (see Figure 19). This is a common practice in the UAE and Middle East where infrastructure projects are regarded of high-security targets.

Additionally, given that SNOC is planning to locate its gas receiving station on the beach, unpermitted fishing activity is likely to be prohibited by the authorities.. Figure 18 and Figure 19 show the beach adjacent to site during our site visit in May 2018.

Figure 18: Beach adjacent to site

Source: Mott MacDonald, 31/05/2018

Figure 19: Announcement from SEWA that access to beach are is prohibited

Source: Mott MacDonald, 25/09/2018

Figure 20: Location of potential sensitive receptors

Source: Mott MacDonald, 2018

3 Legal and institutional framework

3.1 Introduction

This section outlines the applicable national legal framework related to planning and environmental and social protection in UAE, as well as the international standards and guidance observed by potential financiers to the project. It is understood that potential financers comprise JBIC and NEXI. Where national legal standards are not as stringent as international requirements or vice versa, the project will be subject to the most stringent requirement with the exception of ambient air quality, where national standards take precedence if they exist and where following intern national guidance would lead to a breach of national laws.

3.2 National regulatory framework

3.2.1 UAE federal requirements and guidelines

Federal Law No. 24/1999

Federal Law 24/1999 for the Protection and Development of the Environment sets out the legal framework for environmental protection in the United Arab Emirates (UAE). These regulations apply to the UAE as a whole and are the overarching regulations applicable in all seven emirates.

The main objectives of Federal Law 24/1999 are as follows:

- Protection and conservation of the quality and natural balance of the environment
- Control of all forms of pollution to avoid the immediate or long-term harmful effects results from developments
- Development of natural resources and conservation of biological diversity and the exploitation of resources with consideration of present and future generations
- Protection of society, human health from activities and acts, which are environmentally harmful
- Protecting the State environment from harmful effects of activities undertaken outside the region of the state
- Compliance with international and regional agreements ratified or approved by the state regarding environmental protection, control of pollution and conservation of natural resources

The key areas covered by Federal Law 24/1999 are as follows:

- Development and the environment; including the requirement for environmental impact assessments (EIA) and environmental monitoring
- Protection of the water environment; including the marine environment, groundwater and surface water
- Soil protection
- Protection of air from pollution
- Handling of hazardous substances and waste and medical waste
- Natural reserves
- Liability and compensation for environmental damages

- Penalties

According to Chapter 1, Section 1, Article 3 of the Federal Law 24/1999 the Federal Environment Agency (FEA), in consultation with the local authorities in each emirate, is responsible for identifying the project categories that should be subject to an EIA. Article 4 of the same legislation states that no project shall be allowed to commence activity until the evaluation of the environmental impacts has been determined by The Federal Environment Agency and the local authority of the emirate within which the development will take place.

The following federal regulations enact detailed provisions of Federal Law 24/1999:

- Regulation of the Assessment of Environmental Effects of Installations (2001)
- Regulation for the protection of the Maritime Environment (2001)
- Regulation Concerning Protection of Air from Pollution (2006)
- Regulation for Handling Hazardous Materials, Hazardous Wastes and Medical Wastes (2001)

Other relevant UAE laws

Federal Decree – Law No.2 of 2011 ‘On the National Emergency and Crisis Management Authority’ establishes the UAE National Emergency and Crisis Management Authority (NECMA). The purpose of the NECMA is to implement state policy with regards to the necessary procedures to manage emergencies, crises and disasters. The roles of NECMA with relevance to the project include:

- Participation in preparing and coordinating strategic plans to manage emergencies, crises and disasters, including response plans and the adoption of necessary procedures for the execution thereof in coordination with concerned parties in the state
- Participation in the preparation and coordination of necessary emergency plans for vital installations and infrastructure of the state, and to pursue the execution thereof in cooperation and coordination with competent parties of the state
- Participation in the preparation, coordination and execution of special exercises in the management of emergencies, crises and disasters in coordination with concerned parties and to follow up the execution thereof
- Proposal of legislations and organizational regulations to manage emergencies, crises and disasters and specify the Authority’s relation with concerned parties

3.2.2 Local environmental requirements and guidelines

The Environment and Protected Areas Authority (EPAA)

In December 2017Law No. 11 of 2017 concerning the organisation of the Environment and Protected Areas Authority, EPAA in Sharjah was issued. Under the law, the EPAA was established in Sharjah, with legal capacity to carry out all acts that achieve its objectives.

Article 5 of the Law defines the responsibilities of the EPAA which include issuing environmental approvals and permits for public and private industrial, commercial and urban activities which may impact on the environment and wildlife.

EPAA is responsible for the protection of the Sharjah environment through scientific research, setting of appropriate policies and supporting sustainable development.

Sharjah Municipality acts as the environmental regulatory body for Sharjah, including permitting of new development and the issuance of permits; for example: to allow wastewater discharge, solid waste disposal and air emissions.

Sharjah Municipality

Sharjah Municipality, Directorate of Environmental Services, Environment Protection Section has developed their Guidelines for the Preparation and Presentation of EIA Reports (undated) to guide developers in the format of their submission in pursuit of an environmental permit. Although the environmental permitting process has changed in Sharjah and currently falls under the responsibility of EPAA, we have reviewed these guidelines and considered them where applicable in the report.

A summary of relevant environmental laws and orders in Sharjah is provided below:

- Law No. 11 of 2017 concerning the organisation of the Environment and Protected Areas Authority, EPAA in Sharjah
- Law No. 6 of 1998, on the establishment of the Environment and Protected Areas Authority (superseded)
- Amiri Decree No. 12 of 1997 on the establishment of the Environment and Protected Areas Authority
- Executive Council of the Emirate of Sharjah Decision No. 9 of 2000, concerning the formation of a special "Solid Waste Committee of the Commission"
- Executive Council of the Emirate of Sharjah Decision No. 2 for the year 2001, on the formation of the Standing Committee of Emergency in the Emirate of Sharjah
- Administrative Decision No. 1 of 2008, on the conserving and maintaining the sustainable desert environment in the Emirate of Sharjah
- Executive Council Resolution No. 9 for the year 2012, on the prevention of environmental degradation in the wilderness areas in the Emirate of Sharjah
- Executive Council Resolution No. 11 of 2014 on the prohibition of distortion of the mountainous areas in the Emirate of Sharjah
- Ministerial Decree No. 72 of 2014 on the re-formation of a committee to organize fishing in the Emirate of Sharjah

3.2.3 National social legislation

Federal social legislation

The main source of legislation in the UAE is Islamic law and this is enshrined in the UAE Constitution. The UAE Constitution was issued on 18 July 1971. It establishes the governing principles of the UAE federation and guides the formation of federal and municipal laws. The UAE Constitution comprises 152 Articles, a number of which establish social principles of relevance to the project. These include:

- Article 14: Equality, social justice, safety, security and equal opportunities for all citizens shall be the pillars of the society. Solidarity and compassion shall constitute the closest bonds between them
- Article 16: Society shall include in its care childhood and motherhood and shall protect minors and others unable to look after themselves for whatever reason, such as illness or incapacity or old age or forced unemployment. It shall extend assistance and rehabilitation to them for their own benefit and that of the society. Such matters shall be regulated by welfare and social security legislations
- Article 20: Society shall consider work as a cornerstone of its development. It shall strive towards making it available for citizens and training them so that they are prepared for it. It shall create the appropriate circumstances by enacting legislations protecting the rights of

the employees and the interests of the employers in the light of developing international labour legislations

- Article 24: The basis of the national economy is social justice. It is founded on sincere cooperation between public and private activities. Its aim shall be the achievement of economic development, increase of productivity, rise in the standards of living and achievement of prosperity for the citizens, all within the limits of law. The federation encourages cooperation and savings
- Article 34: Every citizen shall be free to choose his occupation, trade or profession within the limits of the law and with due observance of the regulations organizing some of these professions and trades. No person may be subjected to forced labour except in exceptional circumstances provided for in the law and in return for a consideration. No person may be enslaved
- Article 40: Aliens shall enjoy in the federation all rights and liberties provided in international charters in force or in treaties or conventions in which the federation is a party. In exchange they have to abide by the corresponding duties
- Article 117: Governance in each emirate shall aim in particular at the maintenance of security and order within its territories, the provision of public utilities for its inhabitants and the raising of social and economic standards

Federal Law No.8 of 1980 Labour Law and its Amendments

Federal Law No.8 of 1980 'Labour Law and its Amendments' (Law 8/1980) is the key legislation governing the rights of workers in the UAE, translating into federal law UAE obligations under ratified social international treaties, conventions and protocols (refer to Section 3.4). Those issues covered by Law 8/1980 include:

- Employment of workers, juveniles and women
- Employment contracts, records and remuneration
- Working hours and leave entitlement
- Employee safety, protection, health and social care
- Disciplinary penalties that may be imposed by an employer or agent upon employees
- Employment contract termination
- End of service remuneration
- Indemnity for labour accidents and occupational diseases
- Collective labour disputes
- Labour inspectors
- Permanent disability compensation
- Terms and provisions governing the distribution of death compensation among family members of a deceased employee

Additional federal legislation

The following federal legislation also covers social issues and will be considered further in this ESIA as relevant:

- Cabinet Decision No.3 of 1977 'Concerning the Regulation of the Supply and Recruitment of Foreign Workers'
- Federal Decree Law No.1 of 2003 'Concerning the Establishment of the Mother and Child Supreme Council'

- Federal Law No.7 of 1999 ‘Concerning the Issuance of the Law on Pensions and Social Security’
- Federal law No.6 of 2008 ‘On the Establishment of the National Council for Tourism and Antiquities’
- Federal Law No.27 of 1999 ‘On their Establishment of the National Human Resource Development and Employment Authority TANMIA’
- Federal Supreme Council Decision No.4 of 1984 ‘Concerning the Regulation of the Incoming Employment’

3.3 International requirements

In addition to federal and municipal laws and legislation, as the consortium is seeking international finance it is important that the project meets international lending requirements. The following international guidelines are relevant to the project and were considered during the ESIA process:

- The Equator Principles (2013)
- IFC Performance Standards on Environmental and Social Sustainability (January 2012)
- World Bank Group General Environmental, Health and Safety (EHS) Guidelines (April 2007)
- World Bank Group Industry Sector EHS Guidelines: Thermal Power (December 2008)
- Organization for Economic Co-operation and Development (OECD) Recommendation for Common Approaches for Export Credits (as updated 2005 and revised 2007)
- Nippon Export and Investment Insurance Guidelines on Environmental and Social Considerations in Trade Insurance (April 2017)
- Japan Bank for International Cooperation Guidelines for Confirmation of Environmental and Social Considerations (2015)
- Adopted international conventions and protocols

3.3.1 Equator Principles (EPs)

The Equator Principles 2013 (EPs) are a credit risk management framework for determining, assessing and managing environmental and social risks in project finance transactions. Currently (July 2018), 93 Equator Principles’ Financial Institutions (EPFIs) across 37 countries have officially adopted the EPs. The EPs apply to projects under financing consideration with a total project capital cost greater than USD 10 million to ensure these projects are developed in a manner that is environmentally and socially responsible. Under the EPs, countries are either ‘designated’ (as having robust environmental and social governance, legislation systems and institutional capacity designed to protect their people and the natural environment) or ‘non-designated’. UAE is currently a non-designated country, meaning the environmental and social impact assessment would need to be evaluated by the lender banks against the Equator Principles, the IFC Performance Standards and World Bank Group EHS Guidelines on which the EPs rely. Details of the EPs can be found at: http://www.equator-principles.com/.

The EPs classify projects based on the extent of their social and environmental impacts and potential hazards into three distinct categories:

- Category A: Projects with potential significant adverse social or environmental impacts that are diverse, irreversible or unprecedented
- Category B: Projects with potential limited adverse social or environmental impacts that are few in number, generally site-specific, largely reversible and readily addressed through mitigation measures

- Category C: Projects with minimal or no social or environmental impacts.

It is considered likely that the proposed project would be a Category A project and the ESIA has been completed with the IFC's requirements associated with such a category of development.

A summary of the EPs requirements for non-designated countries is presented in Table 7.

Table 7: Summary of Equator Principles requirements for non-designated countries

Equator Principle (EP)	Description
EP1: Review and Categorisation	Review and categorisation of project based on potential impacts and risks in accordance with environmental and social screening criteria of IFC
EP 2: Environmental and Social Assessment	For projects categorised as A or B, social and environment assessment shall be conducted to address relevant social and environmental impacts and risks.
EP 3: Applicable Environmental and Social Standards	Applicable IFC performance standards and applicable industry standard HSE guidelines will be applied.
EP 4: Environmental and Social Management System and Equator Principles Action Plan	For all category A and B projects, an Environmental and Social Management System (ESMS) must be prepared. An Environmental and Social Management Plan (ESMP) will be prepared by the client to address issues raised in the assessment process and incorporate actions required to comply with the applicable standards. Where the applicable standards are not met an Action Plan that outline gaps and commitments to meet EPFI requirements in line with the applicable standards and addresses relevant findings and draws on conclusion of assessment.
EP 5: Stakeholder Engagement	Category A and Category B projects require the client to demonstrate effective Stakeholder Engagement as an ongoing process in a structured and culturally appropriate manner with affected communities and, where relevant, other stakeholders.
EP 6: Grievance Mechanism	Ensure that consultation, disclosure and community engagement continues throughout construction and operation of project and establish a grievance mechanism as part of the management system.
EP 7: Independent Review	For Category A projects, and for appropriate Category B projects, an independent social or environmental expert will review the assessment, the Action Plan and consultation process documentation.
EP 8: Covenants	Covenants will be applied to loans to ensure compliance with the EP. These will include (as a minimum): (i) Category A and B project will comply with all relevant national social and environmental law, regulations and permits in all respects. (ii) Comply with the Action Plan and provide periodic reports. (iii) Decommission facilities in accordance with agreed decommissioning plan.
EP 9: Independent Monitoring and Reporting	Ensure ongoing monitoring and reporting over life of the project to be verified by independent environmental and/or social experts
EP 10: Reporting and Transparency	Commit to reporting publicly at least annually about Equator Principle implementation processes and experience.

Source: http://www.equator-principles.com/resources/equator_principles_III.pdf

3.3.2 International Finance Corporation

The EPs set the requirements for projects to follow the IFC Performance Standards (IFC PS) and environmental health and safety guidelines (IFC EHS) that are internationally recognised and widely referred to in order to demonstrate compliance with best practice in environmental and social issues related to industrial developments. There are eight performance standards, updated in 2012, designed to help avoid, mitigate and manage environmental and social risks and impacts as described in Table 8.

Table 8: Summary of IFC Performance Standards requirements

Performance standard	Summary of requirements
PS 1: Assessment and management of environmental and social risks and impacts	The developer is required, in coordination with other responsible government agencies and third parties as appropriate, to conduct a process of environmental and social assessment, and establish and maintain an environmental and social management system (ESMS) appropriate to the nature and scale of the project and commensurate with the level of its environmental and social risks and impacts. The ESMS is required to include policy; identification of risks and impacts; management programs; organizational capacity and competency; emergency preparedness and response; stakeholder engagement; and monitoring and review.
PS 2: Labour and working conditions	PS 2 aims to protect the fundamental rights of workers as guided by relevant conventions of the International Labour Organisation (ILO). If applicable, it can apply to workers directly employed by the developer, contracted workers and supply chain workers.
PS 3: Resource efficiency and pollution prevention	The developer is required to consider ambient conditions and apply technically and financially feasible resource efficiency and pollution prevention principles and techniques that are best suited to avoid, or where avoidance is not possible, minimise adverse impacts on human health and the environment. The principles and techniques applied during the project life-cycle are required to be tailored to the hazards and risks associated with the nature of the project and consistent with good international industry practice. Reference is required to applicable EHS guidelines.
PS 4: Community health, safety, and security	Requires the developer to evaluate the risks and impacts to the health and safety of local communities directly affected by the project during the project life-cycle and to establish preventive and control measures consistent with good international industry practice including EHS guidelines or other internationally recognised sources. Mitigation measures are required to favour the avoidance of risks and impacts over minimisation.
PS 5: Land acquisition and involuntary resettlement	PS 5 requires the developer to consider feasible alternative project designs to avoid or minimise physical and/or economic displacement, while balancing environmental, social, and financial costs and benefits, paying particular attention to impacts on the poor and vulnerable. Where displacement cannot be avoided standards are established for actions that the developer must take, including with regard to engagement, compensation and resettlement.
PS 6: Biodiversity conservation and sustainable management of living natural resources	The developer's ESIA is required to consider direct and indirect project-related impacts on biodiversity and ecosystem services, especially focussing on habitat loss, degradation and fragmentation, invasive alien species, exploitation, hydrological changes, nutrient loading, and pollution and the value of biodiversity and ecosystem services to different stakeholders. The developer is required to seek to avoid impacts and only implement measures to minimise impacts or compensate/offset impacts where this is not possible. The adoption of adaptive management techniques throughout the life-cycle of the project is required.
PS 7: Indigenous peoples	This PS recognises that indigenous peoples may be more vulnerable to the adverse impacts associated with project development than non-indigenous communities. The developer is required to ensure that the development process fosters full respect for the human rights, dignity, aspirations, culture, and natural resource-based livelihoods; to anticipate and avoid adverse impacts, or when avoidance is not possible, to minimize and/or compensate for such impacts; to promote sustainable development benefits and in a culturally appropriate manner; to establish and maintain an ongoing relationship based on informed consultation and participation throughout the project's life-cycle; to ensure free, prior, and informed consent in specified circumstances; and to respect and preserve the culture, knowledge, and practices of indigenous peoples.
PS 8: Cultural heritage	In addition to complying with applicable law on the protection of cultural heritage, including national law implementing the host country's obligations under the Convention Concerning the Protection of the World Cultural and Natural Heritage, the developer is also required to identify and protect cultural heritage by ensuring that internationally recognized practices for the protection, field-based study, and documentation of cultural heritage are implemented.

Source: www.ifc.org

PS3 on resource efficiency and pollution prevention and PS4 on community health, safety, and security require reference to be made to the relevant International Finance Corporation (IFC) Environmental, Health and Safety Guidelines (EHS guidelines). The EHS guidelines are technical reference documents with general and industry-specific examples of good international industry practice (GIIP), as defined in IFC's Performance Standard 3.

The EHS guidelines contain the performance levels and measures that are normally acceptable to IFC, and that are generally considered to be achievable in new facilities at reasonable costs by existing technology. When host country regulations differ from the levels and measures presented in the EHS guidelines, projects will be required to achieve whichever is more stringent (except for ambient air quality where local (national) standards take precedence). If less stringent levels or measures are appropriate in view of specific project circumstances a full and detailed justification for any proposed alternatives is needed as part of the site-specific environmental assessment.

3.3.3 Japan Bank for International Cooperation (JBIC)

It is understood that the consortium will likely seek international finance from the Japan Bank for International Cooperation (JBIC). JBIC requires that proponents of projects seeking financing undertake appropriate actions to prevent or minimise impacts on the environment and local communities. The primary document governing JBIC's environmental and social lending requirements is 'Guidelines for Confirmation of Environment and Social Considerations' first issued in 2003, revised in July 2009 and April 2012, with the latest revision issued in January 2015. JBIC promotes environmental conservation and projects that contribute to the preservation of the global environment, such as reduction of greenhouse gas emissions.

JBIC undertakes a three-stage process to confirm adequate consideration of environmental and social considerations:

- Classifies the project into one of three categories, A, B or C via a screening process
- Conducts a review of environmental and social considerations (in the form of an ESIA submitted by the project proponent) to confirm that requirements are duly satisfied through an environmental review process
- Conducts monitoring and follow-up after the funding decision has been made

Projects are categorised as A, B or C- based on the magnitude of their potential environmental and social effects and in the case of category C projects the value of funding and level of JBIC involvement in the project. An additional category, FI, is also available for projects for which JBIC's funding is provided to a financial intermediary and other specified conditions are met. With reference to JBIC's category definitions provided in Part 1 (4)(2) of the JBIC Environmental and Social Guidelines, the project is considered likely to be classified as a 'Category A' project for the purposes of this assessment, as a large project in the thermal power sector.

Part 1 (4) of the JBIC guidelines identifies the applicable environmental and social standards that are required to be achieved and which JBIC will undertake its environmental review against:

- Host country environmental laws, standards, policies and plans
- Relevant aspects of the World Bank Safeguard Policy regarding environmental and social considerations
- For private sector limited or non-recourse project finance cases or otherwise where appropriate, the relevant aspects of the IFC Performance Standards.

JBIC also refers to standards established by other international financial institutions and other internationally recognised standards and/or good practices established by developed countries in its environmental review process for benchmarking and reference as required. Environmental checklists are provided for different industry types that detail the environmental and social issues that should be assessed. The environmental checklists of particular relevance to the proposed project include:

- Environmental Checklist 12: Thermal Power
- Environmental Checklist 20: Water Supply
- Environmental Checklist 21: Sewage and Wastewater Treatment

This ESIA will consider the Equator Principles/IFC Performance Standards as the principal international guidance which the project will be reviewed against. Where JBIC standards differ, or are particularly relevant to an individual aspect these are outlined further in the relevant sections.

3.3.4 Nippon Export and Investment Insurance (NEXI)

As noted previously, one of the key financial institutions involved in the project is anticipated to be NEXI. NEXI has committed to contributing to Japan's external transactions and ensuring that sponsors/developers have implemented appropriate environmental and social considerations in their projects. As such, they have published the 'Guidelines on Environmental and Social Considerations in Trade Insurance' (April 2017), which seek to identify minimum considerations reviewed within their project investment risk assessment.

Funding applicants are required to submit screening forms to NEXI. Following review, NEXI then categorise projects into one of three categories, which correspond to those noted under JBIC standards. Thermal power plants are indicated within the guidelines as an illustrative sector which would typically be categorised as a 'Category A' project. Category A projects are subject to environmental review and required to submit an ESIA study for the project which NEXI will subsequently review against the environmental checklist developed for the specific sector, thermal power projects.

NEXI may require projects to meet World Bank Safeguard Policies or IFC Performance Standards (or other developed country standards as appropriate). Given the input of JBIC and likelihood that other international banks will be involved in the financing, it is considered that the practices outlined within JBIC standards and further details within the IFC Performance Standards are appropriate to review the proposed project against and, with regard to environmental and social considerations, JBIC and NEXI can effectively be taken as the same standards.

It is considered that the relevant requirements of NEXI will be addressed through completion of the ESIA to IFC/JBIC standards.

3.4 International and regional conventions and treaties

The UAE is signatory to several regional and international conventions and protocols concerned with environmental protection. Table 9 lists these international conventions and treaties.

Table 9: List of regional and international conventions and treaties either signed, ratified and accepted by the UAE

Name of convention or treaty
Vienna Convention for the Protection of the Ozone Layer
Montreal Protocol on Substances that Deplete the Ozone Layer
Basel Convention on the Control of Trans-boundary Movements of Hazardous Wastes and Their Disposal
United Nations Convention to Combat Desertification
Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade
Convention on Biological Diversity
Stockholm Convention on Persistent Organic Pollutants
United Nations Framework Convention on Climate Change
Kyoto Protocol to the UN Convention on Climate Change
Convention on International Trade in Endangered Species of Wild Fauna and Flora – CITES

Name of convention or treaty
Convention on Wetlands of International Importance – Ramsar
International Convention for the Protection of New Varieties of Plants
Minamata Convention on Mercury
Convention on the Conservation of Migratory Species of Wild Animals
Kuwait Regional Convention for Cooperation and Protection of Marine Environment from Pollution and its Protocols
International Convention for the Prevention of Pollution from Ships (1973G.) as amended by Protocol MARPOL (1978G.)

Source: https://government.ae/en/information-and-services/environment-and-energy/environmental-protection

4 Impact assessment and evaluation of significance

4.1 Overview

Integration of environmental and social considerations into the project cycle is an essential part of all projects that aim to contribute to sustainable development. An ESIA process is accepted as being the most effective way of achieving this integration. ESIA is a systematic process that predicts and evaluates the impacts of a project on various aspects of the physical, biological, cultural and socioeconomic environment.

This is followed by the identification of appropriate mitigation measures to avoid, reduce, remedy, offset or compensate for adverse impacts relevant to the nature and scale of the project.

4.2 Objectives of the ESIA report

The key objectives of the ESIA and the ESIA report are:

- To ensure that the IPP complies with national and international policies and framework requirements for environmental and social assessment
- To ensure that the key impacts which may be associated with construction and operation of the IPP are identified, assessed and appropriate mitigation measures specified
- To ensure that the baseline environment is adequately characterised to identify potential sensitive receptors and potential impacts and propose appropriate mitigation for the design of the plant and subsequent construction/operational phases
- To ensure that consultation with affected and interested parties is input into the design and assessment process
- To summarise and outline the mitigation and management measures for environmental and social impacts

4.3 ESIA methodology

4.3.1 Zone of influence

The proposed IPP, in addition to impacting upon the immediate site area has the potential to influence areas remote from the site. The sections below outline the key principles in ascertaining potentially impacted areas.

4.3.1.1 Direct zone of influence

The direct zone of influence (ZoI) for facilities comprises the areas in which the project will be built as well as the extent of physical impacts associated with the construction and operational phases of the project. It includes physical manifestations such as emissions and discharges associated with the project which can impact upon areas off the site.

The direct zone of influence indicates where proposed works will have a direct impact on the physical and social (and economic) environment. The zone comprises direct land-take or impact as a result of the proposed works and includes the footprints of the following:

- Construction of the plant
- Construction of associated infrastructure
- Access roads
- Workers' accommodation (if applicable)
- Areas which are impacted upon by emissions or effluent discharges
- Temporary rights of way during construction

4.3.1.2 Indirect zone of influence

The indirect zone of influence comprises those impacts which are reasonably foreseeable including indirect social, economic and environmental changes which may be caused by the project.

These impacts may be situated off-site and may relate to subsequent effects caused by other aspects of the project which are understood better once additional information related to the project is provided. An example of indirect influence would be additional ship traffic due to increased economic activity related to more power availability.

4.3.2 Assessment of impact significance

The assessment of effects and identification of residual significance within this ESIA has taken account of any incorporated mitigation measures adopted by the project design. Potential impacts and the establishment of their magnitude are largely dependent on the extent and duration of change, the number of people or size of the resource affected and their sensitivity to the change. Impacts can be both adverse and beneficial and, where possible, the methodology elaborated upon below will be applied to define beneficial impacts. The criteria for determining significance are specific for each environmental and social aspect and defined in the specialist chapters. Generic criteria for the definition of magnitude and sensitivity are summarised below.

4.3.2.1 Magnitude criteria

The assessment of magnitude is undertaken in two steps. Firstly, the key issues associated with the project are categorised as beneficial or adverse. Secondly, impacts are categorised as major, moderate, minor or negligible based on consideration of the parameters such as:

- Duration of the impact - ranging from beyond decommissioning to temporary with no detectable impact
- Spatial extent of the impact – for instance, international, national, regional or within the site boundary
- Reversibility - ranging from permanent requiring significant intervention to return to baseline to no change
- Likelihood – ranging from occurring regularly under typical conditions to unlikely to occur
- Compliance with legal standards and established professional criteria - ranging from substantially exceeds national standards and limits/international guidance to meets or exceeds minimum standards or international guidance.

Each environmental and social aspect assessment will define magnitude in relation to their topic. Table 10 presents generic criteria for determining magnitude.

Table 10: Criteria for determining magnitude

Category	Description (adverse impacts)
Major	Fundamental change to the specific conditions assessed resulting in long term or permanent change, typically widespread in nature, and requiring significant intervention to return to baseline; exceeds national/international standards and limits.
Moderate	Detectable change to the specific conditions assessed resulting in non-fundamental temporary or permanent change.
Minor	Detectable but minor change to the specific condition assessed.
Negligible	No perceptible change to the specific condition assessed.

4.3.2.2 Sensitivity criteria

Sensitivity is generally site specific and criteria are developed from baseline information. Sensitivity of a receptor is determined based on the population including proximity, numbers and ability to adapt to change and presence of features on the site or the surrounding area. Generic criteria for determining sensitivity of receptors are outlined in Table 11. Each detailed assessment will further define sensitivity in relation to their topic as appropriate.

Table 11: Criteria for determining sensitivity

Category	Description (adverse)
High	Vulnerable receptor (human or terrestrial) with little or no capacity to absorb proposed changes or minimal opportunities for mitigation.
Medium	Vulnerable receptor (human or terrestrial) with little capacity to absorb proposed changes or limited opportunities for mitigation.
Low	Vulnerable receptor (human or terrestrial) with some capacity to absorb proposed changes or moderate opportunities for mitigation
Negligible	Vulnerable receptor (human or terrestrial) with good capacity to absorb proposed changes or and good opportunities for mitigation

4.3.2.3 Impact evaluation

Impacts will be identified and significance will be attributed taking into account the interaction between magnitude criteria and sensitivity criteria as presented in the significance matrix in Table 12.

Table 12: Impact of significance matrix

Magnitude of impact	Sensitivity of receptors			
	Negligible	Low	Medium	High
Negligible	Insignificant	Insignificant	Insignificant	Insignificant
Minor	Insignificant	Insignificant	Minor	Minor
Moderate	Insignificant	Minor	Moderate	Moderate
Major	Insignificant	Minor	Moderate	Major

4.3.3 Mitigation and enhancement measures

Where feasible the following hierarchy of mitigation measures will be applied:

- Mitigation/elimination through design (embedded mitigation)
- Site/technology choice
- Application of best practice

Each technical chapter of the ESIA identifies a full range of mitigation and enhancement measures. In addition to the above, community engagement and disclosure activities can play a key role in managing the extent of impacts and consideration shall be given to identification of enhancement measures. Enhancement measures are actions and processes that:

- Create new positive impacts or benefits
- Increase the reach or amount of positive impacts or benefits
- Distribute positive impacts or benefits more equitably

4.3.4 Residual impacts

The significance of impacts is discussed before and after mitigation within the ESIA chapters and statements of significance based on the predicted impact after the implementation of proposed mitigation measures are noted. Impacts considered of moderate or major significance after application of mitigation measures are noted as significant.

4.3.5 Uncertainties

Any uncertainties associated with impact prediction or the sensitivity of receptors due to the absence of data or other limitation are explicitly stated within this ESIA, with the notable consideration that baseline surveys have not yet been finalised. Where applicable, the ESIA makes recommendations concerning measures that should be put in place with monitoring and /or environmental or social management plans to deal with the uncertainty so that they can be addressed as they arise during the plants design optimisation process and the construction and operational phases.

4.3.6 Cumulative impacts

The assessment of cumulative impacts considers the combination of multiple impacts that may result when the project is considered alongside other existing or proposed projects in the same geographic area or similar development timetable. The assessment of cumulative impacts will identify where particular resources or receptors would experience significant adverse or beneficial impacts as a result of a combination of projects.

5 Air Quality

5.1 Introduction

5.1.1 Overview

This chapter considers potential air quality impacts associated with the construction and operation of the project. Key potential emission sources of air pollutants which could affect ambient air quality and/or amenity at nearby of local receptors have been considered.

5.1.2 Key pollutants

With respect to construction and decommissioning phase effects the primary pollutant of concern is particulate matter (PM). No other pollutants from construction and decommissioning are considered due to the limited emission sources, the limited duration that emissions would take place, the existing pollutant concentrations and location of sensitive receptors nearby.

During operation the combustion of fossil fuel gives rise to pollutants with the potential to negatively affect local air quality. With respect to natural gas and fuel oil (the proposed fuels for this project), the primary pollutants of concern are:

- Oxides of nitrogen (NO_x)
- Sulphur dioxide (SO_2)
- Particulate matter (PM)
- Carbon monoxide (CO)

The dispersion modelling assessment undertaken for the operation phase has focussed on NOx concentrations and the equivalent NO_2 concentration for comparison with ambient standards because NO_2 is the most significant pollutant associated with natural gas combustion. Emissions of PM, SO_2 and CO are assessed qualitatively is section 5.6.2.4

5.1.2.1 Oxides of nitrogen

Oxides of nitrogen is a term commonly used to describe a mixture of nitric oxide (NO) and nitrogen dioxide (NO_2), referred to collectively as NOx. These are primarily formed from atmospheric and fuel nitrogen as a result of high temperature combustion. The major sources in most countries are road traffic and power generation.

During the process of combustion, atmospheric and fuel nitrogen is partially oxidised via a series of complex reactions to NO. The process is dependent on the temperature, pressure, oxygen concentration and residence time of the combustion gases in the combustion zone.

Most NOx exhausting from a combustion process is in the form of NO, which is a colourless and tasteless gas. It is readily oxidised to NO_2, a more harmful form of NOx, by chemical reaction with ozone and other chemicals in the atmosphere.

5.1.2.2 Sulphur dioxide

SO_2 is a colourless, non-flammable gas that can irritate the eyes and air passages. It reacts on the surface of a variety of airborne solid particles, is soluble in water and can be oxidised within airborne water droplets. The most common sources of SO_2 include fossil fuel combustion, smelting, manufacture of sulphuric acid, conversion of wood pulp to paper, incineration of waste and production of elemental sulphur. Coal burning is the single largest man-made source of SO_2, accounting for about 50% of annual global emissions, with oil burning accounting for a further 25-30%. The most common natural source of SO_2 is volcanoes.

5.1.2.3 Particulate matter

PM is a complex mixture of organic and inorganic substances present in the atmosphere and sources are numerous. Coarse particulates arise mainly from mechanical suspension of soil, dust, sea salt and diffuse industrial / traffic related sources and are predominantly of natural or indirect anthropogenic origin. Particulates are described in term of their size; for example the term $PM_{2.5}$ describes particulate matter that is less than 2.5 microns (10^{-6} metres) aerodynamic diameter. Fine particulates ($PM_{2.5}$ – $PM_{0.1}$) are derived mainly from gas-to-particle reactions in combustion exhausts or between ammonia and sulphate and nitrate and are predominantly of direct anthropogenic origin.

5.1.2.4 Carbon monoxide

CO is a colourless, odourless gas produced by the incomplete combustion of carbon-based fuels and by biological and industrial processes. The major source of carbon monoxide is traffic, particularly in urban areas. CO is produced under conditions of inefficient combustion, is rapidly dispersed away from the source and is relatively inert over the timescales relevant for its dispersion. CO has always been present as a minor constituent of the atmosphere, chiefly as a product of volcanic activity but also from natural and man-made fires and the burning of fossil fuels.

5.1.2.5 Other pollutants

Volatile organic compounds (VOCs) can also be released to the atmosphere from combustion processes. The concentration of VOCs in exhaust gases are dependent on the fuel type and the combustion efficiency. The presence of VOCs in the exhaust gas is a function of incomplete combustion and therefore for the proposed project, which will use technology options designed to minimise incomplete combustion, VOC emissions are expected to be low, and significantly lower than other key pollutant emissions such as oxides of nitrogen.

There are no national emissions limits or emission guidelines issued by the IFC. Therefore, VOC emissions from the project will be managed through the ongoing operating procedures and monitoring of combustion efficiency. The project will seek to avoid incomplete combustion as this will reduce efficiency and therefore reduce power output. Considering this, emissions of VOCs will not have a significant effect on ambient air quality and therefore have not been considered further in the ESIA.

Hydrogen sulphide (H_2S) is a toxic, flammable gas, which has an odour of rotten eggs. The natural gas used for the proposed project will at most contain trace amounts of H_2S, as the gas will be combusted and there is not expected to be fugitive emissions contribution of H_2S is anticipated to be negligible and therefore has not been considered further.

Emissions of greenhouse gases are described and assessed in Chapter 6.

5.2 Methodology and assessment criteria

5.2.1 Area of influence

Construction impacts will be located in close proximity to the project site and will not extend beyond 500m from any construction or decommissioning activity as construction activities lead to the generation of large particles that are unable to travel large distances and therefore usually deposit within 350 metres. This assessment has assumed that particles have the potential to deposit as far as 500 metres from the site boundary to take account of dry conditions in Sharjah and to provide a conservative assessment. This is described further in section 5.2.3.

In accordance with best practice, potential impacts of emissions from operation of the plant on ambient air quality have been assessed within 15km of the project and the worst predicted impacts presented.

5.2.2 Baseline methodology

The baseline assessment has used existing monitoring data available within the study area to characterise the current conditions. Section 5.5 provides full details of the existing data used in the assessment.

Pollutant concentrations derived from the baseline monitoring have been used within the impact assessment to represent the current ambient conditions which take of existing sources of pollution in the study area.

5.2.3 Construction phase

Construction activities can result in temporary effects from particulates (i.e. dust). Dust is a generic term which usually refers to particulates with an aerodynamic diameter range of 1-75 microns. Emissions of construction dust are predominantly associated with the movement and handling of minerals and therefore composed of the larger fractions of this range (predominantly coarser total suspended particulates with relatively minor amounts of PM10 and PM2.5), which do not penetrate far into the respiratory system. Total suspended particulates (TSP) can be considered as anything smaller than 100 microns in aerodynamic diameter. In practice, the large particles (i.e. those greater than 20-30µm in aerodynamic diameter) do not persist in the atmosphere as they tend to fall out rapidly and settle as they are deposited onto surfaces. Therefore, the primary air quality issue associated with construction phase dust emissions is normally loss of amenity and/or nuisance caused by, for example, soiling of buildings, vegetation and washing and reduced visibility. Dust deposition can be expressed in terms of mass per unit area per unit time (e.g. mg/m2/month). In addition, there are applicable UAE hourly (230µg/m3) and annual (90µg/m3) average standards for TSP which are applicable to the project.

Construction dust impacts are typically temporary in nature and comparison against annual standards is not considered relevant. Comparison to the 1-hour, daily and/or monthly standards is preferable.

The usefulness of numerical criteria to determine effects from construction dust is limited as the perception of loss of amenity or nuisance is affected by a wide range of factors such as character of the locality and sensitivity of receptors. Because of this an assessment methodology that is based on a qualitative approach as published by the Institute of Air Quality Management (IAQM) in the United Kingdom was adopted for this assessment based on key issues identified in the guidance.

Undertaking a detailed quantitative assessment of the construction phase is considered unnecessary regarding the particulate concentration levels, given that the emissions will be present for a relatively short duration and the limited number of sensitive receptors near the project. The purpose of the assessment is to determine the level of impact and the mitigation measures required to reduce dust impacts to below levels at which they may cause nuisance or harm to human health.

The first stage of the assessment involved identification of construction activities which have the potential to cause dust emissions, along with the degree of dust potential specific to the project site. Table 13 provides a generic list of potential activities at each stage of construction and their potential to cause dust. Selected information for this table was used within this assessment to determine the impact of the project with respect to construction dust. It should be noted that the same level of impacts would be associated with these activities during the decommissioning phase.

Table 13: Relevant generic dust emitting activities

Potential dust emitting activities	Description	Dust emission potential
Soil handling	Potential to be high in dust nuisance, depends on soil dryness	High
Loading activities	Potential to be high in dust nuisance, depends on material characteristics	High
Storage of materials onsite	Potential to be high in dust nuisance, depends on material characteristics	High
Transport of materials within site	Can be high depends on type of transport and nature of road surface	Medium
Drilling and digging activities (Including soil excavation)	Can be high depending on type of drilling and digging activities and material characteristics	High
Transport of material offsite	Generally low as transport occurs by surfaced roads however has the potential to be medium when on unsurfaced or poor-quality roads	Medium-low
Construction of new buildings	Generally low although some activities with high dust raising such as material cutting can occur	Medium-low
Assembly of plant	Generally low as involves assembling prefabricated pieces	Low

Source: Adapted from UK Department for Environment and Rural Affairs and Buildings Research Establishment guidance

In the second stage of the assessment, all sensitive receptors with the potential to be significantly affected by construction dust emissions have been identified. The distances from source at which construction dust effects are felt are dependent on the extent and nature of mitigation measures, prevailing wind conditions, rainfall and the presence of natural screening by, for example, vegetation or existing physical screening such as boundary walls on a site. However, research indicates that effects from construction activities that generate dust are generally limited to the areas within 350m of the construction site boundary and this forms the basis of international guidance documents. To ensure a conservative approach is applied, considering the arid conditions at the project site, any receptors within 500m of the construction site boundary were identified. The receptor classification of sensitivity used in the assessment was determined in accordance with Table 14.

Table 14: Receptor classification

Classification		
High	**Medium**	**Low**
Hospitals and clinics	Residential areas	Agricultural areas
Old age homes	Road users	Other Industry
Schools	-	Sensitive ecological areas

Source: Mott MacDonald, 2018

5.2.4 Operational phase

5.2.4.1 Stack height determination

The purpose of a stack height calculation is to determine the height necessary to ensure that emissions from a stack do not result in excessive ground level concentrations of air pollutants because of atmospheric downwash, eddies or wakes which may be created by nearby structures or terrain.

Nearby structures are normally the dominant causes of any atmospheric downwash, eddies, or wake effects. For proper dispersion to occur, it is necessary for the emissions to be released well above the top of nearby structures. Dispersion of emissions from a stack is also determined by the emission characteristics of the source, particularly their temperature and emissions velocity when they exit the stack.

Many methods are available to determine an appropriate stack height, including simple equations and air dispersion modelling. Air dispersion modelling was used in this assessment to determine the optimum stack height.

The recommended stack height is based on an assessment of potential impacts on the ambient air quality only. Amongst others, it does not take account of structural requirements, safety issues or associated regulations which should be considered by those using this information to develop the stack design.

5.2.4.2 Cumulative impacts

The proposed project is adjacent to the existing 400-500MW CCGT power plant and the HFZ industrial area is also close to the site. It is likely that there will be cumulative impacts on air quality as a result of mixing of exhaust emissions from the proposed project and existing sources. Existing sources are taken into account by utilising the ambient air quality baseline of the project area, data for which was provided by HFZA that is reported in section 5.5 (Baseline conditions). The air dispersion modelling undertaken to assess the impacts associated with the proposed project considers emissions from the proposed project and when combined with background ambient air quality baseline, provides the cumulative impact.

5.2.4.3 Best available techniques (BAT)

The air quality assessment took into consideration the finding of the BAT study that had been undertaken for the IPP. The full BAT report is presented in Appendix B.

5.2.4.4 Dispersion model

Many commercially available air dispersion models can predict ground level concentrations arising from emissions to atmosphere from point sources such as power plants. The AERMOD air dispersion model was used to inform the basis of the stack height determination and air quality impact assessment.

AERMOD is considered as an advanced dispersion model because of the way it characterises the atmosphere. It was developed on behalf of the US Environmental Protection Agency (EPA) by the American Meteorological Society/EPA Regulatory Model Improvement Committee (AERMIC), which was developed to introduce state of the art modelling concepts into the US EPA’s local-scale air quality models. AERMOD is designed to treat both surface and elevated emission sources in simple and complex terrain.

There are two input data processors that are important components of the AERMOD modelling system; AERMAP and AERMET. AERMET is the meteorological pre-processor for AERMOD, its outputs include surface meteorological conditions and parameters and vertical profiles of several atmospheric parameters. AERMAP is a terrain pre-processor designed to simplify and standardise the input of terrain data for AERMOD. The output includes a location and height scale, which is an elevation used for the computation of air-flow around hills.

AERMOD is classed by the US EPA as their preferred model for regulatory dispersion applications. The model is used and recognised by regulators worldwide and is acknowledged by the International Finance Corporation (IFC) Environmental, Health, and Safety (EHS) Guidelines as an appropriate tool for predicting potential impacts from air emission sources.

5.2.4.5 Emissions data

Emissions data used in this assessment (i.e. for the stack height determination and impact assessment) is based on the information provided by GE who are the proposed gas turbine suppliers and is presented in Table 15.

During the assessment, the following scenarios were assessed to determine the possible impacts of the project:

- Scenario 1: The project operating in combined cycle mode on natural gas at 100% load with a stack height of 60m
- Scenario 2: The project operating in open cycle mode on natural gas at 100% load with a stack height of 45m
- Scenario 3: The project operating in combined cycle mode on fuel oil at 100% load with a stack height of 60m

Table 15: Emissions data used for stack height determination and impact assessment purposes

Parameter	Natural gas		Fuel oil
	Emissions used for the HSRG stack height determination (a)	Emissions used for the by-pass stack height determination (b)	Emissions used for the HSRG stack operating on Fuel oil
	Combined cycle	**Simple cycle**	**Combined cycle**
Normalised volumetric flow (Nm^3/s) (c)	855.3	857.7	890.0
Efflux temperature (°C)	81.1	633.7	121.1
Efflux velocity (m/s)	17.2	41.0	19.6
Stack diameter (m)	8	8.3	8
Stack height (impact assessment) (m)	60	45	60
NO_x emission concentration (mg/Nm^3)	51	51	152
NO_x emission rate (g/s)	44	44	135

Notes:
(a) Emissions based on operating scenario with lowest exhaust gas temperatures and exhaust gas exit velocity
(b) Emissions based on operating scenario with maximum pollutant mass emissions
(c) Normalised flows referenced to 15% O_2, dry, 0°C, 1 atm

Source: Sumitomo Corporation and GE, 2018

5.2.4.6 Meteorological data

The most important meteorological parameters governing atmospheric dispersion of pollutants are wind direction, wind speed and atmospheric stability as described below:

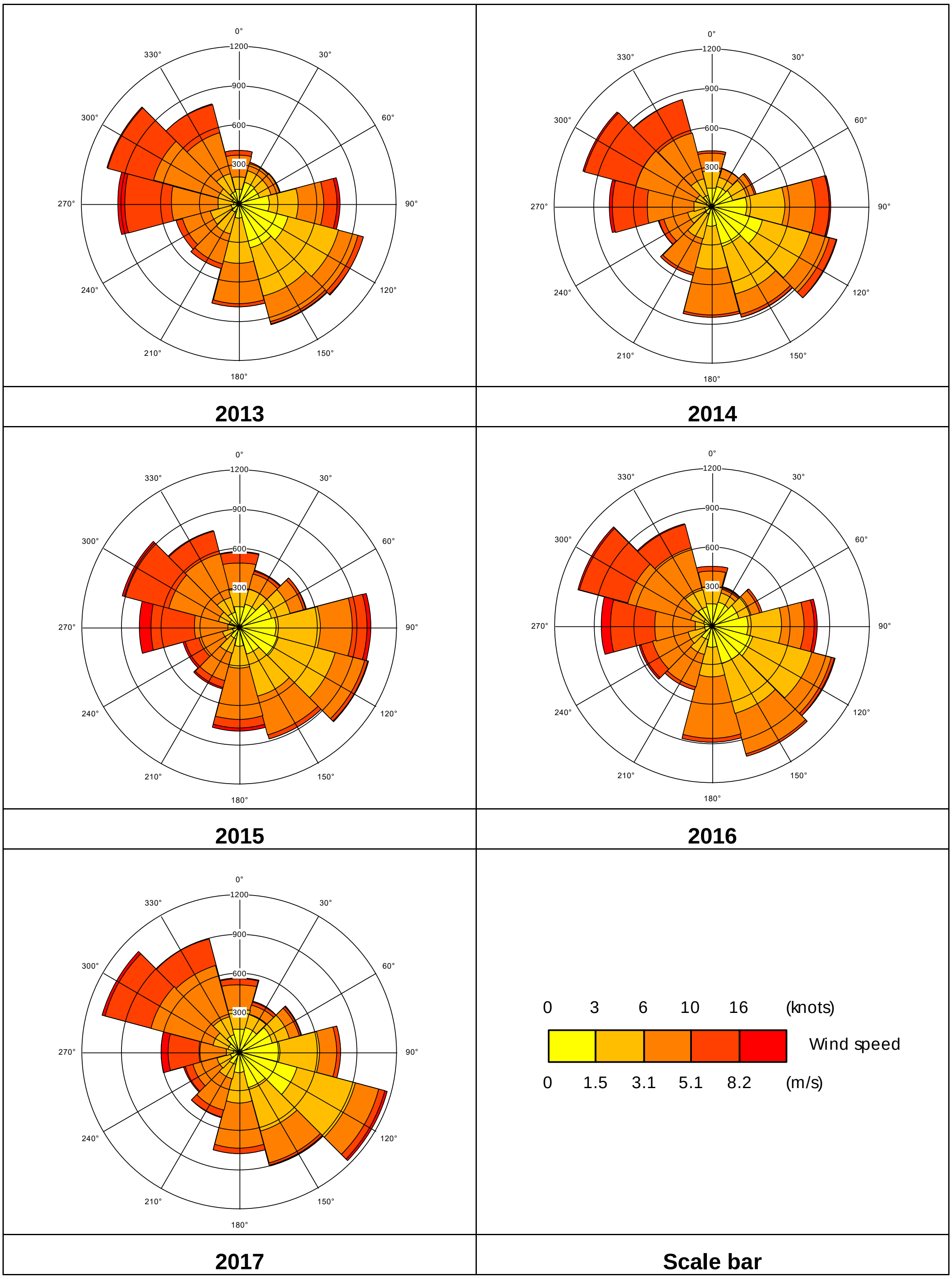
- Wind direction determines the sector of the compass into which the plume is dispersed
- Wind speed affects the distance which the plume travels over time and can affect plume dispersion by increasing the initial dilution of pollutants and inhibiting plume rise
- Atmospheric stability is a measure of the turbulence of the air, and particularly of its vertical motion. It affects the spread of the plume as it travels away from the source. New generation dispersion models, such as AERMOD, use a parameter known as the Monin-Obukhov length that, together with the wind speed, describes the stability of the atmosphere

For meteorological data to be suitable for dispersion modelling purposes, several meteorological parameters are measured on an hourly basis. These parameters include wind speed, wind direction, cloud cover and temperature.

The closest meteorological station to the proposed project with suitable available data is at Sharjah International Airport approximately 15 kilometres to the south-east of the project site. The data is considered representative of conditions expected at the proposed project site due to the short distance between them and there’s no significant topographical differences between them which may influence the predominant meteorological conditions.

Figure 21 presents wind roses of the meteorological data for the monitoring period of 2013 to 2017. The wind roses illustrate that the meteorology in the area is nominated by land and sea breezes. Predominant wind directions are from the north-westerly sector (onshore breeze with increased average wind velocities in comparison to the offshore breezes) and south-easterly sector (offshore breeze).

Figure 21: Meteorological data used within the assessment



Source: Sharjah International Airport Meteorological Station, 2013-2017

5.2.4.7 Terrain and surface roughness

The presence of elevated terrain can significantly affect (usually increase) ground level concentrations of pollutants emitted from elevated sources, such as stacks, by reducing the distance between the plume centre line and ground level. Conversely, hilly terrain can increase turbulence and plume mixing, which may reduce ground level concentrations.

Terrain data has not been included in the dispersion model as the area surrounding the proposed project can be described as flat as there are no hills with gradients greater than 1 in 10.

Roughness of terrain over which a plume passes can have a significant effect on dispersion by altering the velocity profile with height and the degree of atmospheric turbulence. Surface parameters have been accounted for within the processing of the meteorological data for land use around the meteorological station used in the assessment.

5.2.4.8 Buildings and plant layout

The movement of air over and around buildings generates areas of flow circulation, which can lead to increased ground level concentrations in the building wakes. The buildings likely to have the dominant effect (i.e. with the greatest dimensions likely to promote turbulence) are the generation turbine building (housing the gas turbines and steam turbines) and the heat recovery steam generators (HRSGs). They are listed in Table 16 and illustrated in Figure 22.

Table 16: Buildings included within dispersion modelling

Building	X (UTM)	Y (UTM)	Height (m)	Length (m)	Width (m)	Angle (°) [a]
GT Building	347042.7	2816978.5	25.5	280	23	-49
HRSG #3	346998.6	2816993.8	30.6	23.7	20.6	-49
HRSG #2	346951.0	2816914.5	30.6	23.7	20.6	-49
HRSG #1	346903.4	2816835.2	30.6	23.7	20.6	-49
Notes:	[a] Angle shows rotation clockwise from a line running west to east. Building length and widths are model inputs and in some cases, may overlap. This overlap allows a representation of the true building footprint and may not match design length and widths.					

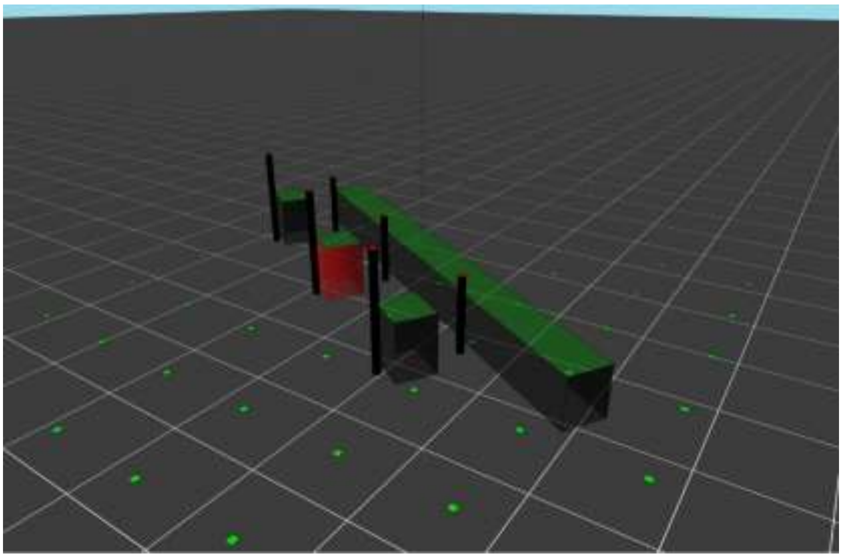
Source: Mott MacDonald, 2018

5.2.4.9 NO_x to NO_2 conversion

NO_x emissions associated with combustion sources such as boilers/turbines will typically comprise approximately 90-95% nitric oxide (NO) and 5-10% NO_2 at source. The NO oxidises in the atmosphere in the presence of sunlight, ozone, and volatile organic compounds to form NO_2, which is the principal pollutant of concern with respect to environmental and health effects.

There are various techniques available for estimating the proportion of NO_x that is converted to NO_2. 50% conversion of NO_x to NO_2 was assumed for short term averaging periods (20-minutes, 1 hour and 24 hour) and 70% conversion for long term averages (annual). This approach is considered appropriate based on guidance from the United States Environmental Protection Agency (US EPA) (United States Environmental Protection Agency, Part 3, 40 CFR Part 51, 2005).

Figure 22: Buildings included within dispersion modelling



Source: Mott MacDonald, 2018

5.2.4.10 Modelled grids

A modelled receptor grid centred on the centre stack was used with a receptor spacing of 50m for a radius of 2.5km to capture the worst-case ground level contributions. A second receptor grid with a radius of 15km was used with a receptor spacing of 500m.

Additional discrete points were added to the model to represent specified sensitive receptor locations within the study area. An elevation of 1.5m was used during modelling to be representative of a typical human height.

The eight discrete receptors included in the model are presented in Figure 23 and represent:

- Residential areas including: the Ajman; Altair; Al Hamriyah residential areas; and Al Zorah Villas
- Recreational areas including: The Beach Campers camping area; the Al Zorah Golf Club and the Oberal Beach Resort Al Zorah
- Sensitive ecological mangrove environment

Figure 23: Location of identified sensitive receptors in relation to the proposed project

Source: Mott MacDonald, 2018

5.3 Legislative framework

5.3.1 Emission standards

5.3.1.1 National standards

Emission standards applicable to the United Arab Emirates (UAE) are set out in Federal Law No.12 of 2006 on Air Quality and Regulation and are presented in Table 17.

Table 17: Relevant emission standards as per Federal Law No. (12) of 2006 on Air Quality and Regulation

Pollutant	UAE Max. emission limits - stationary sources (mg/m^3)	UAE Max. emission limits - hydrocarbon fuel combustion (mg/m^3)
NO_x (expressed as NO_2)	Turbine combustion units: • Gas fuel: 70 • Liquid fuel: 150	Turbine combustion units: • Gas fuel: 70 • Liquid fuel: 150
SO_2	500	500
CO	500 mg/m^3	500 mg/m^3
Total suspended particulate	250	250

Source: Federal Law No. (12) of 2006

In addition to the emission standards in Table 17, Federal Law No. (12) of 2006 regarding the Protection of Air Pollution makes provision for regulation of sulphur content in fuel oil. Specifically, Article 4 states that *'all parties are required to take all the precautionary measures to reduce the pollutants resulting from burning as follows'.* The relevant text states:

'It is prohibited to use diesel containing more than 0.05 % in weight sulphur provided that the competent authorities in each emirate sets the transitional policies, the work plans, and detailed mechanisms for its gradual replacement with clean fuel in order to arrive at the internationally approved percentage of 10 ppm in weight in coordination with the producing authority in the country.' In alignment with this standard, all fuel oils used will have to contain a sulphur content of less than 0.05%.

5.3.1.2 International standards

The IFC Performance Standard 3: Resource Efficiency and Pollution Prevention aims:

"To avoid or minimize adverse impacts on human health and the environment by avoiding or minimizing pollution from project activities" To achieve this, the IFC provides both industry-specific and general guidance on Good International Industry Practice with respect to ambient air quality and emissions to air.

The IFC Environmental Health and Safety (EHS) General Guidelines advise that, with respect to emission limits, when host country regulations differ from the levels presented in the EHS Guidelines, projects are expected to achieve whichever is more stringent (It should be noted that the same approach does not apply to ambient concentrations, as described below).

Relevant IFC standards for emissions to air applicable for gas turbines over 50MWth using natural gas, and fuels other than natural gas, are presented in the IFC EHS Guidelines for Thermal Power Plants 2008.

The IFC standards are presented in Table 18 below. Emission limits for CO are not prescribed by the EHS Guidelines for Thermal Power Plants.

Table 18: Pollutant emissions limit values for all turbine units > 50MWth input

Fuel	Pollutant	IFC Guidelines	
		Non-degraded airshed	Degraded airshed
Natural gas	NO_x	51 mg/Nm^3	51 mg/Nm^3
Fuels other than natural gas	NO_x	152 mg/Nm^3	152 mg/Nm^3
	PM	50 mg/Nm^3	30 mg/Nm^3
	SO_2	Use 1% sulphur fuels or less	Use 0.5% sulphur fuels or less

Notes: Reference conditions: dry, 0ºC, 1 atmosphere, 15% O_2
Source: Environmental, Health and Safety Guidelines for Thermal Power Plants, IFC 2008.

5.3.2 Ambient standards

5.3.2.1 National standards

Ambient air quality standards applicable to the United Arab Emirates (UAE) are set out in Federal Law No. (12) of 2006 on Air Quality and Regulation and are presented in Table 19.

5.3.2.2 International standards

The IFC EHS guidelines advise that ‘relevant standards’ with respect to ambient air quality are national legislated standards or, in their absence, the current World Health Organisation (WHO) Air Quality Guidelines or other internationally recognised sources such as those adopted in the European Union. WHO standards are presented alongside national requirements in Table 19.

The IFC acknowledge that national legislated ambient air quality standards take precedence over WHO standards and are the principal standards that the project is assessed against.

The current WHO Guidelines for NO_2, SO_2 and particulate matter are provided in the Air Quality Guidelines Global Update 2005. These guidelines are intended to support actions for air quality at the optimal achievable level for public health protection in different contexts. The WHO does not formally prescribe how guidelines should be used in air quality management. However, the Air Quality Guidelines Global Update does provide interim targets to aid the progression of policy development to bring air quality in line with the proposed guideline values.

The IFC EHS guidelines suggest that emissions should not contribute more than 25 percent of the relevant air quality standards to allow additional future sustainable development in the same airshed. It also states that projects located within poor quality airsheds (if the nationally legislated standards are exceeded significantly), should ensure that any increase in pollution is as small as feasible, and amounts to a fraction of the applicable short term and annual average air quality guidelines established in the project-specific environmental assessment.

The impacts of the project are discussed in the context of this approach.

5.3.3 Summary

Table 19 provides a summary of the ambient air quality standards that have been applied to the proposed project.

The standards related to short term averaging periods (one hour and 24 hour) are maximum values. In many jurisdictions, such as the United States and Europe, short term standards are not set as having maximum values but rather include a threshold of tolerance to account for exceptional, worst case episodes. In practice this means defining a number of allowable occurrences greater than the prescribed value to account for potential abnormal or infrequent pollutions episodes - these are often referred to the guideline values being applied as percentiles. For example, in the EU the standard for the one-hour NO_2 allows for 18 exceedances within a calendar year and therefore the objective level is expressed as the 99.79th percentile. When analysing one-hour NO_2 results, which is the primary pollutant of concern, the maximum result is presented and compared against national standards as maximum values and using the 99.79th percentile. This provides additional context around the results to account for outliers and results which are influenced by infrequent meteorological conditions.

Table 19: Ambient air quality standards and guidelines relevant to the project

Pollutant	Averaging period	UAE standards [a]	UAE Dubai [b] standards	WHO Air Quality [c] Guidelines
		($\mu g/m^3$)	($\mu g/m^3$)	($\mu g/m^3$)
NO_2	1 hour	400	290	200
	24 hour	150	110	-
	Annual	-	-	40
SO_2	10 minute	-	-	500
	1 hour	350	350	-
	24 hour	150	150	125 (interim target 1) 50 (interim target 2) 20 (interim target 3) 20 (guideline)
	Annual	60	50	-
PM_{10}	24 hour	150	150	150 (interim target 1) 100 (interim target 2) 75 (interim target 3) 50 (guideline)
	1 hour	-	300	-
	Annual	-	-	70 (interim target 1) 50 (interim target 2) 30 (interim target 3) 20 (guideline)
$PM_{2.5}$	24 hour	-	-	75 (interim target 1) 50 (interim target 2) 37.5 (interim target 3) 25 (guideline)
	Annual	-	-	35 (interim target 1) 25 (interim target 2) 15 (interim target 3) 10 (guideline)
TSP	24 hour	230	230	-
	1 hour	90	90	
CO	1 hour	30 mg/Nm^3	23 mg/Nm^3	-
	8 hour	10 mg/Nm^3	10 mg/Nm^3	-

Note:
(a) The UAE standards are the applicable standards for the project.
(b) Dubai standards are indicated for reference purposes as these are regional standards based on the UAE standards however some have been set more stringently.
(c) In the absence of applicable UAE standards, WHO standards can be adopted in alignment with best practice

Source: Federal Law No. (12) of 2006, as amended, WBG EHS Guidelines

5.4 Significance of impacts

5.4.1 Construction phase

A combination of dust emission potential from onsite activities (Table 13) and their expected duration is used to determine the impact magnitude of construction phases presented in Table 20.

Table 20: Determination of impact magnitude – construction phase

Dust Emissions Potential	Duration	Magnitude
High	Any	Major
Medium	> 3 Months	Moderate
Medium	< 3 Months	Minor
Low	Any	Negligible

Source: Mott MacDonald, 2018

Receptor sensitivity is based on the type of receptor and the distance from the construction or decommission activity boundary. Table 21 presents the criteria on which receptor sensitivity was based. The impact magnitudes and receptor sensitivity defined for the construction period have been used in accordance with the overarching significance criteria matrix adopted for this assessment presented in Chapter 4.

Table 21: Determination of receptor sensitivity – construction phase

		Distance to activities			
		0-50m	50-100m	100-200m	200-500m
Receptor Classification	High	High	High	Medium	Low
	Medium	Medium	Medium	Low	Low
	Low	Medium	Low	Low	Negligible
	No Receptors	Negligible	Negligible	Negligible	Negligible

Source: Mott MacDonald, 2018

5.4.2 Operational phase

Many approaches can be used to determine whether the impacts on local air quality of a project are significant during the operational phase. However, there remains no universally recognised definition of what constitutes ‘significance’.

Guidance in the UK has been released to assist in determining the significance of impacts in air quality assessments. This guidance recommends that significance should be determined by a combination of two aspects:

- The change in concentrations as a percentage of the relevant air quality standard(s) (process contribution (PC)) at sensitive receptors caused by the proposed development
- The resulting total concentrations (predicted environmental concentrations (PEC)) at sensitive receptors as a percentage of the relevant air quality standard(s).

This broad approach is considered to represent best practice for assessments of this kind and has been adapted for determining the significance of impacts on local air quality from the project’s emissions.

Table 22 and Table 23 present the approach used for determining impact magnitude (the projects process contribution) and receptor sensitivity for operational phase impacts which have been determined considering World Bank/IFC and UK guidance. Changes in ambient concentrations over 25% of the relevant standards are considered to represent an impact of 'major' magnitude as the IFC General EHS Guidelines note that projects should:

'…prevent or minimize impacts by ensuring that…emissions do not contribute a significant portion to the attainment of relevant ambient air quality guidelines or standards. As a general rule, this guideline suggests 25 percent of the applicable air quality standards…'

The IFC General EHS Guidelines classify 'poor quality airsheds' as those where relevant standards are exceeded significantly. Therefore, receptors experiencing ground level pollutant concentrations above the relevant standards are considered to be of 'high' sensitivity.

Table 22 and Table 23 define the impact magnitude and receptor sensitivity categories applied to operational phase impacts. These criteria have been applied to the maximum ground-level impacts caused by the project.

Table 22: Determination of impact magnitude – operational phase

Change in concentrations as % of standard	Magnitude
Increase >25%	Major
Increase 15-25%	Moderate
Increase 5-15%	Minor
Increase <5%	Negligible

Source: Mott MacDonald, 2018

Table 23: Determination of receptor sensitivity – operational phase

Ground level pollutant concentrations in relation to standard	Receptor sensitivity
Above standard	High
75 to 100% of the standard	Medium
50 to 75% of the standard	Low
Below 50% of the standard	Negligible

Source: Mott MacDonald, 2018

Based on the methods defined above for determining the magnitude of impact and sensitivity of receptors, the significance matrix specified in Chapter 4 has been applied to determine overall significance.

All impact descriptors described as 'moderate' or 'major' are considered to be significant. Notwithstanding the above, any non-negligible increases causing a new exceedance of the relevant standards are considered to represent a significant impact irrespective of their impact magnitude.

5.5 Baseline description

5.5.1 Overview

Ambient air quality monitoring data was obtained from the Hamriyah Free Zone Authority (HFZA). Data for one year was made available and was used to characterise baseline conditions.

The data provided by HFZA is considered sufficient to robustly determine existing concentrations in the study area and the use of this data is in alignment with the requirements of the IFC EHS guidelines.

5.5.2 Baseline ambient air quality

The HFZA daily averaged data from the Hamriyah air quality monitoring station for the 2017 includes the following measured pollutants: PM_{10}, $PM_{2.5}$, SO_2, NO, NO_2, NO_x and CO. A summary of results is presented in Table 24.

Table 24: Averaged data for the Hamriyah HFZA ambient air quality monitoring for 2017

Month	Monthly averages based on daily averaged data (µg/m³)						
	$PM_{2.5}$	**PM_{10}**	**SO_2**	**NO**	**NO_2**	**NO_x**	**CO (mg/m³)**
Jan-17	36.2	129.9	4.6	17.2	21	37.7	0.8
Feb-17	47.2	322.2	4.7	11.3	18.6	30	0.7
Mar-17	32.1	95.9	4.9	34.6	33.4	67.9	0.7
Apr-17	67.6	158.4	8.6	34.3	33.4	67.8	0.5
May-17	55.8	198.3	5.3	19.1	27.4	46.5	0.5
Jun-17	51.7	170	9.4	9.8	20.4	30.2	0.4
Jul-17	89.3	260.5	7.8	13.9	20.7	34.7	0.5
Aug-17	48.3	170.3	5.7	11.1	20.9	32	1.2
Sep-17	99.1	160.1	8.2	17.2	23.7	40.9	1.2
Oct-17	56.1	157.1	8	17.2	22.6	39.9	1
Nov-17	47.9	121	9.8	22.6	24.6	47.2	1.1
Dec-17	44.1	106.2	8.9	29	27.6	56.7	1.1
Annual Average	**56.3**	**170.8**	**7.2**	**19.8**	**24.5**	**44.3**	**0.8**

Source: Hamriyah Free Zone Authority, 2018

Based on available data, PM_{10} concentrations exceed the respective UAE daily average standard of 150µg/m³. Although there are no applicable annual mean national standards for PM_{10} and $PM_{2.5}$ the monitored values exceed the WHO guideline values. Exceedances of the PM_{10} and $PM_{2.5}$ standards are not unexpected due to the arid environment, the proximity to the sea and associated contribution of marine salts to the atmosphere and the presence of nearby industrial sources.

Exceedances were not recorded for any of the other pollutants monitored (i.e. SO_2, NO_2, and CO). Considering the monitored ambient annual mean NO_2 concentrations it can be concluded that there are unlikely to be exceedances of the national ambient standards which are set for one hour and 24-hour averaging periods. In addition, the annual average is well below the WHO standard which is applicable in the absence of an equivalent national standard.

5.5.3 Baseline concentrations used in the assessment

Baseline concentrations used in the assessment are summarised in Table 25 and are based on the data presented above.

When assessing the impacts from the project on short term averaging periods (one hour and 24 hour) the background concentration used to represent ambient conditions has been assumed to be twice that of the long term (annual) concentrations used within the assessment. This approach is widely used in ESIAs and is consistent with international best practice and assessments undertaken within the UAE for separate power plants and for example guidance specified by the UK Environment Agency[3] which states:

'Detailed assessment of short term-effects is often complex as the maximum process contribution and maximum background concentration may be separated both temporally and

[3] Environment Agency, Horizontal Guidance (H1) Annex F – Air Emissions

spatially, so that the addition of the "two worst" concentrations may not represent a likely event. A pragmatic approach is suggested, where the short-term background concentration is taken to be twice the long-term background concentration'.

This approach is considered appropriate for use within the assessment as it is not restricted to location as it is not reliant on specific meteorological conditions.

Table 25: Baseline concentrations used in the assessment

Parameter	Background concentration (µg/m^3)
Annual mean NO_2	24.5
Hourly NO_2	49

5.6 Assessment of impacts

5.6.1 Construction impacts

Although no detailed construction schedule is available at present, the construction period is expected to last for approximately 2.5 years before commissioning begins which will consist of initial operations and smaller construction works. Therefore, the construction assessment was based on generic activities for this 36-month period. Table 26 presents the dust raising potential associated with construction of the project.

Table 26: Construction activities and dust emitting activities during construction

Section	Description of works	Key activities	Dust raising potential	Duration at any one location	Impact magnitude
Site preparation, clearance and groundworks	Excavation and moving material	Earthmoving Excavation Resuspension of dust on unsurfaced roads	High	>3 months	Major
Roads and infrastructure	Ancillary works and delivery of materials to site, removal of wastes from site	Minor excavation works. Transport of materials. Resuspension of dust on unsurfaced roads.	Medium	< 3 months	Minor
Construction of new buildings	Erecting buildings associated with plant.	Transport of materials Material cutting	Medium-Low	> 3 months	Moderate
Assembly of plant	Assembling prefabricated pieces and construction of power generation equipment	Transport of materials Assembling prefabricated pieces	Low	> 3 months	Moderate
Landscaping	Landscaping requirements	Earthmoving Excavation Transport of materials Resuspension of dust on unsurfaced roads	High	< 3 months	Major

Source: Mott MacDonald, 2018

The impact magnitude of construction activities is conservatively described as "major" for the whole construction period in accordance with Table 20. However, not all construction activities have a high dust-raising potential and it can be considered that potential dust episodes may only occur over short periods and not throughout the whole construction phase. Figure 24 presents the project area with associated buffers as detailed in Table 21.

As shown by reference to Figure 20 and Figure 24 and in alignment with the receptor classification in Table 14, there are only two potentially residential receptors (the beach campers camping area and the rest area) and several adjacent industrial receptors within 500m of the project boundary. In accordance with Table 21, the beach campers receptor is classified as having low sensitivity as they are located approximately 230 metres from the project boundary. The adjacent industries sensitivities range from medium to negligible sensitivity as they are located from directly adjacent project boundary to well beyond the 500m buffer to the east and north of the project boundary.

Figure 24: Construction dust buffers for the main plant and construction laydown area

Based on an impact magnitude of major and a receptor sensitivity of low for the beach campers receptor and the rest area, the significance of impacts resulting from the construction phase dust emissions is considered minor. Regarding the adjacent industries sensitivities of medium to negligible, the significance of impacts resulting from the construction phase dust emissions is considered to range from moderate adverse to insignificant.

In the event of decommissioning, it is likely that any potential air quality impacts would be similar to those of the construction phase, as broadly similar activities would be required. Similar to the construction phase these are considered to range from moderate to insignificant prior to mitigation.

Following implementation of appropriate best practice mitigation measures presented in section 5.7 overall impacts would be reduced to minor adverse at worse and considered as insignificant.

5.6.2 Operational phase

5.6.2.1 Overview

This section presents results of the predicted impacts from each operational phase scenario considered within the assessment. Modelled results are discussed in the context of UAE standards and WHO/IFC guidelines where these apply. It should be noted that the UAE standards for ambient air quality are the applicable standards for the project.

As discussed in section 5.1.2, the dispersion modelling assessment has focused on NOx emissions only and the modelled results presented in this section are NO_2 concentrations for comparison with ambient standards. A qualitative assessment of PM, SO_2 and CO is presented in section 5.6.2.4

Appendix C provides results from the stack height determination which confirmed that a height of 60m is appropriate for the main stack and 45m for the bypass stack.

5.6.2.2 Natural gas

Main stack

Table 27 presents the results of all three units operating continuously all year on natural gas and presents the maximum results from the modelled grid (scenario 1).

The modelling demonstrates that the maximum 1-hour NO_2 process contribution predicted based on five years of meteorological data is 127.0µg/m^3. This is approximately 32% of the national standard and results in a predicted environmental concentration of 176.0µg/m^3 which is less than 50% of the national standard (Table 27).

Results show that the 1-hour 99.79th percentile process contribution is 64.1µg/m^3 which, is approximately 16% of the national standard and results in a predicted environmental concentration of 113.1µg/m^3. This indicates that the highest predicted one-hour impacts would be limited to a small number of hours a year.

The maximum 24-hour process contribution concentration is approximately 22% of the daily average standard. No exceedances of the annual WHO guidelines are expected as the annual process contributions are less than 10% of the guideline value and the point of impact is located within the industrial area.

In accordance with the significance criterial adopted for the assessment predicted impacts for all averaging periods are considered insignificant. Figure 25 presents contour plots for the one-hour and annual mean NO_2 process contributions. The plots show that the maximum one-hour concentrations are limited to a very small area which is located over the sea where there would be no relevant human exposure.

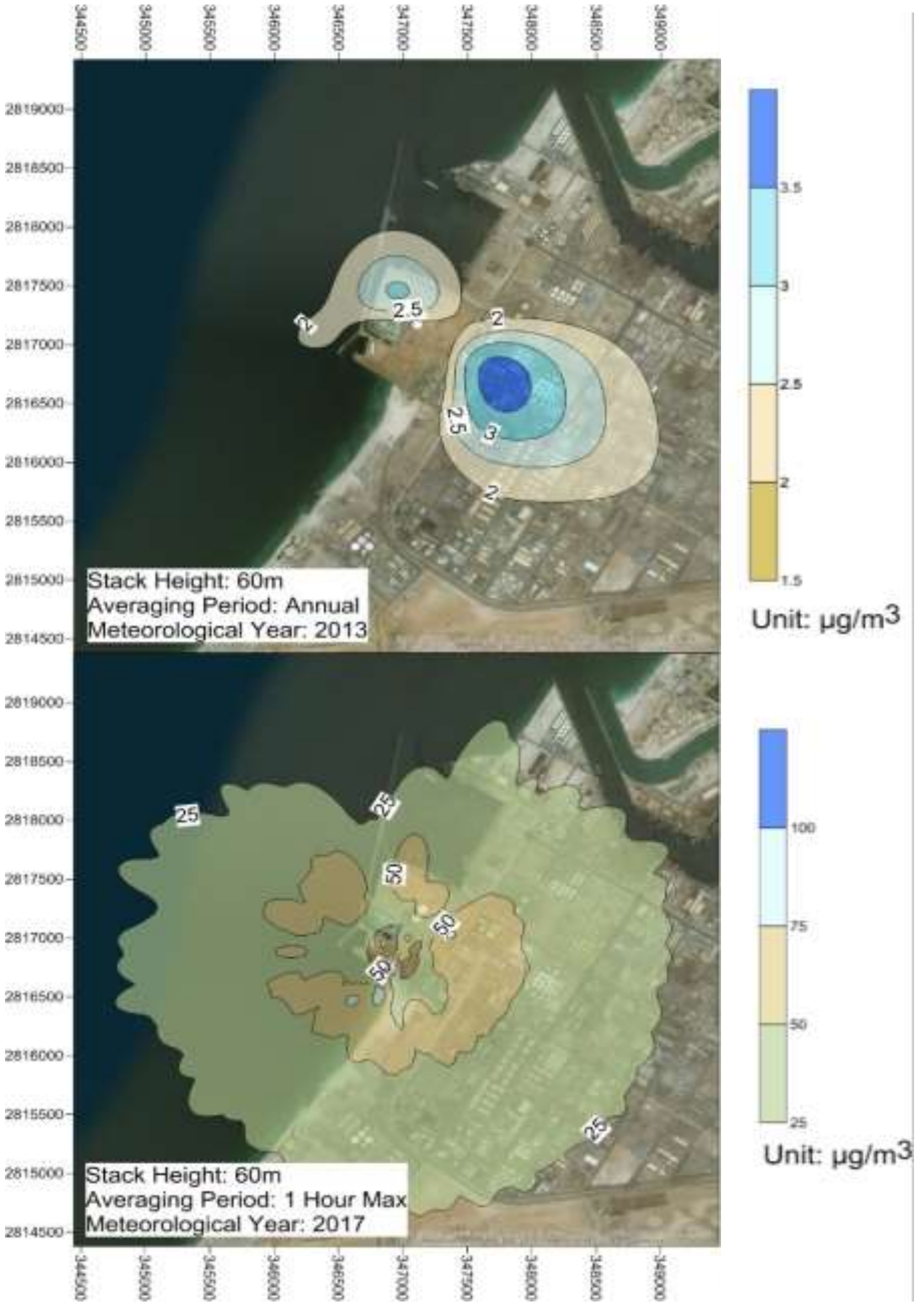
Table 27: Modelled ground level NO_2 contributions from the project with a 60m stack height – Scenario 1 (gas, 100% load) ($\mu g/m^3$)

Averaging period	PC	Impact magnitude	PC as % of UAE standard	AC	PC as % of AC	PEC	UAE standards	Location of maximum impact		Receptor sensitivity	PEC as % of UAE standards	Conclusion
1 hour max	127.0	Major	31.8	49[(a)]	259.2	176.0	400.00	346892.7	2816705	Negligible	44.0	Insignificant
1 hour 99.79	64.1	Moderate	16.0	49[(a)]	130.8	113.1	400.00	347542.7	2817105	Negligible	28.3	Insignificant
24 hour max	33.6	Moderate	22.4	49[(a)]	68.6	82.6	150.00	347492.7	2817055	Negligible	55.1	Insignificant
Annual	3.7	Minor	9.3	24.5	15.1	28.2	40 (WHO Guideline)	347742.69	2816705.3	Low	70.5	Insignificant

Notes: (a) The stations annual average NO_2 concentration is doubled to allow for comparison with other short-term averaged concentration data.
PC = Process Contribution; AC = Ambient Concentrations; PEC = Predicted Environmental Concentration

Source: Mott MacDonald, 2018

Figure 25: One hour and annual mean NO_2 contour plots



Source: Mott MacDonald, 2018

Table 28 presents the 1 hour, 1 hour 99.79 percentile, 24 hour maximum and annual mean NO_2 process contributions from scenario 1 (100% load gas firing) at the discrete receptor locations included within the assessment. The results show that the modelled process concentrations are all below the relevant UAE standards and WHO guideline for annual mean NO_2 concentrations and below the maximum values reported from the modelled grid.

Table 28: Modelled ground level NO_2 contributions from the project at discrete receptors – Scenario 1 (gas, 100% load) (µg/m³)

Receptor ID#	Receptor name	Co-ordinates		1 Hour maximum			1 Hour 99.79th percentile		
		X	Y	PC	Impact magnitude	PC as % of UAE standard	PC	Impact magnitude	PC as % of UAE standard
D1	Beach campers	346893.1	2816426	54.4	Minor	13.6	27.4	Minor	6.9
D2	Ajmzn residential area	349728.7	2813406	12.3	Negligible	3.1	11.1	Negligible	2.8
D3	Mangroves	346844.6	2814151	20.3	Minor	5.1	16.8	Negligible	4.2
D4	Al Zorah Golf Club	347511	2813948	18.5	Negligible	4.6	15.9	Negligible	4.0
D5	Al Zorah Villas	348081	2813995	17.7	Negligible	4.4	16.1	Negligible	4.0
D6	The Oberal Beach Resort Al Zorah	345586.4	2814331	18.0	Negligible	4.5	12.8	Negligible	3.2
D7	Altair residential area	348845.8	2818595	20.9	Minor	5.2	13.8	Negligible	3.4
D8	Al Hamriyah residential area	352113.4	2818379	10.1	Negligible	2.5	8.4	Negligible	2.1

Receptor ID#	Receptor name	Co-ordinates		24 hour maximum			Annual		
D1	Beach campers	346893.1	2816426	7.7	Minor	5.1	0.9	Negligible	2.2
D2	Ajmzn residential area	349728.7	2813406	2.5	Negligible	1.7	0.8	Negligible	2.1
D3	Mangroves	346844.6	2814151	4.1	Negligible	2.7	0.5	Negligible	1.3
D4	Al Zorah Golf Club	347511	2813948	3.1	Negligible	2.1	0.6	Negligible	1.5
D5	Al Zorah Villas	348081	2813995	3.2	Negligible	2.2	0.8	Negligible	1.9
D6	The Oberal Beach Resort Al Zorah	345586.4	2814331	3.1	Negligible	2.1	0.3	Negligible	0.8
D7	Altair residential area	348845.8	2818595	6.3	Negligible	4.2	0.5	Negligible	1.4
D8	Al Hamriyah residential area	352113.4	2818379	2.8	Negligible	1.9	0.5	Negligible	1.3
Note:	PC = Process Contribution								

Source: Mott MacDonald, 2018

Bypass stack

Table 29 presents modelling results of all three units operating continuously all year on natural gas in open cycle mode and emissions discharging through the bypass stack of 45 metres (I.e. scenario 2).

In general, the modelling shows that air quality impacts will be lower with the proposed project operating on open cycle mode compared to combined cycle mode. This is due to the increased exhaust gas temperature as there is no heat recovery operating in open cycle mode.

The exception to this is the process contribution predicted for the maximum one-hour NO_2 concentration. The predicted concentration based on five years of meteorological data is 164.8µg/m^3 which, is approximately 41% of the national standard and results in a predicted environmental concentration of 213.8µg/m^3 which is within the national standards (Table 29). This is an unexpected result and is counter-intuitive because open-cycle operation results in a higher exhaust gas temperature than occurs during combined-cycle operation and better dispersion of the gases in the atmosphere due to the high thermal buoyancy of the plume. The high concentration reported by the model is considered to be a modelling anomaly. There is no breach of any standard by this unexpectedly high concentration.

Modelling results if the 1-hour 99.79th percentile is considered is significantly lower, with a process contribution of 8.4µg/m^3. This demonstrates that the highest one-hour contribution is not expected to occur frequently. The maximum 24-hour process contribution concentration is approximately 9.4% of the daily average standard.

In accordance with the significance criterial adopted for the assessment the predicted impacts for all averaging periods are considered insignificant.

Table 29: Modelled ground level NO_2 contributions from the project with a 45m stack height – Scenario 2 (gas, 100% load)

Averaging period	PC	Impact magnitude	PC as % of UAE standard	AC	PEC	UAE standards	Location of maximum impact		Receptor sensitivity	PEC as % of UAE standards	Conclusion
1 hour max	164.8	Major	41.2	49[(a)]	213.8	400.00	347042.7	2817005	Negligible	53.5	Insignificant
1 hour 99.79	8.5	Minor	2.1	49[(a)]	57.5	400.00	348042.7	2817105	Negligible	14.3	Insignificant
24 hour max	14.1	Minor	9.4	49[(a)]	63.1	150.00	347042.7	2817005	Negligible	42.1	Insignificant
Annual	0.3	Negligible	0.8	24.5	24.8	40 (WHO guideline)	347142.7	2817455	Low	62.0	Insignificant

Notes:
(a) The stations annual average NO_2 concentration is doubled under the precautionary principle to allow for comparison with other short-term averaged concentration data.
PC = Process Contribution; AC = Ambient Concentrations; PEC = Predicted Environmental Concentration

Source: Mott MacDonald, 2018

5.6.2.3 Fuel oil

Table 30 presents the results of all three units operating continuously all year on fuel oil (i.e. scenario 3). Predicted annual mean concentrations have not been presented as fuel oil firing would only be used in an emergency, and for testing purposes, and therefore would not occur for a period of a year or more.

The modelling demonstrates that the maximum NO_2 process contributions predicted based on five years of meteorological data is 280.1µg/m^3 which, is approximately 70% of the national standard and results in a predicted environmental concentration of 329.1µg/m^3 which is within the national standards (Table 30). The 1-hour 99.79th percentile is considerably lower, with a process contribution of 134.2µg/m^3. This demonstrates that the highest one-hour contributions are not expected to occur frequently and the likelihood of fuel oil operation coinciding with the worst case meteorological conditions which would result in the highest process contributions occurring is unlikely.

The maximum 24-hour process contribution concentration is approximately 47% of the daily average standard although it is unlikely that the proposed project would operate for 24 consecutive hours of fuel oil firing unless there was an emergency with gas supply.

In accordance with the significance criterial adopted for the assessment the predicted impacts for all averaging periods are considered insignificant.

Table 31 presents the 1 hour, 1 hour 99.79 percentile, 24-hour maximum and annual mean NO_2 process contributions for scenario 3 (100% load fuel oil firing) at the discrete receptor locations included within the assessment. The results show that the modelled 1 hour, 1 hour 99.79th percentile, 24 hour maximum and annual process concentrations are all below the relevant UAE standards and below the maximum values reported from the modelled grid.

Table 30: Modelled ground level NO_2 contributions from the project with a stack height of 60m – Scenario 3 (fuel oil, 100% load)

Averaging period	PC	Impact magnitude	PC as % of UAE standard	AC	PC as % of AC	PEC	UAE standards	Location of maximum impact		Receptor sensitivity	PEC as % of UAE standards	Conclusion
1 hour max	280.1	Major	70.0	49[(a)]	571.6	329.1	400.00	346892.7	2816705	Negligible	82.3	Insignificant
1 hour 99.79	134.2	Major	33.6	49[(a)]	273.9	183.2	400.00	347642.7	2817105	Negligible	45.8	Insignificant
24 hour max	71.3	Major	47.5	49[(a)]	145.5	120.3	150.00	347592.7	2817055	Negligible	80.2	Insignificant
Annual	7.1	Moderate	17.8	24.5	29.0	31.6	40 (WHO guideline)	346942.7	2817505	Low	79	Minor

Notes: (a) The stations annual average NO_2 concentration is doubled under the precautionary principle to allow for comparison with other short-term averaged concentration data.
PC = Process Contribution; AC = Ambient Concentrations; PEC = Predicted Environmental Concentration

Source: Mott MacDonald, 2018

Table 31: Modelled ground level NO_2 contributions from the project at discrete receptors – Scenario 3 (fuel oil, 100% load) ($\mu g/m^3$)

Receptor ID#	Receptor name	Co-ordinates		1 Hour maximum			1 Hour 99.79th percentile		
		X	Y	PC	Impact magnitude	PC as % of UAE standard	PC	Impact magnitude	PC as % of UAE standard
D1	Beach campers	346893.1	2816426	146.9	Major	36.7	52.1	Minor	13.0
D2	Ajmzn residential area	349728.7	2813406	28.3	Minor	7.1	26.9	Minor	6.7
D3	Mangroves	346844.6	2814151	47.6	Minor	11.9	39.2	Minor	9.8
D4	Al Zorah Golf Club	347511	2813948	42.4	Minor	10.6	38.5	Minor	9.6
D5	Al Zorah Villas	348081	2813995	41.9	Minor	10.5	38.1	Minor	9.5
D6	The Oberal Beach Resort Al Zorah	345586.4	2814331	41.5	Minor	10.4	28.5	Minor	7.1
D7	Altair residential area	348845.8	2818595	50.0	Minor	12.5	21.7	Minor	5.4
D8	Al Hamriyah residential area	352113.4	2818379	23.2	Minor	5.8	20.9	Minor	5.2

Receptor ID#	Receptor name	Co-ordinates		24 hour maximum			Annual		
D1	Beach campers	347511	2813948	11.7	Minor	7.8	1.5	Negligible	3.7
D2	Ajmzn residential area	348081	2813995	6.3	Minor	4.2	1.8	Negligible	4.6
D3	Mangroves	345586.4	2814331	10.2	Minor	6.8	1.0	Negligible	2.6
D4	Al Zorah Golf Club	348845.8	2818595	8.2	Minor	5.4	1.2	Negligible	3.0
D5	Al Zorah Villas	352113.4	2818379	8.0	Minor	5.4	1.5	Negligible	3.8
D6	The Oberal Beach Resort Al Zorah	347511	2813948	8.0	Minor	5.3	0.7	Negligible	1.7
D7	Altair residential area	348081	2813995	9.9	Minor	6.6	1.2	Negligible	3.0
D8	Al Hamriyah residential area	345586.4	2814331	6.6	Negligible	4.4	1.2	Negligible	3.0
Note:	PC = Process Contribution								

Source: Mott MacDonald, 2018

5.6.2.4 Qualitative assessment of other emissions

Particulates ($PM_{2.5}$ and PM_{10})

Ambient baseline concentration of particulates within the Emirate of Sharjah are observed as exceeding the respective daily average standards. The exceedances are due to the arid environment. Based on the projects location, there are several sources of particulates in the near vicinity of the proposed project including nearby industries, combustion emissions from vehicle traffic, mobile and fixed machinery, the Sharjah international airport, marine vessels, and exposed areas of arid land prone to wind erosion.

The project will not emit particulate matter when firing on natural gas, which will be the normal operating scenario. This is confirmed by the European Commission's Best Available Technique Reference (BREF) document for large combustion plants which states 'The efficient combustion of gaseous fuels does not generate particulates'.

Emissions of particulates when firing on fuel oil will be low as the turbine is guaranteed to meet the IFC emission guidelines for degraded airsheds. Considering fuel oil firing is expected to be for emergency use or during testing only emissions of particulates are not considered to have a significant effect on air quality.

Sulphur dioxide (SO_2)

Ambient baseline concentration of SO_2 within the Emirate of Sharjah are observed as being very low and no exceedances of the standards are observed.

The natural gas will contain at most trace levels of hydrogen sulphide or sulphur fuel oil used during emergency periods or testing periods is required to be low sulphur by UAE regulation (0.5% sulphur maximum – see section 5.3.1.1). Therefore, emissions of SO_2 will be negligible and are not considered to have a significant effect on air quality.

Carbon monoxide (CO)

Ambient baseline concentrations of CO within the Emirate of Sharjah are observed as being very low and no exceedances of the standards are observed.

Emissions of CO are expected to be low as high emissions are related to incomplete combustion which will be mitigated through the efficient operation of the project. Additionally, the relevant ambient standards for CO are significantly higher than those for NO_2 and project impacts are not considered to have potential to be significant.

5.7 Mitigation, monitoring and enhancement measures

5.7.1 Construction phase

The following mitigation measures (which are in accordance with the IFC General EHS Guidelines) for controlling air quality impacts will be incorporated into the construction phase:

- Minimising dust from material handling sources, such as conveyors and bins, by using covers and/or control equipment (water suppression)
- Minimising dust from open sources, including storage piles, by using control measures such as installing enclosures and covers, and increasing the moisture content
- Dust suppression techniques should be implemented to minimise dust from vehicle movements on unpaved roads, these should be in accordance Annex 1.15 of the IFC General Guidelines and could include covering roads with gravel or road carpet
- Manage emissions from mobile sources as per the EHS Guidelines for Air Emissions and Ambient Air Quality
- No open burning of solid waste

- Development of a dust management plan for the construction and operational phases

Emissions from on-road and off-road vehicles should comply with national or regional requirements. In the absence of these the following should be considered:

- Drivers should be instructed on the benefits of driving practices that reduce both the risk of accidents and fuel consumption, including measured acceleration and driving within safe speed limits
- Implement regular vehicle maintenance and repair programmes

5.7.2 Operational phase

No combustion mitigation measures in addition to those already accounted for within the dispersion modelling are proposed. The following key design features have been accounted for:

- An exhaust stack height of 60m to ensure effective dispersion of emissions
- Low NO_x technology
- Oil with a maximum sulphur content of 0.05%

Performance tests will be conducted during the commissioning phase on one of the bypass and main stacks to confirm compliance with guaranteed emission limits and UAE standards.

The project will include a continuous emissions monitoring system (CEMS) in accordance with international requirements to monitor stack emissions. Monitoring will be undertaken on a continuous basis for NO_x, SO_2, CO and O_2.

The IFC EHS Thermal Power Guidelines (2008) requires projects with a thermal input greater than 1200MW to monitor air quality for time periods consistent with relevant national standards via continuous ambient monitoring systems. The guidelines state that for projects of this size typically two systems to cover the maximum areas of impacts, sensitive receptors and background locations will be used.

It is recommended that, as a minimum, the stations should:

- Continuously monitor ambient concentrations of NO_x and NO_2 in accordance with internationally recognised approaches
- Install ambient air quality monitoring stations at representative receptor communities agreed with EPAA. These stations will monitor NOx, SOx, ozone, and PM_{10}
- Include a dispersion model ready meteorological station in accordance with US EPA guidance which can monitor wind speed, direction and temperature
- Be subject to regular calibration procedures and audits to ensure proper function in accordance with international best practice
- Be located offsite, at the point of maximum impacts predicted by the dispersion modelling where there is population exposure

Subject to getting clearance from SEWA (due to operational and health and safety reasons), planting trees around the IPP site boundaries will be considered as per EPAA requirement.

The PC will continuously monitor their mode of operation (open cycle/combined cycle) and will monitor emission compliance levels during these operational mode.

5.8 Residual impacts

Table 32 provides a summary of residual impacts following mitigation.

Table 32: Air quality residual impacts

Phase	Activity	Magnitude	Sensitivity	Impact	Mitigation/benefit enhancement measures	Residual effects and significance
Construction	Construction of project	Major	Medium (at worst)	Moderate	Best practice mitigation measures	Insignificant
Operational	Power generation with natural gas fuel	Minor	Low (at worst)	Insignificant	Incorporated mitigation included in the design	Insignificant
	Power generation with Fuel oils	Moderate	Low (at worst)	Insignificant	Incorporated mitigation included in the design	Insignificant

Source: Mott MacDonald, 2018

6 Greenhouse gases (GHGs) assessment

6.1 Introduction

6.1.1 Objective of assessment

6.1.1.1 This assessment evaluates the potential emissions of greenhouse gases (GHG) associated with the Hamriyah IPP project, which has 1,800MW of power generation capacity (hereafter referred to as 'the project'). The assessment estimates the GHG emissions that will be generated by the project during operation, which will be the primary source of GHG emissions, as well as GHG emissions that will be generated during construction, which will be a secondary source of GHG emissions. This assessment was undertaken in accordance with IFC PS3 and its associated guidelines.

6.1.2 Sources considered

Two principle sources of GHG emissions have been considered in this assessment:

- Direct emissions from the combustion of natural gas
- Emissions associated with the construction of the plant

The plant is designed such that it can operate using distillate oil if required, which is the backup generation option should natural gas not be available. Given the existing units at Hamriyah have operated on natural gas aside from oil being used for short periods of testing, plus taking into account the increased security of natural gas supply in the UAE, this assessment has not included for oil fired operation.

6.2 Greenhouse gas policy

6.2.1 International Finance Corporation (IFC) standards and guidelines

Performance Standard 3 of the 2012 edition of the IFC Sustainability Framework (IFC, 2012) states that 'projects that are expected to or currently produce more than 25,000 tonnes of CO_2e annually' will quantify GHG emissions 'in accordance with internationally recognised methodologies and good practice.'

The project's ESIA will determine the key impacts associated with the plant's construction and operation, which are typically relatively localised to the plant's footprint or surrounding areas. However, GHG emissions are global in nature and, unlike other environmental impacts, it is difficult to link the emissions of a single project to a specific receptor. The relationship of individual project emissions to transboundary atmospheric emissions, and uncertainty about the global atmospheric response, is very complex and means that determining the significance of project emissions on a local scale is not possible.

There are currently no published guidelines for determining the significance of project GHG emissions in ESIAs. Guidance Notes for IFC PS3 (IFC, 2012) suggest the criteria for evaluating project GHG emissions which are shown in Table 33. This guidance does not recommend how to assign significance to any of the impacts associated with a project, instead it recommends how to present the impacts.

Table 33: Suggested IFC criteria for assessing GHG emissions impacts

IFC criteria	Comments
The project's GHG emissions relative to the host country's total national emissions.	This has been considered in the comparison to national emissions section of the assessment presented in section 6.5
The project's GHG emissions performance relative to good international performance or the host country's national average performance.	This has been considered in the comparison to national emissions section of the assessment presented in section 6.5
The annual trend of the project's GHG emissions performance over time.	This has been considered in the operation impacts section presented in section 6.5.
Opportunities to further improve the project's GHG emissions performance.	This has been considered in the mitigation measures section of the assessment in section 6.5

Source: Guidance notes for IFC PS3

In addition, Table 4 of the IFC Environmental, Health and Safety Guidelines for Thermal Power Plants (IFC, 2017) presents typical CO_2 emissions performance for power plants. For combined cycle gas turbines (CCGT) above 300MWe the typical net efficiency is around 46-62% and produces around 325-439gCO_2 per kWh on a net lower heating value (LHV) basis.

The World Bank has also published a guidance note: 'greenhouse gas accounting for energy investment operations' in 2013 (World Bank, 2013). This outlines the considerations that should be given to establishing the potential impact of new power projects. This guidance was considered in this assessment. National grid average emissions from the production of electricity in the United Arab Emirates (UAE) have been referenced from the World Resources Institute and World Business Council for Sustainable Development's Greenhouse Gas Protocol calculation tool 'GHG emissions from purchased electricity' (WBCSD, 2013) in order to provide context for the project at the national level.

6.2.2 International policy

UAE has signed up to the following international agreements relating to GHG emissions:

- United Nations Framework Convention on Climate Change (UNFCCC, 2018b), came into force on 28 March 1996.
- Kyoto Protocol to the United Nations Framework Convention on Climate Change (UNFCCC, 2018c). The UAE ratified the protocol to the United Nations Framework Convention on Climate Change in 2005 allowing it to join as a non-Annex I party. The UNFCCC reporting guidelines on annual inventories requires all Parties to submit to the Conference of the Parties an annual national anthropogenic GHG emissions inventory of all GHG not covered by the Montreal Protocol. As a non-Annex I Party, the UAE has no commitments to reduce GHG emissions under this protocol. Biennial update reports are produced which contain national inventory reports as part of the national communications. A national climate change plan of the UAE for 2017-2050 has been published, providing information on climate change policy, risks and opportunities.
- UAE has signed the Paris Agreement and agreed to the global target of keeping global average temperatures well below 2°C, ratified 21 September 2016 (UNFCCC, 2018a). The UAE signed and ratified the Paris Climate Agreement to the UNFCCC and its Intended National Determined Contribution (INDC) became its Nationally Determined Contribution (NDC). While the UAE's NDC is pledging various power sector related measures (including a 24% clean energy target in 2021) it does not provide a quantified economy-wide GHG emissions reduction target.

6.2.3 Local policy

UAE has the following policies relating to GHG emissions (GRI, 2017):

- National Climate Change Plan 2050: The National Climate Change Plan comes in line with the UAE Vision 2021 and the UAE Green Agenda 2015-2030. It seeks to: manage greenhouse emissions while sustaining economic growth. According to executive sources, the plan is designed to address the gaps and opportunities for growth in the short, medium and long term. The plan, which is overseen by the UAE Council on Climate Change and the Environment, has not been published and targets have not been quantified.
- UAE Energy Strategy for 2050: This policy aims to increase the contribution of clean energy in the total energy mix of the County to 50 percent by 2050.The target for the 2050 energy mix is as follows: 44 percent clean energy, 38 percent gas, 12 percent clean coal and 6 percent nuclear. The strategy is expected to result in the reduction of 70 per cent in carbon emissions over the next three decades.
- UAE Green Agenda 2015-2030: An overarching framework of Green Economy actions approved by the UAE Cabinet in 2015. Clean energy and climate action is one of the five strategic objectives. Implementation of the green agenda is overseen by the Emirates Green Development Council.

6.3 Current greenhouse gas emissions - baseline

A significant majority of electricity production in UAE is currently generated from natural gas power generation facilities. In 2015, 125,500GWh of electricity were generated from gas, representing 98.5% of the UAE's total generation (IEA, 2015). The remaining generation was produced using oil (1.25%) and solar (0.25%).

According to the International Energy Agency (IEA) statistics for 2015, UAE emissions from combustion of fuel were 180MtCO_2, equating to 19.7tCO_2 per capita, noting that this also includes fuel used for transportation (IEA, 2015). Emissions from electricity (including water desalination) are around 70.8MtCO_2 (2014). In 2014 UAE's emissions intensity for grid-averaged electricity production (the amount of emissions of CO_2 per kWh of electricity produced, including water desalination) was 643gCO_2/kWh (IEA, 2015).

6.4 Assessment input data and methodology

6.4.1 Scope

This section discusses the methodology for quantifying emissions associated with combustion during the operational phase of the project and emissions associated with the construction phase. The assessment considers emissions relating to combustion of fuel from a new combined-cycle gas turbine power plant. The project will consist of three identical power blocks, with each power block consisting of a gas turbine, generators, steam generators and turbine, condenser and balance of plant equipment.

All fossil fuels produce GHGs during combustion. The mass of fuel consumed by the project annually determines the GHG emissions generated. The amount of these emissions is proportional to the amount of fuel and the carbon-content of that fuel.

The project's calculated GHG emissions are compared to:

- Typical average emissions from electricity production from the national grid, for equivalent electrical output.
- Typical CO_2 emissions from new thermal power plants as described by the IFC, for equivalent electrical output.

This report includes a high-level assessment of construction phase emissions based on the World Bank's 'Guidance note: greenhouse gas accounting for energy investment operations' (World Bank, 2013). The guidance note identifies that these emissions are small in comparison to the operational phase, however, for completeness construction phase emissions have been included in this assessment based on the guidance note methodology.

6.4.2 Emission sources

The methodology used in this chapter is in-line with IFC PS3 (IFC, 2012), which requires the quantification of all direct operational emissions. In addition, construction emissions have been included in line with best practice. Table 34 outlines all potential sources of emissions, whether they have been quantified and, where they have not been quantified, a rational for exclusion.

Table 34: Emissions sources

Project Stage	Emissions source	Quantified?	Rational for exclusion
Construction	Embodied emissions within construction material Transport of materials to site Use of construction plant and equipment	Allowance made using IFC methodology	N/A
Operation	Combustion of fuel	Yes	N/A
Operation	Land use change emissions	No	Considered negligible. No significant land use change as brownfield construction.
Operation	Fugitive emissions of SF6 from switch gear	No	Considered to be small based on previous project experience
Operation	Emissions due to maintenance	No	Considered to be small based on previous project experience
Operation	Emissions due to onsite energy consumption	No	Considered to be small based on previous project experience

6.4.3 Operating scenarios

The project will consist of three gas turbine generators and three steam turbines, which can be used in different configurations. To assess the quantities of GHG produced project, two operating scenarios are considered:

- Scenario 1: full combined cycle operation at full capacity (100% power) at 28°C ambient temperature, which is design condition and representative of the annual average temperature. Emissions are calculated over a one-year period and over the plant lifetime.
- Scenario 2: full combined cycle operation at full capacity (100% power) at 34.1°C ambient temperature, which is the average summer temperature. Operating in the summer at higher ambient temperatures reduces the operating efficiency and increases GHG emissions per kWh. For comparison with Scenario 1, emissions are calculated over a one-year period assuming the summer average ambient temperature.

6.4.4 Operational input data and methodology

Input data required to calculate the operational carbon emissions are shown in Table 35, with the molar proportion of each component of the natural gas shown in Table 36. The grid average of the UAE is assumed to be 642 $kgCO_2e/kWh$ (see ref 7) which is used as a comparison for the project operational emissions.

Table 35: Operational input data

Input	Scenario 1	Scenario 2	Unit
Plant data			
Plant capacity (net)	1,867	1,812	MW
Turbine capacity for each of 3 turbines	600	600	MW
Number of turbines	3	3	
Assumed operating hours per year	8000	8000	Hours/year
Average ambient temperature	28.0	34.1	C
Natural gas consumption	66.81	64.98	kg/s
Project electricity generation	14,938,248	14,502,624	MWh/year

Table 36: Natural gas composition

Component	Value	Unit
Nitrogen	4.43	% (mol)
Methane	93.91	% (mol)
Ethane	1.18	% (mol)
Propane	0.04	% (mol)

Emissions from natural gas combustion have been calculated based on the principles of mass balance. The amount of fuel consumed in the plant and the components of the gas are used to calculate the carbon content of the gas. It is then assumed that all of the carbon in the gas is oxidised to CO_2 during combustion.

This assessment has assumed the following:

- One operational year is equal to 8,000 operating hours, and that the plant will be used to provide baseload. This is a conservative assumption, as it is likely that the output will vary throughout the year to match seasonal demands.
- All carbon that enters the system will be emitted as CO_2.
- In line with design assumptions for the project, it is assumed that the plant will always operate on natural gas. The plant is capable of operating on oil, but it intended that oil will only be for emergency situations.

6.4.5 Construction input data and methodology

The high-level assessment of construction phase emissions is based on the World Bank's 'Guidance note: greenhouse gas accounting for energy investment operations' (World Bank, 2013). The guidance note identifies that construction phase emissions are small in comparison to operational phase emissions, however, for completeness construction phase emissions have been included in this assessment based on the guidance note methodology. This methodology does not assess the breakdown of construction materials and activities in detail, but simply uses the annual power generation output, an assumed project lifetime and prescribes an emission factor to cover 'one-off' emissions associated with construction works for a power plant project:

$$\begin{aligned} &Construction\ emissions\ (tCO_2e) \\ &\quad = Annual\ generation\ (MWh/yr)\ \times\ Assumed\ project\ life\ (years) \\ &\quad \times\ World\ Bank\ emissions\ factor(\frac{tCO_2e}{MWh}) \end{aligned}$$

The input values used in this calculation are shown in Table 37.

Table 37: Construction input data

Parameter	Value	Unit
Assumed annual electrical output	14,938,248	MWh/yr
World Bank emissions factor	2.9	$kgCO_2e/MWh$
Assumed project lifetime	23.5	years

6.5 Calculation of emissions

6.5.1 Overview

This section presents calculated GHG emissions based on the input data and methodology previously described in section 6.4.

6.5.2 Estimate of GHG emissions

Table 38 presents the carbon assessment results, including both operational and construction emissions. The table also contains benchmarks and comparators to contextualise the results.

Table 38: GHG assessment results and comparisons

Input	Scenario 1: Design conditions	Scenario 2: Summer operation	Unit
Operational assessment			
Project plant			
Electricity produced	14,938,248	14,502,624	MWh/yr
Annual carbon emissions	4.84	4.73	$MtCO_2e/y$
Emissions intensity	324	326	gCO_2/kWh
Carbon emissions over the lifetime of the plant (23.5 years)	113.74	111.16	$MtCO_2e/$ lifetime
Comparison with Table 4 of the IFC Environmental, Health and Safety Guidelines for Thermal Power Plants			
Typical carbon intensity of CCGT	325-439	325-439	gCO_2/kWh
Comparison with current grid			
Assume same electricity produced	14,938,248	14,502,624	MWh/yr
Grid emissions intensity	643	643	gCO_2/kWh
Carbon emissions associated with equivalent power production	9.62	9.34	$MtCO_2e/y$
Project carbon saving compared to grid	4.78	4.61	$MtCO_2e/y$
Comparison with national totals			
National electricity production (2015)	125,500	125,500	GWh/yr
Project proportion of national electricity production	11.90%	11.56%	%
National annual emissions from power and water desalination (2014)	70.8	70.8	$MtCO_2e/y$
Project proportion of national emissions from power and water desalination	6.84%	6.68%	%
Construction assessment			
Estimate of construction emissions using World Bank methodology	1.0	1.0	$MtCO_2e$
Construction emissions as proportion of annual operational carbon	21%	21%	%

6.5.3 Discussion of GHG assessment results

6.5.3.1 Comparison of scenarios

Scenario 1, is the design condition, representative of a year-round average ambient temperature, which results in lower carbon emissions intensity (324 gCO_2/kWh) than Scenario 2 (326 gCO_2/kWh), based on summer temperatures. This is expected, due to increased operating efficiencies at lower ambient temperatures.

6.5.3.2 Comparison with IFC Table 4

The calculated emissions intensity of both Scenario 1 (324gCO_2/kWh) and Scenario 2 (326gCO_2/kWh), compare favourably with typical ranges presented in Table 4 of the IFC Environmental, Health and Safety Guidelines for Thermal Power Plants. Under both scenarios the calculated carbon intensity is at the lower end of the range presented for CCGT (325-439g CO2/kWh).

6.5.3.3 Comparison with existing UAE grid electricity and national emissions

Calculated emissions intensities of both Scenario 1 and Scenario 2 are approximately 50% lower than the existing grid carbon intensity of 643 gCO_2/kWh. If the equivalent power to be delivered by the Hamriyah project was instead to be provided by the existing grid, this would result in an additional 4.61 to 4.78 $MtCO_2e$ emitted every year.

Annual electricity generation production for the scenarios assessed would be around 12% of total annual production and just under 7% of the annual emissions from electricity generation and desalination. This highlights that the project is significant on a national scale.

However, the following observations are made:

- It is reported that approximately 30% of the existing grid carbon intensity is associated with desalination of water supply, therefore it is unsurprising that the project is expected to perform significantly better than the existing grid because there is no desalination associated with this project.
- It is noted that in reality the plant is unlikely to operate at full capacity on a year-round basis, as there will be seasonal variations in demand. This assumption is conservative and appropriate to understand a reasonable upper limit to the total carbon emissions impact, but does not necessarily reflect operating practice.

6.5.3.4 Construction emissions

A detailed estimate of construction emissions for the plant is not required to comply with guidance and has not been undertaken. In line with best practice, consideration of construction emissions was made utilising IFC guidance on carbon emission estimation for combustion plant construction which includes vehicle and plant emissions in a factor related to the power output of the plant. This suggests that the construction emissions may be in the order of 1.0$MtCO_2e$.

This is a significant impact and mitigation measures should be identified with low carbon construction techniques and approaches. It is noted that total construction emissions are around 21% of the annual operational emissions. Therefore, in an operating period of less than 3 months emissions associated with gas combustion are likely to exceed total construction emissions.

6.5.3.5 Annual trend of the project GHG emissions performance over time

Future emissions profile of the plant has not been quantitively assessed, and there is no justification to assume a particular trend other than assuming the plant will continue to operate in line with its intended design criteria. There are a range of potential factors that may act to increase or decrease the future emissions, such as:

- Changes to the natural gas blend, or the source of the fuel.
- Changes to operational regimes.
- Degradation of plant equipment over time, or poor maintenance leading to inefficient performance or leakage of fuel.
- Future refurbishments and efficiency improvements.

6.5.4 Mitigation measures

As highlighted by the results above, GHG emissions associated with the project represent an improvement compared to existing grid carbon intensity and are in line with typical ranges for CCGT technologies. However, they still represent a large volume of GHG emissions and it is recommended that consideration be given to mitigation measures to minimise the GHG impact of the project. These measures may include:

- Minimisation of construction emissions; low carbon and efficient design, construction and sourcing of materials should be considered. It is noted that any measures to reduce construction emissions should not be at the expense of operational efficiency, given that more significant impacts are associated with the operational phase.
- To minimise operational emissions, operating the plant efficiently will be essential. Good maintenance practices, upgrades and fuel sourcing strategies can all help reduce emissions.
- The most significant options may be identifying how the plant fits with the UAE's wider decarbonisation strategy, and whether there are opportunities to operate the facility to support the objectives set out in the UAE's energy strategies and climate change plans as part of a more flexible and efficient power network.
- Maintaining the efficiency of the plant to the best practically possible during the life-time of the project by conducting periodic maintenance of equipment
- Quantification and reporting on GHG emissions during the operational phase of the plant

6.6 Summary

This assessment has quantified the GHG emissions predicted from the Hamriyah IPP. The project involves construction and operation of a 1,800MW combined-cycle gas turbine plant to produce power. The sources of emissions that have been considered are from natural gas combustion during the operational phase of the Project and from the construction phase. The calculations were based on current project data, methodology and emission factors taken from the plant technical specifications and World Bank guidance. This assessment has assessed two scenarios to quantify the emissions associated with the plant running under the design conditions (Scenario 1) and using ambient temperatures representative of summer conditions (Scenario 2):

The calculated emission under Scenario 1, the design conditions, can be summarised as:

- Overall GHG emissions from the operational phase are estimated to be 4.84 $MtCO_2e$ per year
- Potential GHG emissions from electricity production by the project are 4.78 $MtCO_2$ per year less than if the electricity was generated according to the current national grid average emissions factor.
- The project is expected to produce around 324 gCO_2 per kWh, which is in line with the typical performance from a new thermal power plant of this type. This is at the lower end of

the typical ranges presented in Table 4 of the IFC Environmental, Health and Safety Guidelines for Thermal Power Plants (325-439g CO2/kWh for CCGT).

- Construction emissions may be in the order of 1.0MtCO_2e. This is a significant impact but total construction emissions are around 21% of annual operational emissions. Therefore, in an operating period of less than 3 months, emissions associated with gas combustion are likely to exceed total construction emissions.

6.7 References

1. Government of the United Arab Emirates (UAE), 2015, Intended Nationally Determined Contribution of the United Arab Emirates [online] http://www4.unfccc.int/ndcregistry/PublishedDocuments/United%20Arab%20Emirates%20First/UAE%20INDC%20-%2022%20October.pdf (Last accessed 01/05/2018)
2. Grantham Research Institute on Climate Change and the Environment and Sabin Center for Climate Change Law (GRI), 2017, Climate Change Laws of the World database [online]
3. IEA – Qatar: Electricity and Heat for 2015
4. IFC Performance Standard 3 – Resource Efficiency and Pollution Prevention, January 2012
5. IFC Environmental Health and Safety Guidelines for Thermal Power Plants, June 2017
6. LSE, 2018, [online] http://www.lse.ac.uk/GranthamInstitute/legislation/ (Last accessed 30/04/2018)
7. United Arab Emirates Ministry of Climate Change & Environment (MOCCAE), 2017, UAE State of Green Economy Report 2017, [online] http://un-page.org/files/public/uae_state_of_green_economy_report_2017_0.pdf (Last accessed 01/05/2018)
8. United Nations Framework Convention on Climate Change (UNFCCC), 2018a, Paris Agreement – Status of Ratification [online] http://unfccc.int/paris_agreement/items/9444.php (Last accessed 30/04/2018)
9. United Nations Framework Convention on Climate Change (UNFCCC), 2018b, Climate Change Convention – Status of Ratification [online] http://unfccc.int/paris_agreement/items/9444.php (Last accessed 30/04/2018)
10. United Nations Framework Convention on Climate Change (UNFCCC), 2018c, Kyoto Protocol – Status of Ratification [online] http://unfccc.int/paris_agreement/items/9444.php (Last accessed 30/04/2018)
11. World Bank Guidance note: greenhouse gas accounting for energy investment operations, June 2013
12. World Business Council for Sustainable Development (WBCSD) GHG Protocol Calculation Tool – GHG Emissions from purchased electricity, May 2015

7 Marine environment

7.1 Introduction

This section considers the potential impacts to marine ecology associated with construction and operation of the project.

This section is structured as follows:

- Description of the methodology used to assess potential impacts on marine ecology at the project site
- An overview of the relevant national legislation and requirements in Dubai and the UAE
- A baseline description based on desk-based information and surveys
- Assessment of impacts associated with construction and operation of the project
- Identification of mitigation and monitoring measures to be employed at the site
- Consideration of residual impacts following the implementation of mitigation measures

7.2 Methodology and assessment criteria

Mott MacDonald commissioned Five Oceans Environmental Services LLC (5OEs) to conduct a marine environmental survey in order to establish the baseline within the project area and its area of influence. The scope of work incorporates measuring water and sediment quality and defining marine habitat within the immediate footprint of the proposed works.

7.2.1 Study area and sampling locations

Sampling locations for the proposed 1,800MW power station expansion can be seen in Figure 26.

Figure 26: Locations of survey points

Source: Five Ocean, May 2018

Sites 1 – 14 and control co-ordinates can be found in Table 39. At S01, S02, S03 locations and control, sediment, water profile and drop-down video surveys were carried out, while at all remaining locations water profile and drop-down video surveys were conducted. Any site changes conducted during the survey (i.e. insufficient sediment for sediment grabs) are included in Table 39.

Table 39: Sampling station and survey points co-ordinates

Water Quality Sample ID	Northing	Easting	Water Profile	Water Sampling	Sediment sampling
S01	25.46924	55.47708	Y	Y	Y
S02	25.46145	55.47388	Y	Y	Y
S03	25.45915	55.47569	Y	Y	Y
P04	25.47291	55.47854	Y	N	N
P05	25.47773	55.47920	Y	N	N
P06	25.48081	55.48365	Y	N	N
P07	25.47436	55.47380	Y	N	N
P08	25.47090	55.47563	Y	N	N
P09	25.46696	55.47440	Y	N	N
S10	25.45582	55.47307	Y	N	N
S11	25.45858	55.46845	Y	N	N
S12	25.45998	55.46239	Y	N	N
S13	25.46473	55.46772	Y	N	N
S14	25.47045	55.47003	Y	N	N
Control	25.54166	55.49880	y	Y	Y

Source: 5OES, July 2018

7.2.2 Seawater quality profiling and sampling survey

Seawater quality data was measured at all 15 sampling locations. All data was recorded using a multi-parameter sonde (Hydrolab HL4), profiling from the seabed to the surface, recording the relevant data through the water column every two seconds (see Table 40 for details). The collected data was then plotted against depth at each surveyed site. It should be noted that this information will only provide a snapshot of the quality of the seawater at the time of sampling and is only truly representative of sea conditions at that time.

Table 40: Hydrolab HL4 water quality probe parameters

Parameter	Detection limit	Equipment
Temperature	0.2 °C	Hydrolab HL4 Probe
pH	0.2 units	Hydrolab HL4 Probe
Dissolved oxygen	0.2 mg O/l	Hydrolab HL4 Probe
Conductivity	1 mS/cm	Hydrolab HL4 Probe
Turbidity	1 NTU	Hydrolab HL4 Probe
Salinity	0.1 PSU	Hydrolab HL4 Probe
Secchi depth	0.5m	Secchi Disk

Source: 5OES, July 2018

Additional data was collected using a Secchi Disk to determine light attenuation and clarity of the water column at the time of the survey. Seawater samples (from sites S01, S02, S03 and control) were collected from approximately 1m below the sea surface using a two litre Van Dorn Sampler and stored in suitable containers in the dark and on ice (see Table 41 for details of parameters for laboratory analysis). Samples for hydrocarbon analysis were collected from just below the sea surface.

Table 41: Seawater quality parameters for laboratory analysis

Parameter		
TSS	Total petroleum hydrocarbons (C10 to C40) EPH	Iron
Oil and grease	Total petroleum hydrocarbons (C5 to C10) VPH - Including BTEX	Lead
Chloride	Arsenic	Mercury
Total & free chlorine	Cadmium	Nickel
Trichloromethane	Copper	Vanadium
Cyanide (easy liberated)	Chromium	Zinc

Source: 5OES, July 2018

7.2.3 Sediment quality

Sediment quality samples were collected at 4 locations (Sites S01, S02, S03 and control). Samples were collected using a two-litre Van Veen grab, following MOOPAM guidelines to avoid sampling contamination. Three sub-samples were collected from each site and combined into one individual composite sample to reduce the risk of a single anomalous sampling event. Collected samples were separated into suitable volumes and containers for laboratory analysis according to the requirements and parameters. All samples were stored on ice in suitable containers and transported to an accredited and certified laboratory for analysis (see Table 42 for details of parameters analysed).

Table 42: Sediment quality parameters for laboratory analysis

Parameter	
Grain size distribution	Lead
Arsenic	Zinc
Cadmium	Total petroleum hydrocarbons (C5 – C40)
Chromium	Mercury
Copper	Nickel
Iron	Manganese

Source: 5OES, July 2018

7.2.4 Benthic infauna

Benthic infauna sampling was conducted at the same locations as sediment and water. Samples were sieved through a 0.5mm mesh sieve to retain the macro-infauna and coarse sediment fraction. The retained fraction was then preserved in a solution of 4-5% formal-saline solution and stained with Rose Bengal solution before the extraction of infaunal specimens by a team of 2 experienced marine biologists and analysed by an experienced marine invertebrate taxonomist for identification and statistical analysis.

7.2.5 Side-scan sonar and drop-down video

A geo-referenced side-scan sonar (SSS) rapid assessment was undertaken as a broad scale verification of seabed substrate, using a dual-frequency side-scan unit. The SSS range settings used were sufficient to yield detailed projections of areas highlighted for investigation and ensured ensonification of the critical nadir region of adjacent survey lines. The SSS towing configuration was set up to ensure that any effects from vessel pitching and rolling on the SSS towfish were minimized, with the SSS towfish towed at the optimum height above the seafloor, where safe and practical to do so. GPS positioning of the SSS towfish was achieved using a layback calculation as part of the side scan software used. In addition to this, depth transducer location relative to the GPS unit was entered into the software prior to commencing the SSS survey to improve bathymetric accuracy. In addition to the SSS, drop down video spot checks were conducted at each of the 15 sites other sites to reinforce the SSS imagery. Notes on dominant habitat were made during each video, with videos then being reviewed by an experienced marine ecologist.

The approach to undertake the SSS assessment rather than dive-based assessment was based on agreement with EPAA (teleconference call on 22/05/2018) in order for the marine survey to cover a wider area and identify potential sensitive receptors within the project area of influence.

7.2.6 Fish population census

A fish population census was carried out using the collected drop-down video and still imagery data. Fish were identified to species level and the number of individuals counted at each survey site.

7.2.7 Intertidal survey

At each site a 10m transect line was established parallel to the shoreline and a total of three 1m^2 quadrats were placed along its length at 5m intervals. The data collected is used for description of habitats and substrates, percentage cover, estimates of relative abundance and species lists/status. All epifauna and flora occurring within the quadrats were photographed for identification and classified by an experienced ecologist. Transect starting co-ordinates can be found in Table 43.

Table 43: Transect co-ordinates for intertidal surveys

Name	Northing	Easting
T1	25.45897	55.47716
T2	25.45723	55.47666
T3	25.45554	55.47590
T4	25.45399	55.47487
T5	25.45250	55.47375
T6	25.45109	55.47250

Source: 5OEs, July 2018

Figure 27 presents the locations for the intertidal surveys in relation to the Hamriyah IPP site.

Figure 27: Locations of intertidal surveys

Source: Mott MacDonald Ltd, 2018

7.3 Assessment criteria

The impact assessment is carried out using the data provided by the marine surveys carried out on behalf of Mott MacDonald by 5OEs as well as habitat maps provided by the Sharjah EPAA and the World Wildlife Fund (WWF). This data is used in collaboration with the thermal and saline plume and water recirculation modelling carried out by HR Wallingford on behalf of Mott MacDonald. The maps of the extents of plumes created by the power plant will inform any potential impacts on the sensitive habitats highlighted by the marine ecology surveys (see Section 7.5).

The environmental assessment determines the sensitivity of each receptor based on published literature, expert judgement and knowledge of the receptor within the local area. The sensitivity of each receptor is determined on a scale of negligible, low, medium or high. Table 44 describes how sensitivities are determined.

Table 44: Sensitivities of potential coastal and marine receptors.

Sensitivity	
High	Species, communities, ecosystems and/or environments which due to their proximity to the project activities, their abundance or vulnerability, existence near their tolerance threshold or protected status, may be affected by permanent irreversible impacts from the project. Receptors of high sensitivity are considered to be: • Hard bottom with coral • Hard bottom with pearl oysters • Species of conservation concern (IUCN Red List)

Sensitivity	
Medium	Species communities, ecosystems and/or environments which though susceptible to changes in their surroundings, due to proximity of project activities their abundance or vulnerability, existence near their tolerance threshold or protected status, may be impacted in the short-term by the project. Receptors of medium sensitivity are considered to be: • Hard bottom with macroalgae
Low	Species, communities, ecosystems and/or environments which may be impacted by project activities but have the capacity to recover. Receptors of low sensitivity are considered to be: • Hard bottom • Unconsolidated bottom • Ambient water quality
Negligible	Minimal effects are detected on species communities, ecosystems and/or environments. Receptors of negligible sensitivity are considered to be: • Dredged area • Beach

Source: Mott MacDonald

The magnitude of the impacts from the plant's construction, operation and decommissioning activities on the receptors identified are assessed using a scale of negligible, minor, moderate and major. Impacts were also identified as being positive or negative and permanent, temporary or reversible. Table 45 describes how magnitudes are determined.

Table 45: Scale used to assess magnitude of impact to the coastal and marine environments.

Magnitude of impact	
Major beneficial/averse	An impact under typical operating conditions that may affect the condition and vulnerability of species, habitats and environments within a widespread area, exceeding national limits /international guidance; an impact that continues beyond the project lifespan and is permanent, requiring considerable intervention to return to the environmental baseline.
Moderate beneficial/adverse	A possible impact that under the worst (negative) or best (positive) operating conditions is likely to affect the condition and vulnerability of species, habitats and environments, slightly exceeding national standard limits or international guidelines; extends beyond the site boundary into the local area or continue beyond the project life so that the environmental baseline is re-established within a year or so, perhaps with some intervention
Minor beneficial/adverse	An impact which under abnormal/exceptional conditions is likely to affect the condition and vulnerability of a small number of species, habitats and environments, or is generally contained within the site boundary and does not extend to beyond the life of the project so that the environmental baseline returns naturally or with limited intervention within a few months.
Negligible	An impact that is localised to a specific location within the project site and is temporary or unlikely to occur with no detectable affect condition and vulnerability of species, habitats and environments so that the environmental baseline remains consistent.

Source: Mott MacDonald

The level of significance is then determined using the matrix shown in Table 46. If the impact is negative then the effect is adverse, if the impact is positive then the effect is beneficial.

Table 46: Levels of significance

Magnitude of impact	Sensitivity of receptors			
	Negligible	Low	Medium	High
Negligible	Insignificant	Insignificant	Insignificant	Minor
Minor	Insignificant	Insignificant	Minor	Moderate
Moderate	Insignificant	Minor	Moderate	Major

Magnitude of impact	Sensitivity of receptors			
	Negligible	Low	Medium	High
Major	Insignificant	Moderate	Major	Major

The matrix identifies those impacts which are most likely to arise as a result of the project activities. Impact identification compares project characteristics and baseline characteristics in order to ensure that all potentially significant environmental impacts (both adverse and beneficial) are identified and considered within this ESIA report. The following issues have been considered in assessment of potential impacts:

- Characteristics and likely consequences of each impact
- Compliance with relevant regulations and standards
- Identification of secondary and cumulative impacts as well as direct impacts
- The potential for each impact to have adverse or beneficial consequences as well as their duration.

The significance of impacts was assessed before and after mitigation. Where feasible, mitigation measures were applied such as technology/design, careful choice of location, materials and best practice. Mitigation options that are consistent with best practice and current and future innovations, over and above legislative requirements have also been reviewed. A great number of potential impacts can be either completely avoided or reduced through mitigation, however some residual environmental impacts may be unavoidable. Each environmental topic will assess whether residual impacts, either beneficial or adverse, remain after mitigation. Residual impacts are depicted within the significance matrix and demonstrate the ability of various mitigation measures to reduce impacts. Mitigation should reduce adverse effects and enhance beneficial impacts.

To determine the full combined effect of the development, potential impacts during both construction and operational phases were assessed where relevant. The assessment of impacts concludes with a discussion of any cumulative impacts identified outside the scope of the full phase development.

7.4 Legislative framework

7.4.1 Discharge standards

The plant has been designed to comply with federal discharge standards (Federal Law 24 of 1999 amended by Law 20 of 2006 and its executive order), as set out in its executive order and IFC standards (EHS Guidelines for Thermal Power Plants (2008)) as shown in Table 9. The EAD treated industrial wastewater discharge standards are provided for reference.

Table 47: Wastewater discharge standards

Parameter	Symbol	Unit	UAE Federal law 24 of 1999 amended by law 20 of 2006 and its executive order	EAD limits (1)	IFC limits (2)
Physical properties					
Temperature		°C	5	5	Determined through modelling and consideration of marine environment

Parameter	Symbol	Unit	UAE Federal law 24 of 1999 amended by law 20 of 2006 and its executive order	EAD limits (1)	IFC limits (2)
Total suspended solids	TSS	mg/l	50	50	50
Total dissolved solids	TDS	mg/l	1500	1500	
pH		pH units		6-9	6-9
Floating particles		mg/m²		None	
Turbidity	NTU		75		
Inorganic chemical properties					
Total ammonia (as N)	NH3	mg/l	2	2	
Nitrate	NO3-N	mg/l	40	40	
Residual chlorine	Cl-	mg/l	1	1	0.2
Cyanide	CN	mg/l	0.05	0.05	-
Dissolved oxygen	DO	mg/l	>3	>3	
Fluoride	F-	mg/l		20	
Sulphide	S-2	mg/l	0.1	0.1	
Biochemical oxygen demand	BOD5-20	mg/l	50	50	
Total Kjeldahl Nitrogen (as N)	TKN	mg/l	10	10	
Total phosphorus (as P)	PO4-3	mg/l	2	2	
Chemical oxygen demand	COD	mg/l	100	100	
Trace metals					
Aluminium	Al	mg/l		20	
Antimony	Sb	mg/l		0.1	
Arsenic	As	mg/l		0.05	0.5
Barium	Ba	mg/l		2	
Beryllium	Be	mg/l		0.05	
Cadmium	Cd	mg/l		0.05	0.1
Total chromium	Cr	mg/l		0.2	0.5
Chromium VI (hexavalent)	Cr+6	mg/l		0.15	
Cobalt	Co	mg/l		0.2	
Copper	Cu	mg/l		0.5	0.5
Iron	Fe	mg/l		2	1
Lead	Pb	mg/l		0.1	0.5
Manganese	Mn	mg/l		0.2	
Mercury	Hg	mg/l		0.001	0.005
Nickel	Ni	mg/l		0.1	
Selenium	Se	mg/l		0.02	
Silver	Ag	mg/l		0.005	
Titanium	Ti	mg/l		-	-
Zinc	Zn	mg/l		0.5	1

Parameter	Symbol	Unit	UAE Federal law 24 of 1999 amended by law 20 of 2006 and its executive order	EAD limits (1)	IFC limits (2)
Organic chemical properties					
Halogenated hydrocarbons and pesticides		mg/l		Nil	
Hydrocarbons	HC	mg/l	15	15	
Oil and grease		mg/l	10	10	10
Phenols		mg/l	0.1	0.1	
Solvents		mg/l		Nil	
Total organic carbons	TOC	mg/l	75	75	
Biological properties					
Total coliform		MPN/100 ml		1000	
Faecal coliform bacteria		Cells/100 ml		1000	
Colon group		No./100cm2		5000	
Egg parasites				None	
Warm parasites				None	

Notes: 1. EAD characteristics of treated industrial wastewater at point of discharge into the sea (TG-0003R, 2008)
2. IFC effluent guideline - EHS guideline thermal power plants (2008)/These levels should be achieved, without dilution, at least 95 percent of the time that the plant or unit is operating, to be calculated as a proportion of annual operating hours

7.4.2 Ambient marine water quality standards

In the absence of federal marine water quality standards, the hydrodynamic modelling analysis/identification of mixing zone and laboratory results were compared to Abu Dhabi specification ADS19/2017 ambient marine water standards (ADS), EAD TGD Standards and Limits for Pollution to Air and Marine Environments Occupational Exposure Pesticides and Chemical Use (TG-0003R) and/or the internationally recognized standard of the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (2000), produced by the Australian and New Zealand Environment and Conservation Council (ANZECC) as part of the National Water Quality Management Strategy (Table 48).

Table 48: Ambient marine water quality standards

Parameter	ANZECC (2000) * (mg/L unless indicated otherwise)	EAD TG-0003R (mg/l)	ADS** (µg/L)
Temperature		+/-3 (Delta ˚C of background concentration	-
Salinity		<5% of background concentration	-
Dissolved oxygen	-	>4	4.0
Turbidity	-	10	-
Arsenic (µg/L)	-	0.005	-
Cadmium (µg/L)	0.7	0.001	0.7
Chlorine residual	-	0.01	

Parameter	ANZECC (2000) * (mg/L unless indicated otherwise)	EAD TG-0003R (mg/l)	ADS** (µg/L)
Chromium (µg/L)	-	0.01	-
Copper (µg/L)	1.3	0.01	3.0
Iron (µg/L)	-	0.3	-
Lead (µg/L)	4.4	0.01	2.2
Mercury (µg/L)	0.1(inorg)	-	0.1
Nickel (µg/L)	7	20	7.0
Vanadium (µg/L)	100	9.4	-
Zinc (µg/L)	15	0.01	-
Free chlorine	-		-
Total petroleum hydrocarbons	-		7.0
Oil & Grease	-	Not visible	-
Trichlorormethane	-		-
Cyanide (easily liberated)	0.002	0.004	-

Note: * As defined in the Australia & New Zealand Guidelines for Fresh and Marine Water Quality, Volume 1 – The Guidelines. 2000. Values apply to typical slightly-moderately disturbed systems. Updates from ANZECC Water quality standards addendum (2005) are also applied. ** As defined in the Abu Dhabi Specification for ambient marine water and sediments specifications ADS19/2017 - indicates that a threshold value is not available for this parameter

7.4.3 Sediment quality benchmarks

The standards used for assessing sediment quality included standards applicable in UAE (ADS 19/2017), as well as Australian and New Zealand (ANZECC), UK, Canadian, and the New Dutch list (2000, 2007 & 2009).

In recent years the 'weight of evidence' method (Long et al. 1995) has been gaining widespread acceptance. Long et al. (1995) examined all available toxicity data for nine trace metals as well as other determinants that had been published in peer reviewed reports. For each parameter the 10th percentile and 50th percentile sediment concentration associated with toxic effects was calculated. The 10th percentile value was named 'Effects Range Low' (ERL) and the 50th percentile was named the 'Effects Range Median' (ERM) (Table 49). It is important to note that both lethal and non-lethal effects (e.g. changed rate of burial for burrowing organisms, changed respiration rates) were tabulated prior to determining the ERL and ERM. Test durations were also variable and this was not taken into account in determining the ERL and ERM.

Table 49: Weight of evidence; Long et. al. 1995 terminology

Terminology	Description
Lower than ERL	Toxic effects rarely observed. It should be noted, however, that sensitive species may be adversely affected at concentrations below the ERL, and this may cause a change in the benthic community.
Greater than ERL but less than ERM	Toxic effects expected for some species.
Greater than ERM	Toxic effects expected for most species.

There are two main disadvantages to adopting the ERL and ERM approach: 1) ERL & ERM values will need to be adjusted periodically to take into account data from the most recent toxicity tests; 2) The ERL and ERM values do not take into account factors that are likely to affect the bioavailability of the contaminants; for example, the organic carbon content, pH, particle size, and acid-volatile sulphide concentrations in the sediment. However, provided that the ERL and ERM values are for screening purposes, the approach is likely to aid interpretation of sediment quality data sets. The ERL and ERM values are non-regulatory benchmarks (Long & MacDonald 1998).

The effects database used to generate the ERL and ERM values is available to anyone with an interest in setting sediment quality guidelines and this gives a degree of control in setting guidelines according to the particular conditions encountered. If necessary, organisations can delete records that they feel are not relevant to their aims and can add regionally relevant data. If desired, the mathematical basis for calculating sediment quality guidelines can be amended. This has resulted in Florida developing a similar, but different set of sediment quality guidelines (Florida Department of Environmental Protection, 1994). The Florida guidelines use the term 'Threshold Effects Level' (TEL) and 'Probable Effects Level' (PEL), and these have a different mathematical derivation to the ERL and ERM values. The TEL and PEL were calculated using effects database (Florida Department of Environmental Protection 1994) and are used as part of the Canadian and UK ISQG guidelines.

In addition to the 'weight of evidence' technique for investigating the ecological effects of heavy metals and other potential toxins, we also compare the concentrations of heavy metals in sediments to internationally recognised standards including those used in Holland, Australia, Canada, and the UK (Table 50).

Table 50: National and international standards of heavy metals in sediments; all values presented in mg/kg unit

	ANZECC		Dutch		UK & Canadian ISQG		Long et al. (1995)		ADS	
Parameter	Lower	Upper	Optimum	Action	TEL	PEL	ERL	ERM	General	MPA
Arsenic	20	70	29	55	7.24	41.6	8.2	70	7	7
Cadmium	1.5	10	0.8	12	0.7	4.2	1.2	9.6	0.7	0.2
Chromium	80	370	100	380	52.3	160	81	370	52	11
Copper	65	270	36	190	18.7	108	34	270	20	20
Lead	50	220	85	530	30.2	112	46.7	218	30	5
Mercury	0.15	1	0.3	10	0.13	0.7	0.15	0.71	0.2	0.2
Nickel	21	52	35	210	15.9	42.8	20.9	51.6	16	7
Zinc	200	410	140	720	124	271	150	410	125	70

7.4.4 National and international treaties

International treaties and agreements which are applicable include:

- The Convention on Biological Diversity, 1992
- United Nations Convention on the Law of the Sea (UNCLOS), 1982
- Convention on the Conservation of Migratory Species of Wild Animals (also known as CMS or Bonn Convention)
- Regional Organisation for the Protection of the Marine Environment (ROPME), 1978 (Gulf region)

7.5 Baseline description

7.5.1 Overview

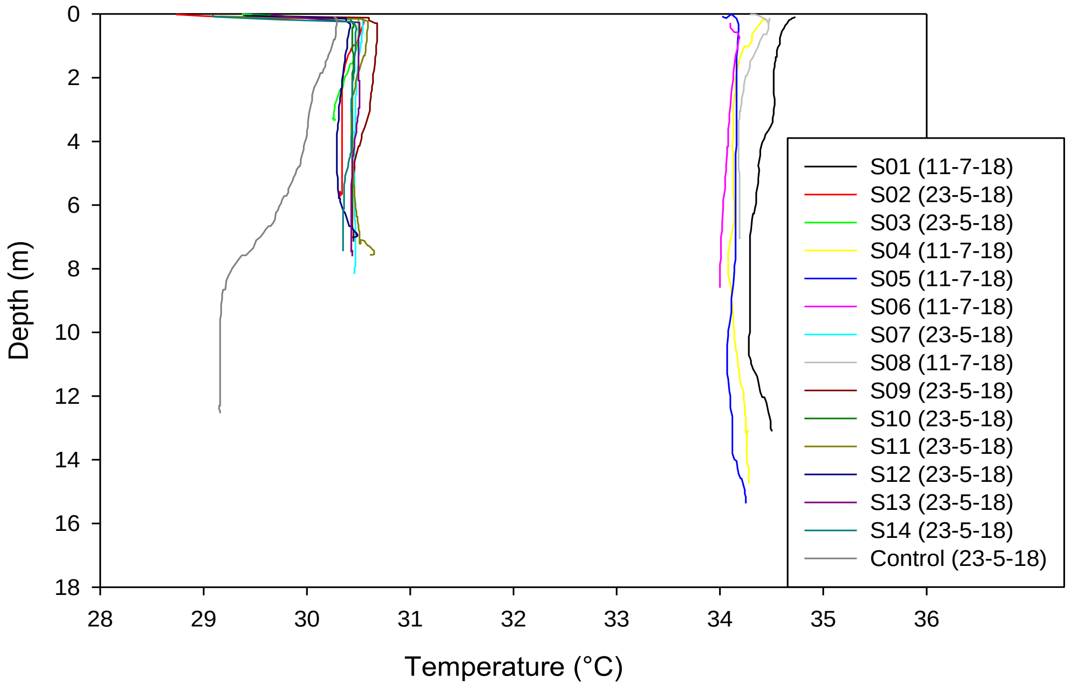
This section reports results obtained from the 5OEsS marine water quality and ecological survey, carried out in June/July 2018, supplemented by data from the EWS-WWF survey which was undertaken earlier in 2018.

7.5.2 Seawater quality and seawater sampling survey

7.5.2.1 Temperature

Temperature profiles for the area ranged from 28.73 to 30.7°C with an average temperature of 30.3°C. Temperature profiles for all sites showed generally stable temperature with depth with the exceptions of sites S8, S11 and S12 which showed a minor increase (less than one degree) or decrease in temperature close to the seabed. This general stability reflects the lack of a thermocline, which in turn indicated a high degree of mixing throughout the water column. Since sites S1, S4, S5, S6 and S8 were sampled at a later date, the temperature observed at these sites are around four degrees warmer compared with earlier measurements. These sites do exhibit a similar pattern i.e. absence of a pronounced thermocline (Figure 28)

Figure 28: Seawater temperature profile

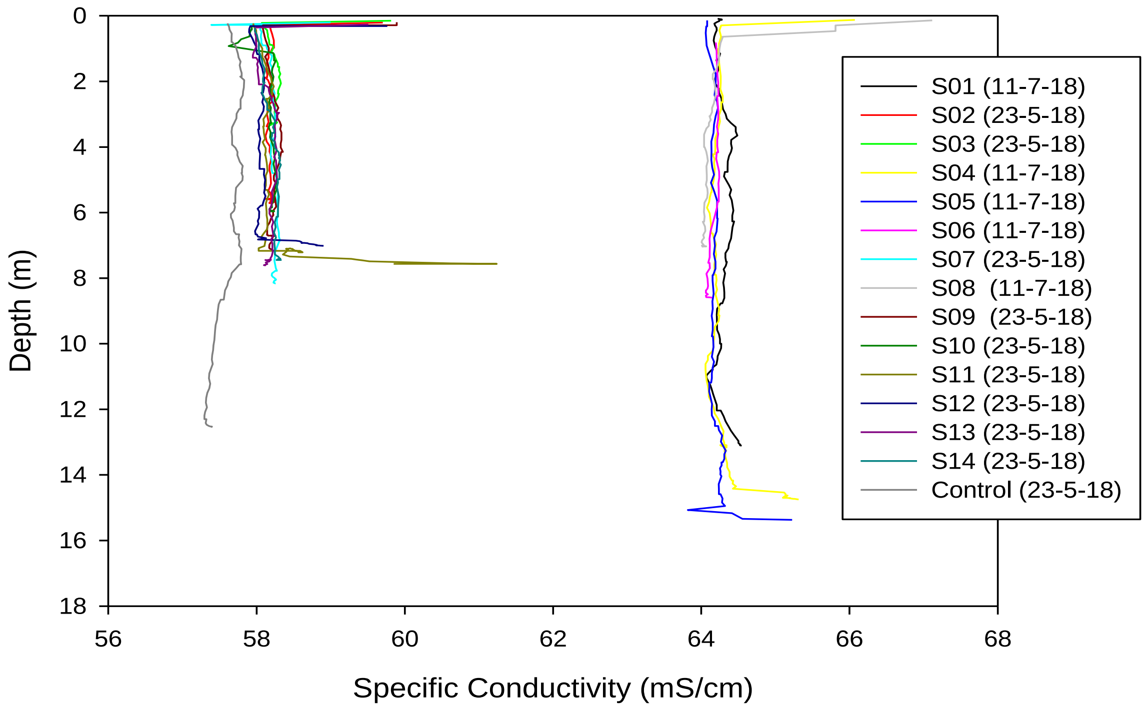


Source: 5OES, July 2018

7.5.2.2 Specific conductivity

Specific conductivity profiles in the area ranged from 57.296 to 61.24mS/L with an average of 58.16mS/L. Conductivity at each site remained relatively constant within their ranges not deviating by more than 0.5mS/L, with the exception of the control site and site S11 where a decrease and an increase can be seen at their maximum depth respectively. Since sites S1, S4, S5, S6 and S8 were sampled in July 2018, and specific conductivity being correlated with temperature the specific conductivity of these sites is significantly different to measurements taken at the site in May 2018. The pattern of conductivity is similar at all sites regardless of the date of sampling and shows an increase in specific conductivity in the surface waters before remaining relatively stable throughout the water column (Figure 29).

Figure 29: Seawater conductivity profile

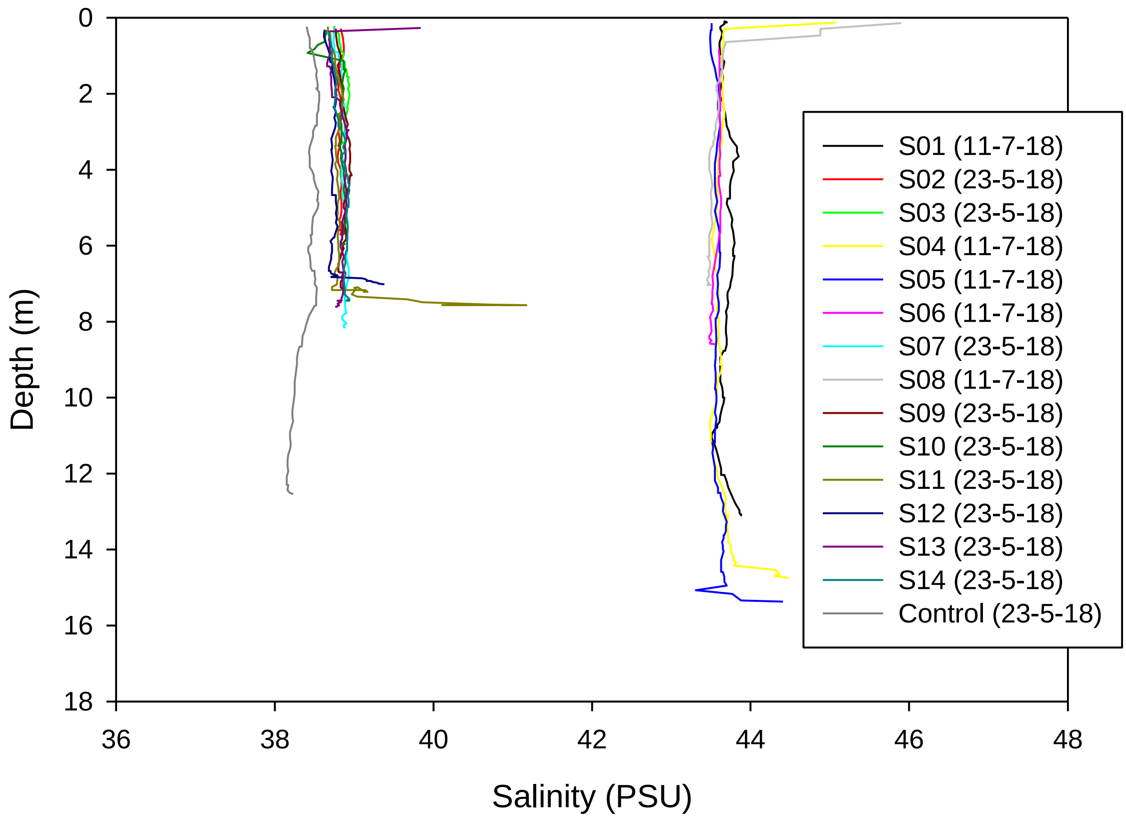


Source: 5OES, July 2018

7.5.2.3 Salinity

Salinity ranged from 38.15 to 45.9 PSU throughout the sites tested during this environmental survey with an average of 40.42 PSU recorded. Salinity was generally stable throughout the water column with the exception of the control site and site S11. This is expected since salinity is a function of conductivity. It should also be noted that the sites sampled later in July 2018 (sites S1, S4, S5, S6 and S8) showed higher salinity levels, though this is expected due to higher evaporation occurring in summer months in the Arabian Gulf (Figure 30). This is expected due to the relationship between salinity the conductivity readings, which showed similar spikes as seen in Figure 29.

Figure 30: Seawater salinity profile

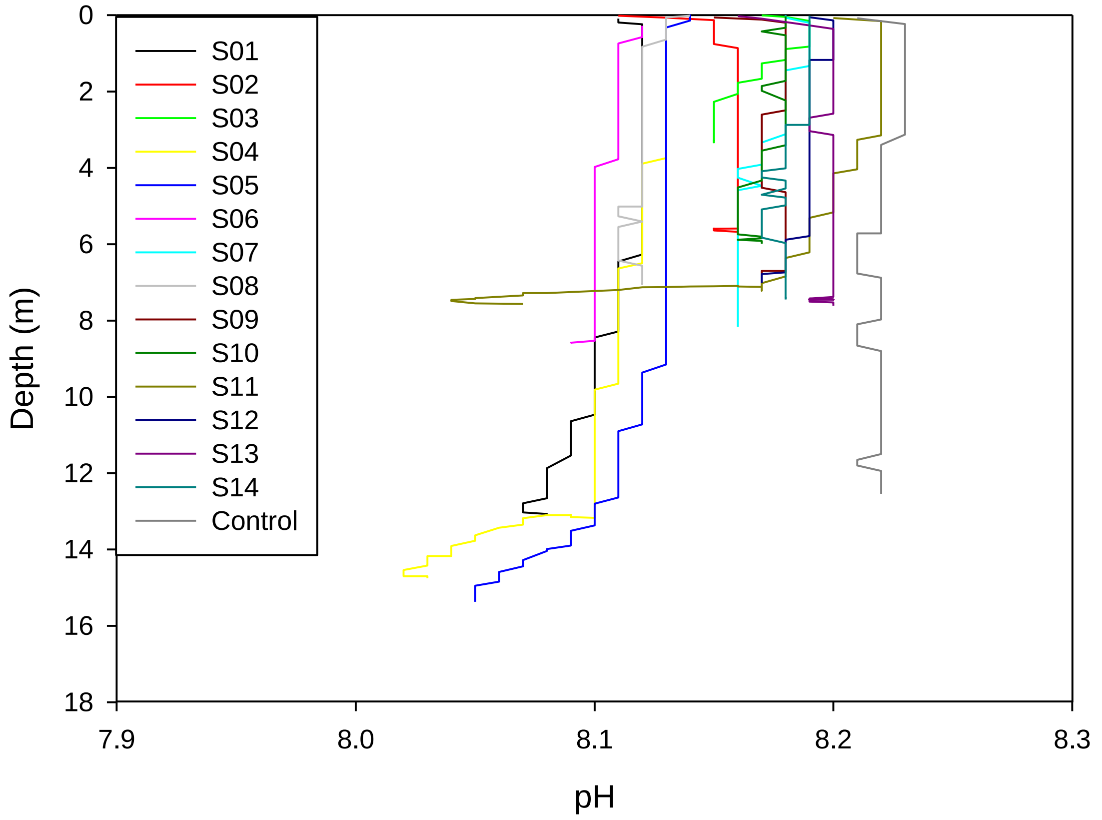


Source: 5OES, July 2018

7.5.2.4 pH

pH ranged from 8.04 to 8.23 with an average of 8.18 recorded during the monitoring event. pH was relatively stable across the majority of the sites. When salinity is taken into account the observed values for pH are consistent with expectations at this time of the year (Figure 31).

Figure 31: Seawater pH profile

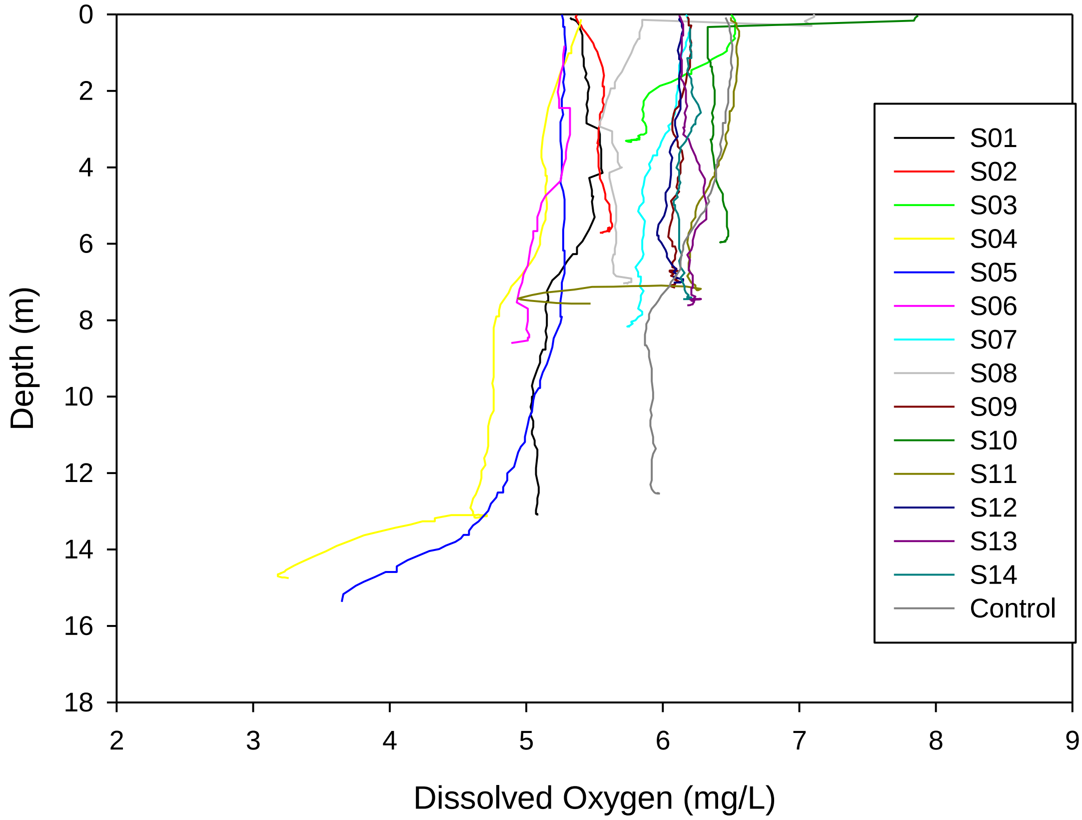


Source: 5OES, July 2018

7.5.2.5 Dissolved oxygen

Dissolved oxygen (DO) has a range of 3.18 to 7.87mg/l with an average concentration of 5.77mg/l. DO concentrations remained relatively constant throughout the water profiles with elevated concentrations seen higher in the water column. The observed pattern is caused by greater gas exchange with the atmosphere and greater light levels (and therefore photosynthesis) in surface waters relative to deeper in the water column (Figure 32).

Figure 32: Seawater dissolved oxygen profiles

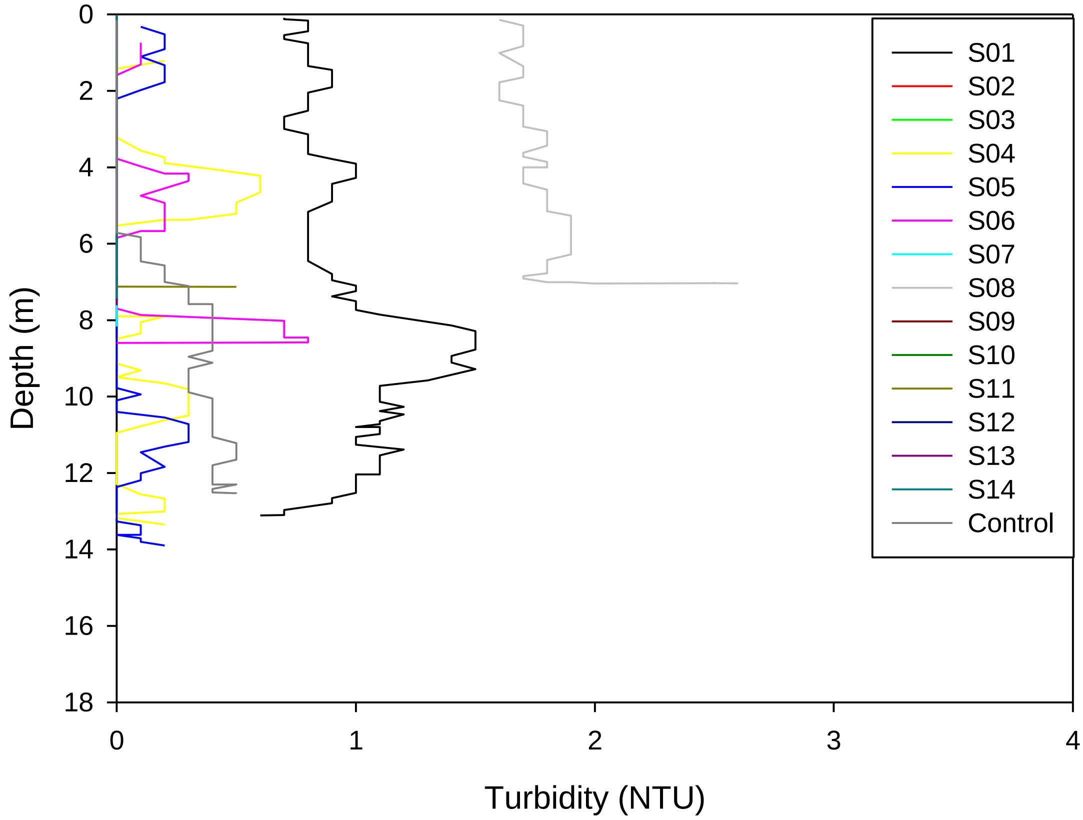


Source: 5OEs, July 2018

7.5.2.6 Turbidity

Turbidity values ranged from 0 to 2.6 NTU with an average of 0.22 NTU, indicating relatively clear water with low concentrations of suspended sediment and good light penetration. An exception to the general pattern was observed at S8 where values ranged from 1.6 to 2.6 NTU. This site is located close to the breakwater and could be expected to have a higher turbidity than the other sites due to greater water movement resulting in some scour and greater sediment resuspension (Figure 33). It should be noted that turbidity will naturally vary according to wave energy (e.g. storms, shamal induced waves) and the time since the last storm event/shamal.

Figure 33: Seawater turbidity profiles



Source: 5OEs, July 2018

7.5.2.7 Light attenuation – Secchi disk

The decrease of light vertically through the water column, i.e. light attenuation, can be expressed by the diffuse light attenuation coefficient for downward irradiance light attenuation coefficient (KD) (Brito et al., 2013) following the Beer-Lambert Law with respect to the sun angle. KD is a useful parameter for characterising a water body since it represents one of the most important ecological properties of seawater and can be used to calculate the depth of the euphotic zone (Mishra et al., 2005). The application of Holmes' (1970) empirically derived relationship between Secchi disk depth and the light attenuation coefficient KD can be applied to provide a convenient first approximation of light attenuation. Secchi disk depth varied between 2m (S8) to 10m (Control) (Table 4.1). Secchi depths taken during the survey indicate average water visibility in the water column; often UW visibility in marinas is low because their low wave energy environment and restricted flushing serves as a sediment trap allowing fine suspended sediments to be retained, while boat movements help to keep fine sediments in suspension. Values of the attenuation coefficient KD have been calculated for all sites except sites S2, S3, S7, S9, S10, S11, S12, S13 and S14 in the current survey, as the seabed was clearly visible from the sampling vessel at these sites (i.e. a 'true' Secchi disk depth was not measured). Light attenuation coefficients ranging from 0.383 to 0.665 were calculated. Table 51 presents the total water column and Secchi disk depth for the survey stations/points.

Table 51: Total water column and Secchi disk depths (m)

Sites	Date/time	Secchi disk depth (m)	Seabed depth (m)	Light attenuation coefficient (KD) (m-1)	Calculated euphotic zone (m)
S01	11/07/2018 12:00	3.00	14.00	0.477	9.00
S02	23/05/2018 9:36	5.58	5.58	-	16.74
S03	23/05/2018 9:13	3.90	3.90	-	11.70
S04	11/07/2018 13:00	3.00	15.00	0.477	9.00
S05	11/07/2018 13:10	3.00	15.00	0.477	9.00
S06	11/07/2018 13:25	4.00	9.00	0.383	12.00
S07	23/05/2018 11:19	8.35	8.35	-	25.05
S08	11/07/2018 15:37	2.00	7.80	0.665	6.00
S09	23/05/2018 11:06	7.56	7.56	-	22.68
S10	23/05/2018 8:52	6.71	6.71	-	20.13
S11	23/05/2018 10:16	7.89	7.89	-	23.67
S12	23/05/2018 10:29	7.68	7.68	-	23.04
S13	23/05/2018 10:39	7.80	7.80	-	23.4
S14	23/05/2018 10:52	7.96	7.96	-	23.88
Control	23/05/2018 11:47	10.00	12.74	0.213	30.00

Source: 5OES, July 2018

Water visibility can be affected by water turbidity, weather (cloud coverage or ambient light intensity) and human influence (e.g. effluence, boating and fishing) (Mishra et al., 2005). Light attenuation coefficients measured in coastal waters tend to be greater than those measured in open ocean waters, with light being scattered by particles in the water column. Open ocean attenuation coefficients ranging from 0.022-0.033m^{-1} are reported from the West Indian Ocean (Jerlov, 1976 and references therein) for comparison.

It is fairly common practice for an estimation of the depth of the euphotic zone (defined as the depth that 1% of ambient surface radiation penetrates) to be calculated by multiplying the Secchi disk depth by a factor of 3 (Holmes, 1970). Using this method indicates that the whole water column is in the euphotic zone at the majority of sampling sites; sites S01, S04, S05 and S08 Secchi disk depths would indicate a euphotic zone of 9m, 9m, 9m and 6m, respectively, shallower than the total water column depth at these sites. These light attenuation values can provide a useful benchmark for comparing water conditions between the survey area and other similar environments, or for estimation of the light intensity reaching a specific depth in the water column (i.e. for the known depth of a specific ecological feature or species).

Since light attenuation is highly variable in time, the attenuation coefficient KD is a useful indicator when recorded as part of a long-term monitoring programme. This is illustrated by the variability seen in KD values over a period of 3 months in the Goleta Bay, California, where calculated KD ranged from 0.183m^{-1} on 10 May 2018 (hazy, slight sea and swell) to 0.683m^{-1} on 3 May 2018 (overcast, slight sea) (Holmes, 1970) and was highly dependent on weather and sea state.

7.5.2.8 Heavy and trace metals in water

Arsenic was present at the control site at a level of 10µg/L, while other sites sampled did not have detectable limits of arsenic present. There are no standards in either ANZECC (2000) or ADS for arsenic (Table 52).

Copper was present at all sites with a level of 2.3 and 1.6 µg/L at sites S01 and S03 respectively. At both these sites the detectable concentration was above the international

ANZECC standard of 1.3, however it is below the Abu Dhabi specification (3.0 µg/L) for marine water.

Cadmium, chromium, iron, lead, mercury, nickel, vanadium and zinc were not detected in any of the samples collected during this survey (Table 52).

Table 52: Heavy and trace metals concentration detected in marine water samples from all sampling sites

		Lab result				ANZECC (2000) * (µg/L)	ADS (µg/L) **
Parameter	**Detection limit (µg/L)**	**S01**	**S02**	**S03**	**Control**		
Arsenic	10	<10	<10	<10	10	-	-
Cadmium	0.1	<0.1	<0.1	0.13	<0.1	0.7	0.7
Chromium	3	<1	<3	<3	<3	27 (CrIII)/4.4(CrVI)	-
Copper	0.3	1.3	0.36	1.6	0.48	1.3	3.0
Iron	30	<30	<30	<30	<30	-	-
Lead	0.2	0.28	<0.2	0.28	0.25	4.4	2.2
Mercury	0.1	<0.1	<0.1	<0.1	<0.1	0.1(inorg)	0.1
Nickel	3	<3	<3	<3	<3	7	7
Vanadium	5	<5	<5	<5	<5	100	-
Zinc	10	<10	<10	<10	<10	15	15
Above Threshold							
Detected values							

Source: 5OES, July 2018. **Note:** * As defined in the Australia & New Zealand Guidelines for Fresh and Marine Water Quality, Volume 1 – The Guidelines. 2000, Table 3.4.1. Values apply to typical slightly-moderately disturbed systems. Updates from ANZECC Water quality standards addendum (2005) are also applied. ** As defined in the Abu Dhabi Specification for ambient marine water and sediments specifications ADS19/2017

7.5.2.9 Anions

As expected in seawater, chloride was present in all samples with concentrations ranging from 22,000 to 23,000 mg/L

Table 53: Anion concentration detected in marine water samples (mg/l)

		Lab result (µg/L)				ANZECC (2000) * (µg/L)	ADS **
Parameter	**Detection limit (µg/L)**	**S01**	**S02**	**S03**	**Control**		
Chloride	2	23000	22000	22000	22000	-	-
Above Threshold							
Detected values							

Source: 5OEs, July 2018. Note: * As defined in the Australia & New Zealand Guidelines for Fresh and Marine Water Quality, Volume 1 – The Guidelines. 2000, Table 3.4.1. Values apply to typical slightly-moderately disturbed systems. Updates from ANZECC Water quality standards addendum (2005) are also applied. ** As defined in the Abu Dhabi Specification for ambient marine water and sediments specifications ADS19/2017

7.5.2.10 Trihalomethanes

Bromodichloromethane, bromoform, dibromochloromethane and chloroform were undetected in this survey. None of these compounds have standards in ANZECC or ADS (Table 54).

Table 54: Trihalomethanes present in water samples

Parameter	Detection limit (µg/L)	Lab result (µg/L) S01	S02	S03	Control	ANZECC (2000) * (µg/L)	ADS **
Bromodichloromethane	1.0	<1.0	<1.0	<1.0	<1.0	-	-
Bromoform	1.0	<1.0	<1.0	<1.0	<1.0	-	-
Dibromochloromethane	1.0	<1.0	<1.0	<1.0	<1.0	-	-
Chloroform	1.0	<1.0	<1.0	<1.0	<1.0	-	-
Above Threshold							
Detected values							

Source: 5OEs, July 2018. Note: * As defined in the Australia & New Zealand Guidelines for Fresh and Marine Water Quality, Volume 1 – The Guidelines. 2000, Table 3.4.1. Values apply to typical slightly-moderately disturbed systems. Updates from ANZECC Water quality standards addendum (2005) are also applied. ** As defined in the Abu Dhabi Specification for ambient marine water and sediments specifications ADS19/2017

7.5.2.11 Total suspended solids in water

Total suspended solids were undetected in this environmental survey at a limit of 5mg/l. There is no legislation in either ANZECC or ADS for total suspended solids in water (Table 55).

7.5.2.12 Petroleum hydrocarbon

Petroleum hydrocarbons both C10-C40 and C5-C10 were below detectable levels ((0.05 mg/l). There is currently no legislation for C10-C40 and C5-C10 in ANZECC and ADS (Table 55).

7.5.2.13 Dissolved and emulsified oil

Dissolved or emulsified oil was undetected at all sites surveyed during this environmental survey. There is no legislation in ANZECC or ADS for dissolved or emulsified oil (Table 55).

Table 55: Dissolved and emulsified oil, total suspended solids, petroleum hydrocarbons (C10-C40) and VPH (C5-C10) present in marine water at all sites

Parameter	Detection limit (mg/L)	Lab result (mg/L) S01	S02	S03	Control	ANZECC (2000) * (mg/L)	ADS**
Dissolved & emulsified oil	10	<10	<10	<10	<10	-	-
Total suspended solids	5	<5	<5	<5	<5	-	-
Hydrocarbons (C10 – C40)	0.05	<0.05	<0.05	<0.05	<0.05	-	-
VPH (C5-C10)	0.007	<0.007	<0.007	<0.007	<0.007	-	-
Above Threshold							
Detected values							

Source: 5OEs, July 2018. Note: * As defined in the Australia & New Zealand Guidelines for Fresh and Marine Water Quality, Volume 1 – The Guidelines. 2000, Table 3.4.1. Values apply to typical slightly-moderately disturbed systems. Updates from ANZECC Water quality standards addendum (2005) are also applied. ** As defined in the Abu Dhabi Specification for ambient marine water and sediments specifications ADS19/2017

7.5.3 Sediment quality

7.5.3.1 Heavy and trace metals

Table 56 presents the results of heavy metals and trace metals in sediment samples.

Arsenic was detected at all sites, with a concentration range of 2.2mg/kg (S01) to 3.2mg/kg (S02 and Control). Detected concentrations are below all national and international guidelines used for comparison in this study.

Cadmium was undetected at all sites sampled during this marine environmental survey (MDL 0.5mg/kg).

Chromium was detected at all sites, with a concentration range of 7.6mg/kg (control) to 18.7mg/kg (S01). Detected concentration at sites S01–S03 exceeded the ADS marine protected areas (MPA) standards presented in ADS but fell well below the ADS general threshold of 52mg/kg for marine sediments, and all other lower thresholds used for comparison.

Copper was detected at sites S01 and S02 with concentrations of 6.6mg/kg and 3.7mg/kg respectively. Detected concentrations fell well below all standards used for comparison in this survey. Copper was undetected in sediment samples from site S03 and the control site (MDL 3.0mg/kg).

Lead was detected at all sites, with concentrations ranging from 1.3mg/kg (S03) to 3.2mg/kg (S01). Detected concentrations fell below all available standards for comparison, including the ADS MPA threshold of 5mg/kg (the lowest threshold used for comparison).

Iron was detected at all sites, with concentrations ranging from 1260mg/kg (control) to 4790mg/kg (S01). There are no available sediment thresholds available against which to compare Iron concentrations in marine sediments.

Magnesium was detected at all sites, with concentrations ranging from 36.9mg/kg (control) to 177mg/kg (S01). As with Iron, there are no available sediment thresholds available against which to compare Magnesium concentrations in marine sediments.

Mercury was detected only at site S01 with a concentration of 0.012mg/kg. This concentration fell below all available guideline thresholds for comparison. Mercury was undetected at all other sites (MDL 0.01mg/kg).

Nickel was detected at all sites, with concentrations ranging from 5.7mg/kg (control) to 22.1mg/kg (S01). Detected concentrations at sites S01–S03 exceeded the ADS MPA guideline of 7mg/kg, whilst detected concentrations at site S01 exceeded the ANZECC lower (21mg/kg), UK and Canadian ISQG TEL (15.9mg/kg), the Long et al., ERL (20.9mg/kg) and the ADS General (16mg/kg) thresholds.

Zinc was detected at all sites, with concentrations ranging from 5.7mg/kg (control) to 22.8mg/kg (S01). Detected concentrations at all sites fell below all available thresholds used for comparison in this survey.

Table 56: Comparison between heavy and trace metal levels acquired from sediment collected at surveyed sites and international guidelines. All values presented as mg/kg

						ANZECC *		Dutch **		Canadian & UK ISQG ***		Long et al. (1995) ****		ADS *****	
Parameter	Det. Limit (mg/kg)	S01	S02	S03	control	Lower	Upper	Optimum	Action	TEL	PEL	ERL	ERM	General	MPA
Arsenic	1.0	2.2	3.2	3.0	3.2	20	70	29	55	7.24	41.6	8.2	70	7	7
Cadmium	1.0	<0.5	<0.5	<0.5	<0.5	1.5	10	0.8	12	0.7	4.2	1.2	9.6	0.7	0.2
Chromium	1.0	18.7	14.5	11.2	7.6	80	370	100	380	52.3	160	81	370	52	11
Copper	3.0	6.6	3.7	<3.0	<3.0	65	270	36	190	18.7	108	34	270	20	20
Lead	1.0	3.2	1.7	1.3	1.6	50	220	85	530	30.2	112	46.7	218	30	5
Iron	70.0	4790	3280	2580	1260	-	-	-	-	-	-	-	-	-	-
Magnesium	3.0	177	149	133	36.9	-	-	-	-	-	-	-	-	-	-
Nickel	1.0	22.1	12.0	8.6	5.7	21	52	35	210	15.9	42.8	20.9	51.6	16	7
Zinc	3.0	22.8	12.0	8.1	5.7	200	410	140	720	124	271	150	410	125	70
Mercury	0.01	0.012	<0.01	<0.01	<0.01	0.15	1	0.3	10	0.13	0.7	0.15	0.71	0.2	0.2

Above threshold

Detected

Source: 5OEs, July 2018. Note: * As defined in the Australia & New Zealand Guidelines for Fresh and Marine Water Quality, Volume 1 – The Guidelines. 2000, Table 3.4.1. Values apply to typical slightly-moderately disturbed systems. Updates from ANZECC Water quality standards addendum (2005) are also applied. ** As defined in the Dutch Contaminated Land, 2000. Dutch Target and Intervention Values (the New Dutch List). *** As defined in the Canadian Council of Ministers of the Environment (CCME) Sediment Quality Guidelines for the Protection of Aquatic Life. **** As defined in Long et al., 1995. Incidence of Adverse Biological Effects Within Ranges of Chemical Concentrations in Marine and Estuarine Sediments. ***** As defined in the Abu Dhabi Specification for ambient marine water and sediments specifications ADS19/2017

7.5.3.2 Petroleum hydrocarbon

Petroleum hydrocarbons both C5-C10 and C10-C40 were undetected at all sites sampled during this marine environmental survey (Table 57).

Table 57: Petroleum Hydrocarbons present in marine sediment (mg/kg)

mg/kg	Detection limit	S01	S02	S03	Control
Petroleum hydrocarbons (C10-C40)	50	<50	<50	<50	<50
Petroleum hydrocarbons (C5-C10)	0.05	<0.05	<0.05	<01.05	0.05

Source: 5OEs, July 2018

7.5.3.3 Sediment size analysis

Standards for sediment classification are given in Table 58. Particle size analysis and interpretation was performed according to Folk and Ward (1957) and the moments method using the Gradistat V8 package (see Blott & Pye 2001). The descriptive terms for the mean grain size follow the Udden-Wentworth grade scale. These techniques involve the division of the sediment sample into a number of size fractions, enabling a grain size classification to be constructed from the weight or volume percentage of sediment in each size fraction (Table 59).

Key impacts associated with sediments are usually related to the proportion of the fines (e.g. silt, clays and colloids) present within the sample: those sediments with higher proportions of fine material (<63µm) are more likely to be re-distributed in the water column and are more likely to bind with potential pollutants such as heavy metals. Fine materials are typically prevalent in dredged environments including channels surrounding port areas. Sediment grains occur in a wide range of sizes from microns to centimetres. Grain size is usually expressed as a projected cross section, with the assumption that the particle is roughly circular. Wentworth 1922 divided sediments into four size categories based on grain diameter: cobble/boulder (size larger 64mm), gravel (size=2- 64mm), sand (size = 0.05-2mm) and mud (size less than 0.063mm).

Table 58: Standards for sediment classification

A. The Wentworth scale for sediment classification

Millimeters (mm)		Micrometers (µm)	Phi (ϕ)	Wentworth size class	
	4096		-12.0	Boulder	Gravel
	256		-8.0	Cobble	Gravel
	64		-6.0	Pebble	Gravel
	4		-2.0	Granule	Gravel
	2.00		-1.0	Very coarse sand	Sand
	1.00		0.0	Coarse sand	Sand
1/2	0.50	500	1.0	Medium sand	Sand
1/4	0.25	250	2.0	Fine sand	Sand
1/8	0.125	125	3.0	Very fine sand	Sand
1/16	0.0625	63	4.0	Coarse silt	Silt
1/32	0.031	31	5.0	Medium silt	Silt
1/64	0.0156	15.6	6.0	Fine silt	Silt
1/128	0.0078	7.8	7.0	Very fine silt	Silt
1/256	0.0039	3.9	8.0	Clay	Mud
	0.00006	0.06	14.0		

B. Sediment classification according to ISO 14688-1

name			size range
Very coarse soil		Large boulder, LBo	>630 mm
		Boulder, Bo	200 – 630 mm
		Cobble, Co	63 – 200 mm
Coarse soil	Gravel	Coarse gravel, CGr	20 – 63 mm
		Medium gravel, MGr	6.3 – 20 mm
		Fine gravel, FGr	2.0 - 6.3 mm
	Sand	Coarse sand, CSa	0.63 - 2.0 mm
		Medium sand, MSa	0.2 - 0.63 mm
		Fine sand, FSa	0.063 - 0.2 mm
Fine soil	Silt	Coarse silt, CSi	0.02 - 0.063 mm
		Medium silt, MSi	0.0063 - 0.02 mm
		Fine silt, FSi	0.002 - 0.0063 mm
	Clay, Cl		≤0.002 mm

Source: 5OEs, July 2018

Table 59: Percentage of grains falling into each size category

	S01	S02	S03	control
% Coarse gravel	0	0	0	0
% Medium gravel	0	0	0	0
% Fine gravel	0	1	2	0
% Coarse sand	1	1	0	26
% Medium sand	2	4	0	50
% Fine sand	89	89	96	21
% Coarse silt	5	4	1	0
% Medium silt	0	1	0	1
% Fine silt	3	0	1	2
% Clay	0	0	0	0

Source: 5OEs, August 2018

7.5.3.4 Benthic infauna

Table 60 shows a taxonomic breakdown of the infauna from the survey. Of the four sites sampled all contained infauna.

Table 60: Taxonomic breakdown of species present

	No of species	No of individual
Sipuncula	2	8
Annelida	10	31
Crustacea	4	25
Mollusca	8	35
Echinodermata	1	8
Total	25	107

Source: 5OEs, August 2018

During this survey, a total of 107 individuals were collected, belonging to 25 species. Annelida was the best-represented taxon in terms of number of species, with 10 species. In terms of abundance, Mollusca were best represented, with 35 individuals. Table 61 shows the breakdown of infauna on a site-by-site basis.

Table 61: Species and diversity index for each of the sites sampled

Site	Number of Species	Number of Individuals (N)	Shannon-Weiner Diversity H'(loge)
S1	6	15	1.87
S2	14	25	2.49
S3	9	59	1.71
Control	3	8	1.07

Source: 5OEs, August 2018

During this survey, the highest numbers of species were collected at S02 with 14 species, followed by S03 with 9 species. S02 also had the highest value for Shannon-Weiner Index, at

2.49. In terms of numbers of individuals, S03 was the highest at 59, followed by S02, with 24. Control had the lowest numbers of species (3) and the lowest number of individuals (8).

Multivariate statistical analysis was not carried out due to insufficient numbers of individuals.

7.5.3.5 Intertidal survey

Habitat

Table 62 summaries the intertidal cover recorded on each transect conducted during this intertidal survey. The substrate type in all transects was sand beach with 100% cover.

In terms of habitat classification, areas both above and below the strandline tended to be classified as sand beach. Initially closer to the sea wall the beach was relatively shallow in gradient but as the beach progresses away from the sea wall its gradient increases, the sediment itself consisted of fine to coarse sediment, with the fine sediment being located at the water’s edge and the coarse at the strand line.

Table 62: Intertidal cover categories recorded during the shoreline surveys

Category	Sub-Category	T1	T2	T3	T4	T5	T6
Substrates & Habitats	Sand						
	Rock						
	Rubble						
	Sand Veneer						
	Sabkha (Halophyte)						
	Sand Beach						
	Rocky Shore						
	Artificial						
	Tidal Flats						
	Halophytes						
	Mangroves						
	Seagrass						
	Macroalgae						

Source: 5OES, July 2018

Fauna

Table 63 summarises the fauna categories recorded during the survey. Fauna represented within the transect surveys, and particularly within the quadrats which form the basis of the density-based estimates in Table 63.

Table 63: Distribution of commonly occurring shoreline macrofauna

Category	Sub-Category	T1	T2	T3	T4	T5	T6
Mollusca	*Mactra lilacea*						

Source: 5OEs, July 2018

The survey was dominated by a mollusca species Mactra lilacea, during the survey no other species were present on the shoreline. Species recorded were relatively limited in number and most were uncommon over the entire length of the area surveyed.

Figure 34 and Figure 35 show typical quadrats from transect one and two (T1 5m) can be seen where there is a population of the bivalve *Mactra lilacea*, while the majority of the quadrats looked like the quadrat T6 10m.

Figure 34: 0.5m^2 quadrats used during intertidal survey - T1 5m quadrat

Source: 5OES, July 2018

Figure 35: 0.5m^2 quadrats used during intertidal survey - T6 10m quadrat

Source: 5OES, July 2018

7.5.1 Marine habitat and ecology

This section provides the results of the marine habitat and ecology surveys (May-July 2018) carried out by 5OEs (see Appendix D for full results).

7.5.1.1 Drop-down video

Drop down video points followed all sites monitored with water profiles as well as points of interest from the side scan survey (Table 64, Figure 36). From these points of interest and water profile sites, a species list of all species recorded was created; hard and soft corals were not identified to species level during the presence assessment (Table 65).

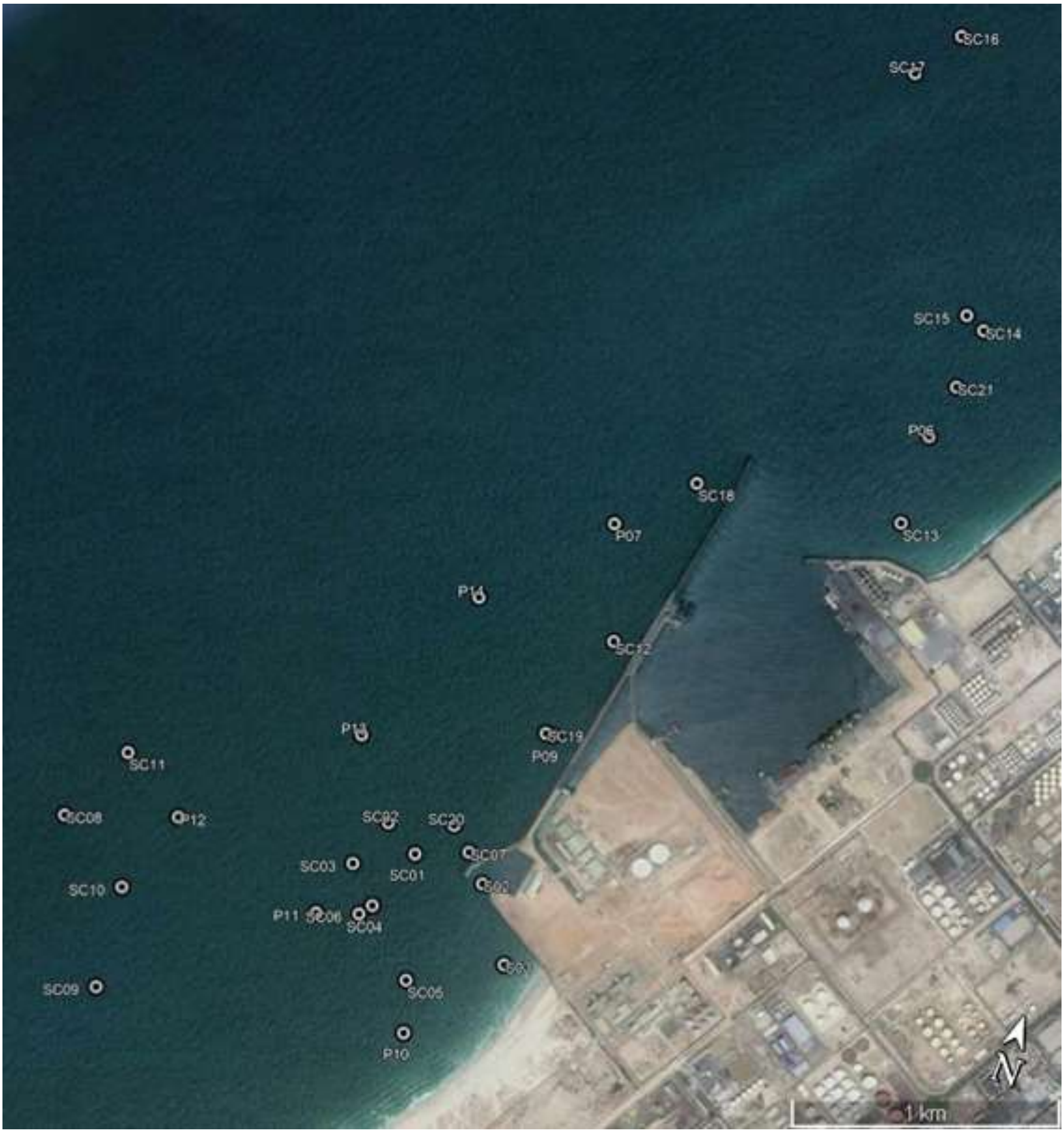
Table 64: Drop-down video locations

Water quality sample ID	Northing	Easting
S2	25.46145	55.47388
S3	25.45915	55.47569
S6	25.48081	55.48365
S7	25.47436	55.47380
S9	25.46696	55.47440
S10	25.45582	55.47307
S11	25.45858	55.46845
S12	25.45998	55.46239

Water quality sample ID	Northing	Easting
S13	25.46473	55.46772
S14	25.47045	55.47003
SC01	25.46160	55.47114
SC02	25.46227	55.46980
SC03	25.46057	55.46909
SC04	25.45947	55.47032
SC05	25.45751	55.47247
SC06	25.45905	55.46996
SC07	25.46229	55.47300
SC08	25.45871	55.45839
SC09	25.45366	55.46173
SC10	25.45711	55.46133
SC11	25.46142	55.45979
SC12	25.47064	55.47531
SC13	25.47775	55.48380
SC14	25.48479	55.48418
SC15	25.48507	55.48339
SC16	25.49382	55.47957
SC17	25.49210	55.47843
SC18	25.47660	55.47615
SC19	25.46694	55.47414
SC20	25.46296	55.47213
SC21	25.48269	55.48396

Source: 5OEs, July 2018

Figure 36: Drop down video location



Source: 5OEs, August 2018

Table 65: Species present at sites surveyed by drop down video

Higher taxa	Genera	Species	S2	P9	P10	P11	P12	P13	Control	SC01	Sc02	Sc03	Sc04	SC05	SC06	SC07	SC08	SC10	SC11	SC12	SC13	SC14	SC16	SC17	SC18	SC19	Sc22
Hard corals	*Dipsastrea (Favia)*							■									■		■					■	■		
	Echinopora																		■					■			
Echinoderms	*Diadema*	*setosum*						■									■	■	■		■		■	■	■		■
	Echinoetra	*mathaei*	■				■	■				■															
	Echinothrix	*diadema*	■				■																				
Porifera		spp.	■				■	■	■												■		■	■	■		
Mollusca	*Pinctada*	*margaritifera*	■																■					■	■		■
	Pinctada	*radiata*					■																				
	Pinna	*muricata*						■																■	■		■
	Unidentified bivalve bed (Malleus sp?)						■										■				■		■				
	Unidentified bivalves																■										
	Strombus	sp		■	■	■																					
	Murex	sp																									
Macroalgae		*Spp.*							■						■	■		■				■		■		■	
	Utodea	*sp*		■																							
	Crustose coraline algae		■																■								
Hydroid		spp.	■									■									■		■				
Ascidian	*Phallusia*	nigra	■						■										■	■	■		■	■	■	■	■
Crustacean	*Anomura*						■	■		■	■		■	■	■		■		■								
Actiniaria		sp								■																	

Source: 5OES, August 2018

7.5.1.2 Fish population

A total of 241 fish were recorded during the surveys consisting of 15 species (Table 68). No species of conservation concern were identified. The most abundant species (54 individuals) was *Scomberoides lysan* (doublespotted queenfish); a reef-associated commercial fish species that feeds on small fishes and crustaceans. The survey location with the most numerous fish population was site 13. The majority of fish species identified were those associated with reefs, with a smaller biodiversity of sand-based species like gobies (live in holes) and goatfish (graze on epifauna). The method of sampling would bias towards the recording of fish species that are associated with benthic habitats, as such, pelagic (mid-water) species may have been under recorded. By nature, pelagic species are transient; passing through an area without relying on it for their survival, in contrast to the species which are associated with benthic marine habitats. Focused survey for pelagic species would add little value to the assessment of the project's impacts because the results would likely be highly variable and inconclusive. Key species for consideration would be commercial species including tunas, sharks, bonitos and billfish, as well as herrings, sardines and anchovies which are more often found in shallow near-shore coastal waters.

7.5.1.3 Marine mammals and reptiles

Table 66 provides a list of marine mammals recorded in the Arabian Gulf and their IUCN status, which could use the offshore marine environment near to the plant.

Table 66: Marine mammals of the Gulf and their IUCN status

Species	Scientific name	Conservation Status
Bryde's whale	*Balaenoptera edeni*	DD
Blue whale	*B. musculus*	EN
Long-beaked common dolphin	*Delphinus capensis*	DD
Indo-pacific bottlenose dolphin	*Tursiops aduncus*	DD
Common bottlenose dolphin	*Tursiops truncatus*	LC
Killer whale	*Orcinus orca*	DD
False killer whale	*Pseudorca crassidens*	DD
Indo-pacific humpback dolphin	*Sousa chinensis*	DD
Finless porpoise	*Neophocaena phocaenoides*	VU
IUCN Conservation Codes: DD = Data Deficient; EN = Endangered; LC = Least Concern; VU = Vulnerable (Red List Source: www.iucnredlist.org)		

Source: Mott MacDonald

Table 67 provides a list of marine turtles recorded in the Arabian Gulf and their IUCN status, which could use the offshore marine environment near to the plant.

Table 67: Sea turtles and their IUCN status

Species	Scientific Name	Conservation Status
Green turtle	*Chelonia mydas*	EN
Hawksbill turtle	*Eretmochelys imbricata*	CR
Loggerhead turtle	*Caretta caretta*	EN
Leatherback turtle	*Dermochelys coriacea*	CR
Olive Ridley turtle	*Lepidochelys olivacea*	EN
IUCN Codes: EN – Endangered; CR – Critically Endangered (Red List Source: www.iucnredlist.org)		

Source: Mott MacDonald

No turtles or cetaceans were observed during the surveys, though sea conditions were not conducive to *ad hoc* observations.

Table 68: Fish species present at sites with drop down video

Genera	Species	Status	S02	S05	S06	S07	S08	S13	Sc2	Sc3	Sc7	Sc12	Sc13	Sc16	Sc17	Sc18	Sc19	Sc22
Amblyeleotris	*downingi*	n/e								2			2					
Carangoides	*bajad*	LC		28	1	2												
Chaetodon	*nigropunctatus*	LC														2		
Cheilodipterus	*sp*	n/e			8	1		1							9	1		5
Chrysiptera	*unimaculata*	LC	1															
Cryptocentrus	*lutheri*	n/e								1								
Halichoeres	*sp*	n/e													2			
Lethrinus	*olivaceus*	LC						1										
Lutjanus	*fulviflamma*	LC	1		1		10				1				2	8		
Parupeneus	*barberinus*	LC				1						1	39		7	3		
Pomacanthus	*asfur*	LC											10				4	
Pomacanthus	*maculosus*	LC						1										
Pseudochromis	*persicus*	n/e																2
Scolopsis	*ghanam*	n/e	1					1	1				22		4			
Scomberoides	*lysan*	n/e												54				

Source: 5OES, August 2018 (IUCN Red List Status: LC – Least Concern. n/e – not evaluated)

7.5.1.4 Habitat mapping and side scan sonar

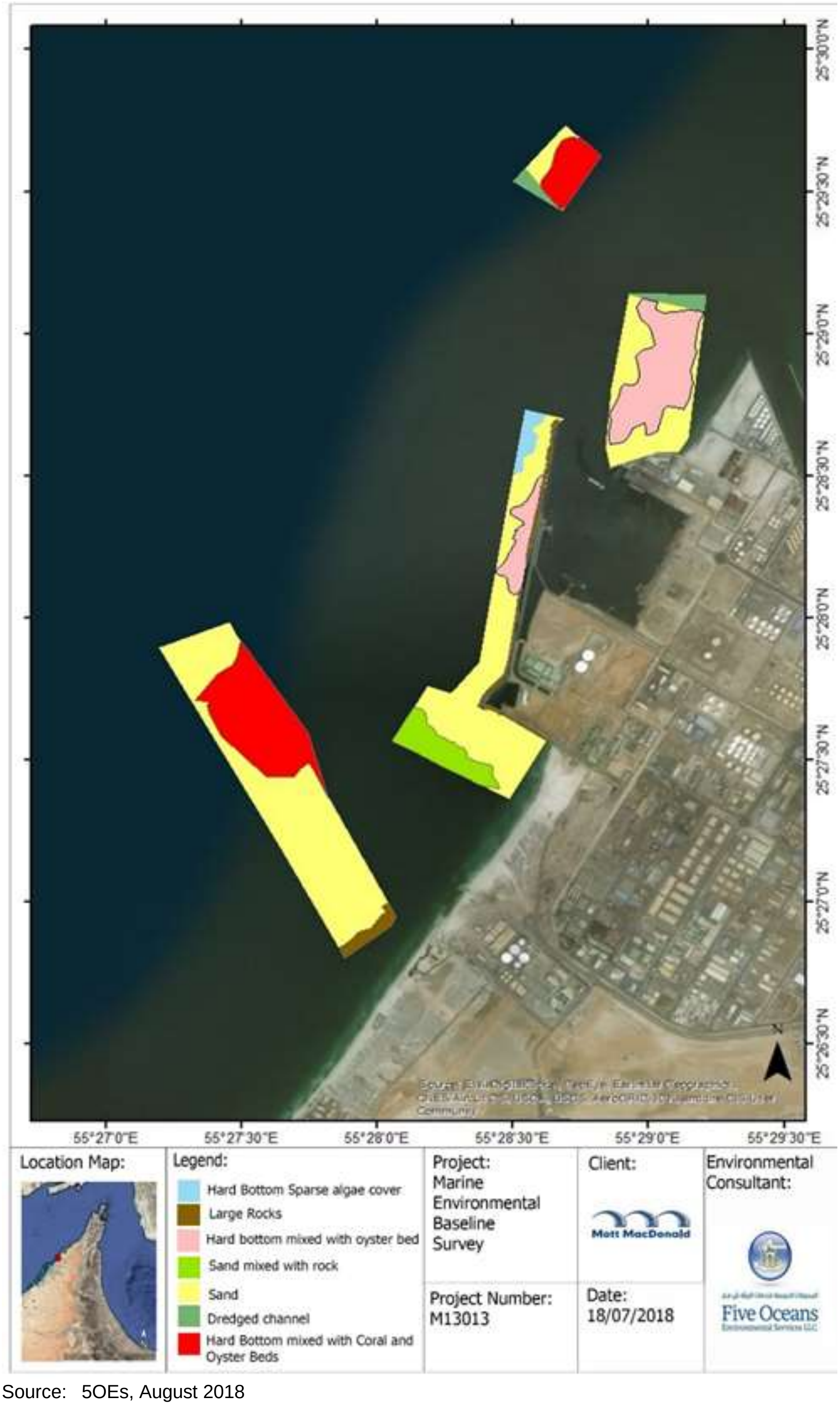
Based on a combination of the drop-down video and side scan sonar data, areas of different habitats were identified and demarcated to polygons using geographical information systems (GIS) software ArcGIS 10.5 (ESRI, 2016). The area covered by side scan survey can be seen in Figure 37. Polygons were then allocated a habitat description as shown in the legend for Figure 38. The predominant habitat recorded in the survey area is hard bottom covered in sand, as would be expected in the Arabian Gulf due to it being a relatively shallow sea and an ecological system under extreme natural pressures of high temperatures and high salinity.

From the data recorded it can be extrapolated that pockets of exposed hard substrate provide 'islands' of habitat for colonising benthic organisms. In the area to the south west of the existing power station inflow, a sparse coral community with low percentage cover has colonised hard ground which can be seen by the red highlighted area. There is also a similar area located to the north of the port entrance. Along the breakwater and to the north east of the port entrance there are areas of hard bottom supporting oyster beds (Figure 14). Examples of habitats encounters at different sites during the surveys are presented in Figures 15-18.

Figure 37: Extent of side scan sonar coverage

Source: 5OEs, August 2018

Figure 38: Habitat map of survey area



Source: 5OEs, August 2018

Figure 39: Examples of habitat encountered during survey - Bivalve bed (SC 16)

Source: 5OEs, August 2018

Figure 40: Examples of habitat encountered during survey - Sparse coral colonies with *D. setosum* (SC 17)

Source: 5OEs, August 2018

Figure 41: Examples of habitats encountered during survey - sand/soft substrate bottom – SC2

Source: 5OEs, August 2018

Figure 42: Examples of habitats encountered during survey - Large rocks present at entrance to inflow of existing power station – S2

Source: 5OEs, August 2018

7.5.1.5 Conclusion and discussion of 5OEs marine survey

Seawater profiling

Water column profiles from within the survey area are considered to be representative of ambient seawater conditions for the region and time of year across all parameters (Bower et al., 2000, Bidokhti and Ezam, 2009). Temperature profiles for the July sampling event showed a more consistent water temperature throughout the water column to the sea bed. With these sites being relatively shallow this is as expected due to greater mixing of the water; this has been shown in a number of studies including the work of Bidokhti and Ezam (2009) where water down to about 100m water temperature stayed relatively consistent. Similar trends were also seen in the data collected from specific conductivity and salinity, due to these two parameters being linked with temperature.

Turbidity, dissolved oxygen and pH are considered to be representative of ambient conditions for this time of year in coastal waters in this region (Smith et al., 2007, Taher et al., 2012, Uddin et al., 2012, Sheppard et al., 2010).

Trace elements in seawater

Out of the ten metals tested for in the marine water samples all except arsenic were undetected. Values for all other metal concentrations were below detectable limits, which means there may be traces of these metals present however not in quantities that are easily detectable and which may affect marine species as a whole. Arsenic was detected only at the control location, indicating that its presence may be due to natural background variation in the wider area.

Suspended solids in seawater

Suspended solids in the marine waters sampled were all lower than the detectable limits <5mg/l. High levels of suspended solids in the seawater are suspected to be detrimental to aquatic animals therefore the levels shown during this survey are adequate to support aquatic assemblages if other factors are also satisfactory (Bilotta and Brazier, 2008).

Trihalomethanes

There were no detectable concentrations of trihalomethanes present in the seawater sites that were sampled. Trihalomethanes originate from chlorates, which may be present due to anti-fouling agents being used in the area. Chlorates react with organic decaying matter; due to undetectable levels of chlorine being present in the sampled water, trihalomethanes cannot form and therefore are not present in the samples that have been tested (Health Canada, 2009).

Trace elements in sediments

Trace elements are natural occurring components of the earth's crust. They cannot be degraded or destroyed. These naturally occurring metals are essential to maintaining metabolism and a healthy human body as well as being necessary for many different organisms both terrestrial and marine (Nieboaer and Richardson, 1978, Emsley, 2011). However, there comes a difference in which trace elements are bio-available (available for organisms to consume) and which cannot easily be accessed due to them being locked in the composition of the rocks they form. The former of these are what scientific studies aim to verify, to determine if the levels are at high enough concentration to cause poisoning in their host. This 'poisoning' can occur through bioaccumulation, drink contaminated water or breathing emissions from certain industrial processes (Kavcar et al., 2009, Luo et al., 2011). For this reason, monitoring of heavy and trace metals in both the water column and sediment are vital to determine if there are underlying issues with the chemical compositions of the sites studied.

Out of the ten trace elements tested for in this marine baseline and environmental survey, nine were detected (only cadmium was below detectable levels at all sites), at a minimum of one site each. Out of these nine metals that were detected (arsenic, chromium, copper, lead, iron, magnesium, nickel, zinc and mercury) only two (chromium and nickel) were above threshold limits. Chromium concentrations at sites S01–S03 exceeded the ADS MPA threshold of 11mg/kg but fell below all other lower guideline thresholds used for comparison in this survey. Nickel concentrations at sites S01–S03 also exceeded the ADS MPA guideline threshold, with concentrations at site S01 also exceeding the ANZECC Lower, Canadian & UK ISQF TEL (lower), Long et al., ERL (lower) and the ADS General threshold guidelines for nickel in sediment. Nickel toxicity in aquatic invertebrates varies considerably by species and abiotic factors present. Mance and Yates (1984) reviewed data on the toxicity of nickel to saltwater organisms and found considerable variation of the sensitivity of marine fauna. Previous studies have shown that the Hajar Mountains have ophiolite sand present in their composition, which may explain the high levels of metals such as nickel, chromium, copper (Dilek and Furnes 2014).

Hydrocarbons in sediments

For the sites surveyed during this baseline survey there was no detection of hydrocarbons in the sediment. This bodes well for the epi/infauna as well as the pelagic species present in the area due to some studies showing a lethal concentration of hydrocarbons able to kill off populations in a short amount of time (Neff et al., 2000).

Sediment particle size analysis

Sediment particle size analysis is the measurement of the proportion of the various size particles as determined by their ability to pass through sieves of certain sizes or by their ability to settle in water. It must be noted that the particle size analysis and interpretation is based on the first 1-2cm of sediment present on the sea bed and relates to the most recent activity of suspension and settle of particles.

Sediments sampled during this baseline showed a to be comprised mainly of 'sand' sized particles with the sites falling into either 'medium' or 'fine' sand particle sizes. This sediment size composition is typical for an area with average wave action and water movement allowing the resuspension of the finer sediments present in river discharge areas for instance.

Infauna

All of the sites sampled except for the control site showed reasonable numbers and diversity of infauna, in line with what might be expected from such habitats in the region. As is often the case, the annelid worms were the dominant taxa, but the molluscs, particularly bivalves, were also quite well represented. The results from the control sites were on the low side in terms of both abundance and diversity compared to the other sites. The reasons for this are not immediately clear but would perhaps be clarified by further study.

The species encountered were not unusual and were typical for shallow sedimentary habitats in the region. Similarly, the taxonomic distribution of the individuals was not unusual, with annelid worms, molluscs and crustaceans and most abundant.

Habitat and ecology

The area covered during the survey comprised 1,342,173 m^2. Whilst the scope of the work was focused it was possible to derive that the most prevalent substrate in the area was sand. Areas of rocks and boulders provide some areas with a greater rugosity and likely habitat for invertebrates, demersal and semi-pelagic fish species, whilst exposed hard substrate hosts small oyster beds in areas of approximately 10 – 14 metres water depth. From the drop-down video and photographs obtained of these oyster beds it is unclear whether they are living or dead. Sparse coral cover was also present at five sites (P13, SC08, SC11, SC17 and SC18). The coral colonies were present in the same areas as the oyster beds; this is likely due to the rocks allowing a hard substrate for coral and oyster spawn to anchor to. No evidence of live sea grass beds was recorded during the course of this survey.

Anecdotal observations are that fishermen utilise this area both for the catching of bait fish but also for setting fish traps. Fishing nets were observed in the area south west of the current inflow.

The majority of fish species identified were those associated with reefs, with a smaller biodiversity of sand-based species like gobies (live in holes) and goatfish (graze on epifauna). No species of conservation concern were identified.

No turtles or cetaceans were observed during the surveys, though sea conditions were not conducive to ad hoc observations. The offshore area of the plant could be used by cetaceans and marine reptiles for feeding and transiting, including species of conservation concern.

EWS-WWF survey

In addition to the marine habitat and ecological surveys carried out specifically for this development by 5OES, a number of other marine surveys have been undertaken within the area of the power station and the wider Sharjah Emirate that can form a baseline of habitats within the area of the power plant.

Most notable of these surveys was undertaken by the Environment Agency – Abu Dhabi in partnership with the EWS-WWF. The surveys were undertaken during three separate survey periods: 3 – 12 October 2017 (Dubai to Umm Al Khaimah); 3 – 4 of November (Sir Bu Nair); and 19 – 22 of January 2018 (Ras Al Khaimah).

The surveys were completed through the use of day boats from a number of different locations. A total of 371 sites were surveyed and ground-truthed, extending from Dubai (the border with Abu Dhabi at Ras Ghantoot), through Sharjah, Ajman, Umm Al Quwain and Ras Al Khaimah up to the border with Oman (Musandum).

For Sharjah, the area of interest included two areas separated by Ajman. Sharjah surveys were undertaken on the 7 and 9 of October 2017 and supported by the Sharjah EPAA, who joined the survey team.

A total of 35 survey points were ground-truthed in Sharjah including offshore areas, coastal developments, channels and inlets (see Figure 43). The points were allocated to provide coverage of the overall area of interest. Points and sample-sizes were assigned on a stratified-random basis using GIS supported software and additional manual points were included based on a review of the imagery.

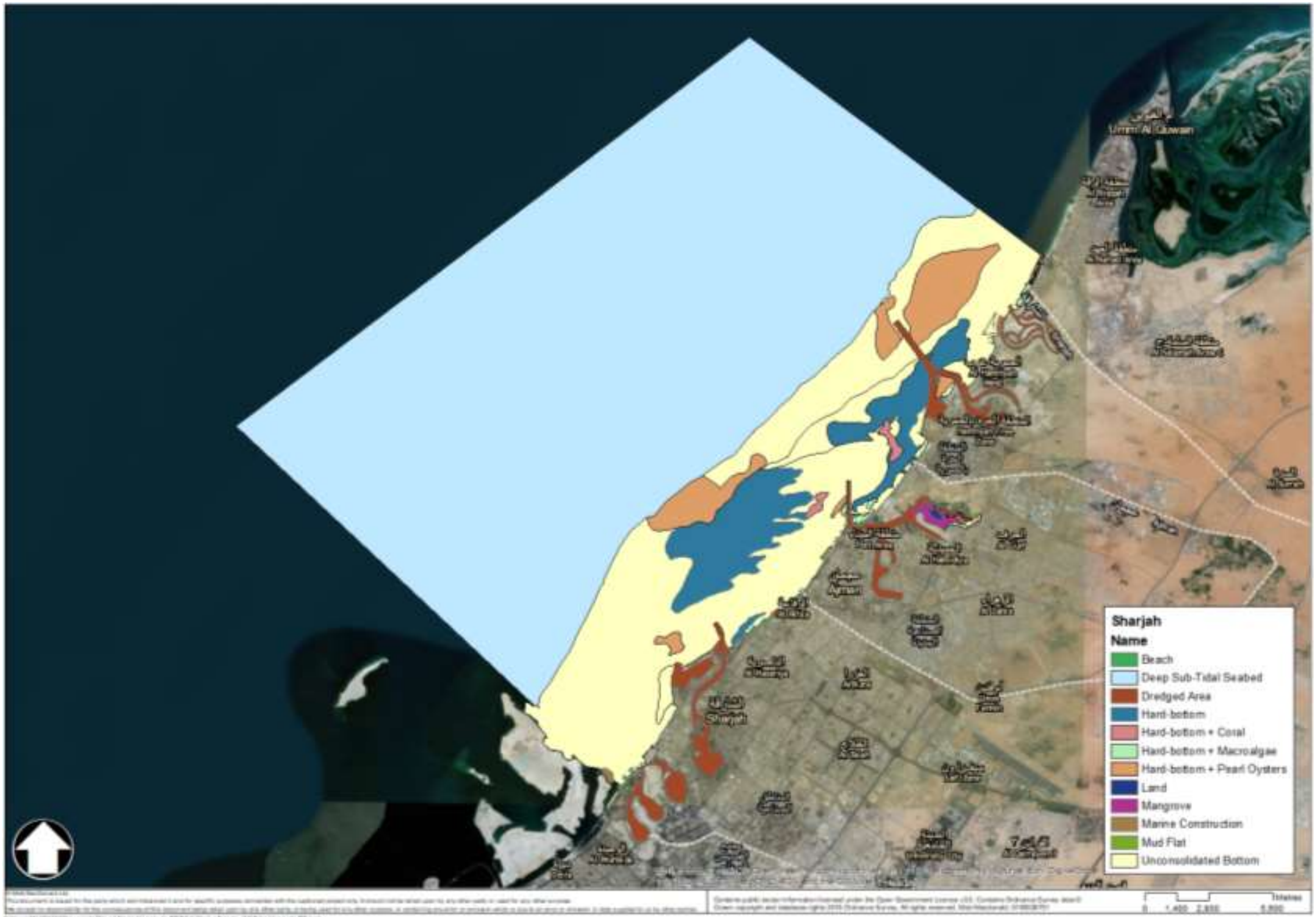
Figure 43: Sharjah-Ajman survey points

Source: EWS-WWF Areas of Particular Importance for Biodiversity Project – 2017 Progress Report.

The survey area was dominated by sand substrates with relatively limited or no benthic cover. Where hard ground was present, then epibenthic colonisation was more apparent, allowing for the attachment of pearl oysters, macroalgae and hard corals (primarily favids) - albeit at low densities for the most part. Sparse seagrass was evident in some sheltered areas adjacent to beaches, or leeward of recent island construction projects. In most areas seagrass density was low (1-5%): too low for image-based classification to distinguish seagrass presence from sand substrate classes. Figure 44 and Figure 45 below show the results of the surveys carried out in the Sharjah region and, more specifically, the marine area around Hamriyah IPP.

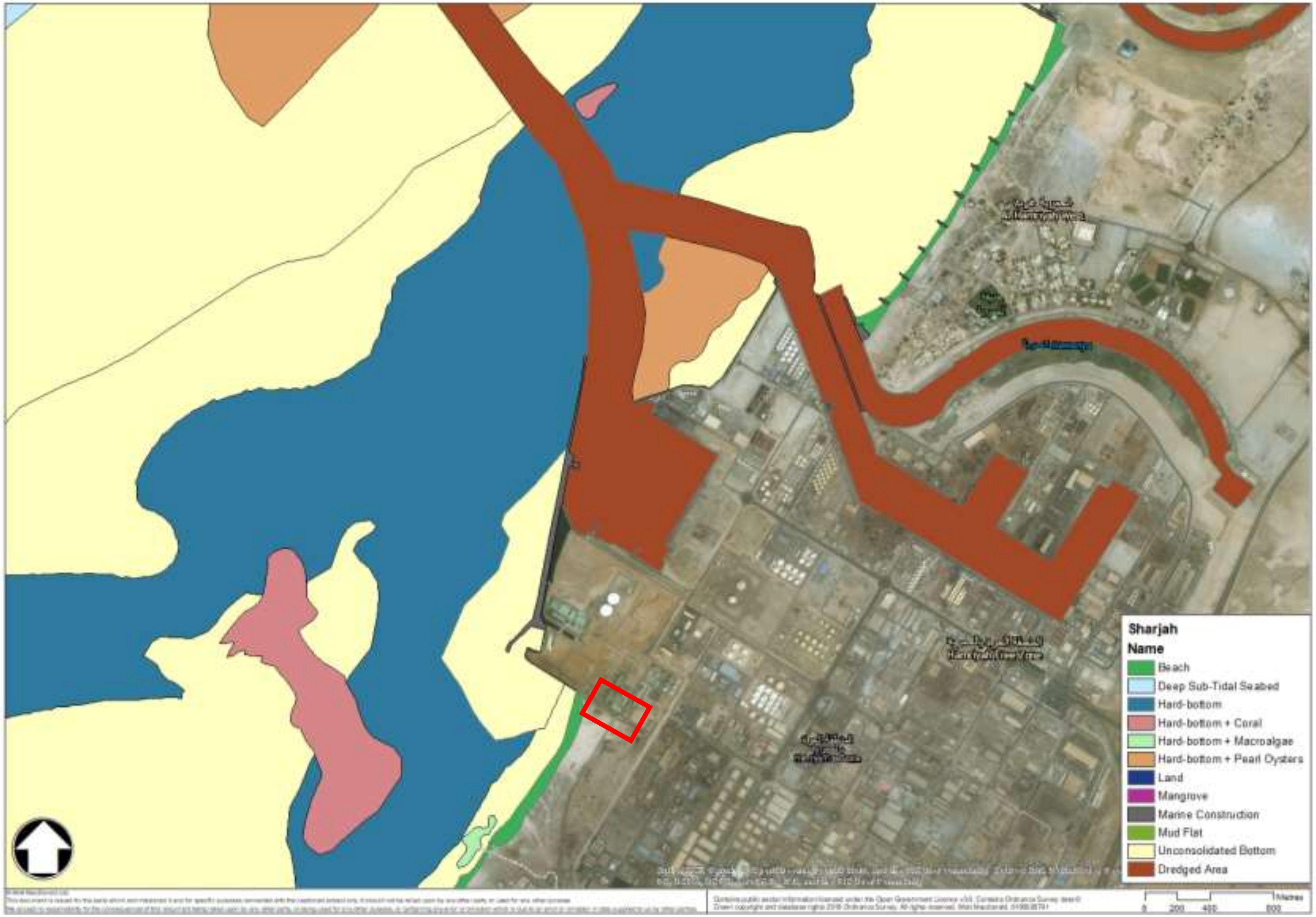
Based on these results, the key habitats of interest within the area of the IPP are hard bottom with coral (high sensitivity), hard bottom with pearl oysters (high sensitivity) and hard bottom with macroalgae (medium sensitivity). The sensitivity ratings are in accordance with the criteria set out in Table 6.

Figure 44: Habitat and sensitive area map for Sharjah



Source: EWS-WWF Areas of Particular Importance for Biodiversity Project – 2017 Progress Report.

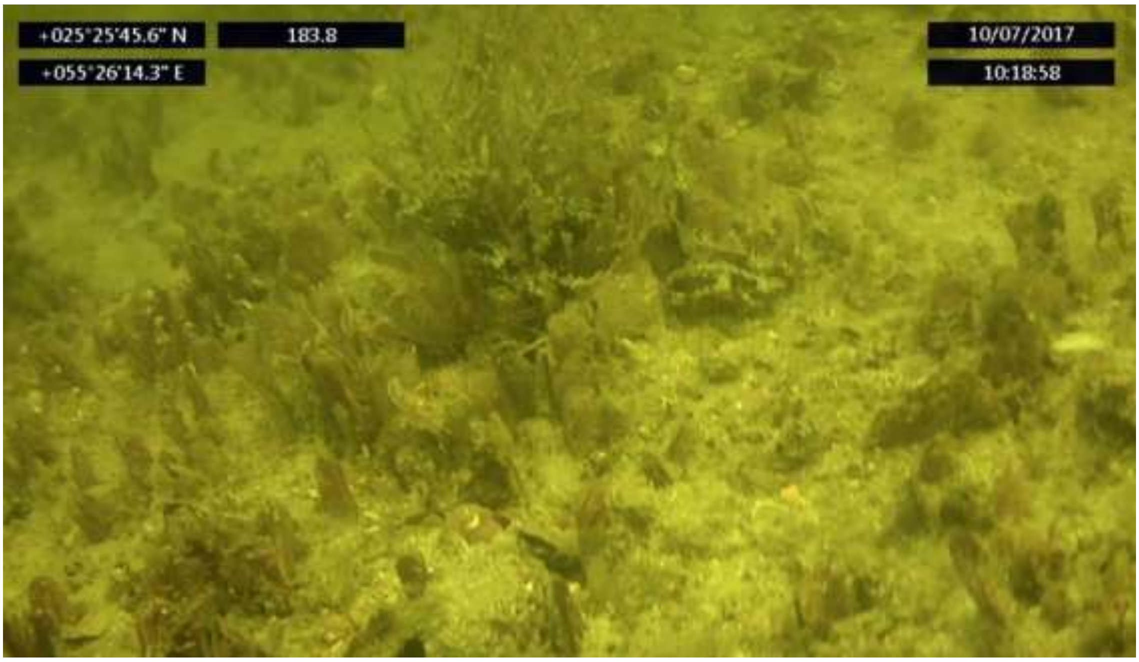
Figure 45: Habitat and sensitive area map for the areas around Hamriyah Power Plant (marked with red rectangle).



Source: EWS-WWF Areas of Particular Importance for Biodiversity Project – 2017 Progress Report

Indicative photos of habitats with high sensitivity are shown in Figure 46 and Figure 47.

Figure 46: Hard bottom with pearl oysters (high sensitivity)



Source: EWS-WWF Areas of Particular Importance for Biodiversity Project – 2017 Progress Report.

Figure 47: Hard bottom with coral (high sensitivity)

Source: EWS-WWF Areas of Particular Importance for Biodiversity Project – 2017 Progress Report.

7.6 Hydrodynamic modelling

This section of the ESIA report provide a summary of the hydrodynamic modelling study that has been undertaken for the project. The full hydrodynamic report is provided in Appendix E for reference.

7.6.1 Hydrodynamic modelling and recirculation study

HR Wallingford were commissioned by Mott MacDonald to carry out hydrodynamic modelling and recirculation/dispersion studies to help determine the impacts of cooling water discharge.

The power plant will use the existing common seawater intake and outfall system for various facilities at the site including the existing the 20 MIGD reverse osmosis desalination plant. In the future, an additional 60 MIGD desalination plant will be developed.

The new plant will be built within the SEWA Hamriyah Power and Desalination Station complex. The cooling water will be drawn from an existing intake channel and the used cooling water will be discharged to the existing outfall channel.

Given the above, three operational scenarios were modelled in order to predict the potential impacts associated with the existing and future power and desalination plant. Assuming worst case scenario, the following were modelled:

- Scenario 1: New Hamriyah 1800 MW power plant only
- Scenario 2: New Hamriyah 1800 MW power plant plus existing 20 MIGD desalination plant
- Scenario 3: New Hamriyah 1800 MW power plant plus existing 20 MIGD and future additional 60 MIGD desalination plants.

The flow, temperature and salinity data for the three individual plants are shown in Table 69 while the combined discharged parameters used to simulate the three operational scenarios are shown in Table 70. For the modelling it was assumed that the streams from the individual plants are fully mixed in the receiving basin before being discharged.

It should be noted that the scenario including the proposed 60 MIGD RO desalination plant represents a predicted cumulative scenario that will occur after the subject 1800MW IPP has been built.

Table 69: Individual plant flow, temperature and salinity data

Plant	Intake flow (m^3/s)	Outfall flow (m^3/s)	Δ Salinity (ppt)	Δ Temperature (ºC)
Power plant	34	34	0	7
Existing 20 MIGD desalination	2.9	1.9	23.47	0
Future 60 MIGD desalination plant	8.8	5.7	23.47	0

Source: Based on data provided by Mott MacDonald and EFS. 60 MIGD plant data scaled from existing 20 MIGD data.

Table 70: Combined plant flow, temperature and salinity data for input to dispersion simulations

Plant	Intake flow (m^3/s)	Outfall flow (m^3/s)	Δ Salinity (ppt)	Δ Temp (ºC)
New power plant only	34	34	0	7
New power plant plus existing 20 MIGD desalination	36.9	35.9	1.24	6.63
New power plant plus existing 20 MIGD desalination plus future 60 MIGD desalination plant	45.8	41.6	4.27	5.73

Source: Based on data provided by Mott MacDonald and EFS.

7.6.1.1 Hydrodynamic modelling background

HR Wallingford's established Arabian Gulf regional model was used to provide time and space-varying boundary conditions for a detailed local model at Hamriyah. This procedure, commonly known as nesting, is a well-established technique for modelling hydrodynamics over wide areas with varying resolution. This regional model is used to model various hydraulic phenomena such as tidal and coastal flows and storm surges.

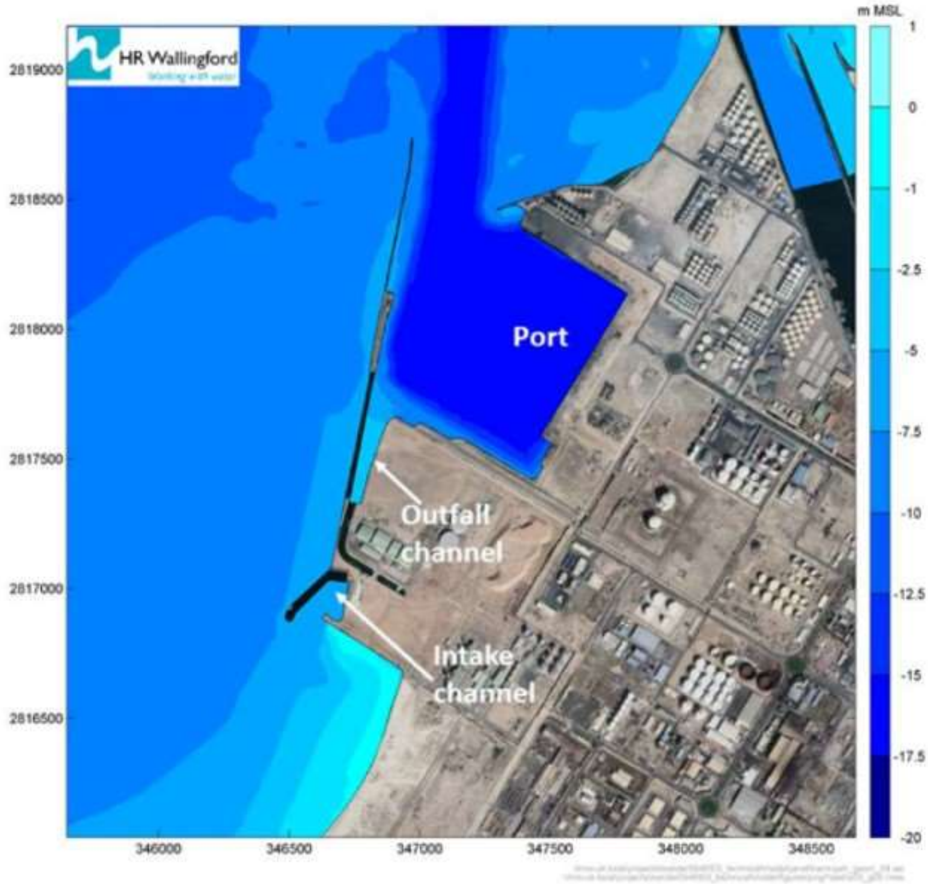
Time and spatially-varying currents and water levels were extracted from the regional model and used to drive the local Hamriyah model which enabled the modelling of salinity and temperature plumes from the proposed power station and desalinisation plant (dependent on optional scenarios 1-3), enabling the potential resulting impacts of the development(s) on the marine environment to be established.

7.6.1.2 Local flow modelling

The local Hamriyah model simulation of brine and cooling water discharge dispersion and recirculation was built using TELEMAC-3D and takes into account the processes of buoyant spreading, inhibition of vertical mixing (associated with sharp density gradients), shear of wind-driven currents and atmospheric heat exchange.

The model bathymetry (Figure 48) was based on data from international hydrographic offices and shows the bed levels in the outfall and intake channels and the dredged bed levels in the port area.

Figure 48: Model bathymetry close to the plant

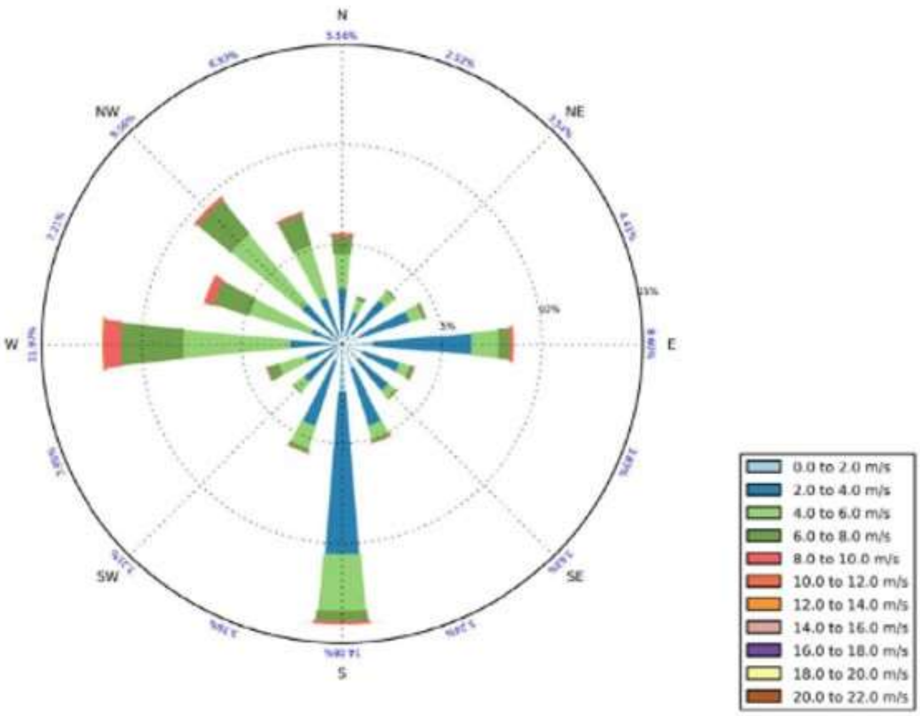


Source: *Background image ©Google Earth (Data ©: SIO,NOAA, US Navy, NGA, GEBCO Image: © Digital Globe)*

7.6.1.3 Wind conditions

Wind conditions at the site were simulated using data from Dubai International Airport accessed through the National Climatic Data Centre (NCDC) database of the United States National Oceanic and Atmospheric Administration (NOAA). Data from Dubai airport was used as it is the most representative of winds at the coast in this region of the UAE. A wind-rose diagram showing the wind climate at Dubai International Airport is presented in Figure 49. Winds from west to north-west occur frequently at speeds of around 5m/s. Weaker winds with speeds of around 3m/s also frequently occur from the south and east. Percentage wind speed distribution is presented in Table 71.

Figure 49: Winds at Dubai International Airport (1983 – 2017)



Source: *NOAA NCDC*

Table 71: Percentage occurrence of wind speeds at Dubai International Airport, 1983 - 2017

Wind Speed (m/s)	Percentage occurrence (%)
< 2	19
2 to 4	41
4 to 6	26
6 to 8	11
8 to 10	2
>10	<1

7.6.1.4 Sea temperature and salinity

Seawater temperatures used for the simulations were based on the design heat and mass balances provided by EFS. These gave a typical summer temperature of 32°C and winter temperatures between 20 and 23.5°C (a temperature of 22°C was chosen for the simulations). Seawater salinity of 42ppt was used for the simulations. This was based on the preliminary modelling carried out by Sogreah in 2009.

7.6.1.5 Test conditions

The simulation of dispersion and recirculation of the cooling water discharge was undertaken for the two wind periods (see section 7.6.2.3), referred to as weaker winds and stronger winds as well as representative summer and winter seawater conditions. Each simulation was run for 17 days to allow for dispersion patterns to reach a dynamic equilibrium.

Recirculation was included in the simulations by increasing the discharge concentrations appropriately during periods when the plume reached the intake. The simulated test conditions are summarised in Table 72.

Table 72: Simulated test conditions

Simulation	Operating scenario	Operating plants			Seawater temperature	Wind condition
		New CCGT	Existing 20 MIGD	Future 60 MIGD		
1	1	Yes			Summer	Weaker
2	2	Yes	Yes		Summer	Weaker
3	3	Yes	Yes	Yes	Summer	Weaker
4	1	Yes			Winter	Weaker
5	2	Yes	Yes		Winter	Weaker
6	3	Yes	Yes	Yes	Winter	Weaker
7	1	Yes			Summer	Stronger
8	2	Yes	Yes		Summer	Stronger
9	3	Yes	Yes	Yes	Summer	Stronger
10	1	Yes			Winter	Stronger
11	2	Yes	Yes		Winter	Stronger
12	3	Yes	Yes	Yes	Winter	Stronger

7.6.1.6 Modelling results

Figure 50 to Figure 61 show the predicted temperature increase during the three scenarios modelled for the power and desalination complex. Similarly, Figure 62 to Figure 69 present the salinity increases during the three operational scenarios modelled for the project. These figures represent a worst-case scenario to assess potential impacts of the power plant, based on a precautionary approach.

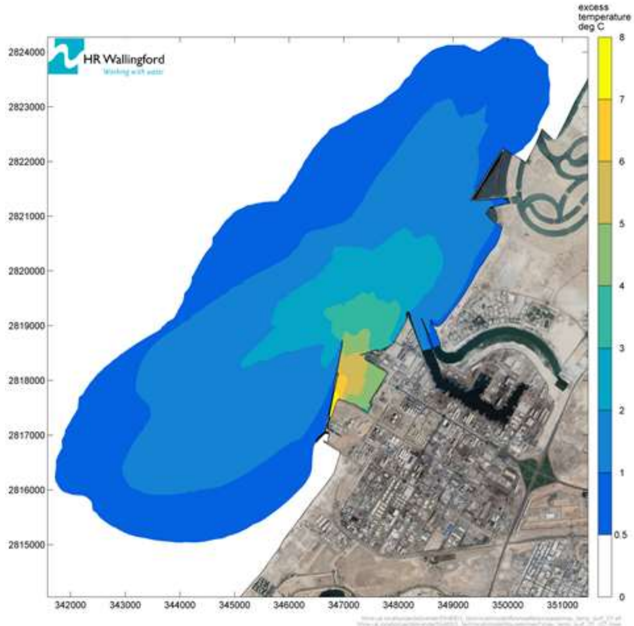
For scenario 1 (Hamriyah power plant only), the discharge forms a buoyant plume that is warmest at the water surface, although close to the outfall, and in shallower waters near the coast, the plume can also be seen near the seabed. Once outside the port area the plume is spread along the coast towards both north-east and south-west under the action of tidal and wind-driven currents.

Introducing the reject brine from the existing 20 MIGD desalination plant in scenario 2 reduces the buoyancy of the plume. This leads to larger areas of elevated temperature and salinity at the seabed, although the increases as the seabed are relatively low.

In scenario 3, with the reject brine from the future 60 MIGD plant included, the increased salinity of the effluent leads to a negatively buoyant plume. The warmest and most saline parts of the plume occur at the seabed. Outside of the port the plume tends to flow along the bottom of the port approach channel.

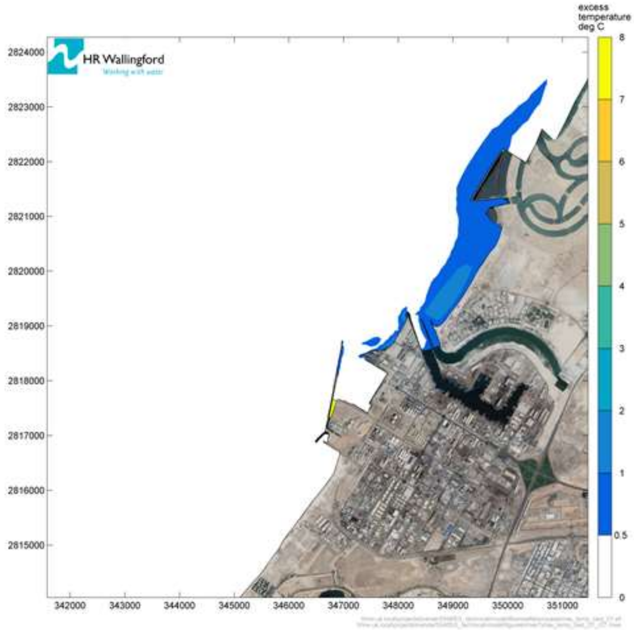
7.6.1.7 Temperature modelling results

Figure 50: Maximum predicted surface temperature with weaker wind, summer Scenario 1



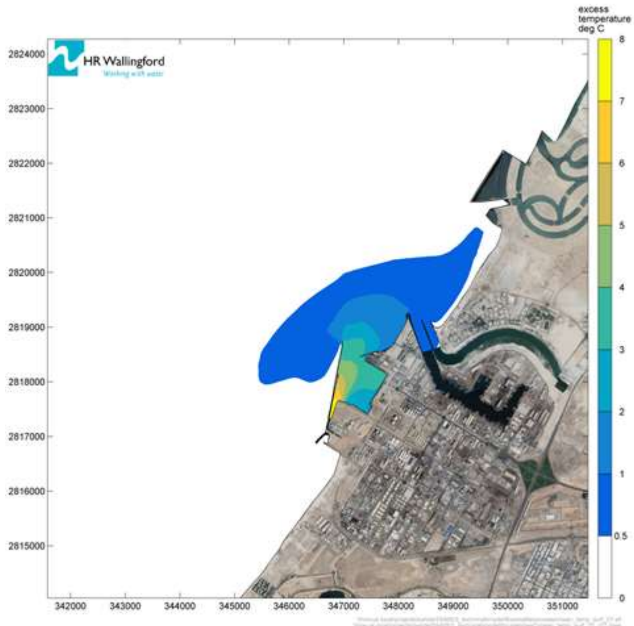
Source: Background image ©Google Earth (Data ©: SIO,NOAA, US Navy, NGA, GEBCO Image: © Digital Globe)

Figure 51: Maximum predicted bed temperature with weaker wind, summer Scenario 1



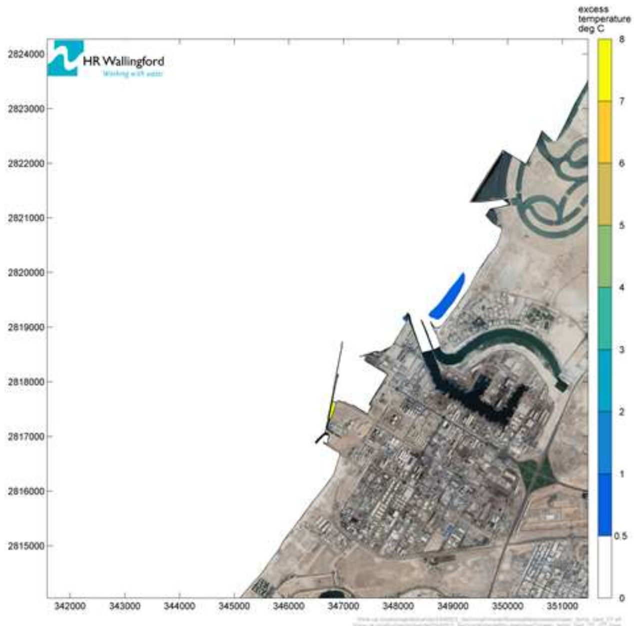
Source: Background image ©Google Earth (Data ©: SIO,NOAA, US Navy, NGA, GEBCO Image: © Digital Globe)

Figure 52: Average predicted surface temperature with weaker wind, summer Scenario 1



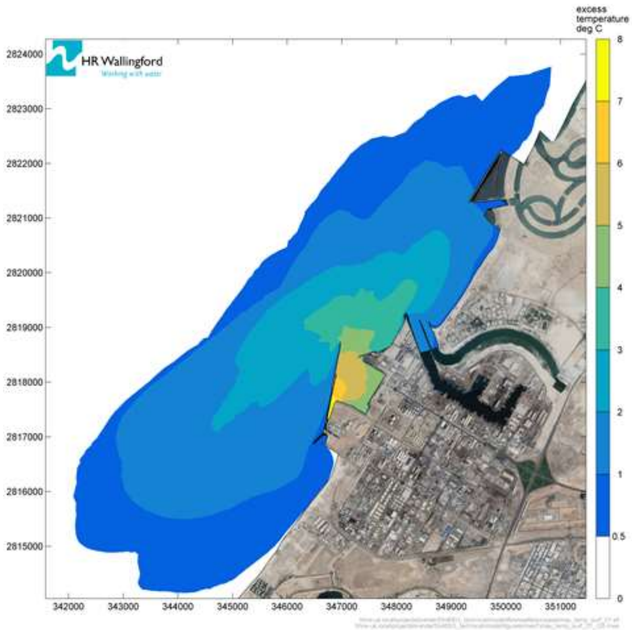
Source: Background image ©Google Earth (Data ©: SIO,NOAA, US Navy, NGA, GEBCO Image: © Digital Globe)

Figure 53: Average predicted bed temperature with weaker wind, summer Scenario 1



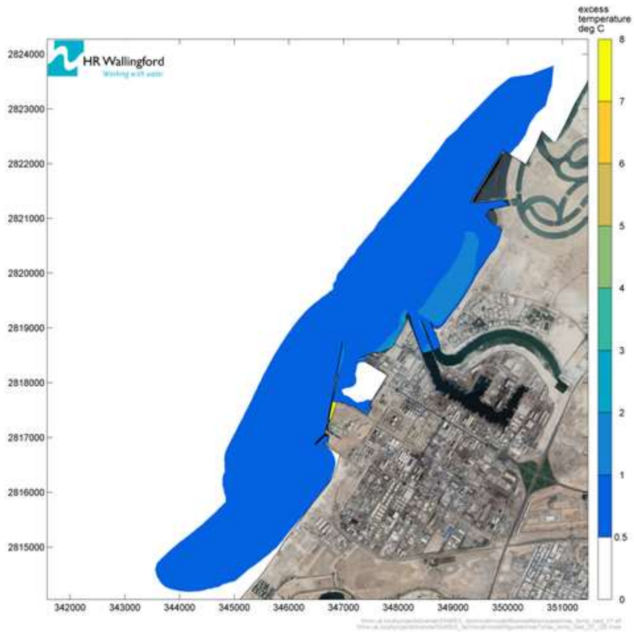
Source: Background image ©Google Earth (Data ©: SIO,NOAA, US Navy, NGA, GEBCO Image: © Digital Globe)

Figure 54: Maximum predicted surface temperature with weaker wind, summer Scenario 2



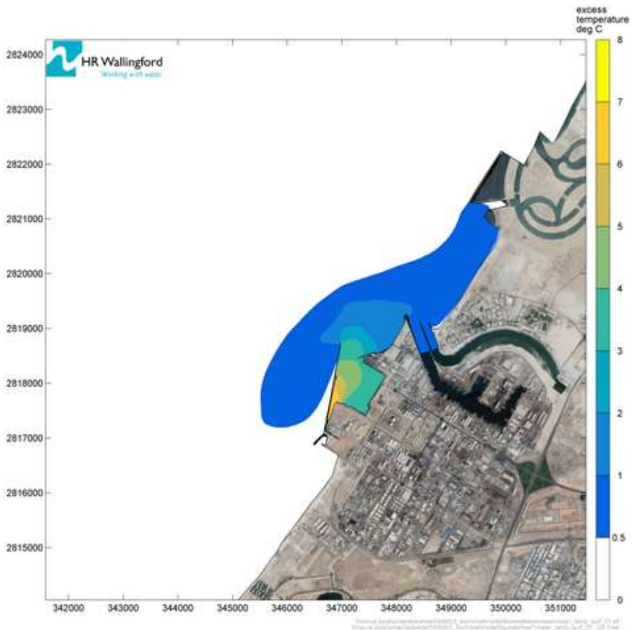
Source: Background image ©Google Earth (Data ©: SIO,NOAA, US Navy, NGA, GEBCO Image: © Digital Globe)

Figure 55: Maximum predicted bed temperature with weaker wind, summer Scenario 2



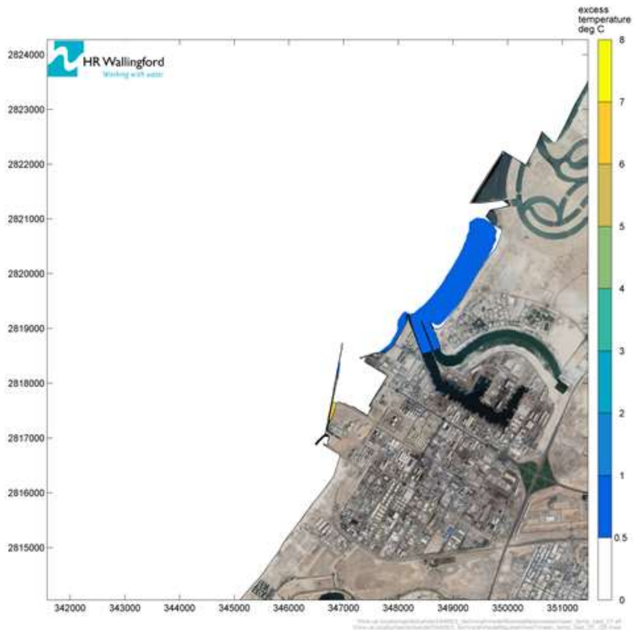
Source: Background image ©Google Earth (Data ©: SIO,NOAA, US Navy, NGA, GEBCO Image: © Digital Globe)

Figure 56: Average predicted surface temperature with weaker wind, summer Scenario 2



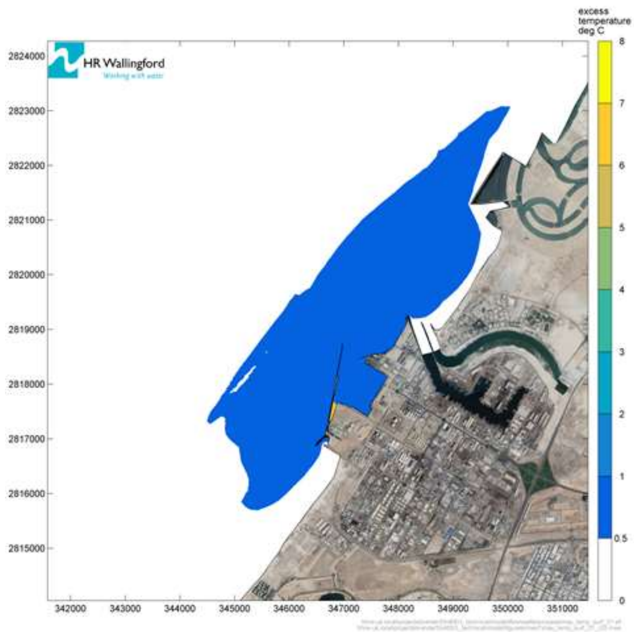
Source: Background image ©Google Earth (Data ©: SIO,NOAA, US Navy, NGA, GEBCO Image: © Digital Globe)

Figure 57: Average predicted bed temperature with weaker wind, summer Scenario 2



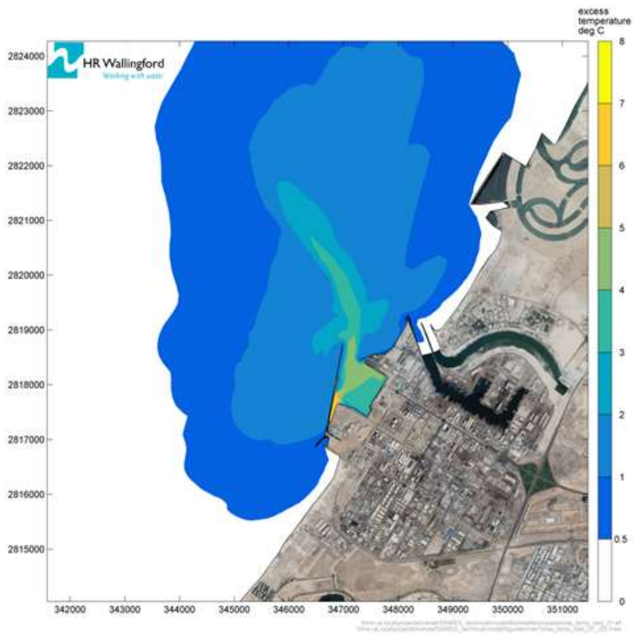
Source: Background image ©Google Earth (Data ©: SIO,NOAA, US Navy, NGA, GEBCO Image: © Digital Globe)

Figure 58: Maximum predicted surface temperature with weaker wind, summer Scenario 3



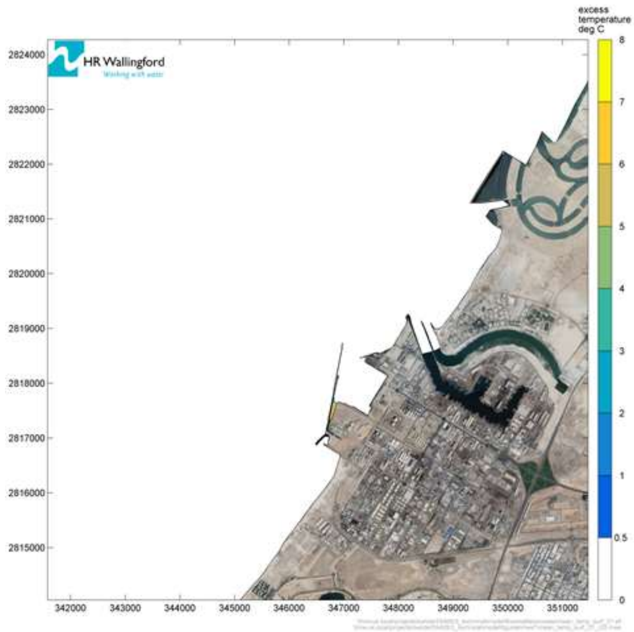
Source: Background image ©Google Earth (Data ©: SIO,NOAA, US Navy, NGA, GEBCO Image: © Digital Globe)

Figure 59: Maximum predicted bed temperature with weaker wind, summer Scenario 3



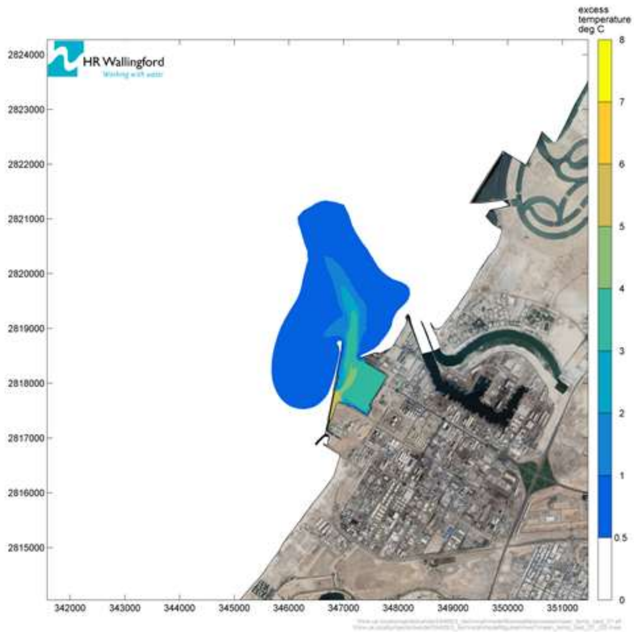
Source: Background image ©Google Earth (Data ©: SIO,NOAA, US Navy, NGA, GEBCO Image: © Digital Globe)

Figure 60: Average predicted surface temperature with weaker wind, summer Scenario 3



Source: Background image ©Google Earth (Data ©: SIO,NOAA, US Navy, NGA, GEBCO Image: © Digital Globe)

Figure 61: Average predicted bed temperature with weaker wind, summer Scenario 3

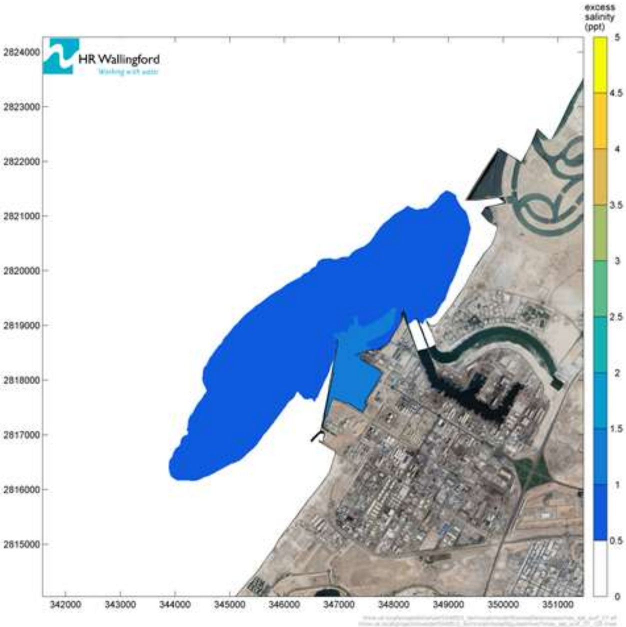


Source: Background image ©Google Earth (Data ©: SIO,NOAA, US Navy, NGA, GEBCO Image: © Digital Globe)

7.6.1.8 Salinity modelling results

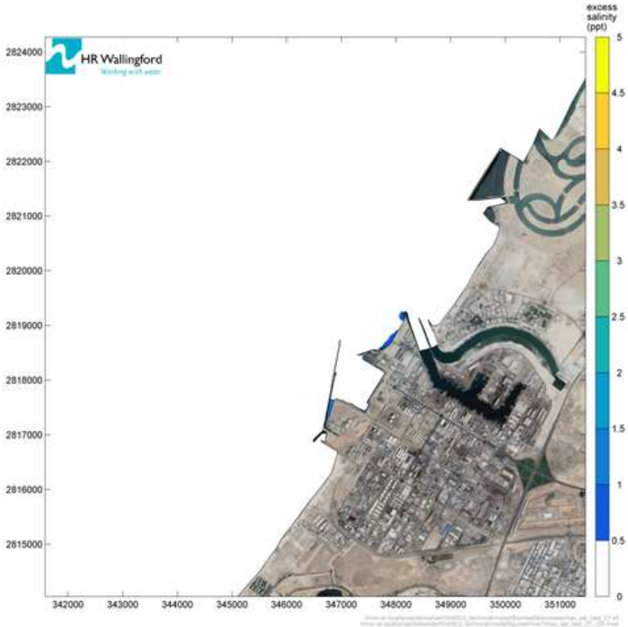
Figure 62 to Figure 69 show the predicted salinity increase during the three scenarios modelled for the complex.

Figure 62: Maximum predicted surface salinity with weaker wind, summer Scenario 2



Source: Background image ©Google Earth (Data ©: SIO,NOAA, US Navy, NGA, GEBCO Image: © Digital Globe)

Figure 63: Maximum predicted bed salinity with weaker wind, summer Scenario 2



Source: Background image ©Google Earth (Data ©: SIO,NOAA, US Navy, NGA, GEBCO Image: © Digital Globe)

Figure 64: Average predicted surface salinity with weaker wind, summer Scenario 2

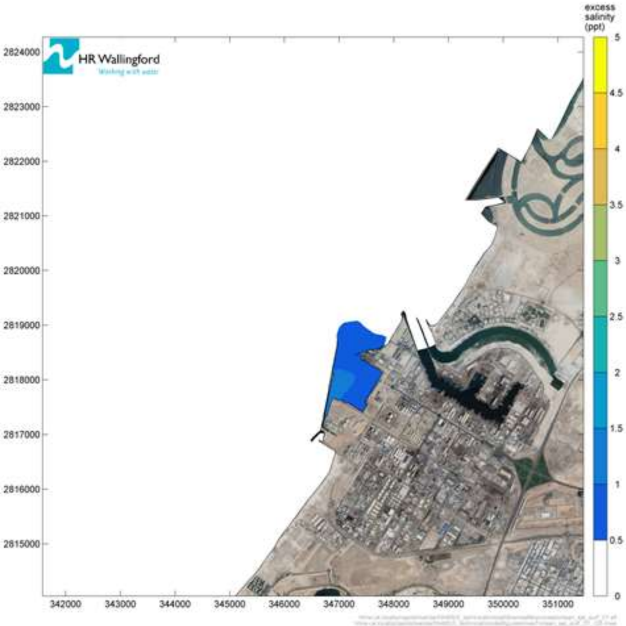
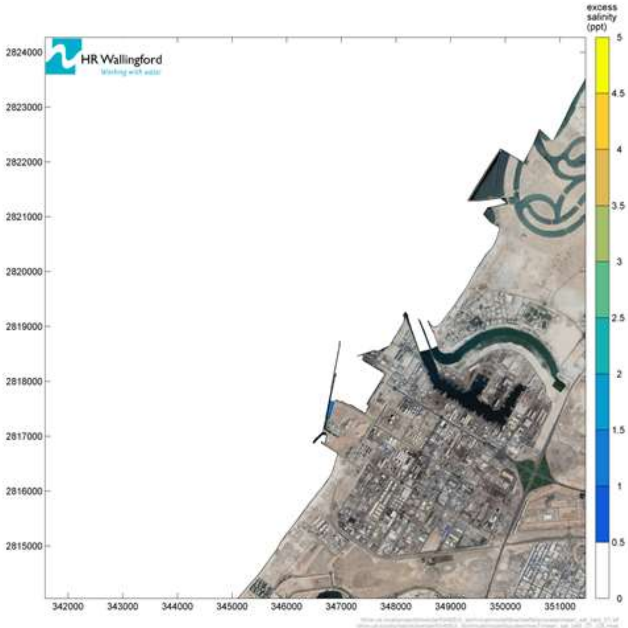


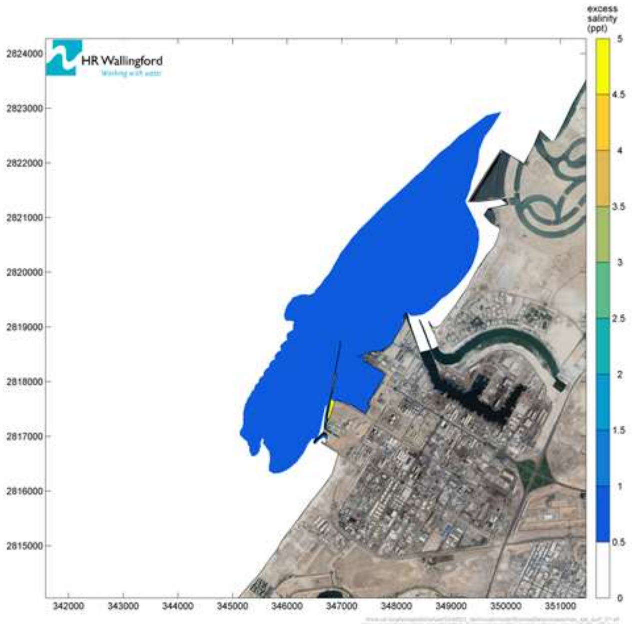
Figure 65: Average predicted bed salinity with weaker wind, summer Scenario 2



Source: Background image ©Google Earth (Data ©: SIO,NOAA, US Navy, NGA, GEBCO Image: © Digital Globe)

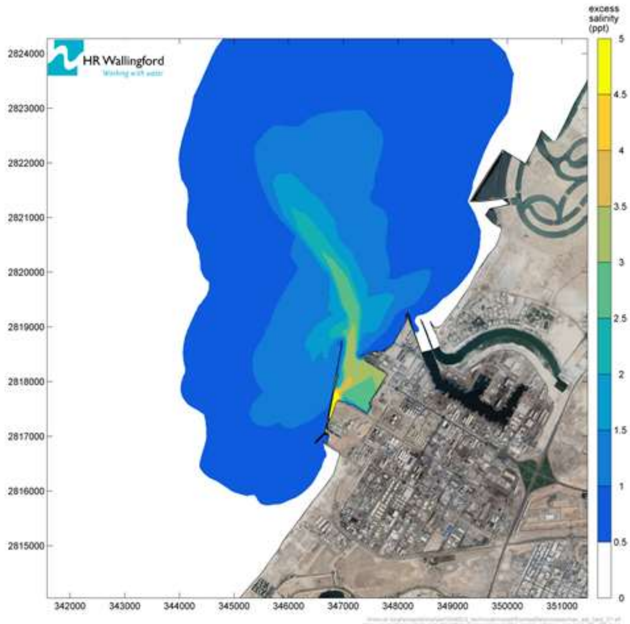
Source: Background image ©Google Earth (Data ©: SIO,NOAA, US Navy, NGA, GEBCO Image: © Digital Globe)

Figure 66: Maximum predicted surface salinity with weaker wind, summer Scenario 3



Source: Background image ©Google Earth (Data ©: SIO,NOAA, US Navy, NGA, GEBCO Image: © Digital Globe)

Figure 67: Maximum predicted bed salinity with weaker wind, summer Scenario 3



Source: Background image ©Google Earth (Data ©: SIO,NOAA, US Navy, NGA, GEBCO Image: © Digital Globe)

Figure 68: Average predicted surface salinity with weaker wind, summer Scenario 3

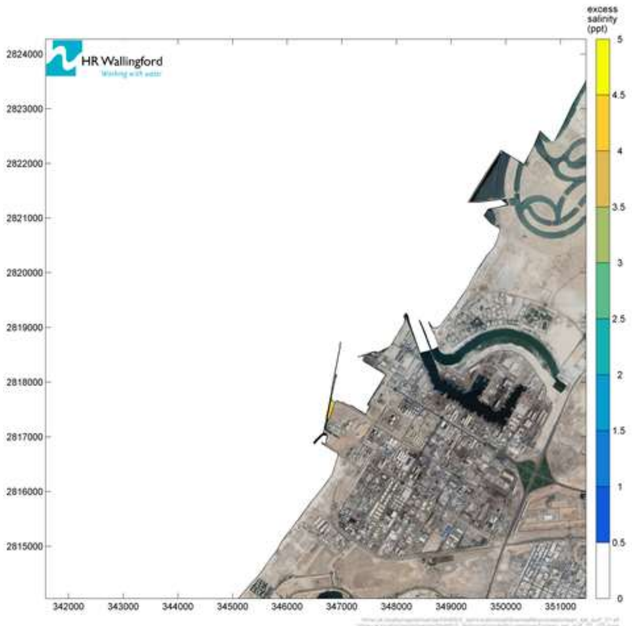
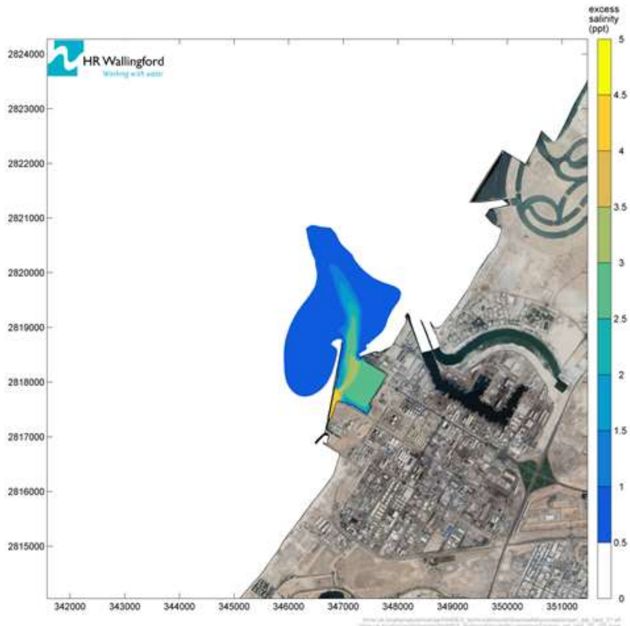


Figure 69: Average predicted bed salinity with weaker wind, summer Scenario 3



Source: Background image ©Google Earth (Data ©: SIO,NOAA, US Navy, NGA, GEBCO Image: © Digital Globe)

Source: Background image ©Google Earth (Data ©: SIO,NOAA, US Navy, NGA, GEBCO Image: © Digital Globe)

7.6.1.9 Environmental compliance

Sharjah's environmental regulatory authority, EPAA, have advised that in the absence of federal standards, either the Abu Dhabi or Dubai water quality standards should be used to assess the discharge.

Abu Dhabi's ambient marine water quality standards (EAD TG-0003R, see Table 48) have been adopted for this analysis. These set temperature and salinity 'mixing zones' are as follows:

- Temperature – The area over which the plume is more than 3ºC above background
- Salinity – The area over which salinity is more than 5% above background. As the design sea water salinity is 42ppt, we have assumed that the salinity mixing zone corresponds to the +2 ppt excess salinity footprint.

The plan area of the port is approximately 80ha, while the plan area of the discharge channel that is included in the model is about 2ha. Therefore, mixing zone areas less than 100ha indicate that mixing zone is contained largely within the port area, while areas of around 2ha indicate that the mixing zone does not extend beyond the discharge channel.

Predicted temperature mixing zone areas are shown in Table 73 for weaker winds and in Table 74 for stronger winds. Scenario 1 which represents the IPP plant operating on its own, and Scenario 2 which represents the IPP plant with the existing 20 MIGD desalination plant added, the predicted temperature zone areas under weaker winds are qualitatively similar, with a maximum of 175–400ha (average mixing zones are around 66– 85ha) at the surface and around 2ha at the sea bed.

For scenario 3 (60 MIGD desalination plant added), temperature mixing zones of around 100ha are predicted at the bed and 2-3ha at the surface.

Table 73: Predicted temperature mixing zone areas, weaker winds

	Mixing zone area (ha)							
	Summer				Winter			
	Maximum		Average		Maximum		Average	
	Surface	Bed	Surface	Bed	Surface	Bed	Surface	Bed
Power plant only	177.6	1.9	66.3	1.9	263.9	2.0	84.5	1.9
Power plant + 20 MIGD desal	235.7	2.0	81.4	1.9	381.5	2.2	84.6	2.0
Power plant + 20 MIGD + 60 MIGD desal	2.1	116.2	2.0	71.1	2.0	104.8	2.0	66.3

Source: HR Wallingford – Hamriyah 1800 MW CCGT Power Plant Dispersion Modelling Report, June 2018.

Table 74: Predicted temperature mixing zone areas, stronger winds

	Mixing zone area (ha)							
	Summer				Winter			
	Maximum		Average		Maximum		Average	
	Surface	Bed	Surface	Bed	Surface	Bed	Surface	Bed
Power plant only	228.9	2.0	28.1	1.9	299.3	2.2	36.8	1.9

	Mixing zone area (ha)							
	Summer				Winter			
	Maximum		Average		Maximum		Average	
	Surface	Bed	Surface	Bed	Surface	Bed	Surface	Bed
Power plant + 20 MIGD desal	245.7	3.6	32.8	1.9	300.3	8.9	48.2	2.0
Power plant + 20 MIGD + 60 MIGD desal	3.0	103.3	2.0	50.8	2.4	96.0	2.0	43.6

Source: HR Wallingford – Hamriyah 1800 MW CCGT Power Plant Dispersion Modelling Report, June 2018.

Predicted salinity mixing zones are shown in Table 75. For the power plant operating on its own, the discharge is at the same salinity as the receiving seawater and no salinity mixing zone exists. When the cooling water is combined with the reject brine from the existing 20 MIGD desalination plant, the excess salinity at discharge will be less than 5% of background (assuming the stream from the individual plants are fully mixed in the receiving basin before being discharged).

With reject brine from the future 60 MIGD plant included, predicted salinity missing zone areas at the bed are up to 150ha as a maximum and 60-75ha on average. Surface excess salinities greater than 5% of background are likely to be largely confined to the discharge channel itself.

Table 75: Predicted salinity mixing zone areas, summer, weaker wind

	Mixing zone area (ha)			
	Maximum		Average	
	Surface	Bed	Surface	Bed
Power plant + 20 MIGD desal	0.0	0.0	0.0	0.0
Power plant + 20 MIGD desal + 60 desal	2.1	145.2	2.1	71.3

Notes: 1. Discharge salinity for scenario 1 - power plant only case is the same as background. 2. Discharge excess salinity is less than 5% of background for scenario 2 with reject brine from 20 MIGD desalination added.

7.6.1.10 Recirculation

Table 76 and Table 77 show the maximum and averaged depth-averaged intake excess temperature and salinity levels for weaker winds, respectively (representing a ‘worst case scenario’). These were generally predicted to be relatively low:

- Maximum depth-averaged excess temperatures were up to 0.7°C
- Mean depth-averaged excess temperatures were up to 0.5°C
- Maximum depth-averaged excess salinities were up to 0.5 ppt
- Mean depth-averaged excess salinities were up to 0.2 ppt

Table 76: Maximum and averaged depth-averaged intake excess temperature

	Excess temperature (°C)							
	Weaker wind				Stronger wind			
	Summer		Winter		Summer		Winter	
	Max	Mean	Max	Mean	Max	Mean	Max	Mean
Power plant only	0.3	0.2	0.4	0.2	0.3	0.1	0.4	0.2

	Excess temperature (°C)							
	Weaker wind				Stronger wind			
	Summer		Winter		Summer		Winter	
	Max	Mean	Max	Mean	Max	Mean	Max	Mean
Power plant + 20 MIGD desal	0.6	0.3	0.7	0.4	0.5	0.2	0.6	0.2
Power plant + 20 MIGD + 60 MIGD desal	0.6	0.1	0.5	0.1	0.4	0.1	0.4	0.1

Source: HRW, 2018

Table 77: Maximum and averaged depth-averaged intake excess salinity

	Excess salinity (ppt)							
	Weaker wind				Stronger wind			
	Summer		Winter		Summer		Winter	
	Max	Mean	Max	Mean	Max	Mean	Max	Mean
Power plant + 20 MIGD desal	0.2	0.1	0.4	0.2	0.2	0.1	0.2	0.1
Power plant + 20 MIGD + 60 MIGD desal	0.5	0.1	0.4	0.1	0.4	0.1	0.4	0.1

Notes: 1. Salinity not modelled for power plant only (scenario 1).

7.7 Assessment of impacts

7.7.1 Construction

No new marine intakes or outfalls are being constructed as part of the project, as the plant will use existing intakes and outfalls already constructed on site. The construction activities that have the potential to impact on the marine environment are those as identified and discussed further in sections 8 (Soil, Groundwater and Land Contamination), 9 (Solid Waste and Material Use Management) and 12 (Wastewater Management) relating to dewatering, hazardous materials and wastes.

As per the EPC proposal, groundwater elevation has been explored, addressed and identified in the preliminary geotechnical investigation. In line with the geotechnical conclusions, all excavations will be performed and maintained in dry conditions with dewatering only if necessary. Given that dewatering is unexpected during the construction phase, impacts of dewatering on the marine environment is considered unlikely.

Construction activities such as dewatering, waste management, excavations might pose adverse impacts on the marine environment. The sensitivity of the marine environment at the immediate/direct zone of influence is considered low and medium-high at the indirect zone of influence. The magnitude of potential impacts is considered moderate. Overall the significance of the potential impacts to the marine environment during the construction phase pre-mitigation are assessed to be -minor.

7.7.2 Operation

Expected impacts during the operation of the power plant include:

- Entrainment at the pumping station intake - abstraction of water has the potential to draw fish into the water pumping system to either be trapped on the intake screens or to pass through these into the water circuit
- Changes to water quality due to discharge of cooling water with consequent temperature rise and a potential increase in contaminant concentrations which is likely to impact on marine habitats and associated benthos, mammals and fish

7.7.2.1 Water abstraction

The abstraction of large quantities of water has the potential to affect the local marine flora and fauna as the water abstracted will contain marine organisms, including both active swimmers and passively mobile species like plankton. This could have a significant effect on local biodiversity and biomass. Low flow intakes and fixed screens preceding the drum screens are included in the design of this project to minimise the volume of bycatch attributable to the abstraction of water. Although this mitigation is generally most effective to minimise the number of active swimming organisms that are caught, passively mobile organisms would still be drawn into the intake and either filtered by the screens or suffer death during entrainment into the plant. The impacts due to water abstraction can therefore include:

- **Impingement:** injury or death of organisms larger than screen mesh. Occurs when organisms are trapped against the intake screens by the velocity and force of water flowing through them
- **Entrainment**: when organisms smaller than the screen mesh size are entrained into the plant and killed by thermal and chemical treatment alterations

There is potential for the presence for high sensitivity receptors (e.g. sea turtles and marine mammals) and less sensitive receptors like fish species in the area, which could be injured or killed as a result of the abstraction of water for the plant. As they are strong active swimmers, the likelihood of impingement occurring is low, therefore the main impact would be focused on planktonic organisms that cannot actively avoid being entrained. The magnitude of the impact on planktonic organisms is considered low due to the small scale of the abstraction volume in the context of the Arabian Gulf. Considering an impact on high sensitivity species as a worst-case scenario, impacts are envisaged to be of minor adverse magnitude leading to a moderate significance score.

Record keeping of impinged organisms that are collected off the screens will be important to understand the actual impact of water abstraction, along with a response procedure for dealing with impinged species of conservation concern with the objective of releasing them back into the wild.

7.7.2.2 Cooling water discharge

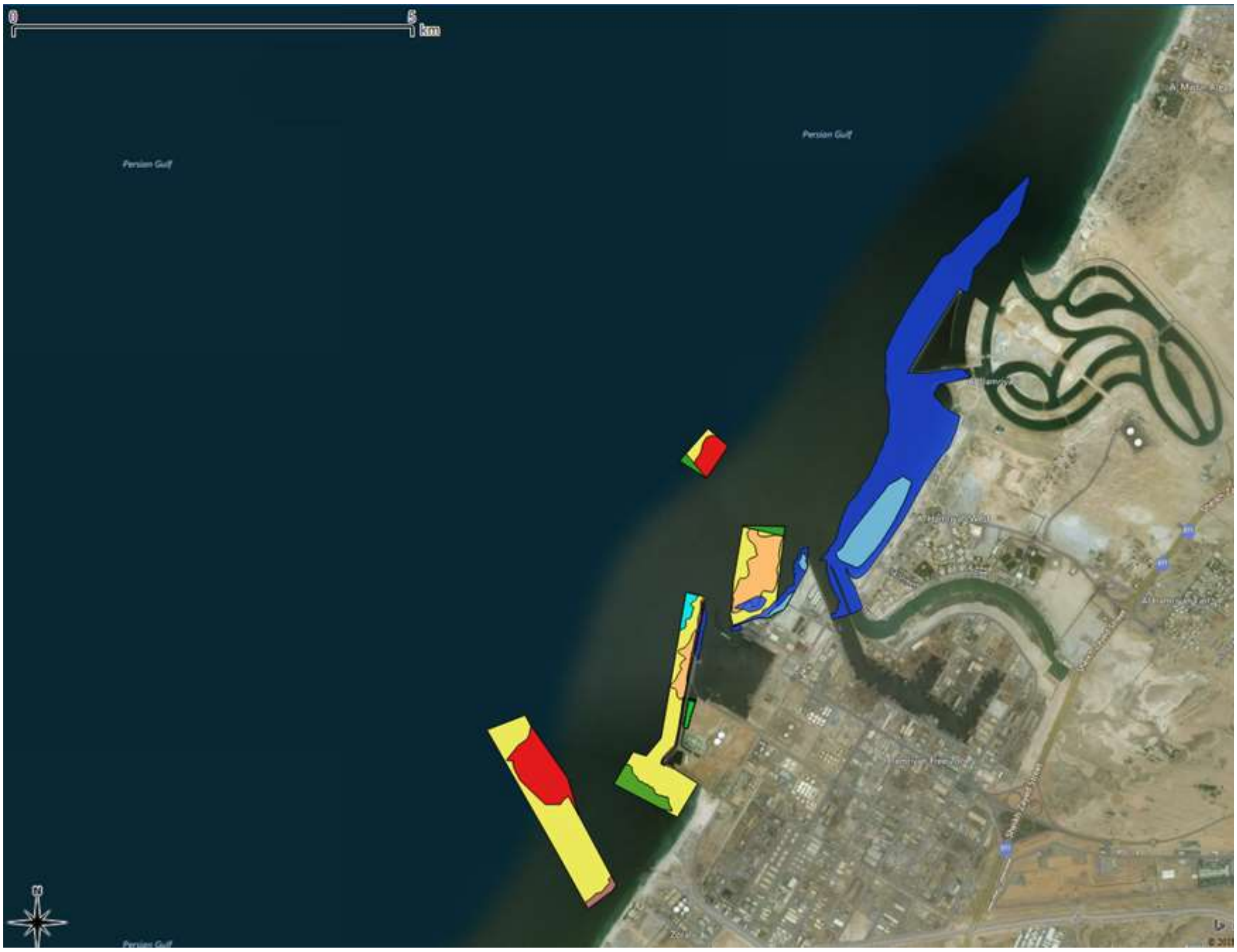
Impacts associated with the operation of the plant are focused on the effects of discharges via the outfall into the marine environment.

Scenario 1 – Hamriyah Power plant alone

The Hamriyah power plant alone will result in warm water being discharged into the outfall channel. The effects of this increase in temperature was modelled as Scenario 1, with the results shown in Figure 50-Figure 53. These results show that water temperatures greater than 3°C above ambient are restricted to a maximum surface mixing area of 177.6 hectares (Table 73), which does not extend far from the port basin. Elevated water levels (0-3°C above ambient) extend considerably further along the coast in both directions and out to sea. In summer, this could mean water temperatures in excess of 35°C outside of the port basin. The water depth in the footprint of the plume is 5-7.5m deep outside of the dredged port channel (Figure 23) where depths increase to 15m. The predicted elevated surface temperatures could therefore create conditions in the top few metres of the water column near to the plant which pelagic species actively avoid. The potentially high sensitivity of these species (particularly in the case of cetaceans and turtles) would suggest an impact would occur, however the area is not considered critical for any species as it does not constitute an important feeding or breeding ground, therefore the magnitude of the impact would be negligible and the impact not considered significant.

The discharged cooling water will have limited penetration down to the sea bed (a maximum bed mixing area of 1.9 hectares) adjacent to the plant, which would be restricted to the outfall channel. This is due to the fact that warmer sea water floats above colder water (forming a thermocline) and as it mixes through the influence of waves and wind it will cool to match background seawater temperatures. Under maximum (worst-case scenario) modelled conditions, elevated water temperatures (0-2°C above ambient) have been predicted to occur in the nearshore environment to the north east of the plant (Figure 45). The habitats that would be in the footprint of the plume would mainly be sand and the intertidal beach, considered of low or negligible sensitivity, respectively due to their limited biomass and biodiversity, the abundance of the habitat types and their limited conservation value. A small area of oyster habitat could be affected, potentially leading to the loss or displacement of the high sensitivity oysters and habitat-associated species due to temperature stress. Under average modelled conditions the oyster habitat is not expected to experience elevated temperatures (Figure 46). In accordance with the criteria set out in Table 7, at worst the magnitude of the impact of the plant (considered in isolation) would be minor leading to the overall impact being considered of moderate significance owing to the potential for impact to the oyster habitat.

Figure 70: Maximum predicted temperature increase from the IPP at bed, weak wind, summer in relation to sensitive habitat



Source: Mott MacDonald, 2018 (based on results obtained from HRW and 5OEs) Legend: Habitats: large rocks (brown), sand (yellow), hard bottom with oyster bed (orange), hard bottom with coral and oysters (red), sand with rocks (green) hard bottom with sparse algae (cyan). Discharge: 2-1°C above ambient (light blue), 1-0.5°C above ambient (dark blue)

Figure 71: Average predicted temperature increase from the IPP at bed, weak wind, summer in relation to sensitive habitat

Source: Mott MacDonald, 2018 (based on results obtained from HRW and 5OEs) Legend: Habitats: large rocks (brown), sand (yellow), hard bottom with oyster bed (orange), hard bottom with coral and oysters (red), sand with rocks (green) hard bottom with sparse algae (cyan). Discharge: 1-0.5°C above ambient (dark blue)

Scenario 2 - Hamriyah Power Plant and 20 MIGD Desalination

The discharge of the Hamriyah power plant was modelled in combination with the existing 20MIGD desalination plant. The results of the modelling demonstrated a worst case surface mixing area (water temperatures 3-8^{o}C above ambient) of 235.7ha and an extensive area of elevated surface water temperatures that are 0-3^{o}C above ambient in all directions from the plant.

Salinity levels were modelled to be elevated to up to 1.5ppt above ambient outside the port area near to the surface under worst-case conditions. Under average conditions, the elevated salinity would be restricted to the port.

Receptors of a surface impact associated with the plume would be restricted to mobile pelagic species, which could include cetaceans and reptiles of conservation concern. Using the same rationale as the assessment of the impact of scenario 1, the impact to pelagic marine ecology is not considered significant for the combined discharge of the proposed plant and the existing desalination plant.

The discharge modelling predicts that under worst-case scenario conditions the sea bed would be subjected to elevated temperatures (0-2^{o}C above ambient) as shown in Figure 30, although salinity levels would not be elevated (Figure 38). The high (coral and oyster) and medium (macroalgae) sensitivity habitats would be subjected to elevated temperatures up to 1^{o}C above ambient, as shown in Figure 47. Under average conditions, the elevated temperature would be restricted to the low sensitivity sandy nearshore area to the north east of the plant avoiding the high sensitivity habitat, as shown in Figure 48.

The magnitude of the impact is considered minor adverse in accordance with the assessment criteria presented in Table 7; the likely impact on species of a maximum 1˚C increase in ambient temperature combined with the limited quality of the habitats. Considering the maximum sensitivity of habitat that could be impacted, the significance of the impact is assessed to be moderate under a worst-case scenario.

Figure 72: Scenario 2 – habitat map with maximum predicted bed temperature with weaker wind, summer

Source: Mott MacDonald, 2018 (based on results obtained from HRW and 5OEs) Legend: Habitats: large rocks (brown), sand (yellow), hard bottom with oyster bed (orange), hard bottom with coral and oysters (red), sand with rocks (green) hard bottom with sparse algae (cyan). Discharge: 2-1°C above ambient (light blue), 1-0.5°C above ambient (dark blue)

Figure 73: Scenario 2 – habitat map with average predicted bed temperature with weaker wind, summer

Source: Mott MacDonald, 2018 (based on results obtained from HRW and 5OEs) Legend: Habitats: large rocks (brown), sand (yellow), hard bottom with oyster bed (orange), hard bottom with coral and oysters (red), sand with rocks (green) hard bottom with sparse algae (cyan). Discharge: 2-1°C above ambient

7.7.2.3 Chlorine

Chlorine is an effective biocide that is added to the intake water to reduce biofouling. Chlorine rapidly degrades over time as a result of physical and chemical process - particularly as a result of temperature and sunlight. Decay and dilution of the chlorine would start immediately upon injection into the intake water flow and continue as the water passes through the plant and is discharged to sea. The residual chlorine concentration at the outfall will be 0.2mg/l, in compliance with IFC standards (EAD discharge limits are 1mg/l). Residual chlorine concentration would therefore reduce as the discharged water flows away from the discharge point, reducing its biocidal potency through distance and time. Residual chlorine is represented as a conservative pollutant and considered to have the same footprint as the thermal plume (assumes a similar mixing zone).

The high (coral and oyster) and medium (macroalgae) sensitivity habitats would be impacted by discharged chlorine under maximum conditions, as shown in Figure 47. Under average conditions, the impact would be restricted to the low sensitivity sandy nearshore area to the north east of the plant avoiding the high sensitivity habitat, as shown in Figure 48. Latteman and Höpner (2008)[4] consider that chlorine levels of 0.1 mg/l can represent a threat to aquatic life. The lethal concentration for residual chlorine on the pearl oyster (*Pinctada radiata)* is considered to be 0.47mg/l (Goksu et al. 2002)[5]. Since the residual chlorine concentration will be 0.2mg/l at point of discharge it is considered unlikely that concentrations in the sensitive habitats will breach the 0.1 mg/l threshold. The magnitude of the impact is therefore considered minor adverse. Considering the maximum sensitivity of habitat that could be impacted the significance of the impact is assessed to be moderate under a worst-case scenario.

7.7.3 Decommissioning

Methods of decommissioning have not yet been decided, however deconstruction is expected to follow best practice at the time – likely to be 25 to 30 years after commissioning. All decommissioning phases will need to consider legislation and guidelines in place at that time to reduce or eliminate impacts on the marine environment.

7.8 Cumulative impacts

There is a proposal for the construction of an additional desalination plant with a capacity of up to 60MIGD. This proposal has the potential to act in combination with the existing 20MIGD desalination plant and Hamriyah power plant.

As such, the potential impacts of the 60MIGD was modelled (as Scenario 3) alongside the existing plants and the results are shown in Table 73 along with Figure 58-Figure 61 (for temperature) and Table 75 along with Figure 66-Figure 69 (for salinity).

The additional saline water discharged by the 60MIGD plant, when acting in combination with the smaller 20MIGD plant, results in a plume that is more dense than the surrounding water causing it to sink to the sea bed. This creates an inverse mixing zone in the water column when compared to the 20MIGD plant. The 60MIGD maximum saline mixing zone (where there is an

[4] Lattemann S. and T. Höpner (2008) Environmental impact and impact assessment of seawater desalination. Desalination 220:1-15.

[5] Goksu, Çevik and Findik (2002) Lethal chlorine concentrations for the pearl oyster Pinctada radiata. Turkish Journal of Veterinary and Animal Sciences, Vol 26, Issue 1

elevated salinity of greater than 2ppt from ambient) area is 2.1ha on the surface and 145.2ha at the sea bed.

This inverse relationship is similar for temperature where the maximum surface temperature mixing zone (where there is an elevated temperature of greater than 3ºC above ambient) for Scenario 2 (20MIGD plant) is 235.7ha on the surface and 2.0ha at the sea bed whereas in Scenario 3 (20MIGD and 60MIGD plant) the areas are 2.1ha at the surface and 145.2ha at the seabed.

This increase in temperature and salinity at the sea bed caused by the density of the discharged water is likely to cause a greater scope and magnitude of impact on marine habitats like corals and pearl oysters, that are sensitive to elevated temperatures and salinities. By comparing the location of these habitats in Figure 45 against the maximum (worst -case scenario) modelled temperature and saline plumes (Figures 34 and 42) it is possible to identify that all of the identified high sensitivity habitats have potential to be adversely affected by the cumulative discharge, although the higher temperatures (2-8ºC above ambient) and salinities (1.5-5ppt above ambient) would be restricted to the outfall, port and dredged channel leading to the port.

Under average conditions the elevated salinity and temperature footprint would be greatly reduced, with elevated levels above 3°C/2ppt (the mixing zone as defined by Abu Dhabi's water quality standards) confined to the port (tables 32 and 33). Elevated levels (0-3˚C/0-2ppt above ambient) would extend further out of the confines of the port and impact nearby coral and oyster habitats.

The sensitivity of coral and pearl oyster habitats is considered to be high and the magnitude of potential cumulative impacts from the discharge of warm and saline water from the Hamriyah power plant, the existing 20MIGD and proposed 60MIGD desalination plants combined are considered to be moderate in accordance with the criteria presented in table 7. Therefore, the overall significance of cumulative impacts is considered to be major.

Any impacts as a result of the cumulative impact associated with the proposed 60MIGD RO desalination plant will have to be considered in detail during the ESIA and environmental permitting process for the 60MIGD RO project.

7.9 Mitigation, monitoring, and enhancement measures

Seawater quality

As the marine outfall has already been constructed, there are limited options available to reduce the significance of the modelled impact on water quality and the identified sensitive habitats. By optimising the performance of the plant to maximise the quality of the discharge, ensuing it complies with relevant standards, the impact to marine water quality would be minimised as much as possible.

Marine ecology

A procedure for returning any live impinged fauna to the sea must be developed. For example, in the event of sea turtles being trapped, trained staff shall (using boats) rescue the turtles and return them to sea. Other power plant operators in the UAE, have agreements with Dubai Turtle Rehabilitation Project where rescued turtles are delivered to the centre, get treated and then released to the sea. Dead organisms will be required to be disposed of in approved landfills.

The quantity of biological organisms trapped by the plant's intake structures must be monitored regularly and extra screens/mitigation measures implemented if necessary. For example, barrier nets are simple nets extended around an intake zone to prevent entry by organisms. They are weighted at the bottom and have floats at the top to ensure they stay stretched and open. Barrier nets are easy to deploy, making them practical for seasonal implementation, and they are inexpensive compared with most technologies. Review of their deployment should consider whether the nets are trapping any organisms or are effectively stopping organisms from reaching the coarse screens.

Monitoring

Monitoring of ecology, sediment and water quality would take place immediately prior to the commencement of dewatering discharge (if it is required) and repeated periodically during the period of discharge.

Monitoring will need to be carried out to check the conditions of the marine environment and quality of the discharge during operation. This would ensure that any unexpected adverse impacts were identified at an early stage so that mitigation measures could be put in place to prevent any deterioration in the marine environment. Monitoring should take place immediately prior to the commencement of construction works (sediment/water quality) and should be continued regularly after completion of works during the plant operation (ecology/sediment and water quality).

In addition, a pre-construction ecological marine survey will be conducted to confirm the status of the key marine habitats (coral/oyster/algae) within the project areas of influence. Repeat annual surveys will be carried out for the first five years of operation to monitor the impacts of the project. The outcomes of the surveys will be analysed and compared against control sites and regional trends, and any additional mitigation measures identified will be incorporated within the operational ESMMP. Proposed indicative locations for the marine surveys for the operational phase is presented in Figure 74. These locations will be adjusted/updated as required following the completion and analysis of results of pre-operational marine survey.

Results from the monitoring programme would then be compared with the baseline conditions as recorded during July 2018, planned pre-construction monitoring and data on the wider Arabian Gulf to assess the likelihood of changes impacting on the Hamriyah area. In the unlikely case that habitats and species are regarded to be in decline due to the operation activities of the project, then further mitigation measures may be identified within the OESMMP.

During operational phase, continuous water temperature monitoring at the point of discharge into the outfall channel shall be undertaken. Chlorine shall be monitored on a weekly basis. The monitoring will be the responsibility of Project Company.

Figure 74: Indicative locations for marine ecology surveys during operational phase

Source: Google Earth, 2018

7.10 Residual impacts

A summary of residual impacts is outlined in Table 78.

Table 78: Marine environment - summary of impacts, key mitigation measures and residual impacts

Phase	Habitat	Impact	Magnitude	Sensitivity	Impact significance	Mitigation measures/benefit enhancement	Residual effect and significance
Construction							
Dewatering	Seawater quality and marine ecology deterioration	Contamination of receiving environments (particularly seawater)	Moderate	Low	Minor	Prior to commencing any dewatering activities, the EPC contractor shall: Develop a comprehensive dewatering plan as part of the CESMMP that details the location of dewatering activities, equipment, discharge point(s), emergency response measures and the proposed monitoring & reporting requirements. The plan shall be reviewed and approved by the regulator The monitoring shall include a requirement for a suite of chemical testing of the water and will include metals, benzene, toluene, xylene and ethylbenzene and hydrocarbons. The results of monitoring should be compared to Canadian water quality guidelines to assess disposal options. There is the potential that that some localised water will be unsuitable for disposal to surface or groundwater due to elevated concentrations of Toluene, therefore this may require disposal off-site to a licenced facility The plan to comply with the requirements and guidelines stipulated within EAD Best Management Practices (BMP) Technical Guidance Document for Discharges from Construction Activities (EAD-EQ-PCE-TG-15) Obtain permit from Sharjah Municipality for the discharge of dewatering water to the existing stormwater network, for discharge to the marine environment or collection by authorised third parties Dewatering systems to include flow control (sedimentation tanks), checked daily for signs of oils and grease and water quality testing by an approved service provider and laboratory on a monthly basis for compliance with relevant applicable standard for discharge to the marine environment	Insignificant

Phase	Habitat	Impact	Magnitude	Sensitivity	Impact significance	Mitigation measures/benefit enhancement	Residual effect and significance
Hazardous material and waste generation, handling, storage, disposal	Seawater quality Marine ecology deterioration	Contamination of receiving environments (particularly seawater)	Moderate	Low	Minor	• Develop and implement CEMP requirements with respect to handling hazardous materials and wastes • Develop and implement environmental incident/spill response procedure as part of the CEMP	Insignificant
Leakage or spill of hazardous materials or waste	Seawater quality Marine ecology deterioration	Secondary impacts to marine environment and human health	Moderate	Low	Minor	• Develop and implement CEMP requirements with respect to handling hazardous materials and wastes • Develop and implement environmental incident/spill response procedure as part of the CEMP	Minor- insignificant
Leakage or spill of sewage	Seawater quality Marine ecology deterioration	Secondary impacts to marine environment and human health	Moderate-major	Low	Minor	• Provide sufficient welfare facilities/toilets for construction workforce • Above ground chemical portable toilet blocks and septic tank facilities to be appropriately designed, monitored and regularly emptied by permitted carrier and disposal site	Insignificant
Operation							
Entrainment	Marine species	Possibility that marine fauna could become entrained at the intake structure	Minor	High	Moderate	• Install screens, barriers/ fenders or other such structures to prevent marine fauna from being trapped • A manual circulation system should be considered which would return any live entrained fauna to the sea (e.g. turtles) • Dead organisms will be required to be disposed of in approved landfills by authorised supplier • The quantity of biological organisms trapped by the plant's intake structures should be monitored regularly and extra screens/mitigation measures implemented if necessary	Insignificant
Generation, treatment and disposal of wastewaters through the existing outfall		Contamination of receiving environments (particularly marine environment)	Moderate	Negligible	Insignificant	• Wastewaters to be treated by appropriate treatment plant processes • All discharges to the existing outfall to be tested for compliance with the relevant requirements and standards	Insignificant

Phase	Habitat	Impact	Magnitude	Sensitivity	Impact significance	Mitigation measures/benefit enhancement	Residual effect and significance
Hazardous material and waste generation, handling and storage and disposal		Contamination of receiving environments (particularly seawater water)	Moderate	Low	Minor	• Prepare and implement hazardous material and waste management plans	Insignificant
Leakage or spill of hazardous materials or waste		Secondary impacts to marine environment and human health	Moderate	Low	Minor	• Prepare and implement hazardous material and waste management plans • Prepare emergency response procedure	Insignificant
Scenario 1 (Hamriyah power plant alone)	Hard bottom and coral, Hard bottom and pearl oysters, seawater	Temperature	Minor	High	Moderate	• Compliance with national and international standards and guidelines • Continuous monitoring of discharge water and sea water within the thermal plume • Regular monitoring of marine environment including water quality, sediment quality and biodiversity. EPAA required an annual monitoring to be undertaken for the first five years of operation.	Moderate
		Salinity	Negligible	High	Insignificant	• N/A	Insignificant
	Hard bottom and pearl oysters	Temperature	Minor	High	Moderate	• Compliance with national and international standards and guidelines • Continuous monitoring of discharge water and sea water within the thermal plume • Regular monitoring of marine environment including water quality, sediment quality and biodiversity	Moderate
		Salinity	Negligible	High	Insignificant	• N/A	Insignificant
Scenario 2 (Hamriyah power plant and 20 MIGD desalinisation plant)	Hard bottom and coral	Temperature	Minor	High	Moderate	• Compliance with national and international standards and guidelines • Continuous monitoring of discharge water and sea water within the thermal plume • Regular monitoring of marine environment including water quality, sediment quality and biodiversity	Moderate
		Salinity	Negligible	High	Insignificant	• N/A	Insignificant

Phase	Habitat	Impact	Magnitude	Sensitivity	Impact significance	Mitigation measures/benefit enhancement	Residual effect and significance
	Hard bottom and pearl oysters	Temperature	Minor	High	Moderate	• Compliance with national and international standards and guidelines • Continuous monitoring of discharge water and sea water within the thermal plume • Regular monitoring of marine environment including water quality, sediment quality and biodiversity	Moderate
		Salinity	Negligible	High	Insignificant	• N/A	Insignificant
	Hard bottom and macroalgae	Temperature	Minor	Medium	Minor	• Compliance with national and international standards and guidelines • Continuous monitoring of discharge water and sea water within the thermal plume • Regular monitoring of marine environment including water quality, sediment quality and biodiversity	Minor
		Salinity	Negligible	Medium	Insignificant	• N/A	Insignificant
Cumulative (Scenario 3 - Hamriyah power plant, 20 MIGD and 60 MIGD desalinisation plant)	Hard bottom and coral	Temperature	Moderate	High	Major	• 60 MIGD desalination project ESIA process to propose appropriate mitigation • The 60MIGD desalination project will establish and implement marine water quality monitoring programme	Unknown
		Salinity	Moderate	High	Major	• 60 MIGD desalination project ESIA process to propose appropriate mitigation • The 60MIGD desalination project will establish and implement marine water quality monitoring programme	Unknown
	Hard bottom and pearl oysters	Temperature	Moderate	High	Major	• 60 MIGD desalination project ESIA process to propose appropriate mitigation • The 60MIGD desalination project will establish and implement marine water quality monitoring programme	Unknown
		Salinity	Moderate	High	Major	• 60 MIGD desalination project ESIA process to propose appropriate mitigation • The 60MIGD desalination project will establish and implement marine water quality monitoring programme	Unknown

Phase	Habitat	Impact	Magnitude	Sensitivity	Impact significance	Mitigation measures/benefit enhancement	Residual effect and significance
	Hard bottom and macroalgae	Temperature	Moderate	Medium	Moderate	• 60 MIGD desalination project ESIA process to propose appropriate mitigation • The 60MIGD desalination project will establish and implement marine water quality monitoring programme	Unknown
		Salinity	Moderate	Medium	Moderate	• 60 MIGD desalination project ESIA process to propose appropriate mitigation • The 60MIGD desalination project will establish and implement marine water quality monitoring programme	Unknown
Sodium hypochlorite dosing impact on seawater quality and marine habitats and species	Seawater quality and marine habitat	Biocide	Minor	High (at habitat area) – low (no habitat)	Moderate – insignificant	• Optimise sodium hypochlorite dosing and review dosing rates based on operational monitoring data to determine whether shock and continuous dosing rates can be reduced, while still maintaining protection against biofouling • Comply with applicable discharge standards for discharges via the outfall • Monitor discharges to the outfall through continuous monitoring or spot sampling at least on a daily basis salinity/conductivity, pH, dissolved oxygen, turbidity and total residual chlorine • If any adverse impacts on marine ecology caused by the project are identified appropriate compensation will be considered	Minor - insignificant

Source: Mott MacDonald, August 2018

8 Soil, groundwater and land contamination

8.1 Overview

This chapter presents the potential impacts on the soils and groundwater associated with the construction and operation of the project.

This section is structured as follows:

- Description of the methodology used to assess potential impacts on soils and groundwater at the project site
- An overview of the relevant national legislation and requirements in Dubai and the UAE
- A baseline description based on desk-based information, site walkover information and sampling results from soils and groundwater
- Assessment of impacts associated with the construction and operation of the project
- Identification of mitigation and monitoring measures to be employed at the site
- Consideration of residual impacts following the implementation of mitigation measures

8.2 Methodology

The impact assessment was carried out using the data provided by the geotechnical and geo-environmental surveys carried out by Tecnicas Reunidas. The full report is included in Appendix F.

The environmental assessment identifies impacts and reports the likely significant environmental effects. The criteria for determining significance are specific for each environmental aspect. In broad terms, it can be characterised as the interaction of the impact and the sensitivity or value of the receptor that is affected. For each aspect the likely magnitude of the impact and the sensitivity of the receptor is defined, quantitatively to the extent possible. Generic criteria for the definition of magnitude and sensitivity are presented below.

Five wells/boreholes up to 10m in depth were installed onsite. Nineteen soil samples were collected from unsaturated soils at approximately 0.5m and between 1 and 2m below ground level, targeting made ground and/or visibly contaminated soils, within the 19 trial pits (Figure 75).

Figure 75: Location of wells/boreholes and soil samples

Source: Environmental contamination survey, final report, Tecnicas Reunidas, 18/07/2018

Groundwater samples were collected a week after the borehole installation. One sample was collected from each borehole. The groundwater depth and well depth below ground level were determined using an oil/water interface probe. Wells were purged of three times their volume of water using a pump, prior to sample collection in order to ensure a representative sample was collected.

In addition, a number of in situ measurements were taken, including: total dissolved solids (TDS), pH, temperature, salinity/electrical conductivity.

Samples were analysed for the following:

- pH
- Total organic carbon (soils samples)
- BTEX compounds (benzene, toluene, ethylbenzene and xylenes)
- Total petroleum hydrocarbons (TPH) speciated in accordance with total petroleum hydrocarbon criteria working group (TPHCWG) specification which includes carbon banding and aliphatic/aromatic split
- Speciated USEPA 16 polyaromatic hydrocarbons (PAH)
- Heavy metals (suite of 17 metals)- arsenic, barium, beryllium, boron, cadmium, chromium (III), chromium (VI), copper, iron, lead, manganese, mercury, molybdenum, nickel, selenium, vanadium, zinc.
- Alkalinity (waters), calcium, magnesium, sodium, potassium, total ammoniacal nitrogen (waters)
- Hardness (water), chloride, fluoride, sulphate, nitrate, nitrite and phosphate
- Polychlorinated biphenyls (PCB) WHO 12 list
- Volatile organic compounds (VOC) plus tentatively identified compounds (TIC)
- Semi-volatile organic compounds (SVOC) plus TICs

8.3 Assessment criteria

The assessment identifies impacts and reports the likely significant environmental effects. In broad terms, it can be characterised as the interaction of the impact and the sensitivity or value of the receptor that is affected. For each aspect the likely magnitude of the impact and the sensitivity of the receptor are defined, quantitatively to the extent possible. Criteria for the definition of magnitude and sensitivity are presented below.

8.3.1 Magnitude of impact

The assessment of magnitude is undertaken in two steps. Firstly, the key issues associated with the project are categorised as beneficial or adverse. Secondly, impacts are categorised as major, moderate, minor or negligible based on consideration of parameters such as:

- Duration of the impact – ranging from short to long term
- Spatial extent of the impact – for instance, within the site, boundary to regional, national, and international
- Reversibility – whether environmental conditions will return to baseline
- Likelihood – ranging from occurring regularly under typical conditions to unlikely to occur
- Compliance – the margin by which an impact meets or fails to meet international, national and local standards, limits or guidance

A source-pathway-receptor method has been employed to consider potential impacts associated with contaminated land. This method identifies potential pollutant linkages in the study area. The following definitions apply:

- Source/hazard - contamination identified
- Pathway - the means by which the contamination can come into contact with the receptor
- Receptor - the entity which is vulnerable to harm from the source

Without an active pollutant linkage, the contamination source may be a hazard but does not constitute a risk to human health or the environment. When the assessment identifies a potential for contamination to cause a significant effect, the extent and nature of the potential source or sources of contamination is assessed, the pathways identified, and any sensitive receptors or resources identified and appraised, to determine their value and sensitivity to contamination related impacts.

The criteria for determining significance for each impact, the magnitude of the impact and the sensitivity of the receptor have been defined, quantitatively where possible, in Table 79.

Table 79: Criteria for determining impact magnitude (beneficial and adverse)

Category	Description
Major	Fundamental change to the specific environmental conditions resulting in loss of feature. The project (either on its own or with other projects) may result in physical removal or degradation (including loss of structure and contamination) of a large area of soil. May affect the integrity of controlled waters either in terms of quality or quantity and could render it permanently unusable.
Moderate	Detectable change to the specific environmental conditions resulting in impact on integrity of feature or loss of part of feature. Physical removal or degradation (including loss of structure and contamination) of a moderate area of soil.
Minor	Detectable but minor change to the specific environmental conditions resulting in minor impact on feature. The impacts result in the physical removal or degradation (including loss of structure and contamination) of a minor area of soil.
Negligible	Results in an impact on feature but of insufficient magnitude to affect the use or integrity of the feature. The impact would lead to no observable change in the feature

8.3.2 Sensitivity

Sensitive receptors can be described as features that are notable in some way, whether due to their local or national importance or if they are especially sensitive to changes. Typically, sensitive receptors relate to ecological or human receptors (habitats, species, population centres) as well as geographical phenomenon or structures. The framework for assigning sensitivity to receptors is presented in Table 80.

Table 80: Criteria for determining land sensitivity

Sensitivity	Definition (considers duration of the impact, spatial extent, reversibility and ability to comply with legislation)
Very high	Nationally or internationally important for its geology. Intensive construction works; residential landuse proposed; sites of international importance or archaeological significance.
High	Regionally important for its geology. Limited construction works; commercial or open spaces proposed; sites with a local interest for education or cultural appreciation.
Medium	Locally important for its geology. Minimal construction works; industrial or infrastructure (e.g. roads, pipelines) landuse proposed; no sites of interest or appreciation.
Low	Not important for its geology. No construction works or change in landuse; no sites of interest or appreciation.

8.3.3 Determining significance

The significance of the effects of the project will be assessed by forming a significance matrix between the sensitivity of the site and the magnitude of impact from the project. Significance criteria are presented in Table 81 and defined in Table 82.

Table 81: Significance criteria

		Sensitivity/value			
		Very high	High	Medium	Low
Magnitude	Major	Major	Moderate	Moderate	Minor
	Moderate	Moderate	Moderate	Minor	Minor
	Minor	Minor	Minor	Negligible	Negligible
	Negligible	Negligible	Negligible	Negligible	Negligible

Table 82: Definition of significance criteria

Significance Criteria	Definition
Major adverse effect	Considerable detrimental or negative impact (by extent, duration or magnitude) of more than local importance or in breach of recognised standards, policy or legislation. Always considered significant.
Moderate adverse effect	Limited detrimental or negative impact (by extent, duration or magnitude) which may be considered to be significant.
Minor adverse effect	Slight, very short or highly localised detrimental or negative impact without a significant consequence.
Negligible effect	Imperceptible impact to an environmental or resource or human health receptor.
Minor beneficial effect	Slight, very short or highly localised advantageous or positive impact without a significant consequence.
Moderate beneficial effect	Limited advantageous or positive impact (by extent, duration or magnitude) which may be considered to be significant
Major beneficial effect	Considerable advantageous or positive impact (by extent, duration or magnitude) of more than local importance or in breach of recognised standards, policy or legislation. Always considered significant.

8.4 Legislative summary

8.4.1 National legislation

The following regulations and standards are applicable to soil, groundwater and land contamination. These are to be incorporated and used as reference within the assessment:

- Articles Federal Law No. 24 of 1999 for the Protection and Development of the Environment, as amended by Federal Law No. (11) of 2006, and its related Ministerial Decree No. 37 issue of 2001 on the regulations concerning Environmental Impact Assessment.
- Local Order No. 61 of 1991 on the Environment Protection Regulations.
- Local Order No. 15 of 2008 on the Protection of Groundwater.

8.4.2 International standards

The ESIA is to be completed to international best practice using relevant legislations for reference such as UK contaminated land practice and principles, namely BS10175 (Code of Practice for the investigation of potentially contaminated sites) and CLR11 Model Procedures for the management of land contamination.

There are no published soil and groundwater quality standards in the UAE. When assessment of soil contamination levels/quality is required these should use the New Dutch List standards (2000). When these standards do not provide limits for certain parameters, other appropriate international standards should be adopted for comparison e.g USEPA or UK Soil and groundwater Screening Values.

8.5 Baseline description

8.5.1 Phase II – Soil and Groundwater Sampling and Assessment

Nineteen soils samples were collected from trial pits and analysed for a range of metals and other contaminants. These were assessed against Dutch Standards. No contaminants measured in the soils were found to exceed intervention values or target values.

Intervention values indicate when the functional properties of the soil for humans, plant and animal life, is seriously impaired or threatened and remediation is likely required. Target values indicate the level at which there is sustainable soil quality (although it should be noted that these were determined for soils in the Netherlands). In terms of curative policy, this means that the target values indicate the level that has to be achieved to fully recover the functional properties of the soil for humans and plant and animal life.

A groundwater sample was taken from each borehole (five total) a week after drilling. These were tested for a range of contaminants and compared to the Dutch Standards. No metals or other contaminants were found to exceed the intervention values. Toluene and cresols were found to exceed the target values in three and two samples respectively. This does not suggest widespread contamination. The exceedances were also compared to the Canadian water quality guidelines for the protection of aquatic life (where available) to assess the risks to the adjacent coastal waters. There were no exceedances of these with the exception of one concentration of Toluene at BH01. This does not trigger a need for remediation but should be considered during any dewatering operations in order to limit potential localised risk to aquatic life. Results of these exceedances can be seen in in Table 83.

Table 83: Contaminants measured in groundwater samples that exceed target value

Contaminant	BH-01	BH-02	BH-03	BH-04	BH-05	Intervention value	Target value	Canadian water quality guideline
Toluene (ug/l)	587	199	164	<0.88	<0.88	1000	7	215
4-Methylphenol/3-Methylphenol (cresols) (mg/l)	0.058	<0.001	<0.001	<0.001	<0.001	0.2	0.0002	n/a

Source: Dutch Soil Remediation circular (2013)

8.6 Assessment of impacts

This section of the report presents the likely sources of impacts and effects associated with the construction and operation phase of the project. Potential land quality impacts have been assessed in accordance with UAE Federal and Dubai laws and guidelines, including:

- Local Order No. 61 of 1991 - Environmental Protection Regulations of the Emirate of Dubai
- Federal Law No. 24 of 1999 for the Protection and Development of the Environment
- DM Environment Department technical guidelines

8.6.1 Effects during construction

Soil and groundwater quality could be impacted during the construction of the project, particularly considering the shallow depth of the water table (1.55 to 4m bgl) and the earthworks required to be carried out in order to prepare the project site.

Construction activities with the potential to directly or indirectly adversely impact soils and groundwater include:

- Earthworks including excavation, piled foundations and dewatering
- Pollution, due to improperly managed earthworks and stockpiles, or water spraying (for dust mitigation)
- Pollution of soil and groundwater from accidental spillages of fuel, lubricants and chemicals;
- Increased infiltration (via rainwater run-off and dust mitigation spray) through soils already impacted by contamination
- Deliberate discharges of, for example, pumped groundwater and treated effluent
- Disturbance of previously unidentified contaminated soils that may be present on the project Site. Mobilisation of contaminants may result in the spread of contamination, most likely via airborne pathways to clean soil or other sensitive receptors

Following analysis of results of the ground investigation at the site, there is not expected to be significant contamination within the soils. There remains a potential for the earthworks to uncover and mobilise as yet unknown contaminated soils and groundwater. Mobilisation of potential contamination presents a direct risk to the environment and an indirect risk to human health.

Due to the shallow depth of groundwater on the site, dewatering may be required during construction works. Dewatering can lead to contaminant migration within soils, contaminating previously clean material as well as potentially resulting in large quantities of contaminated waters to be managed.

Earthworks may include piling and excavations associated with new structures as well as trenches for service interconnections. Piling presents a potential pathway for existing soil contamination to impact groundwater.

During construction a range of potentially hazardous substances would be used, such as oils, lubricants and fuels, as well as sewage from the construction workforce. Accidental spills or leakages of hazardous substances may result in local contamination of soils, with potential implications for groundwater, surface water and human health.

8.6.2 Effects during operation

The main potential land quality impacts for the project during operation are associated with the use, transport and storage of hazardous materials and liquid waste disposal. Impacts to soil and groundwater may result from leaks and spills from the dedicated chemical stores, wastewater collection basins/sumps, dedicated waste management areas and uncontrolled drainage of contaminated run-off from hard surfaced areas due to poor maintenance of drainage system and waste management system.

Impacts may result from the use of pesticides and fertilisers on landscaped areas. Excess usage of chemicals, or usage at inappropriate times (such as prior to heavy rainfall) can result in leaching to underlying soils.

Impacts may also result from incidents such as firefighting, including the infiltration of contaminated waters into the subsurface and dispersion of airborne contaminated material to surrounding areas, with the potential to impact both human health, land and water quality.

8.7 Mitigation, monitoring, and enhancement measures

The project site was investigated by Tecnica Reunidas in June 2018. The investigation involved 19 soil samples from 19 trial pits, 5 soil samples from an existing sand stockpile and 5 groundwater samples from 5 boreholes. No significant contamination was identified on this site. Based on these results, it is considered unlikely that significantly contaminated areas are present on the site. However, there is the possibility that areas of undiscovered contamination do exist on the project site that may be uncovered during construction works. Contamination has the possibility to migrate to groundwater (deep and shallow), affect construction workers, and nearby workers and residents.

Construction stage mitigation measures that will need to be incorporated into the design of the project and the construction environmental management plan (CEMP) include:

- Implement a watching brief for visual signs of contaminated soils and groundwater during excavations and have procedures in place should contaminated land be encountered, including contact details of the relevant consultees and regulators. The watching brief is to compile a daily report during works which includes; daily findings of unexpected contamination, non-compliances and actions taken
- Enforced speed limits for vehicle circulation (20km/h) and minimised off-road movements as well as covering or dampening of stockpiles and use of water sprays, to control dust generation
- Provision and use of appropriate personal protective equipment (PPE) for construction workers
- Hazardous materials will need to be suitably and securely stored to prevent leaks and spills, including adequate bunding;
- Drip trays will be required to be used to intercept leaks and spills from equipment and during refuelling and whilst parked
- Development and implementation of formalised environmental incident/spill response procedures including response measures and incident recording. Spill kits are to be available where hazardous chemicals are stored, handled or transferred, including clear instruction for use
- Provision of sufficient welfare facilities/toilets for construction workforce
- Above ground chemical portable toilet blocks and septic tank facilities are to be appropriately designed, monitored and regularly emptied by DM permitted carrier and disposal site
- Method statement for dewatering operations including a requirement for a suite of chemical testing of the water to include metals, benzene, toluene, xylene and ethylbenzene and hydrocarbons. The results should be compared to Canadian water quality guidelines to assess disposal options. There is the potential that that some localised water will be unsuitable for disposal to surface or groundwater due to elevated concentrations of toluene, therefore this may require disposal off-site to a licenced facility.

Operational stage mitigation measures should include management procedures for hazardous materials, wastes and drainage during operation of the project to ensure that any leaks or spills do not impact the underlying soils in the area. Application of chemicals associated with landscape management, such as pesticides and fertilisers, should be managed to ensure that application is not excessive and timed to ensure minimal leaching into underlying soils.

Emergency response measures are also required to be developed to ensure that potential impacts to the underlying ground and waters are minimal, including firefighting strategies that include provisions for management and disposal of contaminated water in case of fire emergency response and the drainage of associated contaminated liquid.

8.8 Residual impacts

There is potential for residual impacts as a result of operation of the IPP. Fuel and oils used on site could potentially be spilt. Any chemicals used on site could also migrate into the groundwater and soil if not stored appropriately

Mitigation measures and residual impacts are reported in Table 84.

Table 84: Soil, groundwater and land contamination - summary of impacts, key mitigation measures and residual significance

Activity	Impact	Sensitivity	Magnitude	Impact significance	Mitigation measures	Residual impact
Construction						
Excavation of ground for foundations	Movement of potential contaminants in the soils and into shallow groundwater	Medium	Minor	Negligible	• Based on ground investigation there is low risk of contamination of the soils on site. However, an unexpected contamination strategy should be in place in the case of contamination hotspots being on site. • Implementation of a Construction Environmental Management Plan (CEMP) to ensure control of dust emissions and surface run-off. • Use of personal protective equipment (PPE) by construction workers. • Comply with the requirements and guidelines stipulated within EAD Best Management Practices (BMP) Technical Guidance Document for Discharges from Construction Activities (EAD-EQ-PCE-TG-15)	Not significant
Dewatering during ground excavation for deeper foundation piling	Movement of potential contaminants in the shallow groundwater	Medium	Moderate	Minor	• Based on ground investigation there is low risk of groundwater contaminants on site. However, an unexpected contamination strategy should be in place in the case of contamination hotspots being on site. • Use of PPE by construction workers. • Dewatering plan including appropriate disposal of water. Risk Assessment of any groundwater dependant features and potential impacts to aquifers and appropriate mitigation measures in place. • Method statement for dewatering operations including a requirement for a suite of chemical testing of the water to include metals, benzene, toluene, xylene and ethylbenzene and hydrocarbons. The results should be compared to Canadian water quality guidelines to assess disposal options. • Comply with the requirements and guidelines stipulated within EAD Best Management Practices (BMP) Technical Guidance Document for Discharges from Construction Activities (EAD-EQ-PCE-TG-15)	Not significant
Spills and leaks of hazardous material during construction	Contamination of the soils and the groundwater	Medium	Major	Moderate	• Implementation of a CEMP to ensure control of dust emissions and surface run-off. • Ensure proper storage and safe use of any chemicals and fuels used and stored on site, this must include bunding and the availability of spill kits. • Use less hazardous or less toxic materials where possible. • Fuels and chemicals should be stored away from sensitive receptors and stored such that it will not be spoiled by the elements. • Fuels and oils should be easily accessible in a safe manner. • Storage areas should be well ventilated. • Comply with the requirements and guidelines stipulated within EAD Best Management Practices (BMP) Technical Guidance Document for Discharges from Construction Activities (EAD-EQ-PCE-TG-15)	Not significant
Operation						

Activity	Impact	Sensitivity	Magnitude	Impact significance	Mitigation measures	Residual impact
Spills and leaks of hazardous materials that are stored on site for the operation of IPP	Potential contamination of soils and leaching into the groundwater.	Medium	Major	Moderate	• Ensure proper storage and safe use of any chemicals and fuels used and stored on site, this must include bunding and the availability of spill kits. • Use less hazardous or less toxic materials where possible. • Fuels and chemicals should be stored away from sensitive receptors and stored such that it will not be spoiled by the elements. • Fuels and oils should be easily accessible in a safe manner. • Storage areas should be well ventilated.	Not significant

Source: Mott MacDonald Ltd, 2018

9 Solid waste and material use management

9.1 Introduction

This section outlines the proposed approach for the management of solid as well as hazardous materials that will potentially be generated during the construction, operation and decommissioning phases of the project.

Waste management is a key aspect to be assessed by the project to achieve minimisation of raw material consumption and ensure that, where waste generation is unavoidable, any final treatment or disposal of waste associated with the project is conducted in an environmentally sound manner, particularly for hazardous wastes.

The scope of this chapter is limited to material usage and all solid wastes and those liquid wastes that are not treated via wastewater treatment works. The section is structured as follows:

- Description of the methodology used to assess impacts associated with waste generated by the project
- An overview of the relevant national waste management best practice requirements in the UAE
- A baseline description which includes consideration of available local/regional waste management infrastructure
- Assessment of impacts associated with materials usage, hazardous materials and waste arising from the construction and operation of the project
- Identification of mitigation and monitoring measures to be employed at the site
- Consideration of residual impacts following the implementation of mitigation measures

9.2 Methodology and assessment criteria

The assessment of potential impacts associated with the generation of different waste streams and material management during construction, operational and decommissioning phases of the project was primarily based on a desk-based review of project information and data. A walkover of the project site was also undertaken by environmental specialists to further consider the project in relation to existing waste management facilities.

The significance of potential impacts is a function of the presence and sensitivity of receptors and the magnitude of the impact in terms of duration, spatial extent, reversibility and likelihood of occurrence. The criteria for defining magnitude and sensitivity are summarised below.

9.2.1 Magnitude

The assessment of magnitude was considered in two stages. Firstly, the key issues associated with the project have been categorised as beneficial or adverse. Secondly, the magnitude of potential impacts have been categorised as major, moderate, minor or negligible as defined in Table 85 with consideration for duration, spatial extent, reversibility and likelihood of the impact.

Table 85: Magnitude criteria

Component	Unit
Major	Mismanagement of waste and/or materials results in a significant incident which potentially causes a fundamental change to the specific environmental conditions resulting in long-term or permanent change, typically widespread in nature (regional, national or international), and would require significant intervention to return to baseline; may also exceed national standards and limits.
Moderate	Mismanagement of waste and/or materials resulting in an incident that causes a detectable change to the specific environmental conditions resulting in temporary or permanent change.
Minor	Mismanagement of waste and/or materials resulting in an incident that causes a detectable but minor change to the specific environmental conditions assessed.
Negligible	Mismanagement of waste and/or materials resulting in an incident that causes no perceptible change to the specific environmental conditions assessed.

Source: Mott MacDonald

9.2.2 Sensitivity

Sensitivity is generally site-specific and criteria have been considered with the baseline information gathered during the assessment process. The sensitivity of a receptor was determined based on review of the surrounding environment and presence of features within the site. General criteria for determining sensitivity of receptors with regards to waste/hazardous material management are outlined in Table 86.

Table 86: Sensitivity criteria

Component	Unit
High	Waste and/or materials handling-related incident impacts on a vulnerable receptor (human or ecological e.g. schools, residential areas, hospitals, designated environmental areas, high value visual amenity areas) with little or no capacity to absorb proposed changes or minimal opportunities for mitigation.
Medium	Waste and/or materials handling-related incident impacts on a vulnerable receptor (human or ecological e.g. offices, isolated residences, major roads, footpaths/cycle paths, agricultural land) with limited capacity to absorb proposed changes or limited opportunities for mitigation.
Low	Waste and/or materials handling-related incident impacts on a vulnerable receptor (human or ecological e.g. scrubland, public open space, minor roads, industrial areas, car parks) with some capacity to absorb proposed changes or moderate opportunities for mitigation.
Negligible	Waste and/or materials handling-related incident impacts on a vulnerable receptor (human or ecological e.g. scrubland, public open space, minor roads, industrial areas, car parks) with excellent capacity to absorb proposed changes and/or easily applied mitigation measures.

Source: Mott MacDonald Ltd, 2018

9.2.3 Impact evaluation and determination of significance

Impacts have been identified and significance established taking into account the interaction between magnitude criteria and sensitivity criteria described above, as presented in the significance matrix in Table 87. The degree of significance of effects on the sensitive receptors and the waste management infrastructure (adverse or beneficial) has also been considered.

Table 87: Impact evaluation and determination of significance

Magnitude of impact	Sensitivity of receptors			
	Negligible	Low	Medium	High
Negligible	Not significant	Not Significant	Not Significant	Not Significant
Minor	Not significant	Not Significant	Minor	Minor
Moderate	Not significant	Minor	Moderate	Moderate
Major	Not significant	Minor	Moderate	Major

Source: Mott MacDonald Ltd, 2018

For each aspect, the significance of impacts is discussed before and after mitigation (i.e. residual impacts). Residual impacts identified as having major or moderate significance based on the above approach have been classified as being significant.

Where feasible, the following hierarchy of mitigation measures is applied to reduce, where possible, the significance of impacts to acceptable levels:

- Mitigation/elimination through design
- Site/technology choice
- Application of best practice

Any uncertainties associated with impact prediction or the sensitivity of receptors due to the absence of data or other limitation have been highlighted within the assessment as appropriate. These are also summarised as necessary within the accompanying framework CEMP in Appendix G.

9.3 Legislative summary

9.3.1 National legislation

UAE Federal Law

The main relevant provisions in Federal Law No.24 of 1999 on Protection and Development of the Environment with respect to waste and hazardous materials management are:

- Protection and conservation of the quality and natural balance of the environment
- Control of all forms of pollution and avoidance of any immediate or long-term harmful effects resulting from planning for economic, agricultural or industrial development or other programs aimed at improving life standards
- Protection of society, the health of human beings and other living creatures from any activities and acts which are environmentally harmful or impede authorised use of the environmental setting
- Compliance with international and regional conventions ratified or approved by the UAE regarding environmental protection, control of pollution and conservation of natural resources
- Any party, who, intentionally or negligently provokes damage to the environment or to third party as a result of the violation of the present Law, its orders or executive decisions shall be held responsible to repair or eliminate the impairments as well as all compensation which may arise there from. Such compensation includes compensation for the damage caused to the environment itself and for its rehabilitation
- A complete prohibition on the import of hazardous waste – for which there are penalties of imprisonment and a minimum fine of AED 150,000

The Law defines waste as:

> *"All hazardous and non-hazardous remnants and wastes, including nuclear wastes, disposed of or need to be disposed of, in accordance with the provisions of law."*

Law No. 24 and the Executive Order published pursuant to Cabinet Resolution No. 37 of 2001 includes Regulation for Handling Hazardous Materials, Hazardous and Medical Waste.

It worth noting that a newly drafted UAE Federal Law aims for 75% waste recycling was passed by the Federal National Council in May 2018 but had not been enacted at the time of issuing this report.

Sharjah requirements

The Executive Council of the Emirate of Sharjah Decision No. 9 of 2012, on the prevention of environmental degradation in the wilderness area of the Emirate of Sharjah stipulates the requirements for waste management and prohibition of disposing all streams of waste (including hazardous waste) in the desert environment or undesignated areas. The Decision states that:

It is prohibited for both public and private business and individuals to undertake any activity that is not in line with the federal and local legislations and orders and might negatively impact the environment and desert areas within the Emirate of Sharjah, these include:

- Disposal, storage or illegal dumping and covering of hazardous waste in undesignated areas and in the desert
- Contamination of desert areas and impacting the public health and safety by the following:
  - Disposal of construction and demolition waste
  - Disposal of industrial and operational waste
  - Disposal of wastewater and used oil in the public wastewater network and desert areas
  - Disposal of waste, organic waste from food at the desert areas

Decision No. 9 of 2012 additionally stipulates fines that will be imposed on individuals or businesses in the event of non-compliance with the regulations. There is a maximum fine of AED 50,000 for illegal disposal of waste in unauthorised areas.

Dubai requirements

In the absence of detailed waste management standards, regulations and guidelines in the Emirates of Sharjah, this section refers to Dubai waste management regulations hich are in compliance with federal requirements.

Relevant Dubai legislation referred to as local orders with respect to waste and hazardous materials include:

- Local Order 61 of 1991 Concerning the Environment Protection Regulation in the Emirate of Dubai
- Local Order 115 of 1997 - Concerning the Management of Medical Waste
- Local Order 7 of 2002 on Management of Waste Disposal Sites
- Local Order 22 of 2001 on Dubai Coastal Zone Construction and Dredging
- Local Order 11 of 2003 on Public Health and Safety

Dubai Municipality technical guidelines

The DM Environmental Planning and Studies Section (EPSS) technical guidelines applicable to wastes and hazardous material management are listed in Table 88.

Table 88: DM Environment Department technical guidelines applicable to the waste and hazardous materials

No.	Technical guideline	Date
Environmental Planning and Studies Section		
6	Waste Minimisation	April 2011
7	Policy on the Control of Ozone Depleting Substances	April 2011
12	Replacement of Chlorinated Solvents (CFCs, CTCs, MCFs) for Degreasing and Cleaning	April 2011
Environmental Control Section		
1	Disposal of Hazardous Wastes	June 2011

No.	Technical guideline	Date
2	Disposal of Trade Wastewater	June 2011
3	Requirements for the Installation/ Construction and Maintenance of Gravity Oil-Water Separator	June 2011
4	Guidelines for Waste Audit Reports	June 2011
5	Requirements for the Transport of Hazardous Wastes	June 2011
6	Bunding of Storage Tanks and Transfer Facilities	June 2011
7	Development of Emergency Response Procedures for Incidents Involving Dangerous Goods	June 2011
10	Guidelines for the Disposal and Re-Use of Used Chemical Containers	June 2011
13	Reuse of Treated Wastewater for Irrigation and Thermal Treated Sludge for Agricultural Purposes	June 2011
Marine Environment and Wildlife Section		
1	Oil Spill Preparedness and Response	April 2011

Source: DM EPSS

Regional and international conventions

The classification and management of wastes in the UAE is required to be in accordance with the Basel Convention, 1989 (and subsequent Amendments) to which the UAE is a signatory. The Basel Convention restricts and controls transboundary movements of hazardous wastes and their disposal.

9.3.2 JBIC requirements

The JBIC Environmental and Social Guidelines, April 2012 require environmental impacts to be investigated and examined, which includes factors related to human health and safety as well as the natural environment. This is particularly relevant to materials usage and the generation of waste which has the potential to impact on finite resources and can lead to pollution discharges to the environment if wastes are not handled and disposed of in a best practice fashion.

Environmental Checklist 11 for Thermal Power requires projects to consider whether wastes (such as waste oils, and waste chemical agents), coal ash, and by-product gypsum from flue gas desulphurisation generated by the power plant operations are properly treated and disposed of in accordance with the host country's standards.

In addition, project proponents are required to refer to the appropriate parts of the IFC Performance Standards for specific requirements and adherence to these standards are considered to result in compliance. Significance of impacts

9.4 Baseline description

Current statistics indicate that UAE generates more than 6.5 million tonnes of waste per annum. The UAE's per capita waste generation is around 1.2-1.3kg/day which is considered amongst the world's highest, the majority of which (approximately 77%) ends up in landfill sites.

Waste statistics for the UAE including the Emirates in Sharjah were collected from Federal Competitiveness and Statistic Authority[6]. Recent data available is for the year 2016 and can be summarised as below:

- In 2016, the quantity of collected wastes in the UAE was about 35 million tonnes; 99% of wastes were non-hazardous; the collected waste quantity increased by 19% compared to 2015, due mainly to the increase of the construction residues and wastes. The waste collected in Dubai contributed about 56% of the total waste collected in the UAE followed by

[6] http://fcsa.gov.ae/en-us/Pages/Statistics/Statistics-by-Subject.aspx

Abu Dhabi contributing about 28%, Sharjah 8% and the rest of emirates about 8% of the total wastes.

- Data of 2016 revealed that about 86% of the collected waste was collected by private companies either specialised companies or waste producers, especially demolition and constriction companies.
- In 2016, municipal wastes were disposed of safely in the UAE, where 76% of the waste is deposited in landfills. The percentage of recovered waste was about 24% by recycling, composting and other methods of recovery which are considered the least harmful methods environmentally as they transform potentially harmful material into something useful with economic revenue. The Emirate of Dubai contributes 43%, Abu Dhabi 27% and Sharjah 27% of recovery at the country level. In 2016 Sharjah municipality recovered approximately 51% of municipal waste followed by Abu Dhabi with 27% and Dubai with 20%.
- In 2016 the number of working landfills and facilities were 82. Landfill sites totalled 37 and other waste management facilities 45. Approximate 43% of these sites are in Abu Dhabi emirate, the facilities include hazardous waste treatment, recovery units, collecting and sorting units, cutting and crushing units and medical wastes incinerators.

Table 89 shows quantities, percentage and type of collected waste and the waste collector in Sharjah in 2016.

Table 89: Quantity percentage and type of collected waste and waste collectors in Sharjah. 2016

Waste collector	Percentage, %	Total (tonnes)	Hazardous (tonnes)	Non-hazardous (tonnes)
Municipality	36.96	1,051,572.1	271.3	1,051,300.8
Private company	62.88	1,789,086.6	42,627.3	1,746,459.2
Other	0.17	4,737.7	10.4	4,727.3
Total	100.00	2,845,396.4	42,909.0	2,802,487.4

Source: http://fcsa.gov.ae/en-us/Pages/Statistics/Statistics-by-Subject.aspx

Table 90 presents the quantities of non-hazardous wastes that were collected and managed in Sharjah in 2016.

Table 90 presents the quantity of non-hazardous wastes that were collected and managed in dumps in Sharjah, source and method of disposing, 2016 (Ton).

Table 90: Quantities of non-hazardous wastes that were collected and managed in Sharjah in 2016

Source of waste	Recycled	Compost	Landfill	Others	Total	Percentage %
Construction waste	315,659	0	636,298	0	951,957	34
Municipality waste	0	37,959	261,187	380,971	680,103	24.3
Industrial general waste (non-hazardous)	5,700	784	336,747	51,665	394,896	14.1
Agricultural waste	0	0	61,438	2,033	63,471	2.3
Sludge of wastewater	0	55,658	2,093	9,224	66,975	2.4
Others	7,934	0	637,151	0	645,085	23
Total	329,293	94,401	1,934,915	495,544	2,802,487	100

Source: http://fcsa.gov.ae/en-us/Pages/Statistics/Statistics-by-Subject.aspx

Existing waste management operations in Sharjah

As per the official portal of the UAE government[7], the emirate of Sharjah set up a municipal waste management company Bee'ah (the Arabic word for environment) in 2007 in the form of a public-private partnership.

Currently Bee'ah is the leading waste management company in Sharjah with three primary divisions, Bee'ah Tandeef, Bee'ah Tadweer and Bee'ah Residual Management:

- Bee'ah Tandeef: it's a waste collection and management division responsible for providing municipal and commercial waste collection and management services from residential, governmental, commercial and industrial areas in Sharjah and some areas in other emirates, these include waste management services provided for SEWA and HFZA.
- Bee'ah Tadweer is the waste sorting and treatment division undertaking the following activities:
  - Waste recycling facilities for paper, plastic, tyres, rubber, vehicles, metal, electronic waste, industrial liquid waste and construction and demolition waste.
  - A composting plant
  - Material recovery facility which separate recyclable materials from municipal solid waste with an annual capacity of approximately 600,000 tonnes processing 2,000 tonnes daily of which 70% is recycled.
- Bee'ah Residuals Management: This division of Bee'ah is responsible for the management of landfill and medical waste.
  - In 2009, Bee'ah took over the operation and maintenance of Al Saj'ah landfill. This landfill was transformed by Bee'ah into an engineered landfill that complies with international standards. Residual waste is disposed of in this landfill.
  - Wekaya is a premier medical waste management facility specialising in the safe collection, treatment and disposal of medical waste.

All waste management permits and lists of approved waste management companies for non-hazardous and hazardous waste shall be obtained from Sharjah Municipality.

9.5 Assessment of impacts

The principal potential impacts which can arise from the generation of waste from all phase of the project are as follows:

- Contamination of receiving environments (particularly surface watercourses, groundwater and the soils) due to leakage and spillage of wastes associated with poor waste handling and storage arrangements
- Fugitive emissions, such as dust and odour, associated with the handling and storage of some waste streams
- The use of landfill- where waste re-use or recovery is not feasible- which is a finite resource
- Disposal of spoil and excavation material which results in land take
- Visual amenity impacts associated with poor storage of waste
- Increased waste miles and emissions of greenhouse gas emissions associated with transporting waste materials from the project site

[7] https://government.ae/en/information-and-services/environment-and-energy/waste-management

The principal potential impacts which can arise from handling and storage of hazardous materials from all phases of the project are as follows:

- Contamination of receiving environments (soil and water contamination which can lead to aquatic habitat alteration) due to uncontrolled releases of hazardous materials, spills and leaks
- Fugitive emissions (heavy metals, halide compounds, unburnt hydrocarbons and other volatile organic compounds (VOCs) may be emitted associated with unloading, storage and handling of back-up fuel and additives
- Occupational health and safety (exposure to non-ionizing radiation, heat, noise, confined spaces, electrical hazards, fire and explosion, chemical hazards))
- Fire and explosion due to reactive, flammable and explosive materials
- Water contamination (aquatic habitat alteration)

Potential environmental impacts, proposed handling/storage and off-site disposal methods for each of the waste streams highlighted above are presented in Table 91 and Table 92.

There are three general classifications of wastes, namely non-hazardous wastes, hazardous wastes and inert construction wastes. Each project waste stream was identified as belonging to one of the following classifications:

- **Inert construction wastes** are wastes that are solid and when disposed of are not expected to undergo physical, chemical or biological changes to such an extent as to produce substances that may cause an adverse effect. Such wastes include but are not limited to demolition debris, concrete, glass, ceramic materials, unpainted scrap metal, and dry timber or wood that has not been chemically treated
- **Non-hazardous wastes** are all wastes that are not hazardous wastes and are not inert construction wastes. This includes municipality waste/common garbage, office wastes, construction wastes that are burnable such as boxes, and treated sewage effluent and sewage sludge
- **Waste materials are classified as hazardous wastes** when they exhibit on or more of the following characteristics or are hazardous by definition: explosive, flammable, spontaneous combustion potential, oxidizing potential, toxic, and corrosive

Potential impacts generally associated with the wider handling and use of raw materials includes the following:

- Use of potentially finite and/or scarce resources
- Handling and storage of hazardous materials
- Spills and leaks of hazardous materials which lead to an environmental incident

9.5.1 Construction and decommissioning

This section characterises the raw materials to be consumed and the waste streams which are envisaged to arise from construction activities associated with the development of the project. The same types of wastes and material are anticipated to be generated or used during the decommissioning phase and are also addressed here.

Material use

This section characterises the raw materials to be consumed and the waste streams which are envisaged to arise from construction activities associated with development of the project. Details are presented in Table 91

Table 91: Material use – construction phase assessment

Material type	Potential impact/benefit	Pre-mitigation significance	Proposed handling and storage
Non-hazardous			
Non-hazardous materials such as concrete, structural steel, metals, masonry, plastics, wood	Use of finite resources/materials	Minor	Construction laydown area and stores
Hazardous			
Hazardous materials such as fuels, oils, lubricants, solvents, resins, paints, asphalt and bitumen	Contamination of receiving environments Fugitive emissions to atmosphere	Moderate	Fuel storage tanks Chemical storage areas

Source: Mott MacDonald

Waste generation

Considering the proposed facilities and construction works, Table 92 summarises waste streams that are expected to be generated as part of the construction phase of the project as well as their potential impacts, their significance, how they will be handled/stored and the method of disposal for each waste stream.

The most significant waste stream (in terms of volume) which will be generated as a result of construction of the project are likely to be from excavation spoil, construction waste, wood, concrete and metal.

Table 92: Waste – construction phase assessment

Waste type	Potential impact/benefit	Pre-mitigation significance	Proposed handling and storage	Proposed disposal
Solid non-hazardous				
Excavation spoil	Contamination of receiving environments Contamination of receiving environments Fugitive dust emissions Reduction in available landfill capacity	Major	Segregated suitable storage in dedicated waste management area Test excavated spoil/sand sample in an approved service provider and laboratory and inform the proponent authority of results where applicable No storage. If quality permits, spoil material will be used for concrete formation and establishing foundations (e.g. crushed material pumped concrete, road aggregate). Excess material will be disposed of in spoil disposal sites or used to level off the site.	Spoil disposal site through a registered waste management company. The appropriate government regulatory body shall approve these landfills.
Concrete waste	Fugitive dust emissions Opportunity to generate recycled resource (aggregate) from waste Reduction in available landfill capacity	Moderate	Segregated suitable storage of solid waste concrete in dedicated waste management area Return unused cement to supplier for potential alternative use and to limit waste generation onsite	Waste concrete will be crushed and used as road material or fill or buried in a separate landfill site. Soils contaminated by cement can also be used as landfill cover. To a construction waste recycling facility by SM permitted carrier

Waste type	Potential impact/benefit	Pre-mitigation significance	Proposed handling and storage	Proposed disposal
Concrete washings	Contamination of receiving environments	Moderate	Wash water which cannot be immediately reused is to be stored in an open lined pit or open tanks so as to aid evaporation	Concrete wash water to be reused on site wherever possible. On site concrete batching should include wash water recirculation. Remaining wash water to be stored and allowed to evaporate. Any remaining wash water to be fully treated (fine solids removed by filtration or settlement and pH corrected to 6-9) before being discharged to surface water only (i.e. not to bare ground)
Iron and steel scrap	The use of landfill, where waste re-use or recovery is not feasible Visual amenity impacts associated with poor storage of waste Increased waste miles from transporting waste materials from the project site.	Moderate	Segregated and suitably stored in a waste management area	Collected by competent carrier for recycling. Scrap metal will be sold for recycling, if possible.
Non-ferrous scrap	Loss of finite resources/materials Opportunity to generate recycled resource from waste Reduction in available landfill capacity	Moderate	Segregated suitable storage in dedicated waste management area to enable easy reuse/recycling	Collected by competent carrier for recycling.
Bricks and tiles	The use of landfill, where waste re-use or recovery is not feasible	Moderate	Segregated and suitably stored in a waste management area.	Recovery and re-use options to be fully explored. Collected by a competent carrier. Where recovery and re-use is not feasible then disposal in a licensed facility as a last resort.
Packaging and empty containers of non-hazardous materials	Reduction in available landfill capacity Opportunity to generate recycled resource from waste Visual impact of poor housekeeping/waste storage	Minor	Minimise requirements and return packaging to suppliers/delivery companies where possible Segregated suitable storage in dedicated waste management area to enable easy reuse/recycling	Collected by a competent carrier for recycling
Plastics	The use of landfill, where waste re-use or recovery is not feasible Visual amenity impacts associated with poor storage of waste Increased waste miles from transporting waste materials from the project site.	Minor	Segregated and suitably stored in a waste management area.to enable easy reuse/recycling	Collected by a competent carrier for recycling
Paper and cardboard	The use of landfill, where waste re-use or recovery is not feasible	Minor	Segregated and suitably stored in a waste management area.to enable easy reuse/recycling	Collected by a competent carrier for recycling

Waste type	Potential impact/benefit	Pre-mitigation significance	Proposed handling and storage	Proposed disposal
	Visual amenity impacts associated with poor storage of waste Increased waste miles from transporting waste materials from the project site.			
Wood and pallets	Loss of finite resources/materials Opportunity to generate recycled resource from waste The use of landfill, where waste re-use or recovery is not feasible	Moderate	Segregated and suitably stored in a waste management area.to enable easy reuse/recycling	Reuse on site or collected by a competent carrier for recycling
Tyres	The use of landfill, where waste re-use or recovery is not feasible Visual amenity impacts associated with poor storage of waste; and	Minor	Segregated and suitably stored in a waste management area.to enable easy reuse/recycling	Collected by a competent carrier for recycling They can be ground and used in asphalt paving materials.
Drums, barrels and containers	The use of landfill, where waste re-use or recovery is not feasible Visual amenity impacts associated with poor storage of waste	Moderate	Segregated and suitably stored in a waste management area.to enable easy reuse/recycling	Drums, barrels and containers may be disposed of by returning them to the vendor for recycling, or by crushing them, incinerating them and burying them in a landfill after incineration by competent company Collected by a competent carrier
General domestic waste	The use of landfill, where waste re-use or recovery is not feasible Visual amenity impacts associated with poor storage of waste Increased waste miles from transporting waste materials from the project site.	Moderate	Segregated and suitably stored in a waste management area	Collected by a competent carrier for disposal to landfill.
Hazardous Waste				
Oils and lubricants	Hazardous. Contamination of receiving environments The use of landfill, where waste re-use or recovery is not feasible	Major	Collected in bunded, segregated marked drums within a waste management area.	Collected by competent carrier to be disposed of in a licensed facility
Oil contaminated cloths	Hazardous. Contamination of receiving environments The use of landfill, where waste re-use or recovery is not feasible	Major	Segregated and suitably stored in a waste management area.	Collected by competent carrier to be disposed of in a licensed facility.
Paints and chemicals (and their containers)	Contamination of receiving environments The use of landfill, where waste re-use or recovery is not feasible	Major	Collected in bunded, segregated drums within a waste management area	Recovery and re-use options to be fully explored. Collected by a competent carrier. Where recovery and re-use is not feasible then disposal in a licensed facility

Waste type	Potential impact/benefit	Pre-mitigation significance	Proposed handling and storage	Proposed disposal
Batteries	Contamination of receiving environments The use of landfill, where waste re-use or recovery is not feasible	Major	Segregated and suitably stored in dedicated waste management area	Recycling options to be fully explored. Collected by a competent carrier. Where recycling is not feasible then disposal in a licensed facility
Florescent tubes	Contamination of receiving environments The use of landfill, where waste re-use or recovery is not feasible	Major	Segregated and suitably stored in dedicated waste management area	Collected by a competent carrier for recovery and re-use. Where recycling is not feasible then disposal in a licensed facility
Used solvents	Hazardous Contamination of receiving environments	Major	Collected in bunded, segregated drums within a waste management area	Reuse solvents as far as possible or returning them to the supplier. All remaining solvents to be collected by competent carrier and disposed of in a licensed facility
Potential contaminated excavated spoil	Contamination of receiving environments The use of landfill, where waste re-use or recovery is not feasible	Moderate	Segregated and suitably stored in dedicated waste management area	Collected by competent carrier to be disposed of in a licensed facility.

Source: Mott MacDonald

The environmental impacts of generated wastes associated with the construction phase of the project will be short-term and mostly reversible impacts. These potential impacts will be effectively managed through the construction waste management plan requirements and controls of the EPC Contractor’s detailed construction environmental and social management and monitoring plan (CESMMP).

The sensitivity of soils at the project site is assessed to be low as they are low value imported fill materials. The sensitivity of the marine environment close to the site is considered low as the site is within the existing SEWA Hamriyah complex defined as a developed industrial area and adjacent to the HFZA.

Considering the low likelihood of impacts to the soil and marine environment and the likely small quantities of excavated spoil/sand that would be generated by the project, and with consideration for the size of influences beyond the site boundary with respect to the wider Emirate waste management context, the significance of the impact of materials used and waste generated at the construction phase prior to mitigation is assessed to be minor.

9.5.2 Operational phase

Material use

Table 93 lists the anticipated material use and their potential impact during the operational phase of the project.

Table 93: Material use – operational phase assessment

Material type	Potential impact	Pre-mitigation significance	Proposed handling and storage
Non-hazardous			
Non-hazardous materials such as:	Use of finite resources/materials	Minor - not significant	Plant maintenance stores

Material type	Potential impact	Pre-mitigation significance	Proposed handling and storage
• Non-hazardous maintenance materials and spares • Ferrous and non-ferrous metals • Plastic • Glass • Paper and cardboard			
Hazardous			
Hazardous materials such as: • Natural gas • Distillate fuel • Oils • Lubricants • Solvent • Process chemicals such as: – Ammonia – Dry sodium phosphate – Trisodiumphosphate – ZOK 27 (turbine cleaning fluid) – Oxygen scavenger (Eliminox – non-carcinogenic) – Poly Hib CH (pH leveller and corrosion inhibitor for closed cooling water system) • Paints • Batteries • Fluorescent tubes	Contamination of receiving environments Fugitive emissions to atmosphere	Major	Gas Station and pipelines Distillate fuel storage tank and pipelines Chemical store Plant maintenance stores

Source: Mott MacDonald, 2018

Waste generation

An assessment of the anticipated solid non-hazardous and hazardous waste and their potential impact during operation of the project is presented in Table 94.

Table 94: Waste management - operational phase assessment

Waste type	Potential impact/benefit	Pre-mitigation significance	Proposed handling and storage	Proposed disposal
Solid non-hazardous waste				
Sludge from chemical and sewage treatment plant	The use of landfill, where waste re-use or recovery is not feasible Visual amenity impacts associated with poor storage of waste Increased waste miles from transporting waste materials from the project site.	Not significant	Segregated and suitably stored in dedicated sludge drying beds	Disposal by competent carrier in a licensed facility
Material from seawater intake trash screens	The use of landfill, where waste re-use or recovery is not feasible	Moderate	Quantity of biological organisms to be monitored and extra screens/mitigation measures implemented if necessary. Living organisms to be returned to sea. Dead organisms to be disposed of in landfill.	Disposal by competent carrier in a licensed facility

Waste type	Potential impact/benefit	Pre-mitigation significance	Proposed handling and storage	Proposed disposal
Non-hazardous industrial maintenance wastes such as: • Metals • Plastics • Packaging • Wood	The use of landfill, where waste re-use or recovery is not feasible Visual amenity impacts associated with poor storage of waste Increased waste miles from transporting waste materials from the project site. Opportunity to generate recycled resource from waste	Minor	Segregated and suitably stored in a waste management area	Recycling options to be fully explored. Collected by a competent carrier. Where recycling is not feasible then disposal by competent carrier in a licensed facility
Domestic waste	The use of landfill, where waste re-use or recovery is not feasible Visual amenity impacts associated with poor storage of waste Increased waste miles from transporting waste materials from the project site. Opportunity to generate recycled resource from waste	Minor	Segregated and suitably stored in a waste management area	Disposal by competent carrier in a licensed facility
Solid hazardous wastes				
Oil contaminated cloths	Contamination of receiving environments The use of landfill, where waste re-use or recovery is not feasible	Major	Segregated and suitably stored in a waste management area	Disposal by competent carrier in a licensed facility
Empty chemical containers	Contamination of receiving environments The use of landfill, where waste re-use or recovery is not feasible	Major	Segregated and suitably stored in a waste management area	Disposal by competent carrier in a licensed facility
Used filters	Contamination of receiving environments The use of landfill, where waste re-use or recovery is not feasible	Major	Segregated and suitably stored in a waste management area	Disposal by competent carrier in a licensed facility
Batteries	Contamination of receiving environments The use of landfill, where waste re-use or recovery is not feasible	Moderate	Segregated and suitably stored in a waste management area	Disposal by competent carrier in a licensed facility
Fluorescent tubes	Contamination of receiving environments The use of landfill, where waste re-use or recovery is not feasible	Moderate	Segregated and suitably stored in a waste management area	Disposal by competent carrier in a licensed facility

Source: Mott MacDonald

9.6 Mitigation, monitoring, and enhancement measures

9.6.1 General measures

General waste management and overall management of hazardous materials will be managed for the construction and operational phases as follows:

- Detailed construction phase materials storage, handling and use plan and waste management plan which will form part of the construction phase environmental and social management and monitoring plan (ESMMP).
- Operational phase materials storage, handling and use procedures and a waste management procedure which will environmental and social management system. The waste management procedure will be required to include a site waste management plan (SWMP)
- Detailed construction phase hazardous materials storage, handling and use plan and waste management plan
- Material safety data sheets (MSDS) will be provided for all hazardous chemicals and substances during the construction and commissioning phases of the project
- Best practice waste management begins with waste prevention and minimisation which is achieved through the efficient storage, handling and use of raw materials. To achieve this aim for the project in construction and operational phases, the following material use and handling measures will be considered and included in the construction ESMMP and operational phase procedures as appropriate
- Re-using materials on site wherever possible. The most significant opportunity in the construction phase is with respect to excavated spoil
- Instituting good housekeeping and operating practices, including inventory control to reduce the amount of waste resulting from materials that are out-of-date, off-specification, contaminated, damaged, or excess to plant needs
- Instituting procurement measures that recognise opportunities such as ordering the correct amount of materials to be delivered when needed, reducing the amount of packaging used by suppliers and establishing a take-back system with suppliers
- Seeking ways to reduce raw material consumption through efficiency audits in the operational phase
- Substituting raw materials or inputs with less hazardous or toxic materials wherever economically and technically feasible

9.6.2 Material storage, handling and use

Material handling and storage areas will be established during the construction phase and then a number of these will be retained for the operational phase. These will be specifically designed giving due consideration to the following requirements:

- Located away from sensitive receptors
- Not at risk from theft or vandalism
- Prevention of being spoiled by the elements
- Easily accessible in a safe manner
- Well ventilated
- Unlikely to be damaged
- Located next to any required personal protective equipment (PPE) (as necessary for irritants and hazardous materials)
- Bunded and located next to spill kits (as necessary for hazardous liquids)
- The contractor will be required to develop a spill control, prevention and counter measure Plan and an Emergency Preparedness and Response Plan.

The construction ESMMP and operational procedures will include reference to the control measures to minimise the likelihood of incidents associated with materials storage, handling and use. This will include the following:

- Identification of the PPE requirements
- Identification of the bunding and spill kit requirements
- A map showing the material storage locations
- Training requirements (as necessary) with respect to materials handling procedures
- Procedure for reporting and dealing with environmental incidents related to spills/leaks
- Regulatory reporting requirements as they relate to materials storage
- Inventory of hazardous materials and specific procedures/ controls
- All hazardous substances used during the construction phase of the project will have a material safety data sheet (MSDS)

The IFC General EHS Guidelines require all waste material arisings (regardless of the stage of the project) to be segregated into non-hazardous and hazardous wastes for consideration for re-use, recycling, or disposal. Waste management planning should establish a clear strategy for wastes that will be generated including options for waste elimination, reduction or recycling or treatment and disposal, before any wastes are generated. A project-specific waste management plan documenting the waste strategy, storage (including facilities and locations) and handling procedures should be developed and should include a clear waste tracking mechanism to track waste consignments from the originating location to the final waste treatment and disposal location.

9.6.3 Construction phase waste/material management

All wastes generated during construction of the project will be collected and managed according to the management plans and procedures as described below. All wastes will be reviewed to maximise reclamation or recovery of materials through on-site processes or with outside contractors.

Management plans and procedures

The final waste management plan will identify likely waste arisings, appropriate handling, reuse and recycling opportunities and disposal methods. The waste management plan will be prepared in accordance with the applicable federal and local requirements of Sharjah and the IFC EHS General EHS guidelines (2007).

Key considerations for inclusion in the construction phase waste management plan are expected to be as follows:

- Best practice waste handling and final treatment options for each waste stream (e.g. re-use, recycling, recovery or disposal)
- Procedures for reduction of waste production and waste monitoring
- Waste collection and appropriate storage - hazardous waste will be segregated from non-hazardous wastes and shall be kept in a separate fenced area
- Appropriately defined mitigation/control measures for the relevant impacts
- The correct procedure for reporting any environmental incidents related to waste

The safe transportation, storage, handling, use and disposal of all hazardous chemicals and substances will be managed appropriately by activities including:

- MSDSs will be kept at the worksite for all chemicals that will be used for the project
- Hazardous chemicals are only to be allowed on site with the approval of the EPC contractor HSSE manager
- All chemicals will be stored in dedicated areas, which will satisfy the storage requirements of the respective MSDS. The amount of chemicals permitted to be located at the work site will be strictly controlled by the EPC contractor
- Use of dedicated fittings, pipes, and hoses specific to materials in tanks and maintaining procedures to prevent addition of hazardous materials to incorrect tanks
- Use of transfer equipment that is compatible and suitable to the characteristics of the materials transferred and designed to ensure safe transfer
- Provision of secondary containment, drip trays or other overflow and drip containment measures
- Transportation of hazardous substances at the worksite will be carried out in strict compliance with the transportation requirements of the respective MSDS. In all cases the chemical being transported will be clearly identified by signs attached to the transport vehicle
- Prior to any employee, supervisor or manager commencing work which involved hazardous materials they will be properly briefed and trained on all safety requirements pertaining to that particular chemical or hazardous substance and necessary clean-up/treatment procedures
- Disposal of any residual hazardous substance and/or its container shall be carried out in accordance with relevant standards and regulations, EPC contractor, consortium and MSDS requirements.

Temporary waste storage and handling

Temporary waste storage facilities will be provided for the construction phase. It is envisaged that these will be scaled down once the project moves into the operational phase.

These are intended as a secure, short term storage for all waste streams generated on site prior to them being collected by relevant/component waste carriers for final disposal. They will be designed to include the following:

- Separate storage areas for hazardous and non-hazardous wastes
- Separate skips for each waste stream to allow segregation to maximise re-use and recycling opportunities
- All skips to be suitably covered (to avoid dispersion of light materials by wind or filling of skip with rain)
- Liquid wastes/oil/chemicals to be stored in tanks or drums located in bunded areas which can hold 110% of the capacity of the largest tank or drum in the bunded area
- Waste areas shall be located at least 50m from the high tide mark/cliff
- Spill kits to be available at all times

9.6.4 Operational phase waste management

For the operational phase, the production of a detailed waste management procedure for all operations at the project will be fundamental to ensuring best practice waste management is undertaken and embedded into the operational philosophy of the project. The waste management procedure will provide the following:

- Overview of relevant policy and legislation of UAE and Sharjah
- A site waste management plan (SWMP) which will be developed and will contain:

- A map showing each temporary waste storage location for the project
- A description of each waste stream generated by the operation of the facility, the appropriate handling methodology, the correct approach for temporary storage and the correct route for removal/disposal off site
- Staff training requirements with respect to waste handling procedures
- Waste generation data collection for each waste stream by volume. This should include the proportion of each waste stream going for reuse, recycling or disposal. A procedure for the identification of any unusual waste volumes
- Any waste monitoring as deemed necessary
- An audit schedule which details the frequency of waste management audits and those responsible for undertaking them
- A section related to continuous improvement and corrective actions whereby audit findings can be recorded and incorporated into updated waste management procedure. This will also highlight any new and feasible reuse and recycling opportunities which may arise over time
- A mechanism by which to routinely track waste consignments from the originating location to the final waste treatment and disposal location
- Procedures for identification and reporting of any environmental incidents related to waste
- The specific regulatory reporting requirements as they relate to waste

9.7 Residual impacts

Upon consideration of the expected impacts and proposed mitigation and management measures the use of landfill, where waste re-use or recovery is not feasible, is expected to remain. This impact could be reduced to ‘not significant’ or even partially beneficial when re-use and recycling opportunities become more accessible in future and will be continually assessed throughout the lifetime of the project.

A tabulated summary of the residual impacts associated with waste is presented in Table 95 highlighting the specific scheme and the phase of development (e.g. construction, operation) within which the impact will potentially occur.

Table 95: Waste management and material use - summary of impacts, mitigation and residual significances

Activity	Project phase	Potential impact	Sensitivity score	Magnitude score	Impact significance	Mitigation	Residual significance
Use of raw materials	• Construction • Operation • Decommissioning	Use of potentially finite and/or scarce resources.	Low	Moderate	Minor	Material use and handling measures will be considered and imbedded into the construction ESMMP and operational phase procedures as appropriate. • Re-using materials on site wherever possible. The most significant opportunity in the construction phase is with respect to excavated materials. • Implementing good housekeeping and operating practices, including inventory control to reduce the amount of waste resulting from materials that are out-of-date, off-specification, contaminated, damaged, or excess to plant needs • Implementing procurement measures that recognise opportunities such as ordering the correct amount of materials to be delivered when needed, reducing the amount of packaging used by suppliers and establishing a take back system with suppliers • Seeking ways to reduce raw material consumption through efficiency audits in the operational phase • Substituting raw materials or inputs with less hazardous or toxic materials wherever economically and technically feasible.	Not significant
Materials handling and storage	• Construction • Operation • Decommissioning	Spills and leakages of hazardous materials which lead to an environmental incident.	Medium	Moderate	Moderate	Material handling and storage areas will be established and specifically designed giving due consideration to the following requirements; • Located away from sensitive receptors • Not at risk from theft or vandalism • Prevention of being spoiled by the elements • Easily accessible in a safe manner; • Well ventilated • Unlikely to be damaged	Not significant

Activity	Project phase	Potential impact	Sensitivity score	Magnitude score	Impact significance	Mitigation	Residual significance
						• Located next to any required PPE (as necessary for irritants and hazardous materials) • Bunded and located next to spill kits (as necessary for hazardous liquids). The construction ESMMP and operational procedures will include measures and controls to minimise the likelihood of incidents associated with materials storage, handling and use.	
Waste generation, handling and storage	• Construction • Operation • Decommissioning	Contamination of receiving environments (particularly surface watercourses, groundwater and the ground) due to leakage and spillage of wastes associated with poor waste handling and storage arrangements.	Medium	Moderate	Moderate	Construction phase waste management plan which will form part of the construction phase ESMMP will be developed. Waste management procedure for the operational phase will be developed and will form part of an overall environmental and social management system. The waste management procedure will include a solid waste management plan. For the decommissioning phase, a DEMP will be prepared and include a section on waste management detailing the environmental protection controls which will be put in place. This will incorporate best practice at the time. Both the onsite and offsite waste storage facilities will be designed to include the following: • Separate storage areas for hazardous and non-hazardous wastes • Separate skips for each waste stream to allow segregation in order to maximise re-use and recycling opportunities • All skips to have a suitable cover • Liquid wastes/oil/chemicals to be stored in tanks or drums located in bunded areas which can hold 110% of the capacity of the largest storage vessel within the bu • Spill kits to be available at all times.	Not significant
		Fugitive emissions, such as dust and odour, associated with the handling and storage of some waste streams.	Low	Moderate	Minor		Not significant
		Visual amenity impacts associated with poor storage of waste.	Low	Minor	Insignificant		Not significant
Spoil handling and disposal	• Construction	Disposal of spoil and excavation material which results in land take.	Medium	Major	Major	Where possible, spoil material will be used as a construction material and for concrete batching.	Minor

Activity	Project phase	Potential impact	Sensitivity score	Magnitude score	Impact significance	Mitigation	Residual significance
						For material which cannot be re-used, the disposal method will be in spoil disposal sites which have been provisionally identified around the project area. Topsoil and overburden will be carefully removed from each of the proposed spoil disposal sites and stockpiled nearby and preserved for eventual use as rehabilitation material once the spoil disposal sites are no longer required. Geological composition testing will occur prior to commencing excavation. This composition testing will confirm whether the material is inert and can be safely disposed of within the project site. Depending upon the results of the geo-chemical testing, consideration will be given to the development of hazardous and non-hazardous waste management plans for adoption adopted during the detailed design phase. Should the potential for impacts from waste rock impurities be identified, it will be controlled and mitigated by covering waste disposals with non-contaminated soil. Control measures at each spoil disposal site (such as spot checking of spoil loads) to ensure that only material excavated from each of the schemes is deposited there.	
Choice of final waste disposal option	• Construction • Operation • Decommissioning	The use of landfill, where waste re-use or recovery is not feasible, which is a finite resource.	Medium	Moderate	Moderate	Characterise each waste stream as either hazardous or non-hazardous. Seek to minimise waste production in the first instance in accordance with the material use and handling measures. Where waste streams are unavoidable, highlight potential re-use, recycling and recovery (in that order) opportunities according to current best practice. Review the locally available re-use, recycling, recovery and disposal facilities from a capacity and quality perspective. Undertake this during detailed design.	Minor

Activity	Project phase	Potential impact	Sensitivity score	Magnitude score	Impact significance	Mitigation	Residual significance
		Increased waste miles from transporting waste materials from the project site.	Medium	Moderate	Moderate	Potential waste handling facilities will need to be further reviewed and identified for the construction and operational phase waste streams by the EPC and Consortium prior to the commencement of the respective phases. Similarly, there will be a need to review the locally available reuse, recycling, recovery and disposal facilities from a capacity and quality perspective.	Minor

Source: Mott MacDonald

10 Noise and vibration

10.1 Introduction

The construction and operation of the project is expected to generate temporary and permanent noise and vibration impacts which may result in effects at nearby noise sensitive receptors. This chapter presents an assessment of key noise and vibration impacts to identify any potential significant adverse effects and consider appropriate mitigation measures.

Temporary noise and vibration impacts are expected to arise due to the following construction phases:

- Site clearance and preparation
- Excavation and ground works
- Foundations, concreting, blockwork and structural works
- Equipment installation, infrastructure modifications and connections
- Site roads, paving and hard standings
- Testing and commissioning.

Permanent noise and vibration impacts of the project once operational are expected to be associated with additional plant and equipment which will be installed onsite. The main noise-emitting items are identified as the:

- Gas turbine (GT) and steam turbine (ST) packages located within the turbine building
- GT air inlet system and exhaust diffuser (external)
- Gas turbine (GT) and steam turbine (ST) generators (located externally)
- Heat recovery steam generators (HRSG)
- Exhaust stacks
- Bypass stacks
- Gas compressors
- Main GT and ST transformers
- Circulation pumps (water cooling)

The nearest receptors sensitive to noise and vibration are identified as follows with respect to the proposed site location:

- Rest area located approximately 40m south of the closest site boundary
- Hamriyah Town located approximately 2.5km north east
- Oberol Beach Resort located approximately 2.7km south west
- Al Zorah Golf Club located approximately 2.8km south

10.2 Methodology and assessment criteria

Guidance and standards relevant to the assessment of environmental impacts due to noise and vibration during the construction and operation of the project are described below. These are used to set out the methodologies and criteria that are used to assess:

- Temporary noise and vibration impacts due to construction activities

- Noise impacts due to construction (temporary) and operational phase (permanent) road traffic
- Permanent noise impacts due to the operation of fixed plant and equipment

10.2.1 Sensitivity of receptors

Sensitivity criteria for the assessment of noise impacts affecting sensitive receptors are assigned in Table 96.

Table 96: Noise sensitivity receptor criteria

Sensitivity	Type of receptor
High	Residential area, hospitals, schools, colleges or universities, places of worship, designated environmental areas, nature areas, high value amenity areas, cemeteries.
Medium	Offices, recreational areas, agricultural land.
Low	Public open spaces, industrial areas, car parks.
Negligible	Derelict land.

Source: Mott MacDonald, 2018

All of the identified nearest noise and vibration sensitive receptors include residential uses which are considered to have ‘High’ sensitivity for the purposes of this assessment. These are the key sensitive receptors of this assessment.

10.2.2 Magnitude

10.2.2.1 Reference national standards

EPSS TG9 – Requirements for the Reduction of Construction and Demolition Noise

This Technical Guideline[8] issued by the Government of Dubai and Dubai Municipality sets out “general policies, regulations, advices, procedures and other requirements.” It states:

“The noise level when measured outdoor should not exceed 55dB(A) between 7:00 A.M – 8:00 P.M and 45dB(A) between 8:00P.M – 7:00A.M and the UAE Federal Environment Agency noise limit stated in Table 1.”

Table 97 presents the noise level limits of the Executive Orders to Federal Law No. 12 of 2006.

Table 97: Noise level limit-UAE Federal Environment Agency

Receptor areas	Allowable limits of noise, dB(A)	
	Daytime (7 AM – 8 PM)	Night-time (8 PM – 7 AM)
Residential areas with light traffic	40 - 50	30 – 40
Residential areas in downtown	45 – 55	35 – 45
Residential areas with some workshops and commercial or near highways	50 - 60	40 – 50
Commercial areas and downtown	55 – 65	45 – 55
Industrial areas (heavy industry)	60 - 70	50 – 60

Source: UAE Federal Environment Agency

[8] Technical Guideline Number (9) Requirements for the Reduction of Construction and Demolition Noise. Environmental Planning and Studies Section. Environment Department. April 2011.

It is assumed that the closest residential receptors to the project site would be classified into the receptor area described as '*Residential areas with some workshops & commercial or near highways*' and the corresponding allowable limits apply.

The Guideline permitted hours of work are 07:00 to 19:00 Saturday to Thursday with no works allowed on Friday and public holidays. Works outside these hours can only be undertaken under exceptional circumstances and with prior approval.

The use of jack hammers or impact pile-driving is prohibited during night-time hours and in the period 19:00 to 22:00 a limit of 5dB over baseline levels is imposed.

10.2.2.2 Local Order No. 61 of 1991 on the Environmental Protection Regulations in the Emirate of Dubai[9]

Article 42 of Chapter VI – Noise Control states '*Level of noise emission from premises will be deemed reasonable if it does not exceed 55 decibel during the period 7am - 8pm and 45 decibel during the period 8pm – 7am. Exception to that will be holidays, official and popular celebrations and during such periods only'*.

10.2.2.3 World Health Organization 'Guidelines for Community Noise'

The World Health Organization (WHO) '*Guidelines for Community Noise*' (1999)[10] provides broad guidance on noise levels required to protect individuals from harmful levels of noise within a range of environments. This is an important reference which includes guideline noise values that are founded on the results of scientific research into the effects of noise on the population. This forms the basis of standards for noise used worldwide, including those described below. The specific values that are considered appropriate for consideration in the assessment of the project are given in Table 98.

Table 98: Relevant WHO guideline noise values

Specific environment	Critical health effect(s)	Guideline noise value
Outdoor living areas	Serious annoyance – daytime and evening	55 Leq,16hours dB(A)
Dwellings – outside bedrooms (window open)	Sleep disturbance – night-time	45 Leq,8hours dB(A)
Industrial, commercial, shopping and traffic areas, indoors and outdoors	Hearing impairment	70 Leq,24hours dB(A)

Source: WHO, 1999

The Guidelines do not specify the hours of the day over which the time bases apply because what is considered to be daytimes, evenings and night-times are expected to be dependent on the social and cultural trends of a country and therefore vary around the world.

10.2.2.4 Assessment of noise from construction activities

The WHO Guidelines generally apply to the permanent, operational noise impacts of a development. It is accepted that the temporary noise impacts generated during the construction of an industrial site are inherently higher than the permanent impacts arising under operation. Consequently, higher noise levels during construction are usually tolerated in the knowledge that the impacts are temporary.

[9] Local Order No. 61 of 1991 on the Environmental Protection Regulations in the Emirate of Dubai. United Arab Emirates, Emirate of Dubai, Dubai Municipality.

[10] Guidelines for Community Noise. World Health Organization (1999).

British Standard 5228 'Code of Practice for Noise and Vibration Control on Construction and Open Sites' (2009+A1:2014)[11] provides comprehensive guidance on construction noise and vibration including details of typical noise levels associated with various items of construction equipment plant or activities, prediction methods, and measures and procedures that have been found to be most effective in reducing impacts. The guidance forms the basis for the majority of construction noise assessments in the United Kingdom and is widely recognised internationally; it has been adopted for this assessment.

Based on the noise level limits specified by the UAE Federal Environment Agency in EPSS TG9 and guidance given in BS 5228, the magnitude of impact of noise due to general construction noise will be assessed using the scales presented in Table 99 assuming the majority of works will be conducted during normal daytime working hours.

Table 99: Assessment magnitude criteria of construction noise impacts

Definition	Construction noise level Leq dB(A)		Magnitude of impact
	Daytimes	Duration	
Potentially perceptible but non-significant change in conditions	<55	Months	Negligible
	<60	Weeks	
	<65	Days	
Perceptible but restricted change in conditions	55 - 60	Months	Minor
	60 - 65	Weeks	
	65 - 70	Days	
Material but non-significant change in conditions	60 - 65	Months	Moderate
	65 - 70	Weeks	
	70 - 75	Days	
Significant change in conditions	>65	Months	Major
	>70	Weeks	
	>75	Days	

Source: Mott MacDonald,2018

10.2.2.5 Assessment of noise from construction and operational phase road traffic

Traffic accessing the project site during the construction and operational phases may generate temporary increases in road traffic noise in the area. The UK methodology for predicting noise impacts due to free-flowing road traffic is the Calculation of Road Traffic Noise (CRTN)[12]. This demonstrates that a 25% increase in the volume of traffic (all other factors unchanged) is required to result in a corresponding 1 dB increase in traffic noise. This is the smallest change in steady-state road traffic noise that may be perceptible in the short-term.

The project site is accessed via Al Etihad Road, a major highway, and it is expected that associated construction or operational traffic will not increase traffic flows by 25%. Traffic on roads between the highway and the site are relatively remote from sensitive receptors and are accessed through principally industrial areas. Therefore, noise impacts due to road traffic are not expected to be significant provided that basic measures to minimise noise from construction traffic are applied (e.g. no unnecessary revving of engines, provide and maintain the surfaces of site roads with minimal discontinuities to avoid vehicle body rattle). This has therefore not been assessed further.

[11] British Standards Institution (2009+A1:2014) Code of Practice for Noise and Vibration Control on Construction and Open Sites Part 1 – Noise.

[12] HMSO and Welsh Office (1988) Calculation of Road Traffic Noise

10.2.2.6 Assessment of operational noise from fixed equipment

The magnitude criteria for operational noise impacts presented Table 100 have been developed based on the noise level limits specified by the UAE Federal Environment Agency that are presented in Table 97 and Local Order 61.

Table 100: Assessment of magnitude criteria of impact due to the operation of fixed plant

Criteria	Definition	Magnitude of Impact
Residential receptors - Daytime 55 Leq dB(A) - Night-time 45 Leq dB(A)	Operational noise level below criterion	Negligible
	Operational noise level less than 3 Leq dB(A) over criterion	Minor
	Operational noise level less than 5 Leq dB(A) over criterion	Moderate
	Operational noise level 5 Leq dB(A) or more above the criterion	Major

Source: Mott MacDonald, 2018

10.2.3 Assumptions, limitations and uncertainty

10.2.3.1 Construction

Construction noise is inherently variable in nature and strongly dependent on the proximity and duration of noise sources relative to receptors, and the simultaneous use of multiple items of equipment. It is not possible to accurately predict the distribution of equipment and the utilisation. Consequently, the assessment of construction noise impacts is based on an assumed usage of equipment based on the currently available plant inventory and site layout. A precautionary approach was taken in calculating impacts by assuming construction equipment will operate at the closets part of the project to the sensitive receptors.

10.2.3.2 Operation

The specification of equipment to be installed is still under development therefore assumptions regarding the noise emissions have been made with reference to characteristics of equipment used within power plants of a similar scale. All assumptions are stated below.

It should be noted that the assessment of operational noise considers steady state conditions only. It is expected that temporary, short-term noise impacts during start-up and blow-down may be significantly greater in magnitude.

10.3 Legislative framework

10.3.1.1 UAE national legislation

The noise limit levels of Federal Law No.12 of 2006 are listed in Table 97.

10.4 Significance of impacts

The significance of effects due to noise is a function of the magnitude of impact and the sensitivity of the receptor. Table 101 present the significance criteria to be used in this assessment.

Table 101: Impact evaluation, sensitivity and significance of effects

Magnitude of impact	Sensitivity of receptors			
	Negligible	**Low**	**Medium**	**High**
Negligible	Insignificant	Insignificant	Insignificant	Insignificant
Minor	Insignificant	Insignificant	Minor	Minor
Moderate	Insignificant	Minor	Moderate	Moderate
Major	Insignificant	Minor	Moderate	Major

Source: Mott MacDonald

10.5 Baseline description

The baseline noise measurements were undertaken during the daytime on 12 and 13 June 2018 and during the night-time on 26 June 2018.

Measurements were undertaken during the daytime on the existing site boundaries and comprised short-term, attended noise measurements made at three positions described as follows:

- Location 1 (N 25 27' 37", E 55 28' 31") – South west site boundary
- Location 2 (N 25 27’ 32”, E 55 28’ 40”) – South west site boundary opposite existing turbine buildings
- Location 3 (N 25 27' 40", E 55 28' 27") – South west corner of site

Ambient noise sources at the site boundary locations included; influence from the existing power plant operation and environmental noise sources (e.g. noise from ocean waves, birdsong, etc.).

Measurements were undertaken during the daytime and night-time periods at the nearest representative noise sensitive receptors and comprised short-term, attended noise measurements made at four positions described as follows:

- Location 4 (N 25 28' 38", E 55 29' 53") – Hamriyah Town
- Location 5 (N 25 27’ 29”, E 55 28’ 43”) – Rest area, approximately 40m south of the project boundary
- Location 6 (N 25 26' 15", E 55 27' 55") – North east boundary of Oberoi Beach Resort
- Location 7 (N 25 26' 13", E 55 28' 32") – Northern boundary of Al Zorah Golf Club

Ambient noise sources at the receptor survey locations included; road traffic, environmental noise sources (e.g. noise from ocean waves, birdsong, etc.), aircraft and commercial/industrial sources.

Measurement positions are shown in in Figure 76 and Figure 77.

Figure 76: Aerial view indicating ‘on-site’ noise measurement positions

Source: Google Earth Pro- used and annotated under license

Figure 77: Aerial view indicating 'off-site' noise measurement positions

Source: Google Earth Pro- used and annotated under license

All measurements were undertaken by consultants competent in environmental noise monitoring and completed in accordance with the principles of ISO 1996 'Acoustics – Description, measurement and assessment of environmental noise – Part 2: Determination of environmental noise levels' (2007)[13] which describes methods to be used for measuring and describing environmental noise relevant for general land use.

All acoustic measurement equipment used during the noise survey was designed to be in conformance with the Class 1 requirements for accuracy as set out in the international standard IEC 61672[14] for sound level meters and IEC 60942[15] for calibrators. The sound level meter and field calibrator used held current calibration certificates obtained under laboratory conditions

[13] ISO 1996 'Acoustics – Description, measurement and assessment of environmental noise – Part 2: Determination of environmental noise levels' (2007)

[14] International Standard IEC 61672 Electroacoustics – Sound level meters – Part 1: Specifications. 2003

[15] International Standard IEC 60942 Electroacoustics – Sound calibrators. 2003.

traceable to UK and International Standards. The details of the noise measurement equipment are listed in Table 102.

Before and after the measurement session, the reference calibration level of the sound level meter was checked using the field calibrator. No significant drift in sensitivity was identified over the measurement session (i.e. less than 0.2 dB).

Table 102: Noise survey equipment

Equipment	Serial number
Rion NL32 sound level meter	00861873
Larson Davis CAL200 field calibrator	6354

Source: Mott MacDoanld

The microphone of the sound level meter was supported using a tripod at a height of 1.5m above local ground level and fitted with a windshield suitable for outdoor use.

The sound level meter was configured to measure a range of acoustic parameters averaged over the measurement interval of 15 minutes. The following parameters were recorded:

- L_{Aeq} dB. The A-weighted equivalent continuous noise level in decibels
- $L_{A(max)F}$ dB. The A weighted maximum sound pressure level using the fast time weighting
- L_{A10} dB. The A-weighted noise level exceeded for 10% of the measurement interval
- L_{A90} dB. The A-weighted noise level exceeded for 90% of the measurement interval

Photographs of the measurement positions are shown in Figure 78 to Figure 84.

Figure 78: Measurement Location 1 (on-site), south west site boundary

Source: Mott MacDonald, June 2018

Figure 79: Measurement Location 2 (on-site), south west site boundary opposite existing turbine buildings

Source: Mott MacDonald, June 2018

Figure 80: Measurement location 3 (on-site), south west corner of site

Source: Mott MacDonald, June 2018

Figure 81: Measurement location 4 (off-site), Hamriyah Town

Source: Mott MacDonald, June 2018

Figure 82: Measurement location 5 (off-site), rest area

Source: Mott MacDonald, June 2018

Figure 83: Measurement location 6 (off-site), north east boundary of Oberoi Beach Resort

Source: Mott MacDonald, June 2018

Figure 84: Measurement location 7 (off-site), northern boundary of Al Zorah Golf Club

Source: Mott MacDonald, June 2018

Weather conditions during the noise measurements were fine and dry with clear skies. Wind speeds varied during the measurement period but did not affect measurement results.

Results of the noise surveys are summarised in Table 103 to Table 105.

Table 103: Summary of 'on-site' baseline noise survey results, daytime

Location	Start time	LAeq,15min dB	LAmax,f dB	LA10,15min dB	LA90,15min dB
1 South west site boundary	12/06/2018 13:49	55	84	60	50
2 South west site boundary adjacent existing turbine building	12/06/2018 12:56	64	94	67	61
3 South west corner of site	12/06/2018 13:22	53	83	57	50

Source: Mott MacDonald, 2018

Table 104: Summary of 'off-site' baseline noise survey results, daytime

Location	Start time	LAeq,1hour dB	LAmax,f dB	LA10,1hour dB	LA90,1hour dB
5 Hamriyah Town	13/06/2018 12:35	51	87	73	47
6 Rest area	13/06/2018 14:06	61	96	69	58
7 Oberol Beach Resort	13/06/2018 10:00	49	85	63	44
8 Al Zorah Golf Club	13/06/2018 11:08	55	90	77	37

Source: Mott MacDonald, 2018

Table 105: Summary of 'off-site' baseline noise survey results, night-time

Location	Start time	LAeq,1hour dB	LAmax,f dB	LA10,1hour dB	LA90,1hour dB
5 Hamriyah Town	26/06/2018 22:00	53	69	54	50
6 Rest area	26/06/2018 23:22	59	69	60	59
7 Oberol Beach Resort	26/06/2018 00:48	46	61	47	45
8 Al Zorah Golf Club	26/06/2018 02:07	49	72	49	39

Source: Mott MacDonald, 2018

10.6 Assessment of impacts

10.6.1 Construction

Table 106 presents an inventory of noise-emitting equipment that is assumed to be required during the various phases of the project construction. Reference noise levels obtained from BS 5228 – 1:2009 are given and described as the L_{Aeq} dB noise level at 10m distance from one item of plant operating continuously.

Table 106: Assumed construction plant inventory and utilisation

Phase or construction activity	Plant	Reference noise emission level for one item operating continuously LAeq,10m dB
Site clearance and preparation	Dozer	80
	Excavator	79
	Loader	63
	Dump truck	70
	Site generator	74
Excavation and ground works	Piling rig	80
	Dozer	80
	Excavator	79
	Vibratory roller	75
	Hydraulic hammer rig	87
	Vibratory compactor	82
	Loader	63
	Dump truck	70
	Site generator	74
Foundation, concreting and structural works	Heavy cranes	75
	Mobile crane	67
	Excavator	79
	Loader	63
	Dump truck	70
	Site generator	74
	Concrete pump	80
Equipment installation, infrastructure modifications and connections	Heavy cranes	75
	Mobile crane	67
	Excavator	79
	Loader	63
	Dump truck	70
	Site generator	74
Site roads, paving and hard standings	Dozer	80

Phase or construction activity	Plant	Reference noise emission level for one item operating continuously LAeq,10m dB
	Excavator	79
	Vibratory roller	75
	Hydraulic hammer rig	87
	Vibratory compactor	82
	Loader	63
	Dump truck	70
	Site generator	74

Source: Mott MacDonald, 2018

Calculations have been completed using plant reference noise levels given in Table 107 for each construction phase to predict noise levels from works at each sensitive receptor location taking into account variables such as; the proximity of receptors to the works, plant utilisation, the degree of ground absorption and screening attenuation.

It is assumed that the plant would be located at the closest part of the site perimeter with respect to receptor properties to evaluate the worst-case impacts. The results of the calculations are presented in Table 107.

Table 107: Summary of construction noise levels

	Noise level from construction works LAeq dB, façade level				
Receptor Location	Site clearance and preparation	Excavation and ground works	Foundation, concreting and structural works	Equipment installation, infrastructure modifications and connections	Site roads, paving and hard standings
Hamriyah Town	30	36	30	29	35
Rest Area	55	60	54	53	59
Oberol Beach Resort	29	35	29	28	34
Al Zorah Golf Club	29	35	29	28	34

Source: Mott MacDonald, 2018

Results indicate that noise levels from the construction works at the closest noise sensitive receptor (rest area located approximately 40m south of the site perimeter) are not expected to exceed the 60dB(A) noise level limit of the UAE Federal Environment Agency for daytime impacts during all stages of the work. The impacts would be lower still at all other, more remote receptors. With reference to the scales for the magnitude of impacts given in Table 99 and assuming each stage may occur over a period of months, then it is concluded that:

- Construction noise is expected to result in minor adverse impacts at the rest area receptor location during site clearance and preparation, excavation and ground works and site road, paving and hard standings phases
- Negligible impacts at rest area receptor location will occur during all other stages
- Negligible impacts during all stages at all other residential receptors during all phases

It should also be noted that noise level limits of the UAE Federal Environment Agency's '*Requirements for the Reduction of Construction and Demolition Noise*' are only required to be met if the receptor area is classified as '*Residential Areas with Some Workshops & Commercial or near Highways*'. This is because the upper limit is 60 dB(A) for daytime impacts. It is assumed that no significant works are required to be undertaken during the night-time.

10.6.2 Operation

The main noise impacts during operation are expected to arise due to the continuous operation of the plant and equipment to be installed on the site. These are identified as:

- Gas turbine (GT) and steam turbine (ST) packages located within the turbine building
- GT air inlet system and exhaust diffuser (external)
- Gas turbine (GT) and steam turbine (ST) generators (located externally)
- Heat recovery steam generators (HRSG)
- Exhaust stacks
- Bypass stacks
- Gas compressors
- Main GT and ST transformers
- Circulation pumps (water cooling)

A three-dimensional acoustic model was developed within DataKustik GmbH CadnaA software[16] which implements the procedures of the International Standard ISO 9613 'Acoustics Attenuation of Sound during Propagation Outdoors Part 2 General Method of Calculation' (1996)[17]. The model calculates noise levels at the nearest noise sensitive receptor locations during operational conditions.

The acoustic specifications for noise-emitting equipment were provided based on the outline plant design. Calculations assume that all plant operates continuously at typical duty levels for both day and night-time periods. Plant items will be included within the GT hall building which is understood will be constructed using a twin leaf masonry system. Noise break-out from the GT hall building has been determined over each façade and included within model calculations.

The sound power levels for the main noise emitting items to be installed in the outdoor environment that have been assumed for the calculations are presented in Table 108 based upon available information and our experience.

Table 108: Highest noise emitting operational plant items

Item	Single octave frequency band, Hz, sound power levels (dB)									Overall Lw dB(A)
	31.5	63	125	250	500	1k	2k	4k	8k	
Compressor	-	114	114	109	106	110	115	106	102	118
GT Exhaust Diffuser	122	123	119	115	112	108	109	108	105	116
Inlet Filter Face	116	112	101	105	101	112	105	97	93	113
Inlet Ducting	116	104	99	98	102	113	100	84	67	113
ByPass stack top	134	125	113	107	106	103	98	97	78	109
Main GT and ST transformer	112	112	114	110	110	104	99	94	87	109
Main Circulating Pumps	-	106	103	104	104	103	102	100	95	108
Condenser	120	116	112	108	99	95	95	84	68	105
Duct, diverter and stack	122	118	114	110	103	94	92	82	73	105
HRSG Inlet duct	117	115	114	106	94	95	96	94	60	104
Generator	105	105	104	102	98	97	96	84	87	102
HRSG Stack Top	104	102	106	105	98	94	87	76	67	100

[16] DataKustik GmbH CadnaA v2018

[17] ISO 9613 'Acoustics Attenuation of Sound during Propagation Outdoors Part 2 General Method of Calculation' (1996)

Item	Single octave frequency band, Hz, sound power levels (dB)									Overall Lw dB(A)
	31.5	63	125	250	500	1k	2k	4k	8k	
HRSG Body	117	113	109	104	96	85	79	66	58	99

Source: Mott MacDonald, 2018

Table 109 and Table 110 present a summary of the predicted free-field noise levels at each of the noise sensitive receptor locations, with respect to baseline measurements have been undertaken.

Table 109: Summary of predicted operational noise levels, daytime

Receptor location	Calculated steady state operational noise level, LAeq dB (free field)	Measured baseline ambient noise level (daytime) LAeq dB (free field)	Overall ambient noise level with project operational noise level LAeq dB (free field)	Change in ambient noise level due to the operation of the project LAeq dB (free field)
Hamriyah Town	36.9	51.2	51.4	0.2
Rest area	60.8	60.7	63.8	3.1
Oberol Beach Resort	35.0	49.3	49.5	0.2
Al Zorah Golf Club	33.8	54.7	54.7	0.0

Source: Mott MacDonald, 2018

Table 110: Summary of predicted operational noise levels, night-time

Receptor Location	Calculated steady state operational noise level, LAeq dB (free field)	Measured baseline ambient noise level (night-time) LAeq dB (free field)	Overall ambient noise level with project operational noise level LAeq dB (free field)	Change in ambient noise level due to the operation of the project LAeq dB (free field)
Hamriyah Town	36.9	52.5	52.6	0.1
Rest area	60.8	59.4	63.2	3.8
Oberol Beach Resort	35.0	45.9	46.2	0.3
Al Zorah Golf Club	33.8	48.6	48.7	0.1

Source: Mott MacDonald, 2018

A noise contour plot of the predicted noise levels during operation of the project is presented in Figure 85.

Figure 85: Contour plot of operational noise levels (project noise only)

Source: Mott MacDonald, June 2018

The results of predicted noise levels show that the combined noise levels from all plant to be installed is expected to be no greater than 36.9 dB(A) at the Hamriyah Town, Oberol Beach Resort and Al Zorah Golf Club noise sensitive receptors. This is below the day and night-time noise limit values, as described in Table 10.5, and contributes to a negligible increase to existing ambient noise levels. The day and night-time noise impacts at these receptors are therefore assessed as negligible.

Noise levels at the rest area, which is located approximately 40m south of the southern site boundary, are predicted to be 60.8 dB(A) which marginally exceeds both the 60dB(A) limit for the daytime period. For the night time period the existing baseline noise already exceeds the 50dB(A) limit in Article 42 of Local Order No. 61. The addition of the IPP is predicted to increase night time noise levels by 3.8dB(A). The change in ambient noise level is marginally above 3dB during the day time periods. The day and night-time noise impacts at the rest area location is assessed as moderate.

It should be noted that the classification of this receptor is unclear due to the uncertainty of its use and this assessment is based on a conceptual design using the assumptions stated above. It is recommended that the calculation of operational noise impacts at this location is revised as design details become more certain.

10.7 Mitigation, monitoring and enhancement measures

10.7.1 Construction

Noise and vibration impacts arsing during the construction phase of the project will be controlled by the application of best practices and any specific measures set out in the CEMP.

Although the assessment has indicated that impacts due to construction noise are expected to be low or negligible, the following methods should be considered to ensure the assumed conditions are attained. Please note that the recommendations below are not exhaustive but are the ones that are considered most applicable. All construction sites benefit from general best practice including:

- Regular communication with local residents
- All plant onsite should be the quietest model available and where needed silenced according to the manufacturers' recommendations
- Where practicable, construction plant should not be left operating at idle
- Fixed plant items (e.g. site generators) should be located at the greatest practical distance away from the nearest receptors, particularly the rest area located south of the site perimeter boundary
- Undertaking noisier activities during daytime hours and minimising and avoiding where possible any noisier work during more sensitive times of the day
- If undertaking noisy activities at night or in close proximity to a residence is unavoidable consider screening or enclosing the equipment
- Arrange for deliveries of equipment and transport of staff during daytime, avoid where possible the sensitive night time hours
- Establish haul routes away from the existing receptors

10.7.2 Operation

The assessment assumes that mitigation measures will be applied to reduce the breakout of noise from the buildings that enclose the gas and steam turbines and associated equipment. It is anticipated that specific measures will be identified and specified during the design stage, and that environmental impacts will be reviewed accordingly.

Practical, design-orientated measures to mitigate noise due to the operation of gas turbine facilities include:

- Specification of low noise equipment
- Lagging ducts
- Gas turbine vent fan casing and outlet silencers
- Appropriate specification of the building elements, apertures, doors and louvers for the turbine and generator building to minimise breakout noise
- Air inlet and ducting silencers
- The application of acoustic barriers around items such as transformers

With respect to the predicted moderate noise impacts associated with the rest area receptor it should be noted that this assessment is based on a conceptual design using the assumptions stated. It is recommended that the calculation of operational noise impacts is revised as details become more certain which may revise the predicted moderate impact at the rest area.

Mitigation measures to consider, should moderate adverse impacts at the rest area be confirmed, include relocation of the buildings or improving the sound insulation performance of the external building fabric (including external walls, roof elements, glazing and ventilation) to minimise noise impact for occupiers of this receptor.

10.8 Residual impacts and summary of mitigation measures

Table 111 provides a summary of the residual impacts considering the noise assessment undertaken and implementation of mitigation measures. No significant adverse residual impacts are expected with the application of the mitigation measures highlighted and based on the stated assumptions above.

Table 111: Noise and vibration - summary of impacts, key mitigation measures and residual significance

Phase	Activity	Impact	Magnitude	Sensitivity	Impact significance	Mitigation	Residual effect and significance
Construction	Site clearance and preparation Excavation and ground works Site road, paving and hard standings	Day and night-time noise impacts affecting the Rest Area receptor	Minor adverse	High	Minor adverse	Adherence to measures included within CEMP to minimise noise impact. Apply best practices in working methods. Inform residents of ongoing works. Avoid undertaking works during sensitive times of the day.	Negligible Not significant
	Site clearance and preparation Excavation and ground works Site road, paving and hard standings	Day and night-time noise impacts affecting residential receptors >1km away	Negligible	High	Not significant	Adherence to measures included within CEMP to minimise noise impact. Apply best practices in working methods. Inform residents of ongoing works. Avoid undertaking works during sensitive times of the day.	Negligible Not significant
	Foundation, concreting and structural works Equipment installation, infrastructure modifications and connections	Day and night-time noise impact affecting all receptors	Negligible	High	Not significant	Adherence to measures included within CEMP to minimise noise impact. Apply best practices in working methods. Inform residents of ongoing works. Avoid undertaking works during sensitive times of the day.	Negligible Not significant
Operation	Operational noise from plant and equipment to be installed at the site	Day and night-time noise impacts affecting residential receptors >1km away	Negligible	High	Not significant	Specification of low noise equipment. Application of noise control measures such as duct lagging, silencers and barriers.	Negligible Not significant.
	Operational noise from plant and equipment to be installed at the site	Night-time noise impacts affecting the rest area receptor	Moderate adverse	High	Moderate adverse	Specification of low noise equipment. Application of noise control measures such as duct lagging, silencers and barriers. Further assessment of noise impacts when more detail of design is known	Negligible-minor adverse Not significant.

Source: Mott MacDonald, 2018

11 Terrestrial ecology

11.1 Introduction

The United Arab Emirates is a signatory of the Convention on Biological Diversity (CBD). The CBD defines biodiversity as "…the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species, and of ecosystems". As a signatory country, UAE has a responsibility to safeguard its biodiversity, and, in accordance with Article 14 of CBD, as far as possible and as appropriate, to introduce procedures requiring environmental impact assessment of proposed projects likely to have significant impacts on biological diversity and to introduce arrangements to ensure environmental consequences of its policies and procedures are duly taken into account.

As a CBD signatory country, the UAE is also under obligation to address the Aichi Biodiversity Targets (Secretariat of the Convention on Biological Diversity, 2012- http://www.cbd.int/sp/targets/), which include goals to reduce the direct pressures on biodiversity and promote sustainable use (Strategic Goal B), and to improve the status of biodiversity by safeguarding ecosystems, species and genetic diversity (Strategic Goal C).

This section of the ESIA considers the terrestrial ecology of the site and surroundings of the proposed Hamriyah IPP. An assessment is presented of the potential impacts on the terrestrial ecology associated with the project's construction and operational phases which has the potential to negatively impact upon the local flora and fauna. Mitigation measures to address the potential negative aspects are considered within this section. Aspects relating to the marine environment are considered in section 7.

11.2 Methodology and assessment criteria

The methodology and assessment are based on the following actions:

- A qualitative baseline identification of the floral and faunal community types present in the area was established through a site walkover on 31st May 2018, and a desk-based study of available information.
- Assessment of the biodiversity value of the project site and thus indication of national and regional importance
- Emphasis on identification of sensitive and threatened/endangered species or communities
- Stakeholder meetings, particularly consultation with Ajman's Municipality and Planning Department in order to gain further information on the Al Zorah Protected Area Ramsar Site

A desktop study was undertaken. Examples of data sources reviewed as a part of the desktop study includes, but is not limited to:

- Urbanisation in the United Arab Emirates: The challenges for ecological mitigation in a rapidly developing country (Gardner and Howarth, 2009)
- The Comprehensive Guide to the Wild Flowers of the United Arab Emirates (Jongbloed, 2003)
- The Emirates A Natural History (Hellyer, and Aspinal, 2005)
- Al-Zora Protected Area Ramsar Information Sheet (Ramsar, 2017) Convention on Biological Diversity website (https://www.cbd.int/countries/default.shtml?country=ae)

- IUCN Red List of Threatened Species (http://www.iucnredlist.org)
- Red List of the mammals, reptiles and amphibians of the UAE (Environmental Research and Wildlife Development Agency, 2005)
- A Red List for the birds of the United Arab Emirates (Hornby and Aspinall, 1997)
- Bird Life International Data Zone (http://www.birdlife.org/datazone/home)
- Ramsar Convention (http://www.ramsar.org/wetland/united-arab-emirates)

The impact of the proposed project on the flora and fauna in the area is assessed in terms of direct physical disturbance and indirect effects associated with air or water pollution and noise. Particular attention is paid to any surrounding areas of high ecological value if identified which may be affected by the project and otherwise fall within the zone of influence.

Baseline ecological information is reviewed with reference to the concept/detailed design, the potential project and laydown land-use and foreseeable associated impacts such as noise, transport and air quality.

11.2.1 Spatial scope

With respect to the expected activities during the phases of the Hamriyah IPP project, the zone of influence (ZoI) criteria and resultant assessment incorporates the identification of:

- Protected sites
- Key habitats
- Key flora/fauna
- Migratory species

For habitats and species, the direct ZoI is considered to be the site area as defined by its ecological function.

The Al Zora Protected Area, approximately 3km to the south-east of the site, being a Ramsar Site of International Importance is also considered to be in the ZoI having been identified as a sensitive receptor and is considered and assessed for any impact on its terrestrial ecology. Section 7 on the marine environment considers issues potentially affecting the marine elements of Al Zora Protected Area, given that it has an opening to the sea approximately 4.7km south-west of the project site.

11.2.2 Baseline survey

The site is on reclaimed land that has subsequently been cleared and levelled. The baseline survey comprised of the qualitative baseline identification of the floral and faunal community types present in the area, established through a site walkover on 21/02/2018. All the habitats within the study area were identified on the basis of their respective plant communities and a plant species list for the ZoI was compiled.

February is considered to provide a good basis by which the baseline ecological conditions and sensitivity of the area can be ascertained coinciding with spring migration of birds.

Vegetation species present were photographed with GPS references taken, along with the photographing of vegetation in adjacent areas including of the mangroves occurring in Al Zora Protected Area.

Ajman's Municipality, in a stakeholder meeting (11/06/2018), indicated that they felt there would be no impacts from the project on the Al Zorah Protected Area.

11.2.3 Limitations

As the site has already been cleared and levelled the walkover survey confirmed that flora and fauna is very limited. The single survey was also not able to take account of seasonality as desert flora occupying sand habitats are often ephemeral and may only be present for a few weeks. In addition, a snapshot survey conducted at the wrong time of year is likely to underestimate fauna including for example reptile abundance and diversity, and migrant birds. The single survey was not able to examine terrestrial invertebrates, amphibians, reptiles, birds or mammals.

11.2.4 Assessment criteria

The terrestrial ecology assessment has identified possible receptors and determined their sensitivity based on published literature and expert judgement. The sensitivity categories are described in Table 112.

Table 112: Terrestrial ecology sensitivity categories

Sensitivity	
High	Ecosystem containing rich biodiversity, large numbers of threatened or endemic species that appear to be under immediate threat or subject to rapid decline e.g. UAE Red list of Terrestrial Mammalian Species, IUCN Red List 2004 (IUCN 2004) (Extinct, critically endangered, endangered). Habitat is made up of a number of biological units with vital roles to play in maintaining natural processes and dynamics e.g. have important seasonal uses or are critical for migration.
Medium	Ecosystem containing varying biodiversity, some evidence of threatened or endemic species e.g. species are categorised (ICUN 2004) Vulnerable, near threatened but represent a stable population in the survey area
Low	Species – least concern, data deficient. Distribution is unknown but not considered to be significant or threatened by the proposed development.
Negligible	Species – not listed. Habitat is of negligible diversity.

Source: Mott MacDonald

The magnitude of the impact from the plant’s construction, operation and decommissioning activities on that receptor were assessed using magnitude categories as described in Table 113.

Impacts were also identified as being positive or negative and permanent, temporary or reversible.

Table 113: Magnitude of impact categories

Magnitude of impact	
Major Beneficial/Adverse	Greater than 10 % change in total population or total habitat predicted.
Moderate Beneficial/Adverse	1 – 10 % change in total population or total habitat predicted
Minor Beneficial/Adverse	0.1 – 1% change in population or total habitat predicted
Negligible	No measurable change, which could be attributable directly to the development

Source: Mott MacDonald

The level of significance is then determined using the matrix shown in Table 114.

Table 114: Levels of significance

Magnitude of impact	Sensitivity of receptors			
	Negligible	Low	Medium	High
Negligible	Insignificant	Insignificant	Insignificant	Insignificant
Minor	Insignificant	Insignificant	Minor	Minor
Moderate	Insignificant	Minor	Moderate	Moderate
Major	Insignificant	Minor	Moderate	Major

Source: Mott MacDonald

11.3 Legislative framework

11.3.1 National legislation

The UAE has a considerable body of legislation at both federal and individual emirate levels which has been enacted to protect the environment. There are also international legislation and guidelines which must be considered, all of which are covered in Section 3 of this report.

Of key importance is the United Arab Emirates (UAE) Environmental Regulations prescribed within Federal Law Number 24 of 1999 for the Protection and Development of Environment and its successive executive regulations. Article 2, aims to achieve conservation of natural resources and biological diversity.

Sharjah environmental orders

Local orders and guidelines relating to terrestrial ecology specific to Sharjah are as follows:

- Law No. 6 of 1998, on the establishment of the Environment and Protected Areas Authority
- Amiri Decree No. 12 of 1997 on the establishment of the Environment and Protected Areas Authority
- Executive Council of the Emirate of Sharjah Decision No. 9 of 2000, concerning the formation of a special "Solid Waste Committee of the Commission."
- Administrative Decision No. 1 of 2008, on the conserving and maintaining the sustainable desert environment in the Emirate of Sharjah

11.3.2 International standards

Treaties and agreements

International treaties and agreements which are applicable include:

- The Convention on Biological Diversity, 1992
- Convention on the Conservation of Migratory Species of Wild Animals (also known as CMS or Bonn Convention

Lenders requirements

The following guidelines and standards which have to be followed are:

- Equator Principles 2006
- IFC Sustainability Framework and updated Performance Standards January 2012 (Performance Standard 6: Biodiversity, Conservation and Sustainable Management of Living Resources)
- IFC EHS General Guidelines, 2007

11.4 Significance of impacts

Potential impacts and the establishment of their magnitude are largely dependent on the extent and duration of change, the number of people or size of the resource affected and their sensitivity to the change. Impacts can be both adverse and beneficial and, where possible, the methodology elaborated in 11.2 will be applied to define beneficial impacts. The criteria for determining significance are specific for each environmental and social aspect and defined in 11.2.

Biodiversity on the project site is very low, with no species of national or international importance. As such construction, noise and vibration impact is considered of negligible impact and insignificant.

The Al Zora Protected Area, as a Wetland of International Importance (a Ramsar site) situated 3km to the south east of the project site has been identified as a sensitive receptor and is potentially vulnerable to construction and operation noise effects on wildlife, which is considered below.

11.4.1 Construction noise effects on wildlife

In respect to noise thresholds and the disturbance of birds there are three main pieces of research which are relevant to this assessment. The first, undertaken by the Institute of Estuarine and Coastal Studies (IECS), investigated the effects of construction on waterfowl on the Humber Estuary (Cutts et al., 2009[18]). The second area of research was carried out by the Institute for Forestry and Nature Research (IFNR) who have undertaken various studies on the effects of road traffic on woodland and grassland breeding birds in the Netherlands (for example Reijnen & Foppen, 1994[19]). The third research was carried out Leon Hawley (2003[20]) who investigated the effects of noise and vibration on wildlife.

Noise pollution can also cause stress in wildlife. Not unlike humans who can become stressed by the repeated sound of car alarms, animals become equally stressed. With stress, animals can have increased heart rates, metabolism and hormone imbalance, nervous system stimulation, increases respiration rates, increased blood pressure and shrinking of the ovaries and kidneys. All these side-effects from stress caused by noise can be seen as a major ecological impact.

11.4.2 Significance of effect from construction noise and vibration to wildlife

As construction works are to be carried out on the project site which is approximately 3km from Al Zora Ramsar Site, the predicted construction noise level of any task is assumed not to exceed 85dB LAeq,T. Therefore, construction noise impact upon wildlife is considered of negligible impact and insignificant.

11.5 Baseline description

The site is reclaimed land that has been levelled. The baseline is considered as terrestrial ecology recorded during the site walk over in February 2018 and accompanying desk top studies. The site is currently cleared with no significant land features or drainage lines and no signs of potential ground or groundwater contamination.

---

[18] Cutts, N., Phelps, A. & Burdon, D. (2009) Construction and Waterfowl: Defining Sensitivity, Response, Impacts and Guidance.

[19] Reijnen, R. & Foppen, R. 1994. The effects of car traffic on breeding bird populations in woodland. I. Evidence of reduced habitat quality for willow warblers (Phylloscopus trochilus) breeding close to a highway. Journal of Applied Ecology 31: 85-94.

[20] Hawley, L 2003 Effects of Man-made Noise and Vibration on Nearby Wildlife

The habitats identified were as follows:

- Reclaimed land of levelled sand on the site itself
- Laydown area of stockpiled sand

The Al Zora Protected Area, identified as a sensitive receptor is approximately 3km to the south east of the site and was designated a Wetland of International Importance on 27 September 2016 under the Ramsar Convention. The UAE has been a party to the Ramsar Convention since 2007. The location is shown in Figure 86 with the boundary of the protected area presented in Figure 87.

Al Zora Protected Area, as well as being a Ramsar site, is also an Important Bird Area (IBA). The Bird Life International IBA programme sets out to identify, document and protect all places on earth of greatest significance for the conservation of the world's birds. This non-statutory designation of the site as an IBA means that it is also a Key Biodiversity Area (KBA) - a site of global significance for the conservation of biodiversity.

Under Ramsar Convention Resolution VII.16 it is required for signatory parties to ensure that projects, plans and programmes and policies with the potential to alter the ecological character of wetlands on the Ramsar List, or impact negatively on other wetlands within their territories, should be subjected to environmental impact assessment (EIA). The Hamriyah IPP is being subjected to an ESIA and any impact on the ecological character of the wetland is examined in section 11.6 Assessments of Impacts section.

Figure 86: Map showing sensitive receptors and Al Zora mangrove area

Source: Mott MacDonald, 2018

Figure 87: Map showing Al Zora Protected Area

Source: Ramsar Convention, https://rsis.ramsar.org/ris/2309

11.5.1 Key findings

The key findings relating to the terrestrial ecology are summarised in Table 115 and Table 116. None of the vegetation species identified are threatened globally or nationally.

Table 115: Key findings on terrestrial ecology

Habitat/species	Key findings	Sensitivity
Reclaimed, cleared and levelled site	Low vegetation cover, with limited number of common species, dominated by *Tetraena qatarense*. No trees. No sign of small mammals or reptiles	Negligible
Laydown area of stockpiled sand	Low vegetation cover, with limited number of common species. No trees. No sign of small mammals or reptiles.	Negligible
Adjacent beach and littoral zone	Low vegetation cover, with limited number of species. All common. No trees. No sign of small mammals or reptiles	Negligible
Birds	Common species such as Crested Lark likely	Negligible

Source: Mott MacDonald; July 2018

Table 116: Local plants present within the site and adjacent to the site

Scientific name	IUCN Red List	National conservation status	International convention	Legally protected	Local abundance/ habitat	Conservation value
Tetraena qatarense	-	-	-	-	Reclaimed and levelled site; laydown area; Adjacent beach	Low
Halopeplis perfoliata	-	-	-	-	Reclaimed and levelled site; laydown area	Low
Salsola imbricata	-	-	-	-	Reclaimed and levelled site; laydown area	Low
Heliotropium kotschyi	-	-	-	-	Reclaimed and levelled site; laydown area	Low
Cyperus arenarius	-	-	-	-	Reclaimed and levelled site; laydown area; Adjacent beach	Low

Source: Mott MacDonald

11.6 Assessment of impacts

This section provides an assessment of potential impacts to receptors using impact magnitude, receptor sensitivity and the impact evaluation matrix discussed in Section 11.2.

11.6.1 Identification of construction impacts

Potential impacts during construction are as follows.

11.6.1.1 Loss of habitat on the project site

- Destruction of vegetation on main site, consisting of sparsely vegetated sand, dominated by *Tetraena qatarense*
- Destruction of any small mammal and reptile burrows
- Destruction / disturbance of bird nesting sites
- Dust deposition from construction activity
- Dust and exhaust emissions from vehicles and machinery
- Disturbance to neighbouring habitats

11.6.1.2 Impacts to Al Zora Protected Area Ramsar wetland

The potential for impacts of construction works causing adverse changes in the ecological characteristics of Al Zora Ramsar wetland, approximately 3km south-east of the site has to be considered. Potential impacts include:

- Emissions of combustion gases from construction equipment, machinery, diesel generators, diesel fuelled pumps and vehicles
- Dust emissions and deposition from land clearing, excavation, piling, construction loading/unloading/transportation of materials, wind blowing of stockpiles
- Noise generating activities: piling, excavation, construction traffic
- Pressure on wildlife posed by the construction workforce (hunting, poaching, fishing)
- Construction waste

The construction phase will involve emissions of combustion gases and dust generating activities such as earth moving and vehicle movement. The distances from the emission source at which significant construction dust effects are likely to occur are dependent on the prevailing wind direction, rainfall and the presence of screening.

Noise generated during construction will increase both the steady state and impulsive noise levels within the site and its immediate vicinity. Observable changes in bird behaviour are usually detected where steady state noise are above 85db and impulsive noise between 50db and 70db. The impact of construction noise on birds at Al-Zora Protected Area should be considered.

Construction workers can cause an additional pressure on wildlife through hunting, poaching and fishing.

Intentional feeding of food waste by construction staff to feral cats can lead to an increased population and a potential predator threat to wetland birds at Al Zora Protected Area.

11.6.2 Identification of operational impacts

11.6.2.1 Impacts on biodiversity on the project site

During the operation of the project the following are likely to give rise to biodiversity impacts on the project site:

- Bird-building and bird-road traffic collision
- Noise generating activities and road traffic
- Presence and visibility of people
- Artificial lighting
- Green space design

Birds are known to collide with manmade structures of various types including buildings and road traffic. Bird building collisions arise either in daytime, when birds cannot perceive images reflected in glass as reflections, and thus will fly into windows that they think are trees or sky; and at night time when light pollution can cause spatial disorientation which occurs particularly when visibility is low as a result of fog or other meteorological conditions. The site's coastal location and relative proximity to Al Zora wetland known to support migratory birds means that bird-building and bird-road traffic collisions are possible.

During operation, the project site will support a low diversity of species which may use any green space and landscape planting to be provided within the development. Whilst the effects of noise disturbance, presence and visibility of people and artificial light spill will occur on site there is a complete absence of sensitive receptors within the project site. The effects of these potential impacts are however discussed further in relation to Al Zora wetland. Creation of green space within the development will constitute a minor beneficial impact for biodiversity.

11.6.2.2 Impacts and change in the ecological character of Al Zora Protected Area

During the operation of the project the following have potential to give rise to biodiversity impacts on Al Zora Ramsar Site.

- Presence of feral cats and the keeping of free ranging domestic cats crossing into Al Zora Ramsar Site
- Noise generating activities and road traffic
- Artificial lighting

- Introduction and spread of invasive species.

The project has the potential to increase the number of feral cats through inappropriate waste management and to increase the number of free ranging domestic cats kept by project staff. The presence of feral cats and the keeping of free ranging domestic cats have the potential to adversely impact on Al-Zora by increasing the population of predators to wetland birds.

Noise disturbance and light spill are potential impacts during operation. Likely sources of disturbance include road traffic and perimeter on-site lighting.

11.6.3 Assessment of construction impacts

11.6.3.1 Loss of habitat on the project site

The destruction of vegetation on the main site, consisting of sparsely vegetated sand dominated *by Tetraena qatarense* is considered to be of negligible magnitude given the low vegetation species diversity, with no globally or nationally threatened species present.

Destruction of any small mammal or reptile burrows is also considered of negligible magnitude, given that none were observed during the site walk over. This also applies to bird nesting sites as none were observed during the site walk over, combined with the absence of trees. The project site has been cleared of vegetation and supports very limited habitat for reptiles. No reptile species were recorded on the project site during the site walkover; the likelihood of threatened reptile species or significant number of reptiles to occur on the project site is very low. It is considered that construction impacts on reptiles are of negligible magnitude.

Dust deposition from construction activity and exhaust emissions from vehicles and machinery will occur on vegetation on the perimeter boundary. The impact is considered to be of negligible magnitude, given that perimeter vegetation is of low species diversity, some of which are ornamental/amenity landscape plants, with no globally or nationally threatened species present. The landscape design and species to be planted are not known at the time of writing this report. Mitigation through dust suppression measures and screening will be needed.

11.6.3.2 Al Zora Protected Area Ramsar Site

The Al Zora Ramsar site and IBA/KBA is a protected area of international importance and high sensitivity. The individual impacts of construction on Al Zora are assessed below and only the magnitude of each impact is stated. The overall effect of construction on the ecological character of the Ramsar site is stated after taking into account the magnitude of each impact.

Habitats and flora in Al Zora can potentially be affected by dust deposition and emissions of combustion gases from construction activities on the project site. Research indicates that effects from construction activities that generate dust are generally limited to within 150-200m of the construction boundary. The risk of any soil/water pollutants from construction sites reaching the habitats of high sensitivity (intertidal mudflats and lagoons and mangroves) in Al Zora is considered to be low. These impacts are considered to be of negligible magnitude given the 3km separation distance between Al Zora Protected Area and the Site.

The flora in Al Zora Protected Area has low diversity and there are no globally or nationally threatened species. Any impacts on mangroves from dust deposition, combustion emissions or soil/water pollution are likely to be negligible in magnitude given the 3km distance from the construction site.

In the absence of mitigation, the large construction workforce may pose additional pressure on the wildlife in Al Zora through illegal hunting, poaching and fishing in spare time. This impact is considered to be of negligible magnitude given 3km separation distance and demarcation and signage at Al Zora.

Without appropriate waste management, the litter generated during construction may reach Al Zora, but this impact is likely to be of negligible magnitude.

The 3km separation distance between the project site and Al Zora Protected Area means that light spill has low potential to encroach on Al Zora with minimal or no adverse effects on birds. The impacts are considered to be of negligible magnitude because of the separation distance between the functional core of Al Zora and the project site.

Disturbance from noise and the visual presence of people has been found to have a fundamental influence on the behaviour of birds (e.g. Fitzpatrick & Bouchez, 1998[21]). Smit & Visser[22] (1993) found that noise in excess of 84db(A) results in a flight response from waders and wildfowl whilst noise below 55 db(A) elicited no response. Cutts et al.[23] (2009) also concluded that birds in most cases tolerated steady state noise levels between 55db(A) and 85db(A). Taking into account the 2.5 to 3km separation between the functional core of Al Zora and the project site the effect of noise disturbance is considered to be of negligible magnitude.

Cats *Felis catus* have been implicated in the extinction and population declines of a number of bird species (Blancher, 2013[24]) and the IUCN have listed cats in the top 100 most invasive species (Lowe et al., 2000[25]). The range of a domestic cat can be less than 2ha (Horn et al., 2011[26]) but can be as much as 6.88 ha (Thomas et al, 2014[27]). The range of feral cats can be significantly larger with ranges reported to be as large as 547ha but both domestic and feral cats stayed within 300m of buildings (Horn et al., 2011).

The implementation of the project will not involve construction of dwelling units, community facilities or retail and business districts, although construction workers may be inclined to feed food waste to feral and free-ranging domestic cats. The effect of predation from feral cats is considered to be of negligible magnitude.

11.6.4 Assessment of operational impacts

11.6.4.1 Impacts on biodiversity on the project site

During the operation of the project the following are likely to give rise to biodiversity impacts on the project site:

- Bird-building and bird-road traffic collision
- Noise generating activities and road traffic
- Presence and visibility of people
- Artificial lighting

---

[21] Fitzpatrick, S. & Bouchez, B. 1998. Effects of recreational disturbance on the foraging behaviour of waders on a rocky beach. Bird Study 45(2): 157-171.

[22] Smit, C.J. & Visser, G.J.M. 1993. Effects of disturbance on shorebirds: a summary of existing knowledge from the Dutch Wadden Sea and Delta area. Wader Study Group Bull. 68: 6-19.

[23] Cutts, N., Phelps, A. & Burdon, D. (2009) Construction and Waterfowl: Defining Sensitivity, Response, Impacts and Guidance.

[24] Blancher, P. 2013. Estimated number of birds killed by house cats (Felis catus) in Canada. Avian Conservation and Ecology 8(2): 3.

[25] Lowe, S. J., Browne, M. & Boudjelas, S. 2000. 100 of the world's worst invasive alien species. A selection from the global invasive species database. [pdf] Auckland: IUCN/SSC Invasive Species Specialist Group (ISSG). Available at: http://www.issg.org/pdf/publications/worst_100/english_100_worst.pdf.

[26] Horn, J. A., Mateus-Pinilla, N., Warner, R. E. & Heske, E. J. 2011. Home range, habitat use, and activity patterns of free-roaming domestic cats. Journal of Wildlife Management 75: 1177–1185.

[27] Thomas, R. L., Baker, P. J. & Fellowes, M. D. E. 2014. Ranging characteristics of the domestic cat (Felis catus) in an urban environment. Urban Ecosystems, 17 (4): 911-921.

- Green space design

Birds are known to collide with manmade structures of various types including buildings and road traffic. The relative proximity to Al Zora wetland known to support migratory birds means that bird-building and bird-road traffic collisions are possible. Bird building collisions arise either in daytime, when birds cannot perceive images reflected in glass as reflections, and thus will fly into windows that they think are trees or sky; and at night time when light pollution can cause spatial disorientation which occurs particularly when visibility is low as a result of fog or other meteorological conditions. However, given the stack design is a hard structure with no reflective glass the impact is considered of negligible magnitude.

During operation the project site will support a low diversity of species which may use any green space and landscape planting to be provided within the development. Whilst the effects of noise disturbance, presence and visibility of people and artificial light spill will occur on site there is a complete absence of sensitive receptors within the project site and is therefore considered of negligible magnitude. Creation of green space within the development will constitute a beneficial impact with regard to biodiversity and considered to be of minor/beneficial magnitude.

11.6.4.2 Impacts and change in the ecological character of Al Zora Protected Area Ramsar Site

During the operation of the project the following have potential to give rise to biodiversity impacts on Al-Zora Ramsar Site.

- The presence of feral cats and the keeping of free ranging domestic cats crossing into Al Zora Ramsar Site
- Noise generating activities and road traffic
- Artificial lighting
- Introduction and spread of invasive species

The Al Zora Ramsar Site is a protected area of international importance and high sensitivity.

Implementation of the project has the potential to attract predators including feral and free-ranging domestic cats to the project site and the Al Zora Protected Area. The potential impact is similar to those described above for the construction phase. The impact of feral and free ranging domestic cats is considered to be of negligible magnitude.

The effect of noise disturbance and artificial lighting on wetland birds is considered to be of negligible magnitude, and has the same considerations indicated in the assessment of construction impacts.

Landscape planting has the potential to introduce and spread non-native and invasive species. This risk is considered here to be low and of negligible impact magnitude minor, given that the 3km separation and that species used in landscape planting are likely to be selected mainly from native flora.

11.7 Mitigation, monitoring and enhancement measures

This section identifies a range of mitigation and enhancement measures. In addition to the above, community engagement and disclosure activities can play a key role in managing the extent of impacts and consideration shall be given to identification of enhancement measures. Enhancement measures are actions and processes that:

- Create new positive impacts or benefits
- Increase the reach or amount of positive impacts or benefits

- Distribute positive impacts or benefits more equitably

The ecological mitigation included in this ESIA follows the mitigation hierarchy (avoidance, minimisation, and compensation) and the Ramsar Convention guidelines for avoiding, mitigating, and compensating for wetland losses (Ramsar COP11, 2012). These guidelines stress the importance of avoiding wetland losses (or degradation) in the first instance, and this has been the overall objective of the Ramsar Convention since its creation in 1971.

In line with the ESIA methodology, this section presents the first steps of the mitigation hierarchy (avoidance and minimisation) to assess the residual significant effects.

The mitigation measures presented below are classified according to the mitigation hierarchy.

11.7.1 Construction

11.7.1.1 Generic construction mitigation

Minimisation: Control the accidental release of pollutants and potentially contaminated sediments

Pollution prevention and treatment measures will be implemented to include:

- Ensuring all toxic, hazardous and harmful materials, chemicals and the fuel are stored in bunded areas with impervious bases and soak pits to contain accidental spills
- Minimising the stored quantities of diesel, oil, paints, thinner or other chemicals that pose environmental hazards and fit all drums and barrels with flow control taps and ensure proper labelling
- Implementing fuel/chemical spill prevention procedures on the site and proper contingency planning, including availability of spill clean-up materials
- Ensuring emergency response procedures are in place and the construction site staff is adequately trained in spill prevention and clean up procedures. Spill kits and similar equipment should be provided on site

Minimisation: Minimise dust levels during construction

Level of dust will be reduced by implementing the following measures:

- The construction site should be fully fenced to serve as a wind barrier and for security purposes
- All soil that clings to the wheels of the trucks will be removed via spray of water before exiting the site
- All hauling trucks for excavated soil into an approved disposal site must be fully covered to prevent any soil/dust blown during transit from the site
- Ensure there is an adequate water supply available for dust suppression
- Stockpiles should be suitably covered within the site to prevent any wind event to blow dust and soil
- Site internal roads should be kept regularly damped down, compacted or suitably surfaced to minimise dust emissions from vehicle use
- Speed limits up to 20kph should be implemented throughout the site and site traffic should be minimised as practicable via security officers at the exit and entrance points.

11.7.1.2 Ramsar site and sensitive habitats

Avoidance: Avoid loss or degradation of habitat in Al Zora Protected Area

Al Zora Ramsar wetland of international importance and Important Bird Area (IBA) is a natural coastal wetland consisting of low-lying saline flats, lagoon, intertidal mud and sand flats and mangrove swamps. It supports a waterbird assemblage of national and international importance.

The locations and footprints of the works is sufficiently far from Al Zora Protected Area (3km) for construction activities not to cause loss or degradation of habitat in the wetland.

Minimisation: Prevent the spread of non-native invasive species

Non-native (alien) invasive species (AIS) are the second most prominent threat to the global biodiversity after habitat destruction. The likelihood of invasions by alien species is higher in habitats that are altered and disturbed. The A Zora wetland is highly susceptible to marine invasive species and to a lesser extent to terrestrial invasive species.

Invasive terrestrial plant species likely to affect sites in the UAE are the mesquite trees *Prosopis juliflora*. These Central and South American species are highly invasive in the UAE and care should be taken not to plant them on the project site or spread them further, either deliberately or accidentally (Gardner and Howarth, 2009[28]). The locations and footprints of the works is sufficiently far from Al Zora Protected Area (3km) for construction activities not to have any invasive species impacts in the wetland. Site landscaping will need to:

- Use native plants for reinstatement and landscaping
- Assess any non-native species (to be used in landscaping) for AIS potential

11.7.1.3 Mitigation applicable to terrestrial wildlife (mammals, birds and reptiles)

Minimisation: Minimise period excavations are left open, fence off and/or cover open excavations when not working, undertake periodic checks of excavations to remove any entrapped animals

Deep excavations will be fenced off to prevent the access of wildlife and people while not working (including at night). Twice weekly checks of open trenches and other excavations will be undertaken to identify any entrapped mammals. Rescue of any entrapped animals will be undertaken with extra care to minimise animal stress and the risk of injury. For trenches that will need to be left open for a considerable time, install slopes or other escape measures for small animals at places that are not fenced of (where possible). This may reduce the need for twice weekly monitoring and therefore personnel costs considerably.

Minimisation: Capture and translocation of animals from the project site

Any mammals and reptiles seen on site before or during construction will be allowed to leave the site or will be captured and translocated to a site supporting suitable habitats for those species.

It is important to note that species translocation can be time consuming and expensive and should be used in conjunction with other forms of mitigation. Any translocation should follow the IUCN guidelines on effective translocation and reintroduction programmes (Gardner and Howarth, 2009).

Minimisation: Implement noise reduction measures and avoid/reduce artificial lighting to reduce impacts on birds and mammals during construction

[28] Gardner, A., Howarth, B. 2009. Urbanisation in the United Arab Emirates: The challenges for ecological mitigation in rapidly developing countries. BioRisk 3: 27-38.

Noise levels within Al Zora should not exceed 85db(A) for steady state noise and pre-construction baseline or 55db(A), whichever is greatest, for impulsive noise. The following measures will be implemented across the works areas to reduce noise levels and disturbance to birds and other sensitive ecological receptors:

- Avoidance of unnecessary revving of engines and switching off equipment when not required
- Maintenance of internal haul routes and avoidance of steep gradients
- Minimizing drop height of materials
- Artificial lighting used on construction sites and camps will be shaded and directed downwards to avoid light spillage and disturbance to birds and other wildlife

Minimisation: Implementation of hunting ban by construction staff to reduce pressure on threatened species

Hunting of all birds and certain other animals (gazelle, oryx, hare, spiny-tailed lizards) is prohibited in the UAE under Federal Law No. 9 of 1983. Nevertheless, illegal hunting, poaching and fishing may occur by the workforce. Therefore, additional measures are required to ensure all wildlife in Al Zora is protected. All construction staff will be required to follow company rules and code of conduct. The main contractors' environmental, health and safety (EHS) managers will be responsible for implementing the enforcement of bans (on hunting, fishing, keeping animals on site and feeding animals on site) and raising awareness about the relative proximity of Al Zora Protected Area and the importance of its biodiversity. Any staff member breaching the hunting ban will be subject to disciplinary action.

Minimisation: Make all construction staff aware of the importance of the Al Zora Ramsar Site, the threatened species and their habitats

To ensure adverse impacts on the Ramsar Site, threatened species and their habitats are avoided during construction, all contractor staff will be made aware of the importance of these habitats and species and their protection status. The main contractors' EHS managers will prepare and provide sufficient information through staff induction, toolbox talks, posters and leaflets.

Minimisation: Implement strict controls on waste management during construction to avoid feral and free-ranging domestic cats using Al Zora Protected Area

To minimise the potential for food waste available to feral or domestic free-ranging cats, all construction related staff will consume food in an indoors environment. Waste will be separated and managed according to international best practice.

11.7.2 Operation

11.7.2.1 Ramsar site and habitats

Minimisation: Landscape planting including the provision of tree planting

Planting of native trees within the project site will be considered as trees will provide screening, aesthetic and biodiversity value. Drip-fed irrigation of the planted trees will be provided regularly. Any planted trees should be maintained and monitored four times per year for five years. Maintenance would include a check on the condition and health of the planted trees, replacement of any dead or affected trees and control of weeds and pests.

11.7.2.2 Measures relevant to terrestrial wildlife on site

Minimisation: Implement noise reduction measures to reduce impacts on birds and mammals during operation

Noise mitigation measures that will be implemented to minimise disturbance to wildlife include:

- All noisy facilities should be enclosed
- Strictly implement speed limit within the new development
- Planting tree species to serve as noise barriers as well as natural air filters

Minimisation: Minimise artificial light spill by design

Specific measures will include:

- The amount of lighting will be minimised and alternatives such as white lining and LED cats' eyes will be used where this meets national standards for safety
- All operational lighting will be directed away from Al Zora Protected Area and all lighting will be directional and shielded
- Lighting inside commercial premises will be switched off outside of working hours during the hours of darkness unless required for essential security, safety or emergency situations
- No reflective surfaces will be installed beneath lighting.

11.8 Residual impacts

This section outlines the likely residual effects of the project on terrestrial ecology, taking into account all the mitigation measures proposed. Moderate and major effects are considered significant.

11.8.1 Construction

No significant residual effects are predicted for terrestrial habitats and species on the project site or Ramsar Site during the construction phase.

11.8.2 Operation

No significant residual effects are predicted for terrestrial habitats and species on the project site or Ramsar Site during the operation phase.

Mitigation measures and residual impacts are summarised in Table 117

Table 117: Terrestrial ecology - summary of construction and operation impacts and mitigation

Phase	Activity	Impact	Magnitude	Sensitivity	Impact significance	Mitigation measures/ benefit enhancement	Residual effect and significance
Construction	Site preparation, groundwork and clearing, construction	Site terrestrial ecology – pollution, noise, emissions of combustion gases, dust emissions and deposition, construction waste.	Negligible	Negligible	Insignificant	Adopt pollution control measures. Adopt screening & dust suppression to minimise dust levels. Weekly check to release any entrapped animals. Implement noise reduction measures.	Negligible
Construction	Site preparation, groundwork and clearing, construction	Al Zora Protected Area - emissions of combustion gases, dust emissions and deposition, pressure on wildlife, noise, construction waste, spread of invasive species to Al Zora Protected Area	Negligible	Negligible	Insignificant	Adopt pollution control & noise reduction measures. Adopt screening & dust suppression to minimise dust levels. Use of native plants for reinstatement & landscaping. Make staff aware of the location of Al Zora Protected Area Ramsar Site & its importance. Ensure proper waste management & no feeding of feral & domestic cats.	Negligible
Operation	Plant operation	Site terrestrial ecology	Negligible	Negligible	Insignificant	Landscape planting using native species for screening, aesthetic & biodiversity value. Implement noise reduction measures.	Negligible
	Plant operation	Al Zora Protected Area – noise, dust and emissions	Negligible	Negligible	Insignificant	Make operation staff aware of the location of Al Zora Protected Area Ramsar Site & its importance. Adopt pollution control measures. Adopt dust suppression to minimise dust levels. Minimise artificial light spill by design.	Negligible

Source: Mott MacDonald

12 Wastewater management

12.1 Introduction

This chapter considers the potential water quality impacts associated with construction and operation of the project. Key environmental aspects related to the management of wastewater sources and storm water have been considered and the potential impacts of discharge on land, water quality and/or amenity at nearby of local receptors.

12.2 Methodology and assessment criteria

The assessment of potential impacts associated with the generation of different wastewater streams during construction, operational and decommissioning phases of the project has been primarily based on a desk-based review of project information and data. Guidance and standards relevant to the assessment of environmental impacts, as are described in section 12.3 are used to set out the methodologies and criteria that are used to assess:

- Temporary impacts during construction activities
- Temporary impacts during operational phase
- Permanent impacts during operation of fixed plant and equipment

A walkover of the project site was also undertaken by environmental specialists in order to further consider the project in relation to existing wastewater treatment facilities, and connection to the municipal sewage and storm water networks.

The significance of potential impacts is a function of the presence and sensitivity of receptors and the magnitude of the impact in terms of duration, spatial extent, reversibility and likelihood of occurrence. The criteria for defining magnitude and sensitivity are summarised below.

12.2.1 Magnitude

The criteria applied for assessment of magnitude of impacts related to wastewater management are summarised in Table 118.

Table 118: Magnitude criteria

Component	Unit
Major	Mismanagement of wastewater results in a significant incident which potentially causes a fundamental change to the specific environmental conditions resulting in long-term or permanent change, typically widespread in nature (regional, national or international), and would require significant intervention to return to baseline; may also exceed national standards and limits.
Moderate	Mismanagement of wastewater results in an incident that causes a detectable change to the specific environmental conditions resulting in temporary or permanent change.
Minor	Mismanagement of wastewater results resulting in an incident that causes a detectable but minor change to the specific environmental conditions assessed.
Negligible	Mismanagement of wastewater results resulting in an incident that causes no perceptible change to the specific environmental conditions assessed.

Source: Mott MacDonald, 2018

12.2.2 Sensitivity

Sensitivity is generally site-specific and criteria have been considered with the baseline information gathered during the assessment process. The sensitivity of a receptor has been determined based on review of the surrounding environment and presence of features within the site. General criteria for determining sensitivity of receptors with regards to management of wastewater and storm water are outlined in Table 119.

Table 119: Sensitivity criteria

Component	Unit
High	Wastewater handling-related incident impacts on a vulnerable receptor (human or ecological e.g. schools, residential areas, hospitals, designated environmental areas, high value visual amenity areas) with little or no capacity to absorb proposed changes or minimal opportunities for mitigation.
Medium	Wastewater handling-related incident impacts on a vulnerable receptor (human or ecological e.g. offices, isolated residences, major roads, footpaths/cycle paths, agricultural land) with limited capacity to absorb proposed changes or limited opportunities for mitigation.
Low	Wastewater handling-related incident impacts on a vulnerable receptor (human or ecological e.g. scrubland, public open space, minor roads, industrial areas, car parks) with some capacity to absorb proposed changes or moderate opportunities for mitigation.
Negligible	Wastewater handling-related incident impacts on a vulnerable receptor (human or ecological e.g. scrubland, public open space, minor roads, industrial areas, car parks) with excellent capacity to absorb proposed changes and/or easily applied mitigation measures.

Source: Mott MacDonald Ltd, 2018

The level of significance is then determined using the matrix shown in Table 120.

Table 120: Impact evaluation and determination of significance

Magnitude of impact	Sensitivity of receptors			
	Negligible	Low	Medium	High
Negligible	Not Significant	Not Significant	Not Significant	Not Significant
Minor	Not Significant	Not Significant	Minor	Minor
Moderate	Not Significant	Minor	Moderate	Moderate
Major	Not Significant	Minor	Moderate	Major

Source: Mott MacDonald Ltd, 2018

12.3 Legislative framework

12.3.1 National legislation

The Federal Law No.24 of 1999 for the Protection and Development of Environment sets out in Chapter 2 – Protection of water environment and in its successive executive regulations the framework for the management of water and wastewater in the UAE. Local municipalities in the UAE are responsible for managing, disposing and treatment of wastewater. The project has been assessed with respect to the applicable UAE or local standards. Where specific regulations or standards are not available for the Sharjah Emirate, the relevant local legislative framework of Dubai Emirate is used for reference and guidance.

12.3.2 Local legislation

The following local legislative framework of Dubai Emirate is used as a reference guidance for wastewater management in Sharjah Emirate:

- Local Order No. 61 of 1991 on the Environmental Protection Regulations in the Emirate of Dubai
- Local Order No.8 of 2002 regarding Sewerage, Irrigation and Water Drainage
- DM Environment Department Information Bulletin 2003 on Environmental standards and allowable limits of pollutants on land, water and air environment

- DM - ECS Technical Guideline No.3 Requirements for the Installation/ Construction and Maintenance of Gravity Oil-Water Separator (2011)

12.4 Significance of impacts

The principal potential impacts which can arise from wastewater and storm water from all phase of the project are as follows:

- Contamination of receiving environments (particularly surface watercourses, groundwater and the soils) due to discharge of untreated/partially treated wastewater associated with poor handling, collection and treatment/disposal arrangements and controls
- Contamination of receiving environments (particularly surface watercourses, groundwater and the soils) due to discharge of polluted storm water associated with poor handling, collection and discharge arrangements and controls
- Uncontrolled releases, leakage or spill of wastewater due to mismanagement of handling of some wastewater streams
- Increased greenhouse gas emissions associated with onsite wastewater treatment
- Nuisance and odour impacts associated with poor management of wastewater
- Occupational health and safety (potential exposure to pathogen or infectious agent, odour, sanitary hazards).

12.5 Wastewater sources

For the Hamriyah IPP, the drainage systems are designed to allow separation for each of the wastewater streams. Independent drainage systems for each stream will be provided and will allow compliance with applicable requirements. The plant drainage systems are comprised of the following:

- Storm water system: drainage system collecting surface water run-off from building roofs, structures, paved surface, and asphalt roads
- Oily water system: network system collecting oil and grease contaminated effluents from various sources
- Process wastewater system: network system collecting contaminated effluents from various sources
- Sanitary water system: network system collecting sewage generated from offices and service area
- Chemical water drainage system: network system collecting chemical water discharge and runoff from areas where chemicals are applied or stored

The water balance of Hamriyah integrated power plant configuration is shown in Figure 88.

The sea water intake is 128,611.1m^3/hour. After the process cycle and water treatment processes, and considering all losses, as well as input from auxiliary cooling, the final discharge to sea is 128,366.4m^3/hour.

Construction phase

During construction phase, the main wastewater stream will be generated from chemical cleaning activities. Demineralised water with a quantity of approximately 2.5 the volume of each boiler will be used (e.g. 2.5 x 850m^3 = 2,125m^3 per boiler). Given that there will be three boilers on site, the total quantity of wastewater generated due to the chemical flushing activities will approximately be 6,375m^3.

Approximately 2,600m^3 of water will be required for hydrostatic tests of tanks and pipelines and system flushing.

In total 8,975m^3 of wastewater will be treated to meet the applicable standards during the construction phase. Wastewater will be collected and neutralised on site at temporary settling ponds and then collected by an authorised wastewater collection company for final disposal.

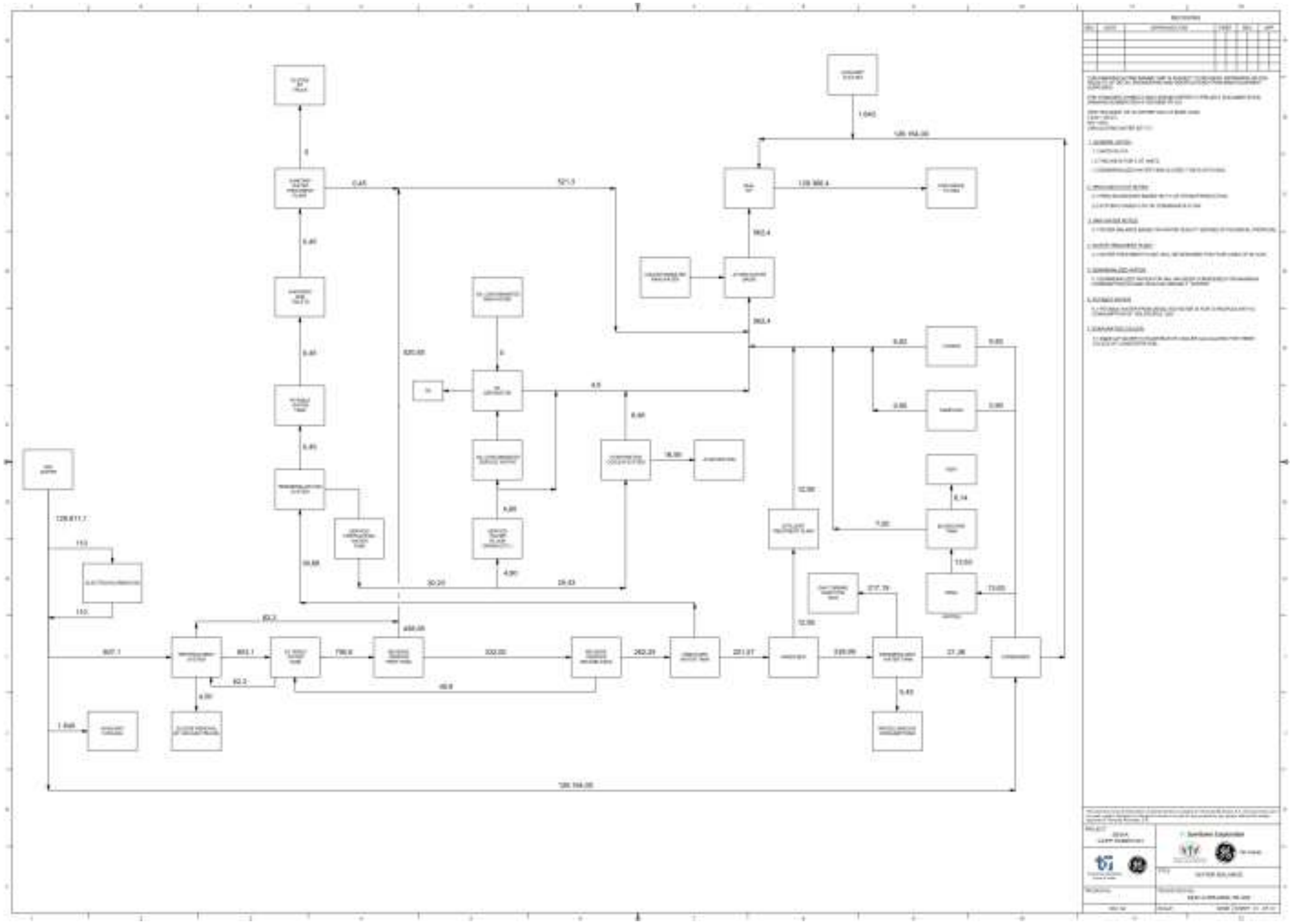
6,500m^3 of seawater will be abstracted during construction for the CW system hydro test and fire protection system ring. The generated wastewater will not require any treatments prior to its final discharge to the sea.

Operational phase

Below is a description of the wastewater streams that will be generated during the operational phase of Hamriyah IPP:

- Non-oily wastewater/drains:
  - Drains from blowdown tank will be collected in the stormwater basin. This stream will have an approximate flow of 7.5m^3/h
  - Other drains from cycle, such as losses and drains from sampling systems, will be collected in the stormwater basin. These streams will have an approximate total flow of 7m^3/h
  - Drains from mixed beds (regeneration water) will be sent to effluent treatment plan (ETP) for neutralisation. This stream will have an approximate flow of 13m^3/h
  - Drains from evaporative cooler blowdown will be sent to the stormwater basin. This stream will have an expected flow of 8.50m^3/h
  - The rejection from the reverse osmosis first pass will be sent to the stormwater basin. This stream will be brine water and will have an expected flow of 450m^3/h
- Oily wastewater/drains:
  - Drains coming from transformer areas will be contained in the transformers associated pits prior to transferring to an oil/water separator where oil will be stored for disposal by an authorised agent. Clean water will be sent to the stormwater basin. This stream has an expected average flow of 5m^3/h
  - Turbine building floor drains will be sent to an oil/water separator where oil will be stored for disposal by an authorised agent. Clean water will be sent to the stormwater basin
- Sewage wastewater/drains:
  - Sanitary wastewater from building facilities will be treated in sanitary water treatment modules. The treated water will be delivered through drainage water network to the seal pit without additional treatment. The sludge will be removed by an authorised agent. The expected flow of this stream will be 0.5m^3/h.
- GT drains:
  - Effluents from the gas turbine wash and from false starts (during liquid fuel operation mode) will be collected in the water wash/false starts tank for disposal by an authorised agent
- Stack drains:
  - Effluent from the drain from the stack will be collected in a container for disposal by an authorised agent

Figure 88: Water balance



Source: EPC proposal, 2018

12.6 Baseline

The Wastewater Management Department of Sharjah Municipality is the competent authority for wastewater and storm water management and the related permitting process in Sharjah Emirate.

The existing sewage treatment plant (STP) of Sharjah is located next to Sharjah City Centre in Al Sajaa Industrial Area 1 and is operated by the municipality. Major works for the STP expansion were completed in 2012, and the plant currently caters for 80 percent of Sharjah city connected to the sewer network. The municipality also operates two tollgates at the treatment plant for the entry and exit of sewage tankers. One of the tollgates is for tankers of private companies and the other for the tankers of the government. A recent initiative was launched in 2018, that is promoted by the Sharjah Municipality, Sharjah Research Academy and University of Sharjah, aimed at implementing a research project for the development of reusable treated wastewater from the Sajaa STP in Sharjah.

A programme aimed at improving the efficiency and capacity of the existing storm water and sewage networks in Sharjah is under development. The works include renovation of the main sanitary sewer system and the establishment of additional drainage points to radically solve the problem of rainwater runoff in many key areas in the emirate of Sharjah.

12.7 Assessment of impacts

Considering the proposed facilities and construction works, Table 121 and Table 122 summarise wastewater sources and streams during the construction, operation and decommissioning phases of the project as well as their potential impacts, their significance, how they will be handled and the method of disposal for each wastewater stream.

12.7.1 Construction and decommissioning

This section identifies environmental aspects and impacts associated with the wastewater streams generated from construction activities of the project. The same types of wastewater are anticipated to be generated/ used during decommissioning phase and therefore are also addressed here.

Table 121: Wastewater - construction phase assessment

Liquid non-hazardous waste	Potential impact/ benefit	Pre-mitigation significance	Proposed handling and storage	Proposed disposal
Washdown water from plant, vehicles or concrete washout	Contamination of receiving environments	Minor	Wash-water which cannot be immediately reused is to be stored in an open lined pit or open tanks so as to allow sedimentation of suspended solids and aid evaporation and prevent wastewater to enter soil/groundwater Comply with the requirements and guidelines stipulated within EAD Best Management Practices (BMP) Technical Guidance Document for Discharges from Construction Activities (EAD-EQ-PCE-TG-15)	Reuse for washing down water where possible Residual wash water to be fully treated (fine solids removed by filtration or settlement and pH corrected to 6-9) Wastewater not meeting the applicable federal standards to be tankered to municipal wastewater treatment facility by a permitted carrier
Dewatering effluent	Contamination of receiving environments	Moderate	Reuse of water onsite (i.e. for dust suppression) subject to water quality compliance with applicable water quality standards (DM Bulletin 2003)	Reuse for dust suppression subject to water quality compliance with applicable water

Liquid non-hazardous waste	Potential impact/ benefit	Pre-mitigation significance	Proposed handling and storage	Proposed disposal
			Develop a comprehensive dewatering plan as part of the CESMMP that details the location of dewatering activities, equipment, discharge point(s), emergency response measures and the proposed monitoring and reporting requirements. The monitoring shall include a requirement for a suite of chemical testing of the water and will include metals, benzene, toluene, xylene and ethylbenzene and hydrocarbons. Results of monitoring should be compared to Canadian water quality guidelines to assess disposal options. There is potential that some localised water will be unsuitable for disposal to surface or groundwater due to elevated concentrations of toluene which may require disposal off-site to a licenced facility Comply with the requirements and guidelines stipulated within EAD Best Management Practices (BMP) Technical Guidance Document for Discharges from Construction Activities (EAD-EQ-PCE-TG-15) Routing through flow control device (i.e. settlement tank, silt trap) prior to discharge to stormwater network	quality standards (DM Bulletin 2003) Permit from Sharjah Municipality – dewatering division for discharge via existing stormwater network or authorised wastewater management companies to be obtained, if required
Runoff water from construction areas	Contamination of receiving environments	Minor	Reuse of water onsite (i.e. for dust suppression) subject to water quality compliance with applicable water quality standards (DM Bulletin 2003) Routing through flow control devise (ie settlement tank, silt trap) prior to discharge to stormwater network Comply with the requirements and guidelines stipulated within EAD Best Management Practices (BMP) Technical Guidance Document for Discharges from Construction Activities (EAD-EQ-PCE-TG-15)	Reuse for dust suppression subject to water quality compliance with applicable water quality standards (DM Bulletin 2003) Permit of Sharjah Municipality for discharge to marine environment via existing stormwater network to be obtained, if required Wastewater not meeting the applicable standards to be tankered to municipal wastewater treatment facility by a permitted carrier
Hazardous waste	Potential impact/benefit	Pre-mitigation Significance	Proposed handling and storage	Proposed disposal
Sewage from workforce welfare facilities	Contamination of receiving environments	Not Significant	Above ground chemical portable toilet blocks and septic tank facilities Comply with the requirements and guidelines stipulated within EAD Best Management Practices (BMP) Technical Guidance Document for Discharges from Construction Activities (EAD-EQ-PCE-TG-15)	Sewage sludge to be tankered from site by an approved carrier to municipal sewage treatment plant All permits required to be obtained from Sharjah Municipality

Source: Mott MacDonald, 2018

12.7.2 Operational phase

An assessment of the anticipated effluents and wastewater streams generated during the operational phase and their potential impacts is presented in Table 122.

Table 122: effluent/liquid wastewater – operational phase assessment

Type	Impact	Generation rate	Flow type	Pre-mitigation significance	Proposed collection, interconnections and treatment	Proposed disposal
Stormwater	Potential contamination of receiving environment	Associated with seasonal rainfall	Temporary Runoff water from roofs, facilities and paved areas	Moderate	Potentially contaminated water. To be tested and classified in accordance with wastewater management regulations	Discharged to stormwater network
Sewage wastewater treatment/sludge	Potential contamination of receiving environment	Associated with routine operation and on-going maintenance in the facility and outages	Continuous	Major	Hazardous waste. Recovery and re-use options to be fully explored Where recovery and re-use is not feasible then disposal in a licensed facility	Wastewater from building facilities will be treated at sanitary water treatment modules. Sludge will be collected and disposed of off-site by an approved carrier at an authorised hazardous waste treatment facility All permits will be obtained from Sharjah Municipality
Effluents collected as a result of spills, leakages and/or accidental discharge	Potential contamination of receiving environment	Associated with routine and on-going maintenance in the facility and outages	-	Minor	Potentially hazardous waste. To be tested and classified in accordance with waste management regulations Recovery and re-use options to be fully explored Where recovery and re-use is not feasible then disposal in a licensed facility	Collected by a competent carrier for recovery and re-use after separate collection from the source. Collected and disposed off site by an approved carrier at an authorised hazardous waste treatment facility
Sewage spill or leakage	Contamination of receiving environments Diffusion of pathogens	Septic tank and sewage pipelines	-	Minor	Regular inspection of septic tank facilities and sewage network	Sewage sludge to be tankered from site by an approved carrier to municipal sewage treatment plant All approvals shall be obtained from Sharjah Municipality

Source: Mott MacDonald, 2018

12.8 Mitigation, monitoring and enhancement measures

General measures for wastewater and storm water management are embedded in the Hamriyah IPP design, as summarised in Table 123.

Table 123: Wastewater management measures embedded in the Hamryiah IPP design

Storm water system	Stormwater will be collected by gravity through the surface drain system to the drainage network, and then discharged to storm-water system
Oily water system	Oily water will be routed to a specific drainage network and it will be connected to the oily water separator and then discharge to oily waste water collection pit
Process wastewater system	The contaminated effluents from various sources will be routed to a specific drainage network and it will be connected to the waste treatment plant and then discharged to final discharge point
Sanitary water system	The sanitary sewer system will be sized to service the plant and will be designed in accordance with local codes and the required standards. Sanitary wastewater will be treated at a sewage treatment plant. Residual sludge will be collected and disposed of by an authorised company
Chemical water drainage system	An independent chemical water discharge system will be designed to discharge runoff from areas where chemicals are applied or stored. Concrete paving will be provided for chemical unloading or stored areas. Chemical water will be collected and neutralized in an effluent treatment plant at the power plant site. The chemical water drainage system will be designed in accordance with local codes and standards. Materials and components will be of adequate quality for the specific liquid to be transported and stored

Source: Mott MacDonald, 2018

12.9 Residual impacts

This section outlines the likely residual effects of the project for wastewater management, taking into account all the mitigation measures proposed.

12.9.1 Construction

No significant residual effects are predicted for wastewater management during the construction phase.

12.9.2 Operation

No significant residual effects are predicted for wastewater management during the operation phase.

Table 124 summarises the potential impacts, mitigation measure and residual impacts associated with the wastewater management.

Table 124: Wastewater - summary of construction and operation impacts, mitigation and residual impacts

Phase	Activity	Impact	Magnitude	Sensitivity	Impact significance	Mitigation measures/ benefit enhancement	Residual effect and significance
Construction	Washdown water from plant, vehicles or concrete washout	Contamination of receiving environments	Minor	Medium	Minor	Re-using water on site wherever possible. Detailed water management measures to be included in the CEMP developed by the Construction Contractor	Negligible
Construction	Dewatering effluent	Contamination of receiving environments	Major	Medium	Moderate	Detailed dewatering plan to be included in the CEMP developed by the Construction Contractor	Minor
Construction	Runoff water from construction areas	Contamination of receiving environments	Minor	Medium	Minor	Re-using water on site wherever possible. Detailed water management measures to be included in the CEMP developed by the Construction Contractor	Negligible
Construction	Sewage from workforce welfare facilities	Contamination of receiving environments	Negligible	Medium	Not Significant	Detailed construction waste management plan to be developed by the Construction Contractor as part of the CEMP Instituting good housekeeping and operating practices at the construction site	Negligible
Operation	Stormwater discharge	Potential contamination of receiving environment	Moderate	Medium	Moderate	The storage of hazardous materials must be on sealed surfaces with separate drainage, drain collection and water treatment for settling out The collection of surface run-off (rainwater) from coal storage area that washes fuel particles away and treating this collected stream (settling out) before discharge	Minor
Operation	Water treatment sludge	Potential contamination of receiving environment	Major	Medium	Moderate	Waste management planning should establish a clear strategy for wastes that will be generated including options for waste elimination, reduction or recycling or treatment and disposal, before any wastes are generated.	Minor
Operation	Effluents collected as a result of spills,	Potential contamination of receiving environment	Minor	Medium	Minor	Identification of the necessary bunding and spill kit requirement	Negligible

Phase	Activity	Impact	Magnitude	Sensitivity	Impact significance	Mitigation measures/ benefit enhancement	Residual effect and significance
	leakages and/or accidental discharge					Identification of the necessary PPE requirements Training requirements (as necessary) with respect to materials handling procedures The correct procedure for reporting any environmental incidents related to spills / leakages and how to deal with any spills / leakages. The specific regulatory reporting requirements. Inventory of hazardous materials and specific procedures/ controls. All hazardous substances used during the Construction phase of the project will be covered by a Material Safety Data Sheet (MSDS)	
Operation	Sewage spill or leakage	Contamination of receiving environments Diffusion of pathogens	Minor	Medium	Minor	Instituting good housekeeping and operating practices The correct procedure for reporting any environmental incidents related to spills / leakages and how to deal with any spills / leakages. Management of sewage sludge in accordance with the waste management plan	Negligible

Source: Mott MacDonald, 2018

13 Socio-economic issues

13.1 Introduction

This chapter of the ESIA presents the social impact assessment (SIA) undertaken for the project. The key areas that are discussed in this chapter include employment generation, workers' rights and working conditions, and community health and safety.

13.2 Methodology and assessment criteria

The SIA considers the area of influence and project affected area. Figure 89 shows the location of potential nearest sensitive receptors in the vicinity of the site, identified during the scoping phase.

Figure 89: Location of potential sensitive receptors

Source: Mott MacDonald, 2018

Within these areas, impacts identified with the potential to change the socio-economic context have been assigned significance using the framework detailed in section 13.2.1.

13.2.1 Determining significance of impacts and effects

Determining the significance of socio-economic and community impacts and their effects is one of the main purposes of an SIA. It enables the identification of necessary mitigation and benefit enhancement measures as well as an indication of the related financial costs associated with the social impacts of a project. A social impact can be either beneficial or adverse and is assessed by comparing the quality of the baseline conditions with the predicted quality of the social environment once the project is in place.

In order to describe the significance of an impact, it is important to distinguish between two concepts, magnitude (of impact) and sensitivity (of receptors). In situations where legal standards and established professional criteria are not available, sensitivity and magnitude is determined according to professional judgement and the classifications ascribed are supported with sound reasoning and factual evidence. The use of these two concepts for this SIA is outlined below.

13.2.1.1 Magnitude

The magnitude of an impact and its effects is the extent to which the impact results in a social receptor gaining or losing access to or control over socio-economic resources, resulting in a beneficial or adverse effect on their wellbeing.[29] The assessment of magnitude has been undertaken in two steps. Firstly, the key social impacts associated with the project and their related beneficial and adverse, direct and indirect, and cumulative effects have been identified. Secondly, the magnitude of impacts and effects have been categorised as either major, moderate, minor or negligible based on consideration of the parameters listed below along with professional judgement:

- Duration of the impact
- Spatial extent of the impact
- Number of people or groups affected
- Likelihood

Table 125 summarises the typical varying degrees of impact magnitude of social impacts.

Table 125: Criteria for determining magnitude of social impacts

Categorisation	Determination
Major adverse / beneficial	A probable impact that affects the wellbeing of groups of many people or business entities within a widespread area beyond the project life.
Moderate adverse / beneficial	A possible impact that will likely affect either the wellbeing of a group of people or business entities beyond the local area of influence into the wider area of influence or continue beyond the project life.
Minor adverse / beneficial	An impact that may affect the wellbeing of a small number of people and/or households or businesses, or occurs exceptionally, mostly within the project area of influence and does not extend beyond the life of the project.
Negligible	An impact that is localised to a specific location within the project's site boundary and is temporary or unlikely to occur with no detectable effect on the wellbeing of people or a business entity so that the socio-economic baseline remains consistent.

13.2.1.2 Sensitivity

The sensitivity of social receptors is related to their socio-economic vulnerability, measured by their capacity to cope with social impacts that affect their access to or control over additional or alternative social resources of a similar nature, ultimately affecting their well-being. Sensitive or vulnerable receptors generally have less means to absorb adverse changes, or to replicate beneficial changes to their resource base than non-sensitive or non-vulnerable receptors.

When considering sensitivity, the type of resources in question varies between social receptors. For example, a community's vulnerability might be measured in terms of their resilience to loss

[29] Well-being refers to the financial, physical and emotional conditions

of community facilities, whereas an individual's vulnerability can be considered as their resilience to deprivation, loss of livelihood assets or opportunities. Activities that increase impoverishment risks contribute to vulnerability. Impoverishment risks include landlessness, joblessness, homelessness, marginalisation, increased morbidity and mortality, food insecurity, loss of access to common property resources, and social disarticulation. Table 126 presents the guideline criteria used to categorise the sensitivity of receptors.

Table 126: Criteria for determining sensitivity of receptors

Value/sensitivity category	Determination
High	An already vulnerable receptor with very little capacity and means to absorb proposed changes or with very little access to alternative similar sites.
Medium	An already vulnerable receptor with some capacity and means to absorb proposed changes or with little access to alternative similar sites.
Low	A non-vulnerable receptor with limited capacity and means to absorb proposed changes and with some access to alternative similar sites.
Negligible	A non-vulnerable receptor with plentiful capacity and means to absorb proposed changes and with good access to alternative similar sites.

13.2.1.3 Assigning significance

The significance of an impact has been determined by the interaction between the magnitude of impacts and the sensitivity of receptors affected as depicted in the significance matrix shown in Table 127. Professional judgement has been used by appropriately qualified social scientists when assigning significance

Table 127: Impact evaluation and determination of significance

Magnitude of impact	Sensitivity of receptors			
	Negligible	Low	Medium	High
Negligible	Not Significant	Not Significant	Not Significant	Not Significant
Minor	Not Significant	Not Significant	Minor	Minor
Moderate	Not Significant	Minor	Moderate	Moderate
Major	Not Significant	Minor	Moderate	Major

13.2.2 Data sources

The socio-economic baseline to inform this SIA was developed through desktop research and a site visit. Desktop research includes a review of specific information as well as census data, web-based databases, human development reports and other documents that provide data concerning the area's socio-economic aspects such as population, demographics, health, education, and employment. The site visit entailed consultation and stakeholder engagement activities as detailed in Chapter 14.

13.3 Legislative framework

13.3.1 Federal social legislation

The main source of legislation in the UAE is Islamic law, which is enshrined in the UAE Constitution. The UAE Constitution was issued on 18 July 1971. It establishes the governing principles of the UAE federation and guides the formation of federal and municipal laws. The

UAE Constitution comprises 152 articles, a number of which establish social principles of relevance to the project. These include:

- Article 20: society shall consider work as a cornerstone of its development. It shall strive towards making it available for citizens and training them so that they are prepared for it. It shall create the appropriate circumstances by enacting legislation protecting the rights of the employees and the interests of the employers in the light of developing international labour legislation.
- Article 34: every citizen shall be free to choose his occupation, trade or profession within the limits of the law and with due observance of the regulations organizing some of these professions and trades. No person may be subjected to forced labour except in exceptional circumstances provided for in the law and in return for a consideration. No person may be enslaved.
- Article 40: aliens (*non-Emirati nationals*) shall enjoy in the Federation all rights and liberties provided in international Charters in force or in treaties or conventions in which the Federation is a party. In exchange they have to abide by the corresponding duties.
- Article 117: governance in each Emirate shall aim in particular at the maintenance of security and order within its territories, the provision of public utilities for its inhabitants and the raising of social and economic standards.

13.3.2 Federal labour laws

The UAE has ratified six of the eight core International Labour Organisation (ILO) labour conventions dealing with the elimination of forced and compulsory labour, the elimination of discrimination in respect of employment and occupation, and the abolition of child labour. The two conventions on freedom of association and collective bargaining have not been signed.

Federal Law No.8 of 1980 'Labour Law and its Amendments' (Law 8/1980) is the key legislation governing the rights of workers in the UAE, translating into federal law UAE obligations under ratified social international treaties, conventions and protocols.[30] The Law requires that employers provide employees with a safe work environment. The Ministry of Labour carries out inspections for compliance with labour legislation and safety standards. The maximum number of working hours per day is ten although the standard is eight. The maximum and standard number of working days is six. Trade unions do not exist and labour law does not address the right to strike. In the case of a dispute, the Ministry of Labour will act as a mediator. Non-national workers' residency permits must be sponsored by their employer. In 2003, the Federal Supreme Court ruled that employers could not legally withhold employees' passports.

In 2005, Ministerial Decree No. 467 was enacted regarding hours of work, weekly rest and paid leave. The Decree stipulates the hours of work, including work done outdoors in the sun. A four-hour midday break (12:30 p.m. to 4:30 p.m.) is required for outdoor labourers during July and August, the hottest months of the year. The Decree requires that if workers work more than 8 hours in a 24-hour period, they are to be paid overtime and employers are to post a sign indicating daily work hours. Employers are also to provide appropriate preventative measures to protect workers against occupational diseases and hazards.

[30] Issues covered by Law 8/1980 include: Employment of workers, juveniles and women; Employment contracts, records and remuneration; Working hours and leave entitlement; Employee safety, protection, health and social care; Disciplinary penalties that may be imposed by an employer or agent upon employees; Employment contract termination; and Indemnity for labour accidents and occupational diseases and compensation for permanent disability and death

Additional federal legislation covers foreign workers and workers' rights.[31] The Ministerial Decree 764 of 2015 aims to protect low-paid migrant workers from becoming forced labourers, and requires workers to sign employment contracts before they can be registered for employment.

13.4 Baseline description

13.4.1 Overview

This section describes the socio-economic conditions of the assessment area prior to project implementation, relating to population and demography, economic context, use of land, natural resources, and social infrastructure and services.

13.4.2 Population and demography

The Emirate of Sharjah's 2018 population is estimated at 1,406,000.[32] The population of Sharjah has increased by 163,000 since 2015, representing a 4.1% annual increase.[33] According to a 2015 census by the Department of Statistics and Community Development, the population is made up of over 175,000 Emiratis, while there are more than 1.2 million expatriates living in Sharjah comprising 88% of the total population.[34] For Sharjah's Emiratis, the population of females slightly outnumbers males, while there are significantly more male expatriates (68% of expatriates) than females (32%).[35]

Within the UAE, 85% of the population is urban based.[36] Most residents of Sharjah work for the private sector, while approximately 75,000 (5.2%) work for local or federal governments. The official language is Arabic while English, Hindi and Urdu are also spoken. The majority of residents follow the Islam religion.[37]

The nearest residential area from the project site is Al Hamriyah Community located approximately 2.7km north-east of the project site and falls under Hamriyah Municipality jurisdiction.

Nearest residential area in Ajman is Al Jerf area (4km from the project site), which contains more than 90% of the population of the neighbouring Emirate of Ajman. Amenities in Al Jerf include the Ajman City Centre shopping mall, Sheikh Khalifa Hospital, Sheikh Zayed Mosque and Ajman University.[38] The Al Etihad Road (E11) is located adjacent to the west of the Al Jerf area, and connects Sharjah, Ajman and Dubai.

[31] These include Cabinet Decision No.3 of 1977 'Concerning the Regulation of the Supply and Recruitment of Foreign Workers', Federal Law No.7 of 1999 'Concerning the Issuance of the Law on Pensions and Social Security' and Federal Law No.27 of 1999 'On their Establishment of the National Human Resource Development and Employment Authority TANMIA', and Labour Ministry Decrees No. 765 and 766, on rules for terminating employment and granting work permits to new employees

[32] These estimates represent the urban agglomeration of Sharjah, which typically includes Sharjah city's population in addition to adjacent suburban areas. https://gulfnews.com/news/uae/general/sharjah-s-population-crosses-1-4m-with-more-than-175-000-emiratis-and-1-2-million-expatriates-1.1965389

[33] 2018 UN World Urbanization Prospects

[34] https://www.thenational.ae/uae/government/more-than-1-4-million-people-live-in-sharjah-1.58066

[35] https://gulfnews.com/news/uae/general/sharjah-s-population-crosses-1-4m-with-more-than-175-000-emiratis-and-1-2-million-expatriates-1.1965389

[36] https://www.cia.gov/library/publications/the-world-factbook/geos/print_ae.html

[37] www.Wworldpopulationreview.com

[38] https://iwannaproperty.com/properties-in-al-jerf-1

13.4.3 Economic context, employment and labour sources

In 2014, the Emirate of Sharjah's GDP reached approximately AED113.89 billion.[39] Sharjah has 19 industrial areas that contribute to more than 48% of the UAE's gross industrial output. There are three ports with a total area of 49.6 million square metres in addition to two free zones: SAIF Zone and Hamriyah Free Zone (HFZA), with the former focusing primarily on light manufacturing and the services industries, and the latter concentrating on heavy industries. SAIF Zone is home to approximately 6,000 businesses from 90 countries while HFZA houses more than 5,000 companies from 150 countries.[40]

Sharjah holds a 10% share of the UAE's tourism economy and tourist attractions within the emirate include cultural and historical museums in the city of Sharjah, desert wildlife park, as well as beach resorts.[41] Fishing is both a source of touristic activities and livelihood, with game fish such as kingfish and barracuda available for deep sea fishing activities,[42] and approximately 1,490 fishing boats catching a total of 18,650 fish per year within the Emirate as of 2014.[43]

Overall, the Emirate of Sharjah is considered one of the key industrial bases of the UAE, having established a particular specialty in the industrial manufacturing sector through a network of free zone and industrial zones.[44]

Foreign labourers constitute over 90% of the private sector workforce in the UAE and primarily originate from India, Egypt, Bangladesh, Pakistan, Philippines and Indonesia.[45] As noted in section 13.3, trade unions, collective bargaining and striking are prohibited for migrants in the UAE. Through the Kafala immigration system, employers in the UAE exercise a significant degree of control over migrant construction workers, as this system binds individual migrant workers to a single employer and restricts workers' labour market mobility and bargaining power. Typical risks faced by workers include poor accommodation provision, retention of workers' passports, withholding of and insufficient payment of wages, payment of exorbitant fees by workers to recruitment agents,[46] as well as workplace accidents and injuries and health-related issues related to working in extreme temperatures.[47]

While legislation does exist for the UAE Ministry of Labour to monitor labour conditions such as the Ministerial Decree 764 of 2015 (as described in section 13.3.2), there continues to be challenges in monitoring and enforcing labour standards particularly in the construction industry, which often employs a highly contingent and flexible labour force through heavily subcontracted employment arrangements.

Foreign labourers with low incomes and dependent families in their home countries to who they have personal commitments to send remittances to, are considered to have high vulnerability and are therefore sensitive receptors.

---

[39] https://www.government.ae/en/about-the-uae/the-seven-emirates/sharjah

[40] http://hkmb.hktdc.com/en/1X09YM15/hktdc-research/Sharjah-The-UAE%E2%80%99s-Manufacturing-Stronghold

[41] https://www.sharjah.com/v/economy/

[42] https://visitsharjah.com/en/activities/all-activities/deep-sea-fishing/

[43] http://www.dscd.ae/en/MediaCenter/Publications/Pages/2014-year-book.aspx

[44] https://oxfordbusinessgroup.com/uae-sharjah-2018/economy

[45] https://www.migrationpolicy.org/article/labor-migration-united-arab-emirates-challenges-and-responses

[46] While UAE employers are prohibited from working with agencies that charge recruitment fees, the practice is still endemic in the construction sector.

[47] http://www.ilo.org/wcmsp5/groups/public/---ed_protect/---protrav/---migrant/documents/publication/wcms_538487.pdf, https://www.hrw.org/report/2006/11/11/building-towers-cheating-workers/exploitation-migrant-construction-workers-united

13.4.4 Use of land natural resources

The proposed project will be located within the Sharjah Electricity and Water Authority (SEWA) complex, where there are no settlements or assets belonging to other parties. The area to be developed is on reclaimed land which, although currently not utilised, was historically used as a laydown area and parking for construction equipment and machinery during the construction of the seawater intake and outfall structures.

The surrounding area is largely composed of industrial sites as part of the HFZA area. Recreational resources in the vicinity include a beach located adjacent to the boundary of the overall power and desalination complex (150-200m to the south of the IPP site) used by recreational campers and fishermen (Figure 90 and Figure 91).

Figure 90: Campers adjacent to the site

Source: Mott MacDonald, 22/02/2018

Figure 91: Campers on beach near site

Source: Mott MacDonald, 22/02/2018

Further away, the Oberoi Beach Resort Al Zorah in Ajman is located approximately 2.5km to the south of the site, while Al Zorah nature reserve and mangrove area, as well as the Al Zorah villa complex and golf club, are situated approximately 2.5-3km southeast of the site. The Al Hamriyah Public Beach is found 3km north of the site.

Traditional fishermen from Al Hamriyah, the Sharjah municipality in which the project site is to be located, engage in fishing in the vicinity through the Al Hamriyah Cooperative Association for Fishermen.

13.4.5 Social infrastructure and services

Residents in the country use approximately 550 litres of water and 20-30 kilowatt-hours of electricity per day.[48] As the economy grows, it is predicted that the energy demand will increase by 9% annually. Electricity demand in the UAE had reached 105 billion kilowatt-hours in 2013, placing the UAE among the highest electricity consumers per capita in the world.

Sharjah's current population stands at 1.4 million and is expected to grow to almost 2 million by 2020, making it the second-most populated emirate. SEWA plans to improve its power generation capacity by at least 1.5GW to reach self-sufficiency by 2021. It is understood that Sharjah is currently importing energy ranging from 700MW to 1,200MW, depending on the season, from the national grid.

[48] According to UAE State of Energy Report (2015)

Health care and medical services are of a high standard and life expectancy at birth in the UAE is 78 years of age for women and 74.5 for men.[49] Federal government hospitals provide free treatment to nationals while foreigners have to pay for medical services. In Sharjah, there are 15 hospitals with one bed per 1,670 individuals, serving a total of 1.5 million people.[50] School is compulsory for all children up to grade nine and there are high standards for education. Literacy rates for both genders are nearly 95% and the UAE is home to several public and private higher education institutions.[51] UAE citizens are eligible for free or subsidised housing. There is a social welfare system to assist vulnerable members of society, overseen by the UAE Ministry of Community Development.[52]

In contrast, social infrastructure and services available for migrant workers in the UAE are generally of poorer quality. Migrant workers in the construction sector are housed within temporary worker accommodation. Workers' rights issues that have been identified in such camps in the UAE include lack of freedom of movement, overcrowding, overheating, unhygienic conditions and violation of national minimum health and safety standards. Workers have also reported poor healthcare treatment, expensive treatments and difficulties in accessing medical professionals, despite the UAE having mandated employers' provision of health insurance for low-skilled workers.[53]

13.5 Assessment of impacts

13.5.1 Overview

The following have been identified as the key socioeconomic receptors who will be affected by the impacts of the project:

- The population of UAE who use electricity
- Potential skilled and unskilled local and foreign labourers
- Residential and recreational users of beach and sea, including fishers, residents and tourists

The significant impacts and risks that have been assessed for each phase are as follows:

- Construction phase: employment generation, risks to workers' rights and working conditions, local fishing livelihoods and amenities for local communities, beach residents and tourists
- Operations phase: local fishing livelihoods
- Decommission phase: none identified

An assessment of how the receptors may be affected, and further details on the impacts and risks that have been assessed, are presented in the following sections.

13.5.2 Construction phase

13.5.2.1 Employment generation

Employment generation will be the main socio-economic impact during the construction phase. The construction phase is expected to require approximately 1,500 labourers and up to 1,150

[49] https://gulfnews.com/news/uae/health/uae-residents-are-now-living-longer-says-study-1.1910020

[50] http://usuaebusiness.org/wp-content/uploads/2014/06/HealthcareReport_Update_June2014.pdf

[51] https://www.uae-embassy.org/about-uae/education-uae

[52] Widowed and divorced women, the disabled and the handicapped, the aged, orphans, single daughters, married students, relatives of jailed dependants, estranged wives and insolvents are entitled to monthly social benefits under Federal Law No. 2 of 2001.

[53] https://www.hrw.org/report/2009/05/19/island-happiness/exploitation-migrant-workers-saadiyat-island-abu-dhabi, https://www.thenational.ae/uae/400-labour-camps-risk-closure-for-violations-1.497524, https://www.business-humanrights.org/en/a-human-rights-primer-for-business-understanding-risks-to-construction-workers-in-the-middle-east

labourers at peak periods. International migrant workers from developing countries, typically in South Asia will be hired to fulfil many of the roles.

As noted in the baseline, foreign labourers are considered to be highly sensitive receptors to whom the creation of jobs will benefit in terms of increased incomes which can be used to send to families in the form of remittances. The workers who obtain jobs on the project may improve their skills base if training is provided and up-skilling takes place.

Combining high sensitivity and minor magnitude, this impact is considered to be minor beneficial.

13.5.2.2 Risks to workers' rights and working conditions

The approximately 1,500 migrant workers that will be used for the construction phase poses the risk that the project will not be able to uphold their human and labour rights in accordance with UAE labour laws and international good practice reflected by ILO core labour standards and lenders' labour standards. These risks are most relevant for migrant subcontracted construction workers because oversight of labour compliance is more difficult for the project to manage for these workers. Risks to workers' rights will be carefully managed and mitigated through measures detailed in section 13.6 so that these risks do not turn into significant adverse impacts.

13.5.2.3 Risks to community health, safety and security

A labour camp will not be built to accommodate labourers. Each sub-contractor will manage their own worker's accommodation and they will be brought in by buses to the site each day. The camps used will be existing facilities in 'worker cities' and the exact locations and names of the areas to be used is unknown at this time. The influx of migrant workers is not expected to negatively affect local communities as interaction between the two groups is likely to be minimal. There may be risks of road traffic accidents with construction vehicles for local communities, as access to the project site will be through the existing Al Etihad Road (E11) which is located adjacent to the Al Jerf residential area as discussed in section 13.4.2. This will be minimised with the implementation of mitigation measures proposed in Appendix G.

13.5.2.4 Local fishing livelihoods

Impact on biodiversity, in particular reduction of fish stocks due to entrainment of plankton, eggs or fish larvae, may reduce fisheries' stocks, which would potentially impact the livelihood of traditional fishermen from Al Hamriyah. Ajman Municipality and Hamriyah Municipality has indicated that fishing and recreational activities on the beach adjacent to SEWA Complex is illegal. Hamriyah Municipality confirmed that the beach was evacuated in February-March 2018. Additionally, a meeting with the Fishermen Society of Hamriyah was undertaken on 03/10/2018. The Project was described to them and copy of the scoping report was provided for their review. Subsequently, an official letter along with the executive summary of the ESIA and marine assessment chapter was submitted on 18/10/2018. Any comments received from the Society will be reflected within the project SEP and associated EMPs.

Based on information available at this time and confirmation from Hamriyah Municipality that fishing activities are carried out at least four-miles off the coast of the Hamriyah Community to the north east of project; we do not consider that fishermen will experience adverse impacts. Combining low sensitivity and minor magnitude, this impact is considered to be minor adverse.

13.5.2.5 Amenities for local communities, beach residents and tourists

Construction of the project may disrupt access to the amenities available on the adjacent beach, which is used by recreational campers and tourists (as described in section 13.4.4).

Given that the disruptions will likely affect a small number of local residences and there are several alternative beaches with amenities in the Emirate of Sharjah and neighbouring emirates, combining low sensitivity and minor magnitude, this impact is considered to be minor adverse.

13.5.3 Operations

13.5.3.1 Employment generation

The operational phase is expected to generate few direct employment opportunities with the number of jobs expected unknown at this time. Some roles such as management and administrative staff may be performed by the same personnel as in the construction phase, so the actual number of new jobs created may be lower than this estimate. The operational jobs will be primarily permanent, specialised and supervisory roles for skilled technicians.

Emirati job-seekers who qualify for these employment opportunities are less sensitive than the migrant labourers due to their higher level of livelihood capital in terms of education, skills, income earning potential and national rights. These jobs will be longer term or permanent positions but for fewer people than the construction phase. As such, due to the low sensitivity of the receptors and an impact of minor magnitude, the impact is considered to be beneficial but not significant.

13.5.3.2 Provision of additional electricity and energy security

During operations, the project will generate a 1,800MW of electricity which will be transmitted to the national grid. The increased electricity generation will contribute to national energy security and national income from energy for this growing emirate and is an impact of moderate magnitude. The population has existing access to the national grid and is therefore considered to have low sensitivity. Therefore, this is a beneficial impact of minor significance.

13.5.4 Decommissioning

13.5.4.1 Employment retrenchment

Upon potential decommissioning, there may be retrenchment (job loss due to closure of the power plant). As decommissioning is not likely to take place for several decades if it does occur, it is difficult to produce an accurate and meaningful prediction of the significance of the retrenchment impacts at this point. With appropriate retrenchment planning in place as detailed in Appendix G, we consider that any adverse impact of retrenchment can be sufficiently managed.

13.5.5 Summary of impacts

A summary of the potential impacts is shown in Table 128. Decommissioning phase impacts are not indicated as these impacts cannot be rated in terms of their magnitude and sensitivity at this stage.

Table 128: Summary of significance assessment of potential impacts

Potential impact	Adverse/ beneficial	Magnitude	Sensitivity	Impact significance
Construction phase				
Employment generation	Beneficial	Minor	High	Minor beneficial
Impact on fishing livelihoods	Adverse	Minor	Low	Minor adverse
Impact on local communities and beach users	Adverse	Minor	Low	Minor adverse
Operational phase				
Employment generation	Beneficial	Minor	Low	Insignificant
Provision of more electricity	Beneficial	Minor	Low	Minor beneficial

13.6 Cumulative impacts

Cumulative social impacts for a project such as this can include strategic induced population growth. We do not consider that the project will result in such cumulative social impacts.

13.7 Residual impacts

Provided that the mitigation measures identified within the ESMMP in Appendix G are put into place to ensure suitable working conditions for workers during the construction phase, residual socio-economic impacts are not anticipated.

13.8 Mitigation, monitoring and enhancement measures

13.8.1 Overview

In this section measures are proposed with the objective of enhancing beneficial and minimising adverse impacts and effects. These measures have been consolidated with mitigation and enhancement measures for other disciplines and will be implemented through the ESMMP. A outline of has been prepared to avoid, reduce and compensate adverse social impacts and enhance the beneficial impacts of the project during construction, operational and decommissioning phases. This document is to establish the management, mitigation and monitoring measures to be undertaken throughout the lifecycle of the project. Key social issues for monitoring in the construction and operation phases will be labour rights and working conditions as well as occupational health and safety. The ESMMP and subplans will include specific indicators and processes for monitoring and auditing including regularity, indicators and verification methods.

More details are provided within the ESMMP Framework (Appendix G).

13.8.2 Skill utilisation and development for local people

The generation of local employment, in particular permanent employment, and skills development has the potential to be one of the key benefits the project will provide to local communities. Resources will be allocated to recruiting and retaining local Emiratis, subject to availability of appropriately qualified staff. In order to maximise the long-term employment and skills development benefits to local communities, the project will adopt the following measures:

- Develop and disclose a recruitment policy that prioritises local employment, which will also be reflected in the contractor's employment policy.
- During the construction phase the EPC contractor will be required to identify local staff who can carry out construction work.

- Provide a description of the types of employment opportunities to be provided to local people from the construction and operational phases of the project including skills levels, indicative timeframes of recruitment, remuneration and benefits packages and likely duration of contracts.
- Provide vocational training schemes for young local people and people who worked in the construction phase to develop the skills base of the local community and enable people to benefit from long-term employment on the project in the operational phase. This could take a number of forms beginning with sessions in local schools.
- Develop a training and skills development programme for local workers to increase their skills and knowledge.
- To further support project staff, additional specialised training will be offered to unskilled or low skilled workforce in skills required by the project, and assistance will be provided to workers in obtaining professional certification or accreditation during their contract period.

Through such measures, the project will aim to enhance the significance of employment benefit to the region and local communities.

13.8.3 Labour and occupational health and safety management

The following specific measures and/or the development of labour policies and procedures will be employed by the project to ensure that the well-being of both project and sub-contractor workers are protected in accordance with national law, International Labour Organisation (ILO) core labour standards and international best practice:

- Working conditions and management of worker relationships:
  - Develop and disclose staff grievance polices and mechanisms for complaints about unfair treatment or unsafe living or working conditions without reprisal
  - Adopt a human resource policy appropriate to the size and workforce which indicates the approach for management employees
  - Produce job descriptions and provide written contracts and other information that outline the working conditions and terms of employment, including the full range of benefits
  - Report regularly on the labour force profile, including gender, ethnicity, and geographical origin of workers
  - Report regularly on labour and working condition key performance indicators, for instance hours worked (regular and overtime) during period and cumulatively, hours lost, number and type of accidents, near misses, site audits and meetings, training, use of labour grievance mechanism.
  - Hold toolbox talks on labour law issues and the labour grievance mechanism twice a year during the construction phase
  - Organise a training programme and keeping individual training registers for each construction worker which they can have at the end of contract for procuring future work
  - Develop a retrenchment plan in accordance with Emirati law to be used in the post operation/ decommissioning phase or any other periods whereby the need to lay off members of staff is anticipated
  - Develop a workers' accommodation plan to address international standards presented in the IFC guidance note on Worker's Accommodation: Processes and Standards (2009)
- Protecting the workforce and occupational health and safety (OHS):
  - Include clauses for contractors in line with the project's labour management procedures and welfare safeguard measures

- Establish occupational health and safety procedures in the overall environmental management system which provide workers with a safe and healthy work environment taking into account the inherent risks for this type of project
- Undertake an OHS assessment and audit and develop and implement OHS management plans (for all phases of the project) in accordance with Emirati health and safety laws and international best practice

These mitigation measures will enable the project to maximise the employment benefits, manage the project's workforce appropriately and reduce health and safety risks for workers on site, for the project sponsor, the EPC contractor and subcontractors.

Labour management and working conditions will require monitoring. Monitoring and supervising subcontractors' management of labour and working conditions should contractually be made an EPC contractor responsibility. The ESMMP will identify the regularity, indicators and verification methods to address labour rights and working conditions. International lenders will likely include these issues in their own third-party monitoring.

Monitoring of OHS will also require monitoring to prevent site accidents and illnesses. The OHS plan will need to identify monitoring requirements including safety inspection, testing and calibration, surveillance of the working environment, surveillance of workers health, and monitoring of training. The plan will need to identify the procedures and systems for reporting and recording OHS accidents and diseases and dangerous occurrences and incidents, including occupational, lost work case incidences, injuries, near misses and any suspected cases of disease. The EPC contractor and other project employers will be obligated to hire staff responsible for supervising occupational health and safety and worker accommodation on a daily basis. Monitoring results will be reported in monthly health and safety reports.

Key performance indicators will need to be established in the various plans and implemented for the monitoring system to be effective. Typical indicators include: lost workday resulting from accidents; fatality; lost time accident; medical treatment case/first aid case; and near miss (unsafe acts or conditions). The project will aim to achieve an OHS accident rate of zero.

13.8.4 Community health, safety and security

In order to mitigate potential impacts on community health, safety and security, infrastructure and equipment safety and hazardous material safety will be addressed in the project's health and safety plan and emergency preparedness and response plan.

Access barriers and other methods will be implemented to prevent public having contact with dangerous locations, equipment and hazardous materials. Appropriate site layouts, fencing of work sites, use of qualified personnel, separation and signage for hazardous materials and good traffic management will be addressed. In relation to driving in the local community, the contractors will develop procedures that prevent accidents related to traffic that include safe driving on site, establishing rights of way, speed limits, vehicle inspection requirements and other measures.

The contractors will coordinate with local civil services including police, fire fighters and medical personnel with regards to establishing the emergency preparedness and response plan and any drills or training addressing it. As defined in the plan, people living near or on the site will be informed and trained in appropriate emergency responses.

With regards to security and safeguarding of personnel and property, the contractors will be required to hire security staff responsible for control of access to site and ensure that appropriate due diligence is performed on them (companies and individuals) before they are appointed. Security staff will need to be trained at least annually in the use of force, the emergency preparedness plan, human rights, security procedures and reporting of incidents. A registry/identification system for staff and visitors upon entrance to site and appropriate signage around the site perimeter will be established.

13.8.5 Stakeholder engagement

The project will need to develop a comprehensive and culturally appropriate approach to consultation and disclosure for the lifecycle of the project, to manage its stakeholder relations and engagement activities and address any potential adverse impacts or risks for local communities that may arise throughout the life of the project. Refer to Chapter 14.

14 Stakeholder engagement

14.1 Introduction

This chapter outlines the information disclosure, consultation and participation activities that have been undertaken as part of the ESIA process in accordance with UAE and international requirements. This chapter reports the outcomes of these activities, as well as those activities planned for future phases in the lifecycle of the project, which are further detailed within the stakeholder engagement plan (SEP) (Appendix H).

14.2 Consultation requirements

The objective of the consultation and disclosure activities undertaken as part of the ESIA process is to meet the relevant legislation and policy regulations of the Government of the UAE, and the information disclosure, consultation and stakeholder participation requirements of key international standards including IFC Performance Standards, World Bank Environmental and Social Framework and Equator Principles III.

The project must consult with project stakeholders about the project's environmental and social impacts and take their views into account. These stakeholders can include governmental authorities, statutory bodies, project-affected persons and civil society organisations.

14.3 Project stakeholders

The following stakeholders have been consulted during the ESIA phase:

- Sharjah Municipality
- Environment and Protected Areas Authority (EPAA) in Sharjah
- Ajman Municipality
- Hamriyah Free Zone Authority
- Emirates-Wildlife Society with World Wide Fund for Nature (EWS-WWF)
- Ministry of Climate Change and Environment
- Hamriyah Municipality
- Hamriyah Coop Society for Fishermen

Records of these consultations are presented in Appendix I

Public hearing and consultation is not culturally acceptable in the UAE and GCC countries in general. Instead, local municipalities and environmental regulators are deemed to act on behalf of and represent the interests of the public. Therefore, and given the proposed location within the existing power plant complex, it is anticipated that potential affected parties will be limited and consultation with governmental stakeholders in light of their remits to represent the communities are sufficient to ensure relevant concerns are addressed.

14.4 Project consultation activities and outcomes

The following consultation activities have been conducted to date (July 2018).

- 2018-04-23: Meeting with Environment and Protected Areas Authority (EPAA) - The project was introduced and the applicable environmental permit authorisation process, importance of specialised studies and environmental monitoring data to be acquired for the project were discussed.

- 2018-06-11: Meeting with Ajman Municipality (AM) - Environment and Planning Department – The project was introduced to the municipality. Questions and concerns around potential environmental impacts including on air quality, marine environment and noise were discussed.
- 2018-06-18: HFZA - EHS Department - The project was introduced. HFZA indicated that they have no major environmental concerns relating to the project. Environmental assessment measures to be undertaken including air quality modelling and marine ecology survey were discussed.
- 2018-04-12: a letter from Sharjah Municipality (SM) was received in response to a letter sent by SEWA (13/03/2018) on Mott MacDonald's behalf to organise a meeting with SM. The letter was addressed to EPAA as the new regulator responsible for providing the environmental permits in Sharjah.
- 2018-05-29: The Ministry of Climate Change and Environment (MOCCE) was contacted by Mott McDonald in order to organise a stakeholder consultation meeting. The Ministry referred us to Sharjah Municipality as a regulator (currently EPAA) and proposed that SM should contact them officially for consultation.
- 2018-08-13: Meeting with Hamriyah Municipality was undertaken where an introduction to the project, potential impacts and assessment methodology was provided. Contact with the Hamriyah Fishermen Co-op Society as a stakeholder was discussed and the municipality proposed that they communicate with the society directly. The municipality indicated that they do not expect there will be any impacts on Hamriyah Community and the fishing activities given the distance to HFZA and port (which are restricted areas) and the location of fishing area which is approximately four-miles from the coast.
- 2018-09-26/25: Meetings with JBIC and NEXI and various governmental authorities were undertaken between 25-26/09/2018 for JBIC/NEXI to get better understanding of environmental and social concerns associated with the development of the project. Meetings with EPAA, Sharjah Municipality and Ajman Municipality were conducted and no key issues were raised. In addition, meetings between Mott MacDonald and JBIC/NEXI were undertaken during these two days to discuss their environmental and social concerns.
- 2018-10-03: Meeting with Hamriyah Coop Society for Fishermen was undertaken where the project was described and a copy of the scoping report was handed over for the society to review. The society commented that there will be no issue as long as appropriate environmental assessment is undertaken. They requested a formal letter to be sent to them by the project company.
- 2018-10-18: A letter along with a copy of the executive summary and marine environment chapter of the ESIA study was issued to the Hamriyah Coop Society for Fishermen to give them additional details on the project and provide them an opportunity to voice their concerns (if any). Any comments received will be considered within the SEP and project environmental and social management plans.

Several attempts to contact the Hamriya Cooperative Society for Fishermen in Sharjah were made by Mott MacDonald during the ESIA process, with no success. It was unclear if this NGO is currently active. Local news available in the public domain states that on 20/02/2017, H.H. Sheikh Sultan Bin Mohammed Al Qasimi, member of the Supreme Council and Ruler of Sharjah, ordered the development of a Fishermen Village to serve the requirements of fishermen in Hamriyah area. [54] Subsequently, a non-scheduled visit to their offices was undertaken where the chairman of the society, Mr Saif Khalifa Al Shamsi, was called in. A brief on the project, its potential environmental and social impacts and its importance was provided along with a copy of the scoping report.

The following consultation activities are scheduled for the future to present the outcome of the ESIA report:

It was proposed by EPAA that following review of the ESIA report by EPAA, Mott MacDonald will present the findings to EPAA team. If required by EPAA, SEWA will be responsible to officially invite relevant stakeholders (e.g. SM, AM, MOCCE) to this meeting.

14.5 Information disclosure

Public disclosure activities and meetings are not allowed and are uncommon practice in the UAE and GGC region. This was confirmed during meetings with Sharjah Municipality and EPAA on 26/09/2019. The project company will publish the ESIA report and/or its executive summary on their website when the project company is set up. Currently, the sponsors are finalising the formalities and agreement to set up the company, it is understood that paperwork for registering the project company have been already submitted Sharjah Department of Economy and Development.

JIBIC and NEXI will publish the ESIA report on their websites for the disclosure period required by the banks.

[54] https://aliqtisadi.com/885226-%D8%A5%D9%86%D8%B4%D8%A7%D8%A1-%D9%82%D8%B1%D9%8A%D8%A9-%D9%84%D9%84%D8%B5%D9%8A%D8%A7%D8%AF%D9%8A%D9%86-%D8%A8%D8%A7%D9%84%D8%B4%D8%A7%D8%B1%D9%82%D8%A9/

15 Landscape and visual amenities

15.1 Introduction

This section identifies and assesses the potential impacts associated with the construction and operational phases of the proposed project on landscape and visual amenities. It sets out proposed mitigation measures in order to minimise, or, where possible, avoid, the potential impacts of the project upon the existing landscape character and visual amenity of the area.

15.2 Methodology and assessment criteria

The assessment was undertaken based on an environmental walkover of the site and review of desk-based information and satellite imagery. The assessment considered landscape value, sensitivity of receptors and magnitude of potential impacts as per the criteria defined in Table 129, Table 130, Table 131 respectively.

Table 129: Criteria for landscape value

Sensitivity	Description
High	Landscapes which, by nature of their character, quality and recognised value, could be highly sensitive to change, and could not be substituted. Typically, these would be of very high quality and likely to be designated, or areas of special recognised value through use, perception or historic and cultural associations. This could typically be categorised as landscape of the highest quality or very attractive landscapes.
Medium	Typically, these would be of high quality and likely to be designated, but this value may also be present outside designated areas, especially at the local scale. This could be categorised as a ‘good landscape’ with countryside and or urban features with frequent open spaces and natural vegetation cover providing a pleasant aspect and combination of landscape, ecological and cultural features.
Low	Landscapes which, by nature of their character, quality and value, would be moderately sensitive to change, with some features or elements that could be substituted. Typically, these would be fairly commonplace, but maybe locally designated, or their value may be expressed through non-statutory local publications. This would be considered an ‘ordinary landscape’.
Negligible	Landscapes which by nature of their character, quality and value may not be particularly sensitive to change, and which could be substituted or improved. Typically, these would be partly degraded or damaged landscapes which are not designated.

Source: Mott MacDonald, 2018

Table 130: Sensitivity criteria

Sensitivity	Description
High	Occupiers of residential properties and associated outdoor areas (e.g. gardens, courtyards). Users of nationally protected areas, recreational scenic trails or users of designated tourist routes.
Medium	Workers in predominately outdoor professions (e.g. farmers and horticulturalists). Users of secondary or minor roads in scenic areas, schools and outdoor recreational areas (e.g. sports grounds).
Low	Workers in predominately indoor professions (e.g. factories and offices). Users of main roads or passengers in public transport on main arterial routes.
Negligible	No receptors

Source: Mott MacDonald, 2018

Table 131: Magnitude of impact

Sensitivity	Description
Major	Total loss or large-scale damage to existing character or views, and/or the addition of new but uncharacteristic conspicuous features and elements.
Moderate	Partial loss or noticeable damage to existing character or views, and/or the addition of new but uncharacteristic noticeable features and elements.
Minor	Slight loss or damage to existing character or views, and/or the addition of new but uncharacteristic features and elements.
Negligible	Barely noticeable loss or damage to existing character or views / No noticeable loss, damage or alteration to character or views.

Source: Mott MacDonald, 2018

15.3 Baseline description

The immediate surrounding landscape is largely made up of industrial features such as the HFZ, Hamriyah Port, Al Jerf Industrial 1 area, FEWA desalination plants and wider SEWA power and desalination complex.

It is also noted that recreational campers and fishermen visit the beach adjacent to the site. Approximately 2.5-3km to the south, south-east and south-west, a number of potential sensitive receptors were identified. These include, the Ebori Beach Resort, Al Zorah Golf Club, Al Zorah Residential Community, Al Zora protected area (Ramsar listed site).

The landscape includes transmission lines leaving the SEWA power and desalination complex, fence lines and some landscaping/trees along the fence of the project site.

The receptors include:

- Residents of the Ebroi Beach hotel
- Residents of the Al Zorah residential area and golf club
- Al Zora protected area
- Operational staff of the SEWA complex
- Operational staff of the surrounding plants

15.4 Assessment of impacts

15.4.1 Construction phase

During the construction phase, land within the SEWA Hamriyah complex will be used for construction site laydown areas. Given the project site is currently being used for this same purpose this will result in limited change to the landscape features during construction. Levelling and clearing activities are not anticipated to be significant. Assessment of impacts to terrestrial ecology in the form of existing vegetation is considered within Chapter 11.

Other potential impacts during construction are the use of plant and equipment and high cranes that may potentially dominate the landscape for the duration of specific construction tasks as well as extra lighting which may be needed during the night-time, either for construction or for security and safety reasons and, if not effectively managed, have the potential to cause a nuisance to nearby receptors.

From experience on similar projects within the UAE, the need for the project to identify and adopt appropriate workforce bus waiting and drop-off/pick-up areas to prevent queues shall be considered in order to avoid causing adverse impacts to landscapes and nuisance to nearby residents and at community facilities. This applies in all the locations that the workforce buses may occupy including the project site, SEWA complex perimeter and at external sites.

Given the existing extent of industrial development in the immediate surrounding area, the landscape value is considered to be negligible. The sensitivity of receptors is considered to be low. Given the size of the project with respect to the wider industrial area, the magnitude of impact on the landscape is considered to be minor.

Overall the significance of impacts on the surrounding landscape prior to mitigation is assessed to be negligible.

15.4.2 Operational phase

During the operational stage, the project will alter the landscape of the area through the addition of new plant buildings and most notably through the addition of the main and bypass stacks.

Given the existing extent of industrial development in the immediate surrounding area the landscape value is considered to be negligible. The sensitivity of receptors is considered to be low. Given the nature of the changes resulting from the project with respect to the existing industrial features in the adjacent HFZ and SEWA complex, the magnitude of impact on the landscape is considered to be minor.

Overall the significance of impacts on the surrounding landscape prior to mitigation is assessed to be not significant.

15.5 Mitigation, monitoring and enhancement measures

15.5.1 Construction phase

Standard construction stage mitigation measures with respect to landscape and visual impacts include:

- In general, and with consideration of health and safety requirements, the number of construction phase lights should be kept to a minimum, and, where possible, directional lighting should be used that minimises the extent of impact on the wider area outside the perimeter of the site, in particular with consideration for the residential areas and the marine environment.
- Appropriate siting of labour force bus pickup and drop-off area.

15.5.2 Operational phase

Standard operational phase mitigation measures with respect to landscape and visual impacts include:

- In general, and with consideration of health and safety requirements, directional lighting should be used that minimises the extent of impact in the wider area outside the perimeter of the site
- Use appropriate paint colours, the choice of colour finish applied to the steelwork of the superstructures and to the buildings should be the same and in line with the existing structures within the SEWA complex and as per government regulations/guidance
- With consideration of restrictions imposed by aviation standards, lighting on the higher structures should be minimised, without compromising air safety imposed by the national aviation authority

15.6 Residual impacts

Following implementation of appropriate mitigation measures during the construction and operational phases of the project, the residual impacts on the landscape and visual amenity of the area are considered not significant.

Table 132 summarises the impacts, key mitigations and residual impacts associated with the landscape and visual impacts.

Table 132: Summary of impacts, key mitigation measures and residual significances

Activity	Impact	Magnitude	Sensitivity	Impact significance	Mitigation/benefit enhancement measures	Residual effect and significance
Construction						
Use of construction plant and high equipment such as cranes	Nuisance to residential areas	Minor	Negligible	Not significant	Installation of site hoardings	Not significant
Construction stage lighting for potential night works	Light pollution to residential areas and to marine environment	Minor	Negligible	Not significant	With consideration for safety requirements, minimise and use appropriate directional lighting	Not significant
Operation						
Existence of stacks and buildings, including associated lighting	Additional industrial features to the landscape Light pollution	Minor	Negligible	Not significant	Match external materials and paintwork with existing plant With consideration for safety and aviation standards requirements, minimise and use appropriate directional lighting	Not significant

Source: <Insert Notes or Source>

16 Cultural heritage and archaeology

16.1 Introduction

This chapter of the ESIA assesses the key potential cultural heritage and archaeological impacts associated with the construction and operation of the proposed Hamriyah IPP and its associated infrastructures (where applicable), including the likelihood of archaeological finds.

The assessment of cultural heritage and archaeological impacts is based on desktop studies, site walkovers and consultations with relevant governmental stakeholders.

16.2 Methodology and assessment criteria

The assessment was undertaken in accordance with Sharjah Antiquity Law (Law of Antiquities No. 1 of 1992 in the Emirate of Sharjah), IFC Performance Standards, and, where applicable, the Chartered Institute for Archaeologists (CIfA) in the United Kingdom (UK).

The assessment incorporates outcomes from a baseline walkover survey, desk-based review of relevant available data and preliminary consultation with Ajman Municipality, HFZA and EPAA.

Spatial consideration of cultural heritage and archaeology was made with reference to the direct site footprint.

Consideration of the project's potential impacts on cultural heritage/archaeology during the construction and operational phases is made within this section.

16.2.1 Desk-based review

A desk-based study was carried out in accordance with the Chartered Institute for Archaeologists (CIfA) Standards taking into consideration the Standards and Guidance for Historic Environment Desk-Based Assessment (published December 2014 and updated January 2017).

The information published on Sharjah Archaeology Authority[55] public domains were reviewed in order to identify any sensitive receptors in the projects area of influence.

The purpose of desk-based review and assessment is to collect information and gain understanding of the area and the potential (known or unknown) archaeological resources within a given area. The desk-based review consisted of collation of existing written, graphic, electronic and photographic information in order to determine the likelihood of the presence of any potential archaeological resources at the proposed IPP site.

16.2.2 Site walkover

Two site visits and walkovers have been carried out by the project team. These site visits focussed on identifying any above-ground antiquities and archaeological structures.

16.2.3 Significance of impacts

An assessment of the significance of impacts with regards to cultural heritage and archaeology was made for the construction and operational phases of the project. The significance of

[55] http://sharjaharchaeology.com/

potential impacts is a function of the presence and sensitivity of archaeological receptors, and the magnitude (duration, spatial extent, reversibility, likelihood and threshold) of the impact.

The sensitivity of the archaeological potential for a site is shown in Table 133

Table 133: Sensitivity of archaeological features

Importance	Level of importance	Description
High	National or international	The highest status of site, e.g. assets of high quality and importance, including buildings. Well preserved historic landscape, whether inscribed or not, with exceptional coherence, time depth, or other critical factor(s).
Medium	Regional	Designated or undesignated archaeological sites; well preserved structures or buildings of historical significance, historic landscapes or assets of a reasonably defined extent and significance, or reasonable evidence of occupation/settlement, ritual, and industrial activity. Examples include burial sites, deserted medieval villages, historic roads and dense scatter of finds.
Low	Local	Comprises undesignated sites with some evidence of human activity but which are in a fragmentary or poor state, or assets of limited historic value but which have the potential to contribute to local research objectives, structures or buildings of potential historical merit. Examples include sites such as historic field systems and boundaries, agricultural features such as ridge and furrow, ephemeral archaeological evidence, and locally significant buildings.
Negligible	Negligible	Historic assets with very little or no surviving archaeological interest or historic buildings and landscapes of no historical significance. Examples include destroyed antiquities, buildings of no architectural merit, or relatively modern landscape features such as quarries, field boundaries, drains and ponds.
-	Unknown	Insufficient information exists to assess the importance of a feature (e.g. unidentified features on aerial photographs).

Source: Mott MacDonald, 2018

The degree or magnitude of effect is determined through consideration of the nature, scale and extent of effect. The criteria for determining magnitude is shown in Table 134.

Table 134: Criteria for determining magnitude of impacts

Magnitude of impact (positive or negative)	Criteria
Major	Where there is severe damage or loss of the archaeological resource.
Moderate	Where a high proportion of the archaeological resource is damaged or destroyed
Minor	Where a small proportion of the archaeological resource is damaged or destroyed
Negligible	Where the archaeological resource will not be affected because of distance from the development or method of construction
Uncertain	Where the extent or nature of the historic resource is unknown, or construction techniques have not yet been determined

Source: Mott MacDonald, 2018

The significance of the effect is dependent upon the importance of particular site and the amount of potential damage. Table 135 shows the assessment of significance criteria.

Table 135: Levels of significance

Magnitude of impact	Sensitivity of receptors			
	Negligible	Low	Medium	High
Negligible	Insignificant	Insignificant	Insignificant	Insignificant
Minor	Insignificant	Insignificant	Minor	Minor
Moderate	Insignificant	Minor	Moderate	Moderate
Major	Insignificant	Minor	Moderate	Major

Source: Mott MacDonald, 2018

16.3 Legislative framework

16.3.1 National requirements

The Ministry of Culture and Knowledge Development is the appropriate authority within the UAE responsible for exploring and maintaining the historical heritage of the UAE. In October 2017, the Federal Law No. 11 of 2017 on Antiquities was approved. The new law is aimed at protecting the UAE's fixed assets in order to promote national identity and preserve cultural heritage.

The law states that anyone who defaces or destroys an antiquity or artefact could face a minimum of two years in jail and AED10 million in fines. In addition, building on, planting or changing the characteristics of an archaeological site, making excavations without a permit and smuggling items into or out of the country would be punishable with the same penalties.

Sharjah Archaeology Authority is the local authority responsible for i) providing protection for all archaeological sites within Sharjah and ii) eliminating the illegal trafficking and smuggling of archaeological artefacts.

The Emirate of Sharjah has its own law of antiquities, Law of Antiquities No. 1 of 1992 in the Emirate of Sharjah. The law identifies two types of antiquities, non-movable monuments and movable monuments. These antiquities can be defined as:

- An antiquity left behind by earlier civilizations or generations, movable or non – movable, created, made, engraved, portrayed, inscribed or built by man before 1900 AD, including caves, coins, potteries, manuscripts, documents and other handicrafts which indicate the emergence of science, arts, crafts, religions, civilizations related traditions or vital historical events related regions, any additions to the same or whatever rebuilt after the date of such antiquities
- Human, animal and plant remains dated before 600 A.D
- Upon the approval of the Head, the Directorate may consider the non-movable or movable properties as antiquities as bearing historical or artistic characteristics and representing a national heritage

The law recognises heritage in the form of antiquity, monuments, objects of historical, archaeological or palaeontological interest and protected objects.

Obligations to report heritage finds are specified within Article 21 and Article 22 of the law. The provisions of Sharjah legislation are typical in requiring the discoverer of a site or material of cultural heritage or archaeological value to immediately stop the work on site and report the finding. The articles state:

Article 21

A person who accidentally or through some works finds an archaeological site shall stop carrying on such works and inform the Directorate of such discovery. The Directorate is the only authority authorized to take a decision on continuing the works or stopping them temporarily or completely. If the discontinuation was temporary or complete, the Directorate should give priority to the excavation of such site and remove the causes of the discontinuation insofar as allowed by its annual plan or its related budget.

Article 22

A person who finds, due to excavation works, an antiquity and does not have an excavation license shall approach the Directorate within 48 hours from the time of finding the antiquity or knowing about it. He shall not take any action that may cause damage, nor change the monument. A report shall be made directly to the Directorate or to the nearest police station in the region where the antiquity was discovered.

16.3.2 IFC Performance Standards

Consistent with the Equator Principles framework, projects located in non-OECD countries (such as UAE) the assessment will refer to applicable IFC Performance Standards (IFC PS) and applicable industry specific EHS Guidelines. Accordingly, the proposed Hamriyah IPP would be required to comply with IFC Performance Standard 8: Cultural Heritage. PS 8 recognizes the importance of cultural heritage for current and future generations. Consistent with the Convention Concerning the Protection of the World Cultural and Natural Heritage, PS 8 aims to ensure that clients protect cultural heritage in the course of their project activities.

IFC PS8 Guidance Note states:

GN1. The objectives of Performance Standard 8 aim to preserve and protect cultural heritage by avoiding, reducing, restoring, where possible, and in some cases compensating for the adverse impacts that projects might cause to cultural heritage. In addition, private sector projects can play a role in promoting awareness of and appreciation for cultural heritage. Where the project proposes to use the cultural heritage of a community, Performance Standard 8 seeks to ensure that the development benefits accruing from the commercial use of cultural heritage flow equitably to the affected communities.

A screening process in line with guidance GN4 has been undertaken

GN 4. The screening phase of the risks and impacts identification process should identify the extent and complexity of potential cultural heritage risks and impacts in the project's area of influence. If the screening indicates potential adverse impacts, further analysis will be necessary to ascertain the nature and scale of these impacts and proposed mitigation measures. The breadth, depth, and type of analysis should be proportionate to the nature and scale of the proposed project's potential adverse impacts on cultural heritage resources. On the basis of the guidance described above no further analysis was required.

16.4 Baseline description

Desk-based research and initial consultation with a number of governmental departments indicated that there are no immediate culturally important areas in the immediate vicinity of the proposed site.

Sharjah hosts ten key sites of archaeological or cultural importance spanning a period from approximately two million years ago to the pre-Islamic period[56]. The closest archaeological site, Tell Abraq, is under 8km from the proposed site. The list below summarises the archaeological sites in Sharjah that are less than 20km from the project site:

- **Tell Abraq:**
  This site is located less than 8km to the north-east of the proposed IPP on a large mound rising over ten metres above the surrounding plain near the junction of the coastal highway linking Sharjah and Ras al-Khaimah and the inland road from Umm al-Qaiwain to Falaj al-Mu'alla.
  The Tell comprises a settlement consisting of largely palm-frond houses (Barasati) which surround a massive circular fortress built out of mud brick and faced with stones. The palm

[56] http://sharjaharchaeology.com/archaeological-sites/

houses are evidenced by a large number of post-holes which have been found all over the excavated areas.

- **Muweilah**

  This site is located approximately 17km south-east from proposed site. Muweilah is an Iron Age settlement located approximately 15kms from the present-day coastline in Sharjah and about 45kms from the inland Dhaid plain. It is likely that when it was occupied in antiquity it was situated near an ancient lagoon, or Khor, that came in from the coast. The site was principally occupied during the Iron Age II period (1000 – 6600 BC), this period follows the Iron Age I period (1300-1000 BC) but sees a rapid increase in the number and size of settlements throughout out this region. Muweilah shows one aspect of this settlement growth but differs from contemporary settlements in several ways.

The list below summarises the archaeological sites in Sharjah which are located more than 20km from the site:

- Al Thuqaibah
- BHS 18
- Dibba Al-Hisn
- Jebel Al Buhais
- Kalba
- Khor Fakkan
- Mleiha
- Wadi Al Hilo

Figure 92 shows the locations of archaeological sites in the Emirate of Sharjah.

Figure 92: Sharjah archaeological map

Source: http://sharjaharchaeology.com/img/2016/05/Sharjah-Archaeological-map.jpg?e39b24

16.5 Assessment of impacts

16.5.1 Construction phase

Construction activities associated with the development of projects would involve foundation excavation, site levelling and material transportation which might impact on potential known or unknow artefacts and sites of cultural heritage and archaeological significance.

No artefacts or archaeological features have been identified on site as a result of the site visits undertaken during 2018, the desk-based study and initial consultation with EPAA, Ajman Municipality and HFZA. In addition, the site will be developed within the boundaries of the overall Hamriyah Power and Desalination complex and the majority of the site is reclaimed land. Based on the information gathered to date, it is considered that potential impacts associated with the construction of the IPP project on known and unknown resources onsite are unlikely.

As described above, the nearest site of archaeological importance is Tell Abraq which is located approximately 8km away from the site. Given the distance of known sensitive sites from the proposed IPP and given that the project will utilise existing infrastructure facilities (e.g. roads, intake/outfall facilities, transmission lines, gas pipelines), impacts associated with the construction of the project on known or unknown artefacts and sites of archaeological importance are considered unlikely.

16.5.2 Operational phase

It is envisaged that there are no impacts associated with the operation phase of the proposed IPP on the known or unknown artefacts, antiquities or archaeological resources, therefore this aspect is considered neutral.

16.6 Mitigation, monitoring and enhancement measures

16.6.1 Construction phase

A watching brief will be maintained during all excavation or earthworks during the construction phase of the project. The scope of the watching brief is outlined as follows:

- To be prepared for unexpected finds in all areas of the project
- To look out for burned or blackened material, brick or tile fragments, coins, pottery or bone fragments skeletons, timber joists or post holes, brick or stone foundations or in-filled ditches during excavations
- To call on the guidance of an archaeologist and Sharjah Archaeology Authority where there is any uncertainty

The main phases of monitoring for the construction will be during topsoil stripping, trench excavation and drainage preparation. Monitoring will include all project areas to be stripped of topsoil, construction corridors and borrow areas, IPP main site and laydown areas.

If any unexpected finds are encountered during earthworks or excavation works the following mitigation approaches will be employed by the project:

- Work will be immediately stopped in the area
- The find(s) will be demarked and protected via fencing/blocking off and the site manager and project environmental manager will be contacted
- The Sharjah Archaeology Authority and nearest police station (as per Law) will be informed in order to seek guidance and specialist advice for management of the find(s) and how best to proceed, given its nature and extent
- All finds of human remains will be reported to the proponent authority
- All finds will be recorded.

A ‘chance finds procedure’ in line with international best practice will be developed and implemented by the project during the construction phase to capture in more detail the above mitigation approach. The EPC contractor will consult with Sharjah Archaeology Authority to ensure that the procedure is acceptable to them and that it complies with local and national regulations.

16.6.2 Operational phase

In the unlikely event of uncovering artefacts, archaeological and cultural heritage features on site during the operational phase, Sharjah Archaeology Authority should be notified immediately in line with the project 'chance finds procedure.'

16.7 Residual impacts

The overall residual impact on known and unknown artefacts, archaeological and cultural heritage features are considered unlikely or negligible following the implementation of mitigation measures.

Table 136 summarises the impacts, key mitigations and residual impacts associated with the cultural heritage and archaeology.

Table 136: Summary of impacts, key mitigation measures and residual significances

Activity	Impact	Magnitude	Sensitivity	Impact significance	Mitigation/benefit enhancement measures	Residual effect and significance
Construction						
Excavation work	Potential destruction of artefacts	Minor	Negligible	Not significant	Maintain a ‘chance finds procedure’ for artefacts during excavation works - stop if any findings until Sharjah Archaeology Authority has been consulted	Not significant
Operation						
No activities have been identified that are likely to lead to significant impacts.						

Source: Mott MacDonald, 2018

17 Transportation and traffic assessment

17.1 Introduction

This section considers the potential impacts to traffic and transport with construction and operation of the project.

This section is structured as follows:

- An overview of the relevant national legislation and requirements in Sharjah and the UAE
- A baseline description developed from desk-based information
- Assessment of impacts associated with the construction and operation of the project
- Identification of mitigation and monitoring measures to be employed at the site
- Consideration of residual impacts following the implementation of mitigation measures

17.2 Legislative framework

Road traffic in the UAE is governed by Law No. 21 for the year 1995 on the regulation of traffic. The Sharjah Roads and Transport Authority (SRTA) is responsible for developing the transportation systems and services in Sharjah including preparation of growth plans, policies and legislation as well as setting and monitoring objectives and targets for environmental, health and safety performance of the Sharjah transportation networks.

17.3 Baseline description

The site will be accessed through the HWPP main gate and is accessible via Al Etihad road (E11). Al Etihad is the longest road/highway in the UAE and it stretches from Al-Silah in Abu Dhabi and ends at Ras Al Khaimah running parallel to the coastline along the Arabian Gulf.

Hamriyah Port and other ports in the UAE such as Jebel Ali port are connected to the E11.

As shown in Figure 93, the project site is approximately 4.6km from Al Etihad road.

Figure 93: Road access to the site

Source: Google Earth, 2018

17.4 Assessment of impacts

17.4.1 Construction phase

The main construction vehicle movements on public roads and site access roads will be associated with construction materials and workforce being brought to site and, to a lesser extent, construction-phase waste materials being removed from site.

The primary vehicle movements during the construction stage will be the drop-off and pick-up of the construction workforce that is anticipated to reach a maximum of approximately 1,500 people split over two shifts and a maximum of 1,150 people at peak times. This is likely to result in approximately 23 vehicle movements per day at peak times. With respect to the existing volumes of traffic on the adjacent E11 road, this number of additional vehicle movements is assessed to be negligible.

Inappropriate selection of waiting or drop-off locations of construction workforce can lead to nuisances to nearby communities and sensitive receptors and adverse visual impacts as well as potential health and safety risks associated with additional traffic movements on existing roads or construction workforce inappropriately trying to cross major highways by foot. The assessment of potential impacts with respect to socio-economic and landscape and visual aspects associated with construction traffic are considered minor.

Bulky and heavy loads are anticipated to be delivered by boat/barge to Hamriyah Port before transfer to the site by road. Marine vessels increase the potential for impacts on seawater quality and marine ecology. Unloading activities are likely to be undertaken in the existing permanent Hamriyah Port facility.

The sensitivity of the marine environment at the Hamriyah Port where unloading activities may occur is considered to be low within the existing port where unloading activities will occur. The overall sensitivity criteria of the receiving environment of project site is considered to be low as the site is within the existing Hamriyah Power and Desalination complex that lies within a developed industrial area and adjacent to HFZ.

Due to the low number of anticipated additional vehicle movements, the magnitude of impacts of land-based transportation are considered to be not significant.

Overall the significance of impacts with respect to traffic and transport at the construction stage prior to mitigation is assessed to be not significant.

17.4.2 Operational phase

Transportation activities will be limited to land-based movements during the operational phase.

Given the additional number of operations staff anticipated to be required for the project is minimal, the additional vehicle movements travelling to and throughout the Hamriyah Power and Desalination complex is assessed to be negligible.

The number of additional delivery, maintenance and waste collection vehicle trips as a result of the project are anticipated to be low due to the nature of the project and low quantities of additional waste streams to be generated at the operational stage. There is a potential that vehicle trips such as waste collection may also be combined with trips which currently take place for existing power and desalination plant operations.

17.5 Mitigation, monitoring and enhancement measures

17.5.1 Construction phase

In addition to the mitigation measures already defined in the respective air quality, noise, socio-economic and landscape and visual sections, the following mitigation measures should be implemented:

- Development and incorporation of a traffic management plan (TMP) into the site management plan
- Management of vehicle flows and provision of adequate signage to prevent collisions, avoid interaction between vehicles and the workforce, existing power and desalination plant’s operational staff or pedestrians as well as to warn of heavy vehicles using roads
- Construction vehicle speed restriction devices, restrictions on roads close to sensitive receptors such as schools, places of worship and residential areas and restriction to 15kph on construction roads
- Any abnormal load movements to be confirmed with the competent administrative authority and adhere to prescribed routes
- Scheduling of traffic, deliveries and waste collection will be undertaken to avoid peak hours on the local road network wherever practicable
- Consideration for staggering construction shifts to split arrival and departure times
- Construction workers to be transported to the site by contract bus
- Appropriate drop-off and waiting locations will be identified and adhered to

- Regular servicing and maintenance of vehicles to minimise emissions to air
- Provision of wheel washes for vehicles leaving to minimise the movement of debris onto public roads
- Ensure all vehicles leaving the site have properly fitted tail-gates and tarpaulins (if carrying friable material)
- Provision of safety training to vehicle drivers and ensure that all drivers have the required driving licenses and training specific to the project as necessary
- Management of driver shifts to prevent overtiredness
- Medical checks for drivers
- Selection of transport routes to avoid potentially sensitive receptors, such as schools, hospitals

17.5.2 Operational phase

Given the low number of additional vehicle movements anticipated in the operational phase, the following mitigation measures could be implemented:

- Adherence to the existing Hamriyah Power and Desalination complex traffic rules and requirements
- Regular servicing and maintenance of vehicles to minimise emissions to air
- Provision of safety training to delivery/collection vehicle drivers
- Provision of adequate signage to warn of heavy vehicles using roads

17.6 Residual impacts

The outcomes of assessment of impacts, proposed good practice mitigation measures and overall residual impacts are presented in a tabulated summary Table 137.

Table 137: Transport and traffic assessment - summary of impacts, key mitigation measures and residual significance

Activity	Impact	Sensitivity	Magnitude	Impact significance	Mitigation/benefit enhancement measures	Residual effect and significance
Construction						
Construction vehicle movements to/from site	Health and safety risks from traffic accidents, injuries, fatalities Congestion, nuisance to local communities	Low	Not significant	Not significant	Develop a traffic management plan (TMP) as part of the site management plan	Not significant
Construction vehicle movements onsite	Health and safety risks from traffic accidents, injuries, fatalities	Low	Not significant	Not significant	Develop a traffic management plan (TMP) as part of the site management plan	Not significant
Operation						
Vehicle movements to/from site by operations staff and delivery/collection vehicles	Emissions to air Noise emissions Health and safety risks from traffic accidents, injuries, fatalities Congestion, nuisance to local communities	Low	Not significant	Not significant	Adherence to Hamriyah complex traffic rules and requirements Regular servicing and maintenance of vehicles to minimise emissions to air Provision of safety training to delivery/collection vehicle drivers Provision of adequate signage to warn of heavy vehicles using roads	Not significant

Source: Mott MacDonald Ltd, 2018

Appendices

A. Plant layout

B. Best available techniques (BAT)

C. Summary of stack height determination

C.1 Overview

The purpose of the stack height determination is to determine the minimum height necessary to ensure that emissions from a stack do not result in excessive ground level concentrations of air pollutants from atmospheric downwash, eddies or wakes which may be created by the source itself or nearby structures. A number of methods are available to determine an appropriate stack height, including simple equations and dispersion modelling. In this case, the stack height was determined by dispersion modelling.

The stack height determination was undertaken for both the Heat Recovery Steam Generator (HRSG) stacks (main stacks) and the bypass stacks. Simulations of the effective dispersion of pollutants was undertaken with stack heights of 40m, 50m, 60m, 65m, 70m and 80m for the main stack and 35m, 40m, 45m, 50m and 55m for the bypass stacks.

The stack height determination undertaken provided recommended stack heights based on an assessment of potential impacts on the ambient air quality only. Amongst others, it did not take account of structural requirements, safety issues or associated regulations which should be considered by those using this information to develop the stack design.

The following two sections provide a succinct summary of the results of the stack height determination assessment for the identified optimum stack heights of 60m for the main stacks and 45m for the bypass stacks only. For further information on the stack height determination as undertaken, please refer to the ESIA Appendix J (Stack Height Determination Report for the Hamriyah IPP Sharjah UAE - dated 11 June 2018).

C.2 Results

C.2.1 Main stack

Table 138 presents the results of the stack height determination for the main stack operating on natural gas and Figure 94 presents a graph of results. The results of the stack height determination are based on one unit operating at full load continuously all year. These results have been used to determine the appropriate stack height for the project based on maximum predicted process contributions and how this changes with increased stack heights.

Modelled results indicate that building wake effects influence dispersion when the main stack height is below 70m. Figure 94 shows that, for heights above 70m, any additional improvement in ground level concentrations is small and not significant. With a stack height of 60m, the modelling indicates that building wake effects are experienced as the maximum 1-hour process contributions are 78.5µg/m^3 compared to 23.1 µg/m^3 for a 70m stack height. With a stack height of less than 60m, significant building wake effects are experienced as elevated one hour process contributions are predicted.

The results indicate that when looking at the maximum one hour impacts a stack height of 70 metres is optimum. However, considering the annual mean concentrations and the 1 hour 99.79th percentile a shorter stack of 60 metres may also be considered acceptable.

The results for the one hour 99.79th percentiles indicate that a lower stack height of 70 metres would be appropriate as the number of hours where the largest one hour concentrations are predicted is limited.

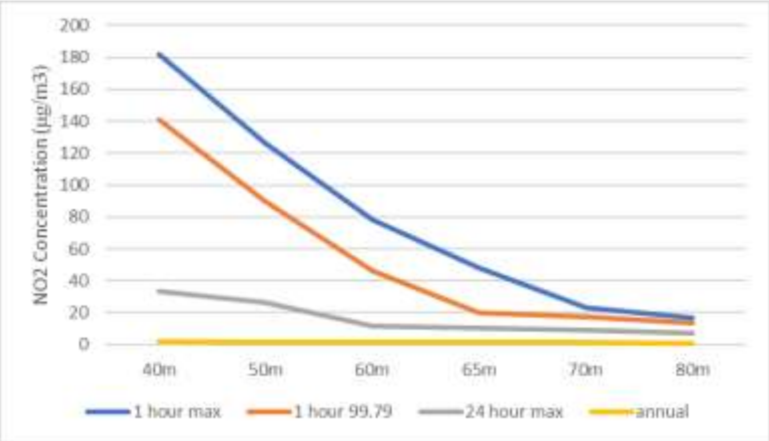
Section C.2.3 presents results of both 60 and 70 metres considering all three units operating and the existing baselines concentrations for both natural gas and fuel oil firing.

Table 138: Maximum modelled NO_2 process contributions (one unit in operation) per stack height (µg/m^3)

Averaging period	Stack height						UAE standard
	40m	50m	60m	65m	70m	80m	
1-hour max	181.8	126.5	78.5	48.0	23.1	17.1	400
1 hour 99.79 percentile	141.0	89.7	46.1	20.1	17.5	13.5	400
24-hour max	33.5	26.1	11.9	10.4	9.1	7.3	150
Annual	2.0	1.6	1.3	1.2	1.1	1.0	40 (WHO standard)

Source: Mott MacDonald, 2018

Figure 94: Maximum modelled NO_2 process contributions (one unit in operation) per stack height



Source: Mot MacDonald, 2018

C.2.2 Bypass Stack

The project is not expected to operate in open cycle for long periods of time once fully operational. However, an appropriate stack height for open cycle operation is still required to allow effective dispersion. Modelling was undertaken with a by-pass stack height of 35m to 55m. Table 139 shows the maximum process contribution from the proposed project and Figure 95 presents a graph of results.

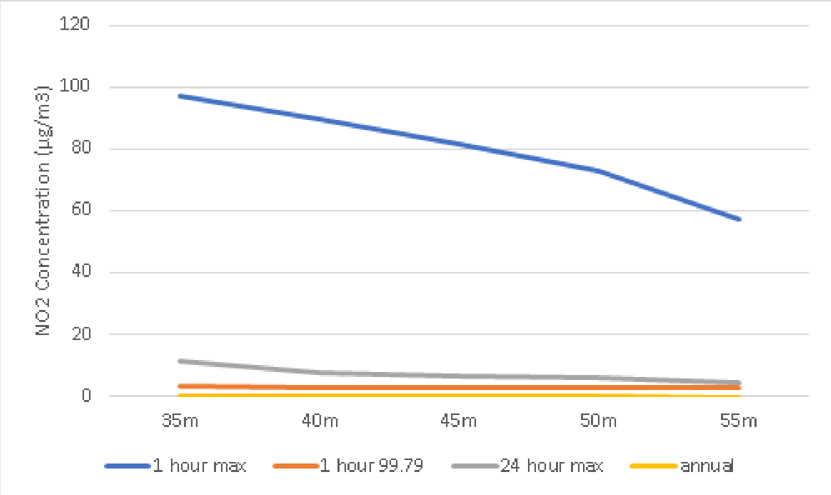
Modelled results indicate that building wake effects are having limited effects on dispersion and there is no significant reduction in maximum ground level NO_2 concentrations with increased height. Therefore. the proposed stack height of 45 metres is considered appropriate.

Table 139: Maximum modelled NO_2 process contributions (one unit in operation) per stack height (µg/m³)

Averaging period	Stack height					UAE standard
	35m	40m	45m	50m	55m	
1-hour max	97.2	89.6	81.3	72.6	57.0	400
1 hour 99.79 percentile	3.3	3.0	2.9	2.8	2.7	400
24-hour max	11.3	7.8	6.8	5.8	4.5	150
Annual	0.14	0.12	0.11	0.11	0.11	40 (WHO standard)

Source: Mott MacDonald, 2018

Figure 95: Maximum modelled NO_2 process contributions (one unit in operation) per stack height



Source: Mott MacDonald, 2018

C.2.3 Operational impacts

C.2.3.1 Main stack – natural gas

Table 140 presents the results of all three units operating continuously all year on natural gas and compares the maximum results from the modelled area for 60m and 70m stack heights.

The modelling with a 60m stack height demonstrates that, the maximum process contributions predicted based on five years of meteorological data is 127.0µg/m³ which, is approximately 32% of the national standard and results in a predicted environmental concentration of 176.0µg/m³ which is below 50% of the national standard (Table 140).

The results show that the 1-hour 99.79th percentile process contribution is 64.1µg/m³ which, is approximately 16% of the national standard and results in predicted environmental concentration of 113.1µg/m³. This indicates that the highest predicted one hour impacts would be limited to a small number of hours a year.

The maximum 24-hour process contribution concentration is approximately 22% of the daily average standard. No exceedances of the annual standard are expected as the annual process contributions are very minimal (i.e. less than 10% of the national standard).

The modelling with a 70m stack height demonstrates that, the maximum process contributions predicted based on five years of meteorological data is 60.6µg/m³ which, is approximately 17% of the national standard and results in a predicted environmental concentration of 109.6µg/m³ (Table 140).

The results show that the 1-hour 99.79th percentile process contribution is 49.0µg/m³ which, is approximately 12% of the national standard and results in a predicted environmental concentration of 98.0µg/m³. The maximum 24-hour process contribution concentration is approximately 17% of the daily standard and the predicted environmental concentration is less than 50% of the national standard.

No exceedances of the annual mean standard applied to the proposed project are expected as the annual process contributions are less than 10% of the applicable standard.

Table 140: Modelled Ground Level Contributions from the project – Scenario 1 (gas, 100% load) (µg/m³)

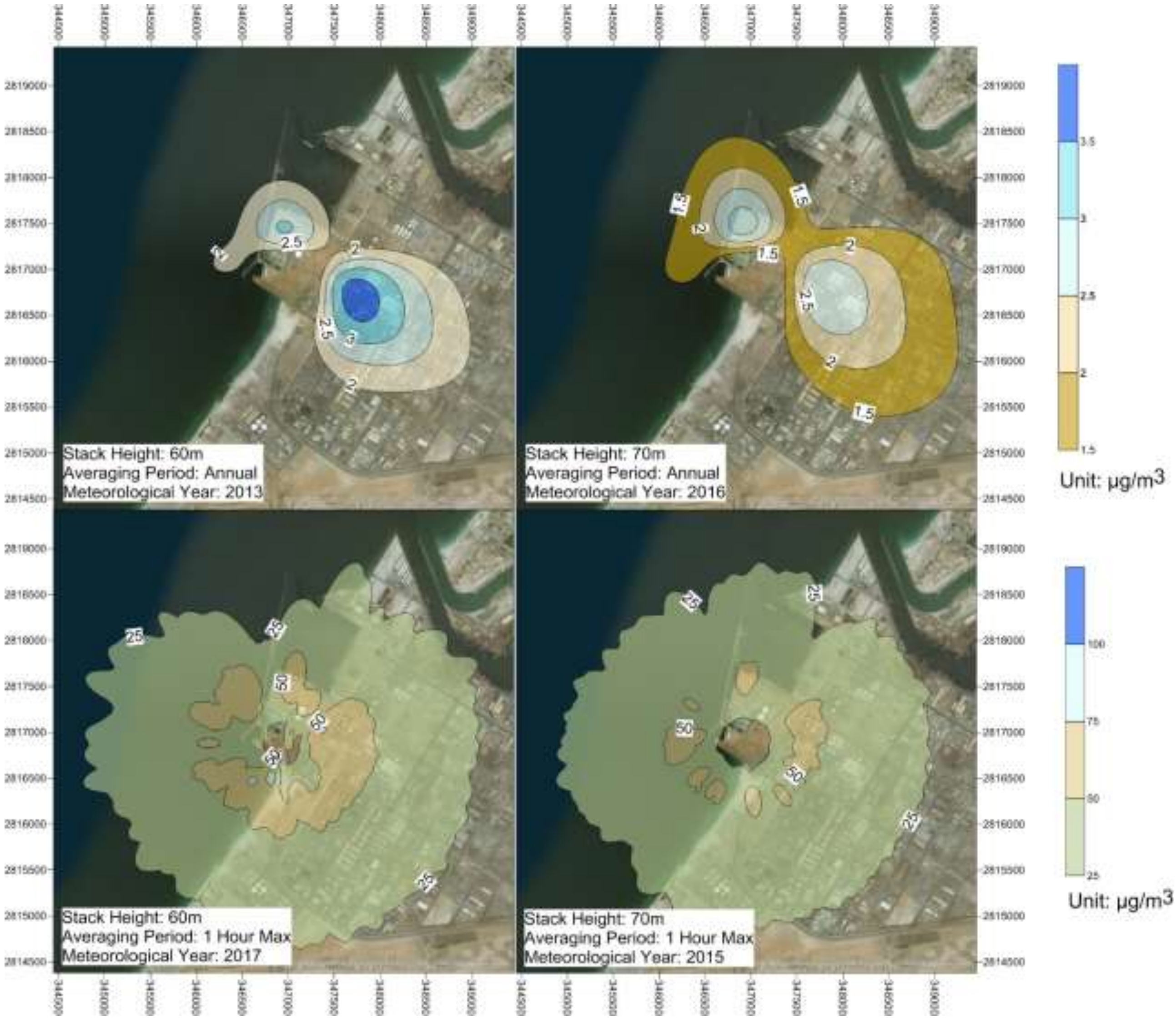
Averaging period	Process contribution per stack height		Ambient concentration	Predicted environmental concentration per stack height		UAE standards
	60m	70m		60m	70m	
1 hour max	127.0	60.6	49[(a)]	176.0	109.6	400.00
1 hour 99.79	64.1	49.0	49[(a)]	113.1	98.0	400.00
24 hour max	33.6	26.0	49[(a)]	82.6	75.0	150.00
annual	3.7	3.3	24.5	28.2	27.8	40 (WHO standard)
Note:	[(a)] The stations annual average NO_2 concentration is doubled under the precautionary principle to allow for comparison with other short-term averaged concentration data.					

Source: Mott MacDonald, 2018

Figure 96 presents contour plots for the one hour and annual mean process contributions for both 60m and 70m stack heights. The plots show that with a stack height of 60m the maximum one hour concentrations are limited to a very small area which is located over the sea where there would be no relevant human exposure.

Considering the air quality impacts, a stack height of 60m is considered appropriate.

Figure 96: One hour and annual mean contour plots



Source: Mott MacDonald

C.2.3.2 Main stack - fuel oil

Table 140 presents the results of all three units operating continuously all year on fuel oil and compares the maximum results from the modelled area for 60 and 70metres stack heights. Predicted annual mean concentrations have not been presented as fuel oil firing would only be used in emergency situation, and for testing purposes, and therefore would not occur for a period of a year or more.

The modelling with a 60m stack height demonstrates that, the maximum process contributions predicted based on five years of meteorological data is 280.1µg/m^3 which, is approximately 70% of the national standard and results in a predicted environmental concentration of 329.1µg/m^3 which below the national standards (Table 141). The 1-hour 99.79th percentile is considerably lower, with a process contribution of 134.2µg/m^3. This demonstrates that the highest one hour contributions are not expected to occur frequently and therefore the likelihood of fuel oil operation coinciding with the worst case meteorological conditions which would result in the highest process contributions occurring is unlikely.

The maximum 24-hour process contribution concentration is approximately 47% of the daily average standard although it is unlikely that the proposed project would operate for 24 consecutive hours of fuel oil firing unless there was an emergency situation with gas supply.

The modelling with a 70m stack height demonstrates that, the maximum process contributions predicted based on five years of meteorological data is 156.1µg/m^3 which, is approximately 39% of the national standard and results in a predicted environmental concentration of 205.1µg/m^3 (Table 141). The 1-hour 99.79th percentile is considerably lower, with a process contribution of 106.1µg/m^3 which, is approximately 27% of the national standard and results in a predicted environmental concentration of 155.1µg/m$^{3.}$

The maximum 24-hour process contribution concentration is approximately 38% of the daily average and as with the 60m stack height it is unlikely that the proposed project would operate for 24 consecutive hours of fuel oil firing unless there was an emergency situation with gas supply.

The predicted results for the 60 m and 70m stack heights do not change the conclusions when assessing the proposed project when firing on fuel oil and a 60m stack height is considered appropriate.

Table 141: Modelled Ground Level Contributions from the project – Scenario 2 (Fuel oil, 100% load)

Averaging period	Process contribution per stack height		Ambient concentration	Predicted environmental concentration per stack height		UAE standards
	60m	70m		60m	70m	
1 hour max	280.1	156.1	49$^{(a)}$	329.1	205.1	400.00
1 hour 99.79	134.2	106.1	49$^{(a)}$	183.2	155.1	400.00
24 hour max	71.3	57.1	49$^{(a)}$	120.3	106.1	150.00
Annual	7.1	6.3	24.5	31.6	30.8	40 (WHO standard)
Note:	$^{(a)}$ The stations annual average NO_2 concentration is doubled under the precautionary principle to allow for comparison with other short-term averaged concentration data.					

Source: Mott MacDonald, 2018

C.3 Conclusion

The stack height determination undertaken has demonstrated that main stack height of 60m and a by-pass stack of 45m are appropriate and allow effective dispersion of pollutants from the proposed project and don not result in exceedances of the national air quality standards.

D. Marine survey

D.1 Marine survey report

D.2 Images and videos (soft copy only)

E. Hydrodynamic modelling

F. Soil and groundwater contamination survey

G. Environmental and social management and monitoring plan (ESMMP) framework

H. Stakeholder engagement plan

I. Stakeholder consultation records

J. Stack height determination report

Glossary

ACW	**Auxiliary Cooling Water**
ADS	**Abu Dhabi specification**
AERMAP	**AERMOD Terrain Pre-processor**
AERMET	**General Purpose Meteorological Pre-processor for AERMOD**
AERMOD	**Atmospheric Dispersion Modelling System**
AM	**Ajman Municipality**
ANZECC	**Australian and New Zealand Environment Conservation Council**
BOOT	**Build, Own, Operate, Transfer**
BTEX	**Benzene, Toluene, Ethylbenzene and Xylene**
CBD	**Convention on Biological Diversity**
CCPP	**Combined Cycle Power Plant**
CCW	**Closed Cooling Water**
CESMMP	**Construction Environmental and Social Management and Monitoring Plan**
CFCs	**Chlorofluorocarbons**
CIfA	**Chartered Institute for Archaeologists**
CITES	**Convention on Wetlands of International Trade in Endangered Species of Wild Fauna and Flora**
CO	**Carbon Monoxide**
CO_2	**Carbon Dioxide**
COD	**Commercial Operation Date**
COSHH	**Control of Substances Hazardous to Health**

CRTN	**Calculation of Road Traffic Noise**
CTCs	**Carbon tetrachloride**
dB	**Decibel**
DCS	**Distributed Control System**
DLN	**Dry Low Oxides of Nitrogen**
DM-EPSS	**Dubai Municipality Environment and Planning Studies Section**
ECOD	**Early Commercial Operation Date**
EHS	**Environment, Health and Safety**
EIA	**Environmental Impact Assessment**
EP	**Equator Principles**
EPAA	**Environment and Protected Area Authority**
EPC	**Engineering Procurement Construction**
EPFIs	**Equator Principles' Financial Institutions**
ESIA	**Environmental and Social Impact Assessment**
ESMMP	**Environmental and Social Management and Monitoring Plan**
ESMS	**Environmental and Social Management System**
ETP	**Effluent Treatment Plant**
EU	**European Union**
EWS	**Emirates Wildlife Society**
EWS-WWF	**Emirates-Wildlife Society with World Wide Fund for Nature**
FEA	**Federal Environment Agency**
FSRU	**Floating Storage Regasification Unit**

GE	**General Electric Company**
GHGs	**Greenhouse Gases**
GIIP	**Good International Industry Practice**
GIS	**Geographic Information System**
GPS	**Global Positioning System**
GT	**Gas Turbine**
GW	**Gigawatt**
H_2S	**Hydrogen Sulphide**
HFO	**Heavy Fuel Oil**
HFZA	**Hamriyah Free Zone Authority**
HSSE	**Health, Safety, Security and Environment**
HRSG	**Heat Recovery Steam Generator**
HWPP	**Hamriyah Power and Water Plant**
IAQM	**Institute of Air Quality Management**
IEA	**International Energy Agency**
IFC	**International Finance Corporation**
IFC PSs	**International Finance Corporation Performance Standards**
ILO	**International Labour Organisation**
IPP	**Independent Power Plant**
ISO	**International Organisation for Standardisation**
IUCN	**International Union for Conservation of Nature**
JBIC	**Japan Bank for International Corporation**
KM	**Kilometre**

KWH	**Kilowatt per Hour**
LFO	**Low Fuel Oil**
LNG	**Liquefied Natural Gas**
LNTP	**Limited Notice to Proceed**
MCFs	**Methyl chloroform (MCF-only 1,1,1-trichloroethane)**
MCWS	**Man Cooling Water System**
MIGD	**Million Imperial Gallons Per Day**
MOCCE	**Ministry of Climate Change and Environment**
MOOPAM	**Manual of Oceanographic Observations and Pollutant Analysis Methods**
MPAs	**Marine Protected Areas**
MRF	**Material Recycling Facility**
MSDS	**Material Safety Data Sheets**
MW	**Megawatt**
MWh	**Megawatt Hour**
NCDC	**National Climatic Data Centre**
NDC	**Nationally Determined Contribution**
NECMA	**National Emergency and Crisis Management Authority**
NEXI	**Nippon Export and Investment Insurance**
NOAA	**National Oceanographic Atmospheric Administration**
NOC	**No Objection Certificate**
NO_x	**Oxides of Nitrogen**
NTP	**Notice To Proceed**
NTU	**Nephelometric Turbidity Units**

O&M	**Operations and Maintenance**
O_2	**Dioxygen**
OECD	**Organisation for Economic Co-operation and Development**
OESMMP	**Operation Environmental Social Management and Monitoring Plan**
OHS	**Operational Health and Safety**
PC	**Process Contribution**
PCB	**Polychlorinated Biphenyls**
PEC	**Predicted Environmental Concentrations**
PM	**Particulate Matter**
PPE	**Personal Protective Equipment**
RO	**Reverse Osmosis**
SEWA	**Sharjah Electricity and Water Authority**
SHMD	**Sharjah Halcrow Municipality Datum**
SIA	**Social Impact Assessment**
SM	**Sharjah Municipality**
SNOC	**Sharjah National Oil Corporation**
SO_2	**Sulphur Dioxide**
SRTA	**Sharjah Roads and Traffic Authority**
SSS	**Side Scan Sonar**
ST	**Steam Turbine**
SVOC	**Semi-volatile Organic Compounds**
SWMP	**Site Waste Management Plan**
TBC	**To be completed**

TDS	**Total Dissolved Solids**
TIC	**Tentatively Identified Compounds**
TMP	**Traffic Management Plan**
TPH	**Total Petroleum Hydrocarbons**
TPHCWG	**Total Petroleum Hydrocarbon Criteria Working Group**
TSP	**Total Suspended Particulates**
UAE	**United Arab Emirates**
UNFCCC	**United Nations Framework Convention on Climate Change**
US EPA	**United States Environmental Protection Agency**
VOCs	**Volatile Organic Compounds**
WHO	**World Health Organisation**
WMC	**Waste Management Centre**
WWF	**World Wide Fund for Nature**
ZoI	**Zone of Influence**

mottmac.com